10.1071/EN22057
Environmental Chemistry

Supplementary Material

Sulfur mass balance and speciation in the water cap during early-stage development in the first pilot pit lake in the Alberta Oil Sands

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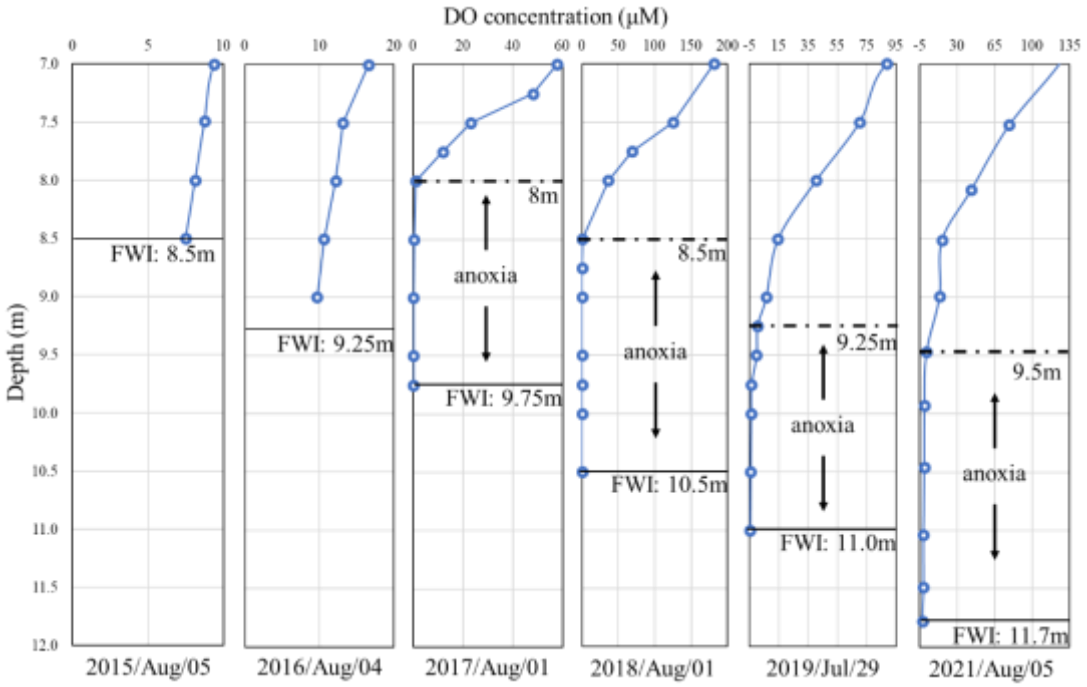
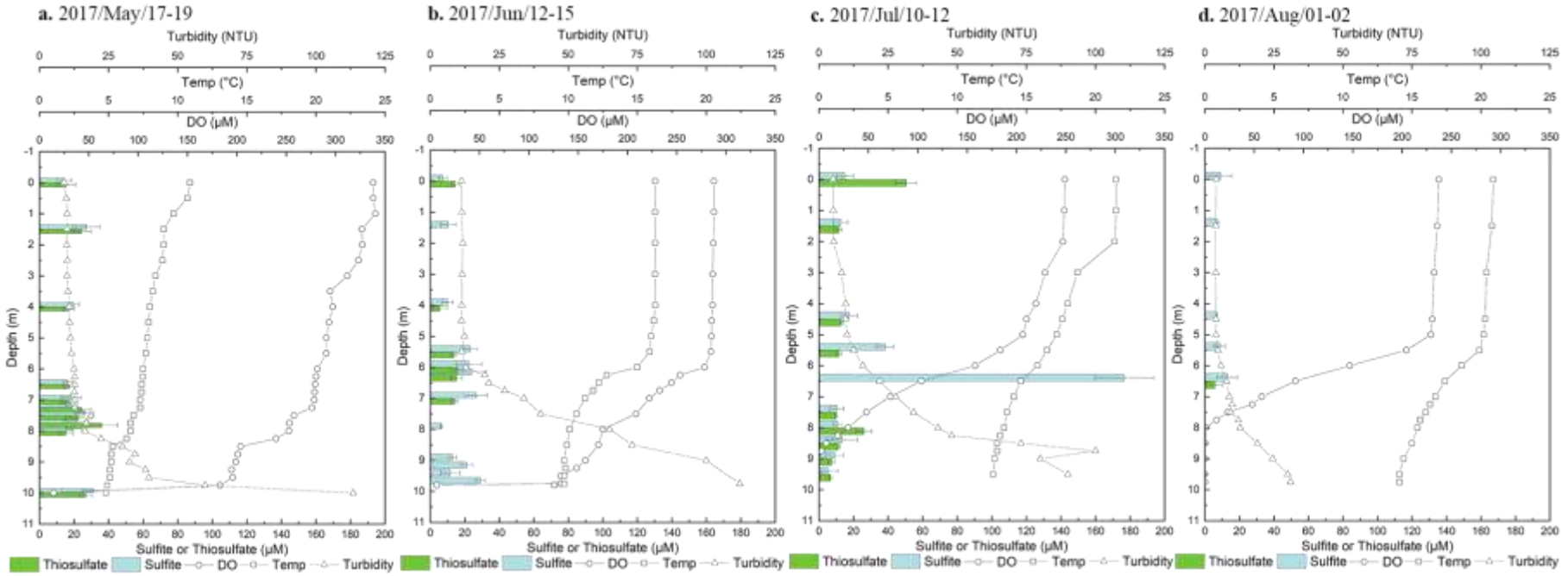
Supplementary



Supplementary Fig. 1. August BML water cap oxygen profiles from 2015-2019, 2021 for P1 identifying the increased depth of anoxia observed post alum addition.



Supplementary Fig. 2. P1 sulfite and thiosulfate concentration with oxygen, temperature, and turbidity profiles from May-Aug, 2017.

