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Environmental Standards Division

BRADY ROAD RESOURCE MANAGEMENT FACILITY
ANNUAL REPORT - 2019

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BRADY ROAD RESOURCE MANAGEMENT FACILITY ANNUAL REPORT – 2019

EXECUTIVE SUMMARY

The Brady Road Resource Management Facility (BRRMF) is the City of Winnipeg's only active landfill. The site is bordered by the Perimeter Highway on the North, Waverley Street on the East, Brady Road and the R.M. of Macdonald on the West, and Rue des Trappistes on the South. The landfill has been in operation since 1973 and is estimated to have sufficient capacity for approximately 100 years, assuming current waste diversion practices are continued.

Environment Act Licence No. 3081 R, issued on April 23, 2014, requires the City of Winnipeg to submit an annual report on or before April 15th, detailing activities conducted at BRRMF in the previous year. This report provides a summary of major expenditures and construction, major incidents, waste diversion operations, ground water management, surface water management, leachate management, landfill gas management, and nuisance management for 2019.

Major construction in 2019 included: completion of the centralized leachate collection system, completion of the lime mud berm, and construction of a new waste cell.

One incident occurred at the site in 2019; the event was reported to an Environment Officer as required. In 2019, the BRRMF received 38 odour complaints; in all cases the customer was contacted for follow-up and corrective actions were taken as necessary.

In 2019, approximately 50% of the 637,422 metric tonnes of material received at the BRRMF were beneficially re-used, composted, or removed from the site for further processing or beneficial re-use. In addition, 36,763 kL of leachate was hauled to the North End Sewage Treatment Plant for treatment.

Monitoring programs for leachate, ground water, surface water, and subsurface gas migration followed the sampling and analysis plans in 2019 and contingency plans were not activated. Following a malfunction in the centralized leachate collection system, the leachate in Cell 31 exceeded the maximum head level for about 30 days until we were able to implement a contingency mitigation plan, which was not part of our original licence submittal.

Statistical analyses of analytical results obtained for leachate, ground water, and surface water indicate that the BRRMF has not had a negative impact on the ground water and surface water downstream of the site.

BRADY ROAD RESOURCE MANAGEMENT FACILITY ANNUAL REPORT – 2019

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1.0 INTRODUCTION

The Brady Road Resource Management Facility (BRRMF) site is located south of the Perimeter Highway, between Brady Road and Waverley Street. Residential land use is present within 500 m of the site to the east and within 120 m north of the site (Waverly West development), other surrounding land use is agricultural. Opened in 1973, the 790-hectare, Class 1 Solid Waste Disposal facility currently holds approximately 10 million metric tonnes of waste, with over 300,000 metric tonnes of waste materials landfilled on an annual basis. The site has capacity for approximately 100 additional years of waste disposal.

The BRRMF operates in accordance with Environment Act Licence No. 3081 R, which was issued on April 23, 2014. Clause 127 of the license requires the City of Winnipeg to prepare and submit an Annual Report on the activities undertaken at the site during the previous year on or before April 15th of each year. This report contains results and/or comments for each of the clauses of Licence No. 3081 R under which the BRRMF has generated pertinent information during 2019. The report also provides information on the BRRMF proposed activities for 2020.

The layouts of the primary components of the BRRMF are shown on Figure 1. Surface water flows are managed by perimeter ditching and retention ponds. The ground water monitoring well network includes 13 bedrock wells, 13 till wells, and 8 clay wells. The leachate collection system is a network of manholes/risers, drains, and sumps around the perimeter of the landfill cells, which feed into a centralized collection tank/truck fill station. The landfill gas (LFG) management system includes extraction wells, LFG collection piping, and a blower/enclosed flare station.

2.0 MAJOR ACTIVITIES AND CONSTRUCTION

Major activities and construction undertaken in 2019 included:

- Construction of a new waste cell (Cell 32)
- Completion of the centralized leachate collection system: incorporated pumping manholes into the centralized above ground leachate tank
- Completion of the lime mud berm

Major activities and construction planned for 2020 include:

- Expanding the landfill gas collection system for Cell 30
- Accepting organic waste from a curb side collection pilot program from approximately 4000 homes across five collection routes

3.0 MAJOR INCIDENTS

In 2019, there were no disruptions or failures of waste management practices due to equipment breakdown, no major spills occurred, and no alarms were activated.

In April 2019, the main pump in the centralized leachate collection system failed, causing the main discharge line into the collection tank to be severed. While the centralized system was shut down for repairs, leachate was manually pumped out of the eight pumping manholes. Cell 31 is not connected to a pumping manhole, as a result, leachate rose above the crown of the collection system piping for approximately 30 days until a new pump and an interim pipe made of composite steel could be installed. Once stainless steel pipe can be procured and installed, the composite steel pipe will be kept on hand as a backup should a failure occur again in the future. Going forward, the leachate collection system for new waste cells will be built to accommodate a large hydraulic pump to be used for emergency pumping directly into a tanker truck if needed.

The incident was reported to Manitoba Sustainable Development; the Incident report is provided in Appendix A.

4.0 WASTE DIVERSION OPERATIONS

In 2019, 637,422 metric tonnes of material were received at the BRRMF: 308,999 metric tonnes were composted or re-used on-site, 8,181 metric tonnes were removed from the BRRMF for further processing or beneficial re-use, and 320,242 metric tonnes were landfilled. This translates to a diversion rate of 50%, which is a decrease from the 2018 diversion rate of 52%.

The amount of material landfilled decreased in 2019 because biosolids continued to be diverted from the landfill to a soil fabrication pilot project and a land application pilot project. There was a decrease in the amount of clean fill received in 2019, and there was a decrease in the amount of City compost removed from the site. In 2020, the BRRMF will compost organic materials as part of the curbside collection pilot program.

A summary of the BRRMF Waste Diversion Operations is provided in Table 1, the 2019 BRRMF Tonnage Spreadsheet is provided in Appendix B.

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Table 1. 2019 BRRMF
Waste Diversion Summary

	2015	2016	2017	2018	2019
Total Materials Received (a) = (b) + (c) + (d)	**460,506**	**434,403**	**658,871**	**682,779**	**637,422**
Materials Landfilled					
Biosolids	44,717	44,652	42,397	33,030	20,365
Residential Waste Collection	177,846	174,280	172,209	172,041	174,050
Miscellaneous Wastes (dead animals, asbestos, hospital waste, costruction/demolition waste, etc…)	144,205	96,834	93,851	88,813	93,621
Wastes from 4R Depots	n/a	15,872	12,806	12,175	12,883
Wastes from City Operations (street cleaning refuse, grit, non-recyclables from recycling facility, etc…)	19,611	20,878	23,595	20,864	19,323
Wastes from Other Municipalities	3,594	4,729	3,505	20	0
Total Landfilled (b)	**389,974**	**357,246**	**348,364**	**326,942**	**320,242**
Materials Composted or Reused On Site					
Biosolids	3,939	1,899	4,942	1,541	1,916
Ceramic	n/a	164	245	296	331
Clean Fill	4,957	6,198	247,852	281,546	252,113
Compostable Materials (retention pond dredgings, street leaves, leaf and yard waste)	33,475	34,726	28,532	33,041	31,525
Concrete	362	1,338	2,801	5,187	6,565
Glass	9,339	11,534	11,181	12,338	10,965
Lumber	n/a	187	185	202	192
Sweepings (sand)	10,814	11,620	398	259	223
Trees and Wood Chips	6,442	7,521	8,860	7,080	5,168
Total Composted or Reused (c)	**69,328**	**75,187**	**304,998**	**341,489**	**308,999**
Materials Removed from Site*					
Batteries	0	24	33	49	74
Bicycles	n/a	13	11	6	9
City Compost	343	403	3,287	11,483	5,166
Dutch Elm	19	3	102	111	0
Electronics	n/a	375	530	570	665
Household Hazardous Waste	n/a	303	341	594	686
Mattresses	n/a	n/a	n/a	n/a	233
Oil	n/a	22	32	60	90
Oversized Plastics	n/a	15	22	52	43
Ozone-Containing Appliances	78	66	111	180	166
Recyclables	n/a	156	274	471	278
Scrap Metal	543	532	619	607	635
Tires	222	57	146	165	134
Total Removed from Site (d)	**1,205**	**1,970**	**5,510**	**14,348**	**8,181**
Diversion Rate = (c) + (d) / (a)	**15%**	**18%**	**47%**	**52%**	**50%**

* Materials removed from site are stockpiled until sufficient quantities are collected

5.0 GROUND WATER, SURFACE WATER, LEACHATE, AND LANDFILL GAS MONITORING

5.1 GROUND WATER

The land beneath the BRRMF consists of three layers: the uppermost layer is clay (averaging 12 m in thickness), the second layer is till (averaging 6 m in thickness), and the lowest layer is bedrock. Ground water flows downwards through the clay and till layers into the bedrock aquifer, which flows in a north-east direction. The ground water in all three layers is saline and non-potable. The ground water monitoring system includes 34 nested wells: 13 bedrock wells, 13 till wells, and 8 clay wells. The locations of the ground water monitoring wells are shown on Figure 2.

As per the BRRMF Operating Plan, ground water is monitored in accordance with the Ground Water Sampling and Analysis Plan (SAP), as specified under Clause 123. Sampling frequency is twice per year for bedrock wells and downgradient till wells, and once per year for clay wells and other till wells distant from the waste areas. As neither Federal nor Manitoba Provincial Governments regulate non-potable ground water quality, the Ontario Ministry of Environment (MOE) guidelines for non-potable groundwater quality are used as the regulatory guideline (MOE, 2011).

In 2019, a total of 49 ground water samples were analyzed – 5 samples from wells upgradient of the site (background water quality), and 44 samples from wells crossgradient and downgradient of the site. There were no deviations from the Ground Water SAP or from normal sample collection and preservation practices. The majority of results met the guidelines with the exception of chloride in some till and bedrock wells, and hydrocarbons in two of the bedrock wells. The 2019 ground water results are provided in Tables 2.1-2.3.

The 2015-2019 average values are provided in Tables 3.1-3.3. Some variability from historical data was observed in some of the samples, this may be a statistical anomaly; we will continue to monitor these parameters to better evaluate trends.

Based on the Piper diagrams provided in Appendix C, the major ions in the ground water from the clay layer are calcium, magnesium, sulfate and bicarbonate. Sodium and chloride are the major ions in the bedrock aquifer. Ground water in the till layer is generally intermediate in brackishness and shows a gradual change with depth. The Piper diagrams display tight groupings of ground water sampling data, which is indicative of no significant ground water chemical changes.

Time versus concentration graphs provided in Appendix D show the historical relationship of the analytical parameters at each monitoring location. In general, the analytical results for ground water obtained in 2019 were found to be similar to those obtained in 2015-2018, and are consistent with background levels.

The Contingency Action Plan identified under Clause 125 was not implemented in 2019.

At this time we have no recommendations for changes in the ground water monitoring program.

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Table 2.1 2019 Ground Water Monitoring - Clay Wells

			Upgradient	Downgradient and Crossgradient						
			GWQ25-6N60DR	GWQ25-5N62D	GWQ25-6N63E	GWQ25-6N57DR	GWQ25-6N67E	GWQ25-4N34B	GWQ25-4N34C	GWQ25-6N59DR
	Units	Criteria	Spring	Spring	Spring	Spring	Spring	Spring	Spring	Spring
Inorganic Parameters										
Alkalinity - Bicarbonate	mg/L		530	464	493	481	464	566	808	NS
Alkalinity - Carbonate	mg/L		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	NS
Alkalinity - Hydroxide	mg/L		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	NS
Alkalinity - Total	mg/L		530	464	493	481	464	566	808	NS
Dissolved Hardness (CaCO3)	mg/L		1,720	2,720	2,620	2,170	1,810	1,840	2,050	NS
pH	units		6.89	6.74	6.77	7.42	6.86	7.19	6.89	NS
Specific Conductivity	(µS/cm)		4,800	8,750	7,200	6,230	4,880	7,140	5,530	NS
Turbidity	(ntu)		24.3	8.1	25.6	17.6	14.3	24	164	NS
Total Dissolved Solids	mg/L		3,880	6,610	5,620	5,050	3,750	6,270	13,400	NS
Total Suspended Solids	mg/L		268	715	635	308	409	353	3,400	NS
Total Solids	mg/L		4,150	7,320	6,260	5,350	4,160	6,630	16,800	NS
Dissolved Chloride (Cl)	mg/L	2,300 *	570	1,550	1,120	780	620	1,280	1,050	NS
Dissolved Sulphate (SO4)	mg/L		1,730	3,030	1,920	2,080	1,380	2,790	1,760	NS
Nutrients										
Ammonia - Dissolved	mg/L N		0.005	0.397	0.388	0.050	0.617	<0.003	0.685	NS
Nitrate - Dissolved	mg/L N		0.855	0.855	0.288	0.870	0.037	0.055	0.032	NS
Total Kjeldahl Nitrogen	mg/L N		0.2	1.0	0.8	0.5	0.9	0.8	1.5	NS
Phosphorus - Dissolved	mg/L P		<0.013	<0.013	<0.013	0.025	0.025	0.018	0.020	NS
Other										
Cyanide - Total (CN)	ug/L	66	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	NS
Organic Indicators										
Chemical Oxygen Demand	mg/L		32	101	66	50	33	54	630	NS
Total Organic Carbon	mg/L		10.0	19.8	14.8	16.4	10.9	18.5	57.3	NS
Metals										
Arsenic (As)- Dissolved	ug/L	1,900 *	0.48	0.87	0.66	0.52	0.44	0.76	1.30	NS
Barium (Ba)- Dissolved	ug/L	29,000 *	8.10	14.3	12.8	9.29	9.36	8.91	10.3	NS
Beryllium (Be)- Dissolved	ug/L	67 *	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	NS
Cadmium (Cd)- Dissolved	ug/L	2.7 *	0.0465	0.118	0.101	0.116	0.328	0.110	0.158	NS
Calcium (Ca)- Dissolved	mg/L		579	914	757	676	521	774	542	NS
Chromium (Cr)- Dissolved	ug/L	810 *	<0.10	0.11	<0.10	<0.10	0.14	0.21	0.10	NS
Copper (Cu)- Dissolved	ug/L	87 *	1.40	2.04	1.51	2.18	2.19	3.34	1.12	NS
Iron (Fe)- Dissolved	ug/L		<10	<10	<10	<10	<10	13	317	NS
Lead (Pb)- Dissolved	ug/L	25 *	<0.050	<0.050	<0.050	0.059	0.060	0.051	<0.050	NS
Magnesium (Mg)- Dissolved	mg/L		212	341	309	253	222	629	249	NS
Manganese (Mn)- Dissolved	ug/L		860	2,300	2,290	2,210	711	135	1,620	NS
Mercury (Hg)- Total	ug/L	2.8 *	<0.0050	<0.0050	0.0060	<0.0050	<0.50	0.0070	0.38	NS
Nickel (Ni)- Dissolved	ug/L	490 *	6.67	10.8	11.5	9.98	6.83	11.3	7.91	NS
Potassium (K)- Dissolved	mg/L		10.2	14.7	12.1	11.5	9.65	10.7	9.93	NS
Selenium (Se)- Dissolved	ug/L	63 *	0.135	0.155	0.188	0.305	0.188	66.9	3.58	NS
Silver (Ag)- Dissolved	ug/L	1.5 *	0.010	0.017	0.015	0.019	0.022	0.035	0.011	NS
Sodium (na)- Dissolved	mg/L	2,300 *	332	831	654	593	323	461	435	NS
Zinc (Zn)- Dissolved	ug/L	1,100 *	4.5	7.3	5.7	6.1	6.1	2.5	5.1	NS
Field Parameters										
pH	units		7.44	7.55	7.04	7.85	8.05	7.65	7.86	NS
Specific Conductivity	(µS/cm)		4,050	7,410	6,300	5,140	4,330	4,860	3,730	NS
Polycyclic Aromatic Hydrocarbons										
Naphthalene	ug/L	6,400	<0.050							
Benzo(a)pyrene	ug/L	0.81	<0.0050							
Anthracene	ug/L	2.4	<0.010							
Petroleum Hydrocarbons										
F1 (C6-C10 Hydrocarbons)	ug/L	750	<100							
F2 (C10-C16 Hydrocarbons)	ug/L	150	<100							
F3 (C16-C34 Hydrocarbons)	ug/L	500	<250							
F4 (C34-C50 Hydrocarbons)	ug/L	500	<250							
Benzene	µg/L	430	<0.50							
EthylBenzene	µg/L	2,300	<0.50							
Toluene	µg/L	18,000	<0.50							
Xylene (Total)	µg/L	4,200 *	<0.50							
Volatile Organic Carbons										
Vinyl chloride	µg/L	1.7	<0.50							
Pesticides										
Diazinon	µg/L		<0.10							
Herbicides										
2,4-D	ug/L		<0.10							

Note: Criteria from Ontario Ministry of the Environment. (2011, July 1). Soil, Ground Water and Sediment Standards for Use Under Part XV.I of the *Environmental Protection Act* Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition
* Criteria for total chloride, total metals and xylene mixture
NS - Sampled every other year

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Table 2.2 2019 Ground Water Monitoring - Till Wells

			Upgradient		Downgradient and Crossgradient									
			GWQ25-6N60ER		GWQ25-5N62E		GWQ25-W13A		GWQ25-W14A		GWQ25-W15A		GWQ25-W16A	
	Units	Criteria	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
Inorganic Parameters														
Alkalinity - Bicarbonate	mg/L		576	631	357	525	627	1,790	594	568	2,670	3,580	399	422
Alkalinity - Carbonate	mg/L		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Alkalinity - Hydroxide	mg/L		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Alkalinity - Total	mg/L		576	631	357	525	627	1,790	594	568	2,670	3,580	399	422
Dissolved Hardness (CaCO3)	mg/L		1,440	1,580	1,910	2,460	3,080	4,590	4,170	2,360	5,160	12,200	1,510	1,800
pH	units		6.93	6.92	7.37	7.40	7.15	7.25	7.45	7.41	6.78	6.84	7.03	6.92
Specific Conductivity	(µS/cm)		4,340	4,200	8,540	8,520	8,330	8,280	8,470	8,520	6,780	6,840	5,380	5,370
Turbidity	(ntu)		219	275	1410	3,025	1290	7,500	96.9	1,330	7600	335	178.4	21,950
Total Dissolved Solids	mg/L		3,360	3,240	5,560	5,180	8,060	5,070	3,540	5,100	2,160	370	4,270	3,700
Total Suspended Solids	mg/L		760	999	2,410	3,770	5,500	10,200	9,480	8,460	35,350	36,550	513	1,080
Total Solids	mg/L		4,120	4,240	7,970	8,950	13,600	15,300	13,000	3,360	37,500	36,900	4,790	4,780
Dissolved Chloride (Cl)	mg/L	2,300 *	520	351	1,720	2,430	3,060	2,220	3,010	2,370	1,360	1,890	990	1,080
Dissolved Sulphate (SO4)	mg/L		1,560	1,190	1,990	810	650	879	650	819	1,860	1,440	1,010	1,050
Nutrients														
Ammonia - Dissolved	mg/L N		0.348	0.424	1.01	0.970	0.922	0.951	1.05	1.06	0.845	0.945	0.737	0.759
Nitrate - Dissolved	mg/L N		0.222	0.189	0.003	0.061	0.122	0.035	<0.003	0.004	0.024	<0.003	0.067	0.105
Total Kjeldahl Nitrogen	mg/L N		0.5	0.9	1.2	1.5	1.2	1.5	1.4	1.7	2.5	3.0	1.1	1.5
Phosphorus - Dissolved	mg/L P		<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	0.053	<0.013	<0.013	0.013
Other														
Cyanide - Total (CN)	ug/L	66	<1.0		<1.0	1.2	<1.0		<1.0		<1.0		1.1	
Organic Indicators														
Chemical Oxygen Demand	mg/L		39	46	100	140	300	380	345	136	1,290	1,700	52	78
Total Organic Carbon	mg/L		9.6	9.2	3.5	4.7	27.3	7.0	32.7	5.0	61.3	46.1	7.2	9.7
Metals														
Arsenic (As)- Dissolved	ug/L	1,900 *	0.98	1.24	2.54	4.63	3.27	1.18	4.51	6.58	0.89	1.12	1.43	0.96
Barium (Ba)- Dissolved	ug/L	29,000 *	7.69	8.38	11.2	12.0	13.2	11.2	13.1	10.9	12.6	13.3	11.4	13.0
Beryllium (Be)- Dissolved	ug/L	67 *	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium (Cd)- Dissolved	ug/L	2.7 *	0.0199	0.0941	0.0077	0.0124	0.0186	0.0236	0.0107	<0.0050	0.0317	0.0290	0.103	0.176
Calcium (Ca)- Dissolved	mg/L		430	434	338	319	442	532	337	388	782	843	530	536
Chromium (Cr)- Dissolved	ug/L	810 *	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Copper (Cu)- Dissolved	ug/L	87 *	1.42	1.29	<0.20	<0.20	<0.20	0.35	<0.20	0.21	0.28	<0.20	0.43	0.22
Iron (Fe)- Dissolved	ug/L		<10	38	445	502	387	169	<10	615	396	1,310	18.0	35
Lead (Pb)- Dissolved	ug/L	25 *	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Magnesium (Mg)- Dissolved	mg/L		184	206	173	182	206	202	175	153	270	241	209	190
Manganese (Mn)- Dissolved	ug/L		1,240	1,090	71.8	58.1	245	322	122	219	1,650	2,240	850	914
Mercury (Hg)- Total	ug/L	2.8 *	0.0230	0.0150	<0.025	<0.0050	0.130	<0.0050	0.130	0.140	0.36	<0.0050	<0.050	0.0050
Nickel (Ni)- Dissolved	ug/L	490 *	7.93	7.88	1.17	1.23	2.39	3.12	1.54	1.89	7.43	9.61	5.61	6.61
Potassium (K)- Dissolved	mg/L		8.29	8.94	34.2	36.4	22.3	19.8	33.0	29.6	14.4	13.2	10.7	11.2
Selenium (Se)- Dissolved	ug/L	63 *	0.104	0.053	<0.050	<0.050	<0.050	2.70	<0.050	<0.050	0.104	0.174	0.064	0.130
Silver (Ag)- Dissolved	ug/L	1.5 *	<0.010	0.025	0.011	0.032	0.013	<0.010	0.038	<0.010	0.020	<0.010	0.012	<0.010
Sodium (na)- Dissolved	mg/L	2,300 *	370	372	1,310	1,380	1,110	1,040	1,320	1,250	606	616	474	469
Zinc (Zn)- Dissolved	ug/L	1,100 *	3.4	3.8	2.3	1.8	2.0	1.9	<1.0	1.3	3.7	4.8	4.0	5.0
Field Parameters														
pH	units		7.65	7.52	7.92	8.18	7.76	7.88	8.03	8.23	7.22	7.78	7.70	7.78
Specific Conductivity	(µS/cm)		3,800	5,500	7,660	6,980	5,530	6,460	5,850	4,900	6,080	5,710	4,760	4,430
Polycyclic Aromatic Hydrocarbons														
Naphthalene	ug/L	6,400	<0.050		<0.050		<0.050		<0.050		<0.050		<0.050	
Benzo(a)pyrene	ug/L	0.81	<0.0050		<0.0050		<0.0050		<0.0050		<0.0050		<0.0050	
Anthracene	ug/L	2.4	<0.010		<0.010		<0.010		<0.010		<0.010		<0.010	
Petroleum Hydrocarbons														
F1 (C6-C10 Hydrocarbons)	ug/L	750	<100		<100		<100		<100		<100		<100	
F2 (C10-C16 Hydrocarbons)	ug/L	150	<100		<100		<100		<100		<100		<100	
F3 (C16-C34 Hydrocarbons)	ug/L	500	<250		<250		<250		<250		<250		<250	
F4 (C34-C50 Hydrocarbons)	ug/L	500	<250		<250		<250		<250		<250		<250	
Benzene	µg/L	430	<0.50		<0.50		<0.50		<0.50		<0.50		<0.50	
EthylBenzene	µg/L	2,300	<0.50		<0.50		<0.50		<0.50		<0.50		<0.50	
Toluene	µg/L	18,000	<0.50		<0.50		<0.50		<0.50		<0.50		<0.50	
Xylene (Total)	µg/L	4,200 *	<0.50		<0.50		<0.50		<0.50		<0.50		<0.50	
Volatile Organic Carbons														
Vinyl chloride	µg/L	1.7	<0.50		<0.50		<0.50		<0.50		<0.50		<0.50	
Pesticides														
Diazinon	µg/L		<0.10		<0.10		<0.10		<0.10		<0.10		<0.10	
Herbicides														
2,4-D	ug/L		<0.10		<0.10		<0.10		<0.10		<0.10		<0.10	

Note: Criteria from Ontario Ministry of the Environment. (2011, July 1). Soil, Ground Water and Sediment Standards for Use Under Part XV.I of the Environmental Protection Act Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition

* Criteria for total chloride, total metals and xylene mixture

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Table 2.2 2019 Ground Water Monitoring - Till Wells

			Downgradient and Crossgradient						
			GWQ25-6N63F	GWQ25-6N57F	GWQ25-6N67F	GWQ25-4N34DR	GWQ25-6N58DR	GWQ25-6N58F	GWQ25-6N59F
	Units	Criteria	Spring	Spring	Spring	Spring	Spring	Spring	Spring
Inorganic Parameters									
Alkalinity - Bicarbonate	mg/L		899	748	397	524	NS	NS	NS
Alkalinity - Carbonate	mg/L		<3.0	<3.0	<3.0	<3.0	NS	NS	NS
Alkalinity - Hydroxide	mg/L		<3.0	<3.0	<3.0	<3.0	NS	NS	NS
Alkalinity - Total	mg/L		899	748	397	524	NS	NS	NS
Dissolved Hardness (CaCO3)	mg/L		3,440	2,530	1,270	1,620	NS	NS	NS
pH	units		6.91	7.12	6.98	7.04	NS	NS	NS
Specific Conductivity	(µS/cm)		6,690	6,130	4,540	6,290	NS	NS	NS
Turbidity	(ntu)		1570	11.2	390	51.5	NS	NS	NS
Total Dissolved Solids	mg/L		4,480	3,820	3,320	5,530	NS	NS	NS
Total Suspended Solids	mg/L		5,940	6,040	548	2,940	NS	NS	NS
Total Solids	mg/L		10,400	9,860	3,870	8,470	NS	NS	NS
Dissolved Chloride (Cl)	mg/L	2,300 *	340	1,040	730	760	NS	NS	NS
Dissolved Sulphate (SO4)	mg/L		1,030	1,450	990	780	NS	NS	NS
Nutrients									
Ammonia - Dissolved	mg/L N		0.809	0.899	0.629	0.443	NS	NS	NS
Nitrate - Dissolved	mg/L N		<0.003	<0.003	0.054	0.192	NS	NS	NS
Total Kjeldahl Nitrogen	mg/L N		1.0	1.3	0.7	0.9	NS	NS	NS
Phosphorus - Dissolved	mg/L P		<0.013	0.023	0.022	<0.013	NS	NS	NS
Other									
Cyanide - Total (CN)	ug/L	66	<1.0	1.0	<1.0	<1.0			NS
Organic Indicators									
Chemical Oxygen Demand	mg/L		185	180	27	39	NS	NS	NS
Total Organic Carbon	mg/L		12.5	19.0	6.4	10.5	NS	NS	NS
Metals									
Arsenic (As)- Dissolved	ug/L	1,900 *	2.12	9.87	1.29	2.09	NS	NS	NS
Barium (Ba)- Dissolved	ug/L	29,000 *	10.3	9.50	10.2	10.7	NS	NS	NS
Beryllium (Be)- Dissolved	ug/L	67 *	<0.10	<0.10	<0.10	<0.10	NS	NS	NS
Cadmium (Cd)- Dissolved	ug/L	2.7 *	0.0062	0.0086	0.0155	0.0182	NS	NS	NS
Calcium (Ca)- Dissolved	mg/L		527	485	407	457	NS	NS	NS
Chromium (Cr)- Dissolved	ug/L	810 *	<0.10	<0.10	<0.10	<0.10	NS	NS	NS
Copper (Cu)- Dissolved	ug/L	87 *	0.23	<0.20	0.29	0.59	NS	NS	NS
Iron (Fe)- Dissolved	ug/L		1,450	1,430	12	125	NS	NS	NS
Lead (Pb)- Dissolved	ug/L	25 *	<0.050	<0.050	<0.050	<0.050	NS	NS	NS
Magnesium (Mg)- Dissolved	mg/L		314	219	231	468	NS	NS	NS
Manganese (Mn)- Dissolved	ug/L		221	505	191	62.4	NS	NS	NS
Mercury (Hg)- Total	ug/L	2.8 *	0.0050	0.070	<0.0050	0.0250	NS	NS	NS
Nickel (Ni)- Dissolved	ug/L	490 *	3.75	5.22	3.85	5.08	NS	NS	NS
Potassium (K)- Dissolved	mg/L		11.1	13.5	9.18	16.2	NS	NS	NS
Selenium (Se)- Dissolved	ug/L	63 *	<0.050	<0.050	<0.050	0.115	NS	NS	NS
Silver (Ag)- Dissolved	ug/L	1.5 *	0.032	0.024	0.077	0.013	NS	NS	NS
Sodium (na)- Dissolved	mg/L	2,300 *	570	638	305	598	NS	NS	NS
Zinc (Zn)- Dissolved	ug/L	1,100 *	1.3	2.2	2.2	2.6	NS	NS	NS
Field Parameters									
pH	units		7.80	7.65	7.50	7.74	NS	NS	NS
Specific Conductivity	(µS/cm)		5,710	5,140	4,330	4,600	NS	NS	NS
Polycyclic Aromatic Hydrocarbons									
Naphthalene	ug/L	6,400				<0.050			
Benzo(a)pyrene	ug/L	0.81				<0.0050			
Anthracene	ug/L	2.4				<0.010			
Petroleum Hydrocarbons									
F1 (C6-C10 Hydrocarbons)	ug/L	750				<100			
F2 (C10-C16 Hydrocarbons)	ug/L	150				<100			
F3 (C16-C34 Hydrocarbons)	ug/L	500				<250			
F4 (C34-C50 Hydrocarbons)	ug/L	500				<250			
Benzene	µg/L	430				<0.50			
EthylBenzene	µg/L	2,300				<0.50			
Toluene	µg/L	18,000				<0.50			
Xylene (Total)	µg/L	4,200 *				<0.50			
Volatile Organic Carbons									
Vinyl chloride	µg/L	1.7				<0.50			
Pesticides									
Diazinon	µg/L					<0.10			
Herbicides									
2,4-D	ug/L					<0.10			

Note: Criteria from Ontario Ministry of the Environment. (2011, July 1). Soil, Ground Water and Sediment Standards for Use Under Part XV.I of the Environmental Protection Act Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition

* Criteria for total chloride, total metals and xylene mixture

NS - Sampled every other year

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Table 2.3 2019 Ground Water Monitoring - Bedrock Wells

			Upgradient		Downgradient and Crossgradient											
			GWQ25-W6		GWQ25-W8		GWQ25-W11		GWQ25-W13		GWQ25-W14		GWQ25-W15		GWQ25-W16	
	Units	Criteria	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
Inorganic Parameters																
Alkalinity - Bicarbonate	mg/L		161	138	144	137	137	131	376	205	144	126	146	145	154	156
Alkalinity - Carbonate	mg/L		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Alkalinity - Hydroxide	mg/L		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Alkalinity - Total	mg/L		161	138	144	137	137	131	376	205	144	126	146	145	154	156
Dissolved Hardness (CaCO3)	mg/L		936	1,060	830	925	757	843	1,060	1,290	797	849	788	1,090	905	1,190
pH	units		7.51	7.64	7.39	7.59	7.54	7.58	7.22	7.25	7.38	7.55	7.48	7.48	7.51	7.49
Specific Conductivity	(µS/cm)		10,100	10,100	8,920	8,700	8,740	8,590	8,580	8,420	8,830	8,180	8,270	7,960	8,180	7,970
Turbidity	(ntu)		5.97	7.58	1.40	1.59	14.6	18.1	1.01	1.12	1.15	4.38	2.41	17.9	37.6	87.2
Total Dissolved Solids	mg/L		6,190	6,250	5,230	5,220	5,120	5,140	5,000	5,110	5,110	4,760	4,920	4,720	4,900	4,730
Total Suspended Solids	mg/L		529	272	544	244	329	348	656	663	445	219	350	570	563	822
Total Solids	mg/L		6,720	6,530	5,780	5,460	5,450	5,490	5,650	5,780	5,550	4,980	5,270	5,290	5,460	5,550
Dissolved Chloride (Cl)	mg/L	2,300 *	3,280	430	2,300	2,440	2,740	2,400	2,500	2,250	3,000	2,280	2,370	2,550	2,480	2,520
Dissolved Sulphate (SO4)	mg/L		770	895	688	634	788	865	673	835	651	703	570	790	590	791
Nutrients																
Ammonia - Dissolved	mg/L N		1.42	1.45	1.11	1.140	1.06	1.11	1.09	1.13	1.04	0.034	0.974	1.08	0.980	1.09
Nitrate - Dissolved	mg/L N		<0.003	<0.003	<0.003	<0.003	0.003	<0.003	<0.003	<0.003	0.008	0.683	<0.003	0.031	<0.003	0.080
Total Kjeldahl Nitrogen	mg/L N		1.8	2.1	1.4	1.7	1.3	1.3	1.5	1.5	1.4	0.4	1.2	1.5	1.2	1.9
Phosphorus - Dissolved	mg/L P		<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	<0.003	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013
Other																
Cyanide - Total (CN)	ug/L	66	<1.0	1.1	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.1	<1.0
Organic Indicators																
Chemical Oxygen Demand	mg/L		113	122	77	88	72	89	74	85	70	87	75	82	75	92
Total Organic Carbon	mg/L		1.7	2.1	3.2	1.7	2.2	0.5	4.9	1.8	2.9	1.1	4.5	1.6	3.5	1.9
Metals																
Arsenic (As)- Dissolved	ug/L	1,900 *	0.82	0.91	3.61	0.45	5.43	5.99	3.54	0.72	2.88	0.75	1.87	1.94	1.29	1.42
Barium (Ba)- Dissolved	ug/L	29,000 *	14.6	15.2	65.0	61.7	13.2	14.8	24.4	25.1	18.5	19.0	30.2	28.9	17.1	17.6
Beryllium (Be)- Dissolved	ug/L	67 *	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium (Cd)- Dissolved	ug/L	2.7 *	0.119	0.160	0.0051	0.0168	<0.0050	<0.0050	0.197	2.270	0.0183	0.0373	0.0342	0.0472	0.0704	0.107
Calcium (Ca)- Dissolved	mg/L		364	341	776	817	315	284	351	309	255	251	102	118.0	312	279
Chromium (Cr)- Dissolved	ug/L	810 *	0.52	0.51	50.4	54.9	<0.10	<0.10	1.32	0.85	0.13	<0.10	0.21	0.18	0.35	0.21
Copper (Cu)- Dissolved	ug/L	87 *	5.23	2.00	3.27	3.39	<0.20	<0.20	0.74	6.62	2.89	2.19	11.9	8.56	6.76	2.95
Iron (Fe)- Dissolved	ug/L		<10	<10	<10	<10	914	501	191	23.0	<10	<10	<10	11.0	<10	<10
Lead (Pb)- Dissolved	ug/L	25 *	0.163	<0.050	0.215	0.491	0.051	<0.50	<0.050	<0.50	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Magnesium (Mg)- Dissolved	mg/L		150	182	0.888	0.446	152	120	148	125	108	140	169	236	174	173
Manganese (Mn)- Dissolved	ug/L		37.8	37.4	0.20	<0.10	15	30.9	81.7	61.9	14.5	14.8	10.4	9.06	50.1	50.8
Mercury (Hg)- Total	ug/L	2.8 *	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nickel (Ni)- Dissolved	ug/L	490 *	2.97	2.80	0.65	<0.50	1.37	0.60	1.98	3.97	0.83	0.55	7.18	8.22	2.77	2.75
Potassium (K)- Dissolved	mg/L		47.4	50.6	20.1	22.7	40.2	37.7	24.5	20.1	35.5	40.8	10.7	10.3	32.0	32.8
Selenium (Se)- Dissolved	ug/L	63 *	0.053	<0.050	0.747	0.657	<0.050	<0.050	0.568	<0.050	0.052	<0.050	1.10	1.71	0.174	0.505
Silver (Ag)- Dissolved	ug/L	1.5 *	0.016	0.012	0.016	0.011	0.011	<0.010	<0.010	<0.010	0.028	0.011	<0.010	<0.010	0.043	0.020
Sodium (na)- Dissolved	mg/L	2,300 *	1,740	1,760	596	663	1,520	1,440	989	864	1,270	1,410	131	196	1,190	1,220
Zinc (Zn)- Dissolved	ug/L	1,100 *	38.3	65.3	1.5	4.1	<1.0	<1.0	1.6	161	9.6	20.7	14.6	21.2	28.9	35.0
Bacteria																
Total Coliforms (MTF)	MPN/100mL		<1	1	<1	<1	<1	<1	25	<1	<1	<1	4	<1	<1	<1
Fecal Coliforms (MTF)	MPN/100mL		<1	<1	<1	<1	<1	<1	1	<1	<1	<1	12	<1	2	<1
E. coli (MTF)	MPN/100mL		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Field Parameters																
pH	units		7.78	7.76	7.78	7.04	8.30	7.98	7.96	7.71	7.84	7.79	7.20	6.86	6.70	6.86
Specific Conductivity	(µS/cm)		8,690	7,740	7,730	6,810	7,530	7,370	7,180	7,050	7,460	6,740	5,480	6,440	5,850	6,510
Polycyclic Aromatic Hydrocarbons																
Naphthalene	ug/L	6,400	<0.050	<0.050	0.161	<0.050	<0.050	<0.050	0.062	<0.050	<0.050	<0.050	<0.050	0.07	<0.050	<0.050
Benzo(a)pyrene	ug/L	0.81	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Anthracene	ug/L	2.4	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Petroleum Hydrocarbons																
F1 (C6-C10 Hydrocarbons)	ug/L	750	<100	<100	<100	<100	<100	<100	<100	120	<100	<100	<100	<100	<100	<100
F2 (C10-C16 Hydrocarbons)	ug/L	150	<100	<100	110	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	ug/L	500	<250	<250	<250	260	<250	<250	<250	<120	<250	<250	310	380	<250	<250
F4 (C34-C50 Hydrocarbons)	ug/L	500	<250	<250	<250	<250	<250	<250	<250	<120	<250	<250	280	620	<250	<250
Benzene	µg/L	430	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
EthylBenzene	µg/L	2,300	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Toluene	µg/L	18,000	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Xylene (Total)	µg/L	4,200 *	<0.50	<0.64	<0.50	<0.64	<0.50	<0.64	<0.50	<0.64	<0.50	<0.64	<0.50	<0.64	<0.50	<0.64
Volatile Organic Carbons																
Vinyl chloride	µg/L	1.7	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
Pesticides																
Diazinon	µg/L		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Herbicides																
2,4-D	ug/L		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10

Note: Criteria from Ontario Ministry of the Environment. (2011, July 1). Soil, Ground Water and Sediment Standards for Use Under Part XV.I of the Environmental Protection Act Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition
* Criteria for total chloride, total metals and xylene mixture

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Table 2.3 2019 Ground Water Monitoring - Bedrock Wells

			Downgradient and Crossgradient											
			GWQ25-W9		GWQ25-W10		GWQ25-W7		GWQ25-W12		GWQ25-W4		GWQ25-W5	
	Units	Criteria	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn	Spring	Autumn
Inorganic Parameters														
Alkalinity - Bicarbonate	mg/L		144	138	140	133	334	126	147	139	74.5	63.5	128	133
Alkalinity - Carbonate	mg/L		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Alkalinity - Hydroxide	mg/L		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Alkalinity - Total	mg/L		144	138	140	133	334	126	147	139	74.5	63.5	128	133
Dissolved Hardness (CaCO3)	mg/L		877	916	845	888	664	739	866	941	535	553	842	947
pH	units		7.41	7.42	7.50	7.43	7.69	7.82	7.47	7.52	7.62	7.88	7.56	7.44
Specific Conductivity	(µS/cm)		9,790	9,680	9,210	9,040	6,980	6,970	9,020	8,970	7,430	7,300	8,380	8,290
Turbidity	(ntu)		2.76	9.91	2.22	2.93	13.4	7.94	4.76	3.39	3.73	33.3	10.8	13.0
Total Dissolved Solids	mg/L		5,920	5,880	5,480	5,460	4,010	3,980	5,380	5,430	4,110	4,160	4,880	5,080
Total Suspended Solids	mg/L		364	416	396	396	512	282	349	300	1,400	271	522	439
Total Solids	mg/L		6,280	6,300	5,880	5,850	4,520	4,260	5,730	5,730	5,510	4,430	5,400	5,510
Dissolved Chloride (Cl)	mg/L	2,300 *	25.3	2,540	3,350	1,330	2,130	316	2,780	2,490	2,460	2,000	3,580	1,910
Dissolved Sulphate (SO4)	mg/L		790	68	750	833	649	634	710	873	546	901	990	6.6
Nutrients														
Ammonia - Dissolved	mg/L N		1.3	1.39	1.24	1.24	1.88	1.89	1.14	1.12	0.761	0.821	0.976	1.04
Nitrate - Dissolved	mg/L N		<0.003	<0.003	<0.003	<0.003	0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Total Kjeldahl Nitrogen	mg/L N		1.5	1.8	1.5	1.7	2.4	2.7	1.2	1.7	0.9	0.9	1.2	1.3
Phosphorus - Dissolved	mg/L P		<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013	<0.013
Other														
Cyanide - Total (CN)	ug/L	66	<1.0	<1.0	<1.0		<1.0		<1.0		<1.0	<1.0	<1.0	
Organic Indicators														
Chemical Oxygen Demand	mg/L		105	104	90	96	66	64	86	94	63	70	70	76
Total Organic Carbon	mg/L		2.9	1.3	2.4	1.7	3.2	1.1	4.6	1.7	1.6	1.4	2.7	1.6
Metals														
Arsenic (As)- Dissolved	ug/L	1,900 *	7.14	7.11	5.77	5.60	0.33	0.48	4.68	12	0.72	0.44	4.56	5.74
Barium (Ba)- Dissolved	ug/L	29,000 *	11.5	12.2	14.4	13.2	48.0	46.8	12.3	18	10.5	10.6	13.5	14.3
Beryllium (Be)- Dissolved	ug/L	67 *	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<10	<0.10	<0.10	<0.10	<0.10
Cadmium (Cd)- Dissolved	ug/L	2.7 *	<0.0050	<0.0050	0.0051	<0.0050	0.0167	0.0157	<0.0050	<0.50	<0.0050	<0.0050	<0.0050	<0.0050
Calcium (Ca)- Dissolved	mg/L		325	329	281	338	384	348	322	325	187	181	317	311
Chromium (Cr)- Dissolved	ug/L	810 *	<0.10	<0.10	<0.10	<0.10	20.9	19.70	<0.10	<10	<0.10	<0.10	<0.10	<0.10
Copper (Cu)- Dissolved	ug/L	87 *	<0.20	<0.20	<0.20	<0.20	2.14	1.16	<0.20	46	<0.20	<0.20	<0.20	0.21
Iron (Fe)- Dissolved	ug/L		884	899	484	904	<10	30	577	<1000	2,930	2,170	559	770
Lead (Pb)- Dissolved	ug/L	25 *	<0.050	<0.50	<0.050	<0.050	<0.050	<0.050	<0.050	<5.0	0.063	<0.050	<0.050	<0.050
Magnesium (Mg)- Dissolved	mg/L		170	152	138	161	23.4	34.9	163	168	102	101	171	171
Manganese (Mn)- Dissolved	ug/L		21.7	22.0	29.9	14.7	0.43	0.85	32.0	63	34.2	26.3	22.4	35.6
Mercury (Hg)- Total	ug/L	2.8 *	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050
Nickel (Ni)- Dissolved	ug/L	490 *	1.41	1.62	0.56	1.37	0.63	<0.50	1.34	<0.50	<0.50	<0.50	1.08	1.50
Potassium (K)- Dissolved	mg/L		39.9	39.2	37.0	41.1	23.8	25.8	37.4	36.9	30.2	28.8	35.8	34.7
Selenium (Se)- Dissolved	ug/L	63 *	<0.050	<0.050	<0.050	<0.050	0.092	0.061	<0.050	<5.0	<0.050	0.096	0.055	<0.050
Silver (Ag)- Dissolved	ug/L	1.5 *	0.012	<0.010	0.011	0.045	<0.010	<0.010	0.011	<1.0	0.075	0.011	<0.010	0.019
Sodium (na)- Dissolved	mg/L	2,300 *	1,590	1,570	1,320	1,500	750	786	1,400	1,390	1,250	1,320	1,330	1,390
Zinc (Zn)- Dissolved	ug/L	1,100 *	1.2	<1.0	<1.0	<1.0	4.7	3.20	1.6	<100	1.8	<1.0	3.1	47.1
Bacteria														
Total Coliforms (MTF)	MPN/100mL		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Fecal Coliforms (MTF)	MPN/100mL		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
E. coli (MTF)	MPN/100mL		<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Field Parameters														
pH	units		8.40	8.01	8.00	8.25	NR	8.05	8.20	6.82	8.61	8.43	8.15	8.01
Specific Conductivity	(µS/cm)		8,590	8,140	8,070	7,610	5,870	5,430	7,880	6,880	5,890	6,390	7,110	7,060
Polycyclic Aromatic Hydrocarbons														
Naphthalene	ug/L	6,400	<0.050	<0.050	<0.050		0.135		<0.050		0.068	<0.050	<0.050	
Benzo(a)pyrene	ug/L	0.81	<0.0050	<0.0050	<0.0050		<0.0050		<0.0050		<0.0050	<0.0050	<0.0050	
Anthracene	ug/L	2.4	<0.010	<0.010	<0.010		<0.010		<0.010		<0.010	<0.010	<0.010	
Petroleum Hydrocarbons														
F1 (C6-C10 Hydrocarbons)	ug/L	750	<100	<100	<100		<100		<100		<100	<100	290	
F2 (C10-C16 Hydrocarbons)	ug/L	150	<100	<100	<100		190		<100		<100	<100	<100	
F3 (C16-C34 Hydrocarbons)	ug/L	500	<250	<250	<250		<250		<250		<250	<250	<250	
F4 (C34-C50 Hydrocarbons)	ug/L	500	<250	<250	<250		<250		<250		<250	<250	<250	
Benzene	µg/L	430	<0.50	<0.50	<0.50		<0.50		<0.50		<0.50	<0.50	<0.50	
EthylBenzene	µg/L	2,300	<0.50	<0.50	<0.50		<0.50		<0.50		<0.50	<0.50	<0.50	
Toluene	µg/L	18,000	<0.50	<0.50	<0.50		<0.50		<0.50		<0.50	<0.50	<0.50	
Xylene (Total)	µg/L	4,200 *	<0.50	<0.64	<0.50		1.63		<0.50		<0.50	<1.1	<0.50	
Volatile Organic Carbons														
Vinyl chloride	µg/L	1.7	<0.50	<0.50	<0.50		<0.50		<0.50		<0.50	<0.50	<0.50	
Pesticides														
Diazinon	µg/L		<0.10	<0.10	<0.10		<0.10		<0.10		<0.10	<0.10	<0.10	
Herbicides														
2,4-D	ug/L		<0.10	<0.10	<0.10		<0.10		<0.10		<0.10	<0.10	<0.10	

Note: Criteria from Ontario Ministry of the Environment. (2011, July 1). Soil, Ground Water and Sediment Standards for Use Under Part XV.I of the Environmental Protection Act Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition
* Criteria for total chloride, total metals and xylene mixture
NR - No result due to equipment malfunction

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Table 3.1 2019 Ground Water Quality Comparison - Clay Wells

	Units	Criteria	2016 Average		2017 Average		2018 Average		2019 Average	
Inorganic Parameters			**Upgradient**	**Downgradient**	**Upgradient**	**Downgradient**	**Upgradient**	**Downgradient**	**Upgradient**	**Downgradient**
Alkalinity - Bicarbonate	mg/L		625	642	621	603	539	585	530	546
Alkalinity - Carbonate	mg/L		<0.50	<0.50	<0.50	<0.50	<3.0	<3.0	<3.0	<3.0
Alkalinity - Hydroxide	mg/L		<0.50	<0.50	<0.50	<0.50	<3.0	<3.0	<3.0	<3.0
Alkalinity - Total	mg/L		512	526	509	495	539	585	530	546
Dissolved Hardness (CaCO3)	mg/L		2,260	2,666	2,120	2,558	2,325	3,065	1,720	2,202
pH	units		6.96	6.97	7.04	6.97	6.81	6.80	6.89	6.98
Specific Conductivity	(µS/cm)		4,560	5,996	4,780	6,386	4,820	6,463	4,800	6,622
Turbidity	(ntu)		40.4	504	91.8	6,463	116	535	24.3	42.2
Total Dissolved Solids	mg/L		3,960	4,967	3,840	4,720	3,890	5,076	3,880	6,783
Total Suspended Solids	mg/L		310	1,247	500	8,842	280	1,357	268	970
Total Solids	mg/L		4,270	6,214	4,340	13,562	4,170	6,433	4,150	7,753
Dissolved Chloride (Cl)	mg/L	2,300 *	450	927	470	990	474	948	570	1,067
Dissolved Sulphate (SO4)	mg/L		2,000	1,959	1,670	1,738	1,750	1,911	1,730	2,160
Nutrients										
Ammonia - Dissolved	mg/L N		<0.003	0.156	0.175	0.584	0.129	0.646	0.005	0.356
Nitrate - Dissolved	mg/L N		13.0	0.680	0.630	0.426	0.635	0.337	0.855	0.356
Total Kjeldahl Nitrogen	mg/L N		2.0	1.6	0.7	1.2	0.4	0.9	0.2	0.9
Phosphorus - Dissolved	mg/L P		0.180	0.012	<0.010	0.020	<0.010	<0.010	<0.013	0.017
Other										
Cyanide - Total (CN)	ug/L	66	NR	NR	NR	NR	NR	NR	<1.0	<1.0
Organic Indicators										
Chemical Oxygen Demand	mg/L		44	122	50	792	40	69	32	156
Total Organic Carbon	mg/L		10.6	22.0	10.8	19.6	29.1	17.7	10.0	23.0
Metals										
Arsenic (As)- Dissolved	ug/L	1,900 *	0.39	0.73	0.36	0.72	0.53	0.80	0.48	0.76
Barium (Ba)- Dissolved	ug/L	29,000 *	9.1	12.5	8.7	11.8	8.7	13.3	8.1	10.8
Beryllium (Be)- Dissolved	ug/L	67 *	0.015	0.008	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium (Cd)- Dissolved	ug/L	2.7 *	0.068	0.181	0.052	0.216	0.215	0.211	0.047	0.155
Calcium (Ca)- Dissolved	mg/L		572	646	540	637	575	713	579	697
Chromium (Cr)- Dissolved	ug/L	810 *	<0.10	0.08	<1.0	<1.0	0.13	0.43	<0.10	0.11
Copper (Cu)- Dissolved	ug/L	87 *	1.98	2.74	1.63	2.26	2.07	8.60	1.40	2.06
Iron (Fe)- Dissolved	ug/L		3.8	14	23	91	<10	115	<10	58
Lead (Pb)- Dissolved	ug/L	25 *	0.037	0.053	0.103	0.098	<0.050	0.343	<0.050	<0.050
Magnesium (Mg)- Dissolved	mg/L		201	256	187	235	216	312	212	334
Manganese (Mn)- Dissolved	ug/L		1,720	1412	1,590	1,866	1,860	2,027	860	1,544
Mercury (Hg)- Total	ug/L	2.8 *	<0.010	<0.010	<0.002	<0.002	<0.005	0.061	<0.0050	0.071
Nickel (Ni)- Dissolved	ug/L	490 *	7.0	9.5	6.4	9.9	7.2	12.8	6.7	9.7
Potassium (K)- Dissolved	mg/L		9.7	10.9	9.2	10.1	10.9	14.0	10.2	11.4
Selenium (Se)- Dissolved	ug/L	63 *	0.18	0.27	<0.40	<0.40	0.13	0.23	0.14	11.89
Silver (Ag)- Dissolved	ug/L	1.5 *	<0.005	<0.005	<0.050	<0.050	<0.010	<0.010	0.010	0.020
Sodium (na)- Dissolved	mg/L	2,300 *	336	485	325	534	345	582	332	550
Zinc (Zn)- Dissolved	ug/L	1,100 *	3.6	5.7	5.5	7.7	6.2	15.5	4.5	5.5
Field Parameters										
pH	units		7.36	7.38	7.84	7.78	7.02	7.19	7.44	7.67
Specific Conductivity	(µS/cm)		2,330	3,271	4,010	5,248	4,330	5,986	4,050	5,295
Polycyclic Aromatic Hydrocarbons										
Naphthalene	µg/L	6,400	<0.050	NR	NR	NR	<0.050	<0.050	<0.050	
Benzo(a)pyrene	µg/L	0.81	<0.010	NR	NR	NR	<0.0050	<0.0050	<0.0050	
Anthracene	µg/L	2.4	<0.050	NR	NR	NR	<0.010	<0.010	<0.010	
Petroleum Hydrocarbons										
F1 (C6-C10 Hydrocarbons)	µg/L	750	<25	NR	<25	NR	<100	<100	<100	
F2 (C10-C16 Hydrocarbons)	µg/L	150	<100	NR	<100	NR	<100	<100	<100	
F3 (C16-C34 Hydrocarbons)	µg/L	500	<200	NR	<200	NR	<250	<250	<250	
F4 (C34-C50 Hydrocarbons)	µg/L	500	<200	NR	<200	NR	<250	<250	<250	
Benzene	µg/L	430	<0.10	NR	<0.10	NR	<0.50	<0.50	<0.50	
EthylBenzene	µg/L	2,300	<0.10	NR	<0.10	NR	<0.50	<0.50	<0.50	
Toluene	µg/L	18,000	<0.20	NR	<0.20	NR	<0.50	<0.50	<0.50	
Xylene (Total)	µg/L	4,200 *	<0.10	NR	<0.10	NR	<0.50	<0.50	<0.50	
Volatile Organic Carbons										
Vinyl chloride	µg/L	1.7	<0.2	NR	<0.2	NR	<0.50	<0.50	<0.50	
Pesticides										
Diazinon	µg/L		<2.0	NR	<2.0	NR	<0.10	<0.10	<0.10	
Herbicides										
2,4-D	µg/L		<1.0	NR	<1.0	NR	<0.10	<0.10	<0.10	

Note: Criteria from Ontario Ministry of the Environment. (2011, July 1). Soil, Ground Water and Sediment Standards for Use Under Part XV.I of the Environmental Protection Act Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition
Note: Where value is expressed as less than (<), the value is halved and used in the calculations, where value is expressed as (>), the value is used in the calculations.
* Criteria for total chloride, total metals and xylene mixture
NR - No result due to lab error.

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Table 3.2 2019 Ground Water Quality Comparison - Till Wells

	Units	Criteria	2016 Average		2017 Average		2018 Average		2019 Average	
Inorganic Parameters			**Upgradient**	**Downgradient**	**Upgradient**	**Downgradient**	**Upgradient**	**Downgradient**	**Upgradient**	**Downgradient**
Alkalinity - Bicarbonate	mg/L		667	399	663	366	683	536	604	1,007
Alkalinity - Carbonate	mg/L		<0.50	<0.50	<0.50	<0.50	<3.0	<3.0	<3.0	<3.0
Alkalinity - Hydroxide	mg/L		<0.50	<0.50	<0.50	<0.50	<3.0	<3.0	<3.0	<3.0
Alkalinity - Total	mg/L		547	327	544	300	683	536	604	1,007
Dissolved Hardness (CaCO3)	mg/L		1,580	1,977	1,550	2,001	1,853	2,415	1,510	3,436
pH	units		6.97	7.21	6.92	7.11	6.96	7.11	6.93	7.12
Specific Conductivity	(µS/cm)		4,380	6,814	4,300	7,027	4,280	6,888	4,270	7,049
Turbidity	(ntu)		209	3,110	183	4,259	215	5,126	247	3,338
Total Dissolved Solids	mg/L		3,470	4,703	3,260	4,774	3,345	4,715	3,300	4,297
Total Suspended Solids	mg/L		610	11,186	640	9,840	616	7,528	880	9,199
Total Solids	mg/L		4,080	15,889	3,900	14,614	3,958	12,245	4,180	12,768
Dissolved Chloride (Cl)	mg/L	2,300 *	380	1,465	390	1,562	398	1,518	436	1,643
Dissolved Sulphate (SO4)	mg/L		1,450	1,343	1,430	1,258	1,465	1,308	1,375	1,101
Nutrients										
Ammonia - Dissolved	mg/L N		0.161	0.709	0.304	0.845	0.496	0.892	0.386	0.859
Nitrate - Dissolved	mg/L N		0.445	0.257	0.371	0.086	0.231	0.086	0.206	0.048
Total Kjeldahl Nitrogen	mg/L N		1.0	3.0	0.8	1.6	0.9	1.4	0.7	1.5
Phosphorus - Dissolved	mg/L P		0.030	0.036	<0.010	0.022	0.012	0.018	<0.013	0.013
Other										
Cyanide - Total (CN)	ug/L	66	<0.50	<0.50	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0
Organic Indicators										
Chemical Oxygen Demand	mg/L		45	259	40	286	25	504	43	354
Total Organic Carbon	mg/L		9.2	39.6	10.0	31.1	19.9	32.3	9.4	18.1
Metals										
Arsenic (As)- Dissolved	ug/L	1,900 *	2.48	1.98	1.21	2.62	1.19	2.58	1.11	3.03
Barium (Ba)- Dissolved	ug/L	29,000 *	9.2	11.5	8.1	15.0	8.3	13.8	8.0	11.6
Beryllium (Be)- Dissolved	ug/L	67 *	0.01	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium (Cd)- Dissolved	ug/L	2.7 *	0.058	0.076	<0.050	0.070	0.037	0.076	0.057	0.033
Calcium (Ca)- Dissolved	mg/L		376	475	367	457	461	544	432	495
Chromium (Cr)- Dissolved	ug/L	810 *	0.30	<1.0	<1.0	1.3	<0.10	0.51	<0.10	<0.10
Copper (Cu)- Dissolved	ug/L	87 *	2.82	1.89	1.85	3.69	1.91	2.27	1.36	0.23
Iron (Fe)- Dissolved	ug/L		6.3	166	194	884	<10.0	662	22	530
Lead (Pb)- Dissolved	ug/L	25 *	0.059	<0.050	0.067	0.530	<0.050	0.650	<0.050	<0.050
Magnesium (Mg)- Dissolved	mg/L		155	201	154	210	171	257	195	231
Manganese (Mn)- Dissolved	ug/L		774	549	868	486	1090	882	1,165	548
Mercury (Hg)- Total	ug/L	2.8 *	<0.010	<0.010	<0.002	0.028	<0.005	0.266	0.019	0.065
Nickel (Ni)- Dissolved	ug/L	490 *	7.4	4.0	7.6	4.6	7.3	5.5	7.9	4.2
Potassium (K)- Dissolved	mg/L		8.2	14.8	7.5	17.6	9.0	19.6	8.6	19.6
Selenium (Se)- Dissolved	ug/L	63 *	0.12	<0.40	<0.40	<0.40	0.10	0.07	0.08	0.25
Silver (Ag)- Dissolved	ug/L	1.5 *	<0.005	<0.050	<0.050	<0.050	<0.010	<0.010	0.015	0.021
Sodium (na)- Dissolved	mg/L	2,300 *	521	651	422	772	396	784	371	835
Zinc (Zn)- Dissolved	ug/L	1,100 *	3.9	7.2	5.5	6.0	6.3	7.9	3.6	2.5
Field Parameters										
pH	units		7.35	7.50	7.85	7.93	7.26	7.37	7.59	7.80
Specific Conductivity	(µS/cm)		3,190	3,147	3,790	6,481	3,630	6,295	4,650	5,581
Polycyclic Aromatic Hydrocarbons										
Naphthalene	µg/L	6,400	<0.050	<0.050	NR	NR	<0.050	<0.050	<0.050	<0.050
Benzo(a)pyrene	µg/L	0.81	<0.010	<0.010	NR	NR	<0.0050	<0.0050	<0.0050	<0.0050
Anthracene	µg/L	2.4	<0.050	<0.050	NR	NR	<0.010	<0.010	<0.010	<0.010
Petroleum Hydrocarbons										
F1 (C6-C10 Hydrocarbons)	µg/L	750	<25	<25	<25	<25	<100	<100	<100	<100
F2 (C10-C16 Hydrocarbons)	µg/L	150	<100	<100	<100	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	µg/L	500	<200	<200	<200	<200	<250	277	<250	<250
F4 (C34-C50 Hydrocarbons)	µg/L	500	<200	<200	<200	<200	<250	<250	<250	<250
Benzene	µg/L	430	<0.10	<0.10	<0.10	<0.10	<0.50	<0.50	<0.50	<0.50
EthylBenzene	µg/L	2,300	<0.10	<0.10	<0.10	<0.10	<0.50	<0.50	<0.50	<0.50
Toluene	µg/L	18,000	<0.20	<0.20	<0.20	0.41	<0.50	<0.50	<0.50	<0.50
Xylene (Total)	µg/L	4,200 *	<0.10	<0.10	<0.10	0.37	<0.50	<0.50	<0.50	<0.50
Volatile Organic Carbons										
Vinyl chloride	µg/L	1.7	<0.2	<0.2	<0.2	<0.2	<0.50	<0.50	<0.50	<0.50
Pesticides										
Diazinon	µg/L		<2.0	<2.0	<2.0	<2.0	<0.10	<0.10	<0.10	<0.10
Herbicides										
2,4-D	µg/L		<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.10	<0.10

Note: Criteria from Ontario Ministry of the Environment. (2011, July 1). Soil, Ground Water and Sediment Standards for Use Under Part XV.I of the Environmental Protection Act Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition
Note: Where value is expressed as less than (<), the value is halved and used in the calculations, where value is expressed as (>), the value is used in the calculations.
* Criteria for total chloride, total metals and xylene mixture
NR - No result due to lab error.

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Table 3.3 2019 Ground Water Quality Comparison - Bedrock Wells

			2016		2017		2018		2019	
			Average		Average		Average		Average	
Inorganic Parameters	Units	Criteria	Upgradient	Downgradient	Upgradient	Downgradient	Upgradient	Downgradient	Upgradient	Downgradient
Alkalinity - Bicarbonate	mg/L		164	166	164	162	1,454	136	150	154
Alkalinity - Carbonate	mg/L		<0.50	<0.50	<0.50	<0.50	<3.0	5.0	<3.0	<3.0
Alkalinity - Hydroxide	mg/L		<0.50	<0.50	<0.50	<0.50	<3.0	17.0	<3.0	<3.0
Alkalinity - Total	mg/L		134	136	134	133	1,454	155	150	154
Dissolved Hardness (CaCO3)	mg/L		1,065	1,237	1,390	1,200	1,544	1,523	998	872
pH	units		7.56	7.67	7.42	7.49	7.54	7.67	7.58	7.51
Specific Conductivity	(µS/cm)		10,350	8,484	9,965	8,373	10,035	8,255	10,100	8,433
Turbidity	(ntu)		15.4	38.9	10.0	26.1	7.6	13.3	6.8	12.4
Total Dissolved Solids	mg/L		6,265	5,033	6,145	5,020	6,320	5,043	6,220	4,989
Total Suspended Solids	mg/L		320	426	640	590	383	416	401	475
Total Solids	mg/L		6,585	5,458	6,785	5,611	6,703	5,459	6,625	5,463
Dissolved Chloride (Cl)	mg/L	2,300 *	3,000	2,413	2,850	2,208	2,785	2,131	1,855	2,281
Dissolved Sulphate (SO4)	mg/L		974	759	943	765	941	747	833	680
Nutrients										
Ammonia - Dissolved	mg/L N		1.31	1.06	1.36	1.10	0.686	1.09	1.44	1.11
Nitrate - Dissolved	mg/L N		0.012	0.025	<0.003	0.011	0.631	0.046	<0.003	0.035
Total Kjeldahl Nitrogen	mg/L N		2.0	1.6	1.6	1.3	1.1	1.2	2.0	1.5
Phosphorus - Dissolved	mg/L P		0.018	<0.010	<0.010	<0.010	0.015	<0.010	<0.013	<0.013
Other										
Cyanide - Total (CN)	ug/L	66	<0.50	<0.50	<0.50	<0.50	<1.0	<5.0	<1.0	<1.0
Organic Indicators										
Chemical Oxygen Demand	mg/L		111	102	90	75	80	59	118	81
Total Organic Carbon	mg/L		3.5	2.1	3.7	3.2	3.4	2.6	1.9	2.3
Metals										
Arsenic (As)- Dissolved	ug/L	1,900 *	1.51	2.83	2.92	3.75	3.14	4.05	0.87	3.52
Barium (Ba)- Dissolved	ug/L	29,000 *	10.2	17.3	14.0	18.7	12.7	19.0	14.9	23.4
Beryllium (Be)- Dissolved	ug/L	67 *	<0.050	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<10
Cadmium (Cd)- Dissolved	ug/L	2.7 *	0.050	0.014	0.214	0.058	0.090	0.052	0.140	0.130
Calcium (Ca)- Dissolved	mg/L		245	303	312	282	340	313	353	326
Chromium (Cr)- Dissolved	ug/L	810 *	0.21	4.54	<1.0	3.60	0.64	3.75	0.52	6.45
Copper (Cu)- Dissolved	ug/L	87 *	0.38	2.93	3.17	1.34	1.66	1.72	3.62	4.16
Iron (Fe)- Dissolved	ug/L		84.1	338	633	648	673	786	<10	516
Lead (Pb)- Dissolved	ug/L	25 *	0.016	0.034	0.161	0.079	0.106	0.163	0.094	0.186
Magnesium (Mg)- Dissolved	mg/L		110	128	149	120	169	180	166	129
Manganese (Mn)- Dissolved	ug/L		20.1	27.2	24.1	29.3	34.8	33.7	37.6	26.8
Mercury (Hg)- Total	ug/L	2.8 *	<0.010	<0.010	<0.002	<0.002	<0.005	<0.005	<0.0050	<0.0050
Nickel (Ni)- Dissolved	ug/L	490 *	1.3	1.3	2.0	1.5	2.0	1.8	2.9	2.8
Potassium (K)- Dissolved	mg/L		30.1	28.7	41.0	29.6	45.4	34.1	49.0	30.8
Selenium (Se)- Dissolved	ug/L	63 *	<0.20	<0.40	<0.40	<0.40	<0.05	0.11	<0.050	0.36
Silver (Ag)- Dissolved	ug/L	1.5 *	<0.025	<0.050	<0.050	<0.050	0.0195	<0.010	0.014	0.036
Sodium (na)- Dissolved	mg/L	2,300 *	1,140	1,074	1,590	1,126	1,750	1,238	1,750	1,129
Zinc (Zn)- Dissolved	ug/L	1,100 *	13.1	9.1	39.8	9.8	14.5	11.0	51.8	17.2
Bacteria										
Total Coliforms (MTF)	MPN/100mL		12	23	<3	<3	<1	21	<1	2
Fecal Coliforms (MTF)	MPN/100mL		<3	<3	<3	<3	<1	1	<1	1
E. coli (MTF)	MPN/100mL		<3	<3	<3	<3	<1	<1	<1	<1
Field Parameters										
pH	units		7.87	7.73	8.34	8.31	7.30	7.96	7.77	7.78
Specific Conductivity	(µS/cm)		5,017	5,073	8,015	7,812	9,140	6,836	8,215	6,961
Polycyclic Aromatic Hydrocarbons										
Naphthalene	µg/L	6,400	<0.050	0.083	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Benzo(a)pyrene	µg/L	0.81	<0.010	<0.010	<0.010	<0.010	<0.0050	<0.0050	<0.0050	<0.0050
Anthracene	µg/L	2.4	<0.050	<0.050	<0.050	<0.050	<0.010	<0.010	<0.010	<0.010
Petroleum Hydrocarbons										
F1 (C6-C10 Hydrocarbons)	µg/L	750	<25	107	<25	<25	<100	<100	<100	<100
F2 (C10-C16 Hydrocarbons)	µg/L	150	<100	<100	<100	<100	<100	<100	<100	<100
F3 (C16-C34 Hydrocarbons)	µg/L	500	<200	<200	<200	<200	<250	<250	<250	<250
F4 (C34-C50 Hydrocarbons)	µg/L	500	<200	<200	<200	<200	<250	<250	<250	<250
Benzene	µg/L	430	<0.10	<5.0	<0.10	<0.10	<0.50	<0.50	<0.50	<0.50
EthylBenzene	µg/L	2,300	<0.10	<5.0	<0.10	0.17	<0.50	<0.50	<0.50	<0.50
Toluene	µg/L	18,000	<0.20	0.46	<0.20	0.48	<0.50	<0.50	<0.50	<0.50
Xylene (Total)	µg/L	4,200 *	<0.10	0.29	<0.10	0.95	<0.50	<0.50	<0.50	<0.50
Volatile Organic Carbons										
Vinyl chloride	µg/L	1.7	<0.20	<10	<0.20	<0.20	<0.50	<0.50	<0.50	<0.50
Pesticides										
Diazinon	µg/L		<2.0	<2.0	<2.0	<2.0	<0.10	<0.10	<0.10	<0.10
Herbicides										
2,4-D	µg/L		<1.0	<1.0	<1.0	<1.0	<0.10	<0.10	<0.10	<0.10

Note: Criteria from Ontario Ministry of the Environment. (2011, July 1). Soil, Ground Water and Sediment Standards for Use Under Part XV.I of the Environmental Protection Act Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition
Note: Where value is expressed as less than (<), the value is halved and used in the calculations, where value is expressed as (>), the value is used in the calculations.
* Criteria for total chloride, total metals and xylene mixture

5.2 SURFACE WATER

Surface water flows at the BRRMF are managed by perimeter ditching and the central access road, which creates a barrier between the impacted water ditches on the North and the clean water ditches on the South; there are also 8 surface water retention ponds. The system is designed to run dry for most of the year, as such, grab sampling is performed three times per year: spring run-off, summer run-off, and fall run-off. The surface water sampling points are shown in Figure 3.

As per the BRRMF Operating Plan, surface water is managed in accordance with the Surface Water Sampling and Analysis Plan (SAP), as specified under Clause 115. Compliance parameters are applied to the upstream and downstream sampling points, with modifications at other locations interior to the site. Sampling for the clean water ponds (SWQ-25-9a and b) is similar to sampling for perimeter ditching. Sampling for impacted water ponds Active Area Collection Pond (SWQ-25-6), Biosolids Storm Water Pond (SWQ-25-7), Leaf and Yard Waste Storm Water Pond (SWQ-25-8) and dry ponds (SWQ-25-11 a, b, and c) is performed only prior to discharge events. The Canadian Council of Ministers of the Environment (CCME) Water Quality Guidelines for the Protection of Freshwater Aquatic Life are used as the regulatory guideline (CCME, 2003). Weekly field monitoring is performed at the weir from spring thaw to freeze-up.

In 2019, a total of 35 surface water samples were analyzed – 6 upstream samples, 5 downstream samples, 8 samples intermediate to the site, and 16 pond samples. There were no deviations from the Surface Water SAP or from normal sample collection and preservation practices. Weekly weir data is provided in Table 4 and the 2019 surface water results are provided in Tables 5.1 and 5.2.

The analytical results for some of the pond samples exceeded the guidelines for pH, chloride, arsenic, copper, iron, nickel, and selenium; the water was retained in the ponds or hauled for treatment as required. Many of the analytical results for perimeter ditching were highly variable between sampling events and between sample points. Dissolved chloride and pH sometimes exceeded the guidelines at the intermediate and downstream locations, and iron concentration sometimes exceeded the guideline at the upstream and downstream locations. Samples collected from the ponds and the perimeter ditching frequently contain elevated levels of arsenic, which is due to its natural occurrence in Manitoba soils.

The 2015-2019 averages for upstream and downstream locations are provided in Table 6 and time versus concentration graphs showing the historical relationship of the analytical parameters at each monitoring location are provided in Appendix D. In general, the analytical results for surface water obtained in 2019 were found to be similar to those obtained in 2015-2018, with similar results for upstream and downstream locations.

The Contingency Action Plan identified under Clause 125 was not implemented in 2019.

At this time we have no recommendations for changes in the surface water monitoring program.

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Table 4. 2019 Weekly Weir Data

Date	Flow (m/s)	pH (units)	Conductivity (m/s)	DO (mg/L)	Temp (°C)
18-Apr-19	0.2	7.50	0.64	6.0	10.8
26-Apr-19	0.0	9.33	4.20	16.5	8.5
3-May-19	0.2	9.12	0.93	11.9	13.5
10-May-19	0.2	8.91	1.14	11.6	10.8
17-May-19	0.0	8.52	1.33	11.6	12.5
24-May-19	0.0	8.44	1.46	10.7	14.3
31-May-19	0.0	8.39	1.55	11.1	16.6
7-Jun-19	0.0	8.91	1.60	10.9	22.7
14-Jun-19	0.0	9.22	1.61	11.8	20.4
21-Jun-19	0.0	9.42	1.65	12.1	21.2
28-Jun-19	0.0	9.96	1.62	14.3	23.1
5-Jul-19	0.0	10.32	1.68	13.8	28.3
13-Jul-19	0.0	9.84	1.70	18.0	26.4
19-Jul-19	0.0	8.40	3.20	7.4	24.1
25-Jul-19	0.0	8.81	3.57	9.0	28.7
2-Aug-19	0.0	8.50	3.62	5.2	27.6
9-Aug-19	0.0	8.81	3.78	10.3	24.7
16-Aug-19	0.0	8.62	3.33	9.0	23.3
23-Aug-19	0.0	8.66	3.71	6.7	19.4
30-Aug-19	0.0	8.36	2.35	7.9	21.5
6-Sep-19	0.0	8.42	2.20	6.9	18.8
13-Sep-19	0.0	8.83	1.97	9.3	18.5
27-Sep-19	0.3	8.43	0.78	4.9	13.0
4-Oct-19	0.1	8.21	0.87	5.2	8.3
11-Oct-19	*ns				
18-Oct-19	*ns				
25-Oct-19	0.1	8.40	0.61	7.3	10.4
1-Nov-19	**ns				
15-Nov-19	**ns				

*ns - no sample, staff reassigned to storm clean-up
**ns - no sample because weir was completely dry and/or frozen

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Table 5.1 2019 Surface Water Monitoring - Ponds

			Ponds															
			SW25-6		SW25-7		SW25-8		SW25-9A		SW25-9B		SW25-11A		SW25-11B		SW25-11C	
Sampling date	Units	Criteria	30-Apr-19	31-Jul-19	30-Apr-19	31-Jul-19	30-Apr-19	31-Jul-19	Spring	31-Jul-19	30-Apr-19	Summer	30-Apr-19	31-Jul-19	30-Apr-19	31-Jul-19	30-Apr-19	31-Jul-19
Inorganic Parameters																		
Alkalinity - Bicarbonate	mg/L		3,220	2,910	136	266	662	660	239	205	253	207	522	677	525	585	407	622
Alkalinity - Carbonate	mg/L		<3.0	<3.0	69.3	46	<3.0	41.7	<3.0	30.0	6.2	35.1	114	108	89.0	178	123	276
Alkalinity - Hydroxide	mg/L		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Alkalinity - Total	mg/L		3,220	2,910	205	312	662	701	239	235	260	242	635	784	614	763	530	898
Dissolved Hardness (CaCO3)	mg/L		1,130	553	189	299	401	360	152	162	142	115	147	286	158	242	127	240
pH	units	6.5-9.0	7.82	7.87	9.48	8.77	8.13	8.43	8.23	8.96	8.34	8.93	9.03	8.63	8.95	8.96	9.11	9.02
Specific Conductivity	(µS/cm)		1,550	8,940	3,410	2,470	834	3,300	940	926	772	761	2,950	4,020	2,650	3,950	2,350	4,140
Turbidity	(ntu)		286.4	820	27.1	6.79	39.68	14.6	22.84	63.8	134	89.6	45.3	63.5	45.7	12.5	43.9	8.35
Total Dissolved Solids	mg/L		6,660	6,180	1,070	1,830	2,330	2,420	504	578	431	497	1,800	2,720	1,720	2,600	1,550	2,890
Total Suspended Solids	mg/L		485	3,280	176	410	196	204	148	228	435	297	201	366	163	292	202	269
Total Solids	mg/L		7,150	9,450	1,250	2,240	2,530	2,630	652	806	866	794	2,000	3,090	1,880	2,890	1,750	3,160
Dissolved Chloride (Cl)	mg/L	640 *	730	1,490	148	298	438	500	79	100	74.4	82	246	680	510	660	489	970
Dissolved Sulphate (SO4)	mg/L		16.0	<0.4	382	582	342	412	94.9	73.0	42.9	42.2	254	443	256.0	423.0	226	349
Nutrients																		
Ammonia - Dissolved	mg/L N		264	NA	0.009	0.292	3.66	0.885	2.98	<0.003	4.34	0.028	9.67	1.10	7.65	0.208	2.13	0.090
Nitrate - Dissolved	mg/L N	13	0.081	NA	0.003	0.399	0.039	0.231	0.340	<0.003	0.541	<0.003	0.381	0.758	1.42	0.469	0.657	0.003
Total Kjeldahl Nitrogen	mg/L N		330	NA	3.9	56	17	16	4.4	1.7	6.7	1.8	22	12	20	10	14	11
Phosphorus - Dissolved	mg/L P		11.8	NA	0.066	0.507	2.72	2.75	0.076	0.986	0.275	0.181	0.030	1.41	0.020	1.16	<0.013	1.82
Other																		
Cyanide - Total (CN)	ug/L	5000	9.6	7.9	1.3	2.0	7.4	6.3	1.3	<1.0	1.2	<1.0	4.5	4.4	4.4	3.9	4.1	3.6
Organic Indicators																		
Chemical Oxygen Demand	mg/L		>5000	4790	206	179	402	428	62	82	95	103	384	359	372	311	347	337
Biochemical Oxygen Demand	mg/L		4390	2140	19	<4	8	9	<4	10	9	14	54	18	54	2	64	103.8
Metals																		
Arsenic (As)- Dissolved	ug/L	5 *	14.3	28.4	7.40	13.6	15.6	23.2	3.92	15.5	5.74	15.2	11.7	38.3	10.4	34.0	11.6	38.5
Barium (Ba)- Dissolved	ug/L		187	155	34.5	55.4	87.9	85.9	56.3	66.6	57.6	70.1	60.6	188	65.8	163	46.3	160
Beryllium (Be)- Dissolved	ug/L		0.15	0.51	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium (Cd)- Dissolved	ug/L	0.09 *	0.0094	0.0190	0.0086	<0.0050	0.0175	0.0224	0.0055	0.0053	0.0088	<0.0050	0.0146	0.0152	0.0170	0.0130	0.0109	0.0153
Calcium (Ca)- Dissolved	mg/L		422	117	70.8	103	142	133	55.1	53.5	45.2	38.5	53.3	90.0	54.0	82.2	42.5	82.6
Chromium (Cr)- Dissolved	ug/L		97.9	75.9	0.19	0.20	1.01	0.97	0.11	<0.10	<0.10	0.12	4.32	1.23	3.80	1.28	2.68	1.36
Copper (Cu)- Dissolved	ug/L	4 *	0.58	0.71	1.15	1.60	6.67	7.16	1.83	1.87	1.14	0.74	5.82	6.37	5.57	4.27	5.38	5.85
Iron (Fe)- Dissolved	ug/L	300 *	192	448	17	37	267	157	24	<10	17	28	47	20	48	28	33	13
Lead (Pb)- Dissolved	ug/L	7 *	0.106	0.496	<0.050	0.091	0.183	0.414	<0.050	0.063	<0.050	0.063	0.090	0.130	0.085	0.089	0.082	0.156
Magnesium (Mg)- Dissolved	mg/L		321	392	104	188	163	165	47.0	51.4	41.8	44.7	164	235	159	228	149	258
Manganese (Mn)- Dissolved	ug/L		3,050	196	15.9	75.7	737	492	263	1.47	244	6.56	16.3	50.6	8.34	22.1	8.66	30.9
Mercury (Hg)- Dissolved	ug/L	0.026 *	<0.025	<0.025	<0.0050	<0.0050	0.0060	<0.025	0.0070	<0.0050	0.0050	<0.0050	0.0060	<0.0050	0.0050	<0.0050	0.0050	<0.0050
Nickel (Ni)- Dissolved	ug/L	150 *	191	225	7.43	10.2	42.7	38.8	5.74	5.07	5.45	4.30	61.9	55.8	55.2	52.0	46.4	57.4
Potassium (K)- Dissolved	mg/L		228	324	35.1	61.7	400	430	16.5	17.1	16.6	17.3	95.5	228	93.8	208	94.4	184
Selenium (Se)- Dissolved	ug/L	1 *	2.47	2.04	0.305	0.361	1.04	1.13	0.210	0.304	0.234	0.202	0.647	0.776	0.562	0.746	0.635	0.675
Sodium (Na)- Dissolved	mg/L		886	1260	103	169	116	111	38.4	45.9	35.4	39.5	269	322	251	318	227	391
Zinc (Zn)- Dissolved	ug/L	30 *	6.2	2.6	<1.0	1.3	5.5	5.30	3.8	<1.0	1.8	1.1	4.8	2.3	4.7	1.7	3.1	1.8
Bacteria																		
Total Coliforms (MTF)	MPN/100mL		3870	>24,200	890	>2,420	250	>24,200	60	>2,420	210	>2,420	1,550	>2,420	200	>2,420	480	>2,420
Fecal Coliforms (MTF)	MPN/100mL		1,790	6130	10	397	180	1,870	<10	225	10	816	550	240	100	613	170	308
E. coli (MTF)	MPN/100mL		650	5480	<10	488	80	1,470	<10	365	30	921	500	326	10	345	160	228
Field Parameters																		
pH	units	6.5-9.0	7.99	8.08	9.63	9.33	8.55	8.58	8.55	9.57	8.76	9.50	9.65	8.87	9.28	9.08	9.81	9.23
Specific Conductivity	(µS/cm)		7,270	7,270	14,790	2,320	3,040	2,940	8,310	867	7,400	755	2,590	3,410	2,490	3,170	2,230	3,520
Temperature	°c		8.8	24.5	5.8	22.5	7.1	24.6	8.0	23.7	8.5	25.0	6.2	22.2	6.8	23.5	6.6	22.4

Note: Criteria from Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines Summary Table. Water Quality Guidelines for the Protection of Freshwater Aquatic Life. (CCME, 2003)
* Criteria for total chloride and total metals
NA - Not analysed due to laboratory error

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Table 5.2 2019 Surface Water Monitoring - Perimeter Ditch

			Upstream						Downstream					Intermediate							
			SW25-1			SW25-12			SW25-2			SW25-16		SW25-13A	SW25-13B	SW25-14A	SW25-14B	SW25-15A		SW25-15B	
Sampling date	Units	Criteria	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Fall	Spring	Summer	Spring	Spring	Spring	Spring	Spring	Summer	Spring	Summer
Inorganic Parameters																					
Alkalinity - Bicarbonate	mg/L		200	336	193	206	515	194	206	865	271	271	743	214	229	213	206	159	837	209	788
Alkalinity - Carbonate	mg/L		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	45.3	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	148	77.3	70.5	56.5	90.0
Alkalinity - Hydroxide	mg/L		<3.0	<3.0	<30	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Alkalinity - Total	mg/L		200	336	193	206	515	194	251	865	271	271	743	214	229	213	221	237	907	265	878
Dissolved Hardness (CaCO3)	mg/L		105	179	242	112	297	137	117	269	178	154	291	155	296	358	139	109	221	119	236
pH	units	6.5-9.0	7.56	7.31	7.65	7.57	7.33	7.65	9.13	8.11	7.81	7.59	7.33	7.65	7.65	8.36	8.74	9.15	8.34	9.10	8.51
Specific Conductivity	(µS/cm)		461	765	492	495	1,920	456	8,710	4,160	1,040	868	1,850	515	731	715	751	721	4,410	924	4,390
Turbidity	(ntu)		19.6	29.6	790	6.52	148	59.5	8.07	2.78	55.4	6.26	74.7	104.8	172	343	62.5	52.0	55.3	36.1	214
Total Dissolved Solids	mg/L		304	491	323	316	532	295	579	2,780	675	501	1,290	318	430	295	431	426	2,920	540	1,870
Total Suspended Solids	mg/L		64	353	1,080	24	5,000	125	77	267	103	65	481	340	660	1,490	265	128	781	256	11,900
Total Solids	mg/L		368	844	1,400	340	5,530	420	656	3,050	778	566	1,770	658	1,090	1,780	696	554	3,700	796	13,800
Dissolved Chloride (Cl)	mg/L	640 *	29.7	45.0	15.8	38.7	222	23.6	111	900	117	49.2	249	35.3	89.6	79.2	81.8	76.6	880	117.0	960
Dissolved Sulphate (SO4)	mg/L		13.4	32.0	3.0	25.9	317	<0.4	75.0	313	<0.4	274	380	24.6	74.8	59.4	40.3	44.9	425.0	78.1	402.0
Nutrients																					
Ammonia - Dissolved	mg/L N		0.005	0.114	0.011	0.065	0.241	0.004	0.028	0.037	>2	0.006	<0.003	0.009	0.007	0.013	3.72	0.011	0.312	0.017	0.749
Nitrate - Dissolved	mg/L N	13	<0.003	<0.003	0.022	0.007	<0.003	0.035	0.016	<0.003	0.829	<0.003	<0.003	<0.003	<0.003	0.009	0.528	0.173	0.082	0.302	0.045
Total Kjeldahl Nitrogen	mg/L N		0.9	1.8	2.2	0.6	3.9	1.2	2.1	10	5.3	1.3	3.8	0.8	1.3	1.1	6.7	4.2	12	4.8	13
Phosphorus - Dissolved	mg/L P		0.064	0.220	0.098	0.104	0.456	0.166	<0.013	1.35	0.344	0.020	0.243	0.100	0.079	0.024	0.255	<0.013	1.74	<0.013	1.66
Other																					
Cyanide - Total (CN)	mg/L	5000	<1.0	<1.0	1.1	<1.0	<1.0	1.2	1.5	3.0	1.2	1.3	1.1	<1.0	<1.0	<1.0	1.1	1.1	2.8	1.4	2.3
Organic Indicators																					
Chemical Oxygen Demand	mg/L		77	156	195	59	176	80	88	320	99	76	193	134	149	220	118	139	442	141	458
Biochemical Oxygen Demand	mg/L		4	7	7	<4	61	<4	8	<4	8	13	15	6	6	9	15	33	29	14	19
Metals																					
Arsenic (As)- Dissolved	ug/L	5 *	3.08	6.69	2.18	3.08	3.83	2.84	5.01	29.2	5.85	3.95	5.86	3.14	2.88	2.63	5.90	4.13	36.3	4.77	35.1
Barium (Ba)- Dissolved	ug/L		32.7	61.5	56.1	36.0	95.4	34.3	50.2	168	65.6	61.0	141	36.7	48.6	56.7	56.0	42.3	155	44.1	151
Beryllium (Be)- Dissolved	ug/L		<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium (Cd)- Dissolved	ug/L	0.09 *	0.0157	<0.0050	0.0178	0.0114	<0.0050	0.0057	0.0116	0.0104	0.0163	0.0060	0.0247	0.0080	0.0054	<0.0050	0.0068	0.0122	0.0056	0.0098	0.0091
Calcium (Ca)- Dissolved	mg/L		41.6	63.3	46.3	44.5	83.5	41.5	46.5	89.5	56.2	61.9	103	45.6	59.3	56.4	46.4	41.0	77.1	42.1	73.5
Chromium (Cr)- Dissolved	ug/L		0.15	0.18	0.20	0.18	0.28	0.22	0.34	1.31	1.14	0.46	0.61	0.14	0.21	0.13	0.11	0.16	1.38	0.37	1.41
Copper (Cu)- Dissolved	ug/L	4 *	1.40	0.20	2.43	1.37	<0.20	2.30	2.57	1.06	2.68	1.79	1.06	1.40	1.46	1.99	1.51	1.99	1.61	2.11	1.40
Iron (Fe)- Dissolved	ug/L	300 *	93	353	44	132	303	207	19	89	77	113	327	124	185	53	30	20	34	16	44
Lead (Pb)- Dissolved	ug/L	7 *	0.097	0.051	0.083	0.064	<0.050	0.067	0.052	<0.050	0.060	1.10	0.126	0.054	0.111	0.107	0.085	<0.050	<0.050	<0.050	0.069
Magnesium (Mg)- Dissolved	mg/L		27.5	45.9	23.9	27.7	99.4	27.2	56.0	251	55.7	39.9	100	27.7	39.3	39.7	41.2	46.1	269.0	55.3	260.0
Manganese (Mn)- Dissolved	ug/L		6.81	197	63.9	9.85	585	57.0	13.7	135	49.4	32.9	592	8.20	53.6	21.4	230	38.3	93.8	8.75	111
Mercury (Hg)- Dissolved	ug/L	0.026 *	0.0070	<0.0050	<0.0050	0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0060	<0.0050	0.0050	<0.0050	<0.0050	0.0110	0.0050	<0.0050	0.0050	<0.0050
Nickel (Ni)- Dissolved	ug/L	150 *	2.47	2.76	4.98	2.70	1.80	2.83	9.48	56.2	12.8	4.72	10.8	2.76	3.23	4.05	5.35	5.09	57.6	8.73	54.2
Potassium (K)- Dissolved	mg/L		13.9	12.6	9.51	12.2	12.6	10.3	27.6	153	38.4	17.4	22.5	11.6	11.5	11.6	16.7	17.0	187	24.0	179
Selenium (Se)- Dissolved	ug/L	1 *	0.260	0.171	0.255	0.189	0.202	0.156	0.287	0.541	0.382	0.242	0.403	0.144	0.170	0.163	0.178	0.219	0.618	0.266	0.621
Sodium (Na)- Dissolved	mg/L		16.4	32.5	12.5	17.9	116	24.9	60.3	389	64.0	55.2	148	18.1	32.6	28.0	35.3	40.1	415	56.9	400
Zinc (Zn)- Dissolved	ug/L	30 *	1.7	<1.0	1.9	4.3	1.2	4.5	1.9	2.0	3.8	4.6	2.8	3.4	92.4	7.1	2.5	1.7	1.9	1.6	5.6
Bacteria																					
Total Coliforms (MTF)	MPN/100mL		1,920	>2,420	>2,420	190	>24,200	>2,420	1,010	>2,420	>2,420	90	>24,200	160	1400	1,660	120	20	>2,420	240	>24,200
Fecal Coliforms (MTF)	MPN/100mL		40	88	225	<10	260	1,730	1,090	1,410	727	<10	3,260	10	<10	670	40	<10	>2,420	<10	2,760
E. coli (MTF)	MPN/100mL		80	46	133	30	170	1,050	750	1,300	866	<10	3,650	<10	10	720	<10	<10	>2,420	10	1,840
Field Parameters																					
pH	units	6.5-9.0	7.98	7.85	8.71	8.18	8.00	8.77	9.11	8.20	8.64	8.40	7.91	8.13	8.31	8.46	8.84	9.41	8.89	9.46	8.68
Specific Conductivity	(µS/cm)		4,760	806	522	4,950	1,549	560	942	3,530	1,078	815	1,765	6,580	6,210	6,960	7,220	715	3,640	783	3,610
Temperature	°c		4.2	17.7	12.1	4.0	17.8	10.8	5.7	19.7	11.0	4.4	16.5	3.2	3.8	5.9	9.2	5.2	20.5	6.3	18.8

Note: Criteria from Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines Summary Table. Water Quality Guidelines for the Protection of Freshwater Aquatic Life. (CCME, 2003)
* Criteria for total chloride and total metals

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Table 6. 2019 Surface Water Monitoring - Perimeter Ditch Comparison

			2016		2017		2018		2019	
	Units	Criteria	Average		Average		Average		Average	
Inorganic Parameters			**Upstream**	**Downstream**	**Upstream**	**Downstream**	**Upstream**	**Downstream**	**Upstream**	**Downstream**
Alkalinity - Bicarbonate	mg/L		254	349	359	433	174	300	243	447
Alkalinity - Carbonate	mg/L		<0.50	<0.50	<0.50	<0.50	<3.0	18	<3.0	16
Alkalinity - Hydroxide	mg/L		<0.50	<0.50	<0.50	<0.50	<3.0	<3.0	<3.0	<3.0
Alkalinity - Total	mg/L		208	287	294	355	174	319	243	462
Dissolved Hardness (CaCO3)	mg/L		515	523	316	448	248	499	175	188
pH	units	6.5-9.0	7.40	8.15	7.68	8.80	7.56	8.84	7.51	8.35
Specific Conductivity	(µS/cm)		1,029	1,588	774	1,154	615	1,590	573	4,637
Turbidity	(ntu)		151	135	118	87.2	37.2	32.8	279.7	22.1
Total Dissolved Solids	mg/L		721	1,025	496	810	370	996	373	1,345
Total Suspended Solids	mg/L		483	531	379	169	116	167	499	149
Total Solids	mg/L		1,204	1,557	875	978	486	1,164	871	1,495
Dissolved Chloride (Cl)	mg/L	640 *	61.3	209	62.0	151	60.0	220	30	376
Dissolved Sulphate (SO4)	mg/L		205	227	32.5	33.2	57.6	170	16	129
Nutrients										
Ammonia - Dissolved	mg/L N		0.295	0.730	0.009	0.560	0.041	0.426	0.043	0.688
Nitrate - Dissolved	mg/L N	13	3.96	2.98	<0.003	0.184	0.234	0.500	0.008	0.282
Total Kjeldahl Nitrogen	mg/L N		5.40	13.1	1.95	3.35	2.55	6.85	1.63	5.80
Phosphorus - Dissolved	mg/L P		0.060	0.060	382	195	0.085	0.252	0.127	0.567
Other										
Cyanide - Total (CN)	ug/L	5,000	1.55	2.69	1.96	2.29	0.70	2.50	<1.0	1.90
Organic Indicators										
Chemical Oxygen Demand	mg/L		131	249	255	135	50	530	143	169
Biochemical Oxygen Demand	mg/L		12	51	<3	23	7	13	6	8
Metals										
Arsenic (As)- Dissolved	ug/L	5 *	2.92	5.91	5.25	8.64	2.80	8.85	3.98	13.35
Barium (Ba)- Dissolved	ug/L		47.9	87.2	54.0	68.9	53.7	70.2	50.1	94.6
Beryllium (Be)- Dissolved	ug/L		<0.010	<0.010	<0.010	<0.010	<0.10	<0.10	<0.10	<0.10
Cadmium (Cd)- Dissolved	ug/L	0.09 *	0.0620	0.0093	<0.0050	0.0071	0.036	0.057	0.012	0.013
Calcium (Ca)- Dissolved	mg/L		126.2	60.4	55.0	42.9	47.7	50.0	50.4	64.1
Chromium (Cr)- Dissolved	ug/L		0.20	0.49	0.23	0.26	0.18	0.42	0.18	0.93
Copper (Cu)- Dissolved	ug/L	4 *	3.48	5.02	2.20	2.67	2.29	5.27	1.34	2.10
Iron (Fe)- Dissolved	ug/L	300 *	172	32	156	34	59	20	163	62
Lead (Pb)- Dissolved	ug/L	7 *	0.041	0.105	0.157	0.150	0.285	0.060	0.077	<0.050
Magnesium (Mg)- Dissolved	mg/L		48.7	90.7	43.5	55.4	31.3	91.0	32.4	120.9
Manganese (Mn)- Dissolved	ug/L		161.4	172.5	301	37.8	10.1	32.2	89.2	66.0
Mercury (Hg)- Dissolved	ug/L	0.026 *	0.003	0.003	0.002	<0.002	<0.005	<0.005	<0.0050	<0.0050
Nickel (Ni)- Dissolved	ug/L	150 *	2.77	18.9	2.45	10.9	2.62	20.1	3.4	26.2
Potassium (K)- Dissolved	mg/L		12.3	37.9	9.0	27.0	10.2	68.4	12.0	73.0
Selenium (Se)- Dissolved	ug/L	1 *	0.233	0.475	0.166	0.258	0.155	0.429	0.229	0.403
Sodium (Na)- Dissolved	mg/L		31.3	100	36.4	89.2	29.4	124	20	171
Zinc (Zn)- Dissolved	ug/L	30 *	4.3	5.3	2.9	3.3	2.6	4.7	1.4	2.6
Bacteria										
Total Coliforms (MTF)	MPN/100mL		11,000	>11,000	5,965	5,715	6,710	3,510	2,253	1,950
Fecal Coliforms (MTF)	MPN/100mL		336	4,008	2,301	33	23	530	118	1,076
E. coli (MTF)	MPN/100mL		336	3,979	2,301	19	6	765	86	972
Field Parameters										
pH	units	6.5-9.0	7.40	8.15	7.68	8.80	7.56	8.84	8.18	8.65
Specific Conductivity	(µS/cm)		947	1,380	720	450	660	1,619	2,029	1,850
Temperature	°C		NA	NA	NA	NA	19.7	7.2	11.3	12.1

Note: Criteria from Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines Summary Table. Water Quality Guidelines for the Protection of Freshwater Aquatic Life. (CCME, 2003)
* Criteria for total chloride and total metals
NA - not analyzed

5.3 LEACHATE

The leachate management system is a network of manholes/risers, drains, and sumps around the perimeter of the landfill cells, which feed into a header pipe. The leachate flows via gravity and lift stations into a 300,000L storage tank located at the intersection of Charette Road and the access road, which acts as a truck fill station for hauling to the North End Sewage Treatment Plant for treatment. Leachate can also be pumped from eight collection manholes and one riser if needed; these sites also serve as sampling points. The locations of the manholes and riser are shown on Figure 3.

As per the BRRMF Operating Plan, leachate is managed in accordance with the Leachate Sampling and Analysis Plan (SAP), as specified under Clause 100. The MOE guidelines for non-potable groundwater quality are used as the regulatory guideline (MOE, 2011).

The total volume of leachate removed from the BRRMF in 2019 was 36,763 kL. There were no occurrences of leachate breakout from the development in 2019, however, the leachate head in Cell 31 exceeded the crown of the collection system piping for approximately 30 days due to a malfunction in the centralized leachate collection system. The Contingency Action Plan identified under Clause 125 was not implemented in 2019, however an interim mitigation plan was used to operate the centralized leachate collection system until stainless steel replacement components could be installed.

In 2019, 10 leachate samples were analyzed; there were no deviations from the Leachate SAP or from normal sample collection and preservation practices. Monthly leachate elevations are provided in Table 7, and the 2019 leachate results are provided in Table 8. The majority of parameters were found to be highly variable between manholes; several of the samples exceeded the guidelines for chloride and hydrocarbons. Leachate is highly variable due to waste composition, amount of precipitation, site hydrology, waste compaction, cover, and interaction of leachate with the environment.

The 2015-2019 average results are provided in Table 9, and Piper diagrams showing the historical relationship of cations and anions at each monitoring location are provided in Appendix C. Many of the other parameters measured vary significantly from year to year. The average alkalinity, hardness, and conductivity have been increasing yearly since 2015 because improved landfill cover allows less water infiltration, which aids the biological breakdown of inorganic compounds.

We have no recommendations for changes in the leachate monitoring program at this time.

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Table 7. 2019 Leachate Levels

	Date	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19
Manhole 3	Top of Manhole Elevation (m)	233.66	233.66	233.66	233.66	233.66	233.66	233.66	233.66	233.66	233.66	233.66	233.66
	Depth to Leachate (m)	1.69	1.62	1.68	3.64	1.69	3.84	1.60	5.33	2.16	0.94	1.29	2.84
	Manhole Leachate Elevation (m)	231.97	232.04	231.98	230.02	231.97	229.82	232.06	228.33	231.50	232.72	232.37	230.82
Manhole 8	Top of Manhole Elevation (m)	236.61	236.61	236.61	236.61	236.61	236.61	236.61	236.61	236.61	236.61	236.61	236.61
	Depth to Leachate (m)	3.38	3.00	3.04	1.94	3.02	4.68	5.49	4.31	1.94	4.52	6.73	7.92
	Manhole Leachate Elevation (m)	233.23	233.61	233.57	234.67	233.59	231.93	231.12	232.30	234.67	232.09	229.88	228.69
Manhole 13	Top of Manhole Elevation (m)	234.89	234.89	234.89	234.89	234.89	234.89	234.89	234.89	234.89	234.89	234.89	234.89
	Depth to Leachate (m)	7.90	8.89	10.05	8.31	5.26	4.58	8.49	9.69	9.61	3.44	5.21	5.58
	Manhole Leachate Elevation (m)	226.99	226.00	224.84	226.58	229.63	230.31	226.40	225.20	225.28	231.45	229.68	229.31
Manhole 24	Top of Manhole Elevation (m)	235.00	235.00	235.00	235.00	235.00	235.00	235.00	235.00	235.00	235.00	235.00	235.00
	Depth to Leachate (m)	6.47	5.38	7.67	7.97	1.89	1.27	7.77	7.67	7.97	1.20	5.80	7.90
	Manhole Leachate Elevation (m)	228.53	229.62	227.33	227.03	233.11	233.73	227.23	227.33	227.03	233.80	229.20	227.10
Manhole 27	Top of Manhole Elevation (m)	235.71	235.71	235.71	235.71	235.71	235.71	235.71	235.71	235.71	235.71	235.71	235.71
	Depth to Leachate (m)	2.02	1.95	1.97	1.94	2.30	2.42	2.48	2.08	2.33	2.10	2.38	1.86
	Manhole Leachate Elevation (m)	233.69	233.76	233.74	233.77	233.41	233.29	233.23	233.63	233.38	233.61	233.33	233.85
Manhole 31	Top of Manhole Elevation (m)	234.74	234.74	234.74	234.74	234.74	234.74	234.74	234.74	234.74	234.74	234.74	234.74
	Depth to Leachate (m)	2.55	1.90	1.74	3.31	1.54	2.21	1.77	3.07	3.52	0.60	7.90	2.44
	Manhole Leachate Elevation (m)	232.19	232.84	233.00	231.43	233.20	232.53	232.97	231.67	231.22	234.14	226.84	232.30
Manhole 34	Top of Manhole Elevation (m)	235.42	235.42	235.42	235.42	235.42	235.42	235.42	235.42	235.42	235.42	235.42	235.42
	Depth to Leachate (m)	2.64	3.31	3.42	2.76	2.97	2.80	2.70	2.61	2.70	2.17	2.41	2.40
	Manhole Leachate Elevation (m)	232.78	232.11	232.00	232.66	232.45	232.62	232.72	232.81	232.72	233.25	233.01	233.02
Manhole 46	Top of Manhole Elevation (m)	235.04	235.04	235.04	235.04	235.04	235.04	235.04	235.04	235.04	235.04	235.04	235.04
	Depth to Leachate (m)	4.20	4.10	3.05	3.77	3.76	4.00	4.83	4.62	5.16	4.51	4.86	4.95
	Manhole Leachate Elevation (m)	230.84	230.94	231.99	231.27	231.28	231.04	230.21	230.42	229.88	230.53	230.18	230.09
Riser 1	Top of Riser Elevation (m)	234.97	234.97	234.97	234.97	234.97	234.97	234.97	234.97	234.97	234.97	234.97	234.97
	Depth to Leachate (m)	7.21	7.26	7.22	7.25	7.13	7.19	7.06	7.04	7.18	7.36	7.41	7.35
	Riser Leachate Elevation (m)	227.76	227.71	227.75	227.72	227.84	227.78	227.91	227.93	227.79	227.61	227.56	227.62

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Table 8. 2019 Leachate Monitoring

			LQ25-MH3	LQ25-MH8	LQ25-MH13	LQ25-MH24	LQ25-MH27	LQ25-MH31	LQ25-MH34	RISER 1	LQ25-MH46	Composite
Sampling Date	Units	Criteria	11-Sep	11-Sep	11-Sep	11-Sep	11-Sep	11-Sep	11-Sep	10-Sep	10-Sep	13-Sep
Field Parameters												
pH	units		7.65	7.71	7.77	8.26	8.64	7.72	8.02	NR	6.52	
Turbidity	ntu		45.5	147	29.3	22.3	1.81	12.7	18.3	1,000	219	
Specific Conductivity	uS/cm		12,680	11,650	9,450	4,840	1,060	9,550	1,550	15,780	11,410	
Temperature	°C		12.1	14.8	9.9	13.3	13.2	14.1	12.1	18	17.8	
Inorganic Parameters												
Alkalinity - Bicarbonate	mg/L		3,640	5,510	5,150	2,950	442	3,390	419	9,420	5,610	
Alkalinity - Carbonate	mg/L		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	
Alkalinity - Hydroxide	mg/L		<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	
Alkalinity - Total	mg/L		3,640	5,510	5,150	2,950	442	3,390	419	9,420	5,610	
Hardness (as CaCO3)	mg/L		516	516	716	713	261	358	368	373	3,140	
pH	units		7.24	7.23	7.08	7.43	7.45	7.54	7.39	7.48	6.32	
Specific Conductivity	uS/cm		15,900	14,900	12,400	8,650	1,150	11,300	1,730	20,600	13,900	
Turbidity	ntu		43.4	197.5	196.5	31.5	7.54	14.96	11.3	127	272	
Total Dissolved Solids	mg/L		7,990	6,920	7,030	4,550	812	5,550	1,180	10,300	12,800	
Total Suspended Solids	mg/L		691	737	569	403	12	362	209	862	1,870	
Total Solids	mg/L		8,680	7,660	7,600	4,960	824	5,910	1,390	11,100	14,700	
Chloride (dissolved)	mg/L	2300 *	3,960	2,470	2,850	1,960	120.0	1,740	190	4,560	1,800	
Sulphate (dissolved)	mg/L		201	519	43.0	46.0	<0.4	208	509	<0.4	321	
Other												
Cyanide (CN)	ug/L	66	13.6	14.5	7.9	16.4	2.2	44.2	3.5	16.3	9.0	
Nutrients												
Dissolved Ammonia	mg/L		793	725	422	364	1.18	464	4.30	1,450	679	
Nitrate Nitrogen	mg/L		2.70	1.15	0.009	<0.003	0.476	NA	3.71	0.024	0.019	
Total Kjeldhal Nitrogen	mg/L		1,100	1,200	600	430	1.8	NA	3.6	1,500	760	
Phosphorus (Total)	mg/L		4.0623	7.0160	3.8014	2.9273	<0.0012	0.8859	<0.0012	10.410	40.853	
Organic Indicators												
Biological Oxygen Demand	mg/L		125	752	88	69	<4	38	8	651	11,700	
Chemical Oxygen Demand	mg/L		1,890	>5,000	1,360	670	45	880	49	3,510	>5,000	
Metals												
Total Arsenic (As)	mg/L	1.9	0.009381	0.021305	0.002630	<0.000017	<0.000017	<0.000017	<0.000017	0.14818	0.016237	
Total Barium (Ba)	mg/L	29	0.79467	0.69706	0.83064	0.22505	0.10242	0.27728	0.13741	0.22320	0.22856	
Total Beryllium (Be)	mg/L	0.067	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	<0.00003	
Total Cadmium (Cd)	mg/L	0.0027	<0.000007	<0.000007	<0.000007	<0.000007	<0.000007	<0.000007	<0.000007	<0.000007	<0.000007	
Total Calcium (Ca)	mg/L		206.48	206.52	286.81	285.62	104.35	143.31	147.47	149.19	1,255.70	
Total Chromium (Cr)	mg/L	0.81	0.22424	0.18580	0.05984	0.02000	0.00332	0.02885	<0.00004	0.36729	0.19416	
Total Chromium (Hexavalent)	ug/L	140	<10	<10	<10	<10	<0.50	<10	<0.50	<10	<10	
Total Copper (Cu)	mg/L	0.087	0.017658	0.012241	0.059827	0.007284	0.003025	0.037759	0.013629	0.035131	0.009577	
Total Iron (Fe)	mg/L		12.761	6.2439	18.107	6.8711	0.33866	2.3165	0.57026	3.7702	20.568	
Total Lead (Pb)	mg/L	0.025	0.006801	0.002310	0.017148	<0.000065	<0.000065	0.005987	<0.000065	0.011731	<0.000065	
Total Magnesium (Mg)	mg/L		626.66	441.11	793.38	410.36	77.671	382.63	105.86	900.25	483.22	
Total Manganese (Mn)	mg/L		0.25812	0.72943	0.78991	0.59571	0.30266	0.24019	0.43188	0.21748	7.6511	
Total Mercury (Hg)	ug/L	2.8	0.0260	0.0140	<0.050	0.0060	<0.0050	0.0130	<0.0050	0.0370	0.0180	
Total Nickel (Ni)	mg/L	0.49	0.44968	0.35750	0.29358	0.11698	0.015250	0.25372	0.038765	0.81611	0.32406	
Total Potassium (K)	mg/L		785.97	603.91	554.62	286.26	19.491	386.69	63.757	961.08	550.01	
Dissolved Selenium (Se)	ug/L	63 *	1.91	1.69	1.01	1.07	<0.50	1.22	<0.50	<5.0	2.46	
Total Silver (Ag)	ug/L	1.5	0.218	0.122	<0.10	<0.10	<0.010	0.134	<0.010	0.22	<0.10	
Total Sodium (Na)	mg/L	2,300	1,979.8	1,832.5	1,678.6	880.4	76.460	1,165.2	113.76	3,163.9	1,390.3	
Total Zinc (Zn)	mg/L	1.1	0.18283	1.7838	0.38668	0.27311	0.29343	0.24964	0.04582	0.47484	1.0797	
Extractables												
Benzo (a) Pyrene (PAH)	ug/L	0.81	0.0196	0.640	9.76	0.0331	0.0519	0.0259	0.0160	0.0174	<0.0050	
Anthracene	ug/L	2.4	0.223	3.78	13.4	0.388	0.043	0.125	0.020	0.032	0.048	
4'4' Methylenebis 2 Chloroaniline	ug/L		<5.0	<50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
Benzo (a) anthracene (PAH)	ug/L	4.7	0.095	2.04	20.2	0.112	0.053	0.072	0.010	0.035	0.027	
Benzo (b/j) fluoroanthene (PAH)	ug/L		0.031	1.16	13.5	0.042	0.155	0.042	0.033	0.016	<0.010	
Benzo (g,h,i) Perylene (PAH)	ug/L	0.2	0.034	1.03	5.10	<0.020	0.032	0.035	<0.020	<0.020	<0.020	
Hexachlorobenzene	ug/L	3.1	<1.0	<50	<50	<1.0	<1.0	<1.0	<1.0	<0.080	<0.40	
Phenanthrene	ug/L	580	1.41	14.7	48.2	1.55	0.184	0.874	<0.050	0.172	0.235	
Phenols	ug/L	12,000	92	51	95	31.2	3.6	30	2.6	680	3,020	

Note: Criteria from Ontario Ministry of the Environment. (2011, July 1). Soil, Ground Water and Sediment Standards for Use Under Part XV.I of the Environmental Protection Act Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition
*Criteria for total chloride and total selenium.
NR - no result due to equipment malfunction
NA - not analyzed as sample matrix was incompatible with instrumentation

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Table 8. 2019 Leachate Monitoring