Supplementary Table 1. Detected ΣH_2S and S^0 in BML field samples (2015-2021)

Sample Time	Site	Depth (m)	Description	ΣH_2S (μM)		S^0 (μM)	
				mean	STD	mean	STD
2015/Aug/05	P1	8.5	FWI	3.4	1	0.0	0
2015/Aug/07	P3	8.5	FWI	3.3	0	0.0	0
2015/Aug/11	P3	8.5	FWI	1.1	0	0.0	0
2015/Aug/12	P2	10.0	FWI	1.4	0	0.0	0
2015/Aug/13	P2	10.0	FWI	2.0	0	0.0	0
2015/Aug/18	P1	8.5	FWI	2.5	0	0.0	0
2015/Aug/19	P1	8.5	FWI	1.6	0	0.0	0
2015/Sep/22	P2	10.5	FFT	184.9	47	11.3	0
2015/Sep/23	P3	9.0	FFT	14.4	0	0.0	0
2016/Jul/08	P1	9.8	FWI	2.2	0	--	
2016/Jul/21	P1	9.7	FWI	5.7	0	--	
2016/Aug/18	P1	9.0	FWI	4.6	0	--	
2016/Aug/24	P1	9.0	FWI	6.4	0	--	
2017/May/19	P1	9.9	FWI	1.0	0	--	
2017/Aug/01	P1	9.8	FWI	1.5	0	--	
2018/Aug/01	P1	9.8	0.7m above FWI	4.5	0	--	
2018/Aug/01	P1	10.5	FWI	9.2	0	--	
2019/May/29	P1	10.9	FWI	15.2	0	4.5	2
2019/Jul/09	P1	11.3	FWI	4.8	0	0.0	0
2019/Jul/10	P2	12.7	FWI	15.1	1	2.6	0
2019/Jul/29	P1	11.0	FWI	1.9	0	1.0	0
2019/Jul/30	P2	12.7	FWI	11.3	0	0.0	0
2020/Mar/09-10	P1	11.6	FWI	1.5	0	6.9	1
2020/Mar/11-12	P2	12.6	FWI	1.8	1	0.0	0
2021/Aug/05	P1	11.7	FWI	3.0	0	0.0	0
2021/Aug/12	P2	12.0	1.1m above FWI	1.9	0	0.0	0
2021/Aug/12	P2	12.5	0.6m above FWI	4.0	0	1.4	0
2021/Aug/12	P2	13.1	FWI	17.7	0	8.8	3

Supplementary Table 2. Summary of the concentration of measured sulfur species (SO_4^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, S^0, ΣH_2S), Total S, and calculated S_{react} along with meta data for samples (2015-2021, P1). (n.b., * denotes mailed bucket samples; "NA" denotes depth not collected or missing samples; "~depth (FWI)" denotes FFT Water Interface (FWI) samples with approximate depths; Top of the water column at the ice interface samples were assigned as "0m" for winter samples).

Sample Date	Depth (m)	ΣH_2S (μM)		S^0 (μM)		SO_3^{2-} (μM)		$S_2O_3^{2-}$ (μM)		Total S (μM)		SO_4^{2-} (μM)		S_{react} (μM)	
		mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
Jun/09/2015	1.5	<DL		NA		<DL		<DL		2239.6	8.5	1958.5	182.7	281.1	182.9
Jun/09/2015	4.75	<DL		NA		<DL		<DL		2256.6	11.3	1982.4	171.8	274.2	172.2
Jun/09/2015	8	<DL		NA		<DL		<DL		2249.5	2.1	2252.0	192.9	-2.5	192.9
Jun/22/2015	6	<DL		NA		5.9	4.9	9.4	1.4	2237.9	14.3	1570.0	45.2	667.9	47.4
Jun/22/2015	7	<DL		NA		58.3	2.0	27.9	0.6	2256.2	8.5	1519.1	50.4	737.1	51.1
Jun/25/2015	5	<DL		NA		8.8	4.1	8.1	1.6	2225.9	9.6	1602.6	141.8	623.3	142.1
Jun/25/2015	6	<DL		NA		<DL		<DL		2235.5	6.3	1534.4	75.4	701.1	75.7
Jun/25/2015	8	<DL		NA		5.7	4.9	10.9	8.5	2221.6	10.2	1510.9	68.1	710.8	68.9
Jul/02/2015	1.5	<DL		NA		NA		NA		2196.9	9.5	1537.3	27.9	659.6	29.5
Jul/02/2015	4	<DL		NA		NA		NA		2220.5	16.1	1587.0	28.3	633.5	32.6
Jul/02/2015	6	<DL		NA		NA		NA		2207.9	6.6	1545.3	81.9	662.6	82.2
Jul/08/2015	1.5	<DL		NA		NA		NA		2172.9	7.9	1398.2	73.1	774.7	73.5
Jul/08/2015	6	<DL		NA		NA		NA		2184.6	2.0	1395.4	46.9	789.2	47.0
Jul/08/2015	9	<DL		NA		NA		NA		2171.8	15.3	1846.0	415.1	325.8	415.4
Jul/16/2015	1.5	<DL		<DL		<DL		<DL		2149.9	8.9	1912.6	73.6	237.3	74.1
Jul/16/2015	4.5	<DL		<DL		<DL		<DL		2159.8	6.2	1990.1	140.2	169.7	140.4
Jul/16/2015	7.5	<DL		<DL		<DL		<DL		2165.2	4.9	1913.9	122.3	251.3	122.4
Jul/22/2015	1.5	<DL		<DL		98.0	0.9	6.6	0.6	2189.0	10.6	1869.4	146.7	319.6	147.1
Jul/22/2015	5.5	<DL		<DL		7.8	7.6	8.9	1.6	2189.1	8.1	1977.2	84.4	211.9	84.8
Jul/22/2015	8	<DL		<DL		10.6	2.3	<DL		2212.8	9.0	1956.8	133.8	256.0	134.1
Jul/28/2015	1.5	<DL		NA		NA		NA		2160.9	12.0	1277.4	290.8	883.5	291.1
Jul/28/2015	5.5	<DL		NA		NA		NA		2178.5	8.6	1995.3	30.5	183.2	31.7