Sampling Date	Units	Criteria	LQ25-MH3 11-Sep	LQ25-MH8 11-Sep	LQ25-MH13 11-Sep	LQ25-MH24 11-Sep	LQ25-MH27 11-Sep	LQ25-MH31 11-Sep	LQ25-MH34 11-Sep	RISER 1 10-Sep	LQ25-MH46 10-Sep	Composite 13-Sep
Petroleum Hydrocarbons												
CCME Petroleum Hydrocarbon Fraction F1	ug/L	750	730	<100	740	<100	<100	<100	<100	290	780	
CCME Petroleum Hydrocarbon Fraction F2	ug/L	150	1,830	3,940	2,470	720	<100	460	<100	1,870	6,740	
CCME Petroleum Hydrocarbon Fraction F3	ug/L	500	8,450	78,500	13,000	1,880	<250	4,500	<250	1,220	2,450	
CCME Petroleum Hydrocarbon Fraction F4	ug/L	500	1,540	13,900	1,480	<250	<250	790	<250	<250	<250	
Volatile Organic Carbons												
Vinyl Chloride	ug/L	1.7	0.94	0.84	2.02	<0.50	<0.50	<0.50	<0.50	0.95	0.62	
1,4 Dichlorobenzene	ug/L	67	8.7	4.0	9.2	<1.0	<1.0	1.3	<1.0	1.6	1.3	
Chloroform	ug/L	22	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	
Trichloroethene	ug/L	17	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	2.74	
Tetrachloroethene	ug/L	17	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.59	
Dioxins and Furans												
2,3,7,8-TCDD	pg/L	23,000										<2.0
1,2,3,7,8-PeCDD	pg/L	23,000										<0.80
1,2,3,4,7,8-HxCDD	pg/L	23,000										<0.83
1,2,3,6,7,8-HxCDD	pg/L	23,000										3.79
1,2,3,7,8,9-HxCDD	pg/L	23,000										1.86
1,2,3,4,6,7,8-HpCDD	pg/L	23,000										183
OCDD	pg/L	23,000										1,340
Total TCDD	pg/L	23,000										<2.0
Total PeCDD	pg/L	23,000										38.6
Total HxCDD	pg/L	23,000										324
Total HpCDD	pg/L	23,000										569
2,3,7,8-TCDF	pg/L	23,000										<0.89
1,2,3,7,8-PeCDF	pg/L	23,000										<0.56
2,3,4,7,8-PeCDF	pg/L	23,000										0.66
1,2,3,4,7,8-HxCDF	pg/L	23,000										1.06
1,2,3,6,7,8-HxCDF	pg/L	23,000										1.32
1,2,3,7,8,9-HxCDF	pg/L	23,000										1.10
2,3,4,6,7,8-HxCDF	pg/L	23,000										0.97
1,2,3,4,6,7,8-HpCDF	pg/L	23,000										9.46
1,2,3,4,7,8,9-HpCDF	pg/L	23,000										1.00
OCDF	pg/L	23,000										20.0
Total TCDF	pg/L	23,000										4.11
Total PeCDF	pg/L	23,000										<0.56
Total HxCDF	pg/L	23,000										11.4
Total HpCDF	pg/L	23,000										9.46
Polychlorinated Biphenyls												
Aroclor 1016	ug/L		<0.040	<8.0	<0.20	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	
Aroclor 1221	ug/L		<0.040	<8.0	<0.20	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	
Aroclor 1232	ug/L		<0.040	<8.0	<0.20	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	
Aroclor 1242	ug/L		<0.15	<46	<3.0	<0.40	<0.040	<0.16	<0.040	<0.15	<0.42	
Aroclor 1248	ug/L		<0.040	<8.0	<0.20	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	
Aroclor 1254	ug/L		<0.065	<8.0	<0.25	<0.060	<0.040	<0.040	<0.040	<0.040	<0.040	
Aroclor 1260	ug/L		<0.040	<8.0	<0.20	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040	
Total PCBs	ug/L	15	<0.20	<52	3.1	<0.45	<0.12	<0.20	<0.12	<0.20	<0.44	
Pesticides and Herbicides												
Diazinon	ug/L		<0.10	<19	<3.5	<0.25	<0.10	<0.55	<0.25	0.21	0.30	
2, 4-D	ug/L		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	6	
Aldrin	ug/L	8.5	<1.0	<50	<50	<1.0	<1.0	<1.0	<1.0	<0.080	<0.40	
gamma-Hexachlorocyclohexane (Lindane)	ug/L	1.2	<1.0	<50	<50	<1.0	<1.0	<1.0	<1.0	<0.080	<0.40	
MCPA	ug/L		<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	
Mirex	ug/L		<1.0	<50	<50	<1.0	<1.0	<1.0	<1.0	<0.080	<0.40	
Methoxychlor	ug/L	6.5	<1.0	<50	<50	<1.0	<1.0	<1.0	<1.0	<0.080	<0.40	
Bacteria												
Total Coliforms	MPN/100mL		>24,200	>24,200	15,500	>24,200	>2,420	>24,200	770	>24,200	>24,200	
Fecal Coliforms	MPN/100mL		620	780	50	17,300	3	2,140	2	200	24,200	
E. coli	MPN/100mL		520	1,090	100	15,500	<1	1,900	5	110	6,130	

Note: Criteria from Ontario Ministry of the Environment. (2011, July 1). Soil, Ground Water and Sediment Standards for Use Under Part XV.I of the Environmental Protection Act Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition

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Table 9. 2019 Leachate Quality Comparison

Sampling Date	Units	Criteria	2015 Average	2016 Average	2017 Average	2018 Average	2019 Average
Field Parameters							
pH	units		6.98	7.41	7.63	7.28	7.79
Turbidity - NTU	ntu		21.4	37.9	119	298	166
Specific Conductivity	uS/cm		6,493	4,278	9,046	10,580	8,663
Temperature	°C		NA	NA	NA	13.8	13.9
Inorganic Parameters							
Alkalinity - Bicarbonate	mg/L		2,937	4,276	4,479	4,270	4,059
Alkalinity - Carbonate	mg/L		<5.0	130	<5.0	<3.0	<3.0
Alkalinity - Hydroxide	mg/L		<5.0	<5.0	<5.0	<3.0	<3.0
Alkalinity - Total	mg/L		2,406	3,720	3,672	4,270	4,059
Hardness (as CaCO3)	mg/L		1,575	1,708	1,966	2,106	773
pH - units	units		7.57	7.24	7.35	7.06	7.24
Specific Conductivity	uS/cm		6,776	10,604	10,494	11,131	11,170
Turbidity - NTU	ntu		108	193	128	136	100
Total Dissolved Solids	mg/L		4,584	6,057	5,864	6,140	6,348
Total Suspended Solids	mg/L		245	13,543	579	789	635
Total Solids	mg/L		NA	NA	NA	6,924	6,980
Chloride (dissolved)	mg/L	2300 *	744	1,060	1,222	1,163	2,183
Sulphate (dissolved)	mg/L		128	115	273	164	205
Other							
Cyanide (CN)	ug/L	66	10.3	10.4	8.0	21.4	14.2
Nutrients							
Dissolved Ammonia	mg/L		250	570	504	243	545
Nitrate Nitrogen	mg/L		0.159	0.310	1.35	8.48	1.01
Total Kjeldhal Nitrogen	mg/L		304	276	621	342	699
Phosphorus (Total)	mg/L		1.87	3.32	3.29	2.12	7.77
Organic Indicators							
Biological Oxygen Demand	mg/L		64	583	726	1,347	1,493
Chemical Oxygen Demand	mg/L		902	1,140	2,540	2,367	2,045
Metals							
Total Arsenic (As)	mg/L	1.9	0.0115	0.0139	0.0248	0.0321	0.0220
Total Barium (Ba)	mg/L	29	0.401	0.372	0.376	0.382	0.391
Total Beryllium (Be)	mg/L	0.067	0.03126	0.00014	0.00012	0.00113	<0.00003
Total Cadmium (Cd)	mg/L	0.0027	0.000195	0.000307	0.000308	0.000452	<0.000007
Total Calcium (Ca)	mg/L		129	147	212	236	309
Total Chromium (Cr)	mg/L	0.81	0.0315	0.0635	0.0724	0.0756	0.1354
Total Chromium (Hexavalent)	mg/L		<0.0010	0.0050	0.0135	<0.010	<10
Total Copper (Cu)	mg/L	0.087	0.0080	0.0084	0.0128	0.0291	0.0218
Total Iron (Fe)	mg/L		10.7	6.8	18.8	20.1	7.9
Total Lead (Pb)	mg/L	0.025	0.00718	0.01072	0.01008	0.01057	0.00490
Total Magnesium (Mg)	mg/L		248	279	329	368	469
Total Manganese (Mn)	mg/L		1.018	0.437	0.832	1.129	1.246
Total Mercury (Hg)	ug/L	2.8	0.004	0.002	0.021	0.273	0.016
Total Nickel (Ni)	mg/L	0.49	0.1222	0.1546	0.1541	0.2522	0.2962
Total Potassium (K)	mg/L		254	314	292	364	468
Dissolved Selenium (Se)	ug/L	63 *	173.3	0.90	1.20	1.86	1.37
Total Silver (Ag)	ug/L	1.5	0.095	0.150	0.090	0.336	0.095
Total Sodium (Na)	mg/L	2,300	598	824	835	1,115	1,365
Total Zinc (Zn)	mg/L	1.1	0.0545	1.18	0.453	0.206	0.530

Note: Criteria from Ontario Ministry of the Environment. (2011, July 1). Soil, Ground Water and Sediment Standards for Use Under Part XV.I of the Environmental Protection Act Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition

*Criteria for total chloride and total selenium

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Table 9. 2019 Leachate Quality Comparison

Sampling Date	Units	Criteria	2015 Average	2016 Average	2017 Average	2018 Average	2019 Average
Extractables							
Benzo (a) Pyrene (PAH)	ug/L	0.81	13.75	0.79	0.26	0.75	1.17
Anthracene	ug/L	2.4	13.75	1.05	0.89	1.33	2.01
4'4' Methylenebis 2 Chloroaniline	ug/L		NA	NA	<50	<50	<5.0
Benzo (a) anthracene (PAH)	ug/L	4.7	13.75	1.23	0.89	1.13	2.52
Benzo (b/j) fluoroanthene (PAH)	ug/L		<50	1.4	0.49	1.17	1.66
Benzo (g,h,i) Perylene (PAH)	ug/L	0.2	13.75	0.725	0.33	1.03	0.697
Hexachlorobenzene	ug/L	3.1	<0.050	<0.050	<0.30	<5.0	<50
Phenanthrene	ug/L	580	0.621	3.74	2.05	5.13	7.48
Phenol	ug/L	12,000	221	391	677	276	445
Petroleum Hydrocarbons							
CCME Petroleum Hydrocarbon Fraction F1	ug/L	750	186	111	450*	114	310
CCME Petroleum Hydrocarbon Fraction F2	ug/L	150	<100	171	230*	20,150	2,014
CCME Petroleum Hydrocarbon Fraction F3	ug/L	500	<200	<200	410*	371,200	12,250
CCME Petroleum Hydrocarbon Fraction F4	ug/L	500	<200	<200	<200*	56,300	2,037
Volatile Organic Carbons							
Vinyl Chloride	ug/L	1.7	1.84	<40	<40	0.50	0.71
1,4 Dichlorobenzene	ug/L	67	2.4	5.1	5.8	2.2	3.1
Chloroform	ug/L	22	<5.0	<20	<20	<0.50	<0.50
Trichloroethene	ug/L	17	<5.0	<20	<20	0.29	0.53
Tetrachloroethene	ug/L	17	<5.0	<20	<20	0.39	<0.50
Polychlorinated Biphenyls							
Aroclor 1016	ug/L		<0.50	<0.50	<0.50	<2.0	<8.0
Aroclor 1221	ug/L		<0.50	<0.50	<0.50	<2.0	<8.0
Aroclor 1232	ug/L		<0.50	<0.50	<0.50	<2.0	<8.0
Aroclor 1242	ug/L		<0.50	0.11	<0.50	<8.0	<3.0
Aroclor 1248	ug/L		<0.50	<0.50	<0.50	<2.0	<8.0
Aroclor 1254	ug/L		<0.50	0.09	<0.50	<7.0	<8.0
Aroclor 1260	ug/L		<0.50	0.10	<0.50	<4.0	<8.0
Total PCBs	ug/L	15	<0.50	0.10	<3.0	<13.0	3.3
Pesticides and Herbicides							
Diazinon	ug/L		<40	<10	<320	<172	<3.5
2, 4-D	mg/L		<0.020	<2.0	<1.0	0.0024	1.1
Aldrin	ug/L	8.5	<0.05	<0.05	<0.30	<5.0	<50
gamma-Hexachlorocyclohexane (Lindane)	ug/L	1.2	<0.03	<0.03	<0.20	<91.0	<50
MCPA	mg/L		<0.040	<4.0	<2.0	<0.0050	<1.0
Mirex	ug/L		<0.20	<0.05	<0.30	<5.0	<50
Methoxyclor	ug/L	6.5	<0.10	<0.10	<0.70	<5.0	<50
Bacteria							
Total Coliforms	MPN/100mL		141,751	4,859	6,158	15,448	18,210
Fecal Coliforms	MPN/100mL		144,943	323	243	3,211	5,033
E. coli	MPN/100mL		139,665	322	193	4,453	2,817

Note: Criteria from Ontario Ministry of the Environment. (2011, July 1). Soil, Ground Water and Sediment Standards for Use Under Part XV.I of the Environmental Protection Act Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition

* Manhole 31 results not included in average due to pump malfunction

5.4 LANDFILL GAS

5.4.1 COLLECTION AND FLARING SYSTEM

Landfill gas (LFG) produced at the BRRMF is comprised primarily of methane (CH_4) and carbon dioxide (CO_2) in approximately equal amounts. These greenhouse gases contribute to global warming, but CH_4 has a global warming potential 25 times that of CO_2. To reduce emissions, the LFG is collected via a series of pipes beneath the BRRMF, and sent to a flare where the CH_4 is reduced to CO_2 and water vapour. The landfill gas collection and flaring system (LFGCFS) is run by Integrated Gas Recovery Systems Inc. on behalf of the City of Winnipeg.

As per the BRRMF Operating Plan, LFG operations and monitoring are managed through the Landfill Gas Operating Plan, submitted October 23, 2014, as per Clause 110.

In 2019, the BRRMF LFGCFS operated as intended, although surface emission monitoring identified some areas where gas was escaping due to weak surface cap and/or manholes with improper seals. Blockages in two sections of underground pipe identified in 2018 were repaired in 2019.

The 2019 Landfill Gas Collection and Flaring Report, prepared by Integrated Gas Recovery Services Inc., is attached in Appendix E.

5.4.2 SUBSURFACE LANDFILL GAS MONITORING PROGRAM

LFG that is not collected or that cannot escape into the atmosphere may migrate into neighbouring land below the ground surface. The purpose of LFG migration monitoring is to detect gas migration before it becomes a safety hazard to neighbouring properties.

As per the BRRMF Operating Plan, subsurface LFG migration is managed in accordance with the Subsurface Landfill Gas Monitoring Program, submitted on October 23, 2014, as specified under Clause 111. Probes are monitored monthly for methane (CH_4), oxygen (O_2), carbon monoxide (CO), and hydrogen sulphide (H_2S).

In 2019, the maximum level of CH_4 measured was 0.1%. The Subsurface Landfill Gas Contingency Plan was not activated, indicating that the LFGCFS is operating effectively.

The 2019 subsurface gas migration probe data is provided in Table 10.

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Table 10. 2019 External Gas Probe Monitoring

Well No.	Date	CH4	O2	CO	H2S
		% LEL	(%)	PPM	PPM
1	10-Jan-19	0.0	22.5	0.0	0.0
	11-Feb-19	0.0	20.0	0.0	0.0
	15-Mar-19	0.0	16.7	0.0	0.0
	18-Apr-19	0.0	16.8	0.0	0.0
	27-May-19	0.1	17.9	0.0	0.0
	6-Jun-19	0.0	16.7	1.0	0.0
	10-Jul-19	0.0	18.5	1.0	0.0
	8-Aug-19	No Access due to construction			
	17-Sep-19	No Access due to construction			
	8-Oct-19	0.0	19.1	0.0	0.0
	15-Nov-19	0.0	18.7	1.0	0.0
	10-Dec-19	0.0	23.8	0.0	0.0
2	10-Jan-19	0.0	21.1	0.0	0.0
	11-Feb-19	0.0	20.9	0.0	0.0
	15-Mar-19	0.0	19.1	0.0	0.0
	18-Apr-19	0.0	16.1	0.0	0.0
	27-May-19	0.0	19.4	0.0	0.0
	6-Jun-19	0.0	17.4	1.0	0.0
	10-Jul-19	0.0	18.9	0.0	0.0
	8-Aug-19	No Access due to construction			
	17-Sep-19	No Access due to construction			
	8-Oct-19	0.0	18.7	0.0	0.0
	15-Nov-19	0.0	19.1	0.0	0.0
	10-Dec-19	0.0	22.9	0.0	0.0
3	10-Jan-19	0.0	21.0	0.0	0.0
	12-Feb-19	0.0	20.8	0.0	0.0
	15-Mar-19	0.0	20.1	0.0	0.0
	18-Apr-19	0.0	21.3	0.0	0.0
	27-May-19	0.0	19.6	0.0	0.0
	7-Jun-19	0.0	18.3	0.0	0.0
	10-Jul-19	0.0	18.5	0.0	0.0
	9-Aug-19	0.0	19.8	0.0	0.0
	17-Sep-19	0.0	14.4	0.0	0.0
	8-Oct-19	0.0	19.7	0.0	0.0
	15-Nov-19	0.0	19.6	0.0	0.0
	10-Dec-19	0.0	23.8	0.0	0.0

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Table 10. 2019 External Gas Probe Monitoring

Well No.	Date	CH4	O2	CO	H2S
		% LEL	(%)	PPM	PPM
4	10-Jan-19	0.0	21.2	1.0	0.0
	12-Feb-19	0.0	20.9	0.0	0.0
	15-Mar-19	0.0	20.2	0.0	0.0
	18-Apr-19	0.0	22.5	0.0	0.0
	27-May-19	0.0	20.2	0.0	0.0
	7-Jun-19	0.0	19.3	0.0	0.0
	10-Jul-19	0.0	19.1	0.0	0.0
	9-Aug-19	0.0	20.1	0.0	0.0
	17-Sep-19	0.0	18.2	0.0	0.0
	8-Oct-19	0.1	19.7	0.0	0.0
	15-Nov-19	0.0	19.5	0.0	0.0
	10-Dec-19	0.0	22.7	0.0	0.0
5	10-Jan-19	0.0	22.0	0.0	0.0
	12-Feb-19	0.0	21.8	0.0	0.0
	15-Mar-19	0.0	22.0	0.0	0.0
	18-Apr-19	0.0	21.8	0.0	0.0
	27-May-19	0.0	20.0	0.0	0.0
	7-Jun-19	0.0	18.5	0.0	0.0
	10-Jul-19	0.0	19.6	0.0	0.0
	9-Aug-19	0.0	20.5	0.0	0.0
	17-Sep-19	0.0	16.2	0.0	0.0
	8-Oct-19	0.1	20.5	0.0	0.0
	15-Nov-19	0.0	20.3	0.0	0.0
	10-Dec-19	0.0	22.7	0.0	0.0
6	10-Jan-19	0.0	21.5	0.0	0.0
	12-Feb-19	0.0	21.1	0.0	0.0
	15-Mar-19	0.0	19.4	0.0	0.0
	18-Apr-19	0.0	20.4	0.0	0.0
	27-May-19	0.0	20.7	0.0	0.0
	6-Jun-19	0.0	19.4	1.0	0.0
	10-Jul-19	0.0	19.2	0.0	0.0
	9-Aug-19	0.0	19.5	0.0	0.0
	18-Sep-19	0.0	19.2	0.0	0.0
	7-Oct-19	0.0	19.5	0.0	0.0
	15-Nov-19	0.0	19.3	0.0	0.0
	10-Dec-19	No Access			

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Table 10. 2019 External Gas Probe Monitoring

Well No.	Date	CH4	O2	CO	H2S
		% LEL	(%)	PPM	PPM
7	10-Jan-19	0.0	21.3	0.0	0.0
	14-Feb-19	0.0	20.3	0.0	0.0
	15-Mar-19	0.0	19.7	0.0	0.0
	18-Apr-19	0.0	17.4	0.0	0.0
	27-May-19	0.0	19.0	0.0	0.0
	6-Jun-19	0.0	18.2	1.0	0.0
	10-Jul-19	0.0	19.4	0.0	0.0
	9-Aug-19	0.0	20.3	0.0	0.0
	18-Sep-19	0.0	18.7	0.0	0.0
	7-Oct-19	0.0	20.1	0.0	0.0
	15-Nov-19	0.0	18.4	0.0	0.0
	10-Dec-19	0.0	20.9	0.0	0.0
8	10-Jan-19	0.0	21.8	0.0	0.0
	14-Feb-19	0.0	21.5	0.0	0.0
	15-Mar-19	0.0	20.2	1.0	0.0
	18-Apr-19	0.0	18.0	0.0	0.0
	27-May-19	0.0	20.0	0.0	0.0
	6-Jun-19	0.0	18.8	1.0	0.0
	10-Jul-19	0.0	19.0	0.0	0.0
	9-Aug-19	0.0	20.5	0.0	0.0
	18-Sep-19	0.0	18.6	0.0	0.0
	7-Oct-19	0.0	18.4	0.0	0.0
	15-Nov-19	0.0	18.0	0.0	0.0
	10-Dec-19	0.0	20.9	0.0	0.0
9	10-Jan-19	0.0	21.3	0.0	0.0
	14-Feb-19	0.0	21.0	1.0	0.0
	15-Mar-19	0.0	19.1	1.0	0.0
	18-Apr-19	0.0	18.9	0.0	0.0
	27-May-19	0.0	19.2	0.0	0.0
	6-Jun-19	0.0	17.5	1.0	0.0
	10-Jul-19	0.0	18.7	0.0	0.0
	9-Aug-19	0.0	20.7	0.0	0.0
	18-Sep-19	0.0	20.8	0.0	0.0
	7-Oct-19	0.0	19.6	0.0	0.0
	15-Nov-19	0.0	19.2	0.0	0.0
	10-Dec-19	0.0	20.8	0.0	72.0

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Table 10. 2019 External Gas Probe Monitoring

Well No.	Date	CH4	O2	CO	H2S
		% LEL	(%)	PPM	PPM
10	10-Jan-19	0.0	21.8	0.0	0.0
	14-Feb-19	0.0	21.0	0.0	0.0
	15-Mar-19	0.0	19.7	1.0	0.0
	18-Apr-19	0.0	14.3	0.0	0.0
	27-May-19	0.0	21.0	0.0	0.0
	6-Jun-19	0.0	19.6	1.0	0.0
	10-Jul-19	0.0	19.3	0.0	0.0
	9-Aug-19	0.0	20.9	0.0	0.0
	18-Sep-19	0.0	20.9	0.0	0.0
	7-Oct-19	0.0	19.8	0.0	0.0
	15-Nov-19	0.0	20.2	0.0	0.0
	10-Dec-19	0.0	20.8	0.0	0.0
P28E	10-Jan-19	0.0	22.8	0.0	0.0
	14-Feb-19	0.0	21.6	0.0	0.0
	15-Mar-19	0.0	21.2	0.0	0.0
	18-Apr-19	0.0	20.9	0.0	0.0
	27-May-19	0.0	20.5	0.0	0.0
	6-Jun-19	0.0	20.0	0.0	0.0
	10-Jul-19	0.0	18.1	0.0	0.0
	9-Aug-19	0.0	18.4	0.0	0.0
	18-Sep-19	0.0	18.9	0.0	0.0
	7-Oct-19	0.0	18.5	0.0	0.0
	15-Nov-19	0.0	20.3	0.0	0.0
	10-Dec-19	0.0	20.3	0.0	0.0
P30ER	10-Jan-19	0.0	22.4	0.0	0.0
	14-Feb-19	0.0	21.6	0.0	0.0
	15-Mar-19	0.0	19.4	1.0	0.0
	18-Apr-19	0.0	19.0	0.0	0.0
	27-May-19	0.0	21.1	0.0	0.0
	6-Jun-19	0.0	20.1	0.0	0.0
	10-Jul-19	0.0	19.4	0.0	0.0
	9-Aug-19	0.0	20.1	0.0	0.0
	18-Sep-19	0.0	18.8	1.0	0.0
	7-Oct-19	0.0	19.3	0.0	0.0
	15-Nov-19	0.0	19.8	0.0	0.0
	10-Dec-19	0.0	21.8	0.0	0.0

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Table 10. 2019 External Gas Probe Monitoring

Well No.	Date	CH4	O2	CO	H2S
		% LEL	(%)	PPM	PPM
P34ER	10-Jan-19	0.0	22.1	0.0	0.0
	14-Feb-19	0.0	18.2	0.0	0.0
	15-Mar-19	0.0	19.9	0.0	0.0
	18-Apr-19	0.0	20.5	0.0	0.0
	27-May-19	0.0	21.0	0.0	0.0
	6-Jun-19	0.0	20.0	0.0	0.0
	10-Jul-19	0.0	20.1	0.0	0.0
	9-Aug-19	0.0	20.0	0.0	0.0
	18-Sep-19	0.0	18.2	0.0	0.0
	8-Oct-19	0.0	18.2	0.0	0.0
	15-Nov-19	0.0	20.5	0.0	0.0
	10-Dec-19	0.0	20.9	0.0	0.0
P106E	10-Jan-19	0.0	21.2	0.0	0.0
	11-Feb-19	0.1	18.6	0.0	0.0
	15-Mar-19	0.1	18.6	0.0	0.0
	18-Apr-19	0.0	20.6	0.0	0.0
	27-May-19	0.1	20.5	0.0	0.0
	6-Jun-19	0.1	19.7	0.0	0.0
	10-Jul-19	0.0	18.4	0.0	0.0
	8-Aug-19	0.0	20.2	0.0	0.0
	17-Sep-19	0.0	17.4	0.0	0.0
	7-Oct-19	0.0	19.9	0.0	0.0
	15-Nov-19	0.1	19.9	0.0	0.0
	10-Dec-19	0.0	20.1	0.0	0.0
P107E	10-Jan-19	0.0	21.5	0.0	0.0
	11-Feb-19	0.0	16.6	0.0	0.0
	15-Mar-19	0.1	18.6	0.0	0.0
	18-Apr-19	0.0	17.4	0.0	0.0
	27-May-19	0.0	19.0	0.0	0.0
	6-Jun-19	0.0	18.9	0.0	0.0
	10-Jul-19	0.0	20.9	0.0	0.0
	8-Aug-19	0.0	19.5	0.0	0.0
	17-Sep-19	0.0	17.6	0.0	0.0
	7-Oct-19	0.1	19.1	0.0	0.0
	15-Nov-19	0.0	19.9	0.0	0.0
	10-Dec-19	0.0	20.6	0.0	0.0

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Table 10. 2019 External Gas Probe Monitoring

Well No.	Date	CH4	O2	CO	H2S
		% LEL	(%)	PPM	PPM
P108E	10-Jan-19	0.0	21.5	0.0	0.0
	11-Feb-19	0.0	19.9	0.0	0.0
	15-Mar-19	0.0	20.3	0.0	0.0
	18-Apr-19	0.0	20.8	0.0	0.0
	27-May-19	0.0	20.7	0.0	0.0
	6-Jun-19	0.0	19.8	0.0	0.0
	10-Jul-19	0.0	19.0	0.0	0.0
	8-Aug-19	0.0	20.1	0.0	0.0
	17-Sep-19	0.0	19.4	0.0	0.0
	7-Oct-19	0.1	19.1	0.0	0.0
	15-Nov-19	0.0	20.0	0.0	0.0
	10-Dec-19	No Access			
P109E	10-Jan-19	No Access			
	11-Feb-19	No Access			
	15-Mar-19	No Access			
	18-Apr-19	No Access			
	27-May-19	0.0	17.7	0.0	0.0
	6-Jun-19	0.0	17.1	0.0	0.0
	10-Jul-19	0.0	16.5	0.0	0.0
	8-Aug-19	0.0	17.3	0.0	0.0
	17-Sep-19	0.0	14.7	0.0	0.0
	7-Oct-19	0.0	19.9	0.0	0.0
	15-Nov-19	0.0	20.0	0.0	0.0
	10-Dec-19	0.0	21.9	0.0	0.0
P110E	10-Jan-19	0.0	21.5	0.0	0.0
	11-Feb-19	0.0	20.7	0.0	0.0
	15-Mar-19	0.0	19.9	0.0	0.0
	18-Apr-19	0.0	20.3	0.0	0.0
	27-May-19	0.0	6.5	0.0	0.0
	6-Jun-19	0.0	13.2	0.0	0.0
	10-Jul-19	0.0	0.0	0.0	0.0
	8-Aug-19	0.0	20.3	0.0	0.0
	17-Sep-19	0.0	16.5	0.0	0.0
	7-Oct-19	0.0	19.9	0.0	0.0
	15-Nov-19	0.0	20.1	0.0	0.0
	10-Dec-19	0.0	18.7	0.0	0.0

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Table 10. 2019 External Gas Probe Monitoring

Well No.	Date	CH4	O2	CO	H2S
		% LEL	(%)	PPM	PPM
P111E	10-Jan-19	0.0	21.5	0.0	0.0
	11-Feb-19	0.0	20.7	0.0	0.0
	15-Mar-19	0.0	18.6	0.0	0.0
	18-Apr-19	0.0	20.9	0.0	0.0
	27-May-19	0.0	20.6	0.0	0.0
	6-Jun-19	0.0	19.5	1.0	0.0
	10-Jul-19	0.0	20.1	0.0	0.0
	8-Aug-19	0.0	20.4	0.0	0.0
	17-Sep-19	0.0	20.1	0.0	0.0
	7-Oct-19	0.1	20.1	0.0	0.0
	15-Nov-19	0.0	20.1	0.0	0.0
	10-Dec-19	0.0	22.8	0.0	0.0
P112E	10-Jan-19	0.1	23.4	0.0	0.0
	11-Feb-19	0.0	21.7	0.0	0.0
	15-Mar-19	0.1	20.3	0.0	0.0
	18-Apr-19	0.0	21.2	0.0	0.0
	27-May-19	0.0	20.7	0.0	0.0
	6-Jun-19	0.0	19.5	1.0	0.0
	10-Jul-19	0.0	20.2	0.0	0.0
	8-Aug-19	0.0	20.2	0.0	0.0
	17-Sep-19	0.0	19.9	0.0	0.0
	7-Oct-19	0.0	19.9	0.0	0.0
	15-Nov-19	0.0	20.3	0.0	0.0
	10-Dec-19	0.0	21.7	0.0	0.0

6.0 NUISANCE MANAGEMENT

In order to reduce odour, litter, and vector nuisances at the landfill, several best practices and operating procedures are used, such as placement of screens, minimizing the working face of each cell, application of appropriate cover material (daily, intermediate, or final), site landscaping, weekly litter control patrols, and odour monitoring. If necessary, a licensed professional will apply vector control products to ensure that proper chemicals are used and properly handled. Noise is not a significant issue due to the separation from surrounding homes. Fugitive dust emissions are minimized by spraying site roads with uncontaminated surface water.

In 2019, there were 38 odour complaints from 15 customers; in all cases the source of the odour was investigated. Several of the calls came from one customer; investigations revealed that the storm sewer adjacent to their property was the source of the odour in many instances. If the source of the odour could be located within the BRRMF, we immediately covered the odour causing material, moved the tipping face to a more favorable area if available, and used compost or wood chips to reduce the odour and prevent further occurrence. Table 11 provides a summary of nuisance complaints received in 2019.

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Table 11. 2019 Nuisance Complaint Monitoring

Date Created	Complaint	Response
	Odours	
1/4/2019	Citizen reached out via Twitter, concerned with the stronger smell of rotten garbage in Bridgewater Trails coming from Brady Rd today.	Responded to the resident stating we investigated your concern and have found that the atmospheric conditions and landfill operations suggest that it would be unlikely the odour originated from Brady landfill. We continuously work to reduce the impact of the landfill on our community. To control odours in and around the landfill, we • cover garbage on a daily basis, • use natural bio filters (woodchips) on manholes to capture and biologically remove odours, • continue to expand the landfill gas capture system, • use dedicated trenches for dead animals and cover all loads immediately, • monitor odours in and around the landfill on a regular basis, • plant trees and shrubs on the berms along Brady Road and the Perimeter Highway, • continue to move landfilling operations further south , and • reduce the amount of biosolids (the nutrient-rich by-product of sewage treatment) being buried through a biosolids composting trial program.
1/5/2019	Citizen who lives in Bridgewater area, sends an email reporting foul smell in their neighborhood. Citizen would like to know if there is anything going on with Brady dump causing this and if the situation is temporary.	Resonded to the resident stating we investigated your concern and have found that the atmospheric conditions and landfill operations suggest that it would be likely the odour originated from Brady landfill. We continuously work to reduce the impact of the landfill on our community. To control odours in and around the landfill, we • cover garbage on a daily basis, • use natural bio filters (woodchips) on manholes to capture and biologically remove odours, • continue to expand the landfill gas capture system, • use dedicated trenches for dead animals and cover all loads immediately, • monitor odours in and around the landfill on a regular basis, • plant trees and shrubs on the berms along Brady Road and the Perimeter Highway, • continue to move landfilling operations further south , and • reduce the amount of biosolids (the nutrient-rich by-product of sewage treatment) being buried through a biosolids composting trial program.
1/19/2019	Citizen states that they are once again expereincing a strong odour in the air in their neighbourhood which they believe is coming from the Brady Rd landfill.	Responded to the resident stating we have received your complaint and are going to continue to try to reduce odour issues at the landfill. At the moment, we are working on reducing the size of the tipping face and diverting some of our dominant odour causing waste streams. We are working to reduce the amount of biosolids (the nutrient-rich by-product of sewage treatment) being buried at Brady through a soil fabrication project. We are starting our second year of this on February 4th, 2019 and this should hopefully greatly reduce some of the odour in the coming months.
1/24/2019	Caller states that he can smell garbage odour at his address which comes from the city dump. Caller states that it is much stonger than it has been in the past.	Responded to the resident stating we have been continuing to monitor the odour coming from Brady and noticed that with the strong south wind over the weekend, there was a distinct odour being pushed northwards. We have checked the area around your residence and did not detect any Hydrogen Sulfide. As such, we are working to reduce the size of our tipping face and hope once the weather warms up we can improve our daily cover. Additionally, I am hoping once we remove biosolids from the site (starting Monday next week) we will also see an improvement in odour.
1/26/2019	Citizen is following up. Citizen states the odour is significant again and smells like meat.	
1/31/2019	Citizen states that for the past 3 days, the odour from the Brady has been medium/low but today (January 30th), it is substantially high to the point what it can also be smelled inside my house.	Spoke with resident on the phone indicating that we are continuing to monitor the odour in that area. We also spoke about directing his concerns to Waste water services, to check and see if the odour is originating from the sewer.
2/18/2019	Citizen reached out for contact information regarding a sewer investagation due to continuing odour issues.	Responded to the resident stating a contact at Waste Water Services and the person I have spoken with regarding the odour issues at your residence. We will continue to monitor odour and H2S levels in and around your residence this week.
2/19/2019	Citizen stated that the air smells like very rotten egg.	
2/27/2019	Citizen states, "There is a strong sewer like odour happening currently"..."I am not sure if it is coming from the Brady Landfill or not. All I know is it smells like sewer and is substantial."	Sent to Sewer Odour Outside Lagan
2/27/2019	Citizen reached out again via email stating, "there is a strong sewer like odour happening currently [Feb 27 1:36pm]"	Responded to the resident stating staff are out as we speak doing an odour round and following up with operations if there was anything out of the ordinary this weekend that could have caused odour from Brady. We did receive an odour complaint on Saturday March 2nd and at that time the wind was from the west at around 9 km/h and the wind on March 1st and 2nd was predominantly from the west to north west and very frigid. Resident's house is approximately north east of the landfill. This in my opinion would not be atmospheric conditions that would be conducive for Brady to be the culprit of the odour complaint as any odour would travel directly east or south east from Brady. As discussed before I believe the resident has alluded that the odour is sewer like for the most part and we have contacted Staff Member from WW and informed her of the current situation and she thinks the odour could be coming from the land drainage sewer which is very close to the resident's property and is going to investigate further. Also another interesting note is that we have not received any other odour complaints from any other residents within at least 1 km from resident's property, I am not really sure why this is but I would have thought that we would receive a few more if the odour was as debilitating as described. This could further support that the odour is more specific to the land drainage sewer than related to the landfill. Councillor's question regarding odour related to the Provincial regulations is another matter and in our license it states in clause 15 that "The Licencee shall not cause or permit an odour nuisance to be created as a result of the construction, operation, or alteration of the Development, and shall take such steps as the Director may require to eliminate or mitigate an odour nuisance" and I believe we are doing our best to mitigate odours caused from the landfill to meet Provincial regulations. I do not know what else we could say on this matter as I think this would be a question that Manitoba Sustainable Development would be better suited to answer.
3/3/2019	Unfortunately, we have actually seen an uptick in odour lately (I reported the vast majority of them to 311). I believe we are experiencing odours from multiple sources - some of which I believe are coming from the sewer system and others from the landfill. I believe your team also feels that way as odours come in situations where the wind is coming from the South or the North. When it comes to the landfill in particular, what I was trying ask in my last email is, based on Provincial Legislation should I expect not to experience odours based on where I live. In speaking to long term residences of Richmond West it seems like this odour issue is something new in past few years and wasn't an issue in years prior. That leads me to conclude that something has changed and that perhaps the odour is outside of what is expected based on the Provicial Legislation. Another way of looking at it is, it would seem surprising to me that residence should expect to have strong odour in residential areas as a norm and that the Provicial Legislation would be such that there wouldn't be odours in residential areas including schools, etc. On Saturday I was literally unable to be in my own yard for more than a few minutes as the smell was so strong.	
3/2/2019	Via email citizen stated There is a medium-low grade garbage like smell now - March 2 15:58 The wind has changed direction and now there is a very substantial sewer like odour - March 2 17:26	
4/15/2019	We are experiencing an odour issue currently. Citizen has previous similar reports	Responded to the resident stating we are continuing to routinely check the area in and around your residence for hydrogen sulfide and odour. The wind on Monday was coming from the south, and could have pushed odour from the landfill northbound. However, when our technologist monitored the area at 1:00pm on Monday no odour or hydrogen sulfide was detected. By Tuesday the wind had changed direction and odour would not have been directed towards your neighborhood. We also checked the area just in case on Tuesday and did not detect any odour or hydrogen sulfide. Solid Waste Services is continuing to try and improve odour issues at Brady Landfill, and we will continue to monitor neighbouring communities for odour causing gases.
4/21/2019	Citizen states on April 19th there was a medium level odour around the block.	Continued to montior concerned citizen residence by checking the level of H2S and odour daily infront of their house.
4/21/2019	Citizen states there is a medium grade odor around the block on April 19th. Citizen has submitted similar concerns previously	
5/3/2019	Citizen states there is a medium grade odor around the block and at citizen's house. He states that the odor was present around 12:00 am on May 02 and the smell was so bad that it woke them up from their sleep.	
7/11/2019	Citizen states that the whole neighbourhood smells like garbage and they can't enjoy being outside.	Responded to the resident stating we investigated your concern and have found that the atmospheric conditions and landfill operations suggest that it would be likely the odour originated from Brady landfill. We continuously work to reduce the impact of the landfill on our community. To control odours in and around the landfill, we • cover garbage on a daily basis, • use natural bio filters (woodchips) on manholes to capture and biologically remove odours, • continue to expand the landfill gas capture system, • use dedicated trenches for dead animals and cover all loads immediately, • monitor odours in and around the landfill on a regular basis, • plant trees and shrubs on the berms along Brady Road and the Perimeter Highway, • continue to move landfilling operations further south , and • reduce the amount of biosolids (the nutrient-rich by-product of sewage treatment) being buried through a biosolids composting trial program.

Date Created	Complaint	Response
	Odours	
7/18/2019	VIA EMAIL: The citizen stated that they are wanting to be advised why there is a very bad odour coming from the Brady Road landfill. The citizen stated that they were outside on Thursday, July 18 at 8:30 p.m. and can't even sit outside on their back yard due to the smell.	Responded to the resident stating we investigated your concern and have found that the atmospheric conditions suggest that it would be unlikely the odour originated from Brady landfill. Although, we have been going through an adjustment period with the new contractors onsite which may lead to a temporary increase in odour when atmospheric conditions are right. We continuously work to reduce the impact of the landfill on our community. To control odours in and around the landfill, we • cover garbage on a daily basis, • use natural bio filters (woodchips) on manholes to capture and biologically remove odours, • continue to expand the landfill gas capture system, • use dedicated trenches for dead animals and cover all loads immediately, • monitor odours in and around the landfill on a regular basis, • plant trees and shrubs on the berms along Brady Road and the Perimeter Highway, • continue to move landfilling operations further south , and • reduce the amount of biosolids (the nutrient-rich by-product of sewage treatment) being buried through a biosolids composting trial program and land application pilot program.
7/24/2019	Via E-mail, citizen reported on July 25 from 17:30 until late night there was a bad compost and garbage smell. They believe this came from the landfill. Citizen stated they could not walk outside, they got headaches and had to close their windows. Citizen would like the City to be more vigilant about the landfill.	Responded to the resident stating we will review with our operators and foreman to see if something was done differently on the 25th of July that could be corrected. We continuously working to reduce the impact of the landfill on our community. In particular, to address odour issues we: • cover garbage on a daily basis, • use natural bio filters (woodchips) on manholes to capture and biologically remove odours, • continue to expand the landfill gas capture system, • use dedicated trenches for dead animals and cover all loads immediately, • monitor odours in and around the landfill on a regular basis, • plant trees and shrubs on the berms along Brady Road and the Perimeter Highway, • continue to move landfilling operations further south , and • reduce the amount of biosolids (the nutrient-rich by-product of sewage treatment) being buried through a biosolids composting trial program.
8/2/2019	Caller states the odour coming from the landfill tonight is unbearable and nauseating. Caller states they cannot even open the windows the odour is so bad. Caller would appreciate if this was investigated.	Staff spoke with citizen and they raised a number of concerns with the odour at Brady. Primarily they was concerned with their health being affected by the odour at the site. I informed her that we do regular checks in the area for Hydrogen Sulfide and have yet to detect any levels that could be harmful to human health. They also mentioned that they had been informed when they purchased the house that the landfill was going to be closed very soon. I informed them that this is incorrect and that the landfill will remain open for the foreseeable future. I also mentioned the various intiatives we are taking to reduce the odour. This includes improving our cap and increasing our landfill gas system. They remain weary of the site and states they get headaches from the odour. They ended the call mentioning that they wished they hadn't purchased in the area given the fact that the landfill is going to stay there.
8/14/2019	Resident states that the odor from the landfill is worse today. She had to go in the house as the smell is giving her a headache. This is an ongoing issue and she is worried about how this will affect her health in the long run.	Staff spoke with the concerned citizen . We will add their address to our odour round route. They are worried the odour will affect their health.
8/14/2019	The caller advised that since 19:00 today the caller can smell a garbage smell from Brady.	Staff spoke with concerned citizen and explained that we are doing work to expand our landfill gas system and this is causing a spike in odour coming from the landfill. Citizen was very appreciative of the work we are doing and understood the importance of expanding this system.
8/14/2019	Citizen is phoning in to complain about the smell coming from Brady road landfill. Citizen claims the smell coming from brady is so bad right now that she is unable to keep her windows open.	Staff left a message to call return call and explained what Brady was doing to mitigate odours and explained that we are doing work to expand our landfill gas system and this is causing a spike in odour coming from the landfill.
8/17/2019	Citizen emailed to report odour from the Brady Landfill.	Staff spoke with concerened citizen and explaied that we are currently working to expand our landfill gas system, which has caused a spike in odour issues. They were understanding and seemed encouraged that we are working to try and mitigate the problem. They will continue to contact us with further odour concerns.
9/10/2019	Citizen emailed 'I would like to report a sulphur like odour in the area.	Responded to the resident stating that we continue to monitor odour in and around your residence. We have not detected any hydrogen sulfide in your neighbourhood , although we have noticed an garbage like odour in the last couple of days closer to the landfill. This issue has been mentioned to the foreman and supervisors at Brady. I believe it is partially attributed to the expansion of our landfill gas collection system, once this work is complete some of the odour issue should be mitigated. We will continue to monitor your neighbourhood and the surrounding area for the foreseeable future.
9/23/2019	Citizen states there the landfill smells really bad right now.	Responded to the resident stating we investigated your concern and have found that the atmospheric conditions and current landfill operations suggest that it would be likely the odour originated from Brady landfill. We apologize for any inconvenience this may have caused and we are working to address the issue to reduce the impact of the landfill on our community. To control odours in and around the landfill, we • cover garbage on a daily basis, • use natural bio filters (woodchips) on manholes to capture and biologically remove odours, • continue to expand the landfill gas capture system, • use dedicated trenches for dead animals and cover all loads immediately, • monitor odours in and around the landfill on a regular basis, • plant trees and shrubs on the berms along Brady Road and the Perimeter Highway, • continue to move landfilling operations further south , and • reduce the amount of biosolids (the nutrient-rich by-product of sewage treatment) being buried through a biosolids composting trial program.
10/4/2019	Citizen emailed 311 stating that she lives on Stan Bailie Drive, and that there has been a strong strong smell afrom the landfill on October 3rd around 10:30pm.	Responded to the resident stating we investigated your concern and have found that the atmospheric conditions (SSW) and landfill operations (having to re-work the tipping face due to the amount of precipitation we have received) suggest that it could be likely the odour originated from Brady landfill. I conducted an odour investigation today, as the winds were once again favourable of moving odour to your area, and am happy to report no (0ppm) H2S was detected, and no odour was detected. We do continuously work to reduce the impact of the landfill on our community. To control odours in and around the landfill, we: • cover garbage on a daily basis, • created a smaller, more controlled tipping face (area the garbage is dumped at), • use natural bio filters (woodchips) on manholes to capture and biologically remove odours, • continue to expand the landfill gas capture system, • cover all loads of dead animals immediately, • monitor odours in and around the landfill on a regular basis, • plant trees and shrubs on the berms along Brady Road and the Perimeter Highway, • continue to move landfilling operations further south (the new cell will be completed by the end of this year), and • currently have zero biosolids (nutrient-rich by-product of sewage treatment) being brought to Brady, as they are being used in the soil fabrication project.
10/7/2019	Via email citizen states that there is another sulfur like smell this morning.	Responded to the resident stating I investigated your concern and have found that the atmospheric conditions (SSE) and landfill operations (having to re-work the tipping face due to the amount of precipitation we have received) suggest that it could be likely the odour originated from Brady landfill. Although, when I was at Aintree investigating the odour, with my H2S reader at 10:30 am, there was no distinct sulfur smell or landfill odour detected. My reader was 0.000ppm H2S in the air, and I was unable to detect any odours outside. We do continuously work to reduce the impact of the landfill on our community. To control odours in and around the landfill, we: • cover garbage on a daily basis, • created a smaller, more controlled tipping face (area the garbage is dumped at), • use natural bio filters (woodchips) on manholes to capture and biologically remove odours, • continue to expand the landfill gas capture system, • cover all loads of dead animals immediately, • monitor odours in and around the landfill on a regular basis, • plant trees and shrubs on the berms along Brady Road and the Perimeter Highway, • continue to move landfilling operations further south (the new cell will be completed by the end of this year), and • currently have zero biosolids (nutrient-rich by-product of sewage treatment) being brought to Brady, as they are being used in the soil fabrication project.

Date Created	Complaint	Response
Odours		
10/12/2019	Citizen emailed 311 stating that you can smell the foul odour from Brady Landfill on the South Perimeter.	Responded to the resident stating we investigated your concern and have found that the atmospheric conditions suggest that it would be unlikely the odour originated from Brady landfill, but due to complications landfill operations, South perimeter proximity to the landfill and the state of emergency the city was in, it is possible the smell originated from Brady. We continuously work to reduce the impact of the landfill on our community. To control odours in and around the landfill, we • cover garbage on a daily basis, • use natural bio filters (woodchips) on manholes to capture and biologically remove odours, • continue to expand the landfill gas capture system, • cover all loads of dead animals immediately, • monitor odours in and around the landfill on a regular basis, • plant trees and shrubs on the berms along Brady Road and the Perimeter Highway, • continue to move landfilling operations further south , and • are currently directing biosolids (the nutrient-rich by-product of sewage treatment) to a soil fabrication program at another location.
10/22/2019	Via email citizen is reporting that there is a terrible odor coming from the landfill. Citizen states they can smell it all the way up to Costco on Kenaston. Citizen is wondering what happened and when it will get better.	Responded to the resident stating, I would like to share with you some of the work we are doing to reduce the impact of the landfill on our community. To control odours in and around the landfill, we • cover garbage on a daily basis, • use natural bio filters (woodchips) on manholes to capture and biologically remove odours, • continue to expand the landfill gas capture system (further extensions are to be done in the new year), • use dedicated trenches for dead animals and cover all loads immediately, • monitor odours in and around the landfill on a regular basis and test for Hydrogen Sulfide, • plant trees and shrubs on the berms along Brady Road and the Perimeter Highway, • continue to move landfilling operations further south , and • reduce the amount of biosolids (the nutrient-rich by-product of sewage treatment) being buried through a biosolids composting trial program.
10/22/2019	Via email citizen states that they live in bridge water trails and they have been experiencing a horrible smell coming from the Brady Landfill.	Responded to the resident stating we investigated your concern and have found that the atmospheric conditions (NNE Wind) and landfill operations suggest that it would be unlikely an odour yesterday originated from Brady landfill. However, we do recognized that given the right conditions, an strong odour can be produced and spread by the landfill. I would like to share with you some of the work we are doing to reduce the impact of the landfill on our community. To control odours in and around the landfill, we • cover garbage on a daily basis, • use natural bio filters (woodchips) on manholes to capture and biologically remove odours, • continue to expand the landfill gas capture system (further extensions are to be done in the new year), • use dedicated trenches for dead animals and cover all loads immediately, • monitor odours in and around the landfill on a regular basis and test for Hydrogen Sulfide, • plant trees and shrubs on the berms along Brady Road and the Perimeter Highway, • continue to move landfilling operations further south , and • reduce the amount of biosolids (the nutrient-rich by-product of sewage treatment) being buried through a biosolids composting trial program.
11/1/2019	Citizen emailed us again complaining of trashy smell in Bridgewater Trails area coming from landfill.	Responded to the resident stating we investigated your concern and have found that the atmospheric conditions and minor complications with landfill operations suggest that it would be likely the odour originated from Brady landfill. Most of the day there was a SSW wind, which would lead to odours migrating to bridgwater area. Operations were in the process of filling in a trench and working to cover the garbage received that day, which could explain the odour. We do continuously work to reduce the impact of the landfill on our community. To control odours in and around the landfill, we: • cover garbage on a daily basis, • use natural bio filters (woodchips) on manholes to capture and biologically remove odours, • continue to expand the landfill gas capture system, • use dedicated trenches and/or folding-in-method for dead animals and cover all loads immediately, • monitor odours in and around the landfill on a regular basis, • plant trees and shrubs on the berms along Brady Road and the Perimeter Highway, • continue to move landfilling operations further south, and • have eliminated biosolids (the nutrient-rich by-product of sewage treatment) being buried through a biosolids soil amendment program at another location.
11/24/2019	Citizen emailed 311 stating that she lives in South Pointe and the Brady Landfill odour has been overwhelming.	Responded to the resident stating we investigated your concern and have found that the atmospheric conditions over the weekend (predominantly South, West-Southwest winds) suggest that it would be likely the odour originated from Brady landfill. Operations is currently trying a new method of handling Specified Risk Material, which will no longer involve opening a trench up, but they have to stock pile garbage to fold the SRM into at the end of the day. Operations was experiencing some teaching and learning curves, but will hopefully be rectified soon. We continuously work to reduce the impact of the landfill on our community. To control odours in and around the landfill, we • cover garbage on a daily basis, • use natural bio filters (woodchips) on manholes to capture and biologically remove odours, • continue to expand the landfill gas capture system, • use dedicated trenches for dead animals and cover all loads immediately, • monitor odours in and around the landfill on a regular basis, • plant trees and shrubs on the berms along Brady Road and the Perimeter Highway, • continue to move landfilling operations further south , and • elimanted the biosolids (the nutrient-rich by-product of sewage treatment) being buried through a biosolids composting trial program at another location.
12/5/2019	Citizen states there is an unbearable smell outside coming from the Brady Landfill. It's really hard to breath. Please do something about the smell. They worried that this will make my family sick.	Spoke with resident about her concerns with the odour being produced at Brady Landfill. Resident recently purchased a new house in close proximity to the landfill and is concerned with how strong the odour is at this time of year. I went over some of the initiatives that we are undertaking to try to reduce some of the odour. I reassured the resident that we have checked H2S levels in and around her residents and have not detected any of the hazardous gas. Some of the initiatives I discussed with her include: • cover garbage on a daily basis, • use natural bio filters (woodchips) on manholes to capture and biologically remove odours, • continue to expand the landfill gas capture system (further extensions are to be done in the new year), • use dedicated trenches for dead animals and cover all loads immediately, • monitor odours in and around the landfill on a regular basis and test for Hydrogen Sulfide, • plant trees and shrubs on the berms along Brady Road and the Perimeter Highway, • continue to move landfilling operations further south
12/14/2019	Citizen emailed 311 wanting to state that the odour coming from the landfill is horrible. She states that she would like this to be looked into as soon as possible. She states that it shouldn't be the atmosphere as it's -25 outside.	Responded to citizen via voice mail asking them to please call back and discuss their concerns further. We have included the address in our odour monitoring rounds.
12/19/2019	Citizen states, they moved in very recently and since their move, they have been getting strong foul odours from time to time on certain days. Just minutes ago, they went out their doors and got the same bad smell. Is there anything that can be done to prevent the smell? They would have never built this home here if they knew they would end up feeling like living in a dump. This is how strong the smell is when it smells. They am very worried about my sick elderly parents who live with me as the strong smell does not help them make it a pleasant place to live.	Further to our discussion this morning, I would like to send you an outline of some of the activities we are doing to try and mitigate some of the odours originating from Brady Landfill. We are continuously working to reduce the impact of the landfill on our community. To control odours in and around the landfill, we • Improve daily coverage of garbage on a daily basis, • continue to expand the landfill gas capture system, • monitor odours and hydrogen sulfide in and around the landfill on a regular basis, • plant trees and shrubs on the berms along Brady Road and the Perimeter Highway, • Improve the vegetative cover on the north slope, to reduce cracking in the clay cap. • continue to move landfilling operations further south , and • reduce the amount of biosolids (the nutrient-rich by-product of sewage treatment) being buried through a biosolids composting trial program. Although all these initiatives will greatly reduce the amount and consistency of odour. We can never guarantee that there will not be odour coming from the site, given the nature of the material being buried.

Date Created	Complaint	Response
Odours		
12/19/2019	Citizen reports that there is a strong garbage like smell occurring in our neighborhood that has been happening for numerous hours.	We did investigate your odour concern on Friday December 20 (and a regular odour monitor on Monday December 23). The atmospheric conditions suggest it was unlikely originating from Brady, but there was an odour due to some operations complications that was getting to the perimeter, so there is a chance it may have made it to your neighborhood but unlikely. As we continue to move operations south and the biosolids soil fabrication program starts up again in February, the odour should start to be less impactful/noticeable.
12/26/2019	Via email citizen states that the smell was so bad tonight that they had to plug their nose when they were walking their dog at 8:15.	Responded to the resident stating we have investigated your concern, and have found that the atmospheric conditions suggest that it would be highly likely the odour originated from Brady Landfill. Operations was dealing with setbacks and complications of being closed the prior day, and receiving some waste that was not planned for. But it was dealt with to their best ability at the time. We are continuing to cover garbage on a daily basis, and find better locations in the landfill for handling more odorous waste (SRM containing material) as options arise with the cell operations moving further south. As well, the biosolids soil fabrication program will be starting up again end of January/beginning of February and that will also help to reduce odour and operation complications.

7.0 CONCLUSION

The diversion operations taking place at the BRRMF have been effective in diverting tens of thousands of metric tonnes of material from the landfill.

Leachate management was successful in 2019 as there were no breakouts of leachate.

The quality of the ground water beneath the site has not been negatively impacted, as demonstrated by the comparison of upstream to downstream ground water quality.

The quality of the surface water measured at the Weir is statistically similar to the quality of the surface water upstream of the BRRMF.

The areas where landfill gas is escaping should be repaired.

The BRRMF will continue to operate so as to ensure that the environment is maintained in such a manner as to sustain a high quality of life, including social and economic development, recreation and leisure for present and future Manitobans.

8.0 REFERENCES

1. Brady Road Resource Management Facility – Manitoba Environment Act Licence No. 3081 R

https://www.winnipeg.ca/waterandwaste/pdfs/garbage/bradylicence.pdf

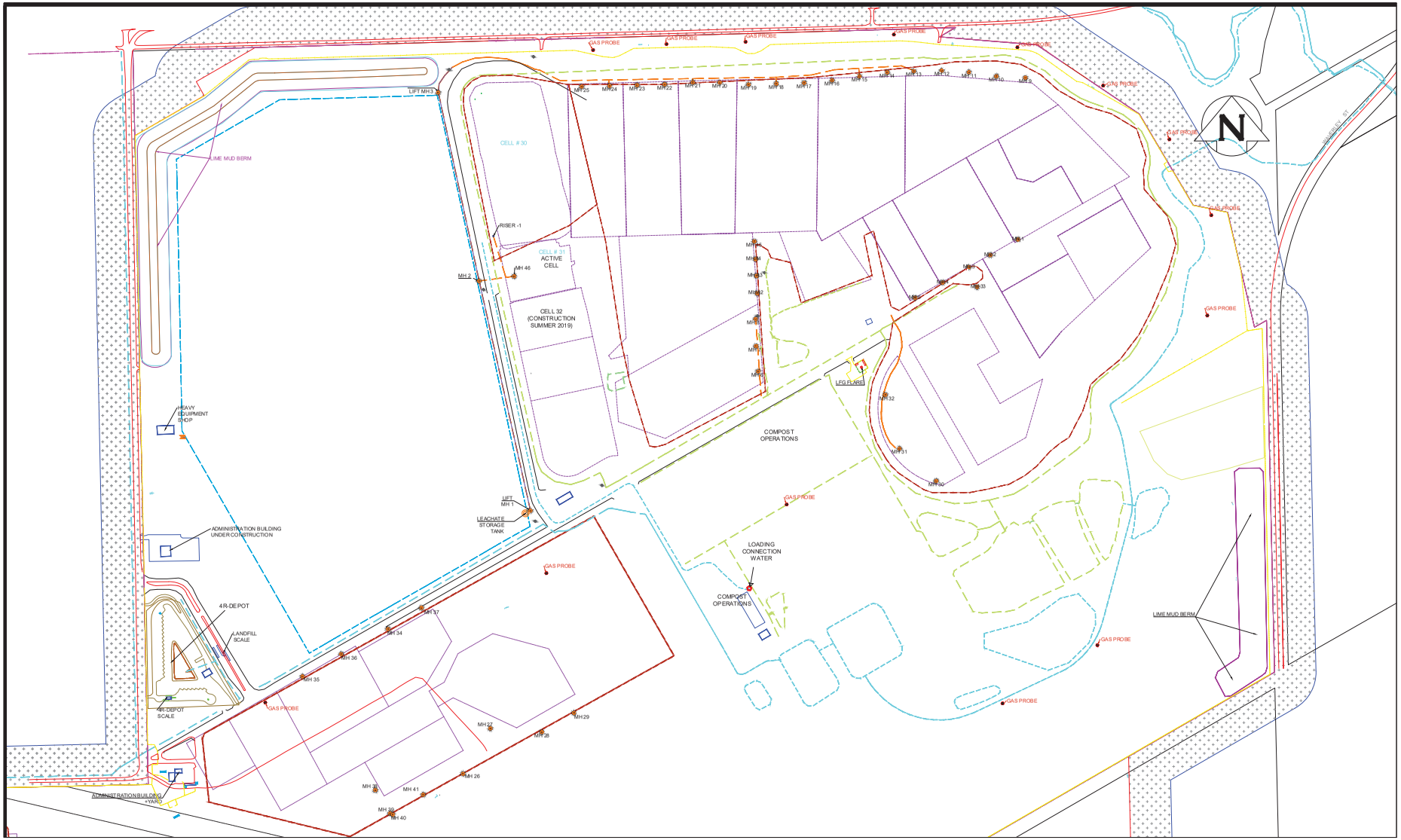
2. Ontario Ministry of the Environment. (2011, July 1). Soil, Ground Water and Sediment Standards for Use Under Part XV.1 of the Environmental Protection Act. Table 3: Full Depth Generic Site Condition Standards in a Non-Potable Ground Water Condition.

https://www.ontario.ca/page/soil-ground-water-and-sediment-standards-use-under-part-xv1-environmental-protection-act

3. Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines Summary Table. Water Quality Guidelines for the Protection of Freshwater Aquatic Life. (CCME, 2003).

http://ceqg-rcqe.ccme.ca/download/en/221

FIGURE 1
BRRMF LAYOUT & LEACHATE COLLECTION SYSTEM



La Ville de Winnipeg
City of Winnipeg

BRRMF

LEGEND/LÉGENDE

- CONTROL ZONE / Zone de contrôle
- LANDFILL SITE/ Site d'enfouissement Area : 802.94 Ha.
- CLEAN WATER DRAINAGE
- IMPACTED WATER DRAINAGE
- BRRMF ROADS
- CLOSED LANDFILL
- LEACHATE HEADER PIPES
- MANHOLE
- GAS PROBE
- GW Well
- RISER

Scale in metres / Échelle en mètres

100 0 100 200

1:4,000

METRIC / MÉTRIQUE
WHOLE NUMBERS INDICATE MILLIMETERS
DECIMALIZED NUMBERS INDICATE METRES
LES NUMÉROS ENTIER INDIQUENT LES MILLIMÈTRES
LES NUMÉROS DÉCIMALISÉS INDIQUENT LES MÈTRES

ORTHOPHOTO Date	FIELD BOOK #:		
2018			
UPDATED FEATURES			
WINTER & SUMMER GW FLOW DIRECTION -			
As per W.L. GIBBONS: HYDROLOGY Report	Aug. 2016	BW/BW	
KGS Leachate Header Pipes -Update	April 2019	IS/MO	
WELLS FEATURES SURVEYED	2017	BM/MN	
AIRPHOTO UPDATED TO 2018	04.26.18	M.O.	
CONVERT TO AUTOCAD DRAWING	OCT. 2018	M.O.	
NO. REVISIONS	DATE	BY.	

LANDFILL ENVIRONMENTAL SECTION /
SECTION ENVIRONNEMENTALE
D'ENFOUISSEMENT

SURVEY BY:	VALIDATED BY:
DRAWN BY: MO	APPROVED BY: MO
HOR. SCALE 1: 4,000	PRINTED
VERTICAL	DATE : April. 05. 2019
DATE April. 05. 2019	

THE CITY OF WINNIPEG / LA VILLE DE WINNIPEG
WATER AND WASTE DEPARTMENT
SOLID WASTE DIVISION

"WARNING"
THE EXACT GROUND AND UTILITY LOCATION CAN BE CERTIFIED ONLY BY DETAILED INVESTIGATION.
THE EXISTENCE AND EXACT LOCATION OF ALL UNDERGROUND SERVICES IN CLOSE
NEW CONNECTIONS MUST BE CHECKED WITH THE APPROPRIATE UTILITIES.

"ATTENTION"
LA LIMITE EXACTE DU RÉSEAU PEUT ÊTRE CERTIFIÉE UNIQUEMENT PAR UNE ENQUÊTE DÉTAILLÉE.
L'EXISTENCE ET LA LOCALISATION EXACTE DE TOUS LES SERVICES SOUTERRAINS. Y COMPRIS
LES NOUVELLES CONNEXIONS DOIT ÊTRE VÉRIFIÉE AVEC LES UTILITAIRES APPROPRIÉS

Site No. 25
Brady Rd.

SHEET 1 OF 1

CITY DRAWING NUMBER

Leachate Collection System 2019

FIGURE 2
GROUND WATER SAMPLING LOCATIONS

LEGEND

▲ OVERBURDEN PIEZOMETER NEST
⬢ GROUNDWATER WELL

0.0 0.05 0.1 0.2 0.3 0.4 0.5
DISTANCES IN KM

B.M. ELEV.	FIELD BOOK #:		
POSTED TO LBIS			
1		11/11/25	KB
NO.	REVISIONS	DATE	BY

Winnipeg

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

BRADY ROAD LANDFILL

WELL LOCATIONS

SHEET 1 OF 1

FIGURE 1_R1

FIGURE 3
SURFACE WATER SAMPLING LOCATIONS

LEGEND:

- IMPACTED WATER POND
- DRY POND
- CLEAN WATER POND
- SWQ-25-16 SURFACE WATER SAMPLING LOCATION
- SURFACE WATER FLOW DIRECTION
- CLOSED LANDFILL BOUNDARY
- LAND DRAINAGE DITCH

NOTES:

1. TOPOGRAPHY SOURCES ARE CITY OF WINNIPEG, KGS GROUP 2013 TOPOGRAPHY OF ACTIVE LANDFILL OPERATING AREA AND ADDITIONAL LANDFILL PERIMETER SURVEY BY KGS GROUP 2013.
2. EXACT SURFACE WATER SAMPLING LOCATION TO BE DETERMINDED IN FIELD.

100 0 100 200 300 400m

SCALE: 1:10000 METRIC

NO.	YY/MM/DD	DESCRIPTION	BY
A	14/05/30	ISSUED WITH DRAFT REPORT	MFH

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

THE CITY OF WINNIPEG
WATER AND WASTE DEPARTMENT

BRADY ROAD RESOURCE MANAGEMENT FACILITY SURFACE WATER MANAGEMENT PLAN

PROPOSED SURFACE WATER MONITORING LOCATIONS

MAY 2014 | FIGURE 10 | REV: A

APPENDIX A
2019 INCIDENT REPORTS

Winnipeg | Water and Waste
Eaux et déchets

File NO. G-130

May 30, 2019

Mainitoba Sustainable Development Environmental Approvals
2nd Floor- 123 Main Street
Winnipeg, MB R3C 1A5
Canada

Attention: Tracy Braun, Director

Dear Ms. Braun:

RE: Exceedance in leachate head in cell developed after August 1st, 2013.

Please consider this letter as formal notification from the City of Winnipeg to the Province of Manitoba advising that a landfill cell (known as "Cell 31") developed after August 1st, 2013 has temporarily exceeded its maximum leachate head allowance - which is described as leachate levels above the crown of the collection system cell bottom piping for a period greater than seven days.

This notification is required under the auspice of **Environment Act Licence No. 3081R -**specifically clause 98 which reads:

Operation – Landfill Gas Collection and Flaring System

105. The Licencee shall report if the maximum depth of leachate in any waste cell, developed after August 1, 2013, exceeds the maximum head, as indicated in the approved Leachate Management Plan, above the crown of the collection system cell bottom piping; for a period of seven (7) days to an Environment Officer within 24 hours.

Reason for Exceedance:

On April 22, the contractor who hauls leachate from the City of Winnipeg facilities notified the City staff that the centralized leachate tank was not functioning and he was unable to pull any leachate out of main tank. An investigation of the leachate collection system was undertaken and it was determined that the main pump in the leachate lift station had malfunctioned and dislodged from its mounts resulting in the main discharge line into the leachate tank becoming severed. The severing of this main line has resulted in leachate not being able to be pumped into the main tank. As a result of the pump failure the City has shut down the leachate collection system to facilitate immediate repairs.

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Cell 31's current design only allows for the leachate produced in the cell to be collected into the centralized leachate tank, so as long as the system is shut down leachate will continue to accumulate in the cell.

Mitigation Plan

Immediate Actions

The existing leachate collection system (series of manholes) is functioning normally, and the city immediately engaged the prior leachate collection methods - manually pumping leachate out of the manholes - in order to maintain compliance with our Environment Act Licence.

Interim Actions

Since the discovery of the leachate tank failure, the city has engaged the original design engineers (KGS Group) to provide an interim solution to get the leachate system back online so as to restart Cell 31's pump to get the leachate levels back into compliance. A preliminary pump and piping design has been developed and is likely to be installed and the system brought back online within the week (June 3-7th) if a suitable contractor can be commissioned.

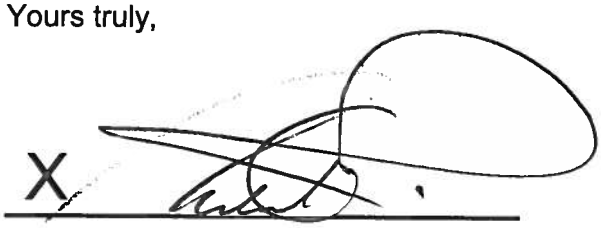
Long Term Actions

The system design engineering team (KGS Group) has indicated the conceptual design used for the interim leachate pumping system will be used as a basis for the final design solution – the main differences being the composition of the piping material. The interim design intends to use composite steel for the piping components – composite steel is readily available and can be custom fit in a relatively short time frame. The long term solution involves the use of stainless steel piping which is considerably harder to find and manufacture to design specifications in short order – thus the desire for the short term composite steel solution. Additionally, after the stainless steel installation having the composite steel components on hand as back up piping components ensures system redundancy and reduces the long term risk of the system being down for any considerable length of time should a pump failure occur in the future.

Once repairs are completed the City will partake in an aggressive pumping schedule to get Cell 31 back into compliance for leachate head, which the City anticipates could be a few weeks.

Should you have any further questions or concerns please feel free to contact Supervisor of Environmental Monitoring and Reporting Chris Kozak at (204) 986-2384 or via email at ckozak@winnipeg.ca.

Yours truly,



Michael Gordichuk
Manager Solid Waste Services

SOLID WASTE SERVICES DIVISION
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APPENDIX B
2019 BRRMF TONNAGE SPREADSHEET

CITY OF WINNIPEG: Brady Road Resource Management Facility Tonnage (metric tonnes) 2019

2018 Actuals for Forecast Purposes
2019 Actuals
Manually entered as not tracked in wasteworks
Mixed manual tracking and WasteWorks tracking

Material Type	WW Material	Item/Acct	January	February	March	April	May	June	July	August	September	October	November	December	Total		WRARS Levy
Domestic Collection - AREA 1-MILLER	DOM REF CT	2400	4830.88	3,897.02	4,573.98	5,706.80	6,177.55	5,541.54	6,207.63	5,743.38	6,007.93	6,403.09	4,896.43	4,760.88	64,747.11		
Domestic Collection - AREA 2-GFL	DOM REF CT	2500	4232.89	3,432.16	4,019.39	4,979.68	5,299.84	4,716.21	5,273.14	4,979.78	5,126.33	5,572.69	4,418.93	4,251.34	56,302.38		
Domestic Collection - BULKY PU-WASTE CONN	DOM REF CT	3500	40.43	27.60	43.18	78.76	119.05	96.85	97.76	101.36	123.27	99.02	56.23	48.75	932.26		
Other (To be Adjusted)	*DOM REF CT*	*	*-2.80*					*7.13*	(4.41)	*0.38*	0.00		0.00	0.00	0.30		
Subtotal Single Family Collection	**DOM REF CT**		**9,101.40**	**7,356.78**	**8,636.55**	**10,765.24**	**11,596.44**	**10,361.73**	**11,574.12**	**10,824.90**	**11,257.53**	**12,074.80**	**9,371.59**	**9,060.97**	**121,982.05**		
Multi-Family NW Area - Waste Connections	APT WT	1093	1700.44	1,489.76	1,637.37	1,940.31	2,024.13	1,760.36	2,110.95	1,960.14	2,059.91	2,200.76	1,662.57	1,767.62	22,314.32		
Multi-Family SW Area - Waste Connections	APT WT	1504	1099.38	965.51	956.94	1,562.03	1,410.25	1,287.90	1,459.96	1,379.83	1,556.95	1,554.15	1,221.74	1,302.20	15,756.84		
Multi-Family E Area - Waste Connections	APT WT	1519	1136.14	995.10	1,174.74	1,001.80	1,281.54	1,128.99	1,332.18	1,281.11	1,267.90	1,329.70	1,045.86	1,021.39	13,996.45		
Subtotal Apt Collection	**APT WT**		**3,935.96**	**3,450.37**	**3,769.05**	**4,504.14**	**4,715.92**	**4,177.25**	**4,903.09**	**4,621.08**	**4,884.76**	**5,084.61**	**3,930.17**	**4,091.21**	**52,067.61**		**0.0**
Total Residential Collection			**13,037.36**	**10,807.15**	**12,405.60**	**15,269.38**	**16,312.36**	**14,538.98**	**16,477.21**	**15,445.98**	**16,142.29**	**17,159.41**	**13,301.76**	**13,152.18**	**174,049.66**	**1,740,496.6**	**0.0**
City Refuse - eg. Street Cleaning	CITY REFUS	4	228.20	538.77	469.41	952.70	1,136.63	1,059.75	2,652.48	867.42	643.27	591.37	785.06	187.21	10,112.27	101122.7	
Construction / Demolition Waste - City	CITY CNDEM	5	1.39	0.33	0.85	9.67	8.28	207.51	55.01	0.57	77.85	0.94	92.92	13.79	469.11	4691.1	
Landscaping - City - trees, etc., & (DE)	TREELFCITY TREES CITY TREES DE 1	6														29712.3	
			579.94	363.59	173.72	215.28	175.16	232.28	218.86	173.97	410.45	138.40	(11.48)	301.06	2,971.23		
Grit	GRIT	7	172.03	98.56	310.73	261.36	239.68	199.02	244.97	179.10	176.90	233.28	192.48	133.83	2,441.94	24419.4	
Bio solids landfilled	SLUDGE		4136.09	604.79	0.00	4,379.78	4,359.82	2,090.27	221.23	(12.70)	0.00	0.00	0.00	4,585.80	20,365.08	203650.8	
Residue from MRF (EMTERRA)	RESIDUE		518.83	430.51	328.36	522.02	345.81	503.92	1,223.83	498.46	1,123.48	402.38	227.30	0.00	6,124.90	61249	
Sweepings	SWEEP		0.00	0.00	0.00	7.22	0.00	13.54	0.00	0.00	154.16	0.00	0.00	0.18	175.10	1751	YES
Total City Depts - Charged			**5,636.48**	**2,036.55**	**1,283.07**	**6,348.03**	**6,265.38**	**4,306.29**	**4,616.38**	**1,706.82**	**2,586.11**	**1,366.37**	**1,286.28**	**5,221.87**	**42,659.63**		
Total Residential + City Depts			**18,673.84**	**12,843.70**	**13,688.67**	**21,617.41**	**22,577.74**	**18,845.27**	**21,093.59**	**17,152.80**	**18,728.40**	**18,525.78**	**14,588.04**	**18,374.05**	**216,709.29**		**#REF!**
	ANIMAL WAS ANIMLS-CHG	8															
Dead Animals-Charge	SRM		509.89	727.36	625.89	593.81	689.84	856.80	1,812.44	2,844.66	1,563.08	1,608.43	1,178.55	829.14	13,839.89		YES
Asbestos	ASBESTOS	9	17.78	32.03	16.87	33.59	32.11	67.13	40.08	34.20	187.69	149.50	113.67	16.23	740.88		YES
Charitable Organization - C / special rate	C-CHARITY	18	107.65	150.30	96.06	235.92	162.25	175.01	211.75	187.95	169.99	302.06	139.13	120.75	2,058.82		YES
Commercial / Industrial - all sources	COMM/INDUS	10															
			3659.13	3,790.77	5,259.20	5,977.68	7,704.70	7,319.11	8,189.20	6,901.45	6,440.22	7,208.02	6,074.26	4,028.39	72,552.13		YES
Commercial Flat Fee	COMM_FF		0.00	0.00	7.17	85.04	40.09	79.94	163.47	36.45	94.00	226.10	33.36	196.58	962.20		
Construction / Demolition Waste	CONST/DEM	11	220.96	119.02	42.71	23.07	11.62	0.00	0.00	45.45	0.00	0.00	0.00	0.00	462.83		YES
Concrete - charged	CONC - CHG	12	0.00	0.00	0.00	29.63	3.33	16.08	14.89	4.78	8.10	2.32	0.00	0.00	79.13		YES
Food waste	FOOD WASTE		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		NO
Hospital Waste	HOSP WASTE	13	0.75	0.46	0.68	0.70	0.74	1.14	0.91	1.10	0.54	1.25	0.50	0.53	9.30		YES
	LANDSCAPE TREELFCOMM TREES COMM																
Landscaping - Com. - trees, etc., & (DE)	TREES DE 2	14	4.03	0.00	6.22	11.48	16.23	15.88	14.12	9.05	17.64	4.65	(0.58)	7.69	106.41		YES
Residue - Canada Fiber	RESIDUE-CF										29.61	689.19	600.64	621.23	1,940.67		
Sawdust - Charged	SAWDUST CH	15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		YES
																	NO
	HYDRO POLE																YES
	RECYC-REFU																YES
	RES/OVER																C?
	SANDBAG																NO
	TIRES																NO
	TOILETS_$5																NO
	TOILETS_CH																NO
Special Waste	WEEDS	17	0.00	0.00	1.27	1.61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.88		YES
Sewer Grit	SEWER-GRIT		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00		
Manure	MANURE-P	16	0.00	104.86	0.00	0.00	79.91	0.00	0.00	0.00	130.67	0.00	0.00	133.40	448.84		YES
Total Non City Depts - Charged			**4,520.19**	**4,924.80**	**6,056.07**	**6,992.53**	**8,740.82**	**8,531.09**	**10,446.86**	**10,065.09**	**8,641.54**	**10,191.52**	**8,139.53**	**5,953.94**	**93,203.98**		
Dead Animals - TFW	ANIMALS N/C	20	0.15	1.30	1.61	2.70	2.21	1.95	2.28	1.32	1.14	2.50	3.29	0.83	21.28		NO
Brady Admin Building Construction Material	1777 BRADY		0.34	1.44	0.36	0.42	0.20	0.00	0.00	0.00	0.00	0.00		0.00	2.76		
Charitable Organization - TFW	CHARITY	19	65.32	55.93	23.83	26.43	27.06	13.48	40.60	49.50	32.37	49.68	41.61	37.61	463.42		YES
October Fall Storm Wood Waste- NC (City and Private)	C-TREE-EMG											443.01	134.71	8.57	586.29		
Neighbourhood clean ups	CLEAN-UP		0.00	0.00	0.00	0.00	8.34	24.11	0.00	0.00	3.53	0.00		0.00	35.98		
Total Non City Depts - Not Charged			**65.81**	**58.67**	**25.80**	**29.55**	**37.81**	**39.54**	**42.88**	**50.82**	**37.04**	**495.19**	**179.61**	**47.01**	1,109.73		**0.0**
Total Non City Depts			**4,586.00**	**4,983.47**	**6,081.87**	**7,022.08**	**8,778.63**	**8,570.63**	**10,489.74**	**10,115.91**	**8,678.58**	**10,686.71**	**8,319.14**	**6,000.95**	**94,313.71**		**0.0**

Material Type	WW Material	Item/Acct	January	February	March	April	May	June	July	August	September	October	November	December	Total	Levy
Other Municipalities																
Manitoba Conservation (Falcon Lake/Hecla)	DOM REF RM	772	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
R. M. of Springfield / Emterra	DOM REF RM	1212	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
R. M. of West St.Paul / Emterra	DOM REF RM	1263	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Total Municipalities 445-454084-201904	DOM REF RM		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**YES**
4R Depots																
4R Contaminated Bins (Garbage)	4RDCONTGRB		3.19	3.04	5.35	22.82	20.61	11.07	2.84	1.50	8.02	5.71	0.00	4.63	88.78	
4R Flat fee garbage	4RDEPTFF		0	0.00	4.00	69.53	151.96	18.64	41.16	81.49	61.93	45.82	13.77	17.27	505.57	
4R Weighed garbage	4RDEPTREG		331.94	284.00	597.15	1,152.83	1,530.88	1,522.29	1,604.57	1,387.87	1,406.03	1,237.50	762.12	471.27	12,288.45	
Total Garbage from 4R Depots 445-454570-201910			**335.13**	**287.04**	**606.50**	**1,245.18**	**1,703.45**	**1,552.00**	**1,648.57**	**1,470.86**	**1,475.98**	**1,289.03**	**775.89**	**493.17**	**12,882.80**	**YES**
														Trees are chipped and not landfilled	(3,663.93)	
														Adjustment for Flat Fee Tonnage	(1,142.28)	
Total Landfilled			**23,594.97**	**18,114.21**	**20,377.04**	**29,884.67**	**33,059.82**	**28,967.90**	**33,231.90**	**28,739.57**	**28,882.96**	**30,501.52**	**23,683.07**	**24,868.17**	**319,099.59**	
Glass delivered to site	GLASS	33	999.55	942.68	1,110.06	1,007.09	855.37	902.93	735.37	739.56	824.20	1,326.99	894.54	547.45	10,885.79	NO
Sweepings N/C	SWEEP NC	24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	223.10	0.00	0.00	0.00	223.10	NO
Compostable -Yard waste/Ponds/Street Leaves/C	PONDS	26														NO
	ST LEAVES															NO
	YARD WASTE															NO
	SAWDUST NC															YES
	CATTAILS		40.15	14.74	34.49	434.70	768.77	639.41	595.94	483.19	491.55	764.80	370.40	71.29	4,709.43	
2600 AREA 1 YARDWASTE-MILLER	LEAFIT-CUR 2600		0.00	0.00	0.00	300.20	2,046.01	1,642.68	1,253.71	797.23	1,345.47	2,694.92	1,024.67	0.00	11,104.89	
2700 AREA 2 YARDWASTE-GFL	LEAFIT-CUR 2700		0.00	0.00	0.00	147.22	2,437.74	1,850.66	1,506.41	1,009.08	1,707.25	3,036.50	1,107.21		12,802.07	
Leaf & Yard Waste self-hauled (per Foreman)															0.00	
	AGGREGATE															
	CLEAN FILL															
Clean Fill - TFW (Tipping Fee Waived)	SHREDDED	30	23,971.89	20,517.07	36,496.82	89,434.93	13,397.84	20,192.21	14,211.80	14,633.22	6,165.14	1,061.32	6,064.44	3,020.03	249,166.71	NO
Concrete - TFW	CONC - N/C	31	240.02	73.97	97.00	158.17	511.82	435.38	597.06	824.96	547.08	343.27	351.18	264.17	4,444.08	NO
	WOOD N/C															
Wood Chips	WC NC LF	32	39.98	45.61	58.71	58.61	162.65	95.16	75.98	186.28	103.07	336.80	249.93	91.74	1,504.52	NO
Bio solids composted	BIO SLUDGE		0.00	0.00	0.00	717.47	813.17	384.98	0.00	0.00	0.00	0.00	0.00	0.00	1,915.62	NO
Wood Chips composted	BIOWOODCHI		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	NO
Total compostable material			**25,291.59**	**21,594.07**	**37,797.08**	**92,258.39**	**20,993.37**	**26,143.41**	**18,976.27**	**18,673.52**	**11,406.86**	**9,564.60**	**10,062.37**	**3,994.68**	**296,756.21**	
4R Battery	4R Battery		0.00	0.00	0.75	1.71	8.91	4.68	4.94	9.83	6.00	12.11	2.90	2.04	53.86	NO
4R Battery - Small (Call2 Recycle)	N/A		2.88	1.94	0.00	1.82	0.00	2.84	2.30	1.67	1.53	0.80	2.39	2.28	20.44	
4R Bicycles	4R Bicycl		1.04	0.00	3.29	0.79	0.33	0.20	0.87	0.00	0.76	0.44	0.99	0.70	9.41	
4R Ceramic	4RCERAMIC		10.03	21.21	15.67	33.56	36.29	40.49	29.63	42.83	31.56	30.00	19.76	19.62	330.65	
4R Clean Fill	4RDCLEANFL		6.18	0.00	0.00	35.59	538.17	698.10	590.23	381.10	378.21	266.73	52.26	0.00	2,946.57	
4R Concrete	4RCONCRETE		4.53	33.61	37.58	117.95	289.24	498.96	298.81	335.68	230.99	166.80	79.01	27.57	2,120.73	NO
4R Electronics	4RELECTRO		58.59	36.70	24.26	47.70	85.36	49.10	87.79	71.71	49.87	51.21	53.04	50.12	665.45	
4R HHW	4RDSOLVENT		31.44	18.47	35.13	57.97	86.86	69.25	87.27	84.53	70.62	87.84	46.50	10.05	685.93	
4R Oil	4RDOIL		1.71	0.46	3.46	6.50	14.94	7.96	13.51	10.62	7.99	11.33	8.32	3.40	90.19	
4R Glass	4RDGLASS		1.65	0.00	9.31	3.63	7.79	4.93	7.98	12.37	12.94	13.33	0.00	5.70	79.63	NO
4R Lumber	4RDLUMBER		3.56	2.09	3.81	17.94	19.65	24.77	43.53	25.35	16.08	20.94	13.76	0.69	192.17	NO
4R Leaf and Yard Waste	4RD LYW															
	4RDLYWLG		20.18	3.35	13.31	260.79	442.41	409.31	366.30	339.61	384.17	486.70	136.68	46.13	2,908.94	NO
4R Mattresses	NOT IN WW		0.00	6.80	15.40	18.55	26.11	23.73	31.30	28.64	27.59	25.34	18.98	10.24	232.69	
4R ODS	4RDODS		9.12	4.16	10.78	14.37	19.49	18.41	21.83	21.45	13.93	13.56	12.32	6.90	166.29	
4R Oversized Plastics	4RDOSPLAST		1.26	0.00	34.58	1.06	0.00	6.52	0.00	0.00	0.00	0.00	0.00	0.00	43.42	NO
4R Recyclables	4RDRECYCL		16.81	6.36	22.75	31.89	18.52	13.39	33.64	29.87	30.67	33.08	24.73	16.23	277.94	
4R Scrap Metal	4RDSCRAPMT		23.08	27.20	24.27	62.12	82.45	63.33	83.11	73.89	70.80	56.92	45.90	22.21	635.27	NO
4R Tires	4RDTIRES		2.39	1.69	3.09	13.19	27.00	11.29	26.51	25.76	18.27	5.24	0.00	0.00	134.43	
Total 4R Depot			**194.44**	**164.03**	**257.44**	**727.12**	**1,703.51**	**1,947.25**	**1,729.55**	**1,494.91**	**1,351.97**	**1,282.37**	**517.55**	**223.88**	**11,594.01**	
Battery Removal	(BATTERYRMV)		0.00				0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	NO
City Compost Removal	(COMPOSTREM)		0.00			(91.26)	(2,042.33)	0.00	(631.02)	(935.10)	(63.82)	(1,402.05)	0.00	0.00	(5,165.58)	NO
Glass Removal	(GLASS REMV)		0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	NO
Leachate Removed	(LEACH REMV)		(1,434.60)	(1,577.69)	(2,885.09)	(3,712.36)	(3,734.67)	(2,989.56)	(3,814.58)	(2,955.01)	(3,025.77)	(2,806.85)	(3,016.83)	(2,536.20)	(34,489.21)	NO
ODS Removal	(ODS REMOVA)	25	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	NO
Scrap Metal Removed	(SCRAP REMV)	22	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	NO
Dutch Elm Removal (Wood Anchor)	(TREESDE-WA)		0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	NO
Tires Removed	(TIRES REMV)	23	0.00			0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	NO
Total material removed from site			**(1,434.60)**	**(1,577.69)**	**(2,885.09)**	**(3,803.62)**	**(5,777.00)**	**(2,989.56)**	**(4,445.60)**	**(3,890.11)**	**(3,089.59)**	**(4,208.90)**	**(3,016.83)**	**(2,536.20)**	**(39,654.79)**	
Total Net All Items			**47,646.40**	**38,294.62**	**55,546.48**	**119,066.56**	**49,979.70**	**54,069.00**	**49,492.12**	**45,017.89**	**38,552.20**	**37,139.59**	**31,246.16**	**26,550.53**	**576,201.01**	
NUMBER OF VEHICLES / LOADS																

Material Type	WW Material	Item/Acct	January	February	March	April	May	June	July	August	September	October	November	December	Total	Levy
Description		***Item/Acct***	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	Total	
BRADY ROAD LANDFILL - VEHICLES / LOADS																
Vehicles - Domestic Refuse - City		*1*	0	0	0	0	0	0	0	0	0	0.00	0.00	0.00	0	
Vehicles - Domestic Refuse - Contract	DOM REF CT	*2*	1458	1219	1336	1437	1485	1315	1540	1432	1412	1,524	1,324	1,366	16,848	
Vehicles - 4R Depot (Brady) - Garbage Area			2306	1863	3563	6091	7567	7309	7564	6900	6702	6105	4081	2910	62,961	
Vechiles - 4R Depot (Brady) - Total			2847	2439	4246	9998	13012	10778	11761	10466	9756	8484	5674	3629	93,090	
Vehicles - 4R Depot (Pacific)			1382	1051	1733	2923	4085	3994	4252	4055	3718	3234	2943	1873	35,243	
Vehicles - 4R Depot (Panet)			2502	1632	2962	5174	7157	7027	7226	6508	6542	6074	4943	3338	61,085	
Vehicles - Commercial / Industrial	COMM/INDUS	*10*	2803		3729	4515	5597	5168	5490	5243	4616	5,292	4,122	2,931.00	49,506	
Vehicles - Special Waste		*17*	0		2			0	0	0	0	0			2	
Vehicles - Mud Trucks - Tandem (manually tracked)			1631	1521	1429	105	532	707	655	712	205	593	98	71	8,259	
Vehicles - Mud Trucks - Semi (manually tracked)			604	433	1183	102	306	559	303	354	101	876	57	29	4,907	
OTHER MUNICIPALITIES - VEHICLES / LOADS																
Manitoba Conservation (Falcon Lake)		*772*	1						0	0	0	0	0	0	1	
RM of Tache		*886*	0						0	0	0	0	0	0	0	
R.M. of MacDonald / Blackhawk Enterprises		*1127*	0						0	0	0	0	0	0	0	
R. M. of Springfield / Emterra		*1212*	0						0	0	0	0	0	0	0	
R. M. of West St.Paul / Emterra		*1263*	0						0	0	0	0	0	0	0	
															0	
TOTAL VEHICLES - ALL PAYING CUSTOMERS			**15,534**	**10,158**	**20,183**	**30,345**	**39,741**	**36,857**	**38,791**	**35,670**	**33,052**	**32,182**	**23,242**	**16,147**	**268,941**	

Blue font = formula = don't type in

Reconcile Monthly Tonnage to WasteWorks Material Analysis report		**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**	Total
Total Actual Weight per WW		26,803.34	22,158.27	26,572.35	37,744.21	51,234.39	43,318.31	47,262.49	40,508.96	40,972.48	45,195.54	35,226.96	30,430.69	447,427.99
														0.00
ss: Removals X 2 (negative here but positive in WW)	(BATTERYRMV)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(COMPOSTREM)	0.00	0.00	0.00	(182.52)	(4,084.66)	0.00	(1,262.04)	(1,870.20)	(127.64)	(2,804.10)	0.00	0.00	(10,331.16)
	(GLASS REMV)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(LEACH REMV)	(2,869.20)	(3,155.38)	(5,770.18)	(7,424.72)	(7,469.34)	(5,979.12)	(7,629.16)	(5,910.02)	(6,051.54)	(5,613.70)	(6,033.66)	(5,072.40)	(68,978.42)
	(ODS REMOVA)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(SCRAP REMV)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(TREESDE-WA)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(TIRES REMV)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	MUD TRUCKS MANULLY TRACK	23,587.50	19,196.00	34,723.00	88,755.00	10,037.00	16,614.00	10,772.00	12,239.00	3,504.00	97.50	1,862.50	1,085.00	222,472.50
Less: Items not on tonnage report	RES/REFUSE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	WEIGH ONLY				(37.72)	(79.62)	(124.68)	(0.86)	(274.57)	(11.69)				(529.14)
	4RDEPTFF WASTEWORKS REP			(6.82)										(6.82)
	4RDEPTFF WRARS LEVY REPO			4.00										4.00
	4R MATERIALS	124.76	95.73	112.04	214.25	341.93	242.53	349.69	324.72	266.59	264.35	190.36	107.24	2,634.18
	COMM_FF WASTEWORKS REP			(95.09)										(95.09)
	COMM_FF WRARS LEVY REPOR			7.17										7.17
	ZRATE ADJ	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	CASH CUSTOMER	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	OTHER ADJUSTMENTS				**(1.94)**		**(2.04)**							(3.98)
	ACCT 472 ARSON PILOT ZONE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Net		**47,646.40**	**38,294.62**	**55,546.48**	**119,066.56**	**49,979.70**	**54,069.00**	**49,492.12**	**45,017.89**	**38,552.20**	**37,139.59**	**31,246.16**	**26,550.53**	**592,601.23**
Total per Tonnage Report		47,646.40	38,294.62	55,546.48	119,066.56	49,979.70	54,069.00	49,492.12	45,017.89	38,552.20	37,139.59	31,246.16	26,550.53	592,601.23
Difference should be zero		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

APPENDIX C
2019 PIPER DIAGRAMS

2019 Groundwater Piper Diagrams

Site: Brady
Well #: W4

Dates:
11-Jun-14
23-Oct-14
2-Jun-15
26-Oct-15
24-May-16
26-Oct-16
23-May-17
19-Oct-17
24-May-18
16-Oct-18
9-May-19
7-Oct-19

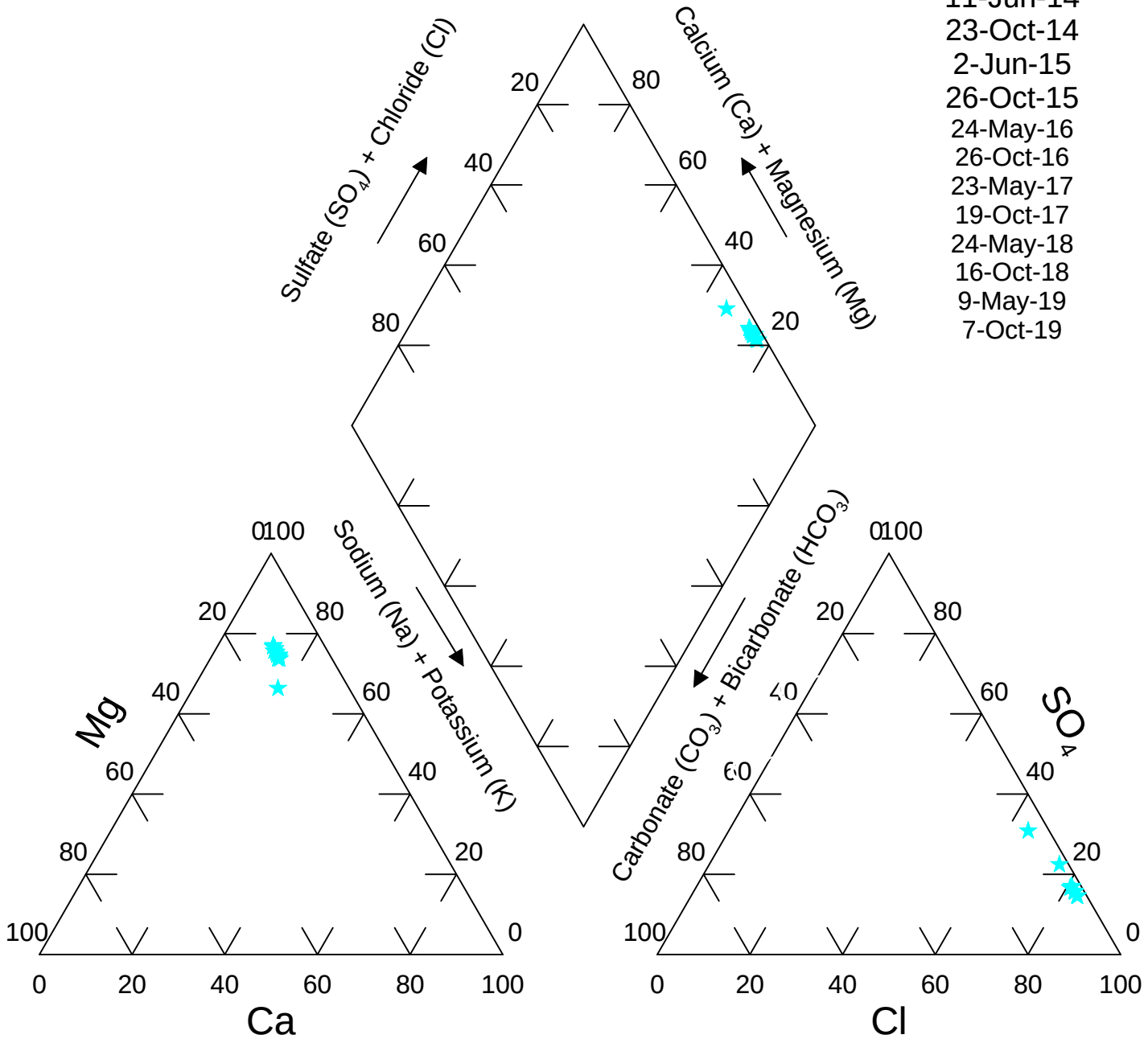


FIGURE: 1P

Winnipeg
Water and Waste Department

Site: Brady
Well #: W5

Dates:
11-Jun-14
23-Oct-14
2-Jun-15
26-Oct-15
24-May-16
26-Oct-16
23-May-17
19-Oct-17
24-May-18
18-Oct-18
9-May-19
7-Oct-19

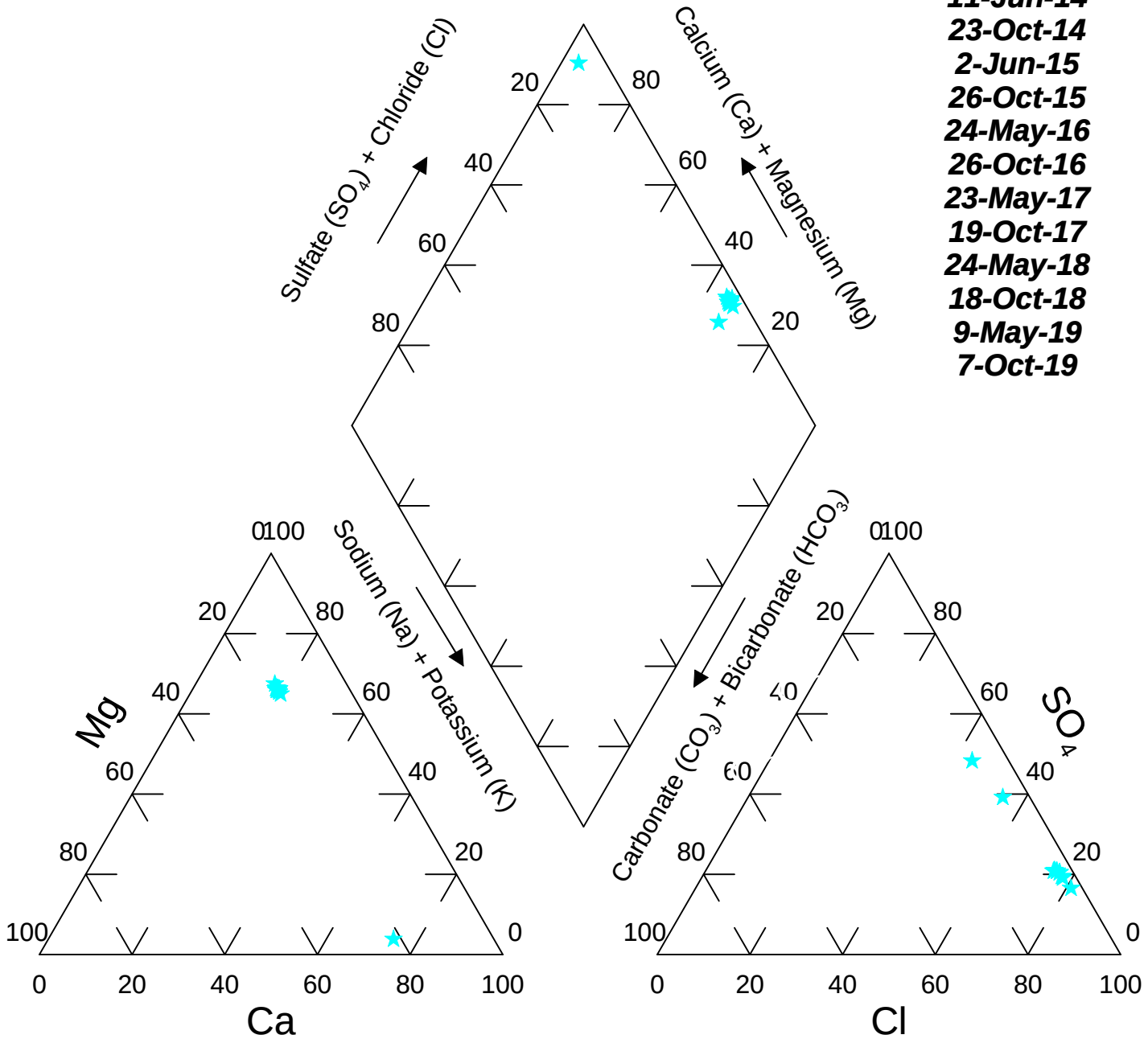


FIGURE: 2P

Winnipeg
Water and Waste Department

Site: Brady
Well #: W6

Dates:
11-Jun-14
20-Oct-14
3-Jun-15
26-Oct-15
30-May-16
25-Oct-16
24-May-17
17-Oct-17
23-May-18
18-Oct-18
14-May-19
13-Nov-19

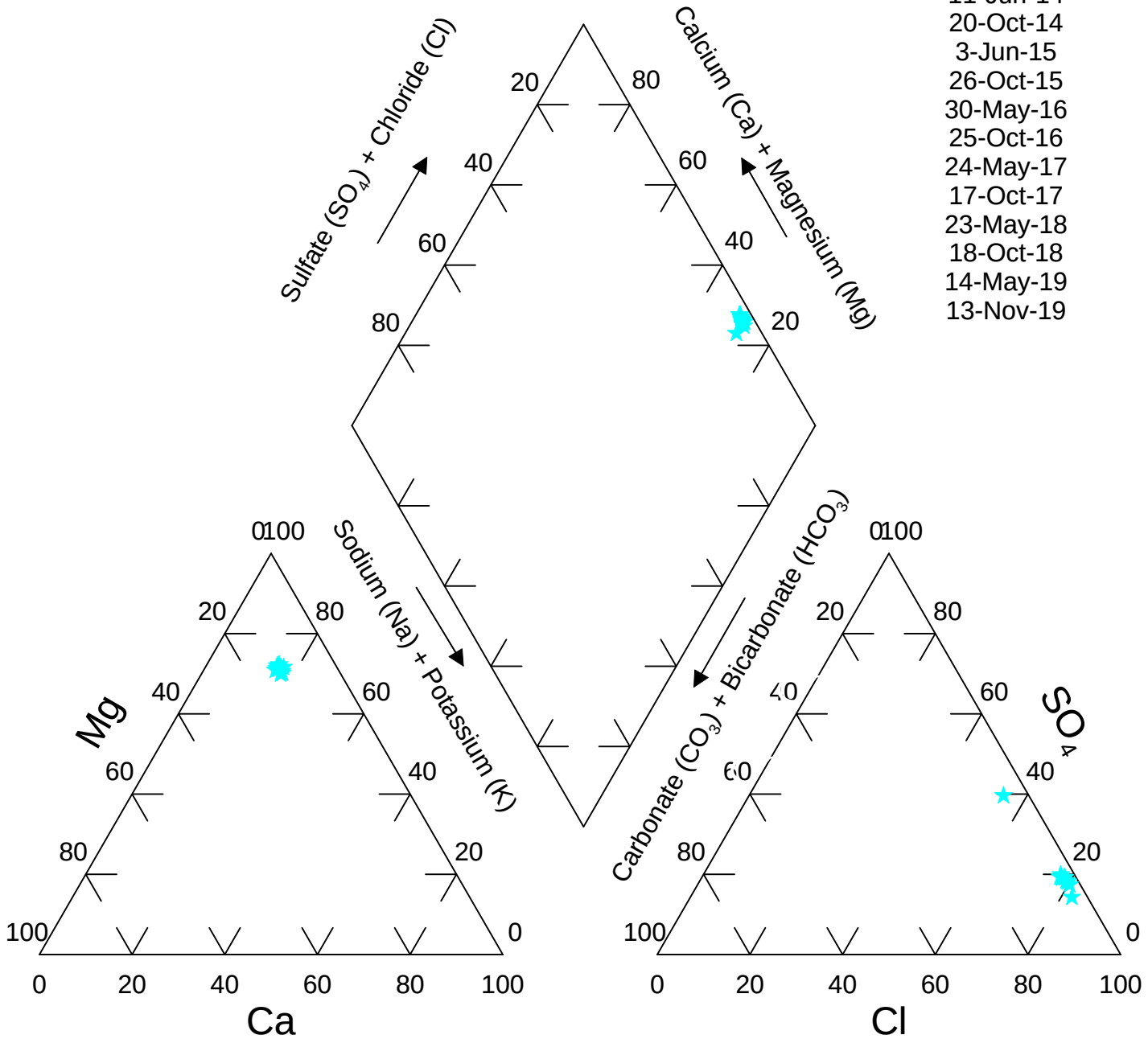


FIGURE: 3P

Winnipeg
Water and Waste Department

Site: Brady
Well #: W7

Dates:
11-Jun-14
20-Oct-14
2-Jun-15
26-Oct-15
24-May-16
24-Oct-16
24-May-17
17-Oct-17
23-May-18
17-Oct-18
14-May-19
13-Nov-19

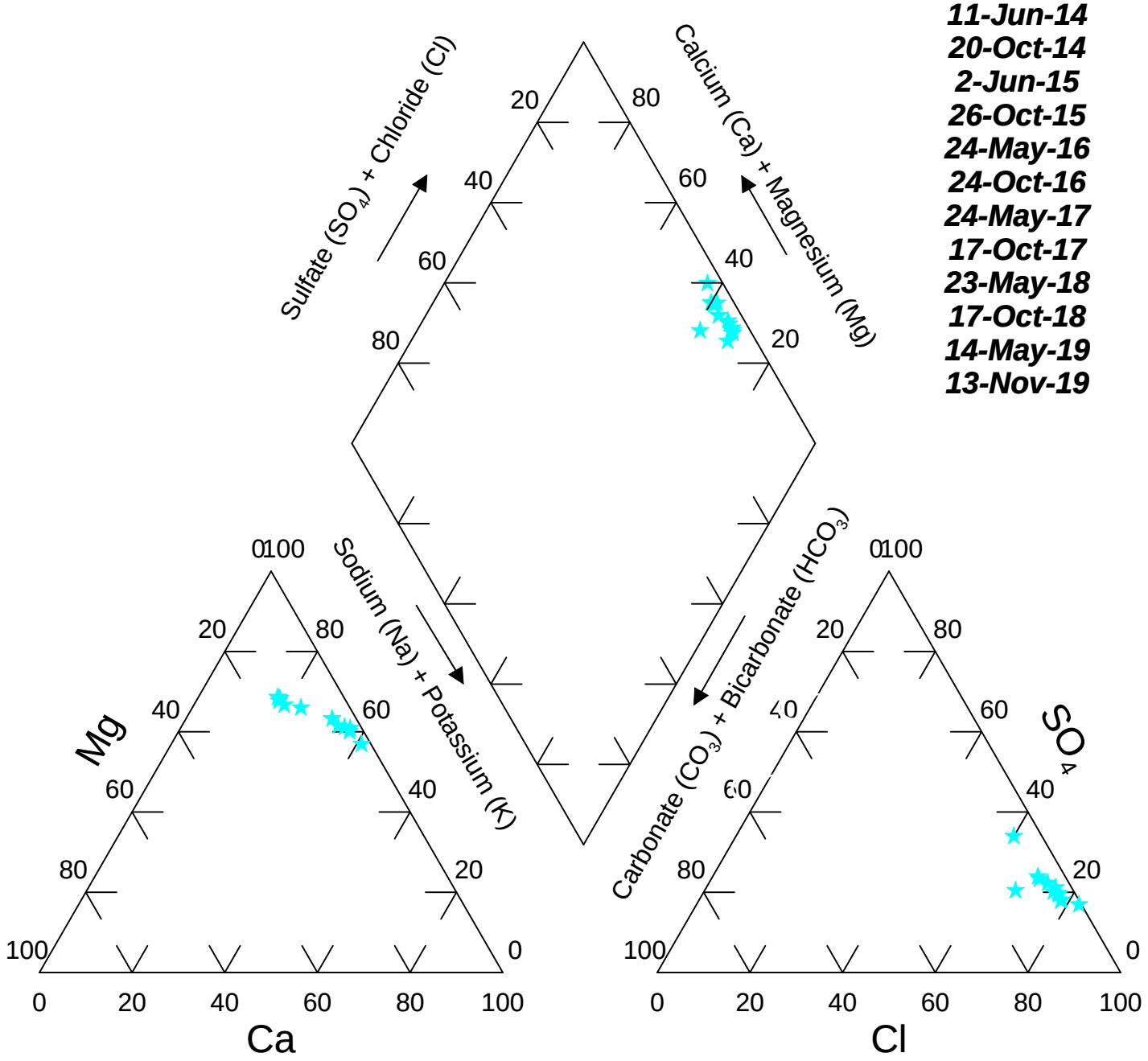


FIGURE: 4P

Winnipeg
Water and Waste Department

Site: Brady
Well #: W8

Dates:
11-Jun-14
23-Oct-14
3-Jun-15
26-Oct-15
25-May-16
24-Oct-16
24-May-17
17-Oct-17
29-May-18
18-Oct-18
13-May-19
13-Nov-19

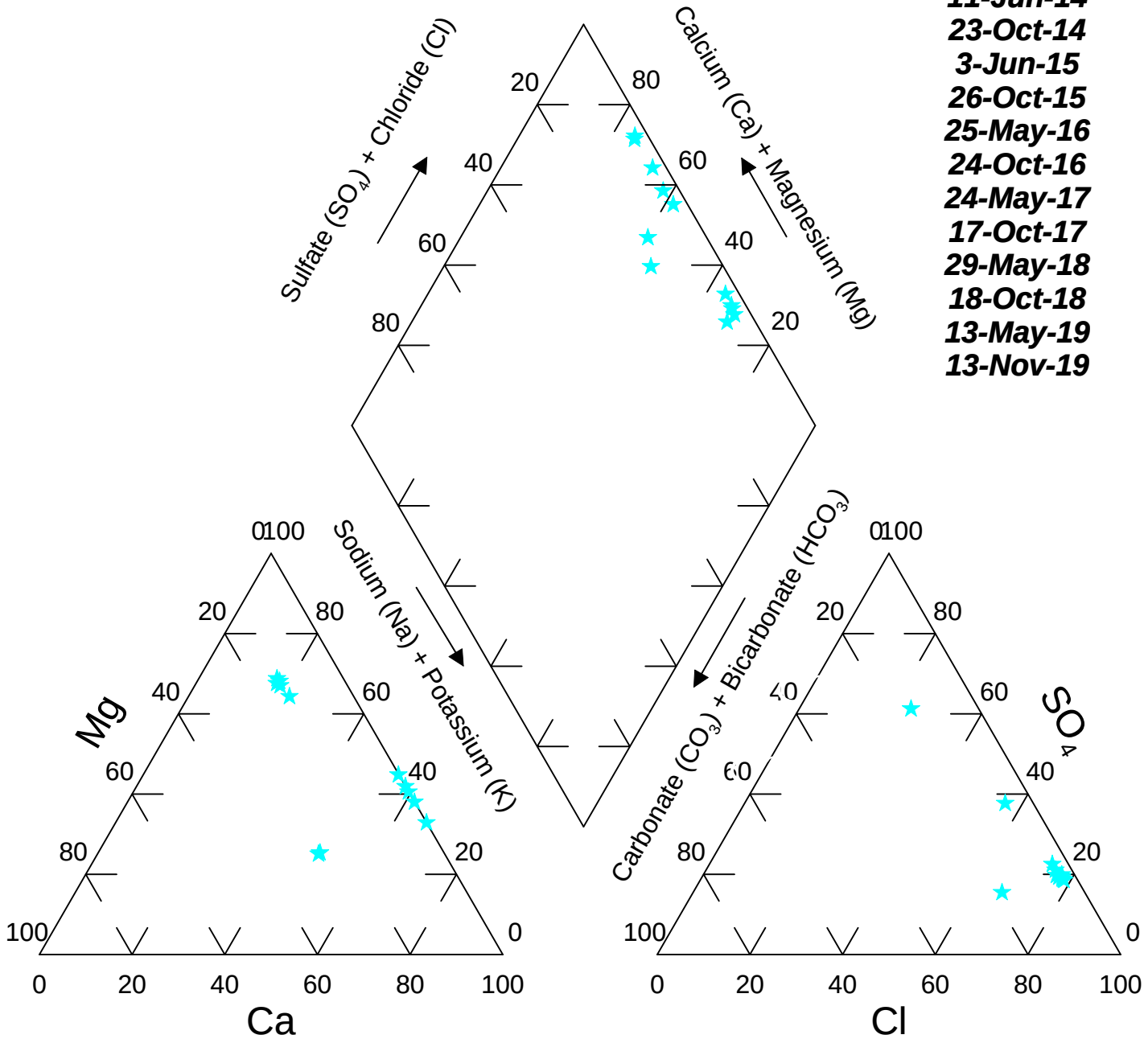


FIGURE: 5P

Winnipeg
Water and Waste Department

Site: Brady
Well #: W9

Dates:
1-Jun-14
20-Oct-14
3-Jun-15
22-Oct-15
24-May-16
26-Oct-16
23-May-17
18-Oct-17
24-May-18
18-Oct-18
15-May-19
8-Oct-19