Sample Date	Depth (m)	ΣH_2S (μM)		S^0 (μM)		SO_3^{2-} (μM)		$S_2O_3^{2-}$ (μM)		Total S (μM)		SO_4^{2-} (μM)		S_{react} (μM)	
		mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
Jul/28/2015	8	<DL		NA		NA		NA		2160.2	12.4	1954.2	64.0	206.0	65.2
Aug/05/2015	1.5	<DL		<DL		<DL		<DL		2148.2	28.4	1440.3	67.2	707.9	73.0
Aug/05/2015	5	<DL		<DL		<DL		<DL		2172.6	24.1	1435.0	75.8	737.6	79.6
Aug/05/2015	6	<DL		<DL		<DL		<DL		2178.9	27.7	1408.6	88.6	770.2	92.8
Aug/05/2015	8.5	3.4	1.2	<DL		<DL		<DL		2152.8	27.8	1335.4	66.0	817.4	71.6
Aug/18/2015	1.5	<DL		<DL		NA		NA		2098.9	11.1	1448.1	72.5	650.8	73.4
Aug/18/2015	6.5	<DL		<DL		NA		NA		2147.1	26.8	1464.6	72.0	682.5	76.9
Aug/18/2015	8.5	2.5	0.2	<DL		NA		NA		2129.2	29.7	1441.3	55.8	687.9	63.2
Aug/19/2015	1.5	<DL		<DL		NA		NA		2079.1	33.2	1920.8	0.0	158.3	33.2
Aug/19/2015	6.75	<DL		<DL		NA		NA		2079.3	46.4	1964.5	347.1	114.8	350.2
Aug/19/2015	8.5	1.6	0.1	<DL		NA		NA		2099.1	17.6	1788.2	123.9	310.9	125.1
Aug/20/2015	1.5	<DL		<DL		NA		NA		2131.5	17.0	1666.0	201.0	465.5	201.7
Aug/20/2015	7.25	<DL		<DL		NA		NA		2106.7	26.9	1631.7	2.8	475.0	27.0
Aug/20/2015	8.5	<DL		<DL		NA		NA		2054.1	14.8	1796.6	122.5	257.4	123.4
Jul/06/2016	0	<DL		NA		NA		NA		1864.3	9.1	1478.8	139.1	385.5	139.4
Jul/06/2016	1.5	<DL		NA		NA		NA		1815.1	16.3	1347.9	95.1	467.2	96.5
Jul/06/2016	4	<DL		NA		NA		NA		1842.4	9.5	1337.6	53.1	504.8	54.0
Jul/06/2016	7	<DL		NA		NA		NA		1898.0	4.3	1416.8	55.9	481.2	56.0
Jul/07/2016	7	<DL		NA		7.2	5.2	7.2	1.3	1855.2	20.6	1674.3	39.3	180.9	44.4
Jul/07/2016	8	<DL		NA		<DL		<DL		1835.7	17.8	1668.4	30.3	167.3	35.1
Jul/07/2016	8.5	<DL		NA		<DL		<DL		1855.0	10.0	1753.6	52.8	101.4	53.7
Jul/07/2016	9	<DL		NA		<DL		<DL		1993.4	35.1	1698.6	31.8	294.9	47.3
Jul/07/2016	9.25	<DL		NA		<DL		<DL		1979.9	5.2	1688.7	75.5	291.2	75.7
Jul/08/2016	8.75	<DL		NA		<DL		<DL		2001.9	38.7	1629.7	84.3	372.2	92.7
Jul/08/2016	9	<DL		NA		<DL		6.1	3.3	2002.0	18.1	1640.9	63.8	361.2	66.3

Sample Date	Depth (m)	ΣH_2S (μM)		S^0 (μM)		SO_3^{2-} (μM)		$S_2O_3^{2-}$ (μM)		Total S (μM)		SO_4^{2-} (μM)		S_{react} (μM)	
		mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
Jul/08/2016	9.25	<DL		NA		<DL		<DL		2012.9	16.4	1618.6	194.4	394.3	195.1
Jul/08/2016	9.5	<DL		NA		<DL		<DL		1974.4	14.8	1709.7	42.0	264.6	44.6
Jul/08/2016	FFT	2.2	0.0	NA		<DL		<DL		1949.9	17.4	1068.6	2.8	881.4	17.6
Jul/11/2016	6	<DL		NA		<DL		6.3	3.5	2044.0	33.3	1633.0	432.0	411.0	433.3
Jul/11/2016	6.25	<DL		NA		<DL		<DL		1996.2	19.7	1701.2	260.2	295.0	261.0
Jul/11/2016	6.5	<DL		NA		<DL		<DL		1988.9	37.0	1714.3	35.3	274.6	51.2
Jul/11/2016	6.75	<DL		NA		<DL		8.1	2.1	2015.9	34.7	1695.3	28.7	320.6	45.0
Jul/11/2016	7	<DL		NA		<DL		<DL		1988.2	35.1	1624.5	134.2	363.8	138.7
Jul/12/2016	7	<DL		NA		<DL		7.6	0.9	1990.2	7.2	1725.5	45.8	264.8	46.4
Jul/12/2016	7.25	<DL		NA		<DL		<DL		2001.0	6.9	1732.7	100.1	268.3	100.3
Jul/12/2016	7.5	<DL		NA		<DL		<DL		1993.7	5.5	1700.5	58.5	293.1	58.7
Jul/12/2016	7.75	<DL		NA		<DL		<DL		1970.7	16.9	1686.1	95.7	284.6	97.2
Jul/12/2016	8	<DL		NA		<DL		<DL		1950.0	16.1	1590.4	103.6	359.6	104.9
Jul/14/2016	0	<DL		NA		<DL		17.1	2.4	1957.8	19.3	1667.1	68.8	290.7	71.5
Jul/14/2016	1.5	<DL		NA		<DL		9.6	5.9	1915.0	7.5	1676.9	11.9	238.1	14.0
Jul/14/2016	4.25	<DL		NA		<DL		7.4	5.2	1937.5	13.5	1740.5	118.1	197.0	118.9
Jul/14/2016	5.75	<DL		NA		<DL		7.4	5.8	1906.2	3.5	1721.5	15.4	184.6	15.8
Jul/14/2016	7	<DL		NA		<DL		10.5	1.0	1939.9	24.6	1672.4	104.3	267.5	107.1
Jul/14/2016	8.5	<DL		NA		<DL		<DL		1925.4	8.5	1732.7	16.5	192.7	18.5
Jul/14/2016	~9.4 (FWI)	<DL		NA		<DL		<DL		1920.0	5.7	1662.5	51.1	257.5	51.5
Jul/14/2016	FFT	NA		NA		NA		NA		1875.3	14.6	NA	NA		
Jul/18/2016	0	<DL		NA		<DL		6.9	4.5	1984.2	5.2	1315.1	147.7	669.1	147.8
Jul/18/2016	1.5	<DL		NA		<DL		<DL		1953.0	27.6	1309.8	81.9	643.1	86.4
Jul/18/2016	4.75	<DL		NA		<DL		<DL		1969.2	21.1	1225.9	87.3	743.3	89.8
Jul/18/2016	5.5	<DL		NA		<DL		<DL		1995.7	25.1	1811.3	76.2	184.4	80.2