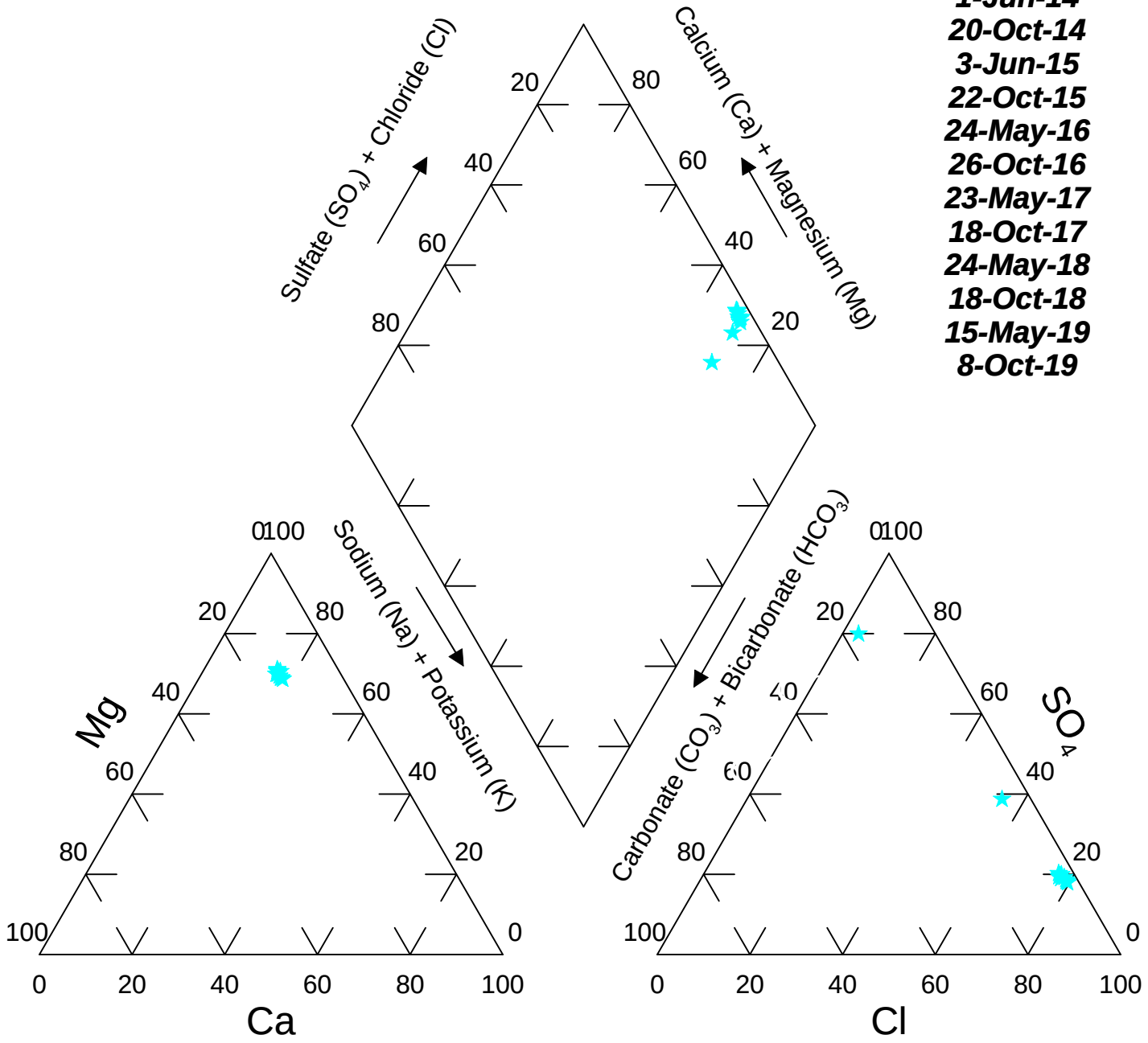


FIGURE: 6P

Winnipeg
Water and Waste Department

Site: Brady
Well #: W10

Dates:
10-Jun-14
20-Oct-14
3-Jun-15
22-Oct-15
25-May-16
26-Oct-16
23-May-17
18-Oct-17
24-May-18
16-Oct-18
15-May-19
8-Oct-19

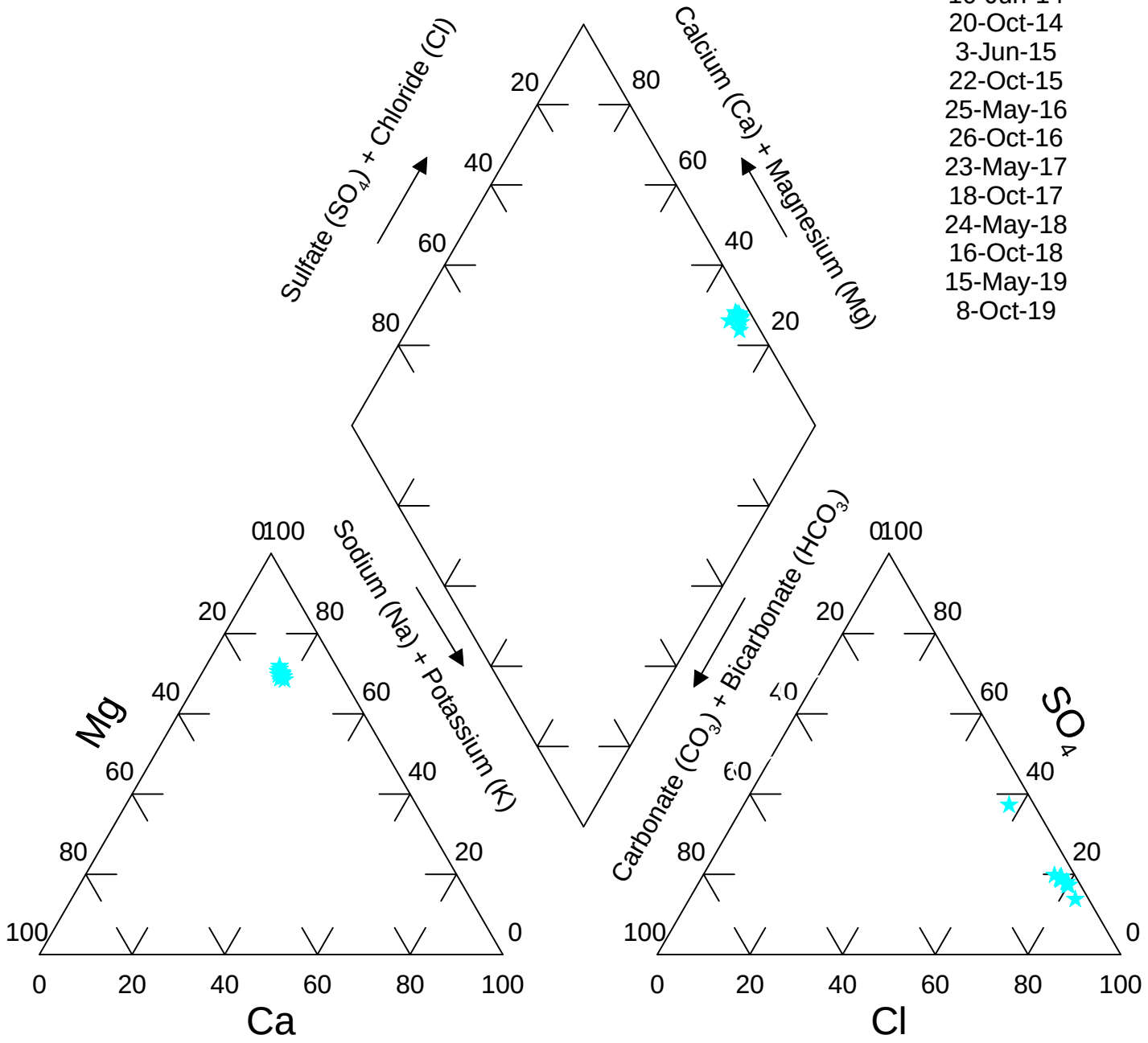


FIGURE: 7P

Winnipeg
Water and Waste Department

Site: Brady
Well #: W11

Dates:
10-Jun-14
23-Oct-14
2-Jun-15
22-Oct-15
25-May-16
26-Oct-16
23-May-17
18-Oct-17
24-May-18
17-Oct-18
15-May-19
8-Oct-19

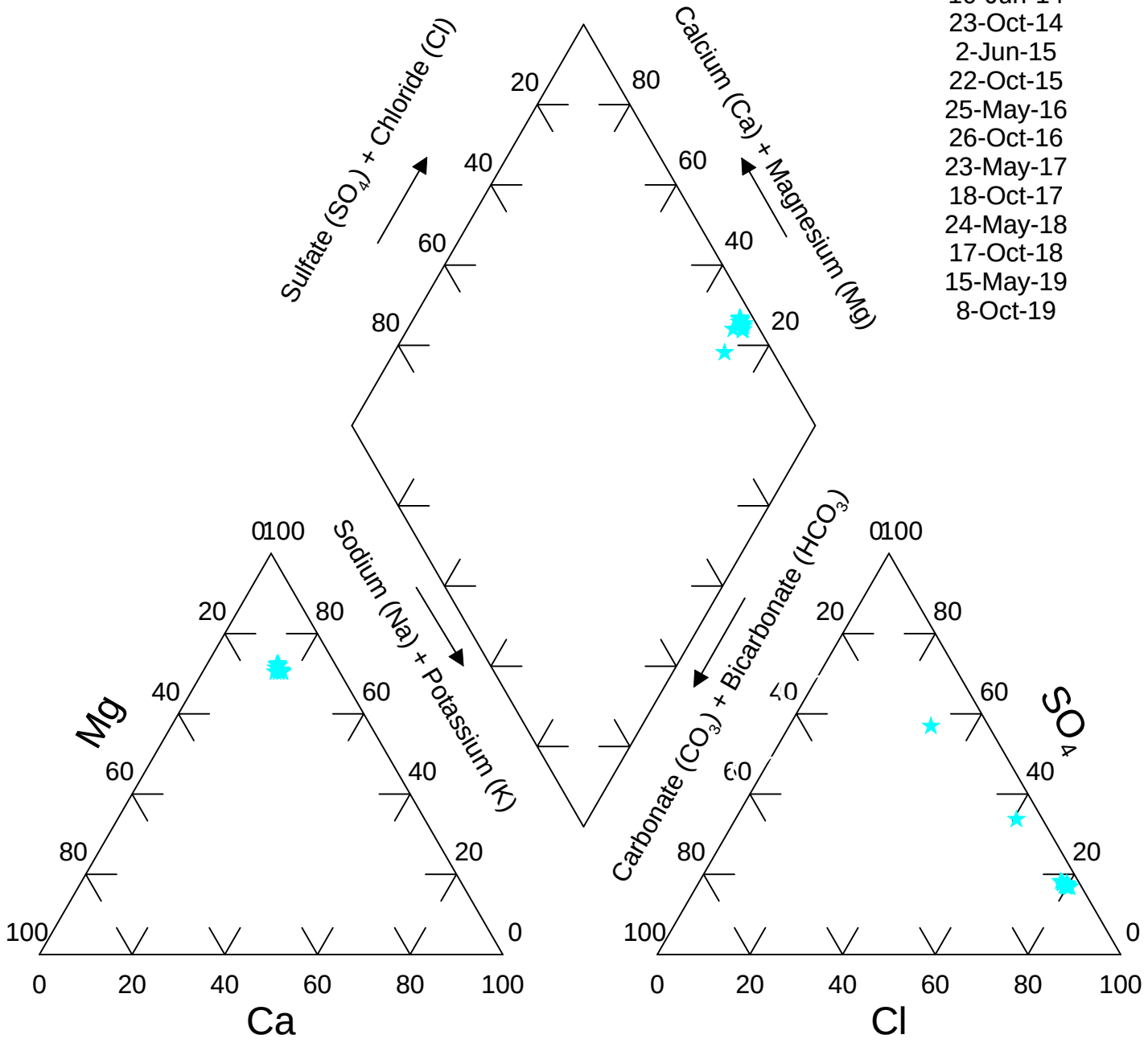


FIGURE: 8P

Winnipeg
Water and Waste Department

Site: Brady
Well #: W12

Dates:
12-Jun-14
20-Oct-14
3-Jun-15
22-Oct-15
25-May-16
26-Oct-16
25-May-17
17-Oct-17
24-May-18
17-Oct-18
15-May-19
14-Oct-19

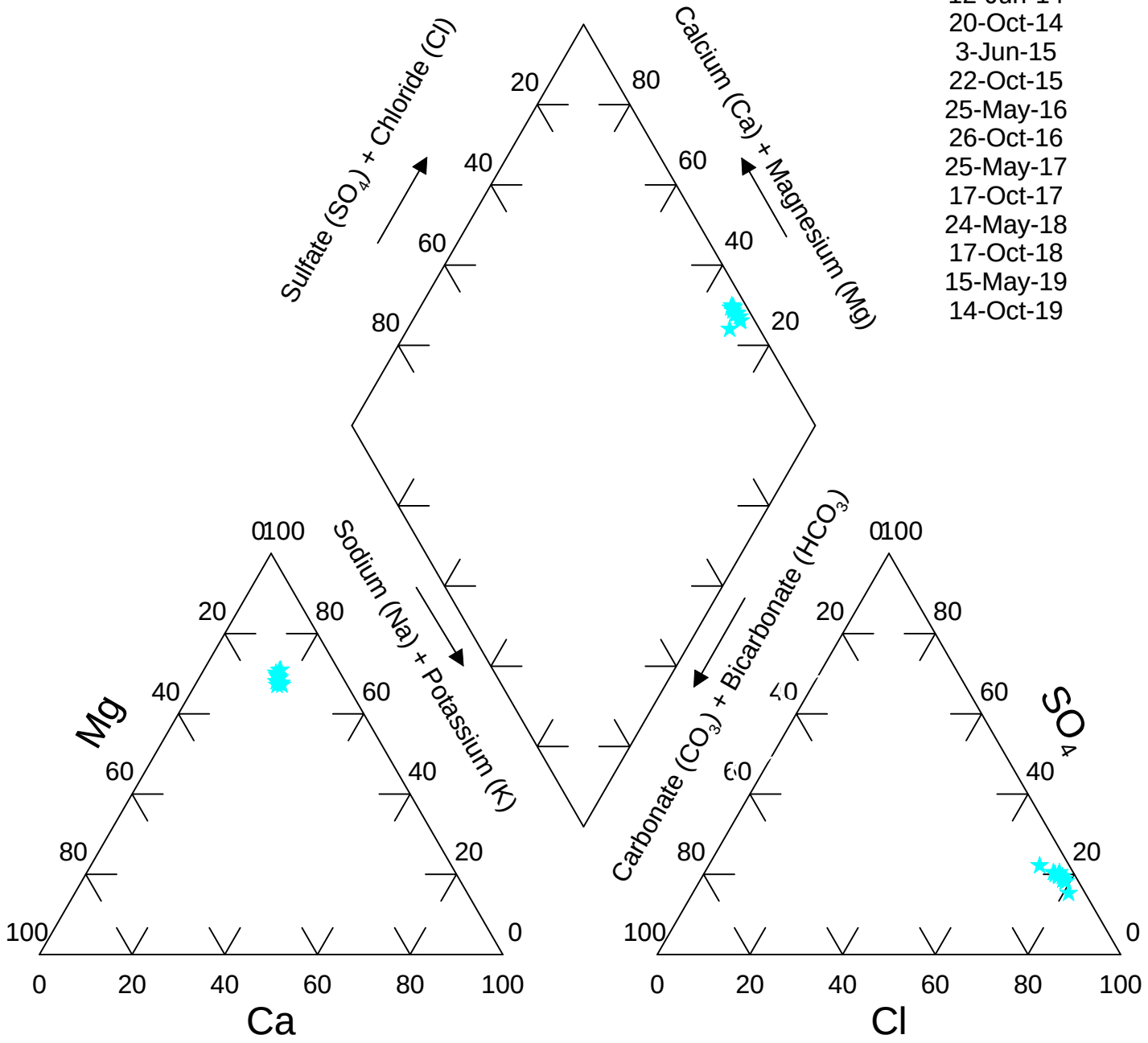


FIGURE: 9P

Winnipeg
Water and Waste Department

Site: Brady
Location : W13

Dates:
1-Jun-15
21-Oct-15
27-May-16
24-Oct-16
24-May-17
16-Oct-17
28-May-18
17-Oct-18
13-May-19
8-Oct-19

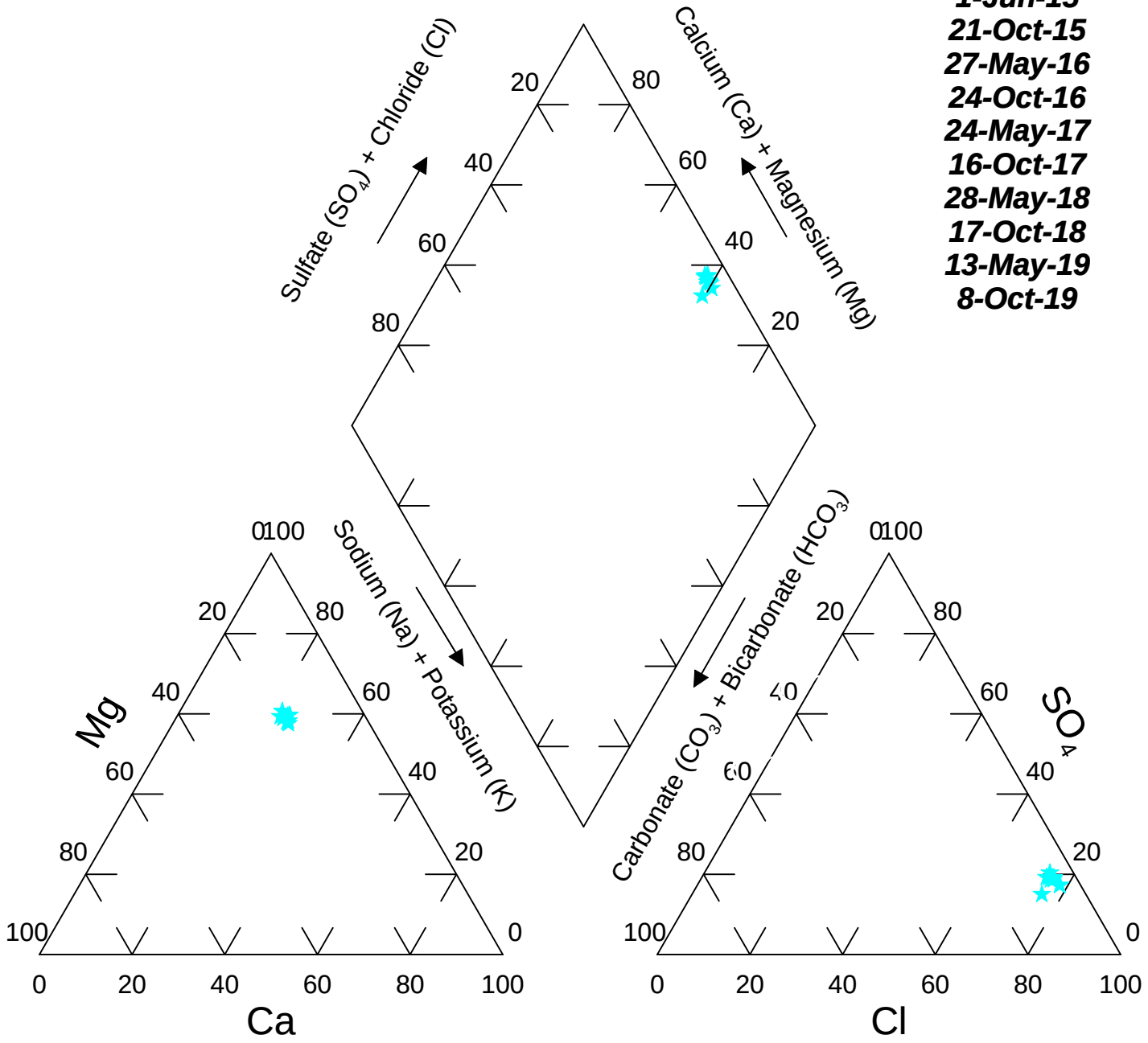


FIGURE: 1z

Winnipeg
Water and Waste Department

Site: Brady
Location : GWQ25-W14

Dates:
3-Jun-15
21-Oct-15
25-May-16
26-Oct-16
25-May-17
16-Oct-17
28-May-18
18-Oct-18
15-May-19
13-Nov-19

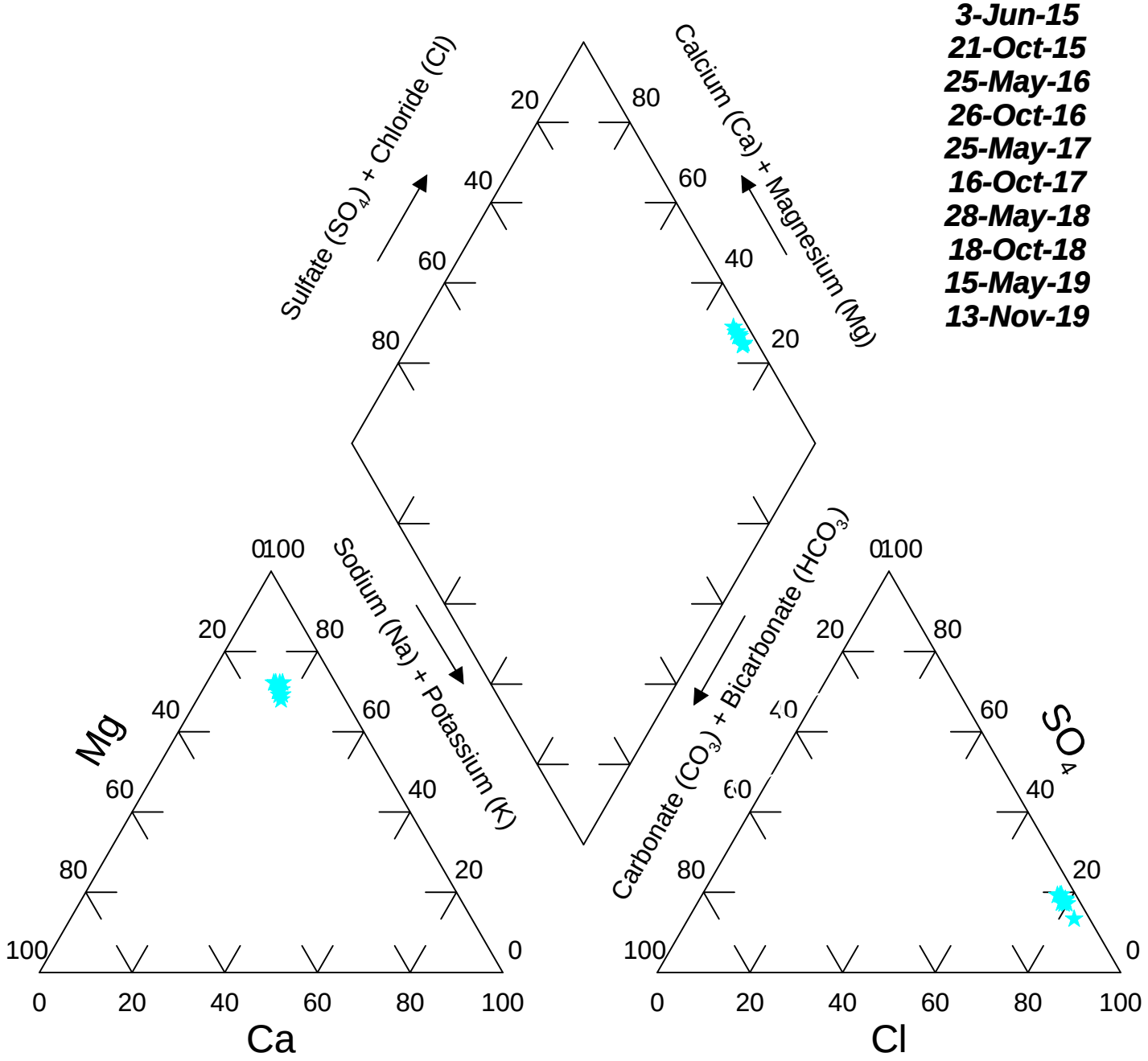


FIGURE: 2z

Winnipeg
Water and Waste Department

Site: Brady
Location : GWQ25-W15

Dates:
3-Jun-15
21-Oct-15
30-May-16
25-Oct-16
25-May-17
16-Oct-17
28-May-18
22-Oct-18
15-May-19
13-Oct-19

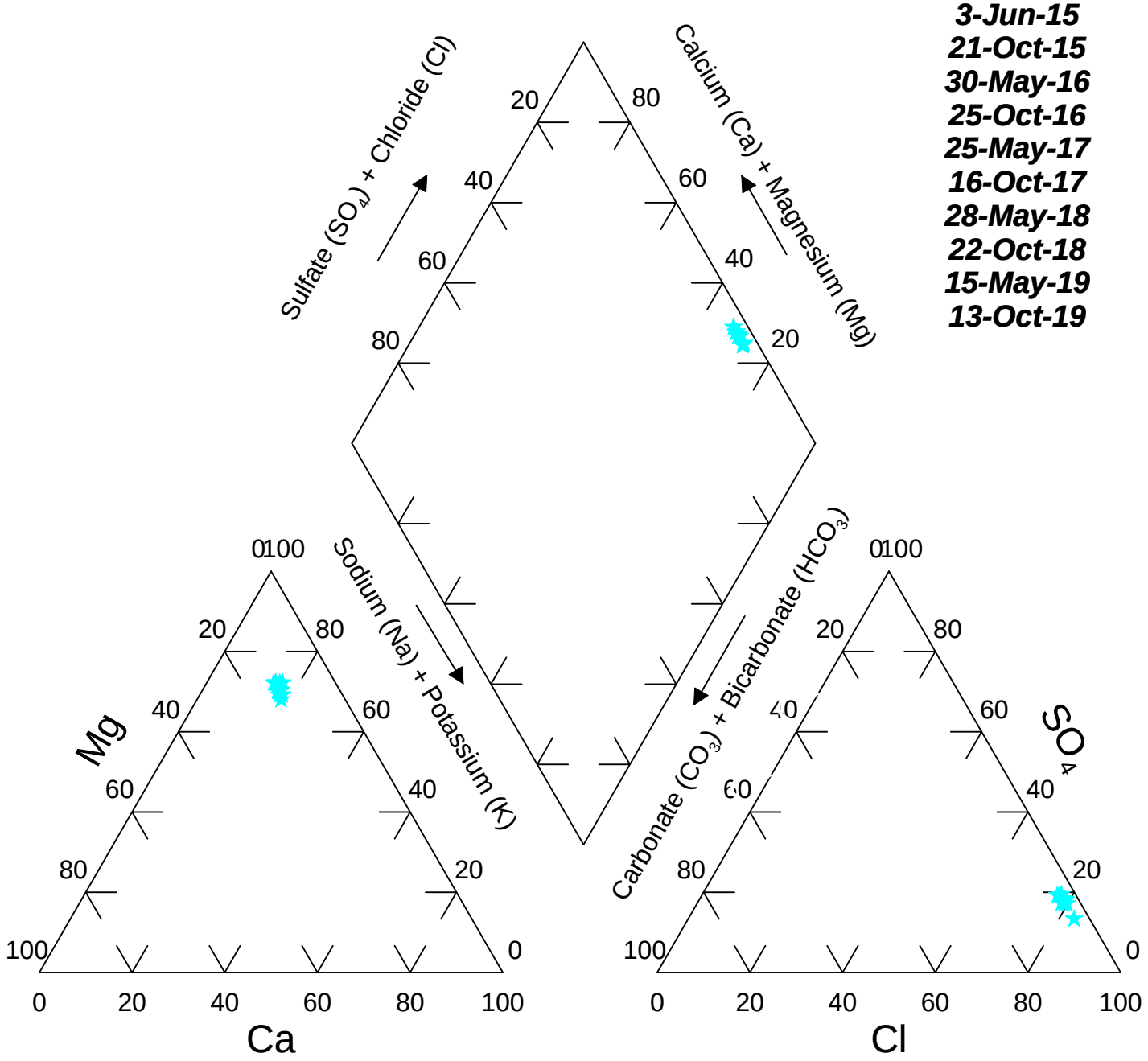


FIGURE: 3z

Winnipeg
Water and Waste Department

Site: Brady
Location : GWQ25-W16

Dates:
4-Jun-15
21-Oct-15
30-May-16
25-Oct-16
25-May-17
16-Oct-17
28-May-18
22-Oct-18
15-May-19
8-Dec-19

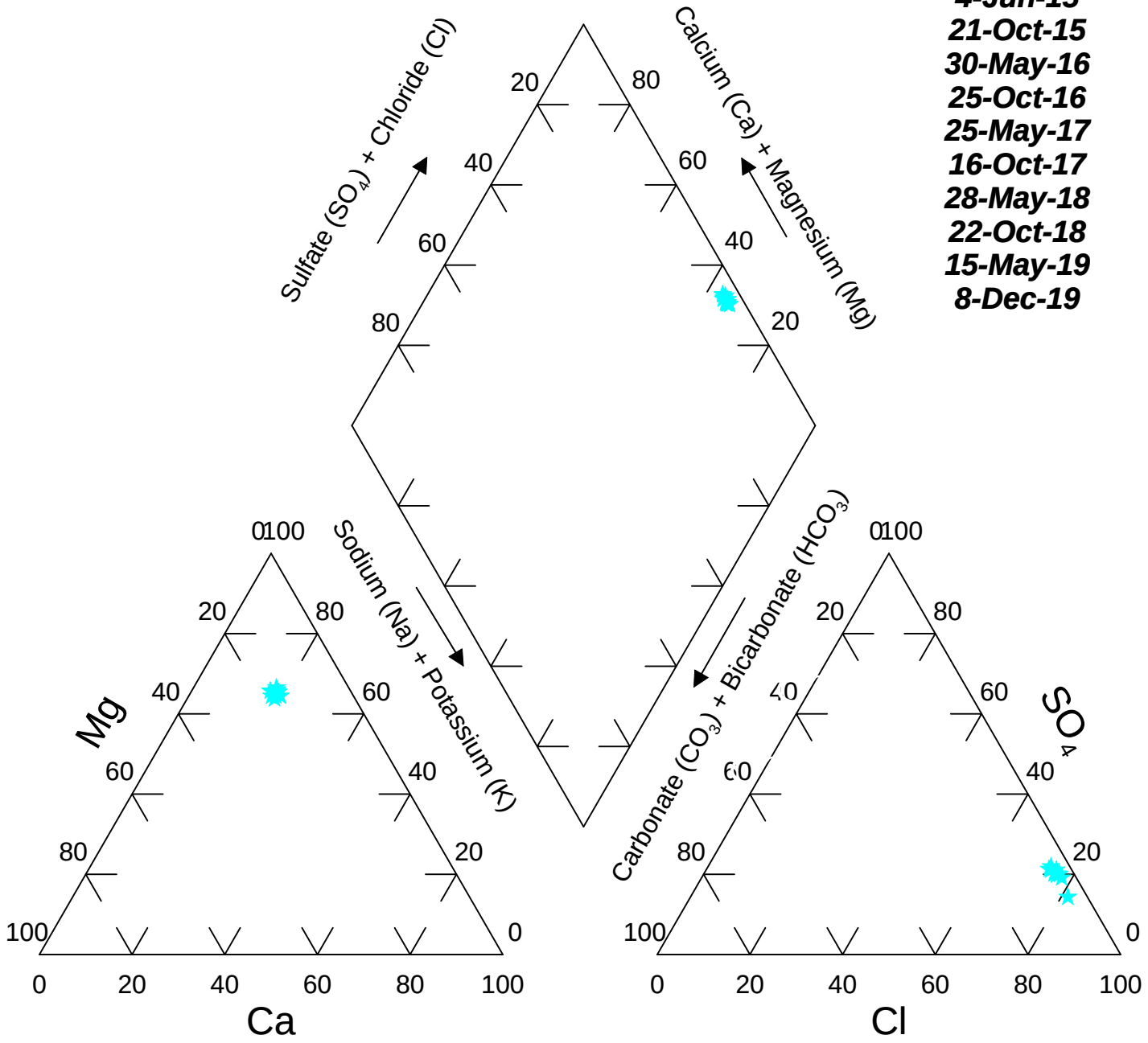
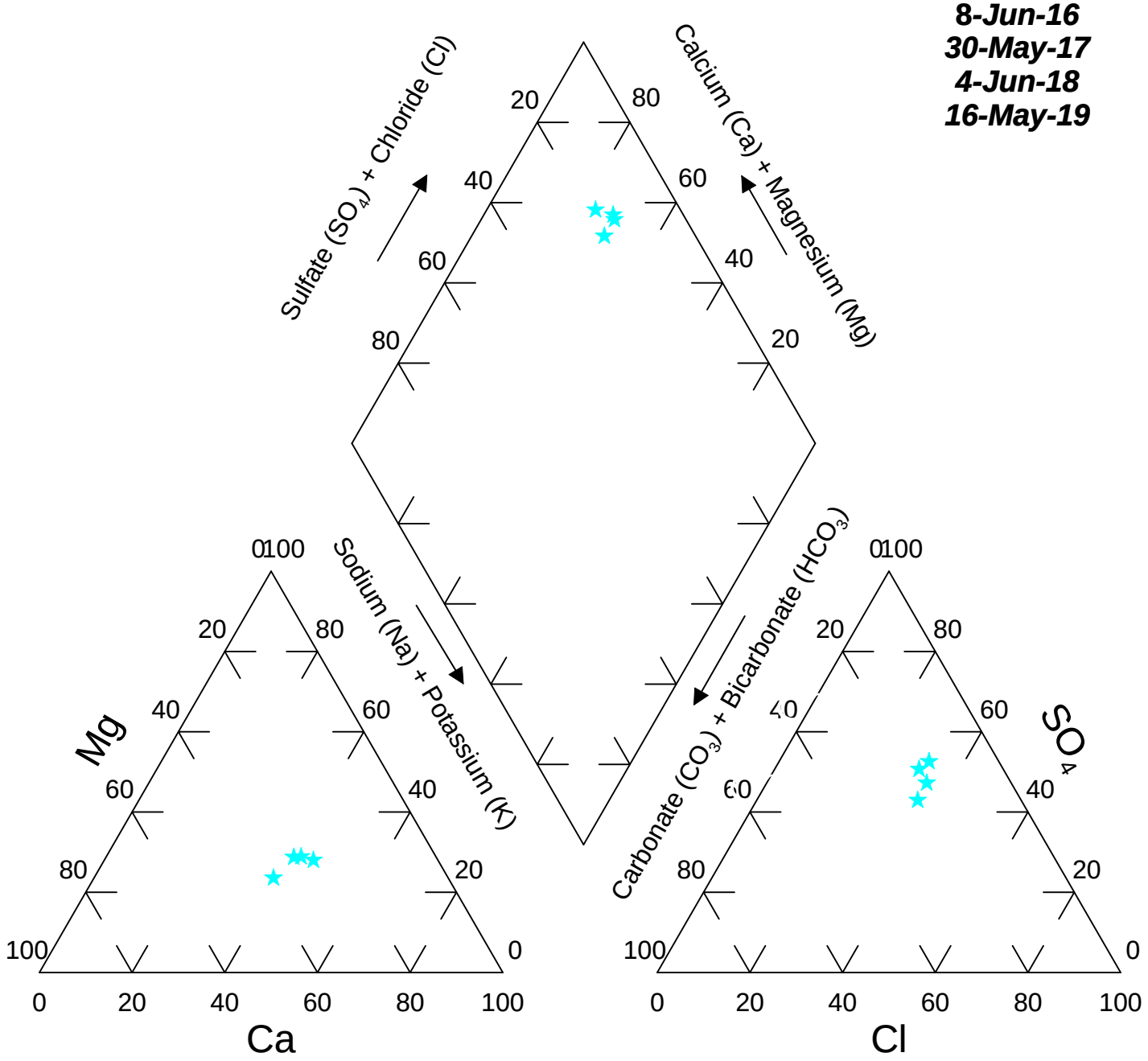


FIGURE: 4z

Winnipeg
Water and Waste Department

Site: Brady
Location : GWQ25-4N34-CR

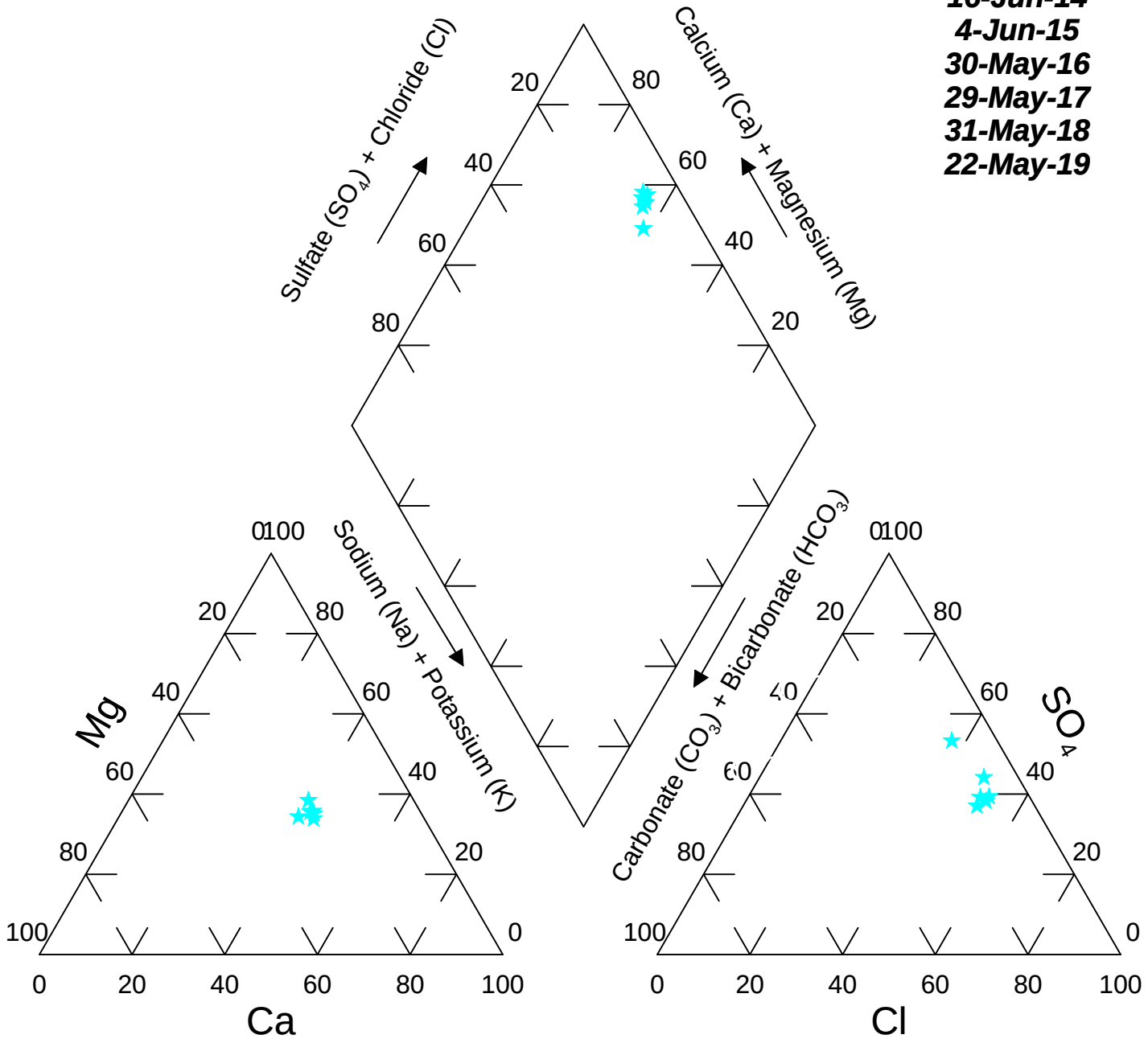
Dates:
8-Jun-16
30-May-17
4-Jun-18
16-May-19



Winnipeg
Water and Waste Department

Site: Brady
Location : GWQ25-5N62-D

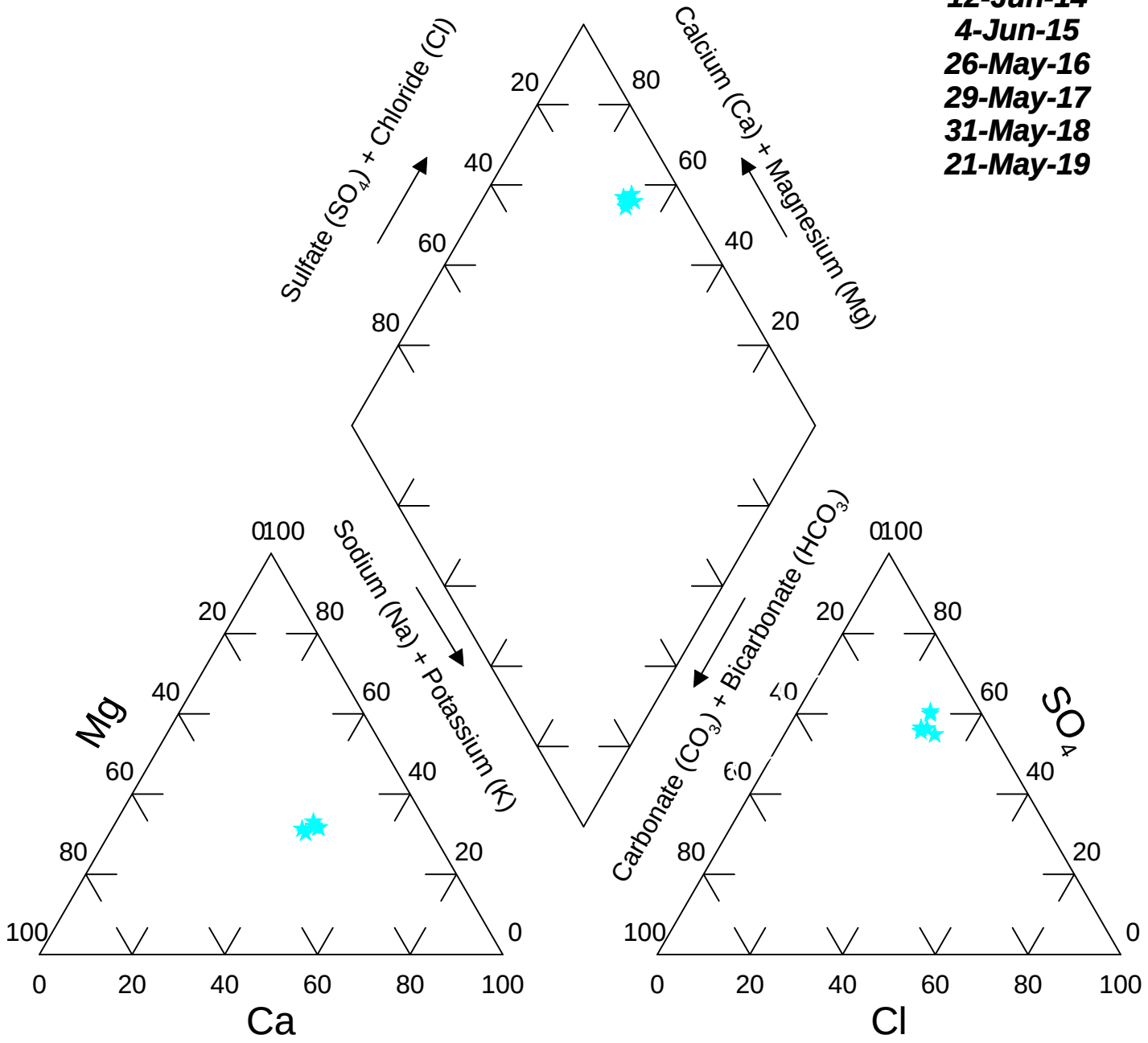
Dates:
16-Jun-14
4-Jun-15
30-May-16
29-May-17
31-May-18
22-May-19



Winnipeg
Water and Waste Department

Site: Brady
Location : GWQ25-6N57-DR

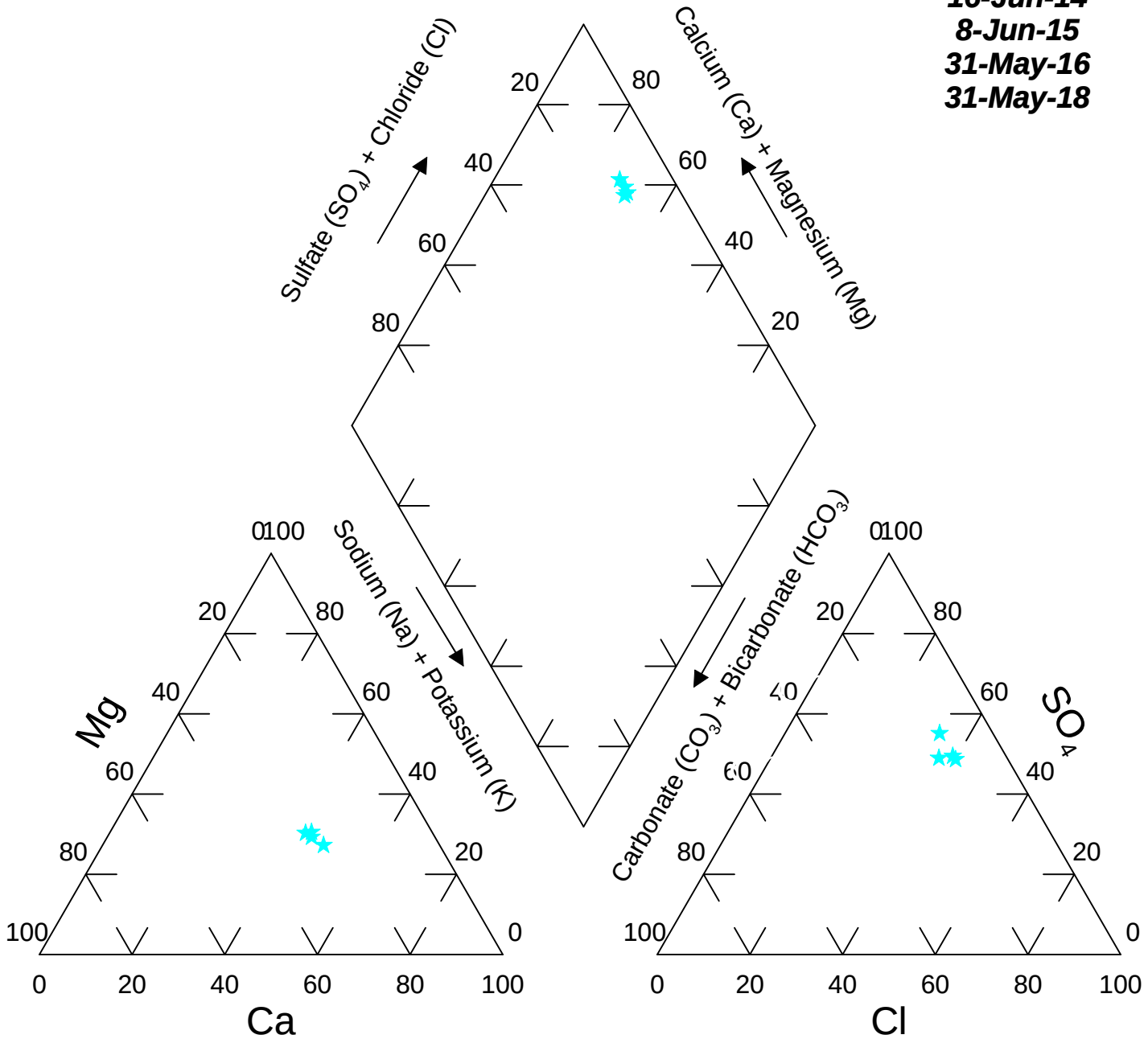
Dates:
12-Jun-14
4-Jun-15
26-May-16
29-May-17
31-May-18
21-May-19



Winnipeg
Water and Waste Department

Site: Brady
Location : GWQ25-6N58-DR

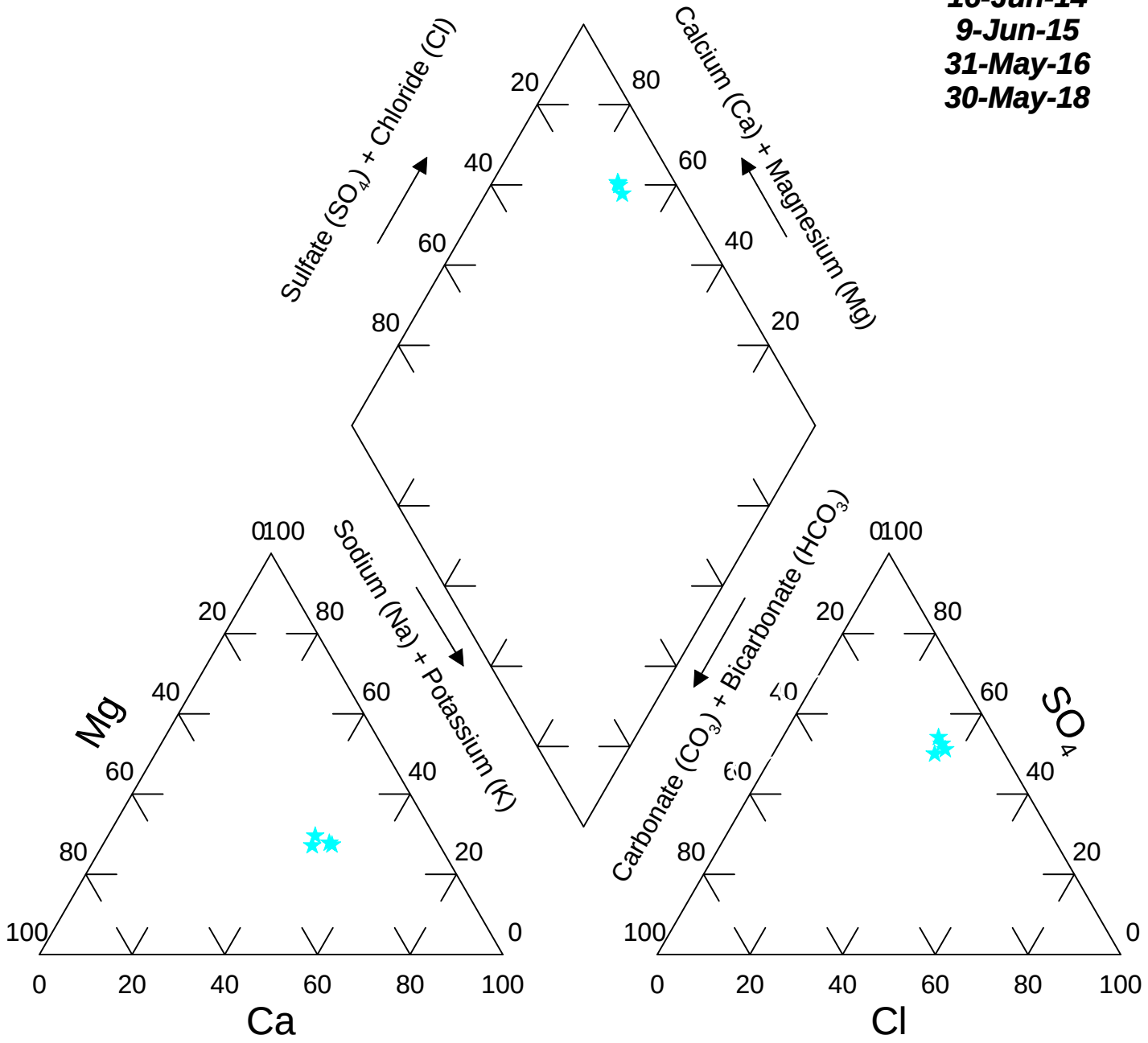
Dates:
16-Jun-14
8-Jun-15
31-May-16
31-May-18



Winnipeg
Water and Waste Department

Site: Brady
Location : GWQ25-6N59-DR

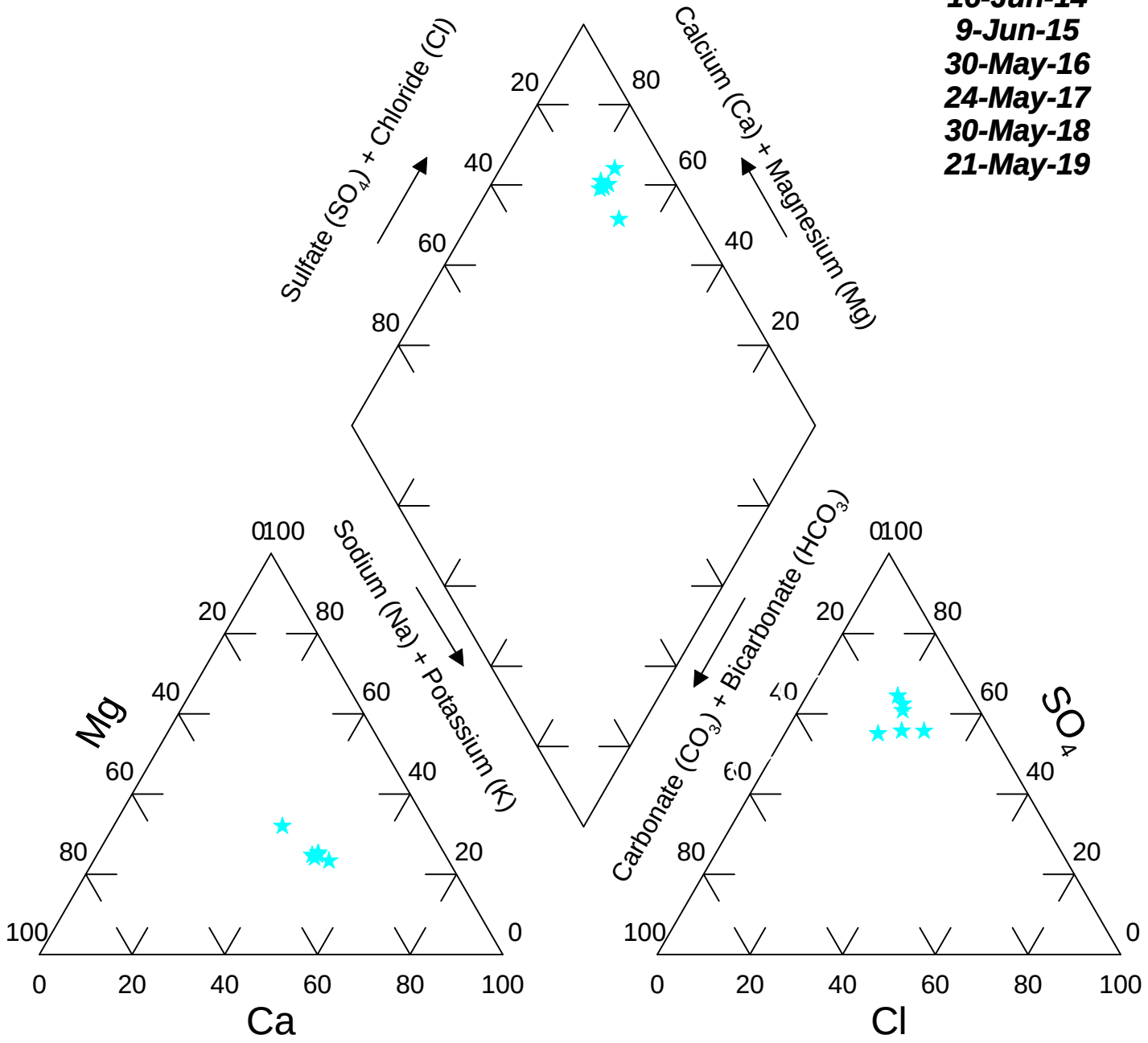
Dates:
16-Jun-14
9-Jun-15
31-May-16
30-May-18



Winnipeg
Water and Waste Department

Site: Brady
Location : GWQ25-6N60-DR

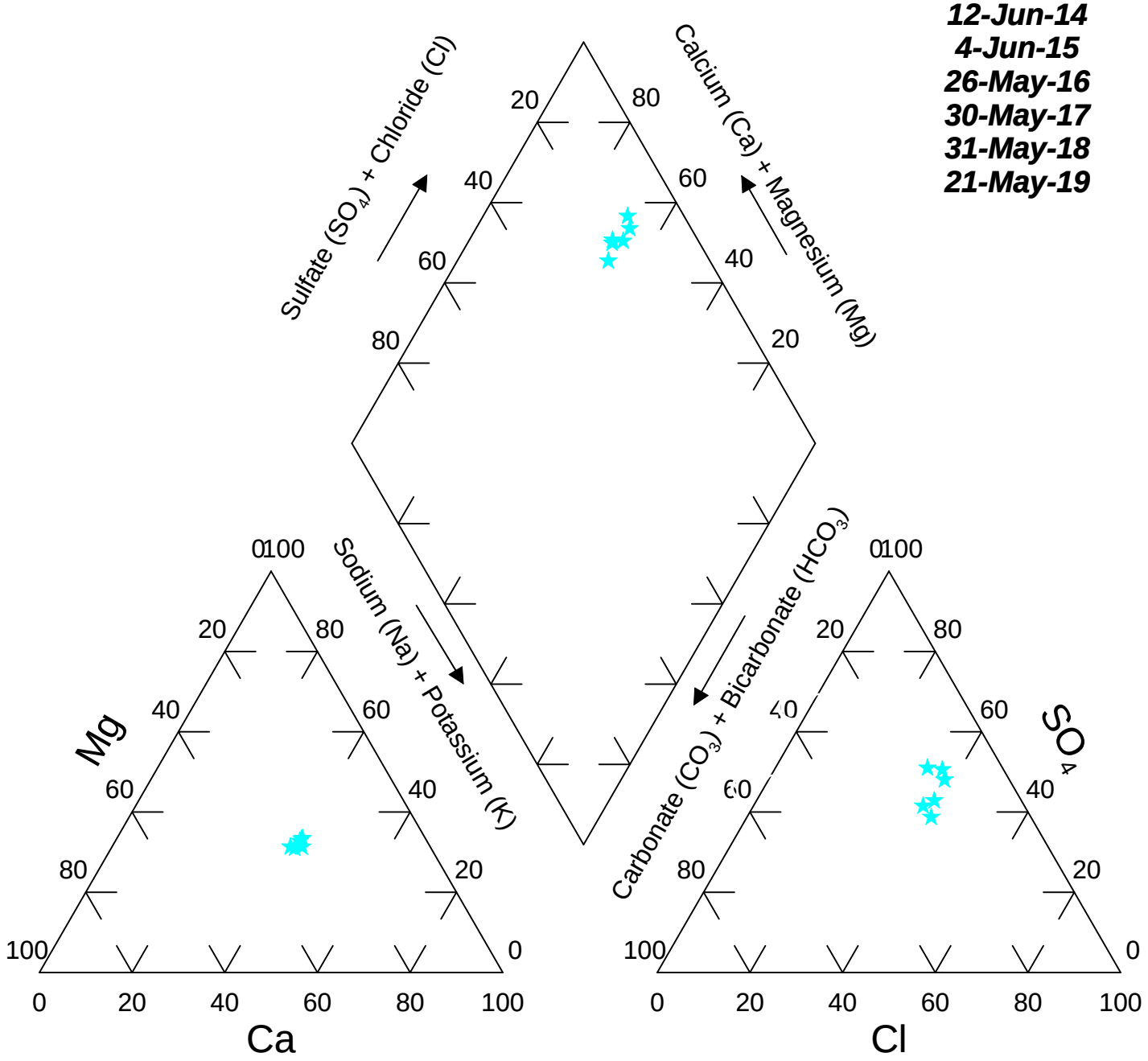
Dates:
16-Jun-14
9-Jun-15
30-May-16
24-May-17
30-May-18
21-May-19



Winnipeg
Water and Waste Department

Site: Brady
Location : GWQ25-6N63-E

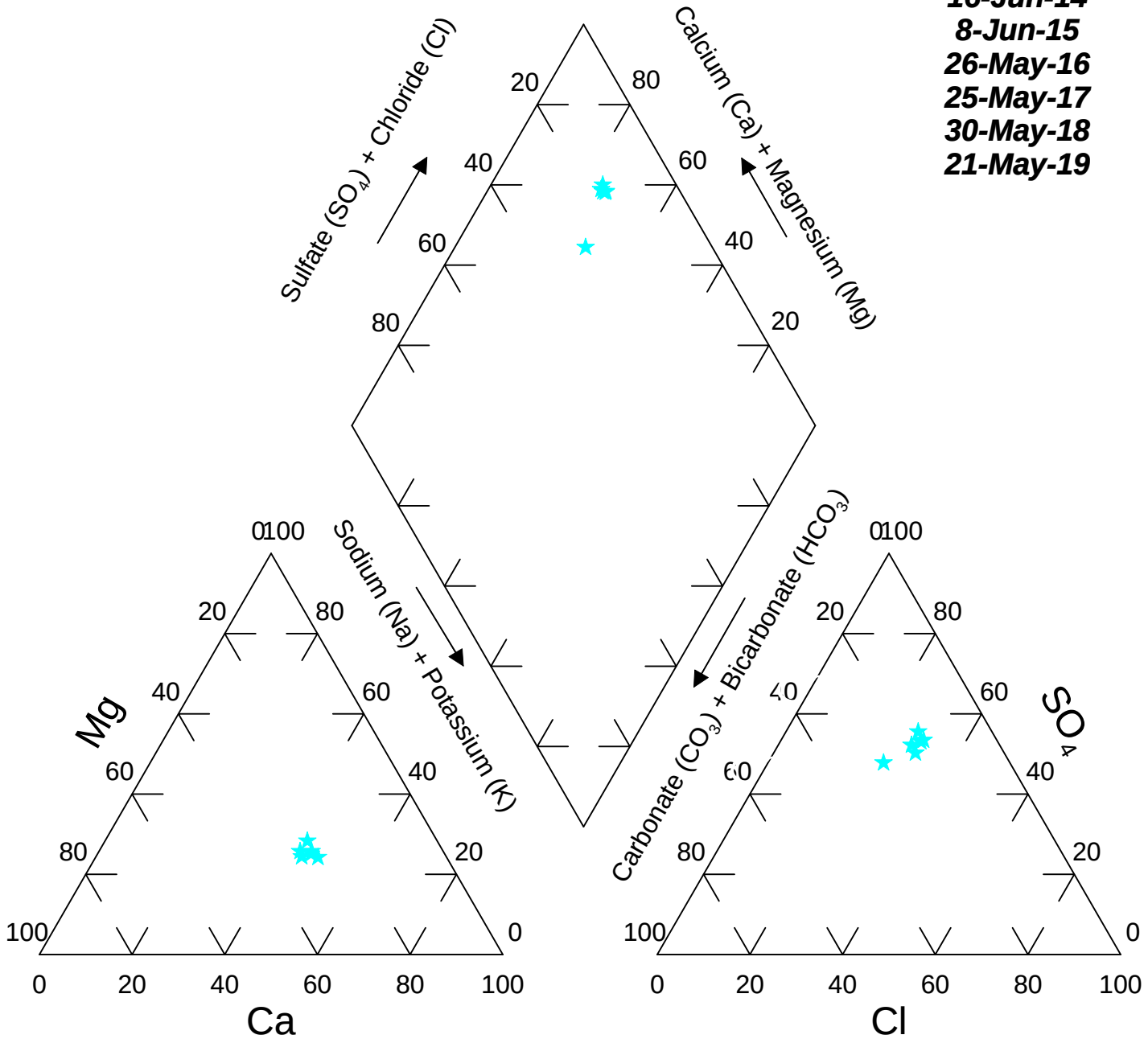
Dates:
12-Jun-14
4-Jun-15
26-May-16
30-May-17
31-May-18
21-May-19



Winnipeg
Water and Waste Department

Site: Brady
Location : GWQ25-6N67-E

Dates:
16-Jun-14
8-Jun-15
26-May-16
25-May-17
30-May-18
21-May-19



Winnipeg
Water and Waste Department

Site: Brady
Well #: 4N34-D/DR

Dates:
12-Jun-14
8-Jun-15
7-Jun-16
25-May-17
4-May-18
16-May-19

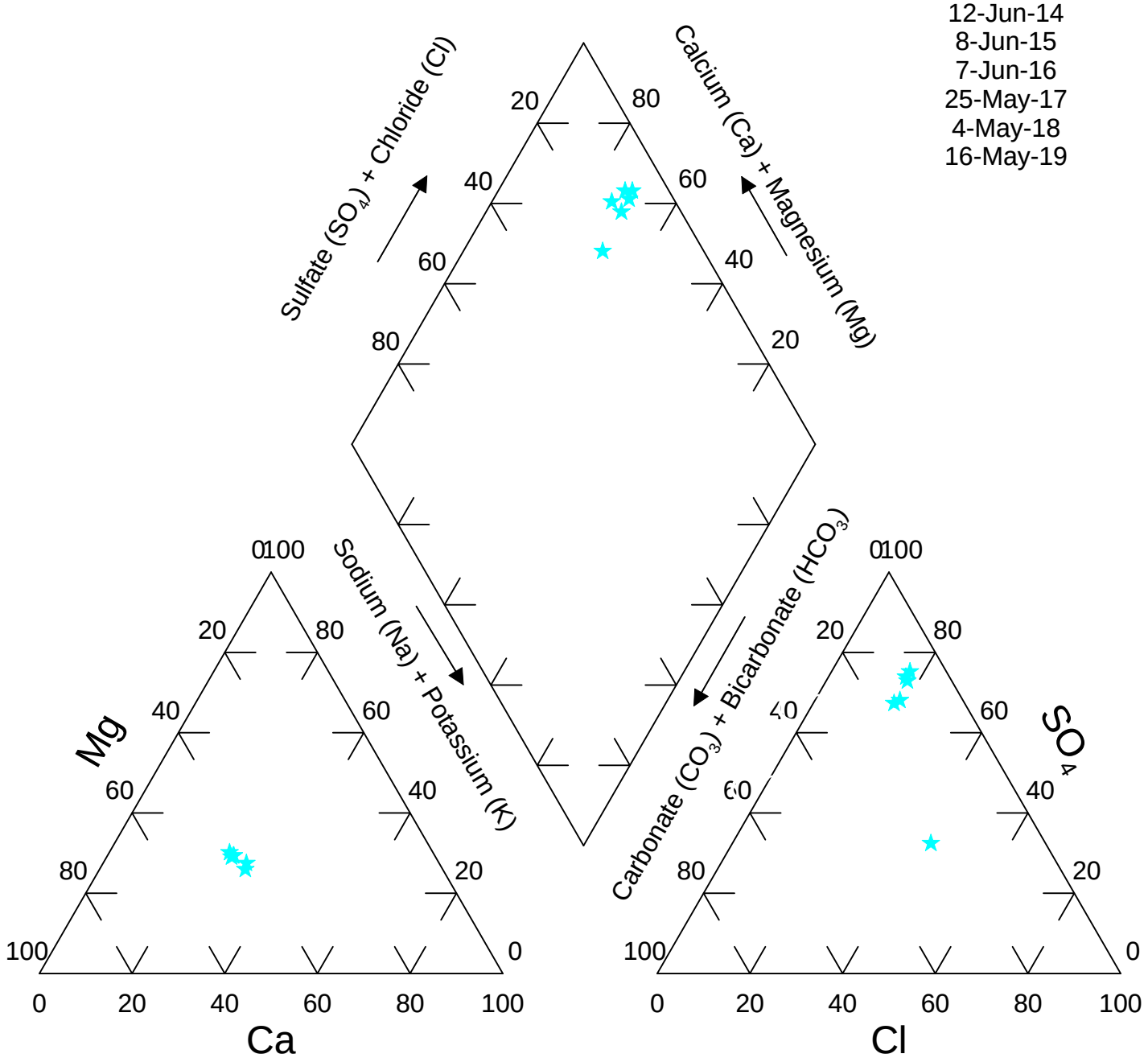
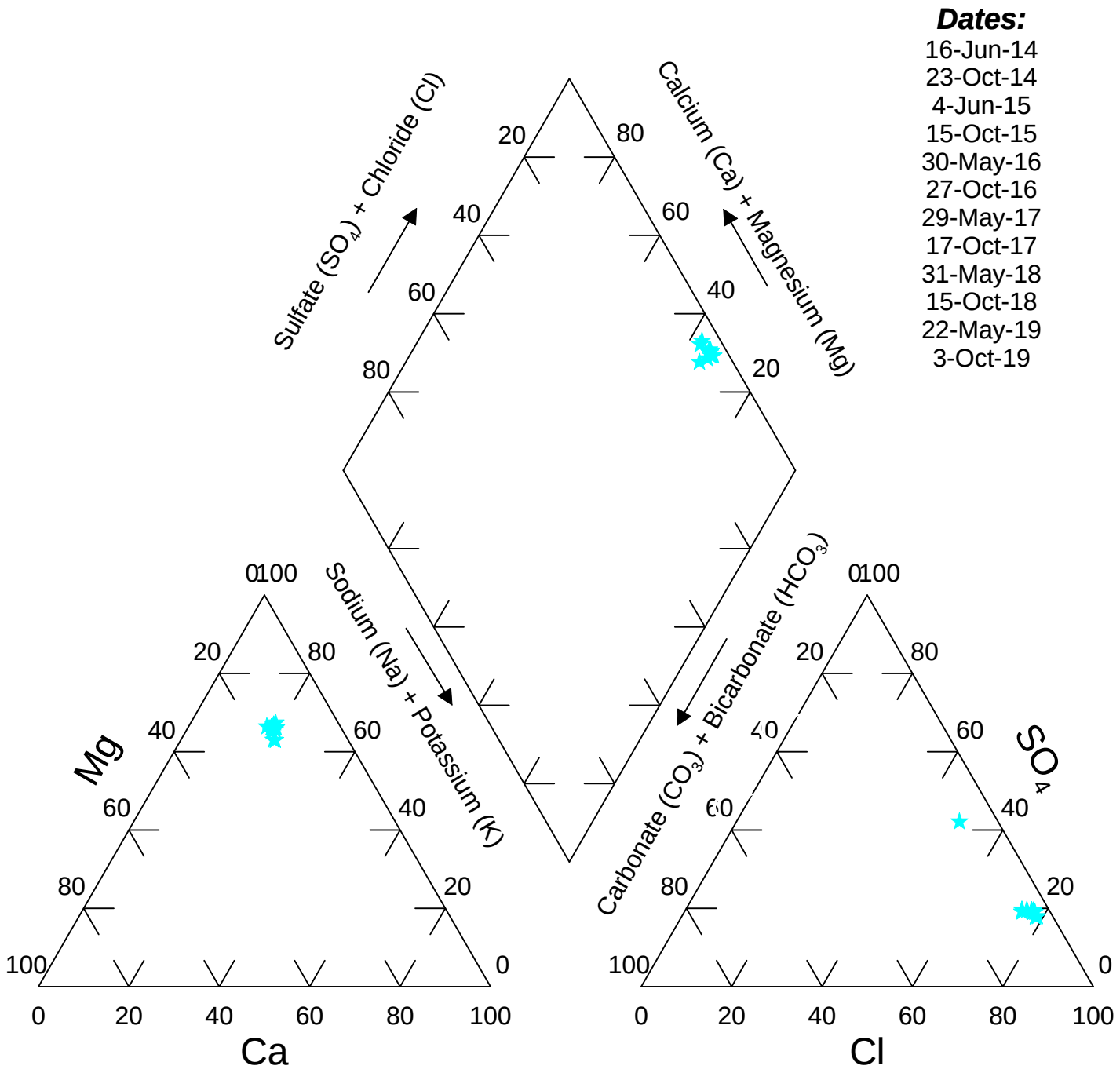


FIGURE: 10P

Winnipeg
Water and Waste Department

Site: Brady
Well #: 5N62-E



Dates:

16-Jun-14
23-Oct-14
4-Jun-15
15-Oct-15
30-May-16
27-Oct-16
29-May-17
17-Oct-17
31-May-18
15-Oct-18
22-May-19
3-Oct-19

FIGURE: 11P

Winnipeg
Water and Waste Department

Site: Brady
Well #: 6N57-F/FR

Dates:
10-Jun-15
26-May-16
24-May-17
30-May-18
21-May-19

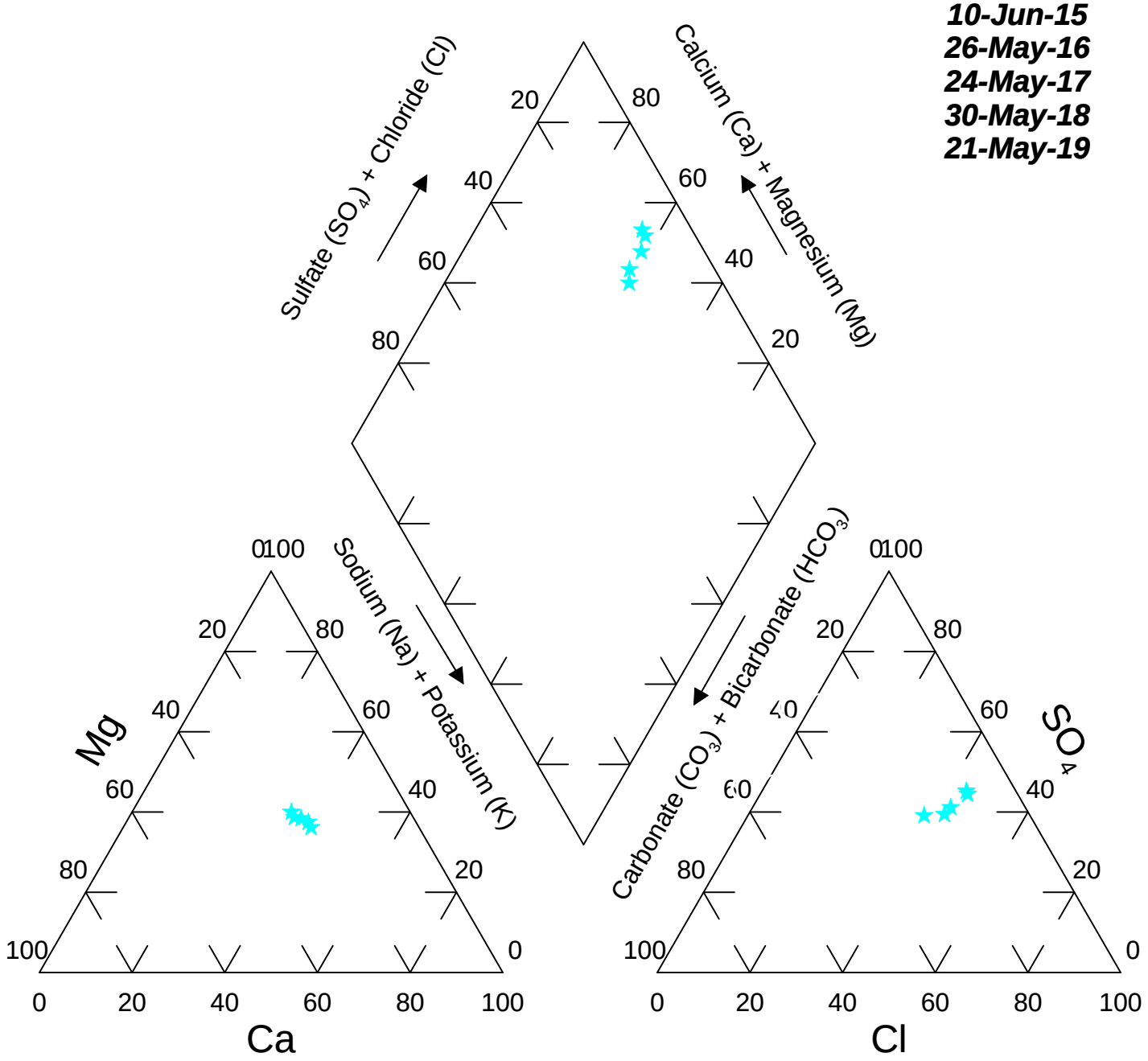
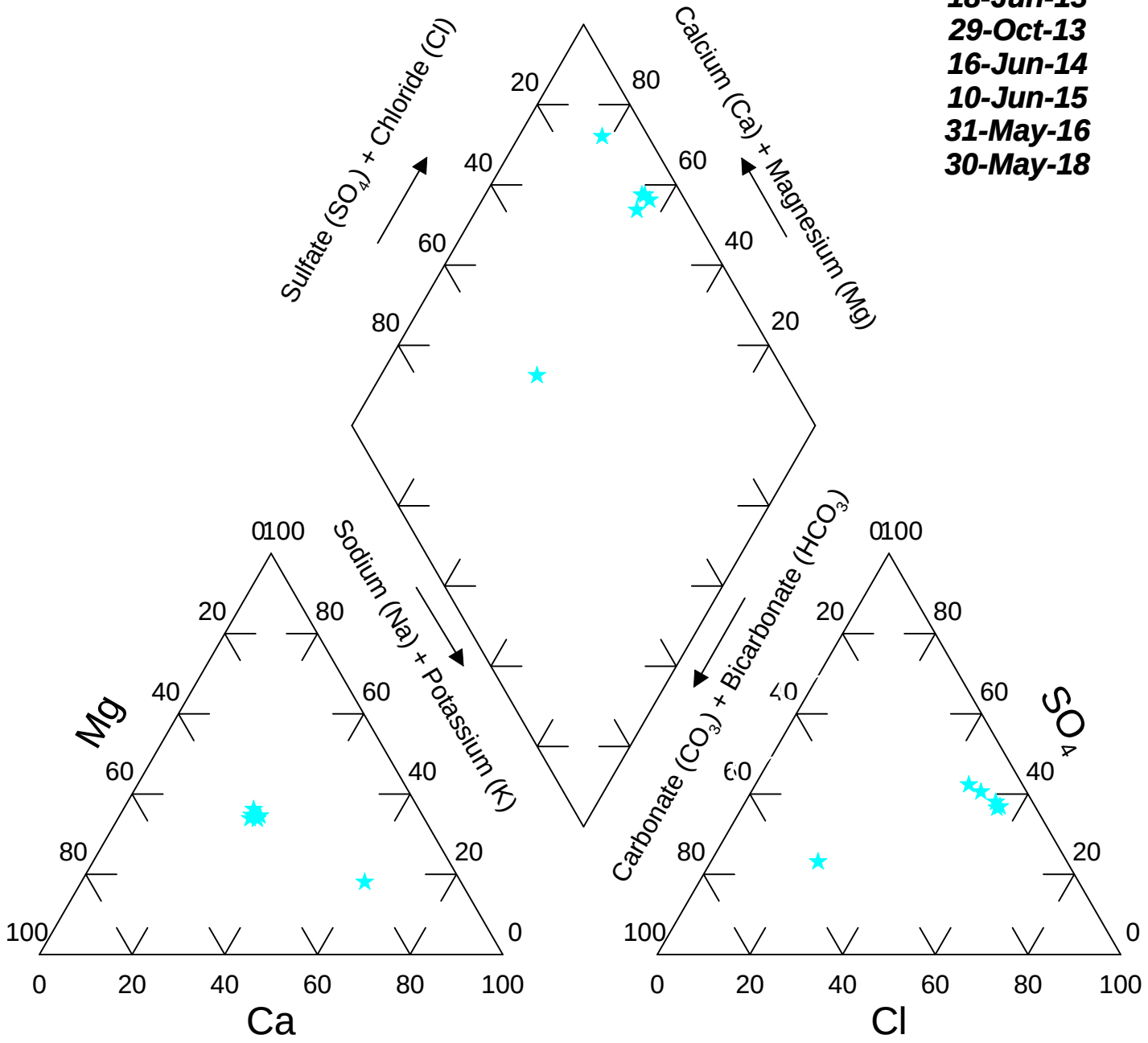


FIGURE: 12P

Winnipeg
Water and Waste Department

Site: Brady
Well #: 6N58FR

Dates:
18-Jun-13
29-Oct-13
16-Jun-14
10-Jun-15
31-May-16
30-May-18



Winnipeg
Water and Waste Department

Site: Brady
Well #: 6N59-F/FR

Dates:
17-Jun-13
28-Oct-13
16-Jun-14
11-Jun-15
30-May-16
30-May-18

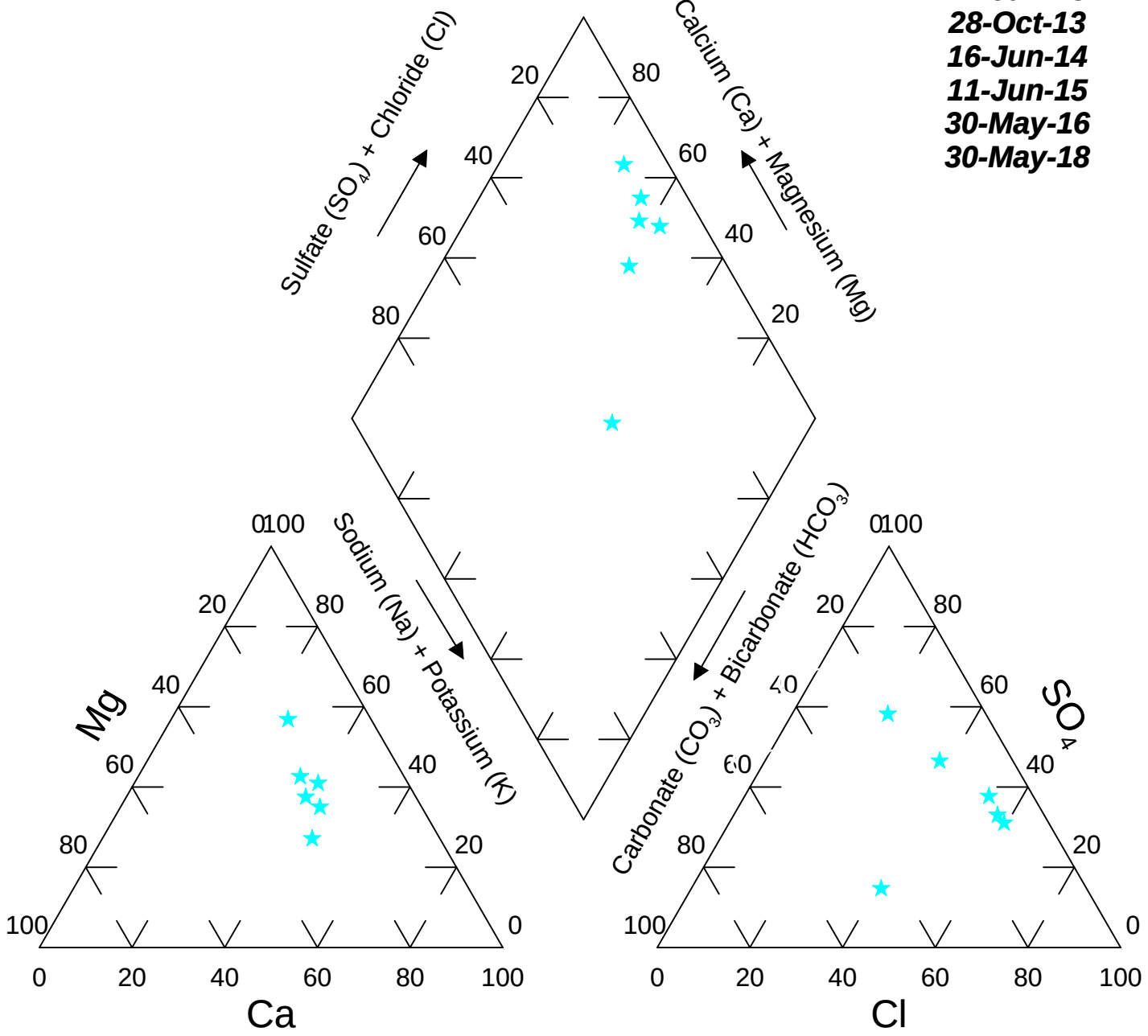


FIGURE: 14P

Winnipeg
Water and Waste Department

Site: Brady
Well #: 6N60-E/ER

Dates:
19-Jun-13
21-Oct-14
8-Jun-15
15-Oct-15
30-May-16
27-Oct-16
24-May-17
17-Oct-17
30-May-18
15-Oct-18

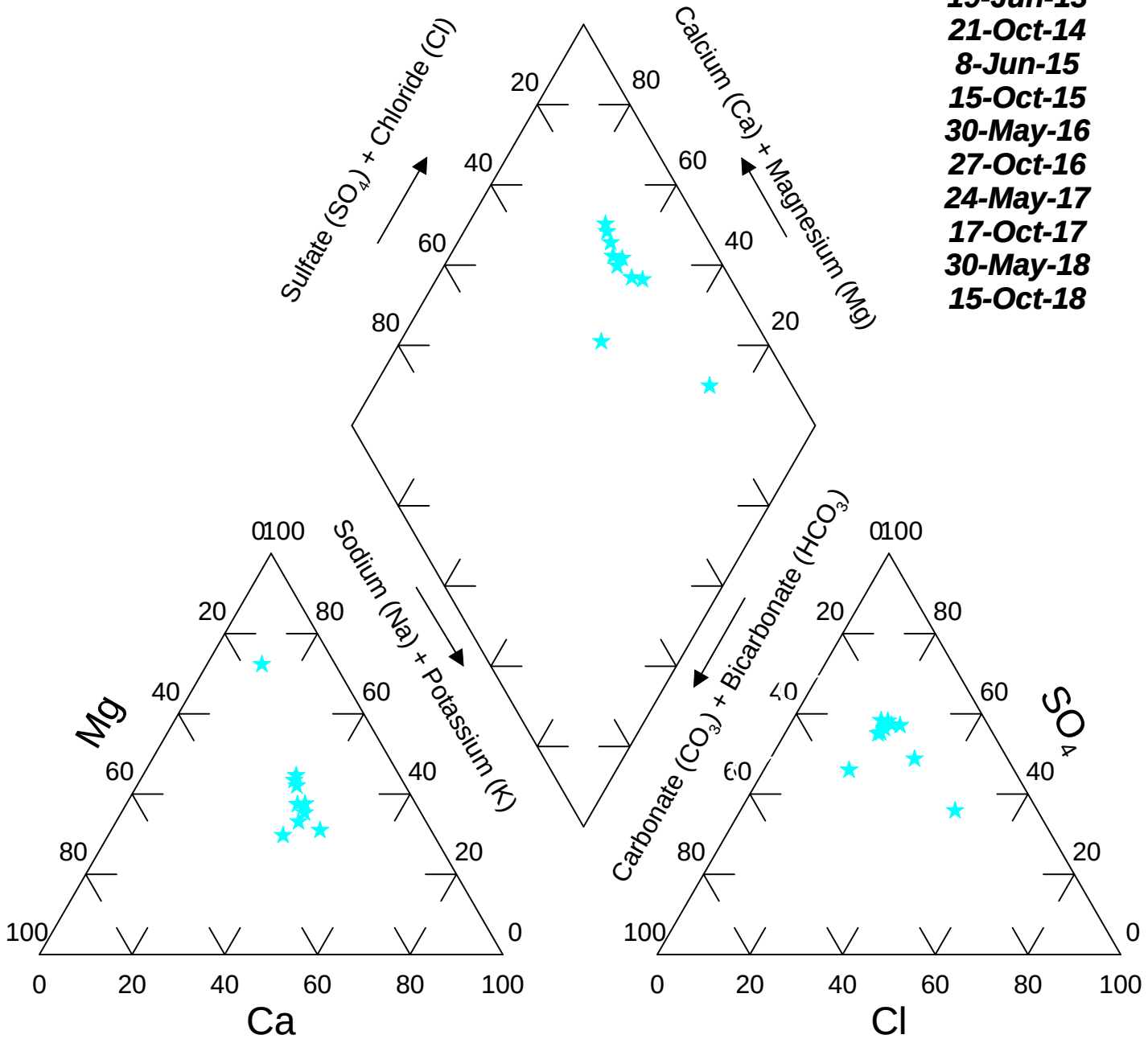


FIGURE: 15P

Winnipeg
Water and Waste Department

Site: Brady
Well #: 6N63-F

Dates:
12-Jun-14
4-Jun-15
26-May-16
29-May-17
31-May-18
21-May-19

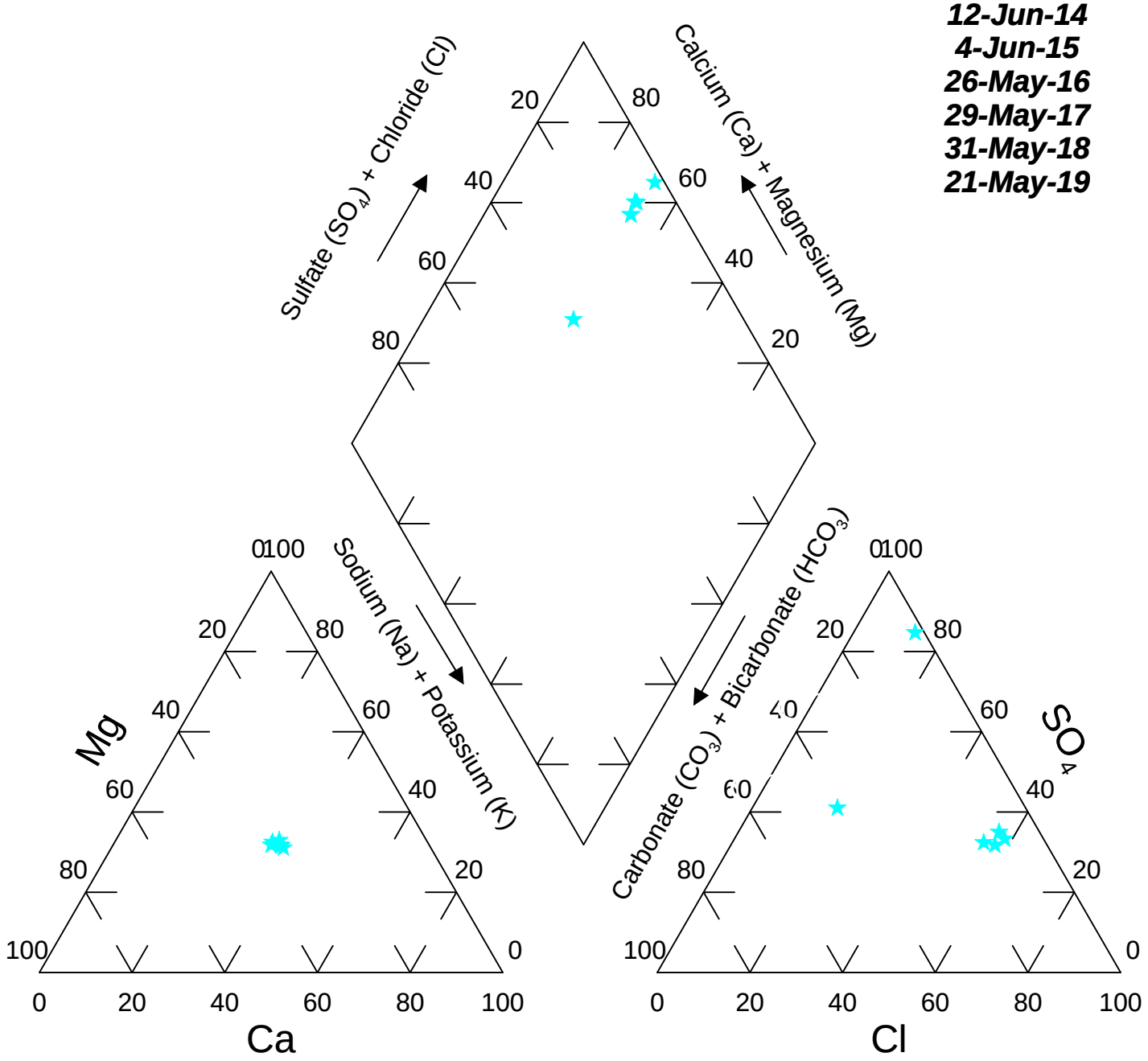


FIGURE: 16P

Winnipeg
Water and Waste Department

Site: Brady
Well #: 6N67-F

Dates:
12-Jun-14
8-Jun-15
26-May-16
25-May-17
30-May-18
21-May-19

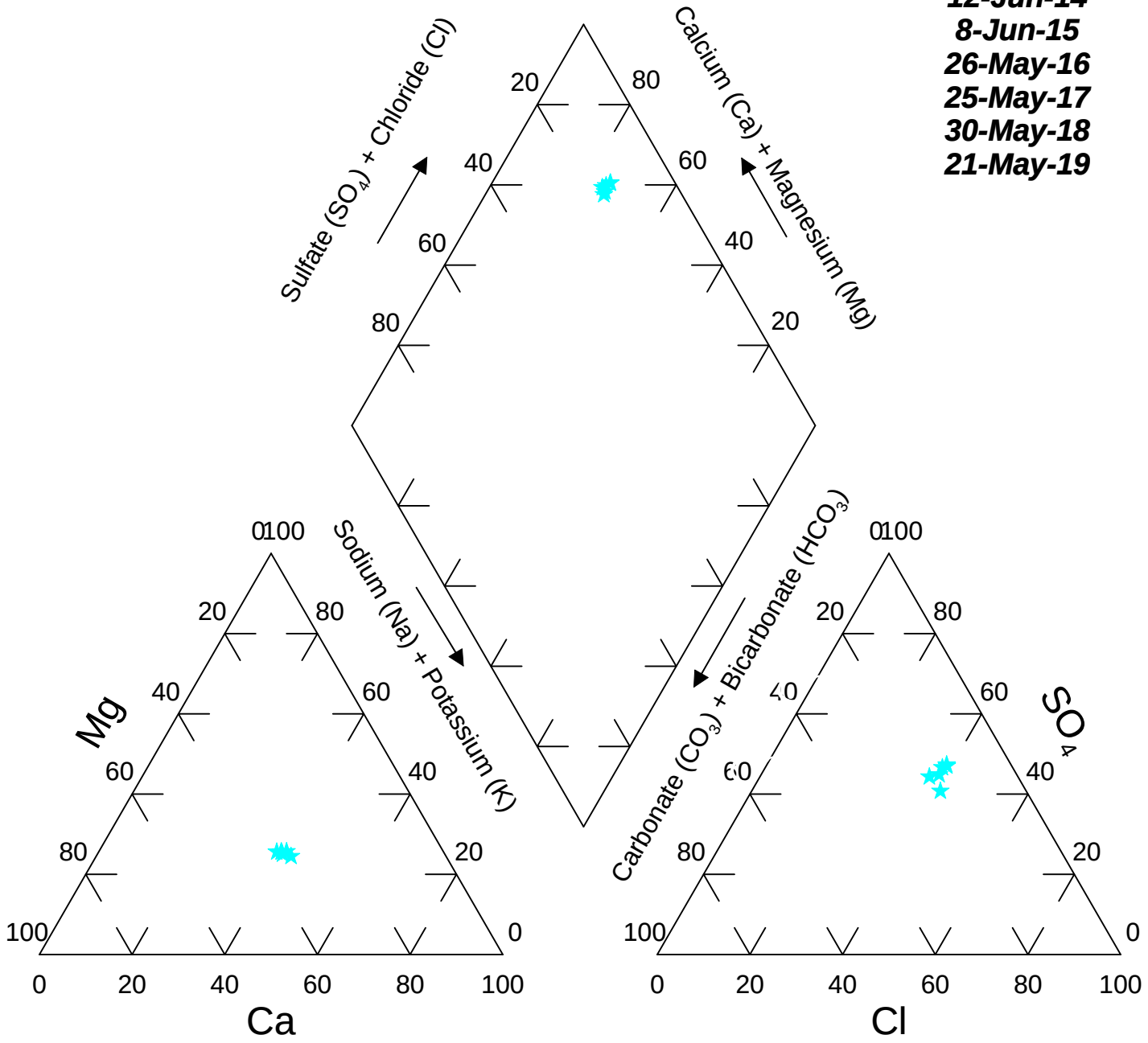
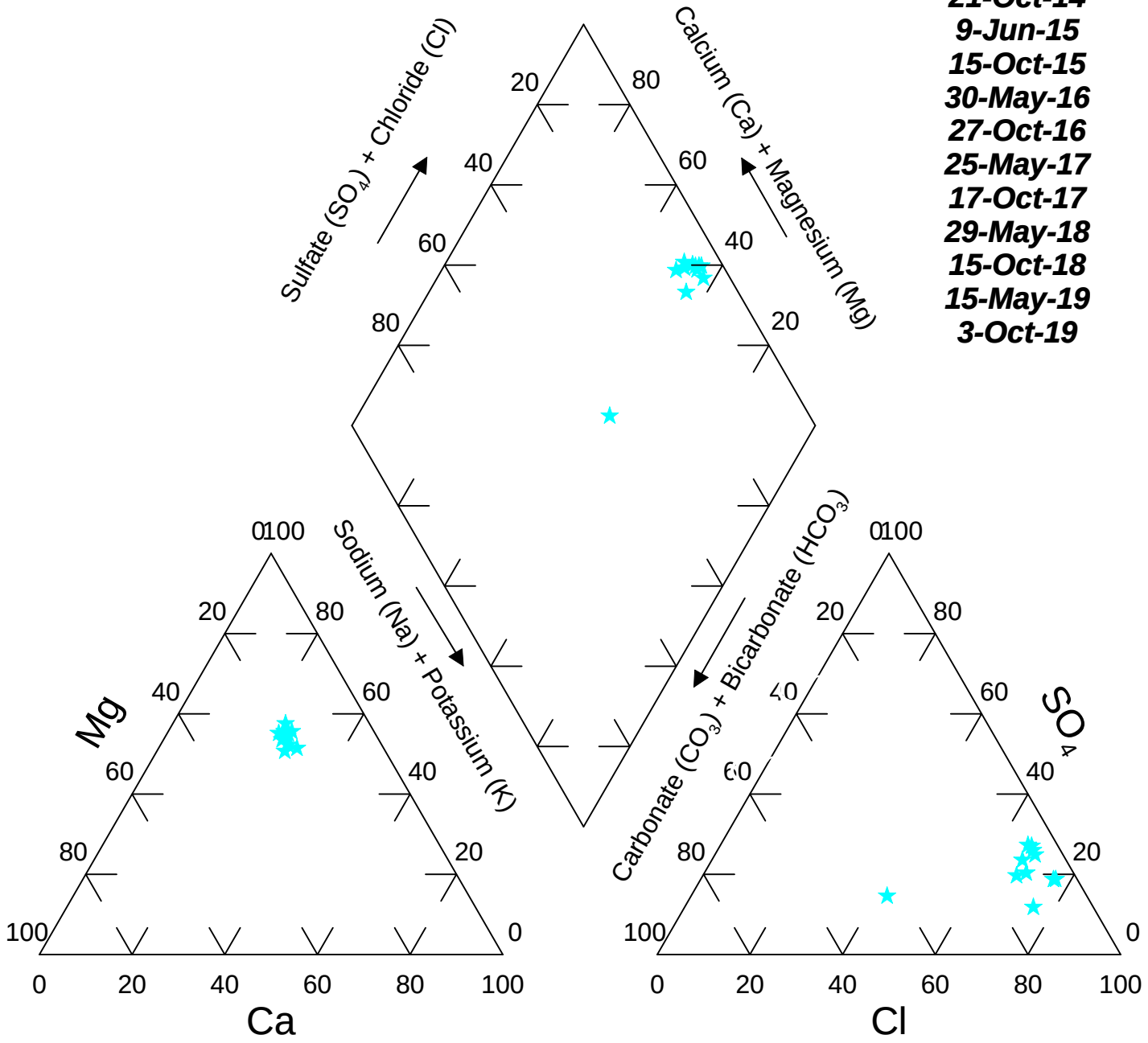


FIGURE: 17P

Winnipeg
Water and Waste Department

Site: Brady
Well #: 13A

Dates:
21-Oct-14
9-Jun-15
15-Oct-15
30-May-16
27-Oct-16
25-May-17
17-Oct-17
29-May-18
15-Oct-18
15-May-19
3-Oct-19



Winnipeg
Water and Waste Department

Site: Brady
Well #: 14A

Dates:
21-Oct-14
4-Jun-15
15-Oct-15
30-May-16
28-Oct-16
25-May-17
17-Oct-17
29-May-18
16-Oct-18
15-May-19
3-Oct-19

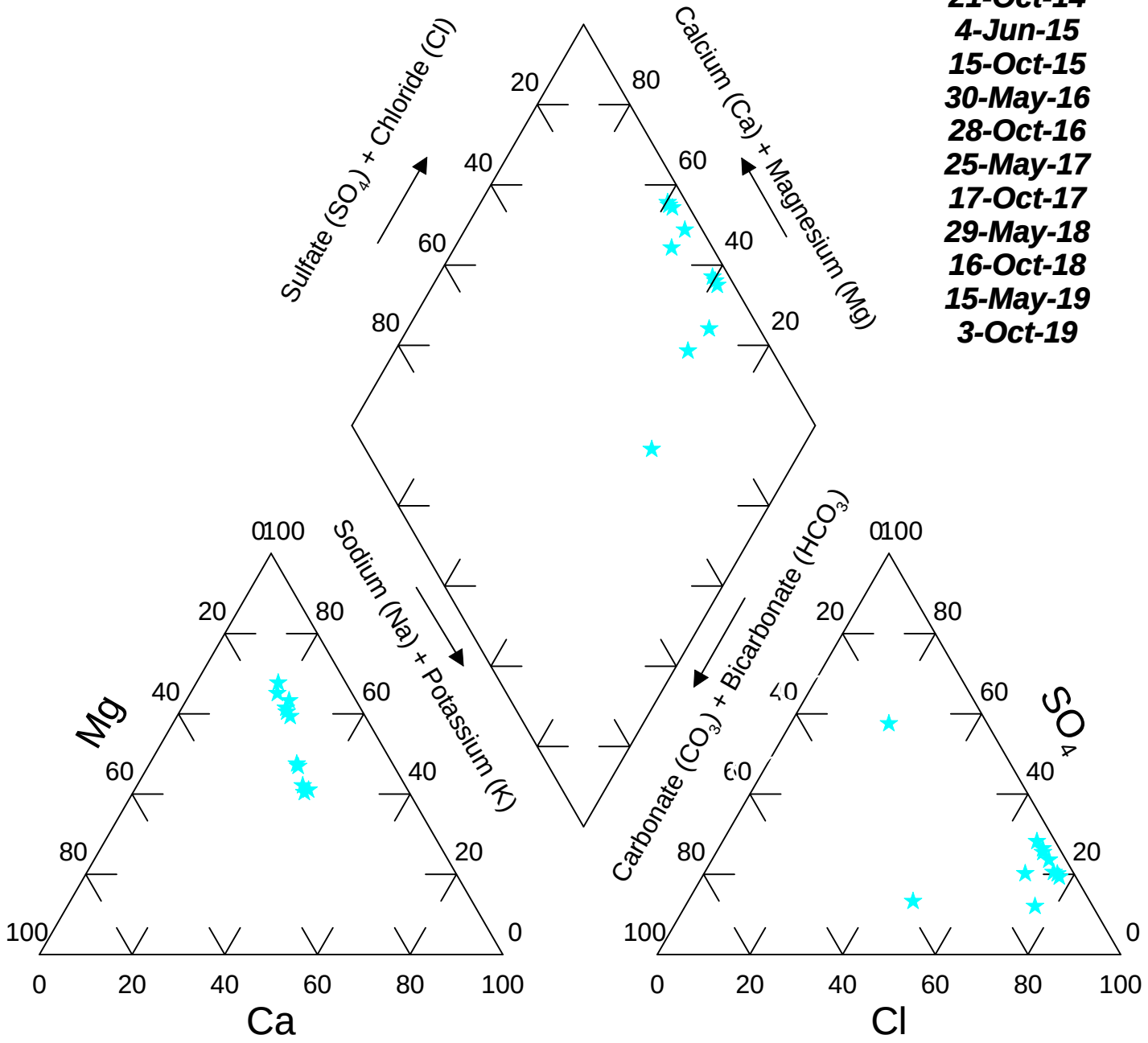
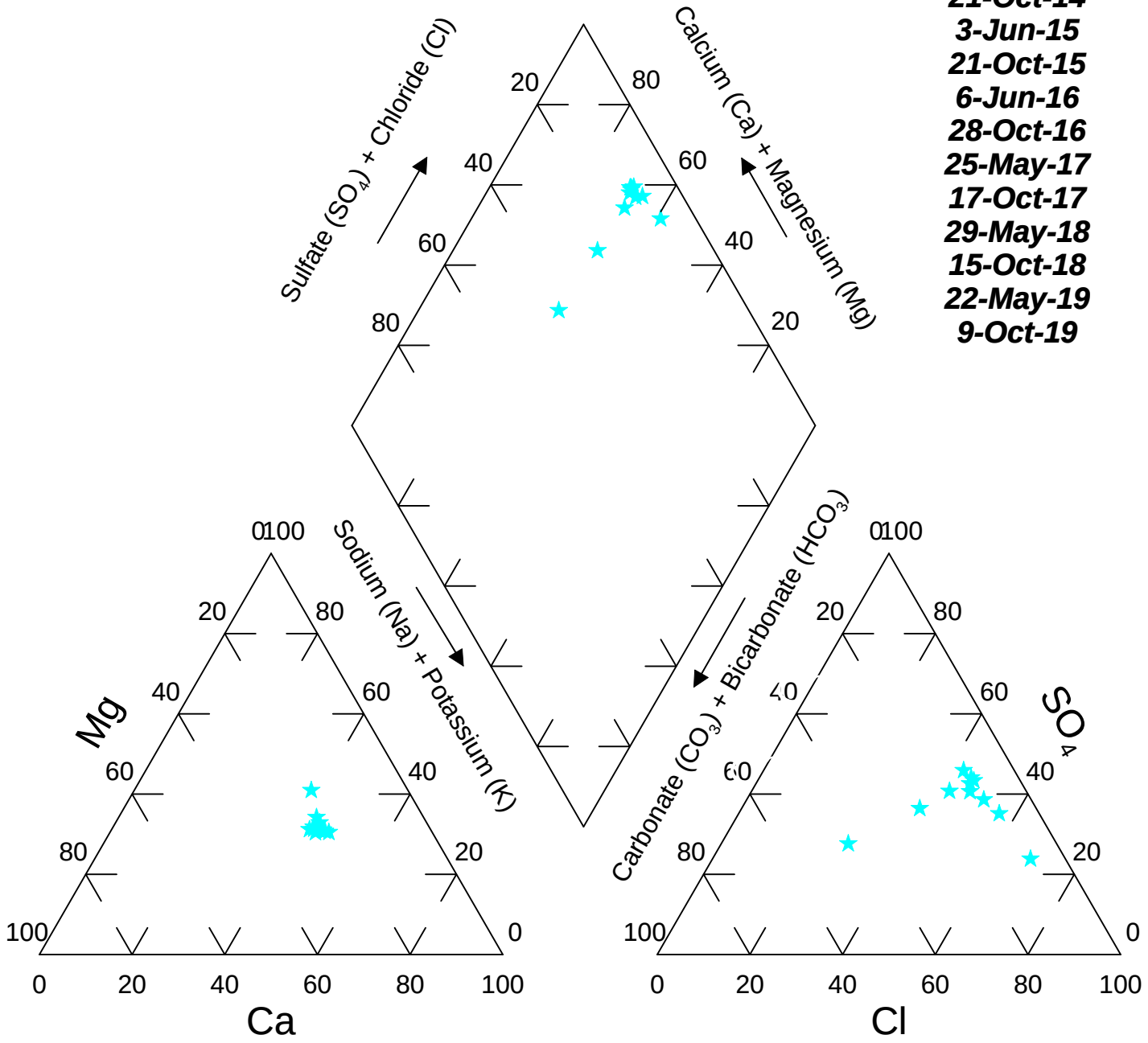


FIGURE: 13P

Winnipeg
Water and Waste Department

Site: Brady
Well #: 15A

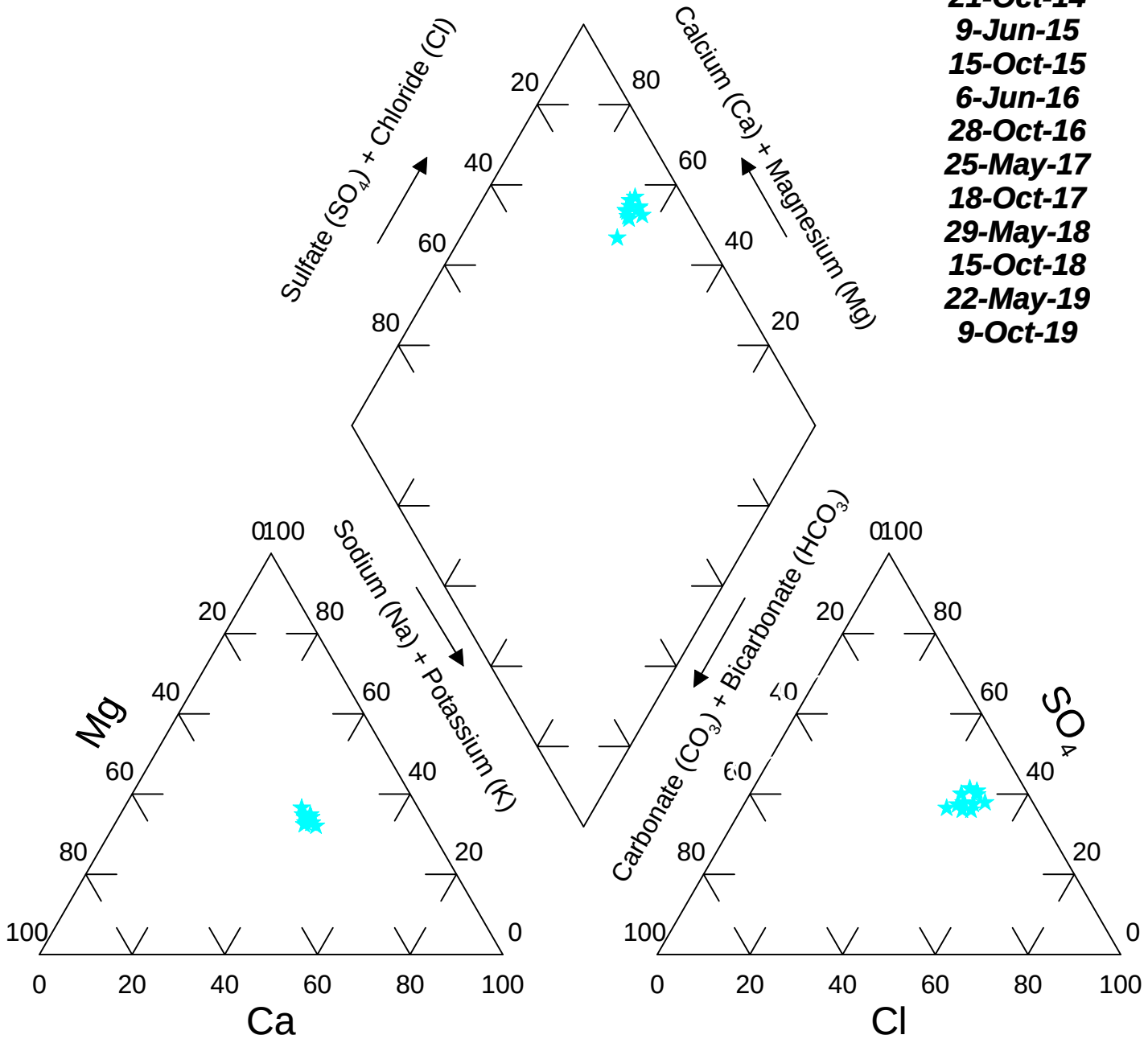
Dates:
21-Oct-14
3-Jun-15
21-Oct-15
6-Jun-16
28-Oct-16
25-May-17
17-Oct-17
29-May-18
15-Oct-18
22-May-19
9-Oct-19



Winnipeg
Water and Waste Department

Site: Brady
Well #: 16A

Dates:
21-Oct-14
9-Jun-15
15-Oct-15
6-Jun-16
28-Oct-16
25-May-17
18-Oct-17
29-May-18
15-Oct-18
22-May-19
9-Oct-19