Sample Date	Depth (m)	ΣH_2S (μM)		S^0 (μM)		SO_3^{2-} (μM)		$S_2O_3^{2-}$ (μM)		Total S (μM)		SO_4^{2-} (μM)		S_{react} (μM)	
		mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
Jul/18/2016	7	<DL		NA		<DL		<DL		1951.3	11.7	1812.0	67.0	139.3	68.0
Jul/18/2016	8	<DL		NA		<DL		<DL		1937.6	24.4	1705.8	206.8	231.8	208.2
Jul/18/2016	9.25	<DL		NA		<DL		<DL		1887.8	9.8	1834.3	28.7	53.5	30.3
Jul/20/2016	7.5	<DL		NA		<DL		6.9	0.8	1950.6	28.5	1732.0	96.1	218.6	100.2
Jul/20/2016	7.75	<DL		NA		<DL		<DL		1944.8	15.7	1880.8	94.0	64.0	95.3
Jul/20/2016	8	<DL		NA		<DL		<DL		1971.1	29.5	1855.9	54.7	115.1	62.1
Jul/20/2016	8.25	<DL		NA		<DL		<DL		1952.3	42.3	1783.1	45.5	169.1	62.1
Jul/20/2016	8.5	<DL		NA		<DL		<DL		2003.0	58.7	1825.1	114.5	177.9	128.7
Jul/21/2016	8.5	<DL		NA		6.1	1.2	28.7	2.9	1959.6	22.5	1852.6	63.6	107.0	67.5
Jul/21/2016	8.75	<DL		NA		<DL		15.9	2.5	2009.6	38.5	1845.4	136.1	164.2	141.5
Jul/21/2016	9	<DL		NA		<DL		11.5	2.5	1973.5	14.0	1815.9	25.6	157.6	29.2
Jul/21/2016	9.25	<DL		NA		<DL		<DL		1977.8	19.0	1749.7	17.2	228.1	25.6
Jul/21/2016	9.7 (FFT)	5.7	0.2	NA		<DL		<DL		1932.8	20.9	1829.0	57.1	103.8	60.8
Jul/28/2016	0	<DL		NA		<DL		28.1	4.4	1938.5	2.5	1718.2	113.5	220.2	113.5
Jul/28/2016	1.5	<DL		NA		<DL		21.4	3.0	1928.6	15.2	1772.7	71.8	155.9	73.4
Jul/28/2016	5	<DL		NA		<DL		24.6	1.9	1948.0	39.1	1739.9	16.0	208.1	42.3
Jul/28/2016	5.75	<DL		NA		<DL		20.3	3.7	1988.8	4.9	1652.0	38.7	336.8	39.0
Jul/29/2016	5.75	<DL		NA		8.0	3.8	38.2	10.3	1965.7	50.2	1772.7	40.2	193.1	64.3
Jul/29/2016	6.5	<DL		NA		6.0	3.1	32.9	10.5	2088.9	7.0	2034.9	89.3	54.0	89.5
Jul/29/2016	8.5	<DL		NA		9.3	0.9	25.0	3.7	2060.4	41.4	1638.9	29.8	421.5	51.0
Jul/29/2016	9.25	<DL		NA		6.8	3.4	24.6	4.5	2009.6	22.8	1623.8	98.7	385.7	101.3
Aug/04/2016	0	<DL		NA		<DL		25.0	3.1	1885.0	9.0	1722.2	169.8	162.8	170.0
Aug/04/2016	1.5	<DL		NA		<DL		16.7	2.5	1924.1	51.5	1680.9	65.5	243.2	83.3
Aug/04/2016	4.5	<DL		NA		<DL		16.6	2.0	1888.3	34.3	1684.2	54.6	204.1	64.5
Aug/04/2016	6	<DL		NA		<DL		14.9	3.5	1967.3	40.3	1673.7	186.8	293.6	191.1

Sample Date	Depth (m)	ΣH_2S (μM)		S^0 (μM)		SO_3^{2-} (μM)		$S_2O_3^{2-}$ (μM)		Total S (μM)		SO_4^{2-} (μM)		S_{react} (μM)	
		mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
Aug/05/2016	6	<DL		NA		<DL		40.6	4.6	2016.6	35.6	1292.8	72.8	723.8	81.0
Aug/05/2016	6.5	<DL		NA		5.5	2.9	38.4	6.3	2002.5	30.6	1340.0	24.2	662.6	39.0
Aug/05/2016	7.5	<DL		NA		9.2	0.9	25.8	1.7	1966.5	16.0	1345.9	38.4	620.6	41.6
Aug/05/2016	~9.3 (FWI)	<DL		NA		<DL		11.3	1.5	1951.6	22.0	1318.3	179.0	633.3	180.3
Aug/12/2016	0	<DL		NA		<DL		18.4	3.7	1965.1	4.8	1234.4	93.4	730.7	93.5
Aug/12/2016	1.5	<DL		NA		<DL		17.0	4.1	1933.1	16.3	1739.9	211.2	193.2	211.8
Aug/12/2016	4.5	<DL		NA		<DL		13.5	2.6	1937.0	11.1	1399.0	193.2	538.0	193.5
Aug/12/2016	6	<DL		NA		<DL		8.2	1.4	1916.7	0.0	1968.3	20.9	-51.7	20.9
Aug/12/2016	7	<DL		NA		<DL		6.4	0.6	1944.4	8.7	1283.6	56.5	660.8	57.2
Aug/12/2016	8	<DL		NA		<DL		<DL		1922.2	7.8	1476.3	253.1	445.8	253.2
Aug/18/2016	0	<DL		NA		<DL		8.0	1.8	1980.2	12.3	1702.5	72.1	277.7	73.2
Aug/18/2016	1.5	<DL		NA		<DL		<DL		1964.5	19.7	1715.0	92.3	249.5	94.4
Aug/18/2016	4.25	<DL		NA		<DL		<DL		1996.3	29.8	1679.6	70.6	316.8	76.7
Aug/18/2016	4.75	<DL		NA		<DL		<DL		1971.2	6.0	1704.5	48.2	266.8	48.6
Aug/18/2016	5.5	<DL		NA		<DL		<DL		1986.3	15.6	1718.9	42.7	267.4	45.5
Aug/18/2016	7	<DL		NA		<DL		<DL		1941.3	36.6	1716.3	24.6	225.0	44.1
Aug/18/2016	9	4.6	0.2	NA		<DL		<DL		1949.3	37.6	1696.0	54.8	253.3	66.5
Aug/24/2016	0	<DL		NA		<DL		24.0	5.6	1929.5	68.0	1303.3	42.4	626.2	80.2
Aug/24/2016	1.5	<DL		NA		<DL		13.7	4.4	1879.6	7.1	1378.0	36.8	501.6	37.5
Aug/24/2016	6.25	<DL		NA		<DL		16.0	4.8	1842.7	40.1	1373.4	41.3	469.3	57.6
Aug/24/2016	7.5	<DL		NA		<DL		16.2	3.2	1827.8	24.7	1301.9	55.2	525.9	60.4
Aug/24/2016	9	6.4	0.4	NA		5.1	2.5	12.2	1.3	1776.9	23.3	1319.6	49.5	457.2	54.7
Sep/01/2016	5	<DL		NA		<DL		<DL		1796.7	28.5	1416.0	96.3	380.6	100.4
Sep/01/2016	9	<DL		NA		<DL		<DL		1755.5	43.2	1509.4	35.1	246.1	55.7
Sep/06/2016	5	NA		NA		<DL		7.7	1.4	1766.3	26.3	NA			

Sample Date	Depth (m)	ΣH_2S (µM)		S^0 (µM)		SO_3^{2-} (µM)		$S_2O_3^{2-}$ (µM)		Total S (µM)		SO_4^{2-} (µM)		S_{react} (µM)	
		mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
Sep/06/2016	9	<DL		NA		<DL		7.4	1.8	1771.5	0.0	NA			
Feb/14/2017	0.5 (ice bottom)	<DL		NA		10.2	6.1	<DL		2139.6	11.6	1901.1	115.7	238.5	116.3
Feb/14/2017	2	<DL		NA		7.7	7.6	<DL		2033.6	22.6	1962.1	66.3	71.4	70.0
Feb/14/2017	4.5	<DL		NA		11.8	5.7	<DL		2012.3	16.9	1962.8	54.3	49.5	56.9
Feb/14/2017	7	<DL		NA		7.2	5.2	<DL		1998.6	22.2	1927.4	33.5	71.3	40.2
Feb/14/2017	8	<DL		NA		8.9	7.8	<DL		2104.8	78.7	1928.7	57.8	176.1	97.6
Feb/15/2017	9	<DL		NA		9.5	6.8	<DL		1993.8	50.7	1909.7	16.7	84.1	53.4
Feb/15/2017	~9.5 (FWI)	<DL		NA		13.3	14.5	<DL		1963.8	24.0	1902.5	13.8	61.3	27.7
May/17/2017	0	<DL		NA		14.6	4.0	15.5	5.5	1930.4	20.8	1396.4	94.2	534.0	96.5
May/17/2017	1.5	<DL		NA		27.5	7.9	24.3	5.6	1946.7	13.8	1422.6	87.6	524.1	88.7
May/17/2017	6.5	<DL		NA		16.5	2.7	17.3	3.1	1938.5	12.0	2046.7	8.2	-108.2	14.5
May/17/2017	7.5	<DL		NA		26.2	5.5	22.8	7.4	1906.2	4.6	2002.1	89.8	-95.9	89.9
May/18/2017	7	<DL		NA		18.7	5.8	17.0	4.4	1876.2	23.2	1970.6	127.0	-94.4	129.1
May/18/2017	7.25	<DL		NA		18.6	3.7	24.6	5.3	1915.6	14.3	1971.3	52.8	-55.7	54.7
May/18/2017	7.5	<DL		NA		15.7	8.2	16.1	1.2	1900.1	3.5	1940.5	64.3	-40.4	64.4
May/18/2017	7.75	<DL		NA		21.6	7.0	36.1	9.2	1882.4	10.9	NA			
May/18/2017	8	<DL		NA		19.7	4.3	15.3	4.3	1930.8	63.0	1920.8	97.6	10.0	116.2
May/18/2017	~9.9 (FWI)	<DL		NA		31.1	5.8	28.0	4.4	1878.7	59.1	2003.4	49.2	-124.7	76.9
May/19/2017	4	<DL		NA		19.9	3.1	17.2	3.2	1870.9	13.2	1475.0	66.0	395.9	67.3
May/19/2017	~9.9 (FWI)	1.0	0.0	NA		30.5	6.1	33.9	3.1	1879.6	28.0	1928.7	35.2	-49.1	45.0
Jun/12/2017	0	<DL		NA		7.5	2.3	14.4	2.5	1878.5	9.6	2628.8	102.4	-750.4	102.8
Jun/12/2017	1.5	<DL		NA		10.6	4.4	<DL		1855.1	45.8	2427.6	27.3	-572.5	53.4
Jun/12/2017	4	<DL		NA		10.1	3.1	5.7	4.4	1803.1	26.6	2208.3	40.3	-405.2	48.3
Jun/13/2017	5.5	<DL		NA		23.3	4.2	13.9	1.4	1828.8	14.4	2266.3	111.3	-437.5	112.2
Jun/13/2017	6	<DL		NA		22.6	7.2	15.7	4.0	1923.7	18.1	2379.7	15.9	-456.0	24.1