Winnipeg
Water and Waste Department

2019 Leachate
Piper Diagrams

Site: Brady
Location: *MH3*

Dates:
22-Jul-14
2-Sep-15
8-Sep-16
26-Sep-17
31-Jul-18
11-Sep-19

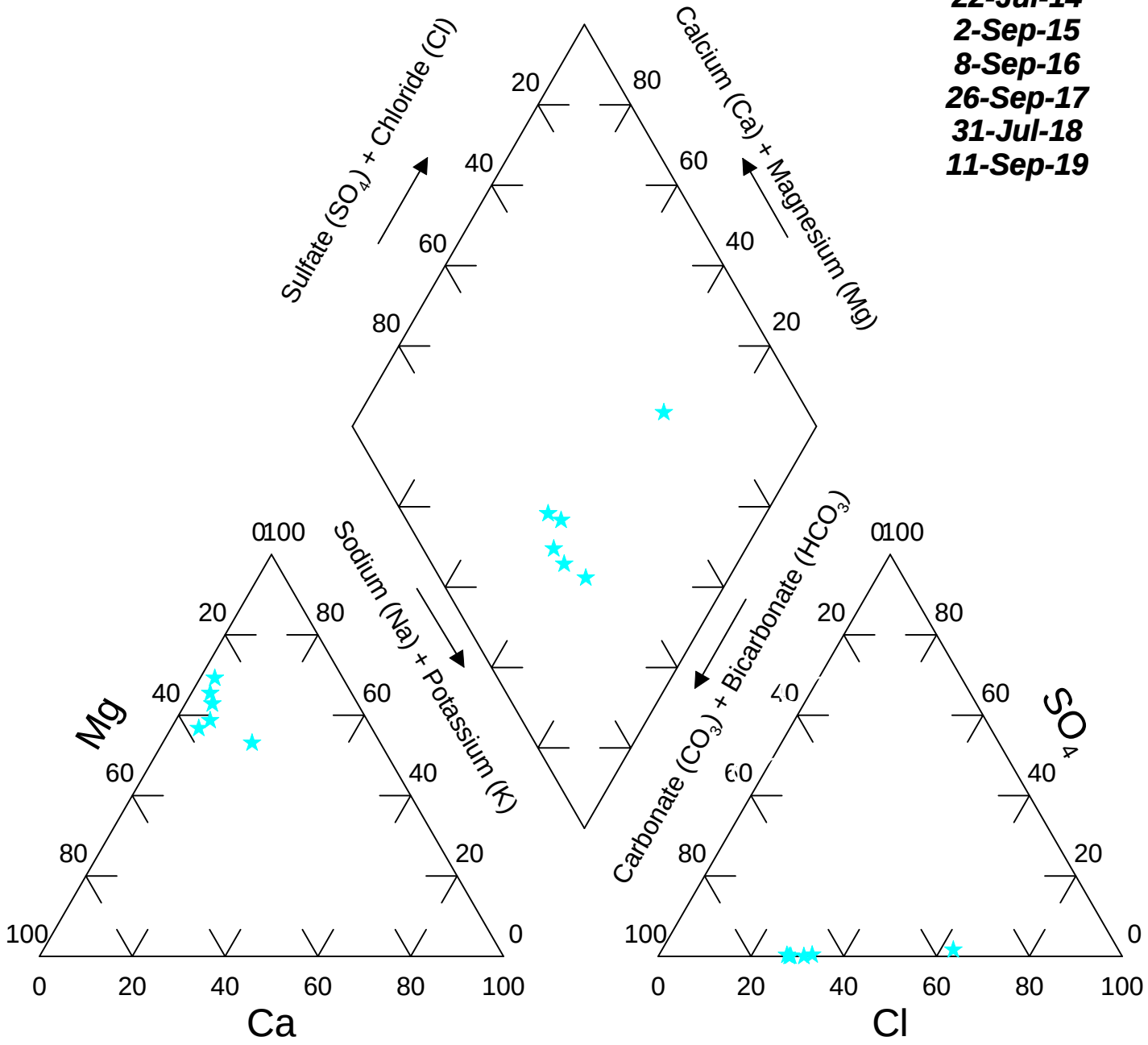


FIGURE: 18P

Winnipeg
Water and Waste Department

Site: Brady
Location: MH8

Dates:
22-Jul-14
2-Sep-15
7-Sep-16
26-Sep-17
31-Jul-18
11-Sep-19

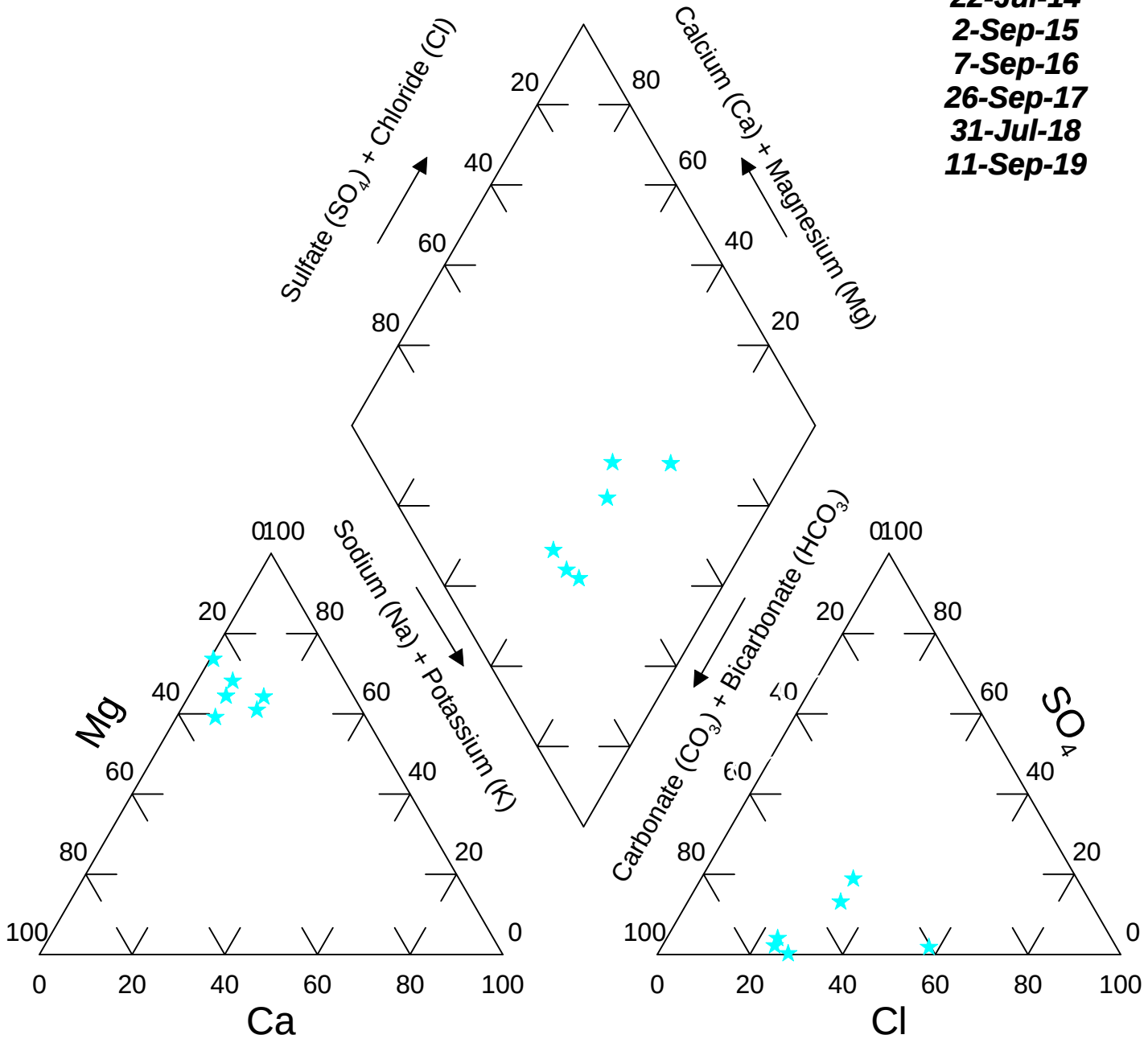


FIGURE: 19P

Winnipeg
Water and Waste Department

Site: Brady
Location: MH13

Dates:
22-Jul-14
2-Sep-15
9-Sep-16
26-Sep-17
31-Jul-18
12-Sep-19

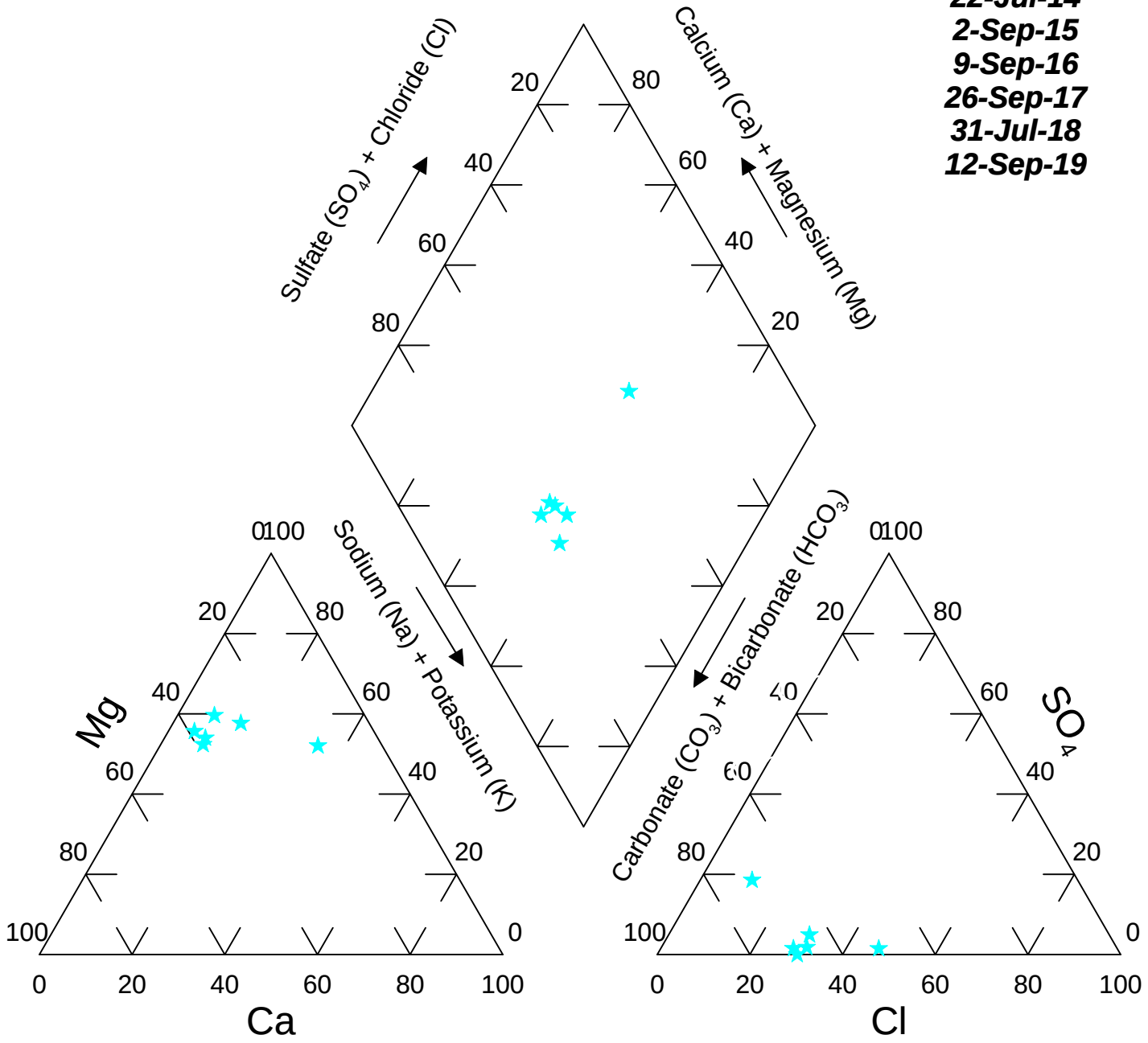


FIGURE: 20P

Winnipeg
Water and Waste Department

Site: Brady
Location: MH24

Dates:
22-Jul-14
2-Sep-15
7-Sep-16
26-Sep-17
31-Jul-18
11-Sep-19

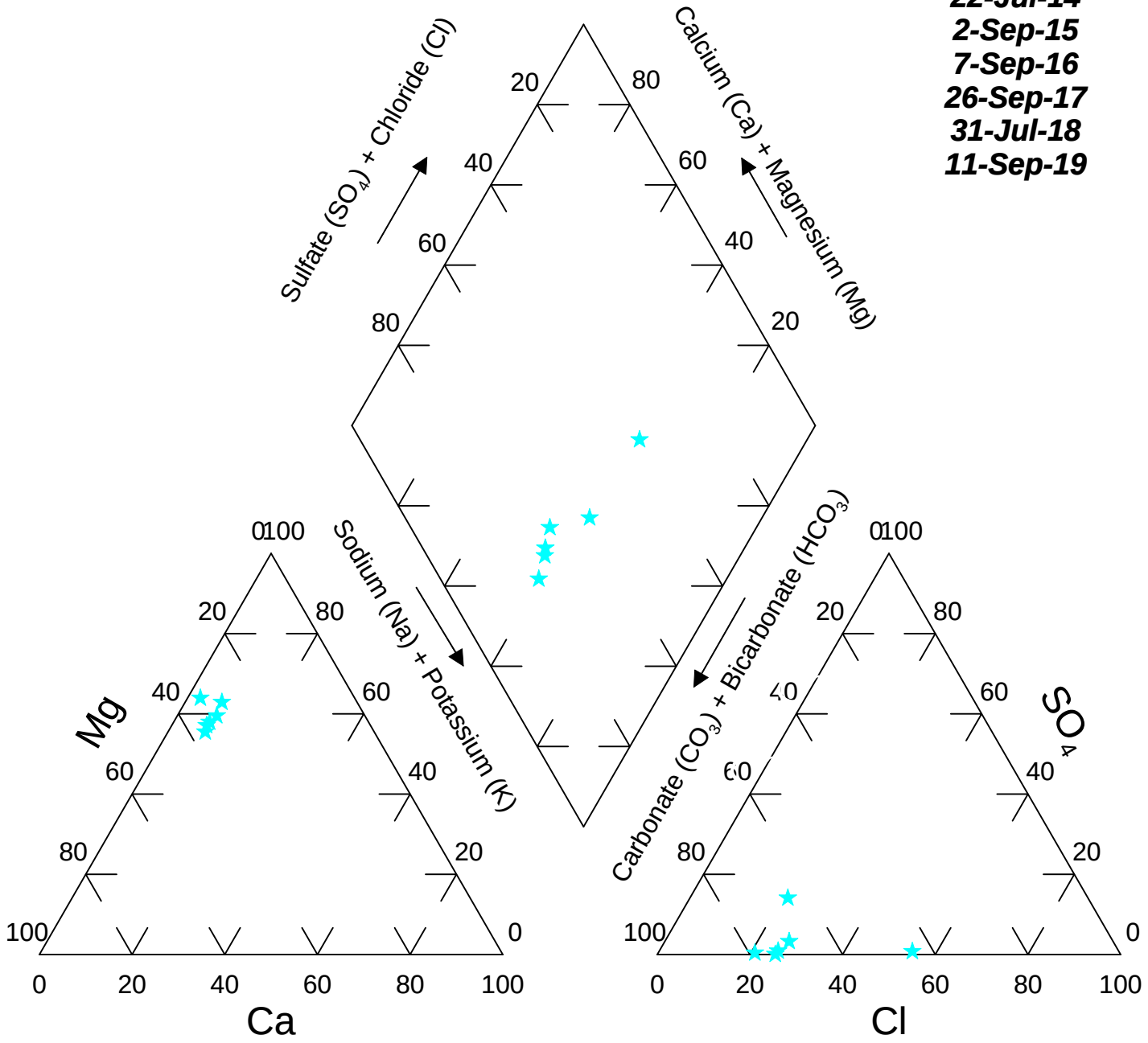


FIGURE: 21P

Winnipeg
Water and Waste Department

Site: Brady
Location: MH27

Dates:
22-Jul-14
2-Sep-15
7-Sep-16
26-Sep-17
31-Jul-18
11-Sep-19

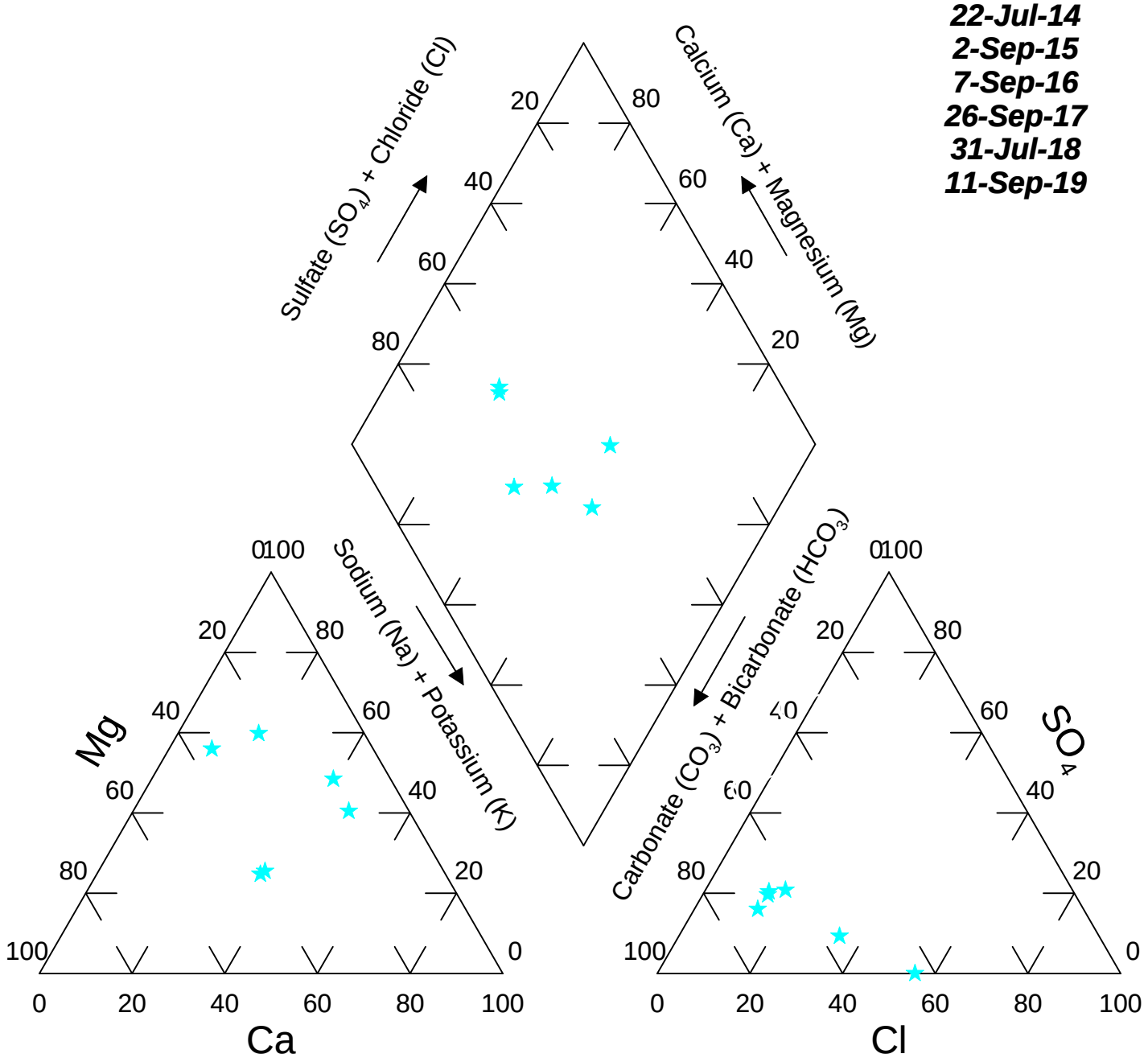


FIGURE: 22P

Winnipeg
Water and Waste Department

Site: Brady
Location: MH31

Dates:
22-Jul-14
2-Sep-15
7-Sep-16
26-Sep-17
31-Jul-18
11-Sep-19

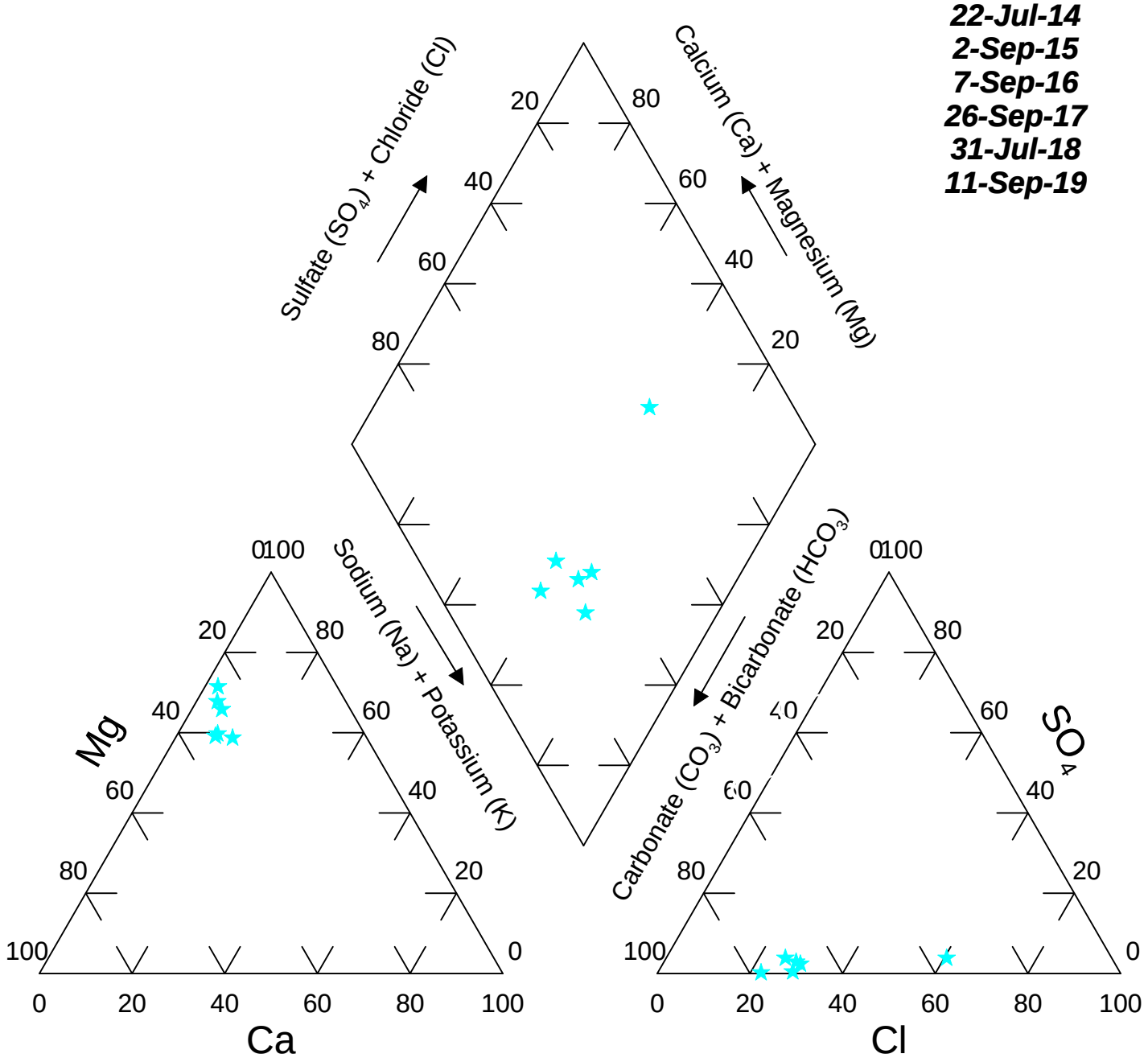


FIGURE: 23P

Winnipeg
Water and Waste Department

Site: Brady
Location: MH34

Dates:
22-Jul-14
2-Sep-15
8-Sep-16
26-Sep-17
31-Jul-18
11-Sep-19

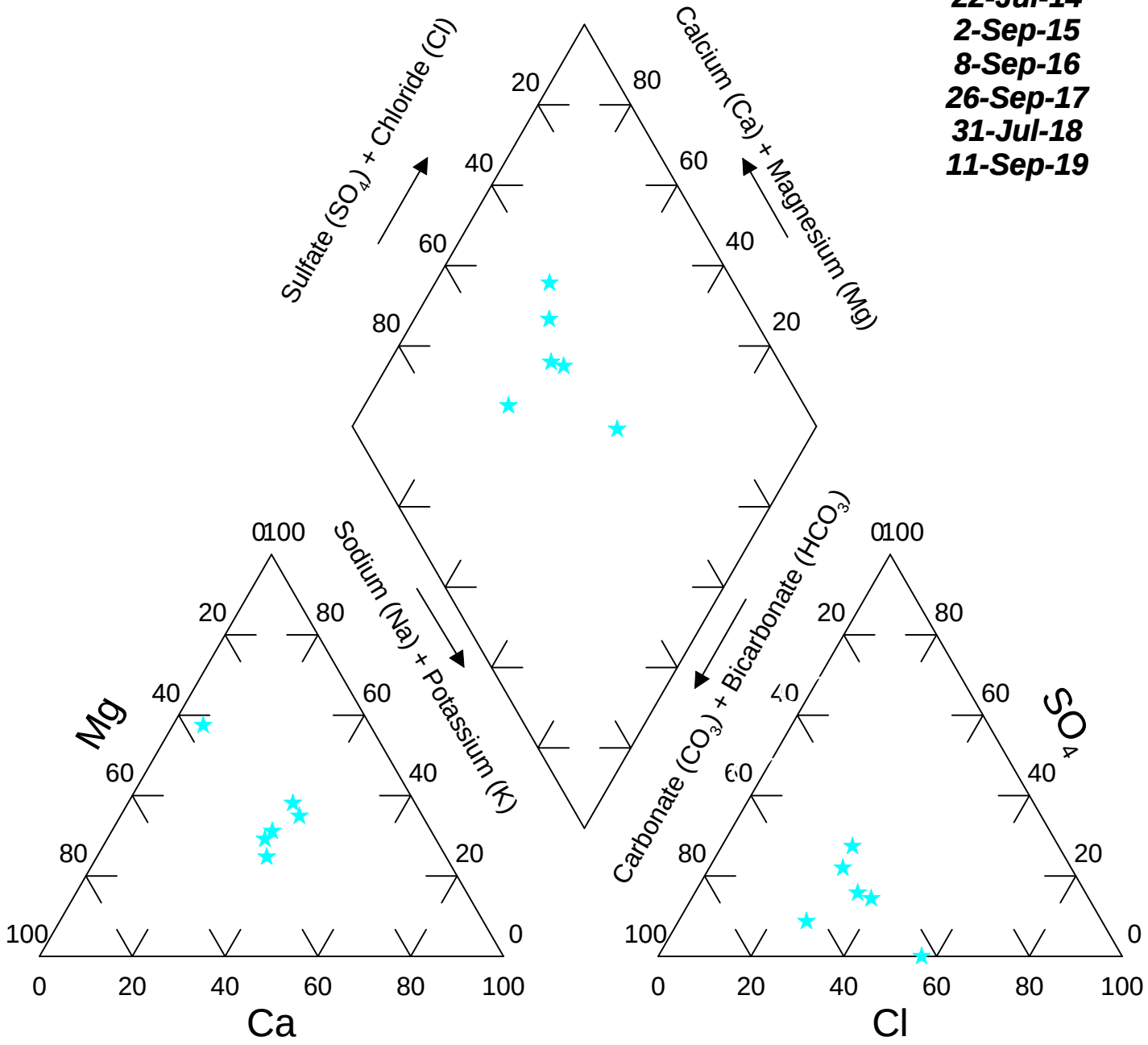


FIGURE: 24P

Winnipeg
Water and Waste Department

Site: Brady
Location: MH46

Date:
31-Jul-18
11-Sep-19

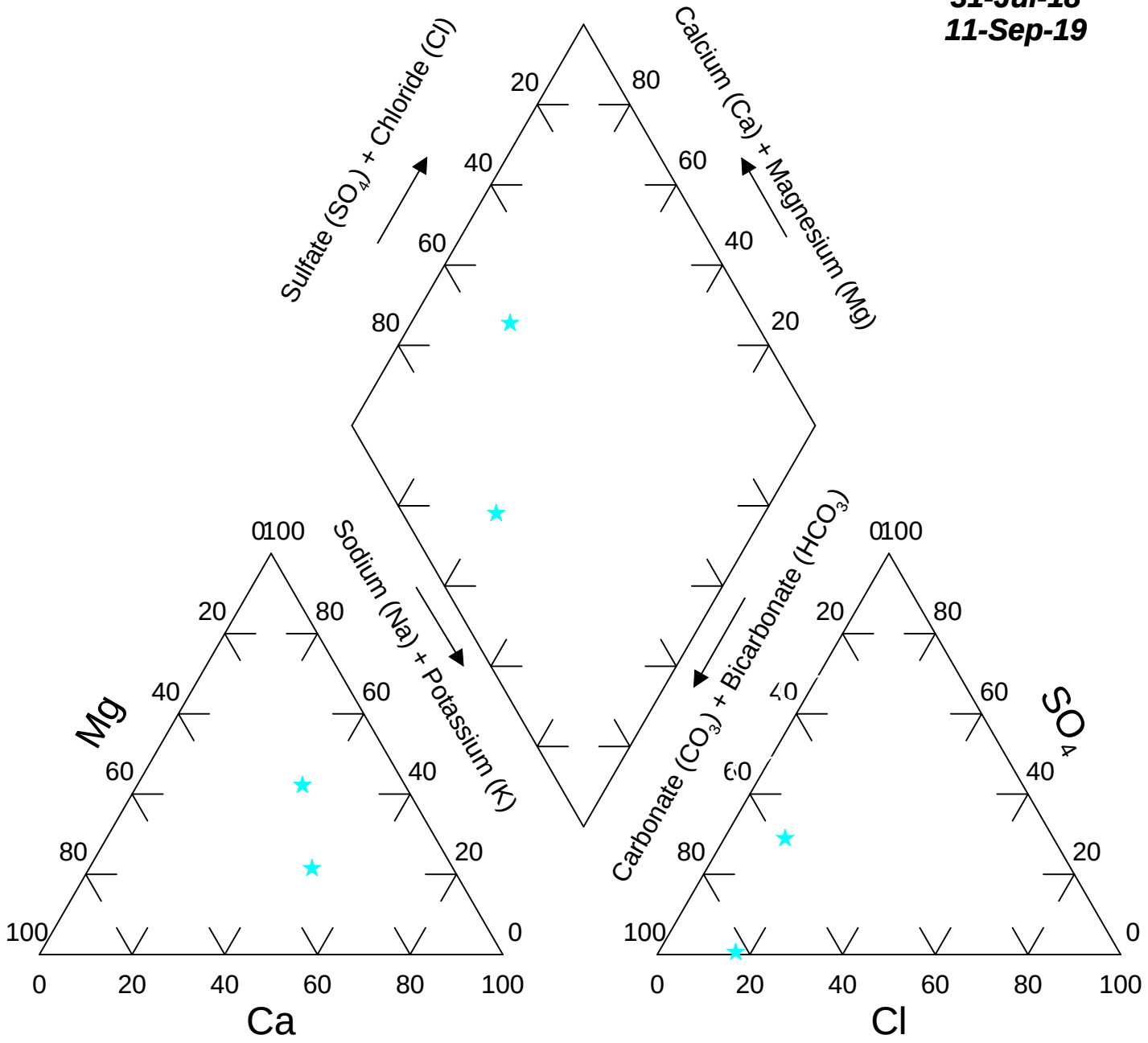


FIGURE: 21P

Winnipeg
Water and Waste Department

Site: Brady
Location: *Riser 1*

Dates:
29-Oct-15
8-Sep-16
26-Sep-17
31-Jul-18
10-Sep-19

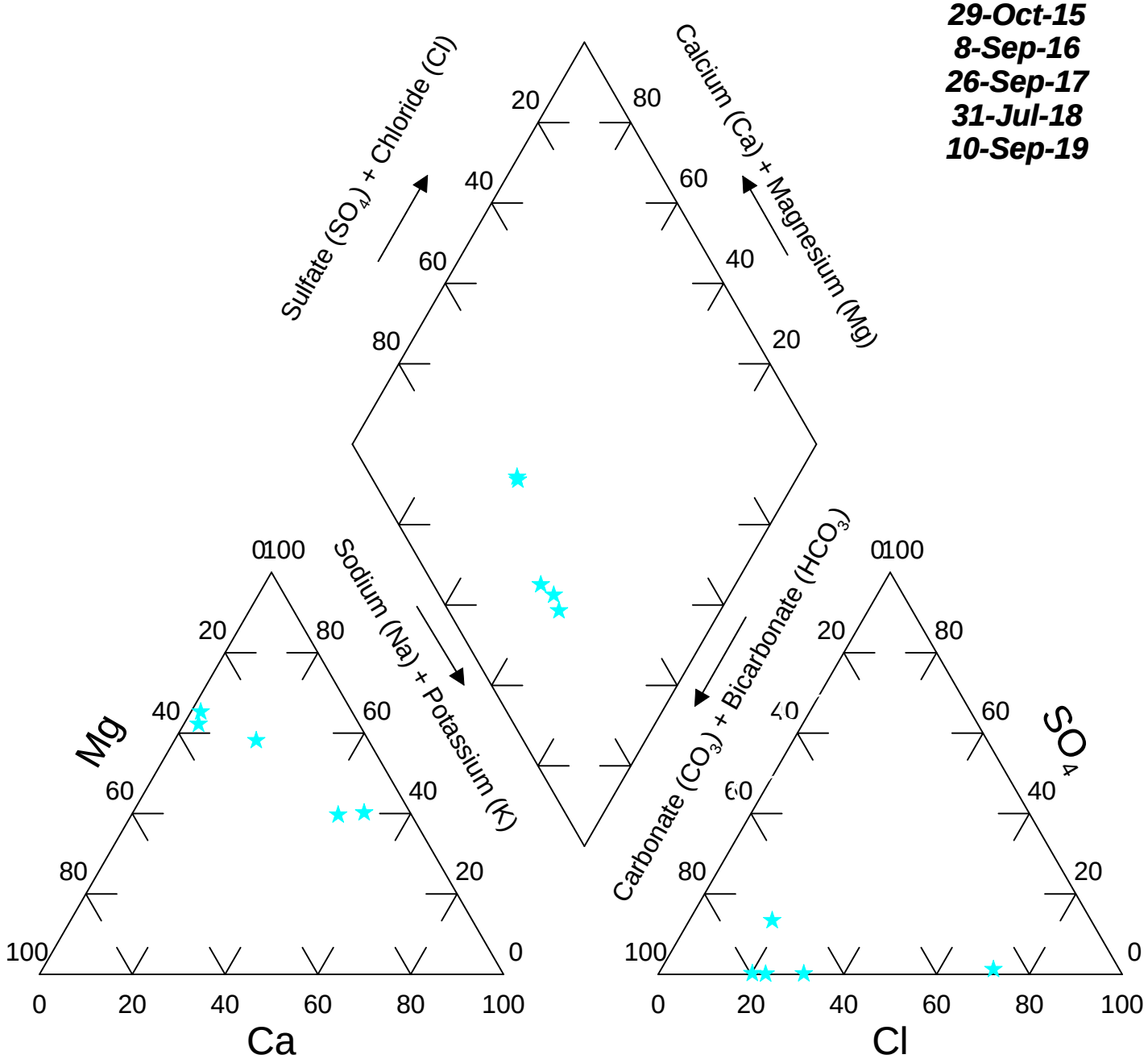
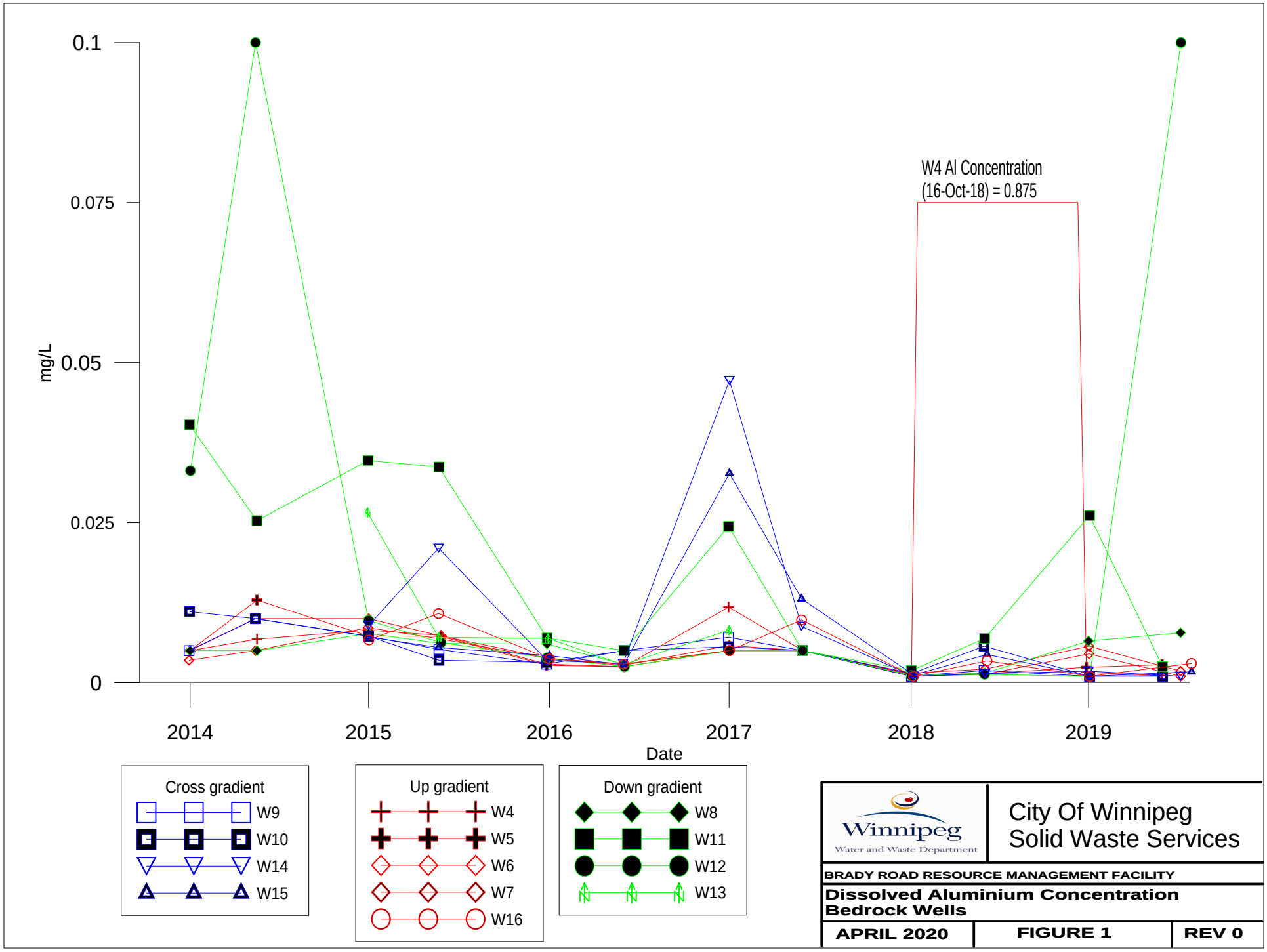


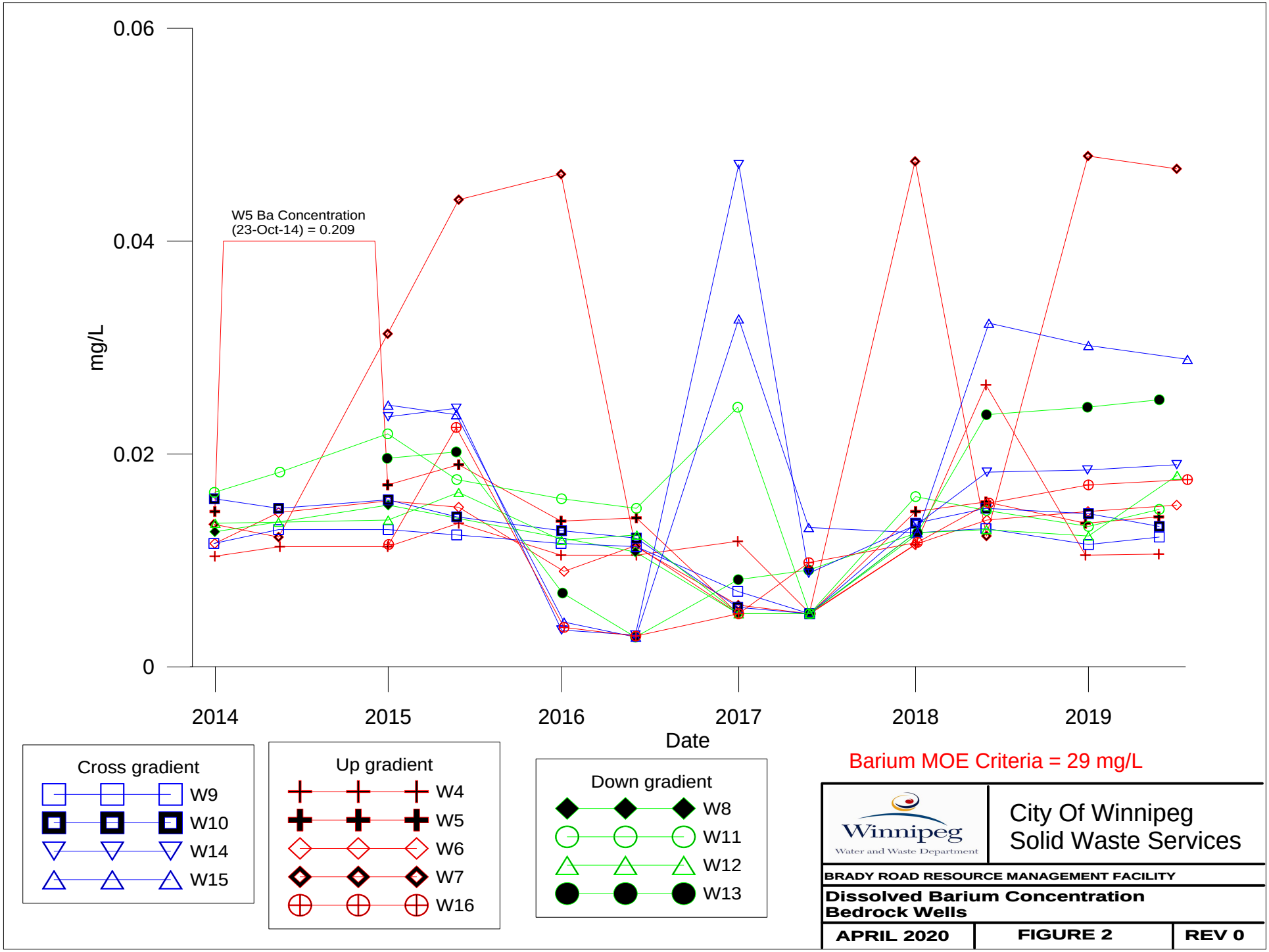
FIGURE: 18P

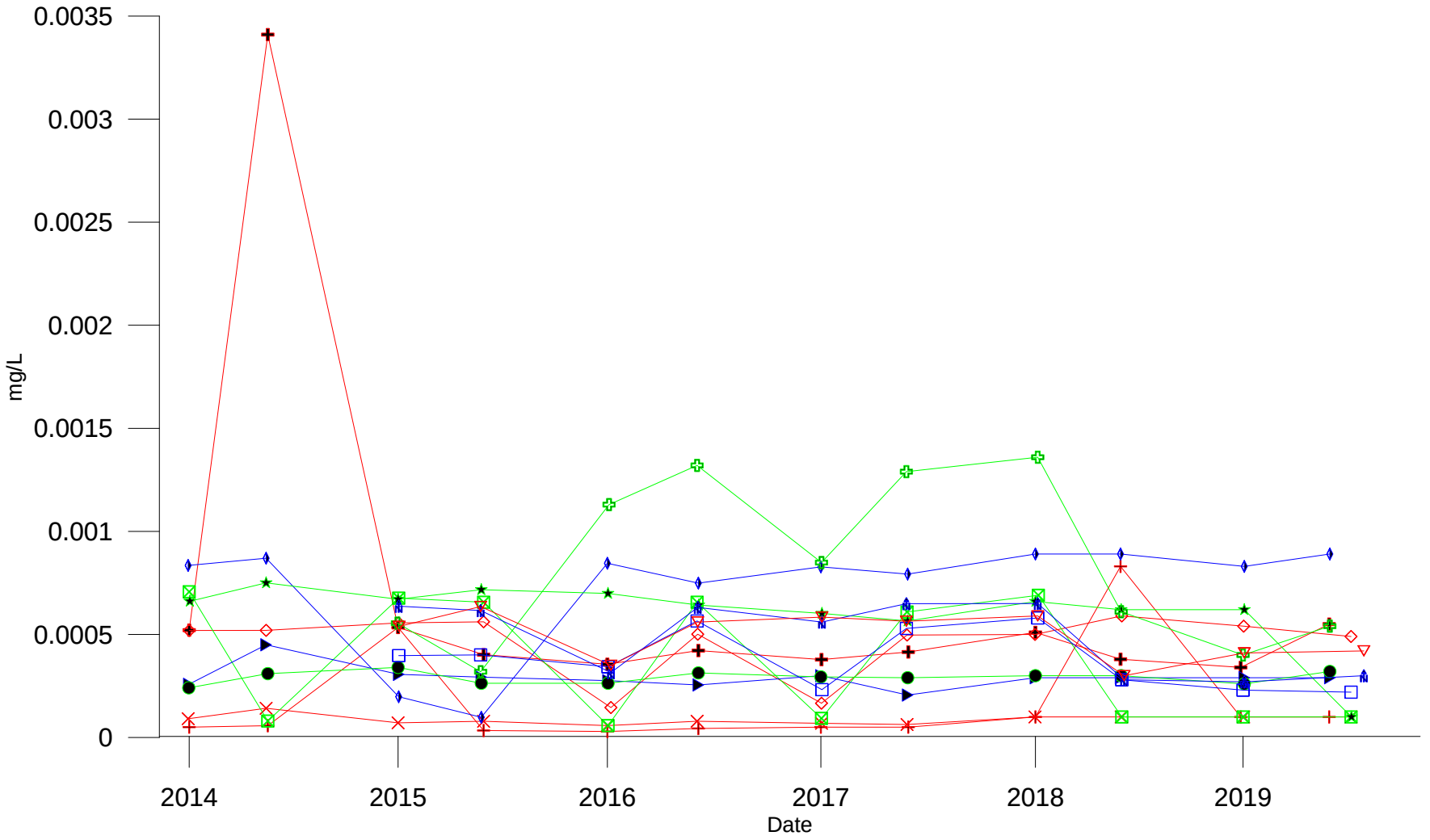
Winnipeg
Water and Waste Department

APPENDIX D
2019 TIME VS CONCENTRATION GRAPHS

2019 Groundwater
Time vs Concentration Graphs


0.1
0.075
0.05
0.025
0
mg/L
W4 Al Concentration
(16-Oct-18) = 0.875
2014
2015
2016
2017
2018
2019
Date
Cross gradient
W9
W10
W14
W15
Up gradient
W4
W5
W6
W7
W16
Down gradient
W8
W11
W12
W13
Winnipeg
Water and Waste Department
City Of Winnipeg
Solid Waste Services
BRADY ROAD RESOURCE MANAGEMENT FACILITY
Dissolved Aluminium Concentration
Bedrock Wells
APRIL 2020
FIGURE 1
REV 0


0.06
0.04
0.02
0
mg/L
W5 Ba Concentration
(23-Oct-14) = 0.209
2014
2015
2016
2017
2018
2019
Date
Cross gradient
W9
W10
W14
W15
Up gradient
W4
W5
W6
W7
W16
Down gradient
W8
W11
W12
W13
Barium MOE Criteria = 29 mg/L
Winnipeg
Water and Waste Department
City Of Winnipeg
Solid Waste Services
BRADY ROAD RESOURCE MANAGEMENT FACILITY
Dissolved Barium Concentration
Bedrock Wells
APRIL 2020
FIGURE 2
REV 0



Cross gradient
W9
W10
W14
W15

Up gradient
W4
W5
W6
W7
W16

Down gradient
W8
W11
W12
W13

MOE Cobalt Criteria = 0.066 mg/L

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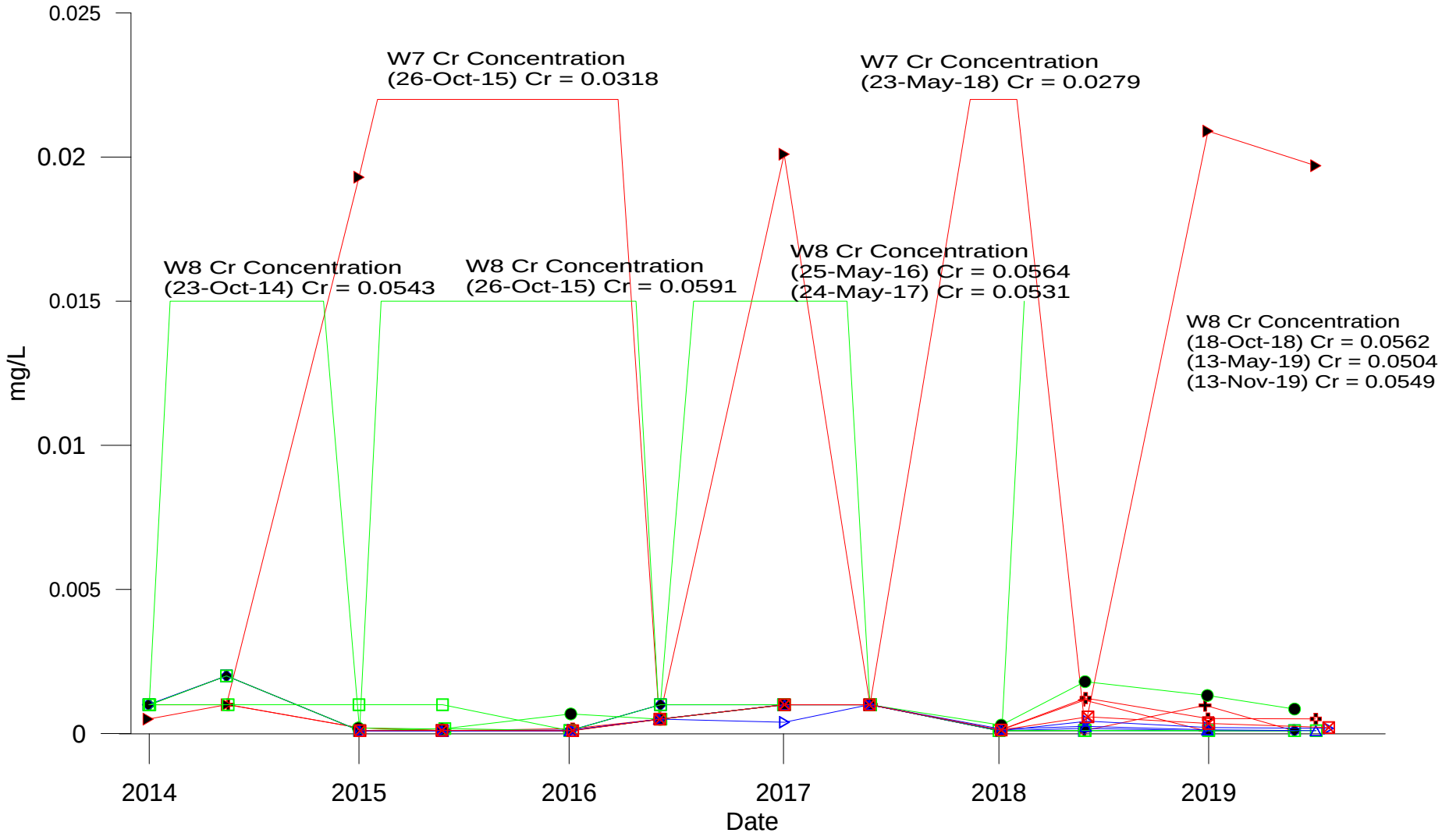
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Cobalt Concentration
Bedrock Wells

APRIL 2019	FIGURE 3	REV 0



Chromium MOE Criteria = 0.81 mg/L

Cross gradient
- W9
- W10
- W14
- W15

Up gradient
- W4
- W5
- W6
- W7
- W16

Down gradient
- W8
- W11
- W12
- W13

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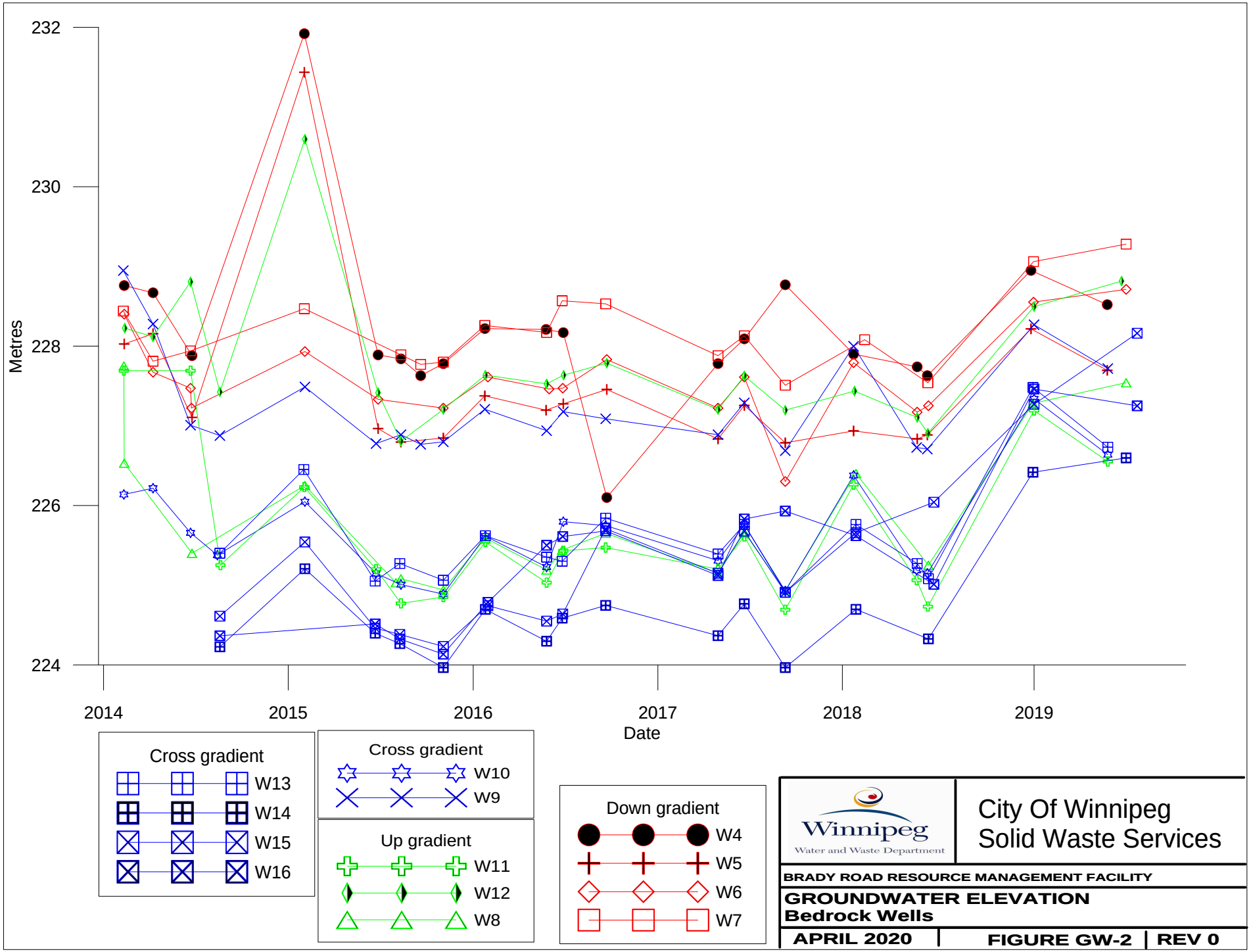
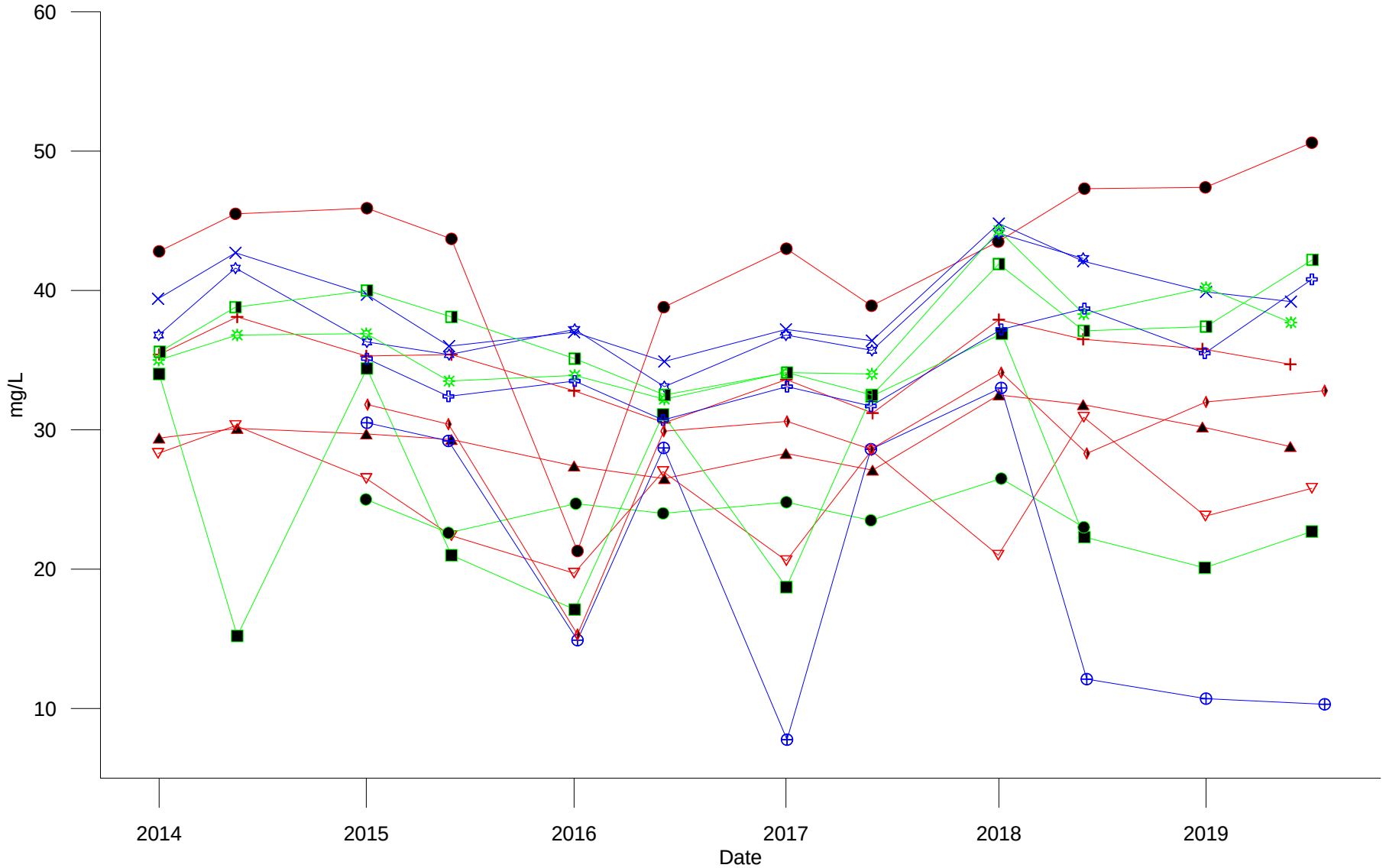
City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Chromium Concentration
Bedrock Wells