Sample Date	Depth (m)	ΣH_2S (μM)		S^0 (μM)		SO_3^{2-} (μM)		$S_2O_3^{2-}$ (μM)		Total S (μM)		SO_4^{2-} (μM)		S_{react} (μM)	
		mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
Jun/13/2017	6.25	<DL		NA		24.0	8.4	15.4	3.2	1905.5	9.9	2388.2	373.7	-482.7	373.9
Jun/13/2017	7	<DL		NA		26.8	6.3	14.0	1.9	1915.0	1.7	1567.1	96.0	347.9	96.0
Jun/14/2017	8	<DL		NA		6.4	0.4	<DL		1905.0	41.6	1781.2	205.2	123.9	209.3
Jun/14/2017	9.5	<DL		NA		11.7	5.6	<DL		1917.3	20.9	1848.0	264.1	69.3	264.9
Jun/15/2017	9	<DL		NA		12.9	2.3	<DL		1905.3	1.6	1443.6	50.0	461.8	50.0
Jun/15/2017	9.25	<DL		NA		21.2	3.4	<DL		1899.9	21.3	1863.1	233.0	36.7	234.0
Jun/15/2017	9.75	<DL		NA		29.0	2.9	<DL		1872.6	39.7	1532.1	170.1	340.5	174.7
Jun/15/2017	FFT	NA	NA	NA		NA		NA		NA		1017.4	0.0		
Jul/10/2017	4.5	<DL		NA		17.7	4.8	13.1	1.1	1904.7	13.5	1788.5	67.5	116.2	68.8
Jul/11/2017	0	<DL		NA		15.0	5.1	50.6	6.1	1913.0	1.0	1815.3	87.5	97.7	87.5
Jul/11/2017	1.5	<DL		NA		12.6	4.2	11.8	1.5	1913.8	2.4	2057.3	0.0	-143.5	2.4
Jul/11/2017	6.5	<DL		NA		176.9	17.1	0.0	0.0	1893.2	66.5	1783.0	109.6	110.1	128.2
Jul/11/2017	8	<DL		NA		10.9	2.6	26.1	4.7	1858.5	16.0	1781.4	121.3	77.1	122.4
Jul/12/2017	5.5	<DL		NA		38.5	4.9	11.6	1.4	1889.6	8.1	1842.4	25.0	47.2	26.3
Jul/12/2017	7.5	<DL		NA		10.4	4.1	9.9	0.8	1922.2	15.3	1772.8	43.6	149.4	46.2
Jul/12/2017	8.5	<DL		NA		13.3	9.3	11.3	0.9	1854.7	50.8	1836.0	103.1	18.7	114.9
Jul/12/2017	9	<DL		NA		9.0	5.1	7.4	1.8	1891.8	7.8	1789.3	96.9	102.5	97.2
Jul/12/2017	9.5	<DL		NA		5.2	6.0	6.8	1.1	1821.5	35.8	1865.2	44.7	-43.8	57.3
Aug/01/2017	7.5	<DL		NA		<DL		<DL		1962.6	30.4	1868.4	91.0	94.2	95.9
Aug/01/2017	7.75	<DL		NA		<DL		<DL		1930.7	0.0	1718.7	427.1	212.0	427.1
Aug/01/2017	8	<DL		NA		<DL		<DL		1965.0	2.5	1962.8	82.7	2.2	82.8
Aug/01/2017	9.75	1.5	0.4	NA		<DL		<DL		1945.3	26.3	1950.5	167.2	-5.2	169.2
Aug/02/2017	0	<DL		NA		9.1	6.5	<DL		1922.5	22.3	1985.4	88.2	-62.9	91.0
Aug/02/2017	1.5	<DL		NA		7.3	1.0	<DL		1838.4	4.1	2031.1	169.0	-192.7	169.1
Aug/02/2017	4.5	<DL		NA		6.8	0.4	<DL		1861.4	26.6	1966.5	163.7	-105.2	165.9

Sample Date	Depth (m)	ΣH_2S (μM)		S^0 (μM)		SO_3^{2-} (μM)		$S_2O_3^{2-}$ (μM)		Total S (μM)		SO_4^{2-} (μM)		S_{react} (μM)	
		mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
Aug/02/2017	5.5	<DL		NA		8.7	3.2	<DL		1920.3	44.9	2036.1	178.5	-115.8	184.1
Aug/02/2017	6.5	<DL		NA		13.0	6.1	5.9	4.6	1942.4	34.6	1969.6	142.8	-27.2	146.9
Sep/19/2017	0	<DL		NA		9.2	0.9	<DL		NA		1758.1	171.9		
Sep/19/2017	1.5	<DL		NA		13.8	2.7	14.6	2.8	1839.6	62.8	1827.8	139.8	11.9	153.2
Sep/19/2017	9.75	<DL		NA		9.6	1.2	<DL		1887.5	31.1	1605.5	109.4	282.0	113.7
Oct/23/2017	0	<DL		NA		<DL		<DL		2065.1	30.3	1705.8	44.8	359.3	54.1
Oct/23/2017	1.5	<DL		NA		<DL		<DL		2012.0	24.0	1689.1	176.4	322.9	178.0
Oct/23/2017	5	<DL		NA		<DL		<DL		2009.3	40.0	1706.2	131.3	303.1	137.3
Oct/23/2017	7.5	<DL		NA		<DL		<DL		1984.3	16.6	1690.3	56.6	294.1	59.0
Oct/23/2017	9.75	<DL		NA		7.6	2.9	<DL		2055.3	51.5	1763.3	80.0	292.0	95.1
Feb/13/2018	0.5 (ice bottom)	<DL		NA		10.6	1.9	<DL		1936.4	0.0	1678.5	131.2	257.9	131.2
Feb/13/2018	2	<DL		NA		<DL		<DL		2052.4	0.0	1611.9	188.0	440.5	188.0
Feb/13/2018	5	<DL		NA		<DL		<DL		1997.4	0.0	1730.7	71.4	266.7	71.4
Feb/13/2018	6.5	<DL		NA		<DL		<DL		2033.4	0.0	1746.0	152.8	287.4	152.8
Feb/13/2018	8	<DL		NA		<DL		<DL		2042.1	0.0	1767.8	73.0	274.3	73.0
Feb/13/2018	9.5	<DL		NA		6.1	6.0	<DL		1979.1	0.0	1726.0	218.6	253.1	218.6
Feb/13/2018	10	<DL		NA		9.2	5.6	<DL		1880.9	0.0	1867.2	374.1	13.7	374.1
Mar/06/2018	0.7 (ice bottom)	<DL		NA		<DL		<DL		NA		1531.1	93.5		
Mar/06/2018	2	<DL		NA		<DL		<DL		NA		1723.8	75.8		
Mar/06/2018	5	<DL		NA		<DL		<DL		NA		1714.2	37.8		
Mar/06/2018	7.5	<DL		NA		<DL		<DL		NA		1706.5	165.1		
Mar/06/2018	8.5	<DL		NA		<DL		<DL		NA		1655.4	105.8		
Mar/06/2018	9	<DL		NA		<DL		<DL		NA		1667.7	135.8		
Mar/06/2018	10	<DL		NA		<DL		<DL		NA		1737.0	129.1		
May/16/2018	0	<DL		NA		<DL		<DL		1970.5	28.3	1696.5	108.0	274.0	111.7

Sample Date	Depth (m)	ΣH_2S (μM)		S^0 (μM)		SO_3^{2-} (μM)		$S_2O_3^{2-}$ (μM)		Total S (μM)		SO_4^{2-} (μM)		S_{react} (μM)	
		mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
May/16/2018	1.5	<DL		NA		<DL		6.6	0.8	1973.1	42.3	1689.1	69.2	284.1	81.1
May/16/2018	4.5	<DL		NA		<DL		8.6	0.3	2012.4	31.7	1687.6	36.5	324.8	48.4
May/16/2018	7	<DL		NA		7.0	0.4	14.0	0.6	1982.5	12.0	1713.6	76.3	268.9	77.2
May/16/2018	8.5	<DL		NA		<DL		<DL		1838.0	44.8	1700.3	96.1	137.8	106.0
May/15/2018	10	<DL		NA		<DL		<DL		1845.8	22.0	1651.5	74.8	194.3	78.0
Jun/26/2018	1.5	<DL		NA		<DL		9.3	1.2	1851.3	9.7	NA			
Jun/26/2018	4.5	<DL		NA		<DL		<DL		1850.7	40.8	1371.9	68.1	478.8	79.4
Jun/26/2018	7.5	<DL		NA		<DL		<DL		1798.7	13.2	1652.6	201.3	146.1	201.7
Jun/27/2018	8.5	<DL		NA		<DL		<DL		1813.6	29.2	1475.2	71.8	338.4	77.5
Jun/28/2018	9	<DL		NA		6.1	5.7	17.6	3.4	1839.8	74.6	1437.8	124.3	402.0	145.0
Jun/27/2018	9.5	<DL		NA		<DL		<DL		1835.1	40.5	1570.6	48.3	264.5	63.0
Jun/27/2018	10	<DL		NA		<DL		<DL		1823.2	45.9	1519.9	87.0	303.4	98.4
Jul/31/2018	0	<DL		NA		<DL		<DL		1801.8	27.2	1549.3	72.1	252.5	77.1
Jul/31/2018	1.5	<DL		NA		<DL		<DL		1711.2	19.6	1555.1	41.6	156.1	46.0
Jul/31/2018	4.5	<DL		NA		<DL		<DL		1746.0	3.0	1539.1	33.6	206.9	33.8
Jul/31/2018	7.5	<DL		NA		<DL		<DL		1768.7	52.3	1579.7	54.8	189.0	75.7
Aug/01/2018	8.75	<DL		NA		20.6	4.1	14.8	2.8	1821.9	80.1	1579.3	56.6	242.6	98.1
Aug/01/2018	9.75	4.5	0.0	NA		20.7	2.2	33.4	8.4	1794.7	44.2	1564.6	105.1	230.0	114.0
Aug/01/2018	10.5	9.2	0.0	NA		16.4	1.7	40.0	7.2	1899.0	83.2	1527.3	51.6	371.8	97.8
Aug/02/2018	9.5	<DL		NA		NA		NA		NA					
May/29/2019	0.5	<DL		<DL		17.3	0.9	20.1	1.2	1761.1	82.2	1715.7	49.6	45.3	96.0
May/28/2019	1.5	<DL		<DL		17.8	2.2	20.0	1.6	1695.8	17.2	1746.1	53.2	-50.3	55.9
May/29/2019	5	<DL		<DL		18.6	2.6	20.4	1.1	1694.7	3.1	1746.8	43.7	-52.1	43.8
May/29/2019	9	<DL		<DL		20.7	0.5	19.5	0.6	1769.8	11.8	1665.4	7.3	104.4	13.9
May/29/2019	10.6	<DL		<DL		20.9	1.8	21.3	1.0	1743.9	10.8	1651.4	48.0	92.5	49.2

Sample Date	Depth (m)	ΣH_2S (µM)		S^0 (µM)		SO_3^{2-} (µM)		$S_2O_3^{2-}$ (µM)		Total S (µM)		SO_4^{2-} (µM)		S_{react} (µM)	
		mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
May/29/2019	~10.9 (FWI)	15.2	0.3	4.5	1.5	21.6	0.9	20.5	1.5	1730.6	0.0	1622.9	80.1	107.7	80.1
Jul/09/2019	0.5	<DL		<DL		41.2	1.3	175.6	3.1	1720.3	14.4	1702.5	54.5	17.8	56.4
Jul/09/2019	7.5	<DL		<DL		50.4	3.8	80.6	13.2	1727.6	5.3	1681.7	73.0	45.9	73.2
Jul/09/2019	8	<DL		<DL		14.5	2.8	35.1	0.5	1722.1	4.3	1744.4	81.8	-22.4	81.9
Jul/09/2019	11	<DL		<DL		12.7	0.9	27.4	3.7	1717.2	7.1	1759.1	75.1	-41.9	75.5
Jul/09/2019	~11.25 (FWI)	4.8	0.0	<DL		12.4	1.2	28.1	5.6	1709.1	6.7	1768.9	72.8	-59.8	73.1
Jul/29/2019	0.5	<DL		<DL		<DL		<DL		1756.0	21.5	1699.3	42.9	56.7	48.0
Jul/29/2019	9	<DL		<DL		6.4	1.2	26.1	3.8	1732.1	6.7	1683.1	49.1	49.0	49.5
Jul/29/2019	9.5	<DL		<DL		<DL		11.8	3.7	1740.0	23.8	1650.6	32.5	89.4	40.3
Jul/29/2019	10	<DL		<DL		<DL		13.6	1.3	1735.3	9.0	1622.6	81.8	112.7	82.3
Jul/29/2019	~11.06 (FWI)	1.9	0.1	1.0	0.1	15.6	0.8	10.8	1.7	1749.0	36.7	1632.9	27.4	116.0	45.8
Feb/11/2020	0.5 (ice bottom)	<DL		<DL		<DL		<DL		1741.5	7.7	1603.4	79.7	138.0	80.1
Feb/11/2020	~11.5m (FWI)	<DL		<DL		<DL		<DL		1670.8	22.2	1482.1	11.7	188.7	25.1
Mar/09-10/2020	0.5 (ice bottom)	<DL		<DL		<DL		<DL		1811.5	9.4	1710.9	36.9	100.5	38.1
Mar/09-10/2020	5	<DL		<DL		<DL		<DL		1789.1	16.8	1636.7	0.9	152.4	16.8
Mar/09-10/2020	8.5	<DL		<DL		<DL		<DL		1765.2	73.5	1712.5	39.9	52.7	83.6
Mar/09-10/2020	9.5	<DL		<DL		<DL		<DL		1708.7	69.3	1796.4	2.9	-87.7	69.4
Mar/09-10/2020	10.5	<DL		<DL		<DL		<DL		1723.0	21.6	1634.6	29.6	88.4	36.7
Mar/09-10/2020	11	<DL		<DL		<DL		<DL		1669.8	8.0	1608.2	8.7	61.7	11.8
Mar/09-10/2020	11.5	<DL		<DL		<DL		<DL		1704.4	47.4	1534.0	36.1	170.4	59.6
Mar/09-10/2020	~11.6 (FWI)	1.5	0.1	6.9	1.3	<DL		<DL		1692.1	6.3	1552.8	50.8	139.3	51.2
Aug/31/2020*	6.5	<DL		<DL		<DL		<DL		1597.7	1.6	1527.4	58.6	70.2	58.7
Aug/31/2020*	FWI	<DL		<DL		<DL		<DL		1564.9	6.3	1569.0	44.5	-4.0	45.0
Oct/20/2020*	11	<DL		<DL		14.4	3.6	<DL		NA		1419.7	30.4		
Feb/23/2021*	10	<DL		<DL		<DL		5.9	0.1	1747.2	13.4	1506.9	21.4	240.3	25.3

Sample Date	Depth (m)	ΣH_2S (μM)		S^0 (μM)		SO_3^{2-} (μM)		$S_2O_3^{2-}$ (μM)		Total S (μM)		SO_4^{2-} (μM)		S_{react} (μM)	
		mean	std	mean	std	mean	std	mean	std	mean	std	mean	std	mean	std
Feb/23/2021*	11	<DL		<DL		16.5	2.6	5.7	0.4	1740.9	5.3	1497.7	15.7	243.2	16.5
Feb/24/2021*	~11.6 (FWI)	<DL		<DL		23.1	0.2	<DL		1708.3	13.0	1462.4	5.8	245.9	14.3
Jul/06-08/2021*	0.5	<DL		<DL		<DL		<DL		1810.0	9.2	1451.7	15.2	358.3	17.8
Jul/06-08/2021*	5	<DL		<DL		<DL		<DL		1782.1	7.2	1439.6	5.5	342.4	9.1
Jul/06-08/2021*	11	<DL		<DL		<DL		<DL		1767.7	19.8	1400.5	3.4	367.3	20.1
Jul/06-08/2021*	11.8	<DL		<DL		<DL		<DL		1772.4	13.4	1415.8	4.4	356.5	14.1
Jul/20/2021*	0.5	<DL		<DL		<DL		23.9	0.7	1785.7	5.8	1450.4	16.2	335.3	17.2
Jul/20/2021*	5	<DL		<DL		<DL		12.5	0.7	1790.9	4.9	1468.2	38.0	322.8	38.3
Jul/20/2021*	7.5	<DL		<DL		<DL		22.5	0.1	1754.4	5.2	1420.0	26.0	334.4	26.5
Jul/20/2021*	10	<DL		<DL		<DL		12.5	0.6	1743.9	7.4	1414.3	17.6	329.5	19.1
Jul/20/2021*	11	<DL		<DL		<DL		13.1	1.5	1737.2	6.9	1403.0	31.1	334.2	31.9
Jul/20/2021*	11.5	<DL		<DL		<DL		25.9	2.5	1655.8	4.8	1394.9	22.0	260.9	22.6
Jul/20/2021*	11.7	<DL		<DL		<DL		22.6	0.2	1654.4	5.5	1395.4	33.6	259.0	34.1
Aug/05/2021	0.5	<DL		<DL		<DL		13.4	1.4	1675.0	21.3	1440.3	28.2	234.7	35.3
Aug/05/2021	3.5	<DL		<DL		<DL		8.6	0.2	1671.2	6.1	1466.5	19.5	204.7	20.5
Aug/05/2021	5.5	<DL		<DL		6.3	0.3	8.1	2.0	1739.2	4.0	1455.8	27.3	283.4	27.6
Aug/05/2021	7.5	<DL		<DL		9.1	0.6	<DL		1732.7	10.7	1443.8	30.8	288.9	32.6
Aug/05/2021	9.5	<DL		<DL		7.7	0.1	<DL		1709.2	6.0	1399.9	51.0	309.2	51.3
Aug/05/2021	11.5	<DL		<DL		10.7	0.7	<DL	3.1	1718.1	8.0	1398.0	16.3	320.1	18.1
Aug/05/2021	~11.7(FWI)	3.0	0.2	<DL		6.3	0.2	6.0	0.4	1713.1	2.6	1426.1	21.3	287.0	21.5
Oct/19/2021*	9	<DL		<DL		<DL		<DL		1694.2	8.5	1532.0	15.8	162.2	18.0
Oct/19/2021*	~11.7(FWI)	<DL		<DL		<DL		<DL		1708.2	12.1	1513.7	28.3	194.4	30.8