APRIL 2020	FIGURE 4	REV 0


232
230
228
226
224
Metres
2014
2015
2016
2017
2018
2019
Date
Cross gradient
W13
W14
W15
W16
Cross gradient
W10
W9
Up gradient
W11
W12
W8
Down gradient
W4
W5
W6
W7
Winnipeg
Water and Waste Department
City Of Winnipeg
Solid Waste Services
BRADY ROAD RESOURCE MANAGEMENT FACILITY
GROUNDWATER ELEVATION
Bedrock Wells
APRIL 2020
FIGURE GW-2 | REV 0



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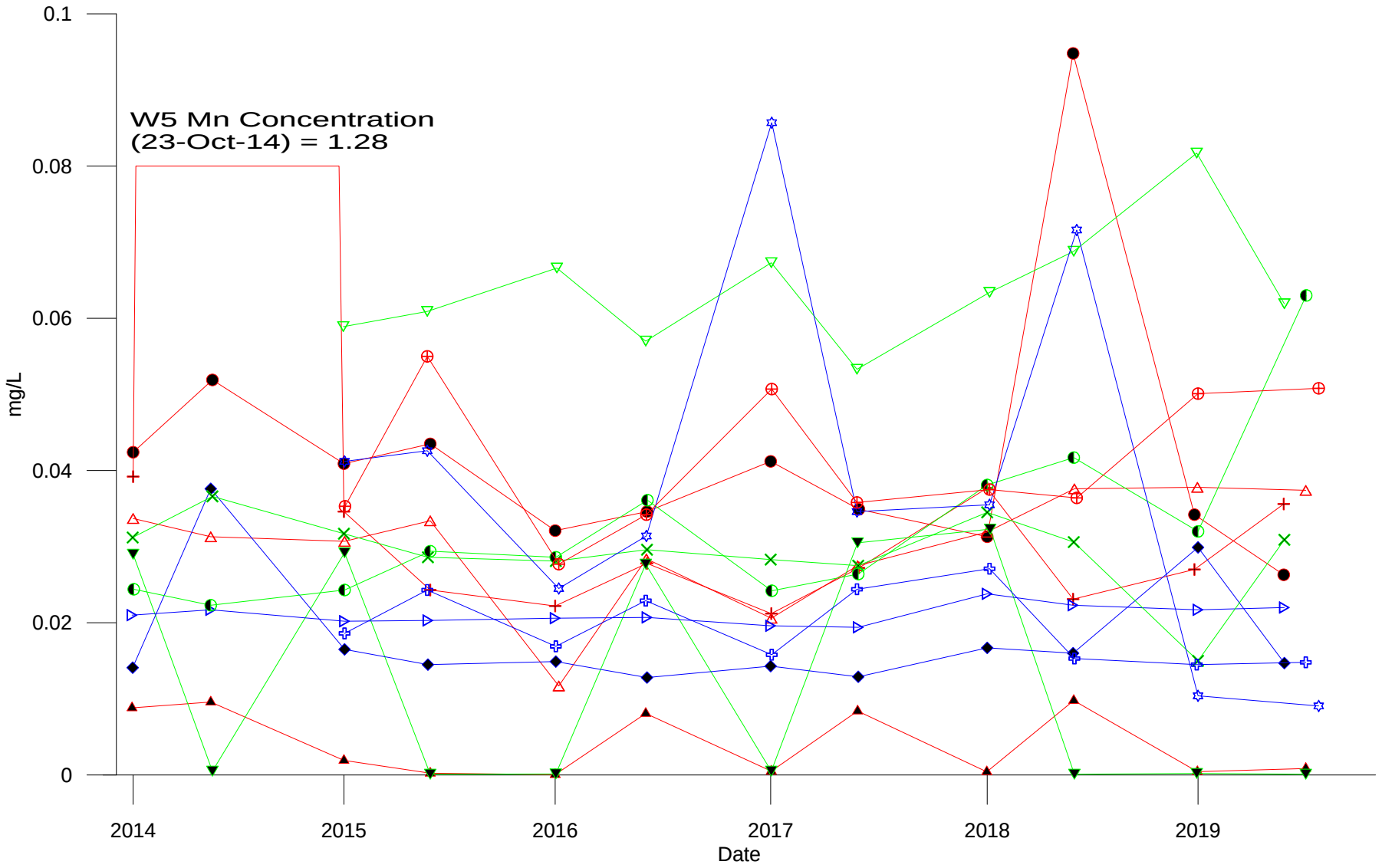
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Potassium Concentration Bedrock Wells

APRIL 2020	FIGURE 5	REV 0



Cross gradient
W9
W10
W14
W15

Up gradient
W4
W5
W6
W7
W16

Down gradient
W8
W11
W12
W13

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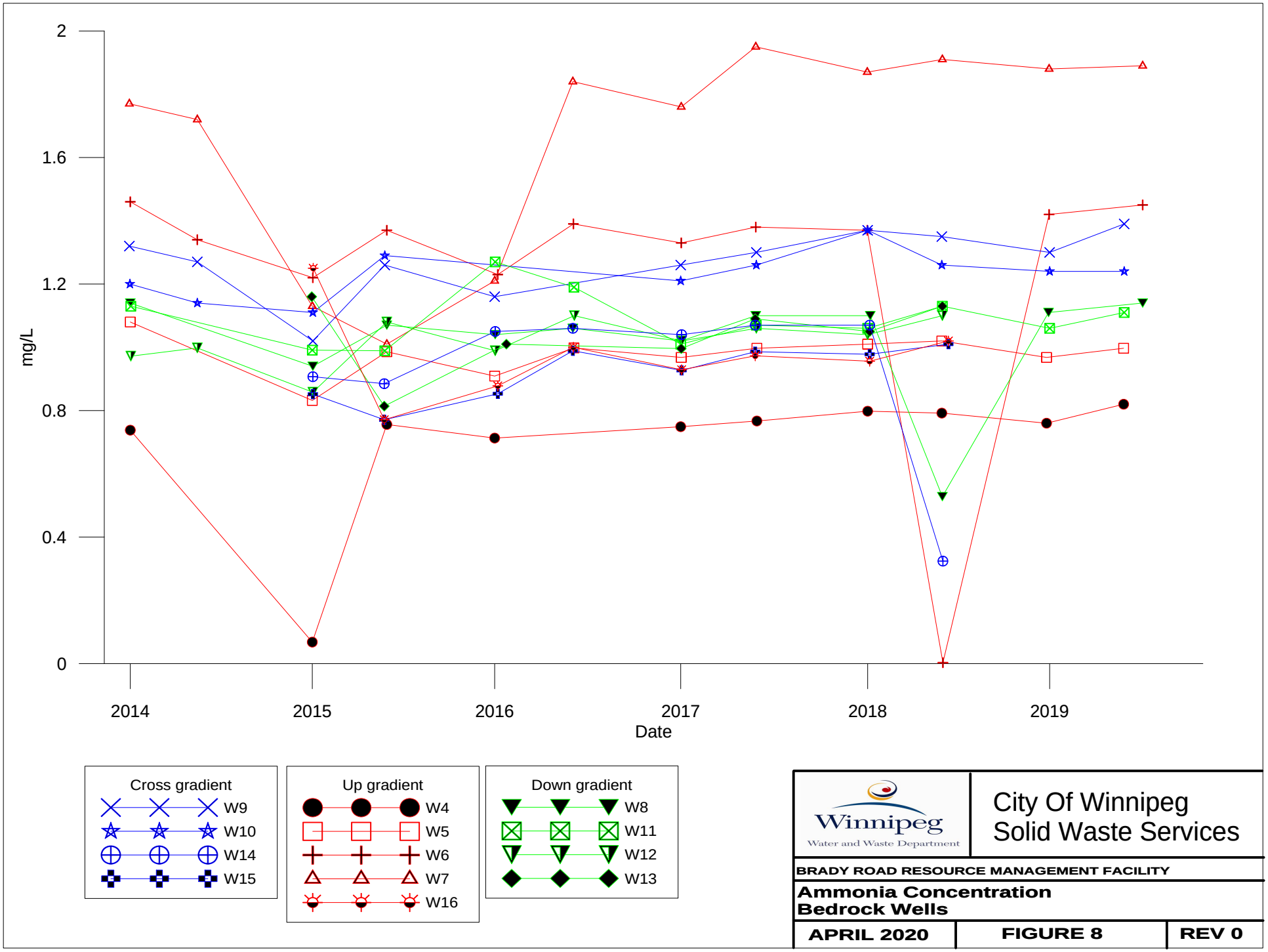
City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Manganese Concentration Bedrock Wells

APRIL 2020	FIGURE 7	REV 0



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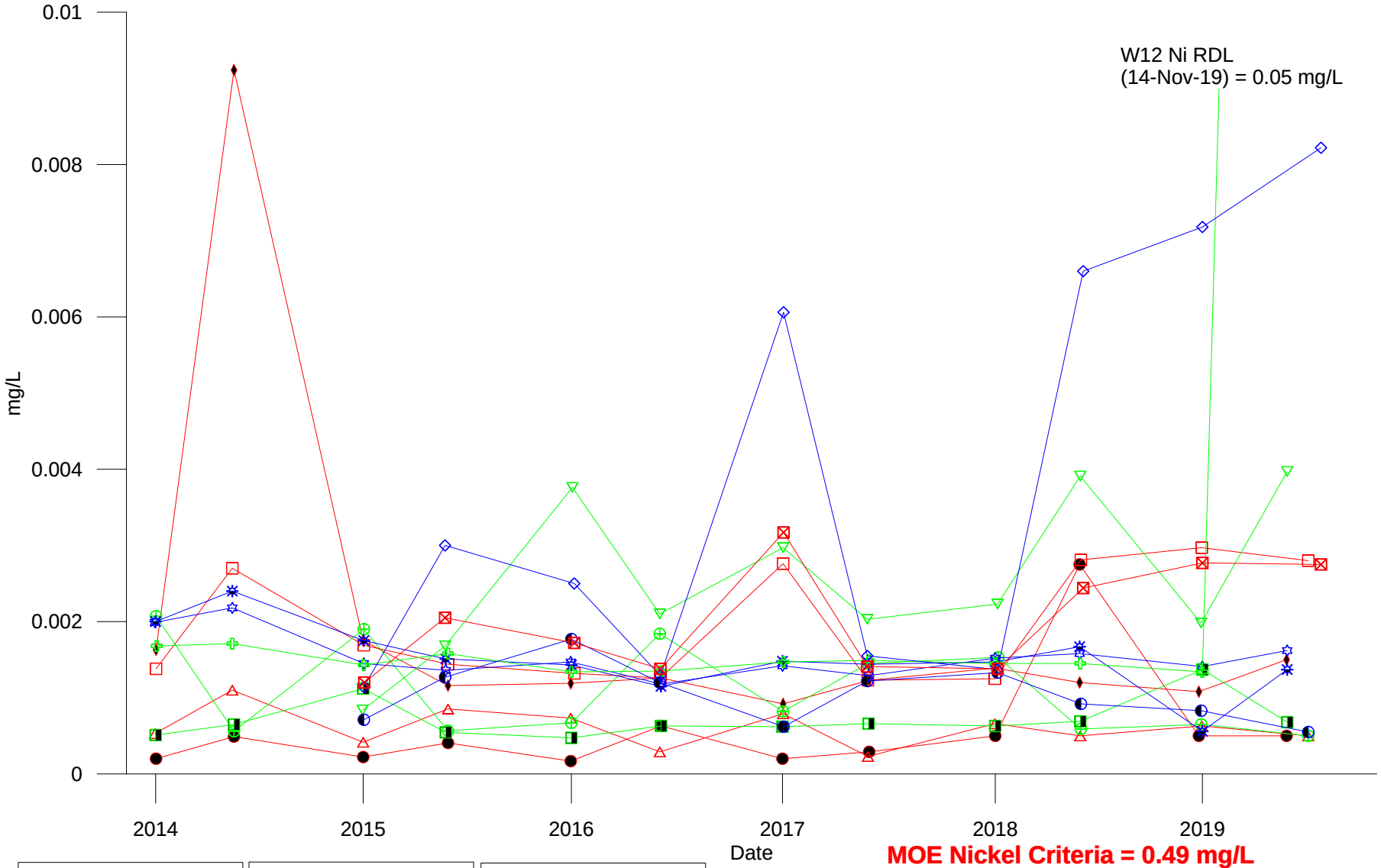
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Ammonia Concentration
Bedrock Wells

APRIL 2020	FIGURE 8	REV 0



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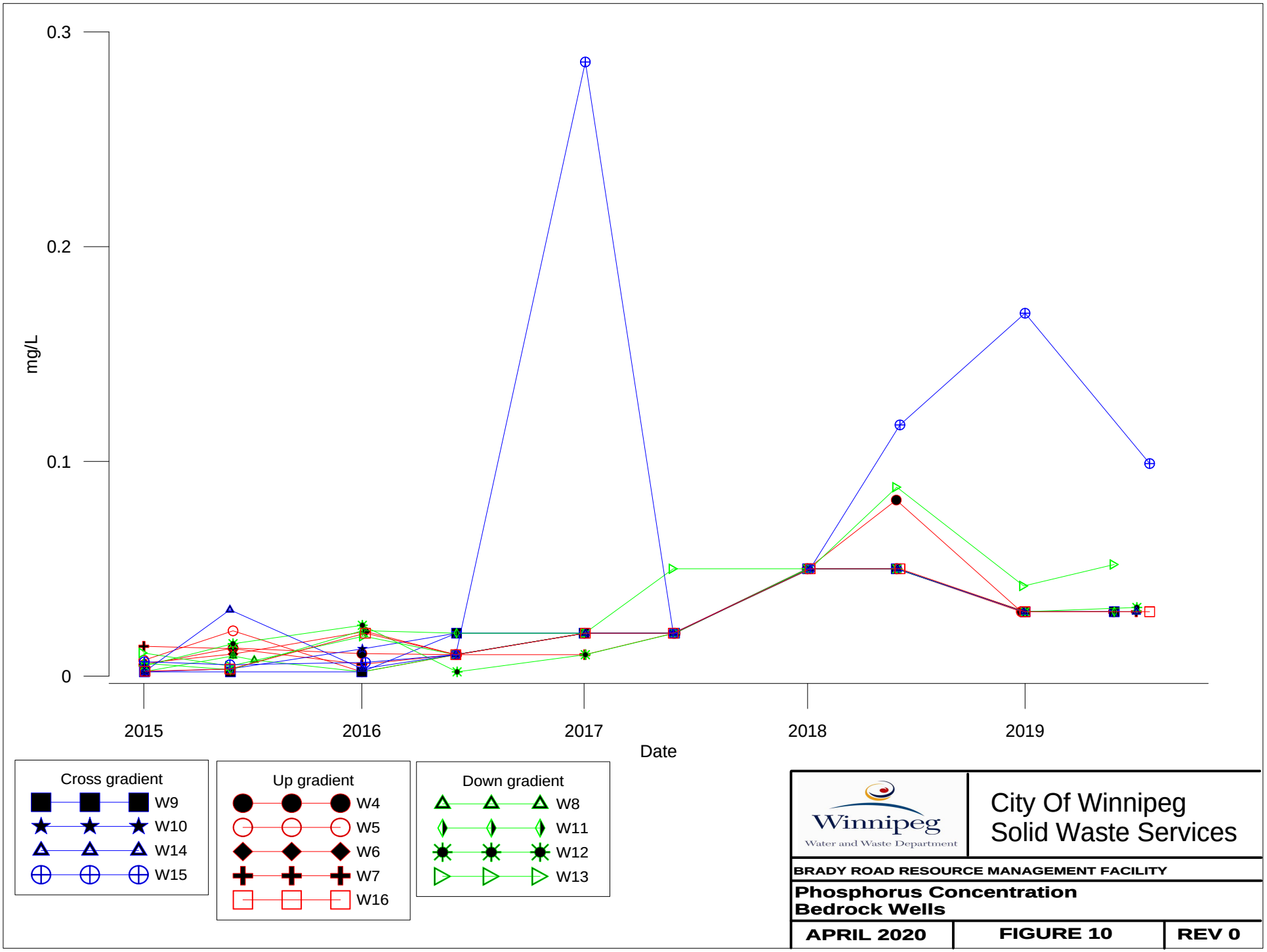
City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Nickel Concentration
Bedrock Wells

APRIL 2020	FIGURE 9	REV 0



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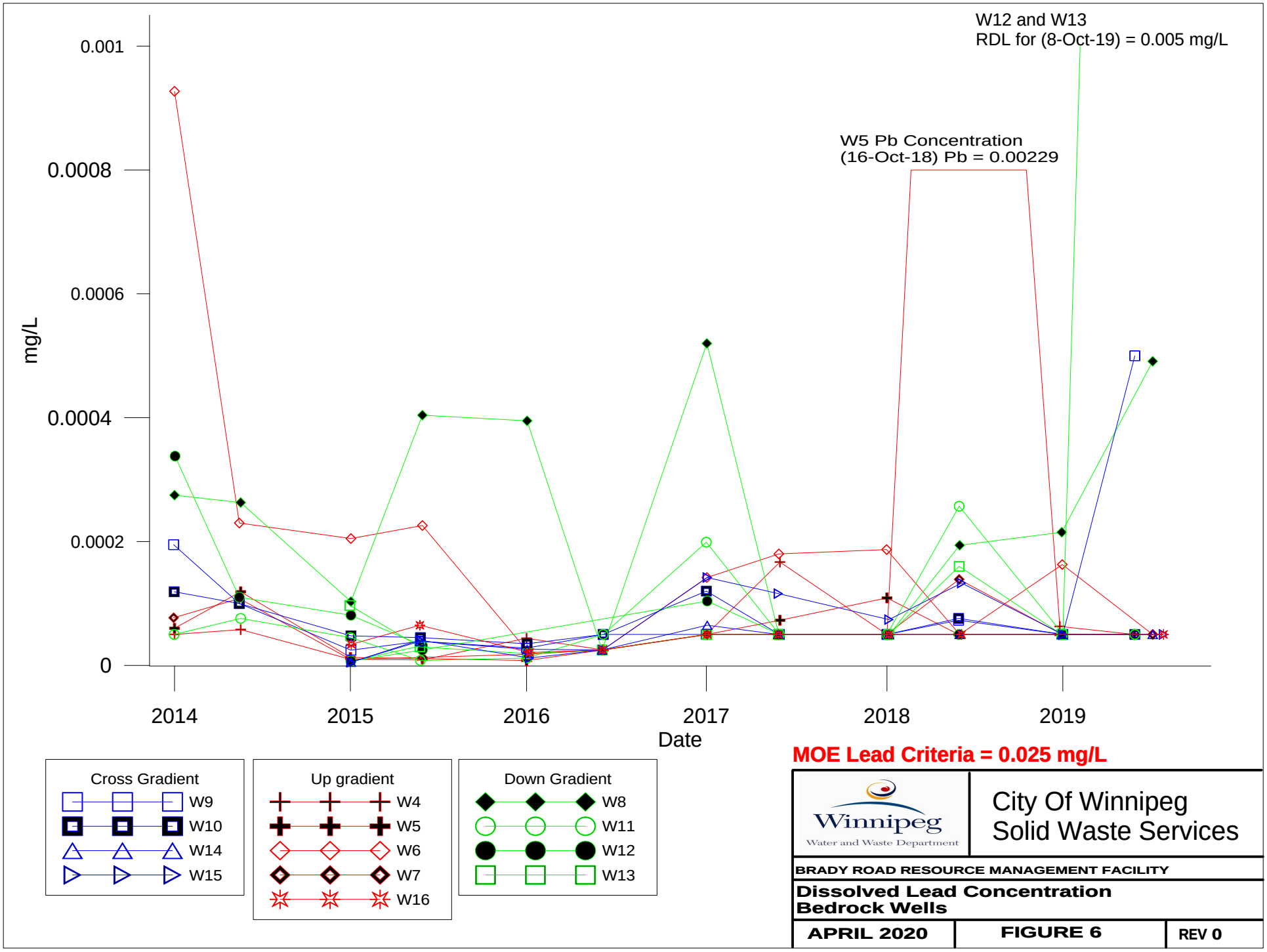
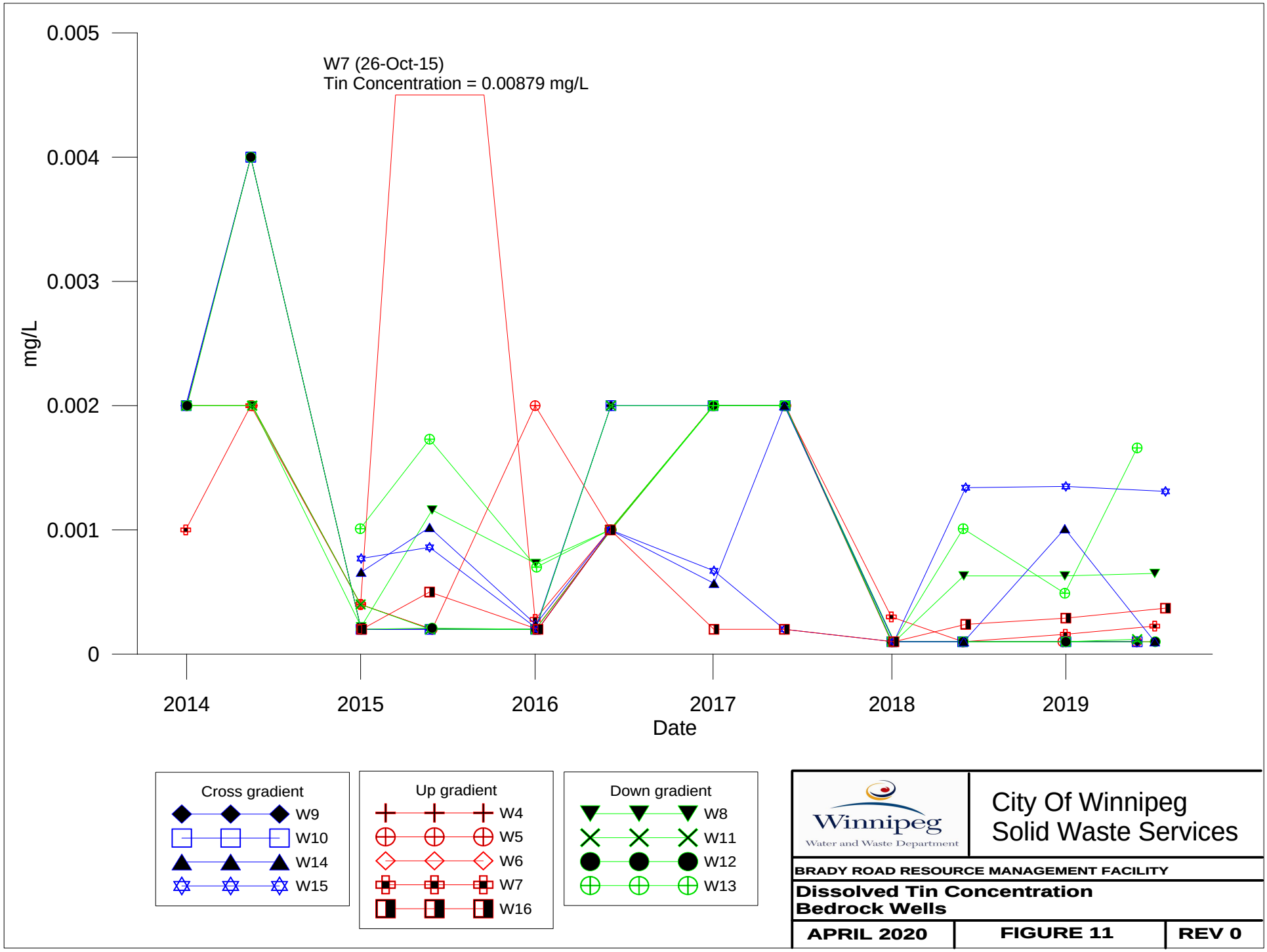
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Phosphorus Concentration
Bedrock Wells

APRIL 2020	FIGURE 10	REV 0


W12 and W13
RDL for (8-Oct-19) = 0.005 mg/L
W5 Pb Concentration
(16-Oct-18) Pb = 0.00229
0.001
0.0008
0.0006
0.0004
0.0002
0
mg/L
2014
2015
2016
2017
2018
2019
Date
Cross Gradient
W9
W10
W14
W15
Up gradient
W4
W5
W6
W7
W16
Down Gradient
W8
W11
W12
W13
MOE Lead Criteria = 0.025 mg/L
Winnipeg
Water and Waste Department
City Of Winnipeg
Solid Waste Services
BRADY ROAD RESOURCE MANAGEMENT FACILITY
Dissolved Lead Concentration
Bedrock Wells
APRIL 2020
FIGURE 6
REV 0



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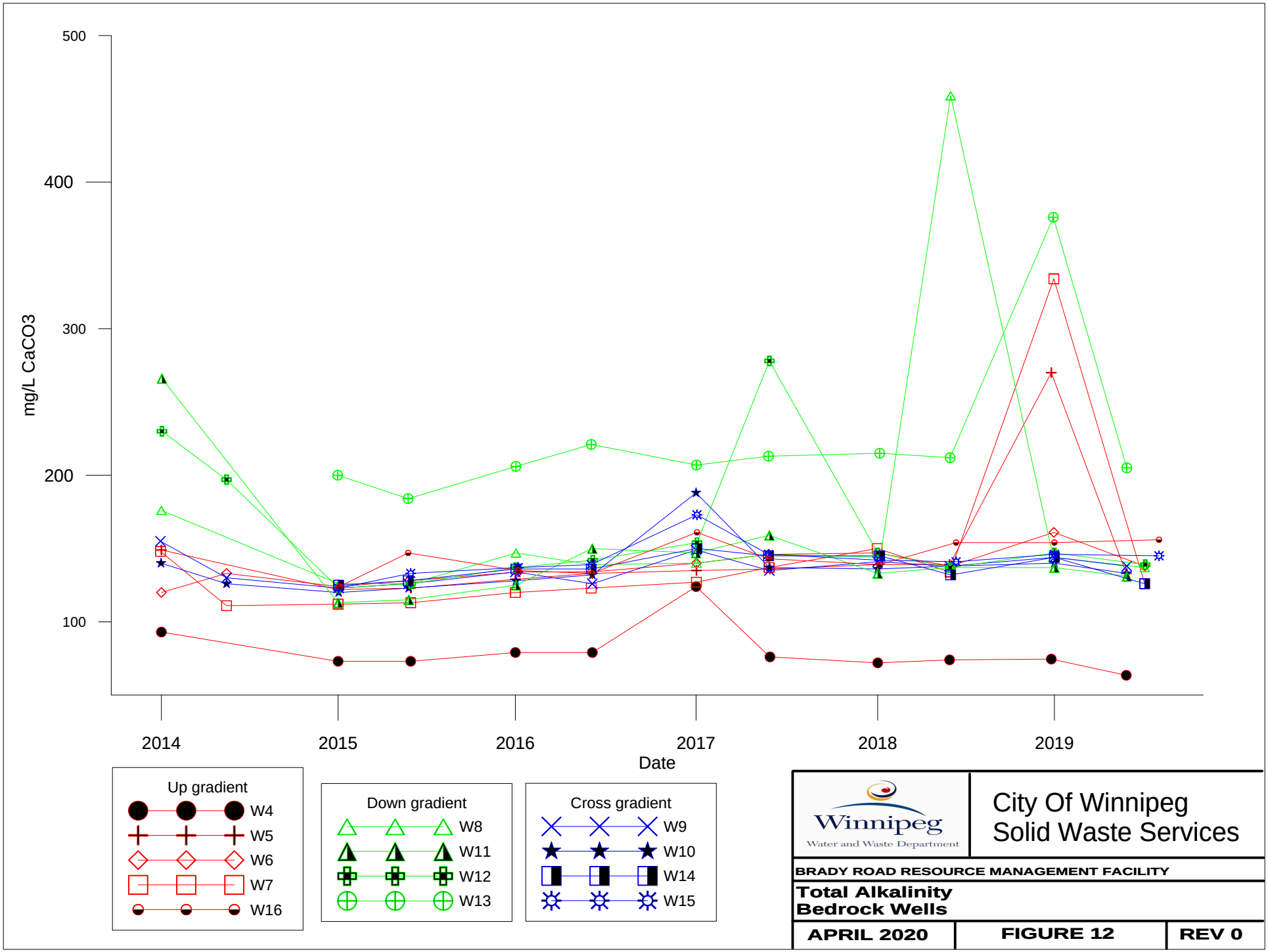
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Tin Concentration
Bedrock Wells

APRIL 2020	FIGURE 11	REV 0



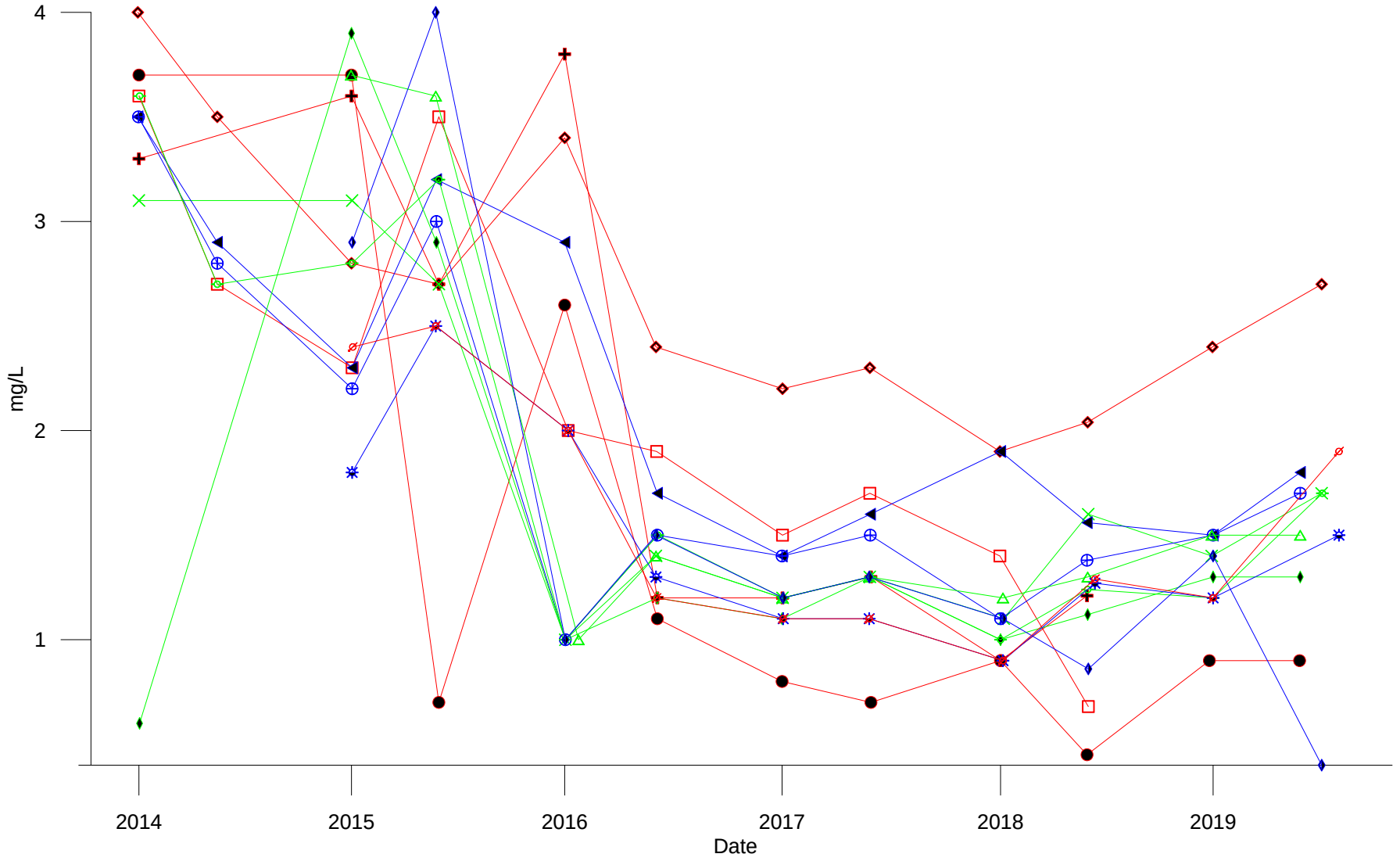
Winnipeg
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Total Alkalinity
Bedrock Wells

APRIL 2020	FIGURE 12	REV 0



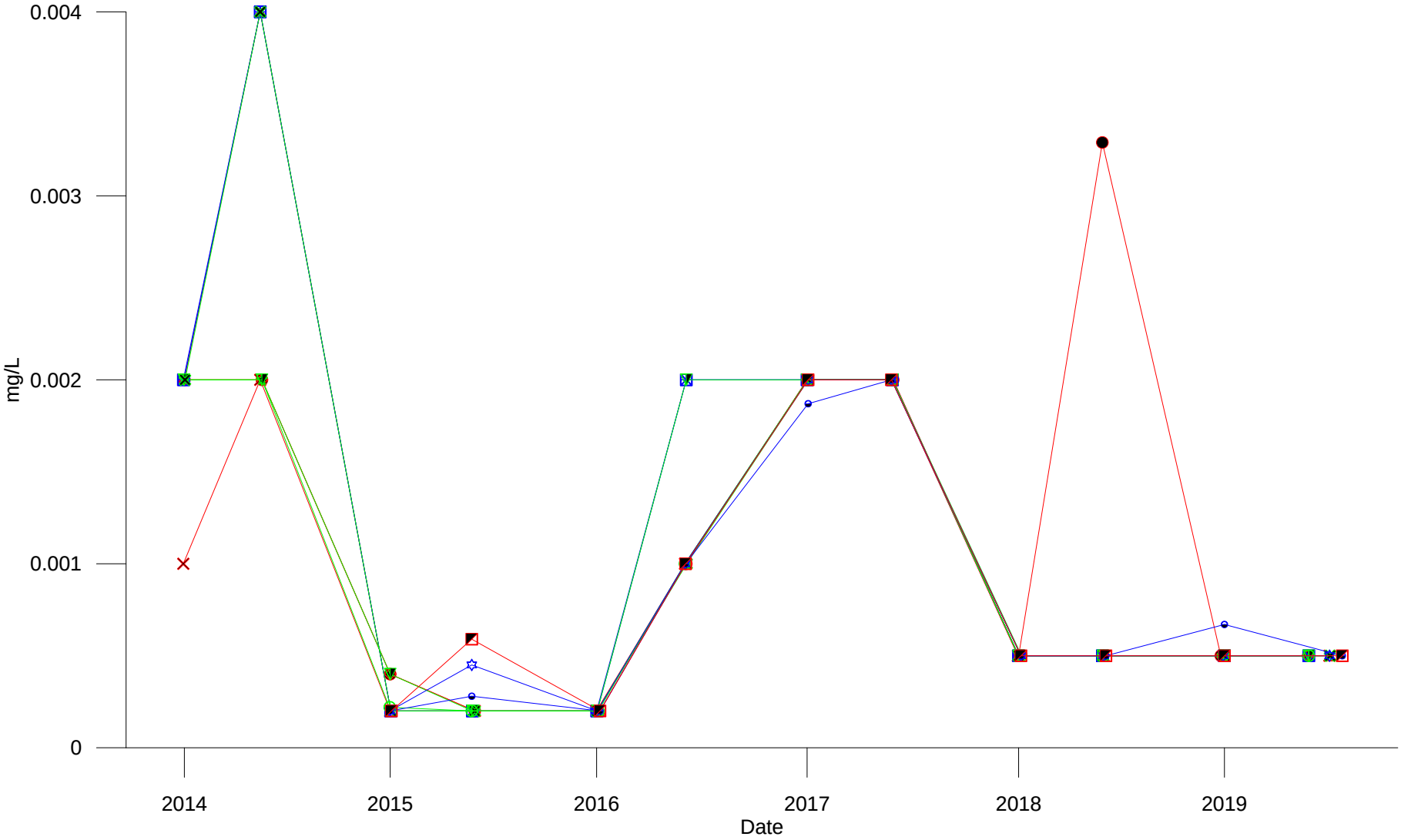
Winnipeg
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

TKN Concentration
Bedrock Wells

APRIL 2020	FIGURE 12	REV 0



Cross gradient
W9
W10
W14
W15

Up gradient
W4
W5
W6
W7
W16

Down gradient
W8
W11
W12
W13

Vanadium MOE Criteria = 0.25 mg/L

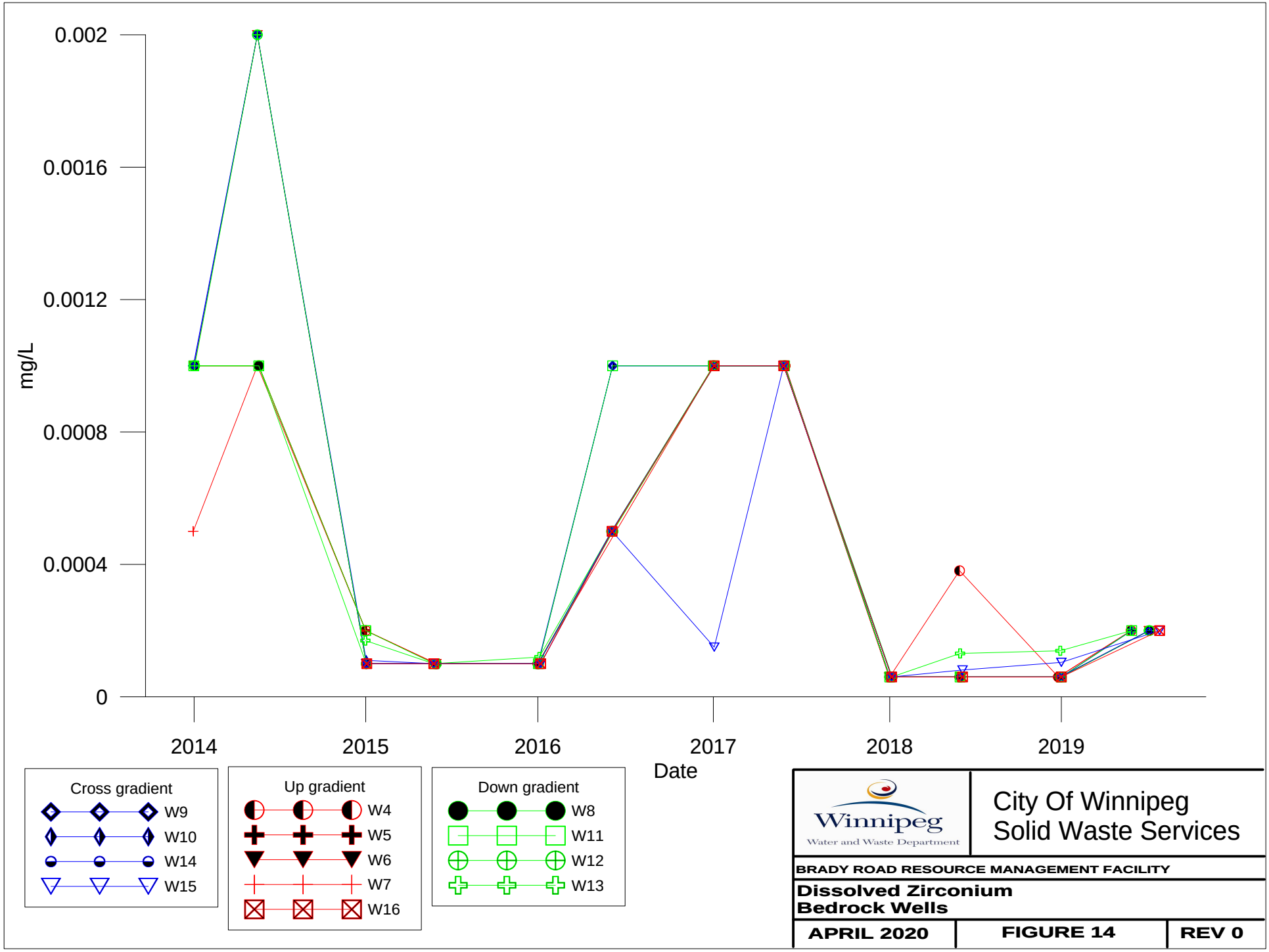
Winnipeg
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Vanadium
Bedrock Wells

APRIL 2020	FIGURE 13	REV 0



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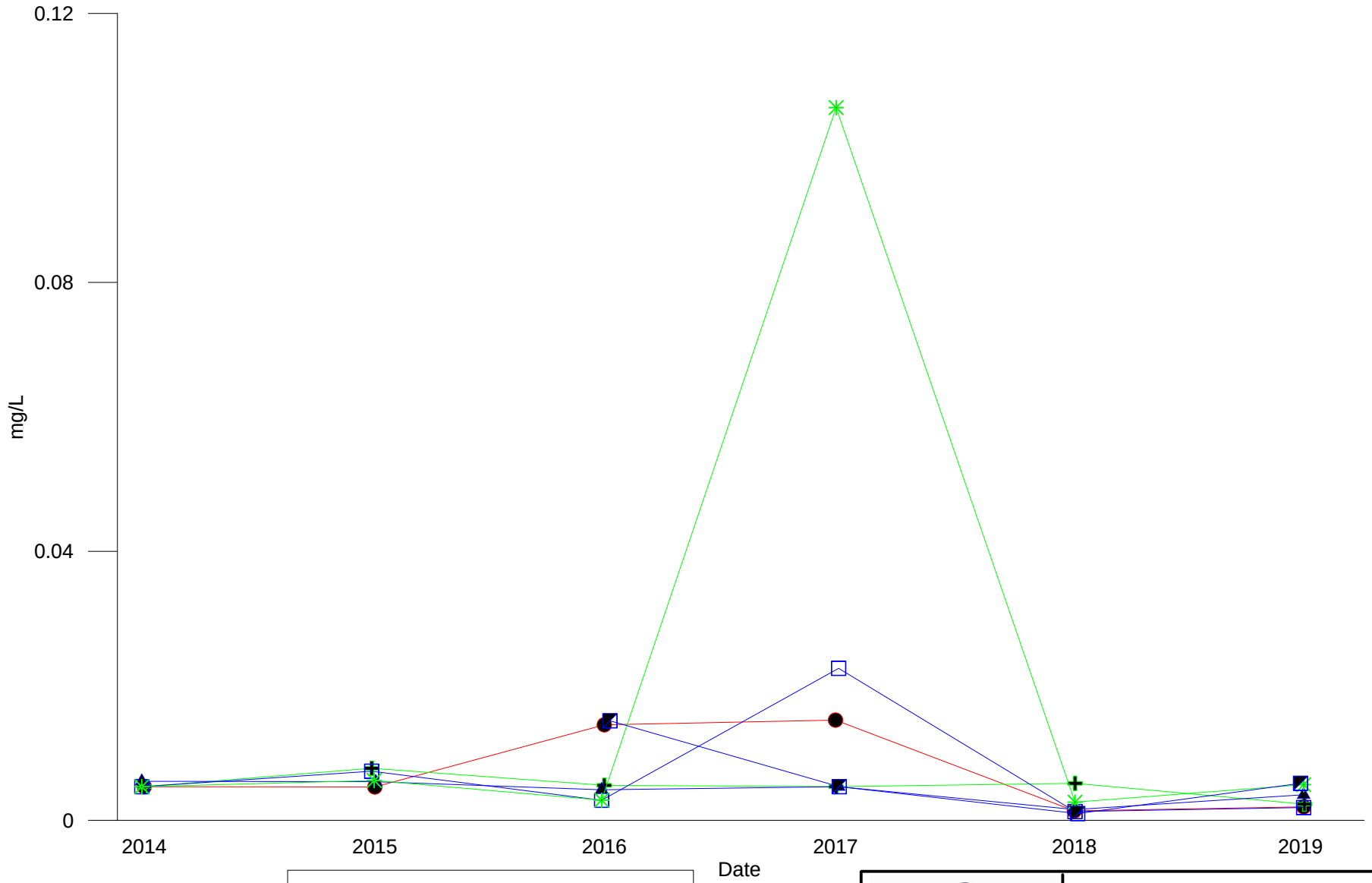
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Zirconium
Bedrock Wells

APRIL 2020	FIGURE 14	REV 0



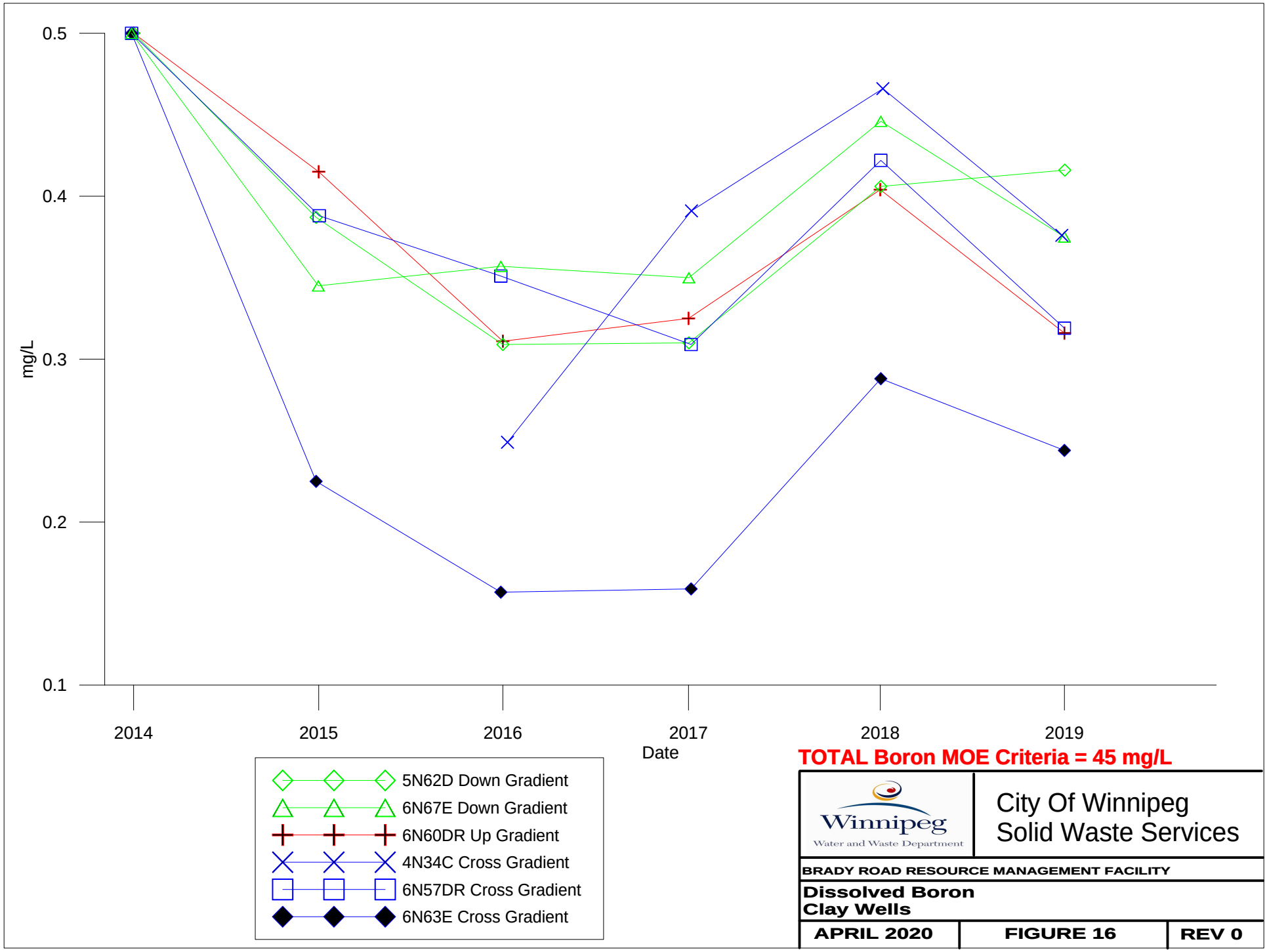
Winnipeg
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Aluminium
Clay Wells

APRIL 2020	FIGURE 15	REV 0



TOTAL Boron MOE Criteria = 45 mg/L

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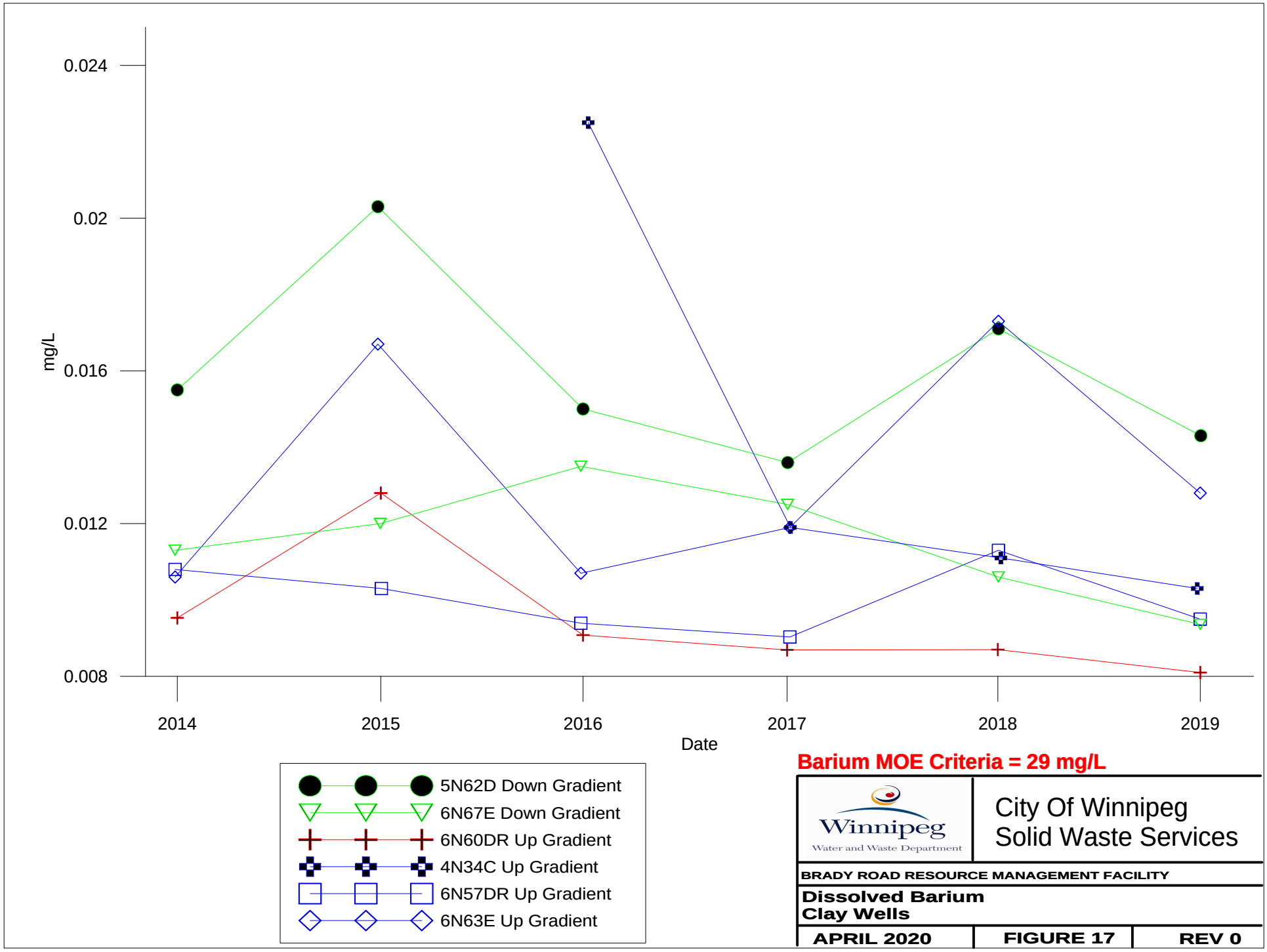
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Boron
Clay Wells

APRIL 2020	FIGURE 16	REV 0



Barium MOE Criteria = 29 mg/L

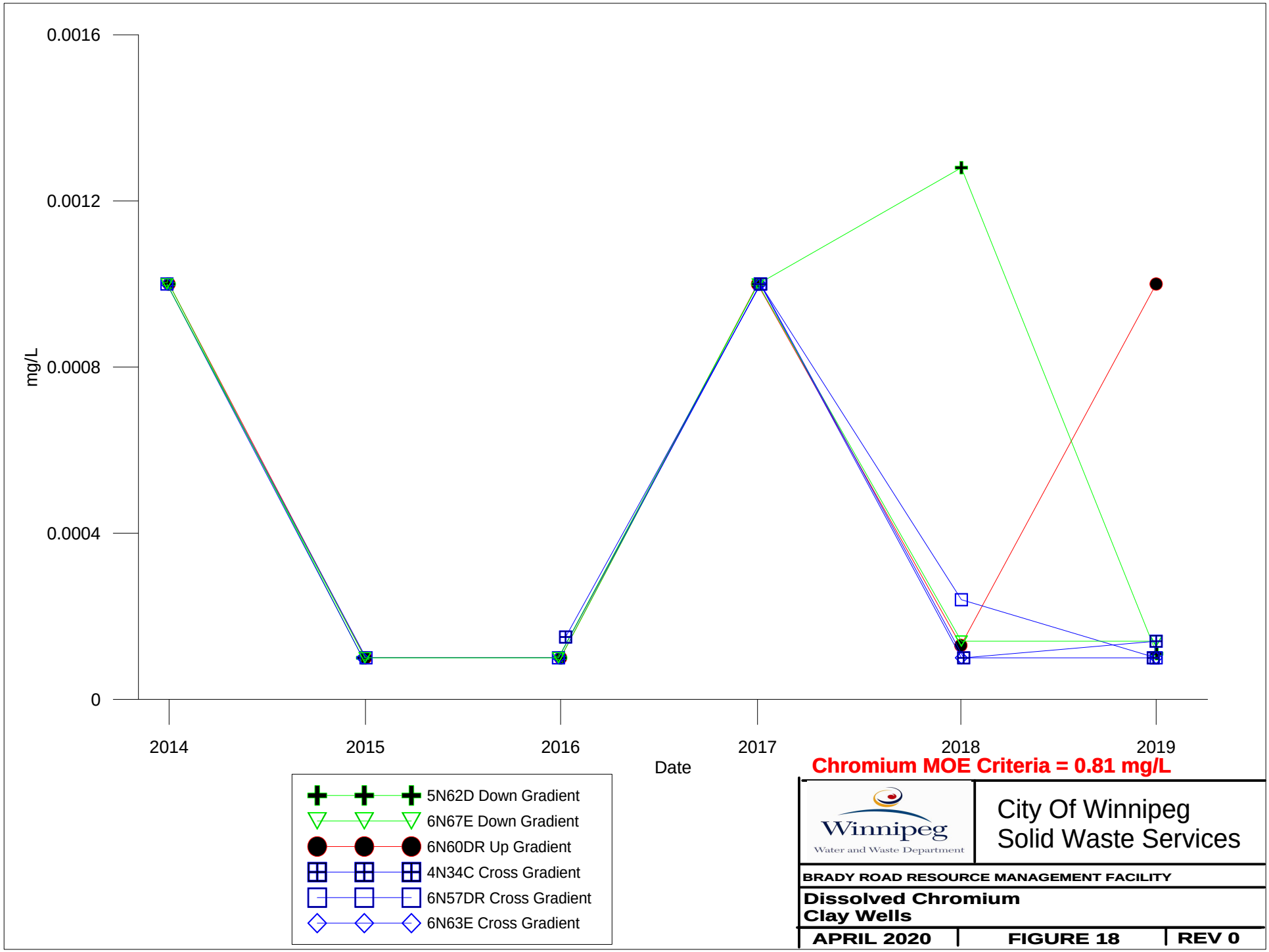
Winnipeg Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Barium
Clay Wells

APRIL 2020	FIGURE 17	REV 0



Chromium MOE Criteria = 0.81 mg/L

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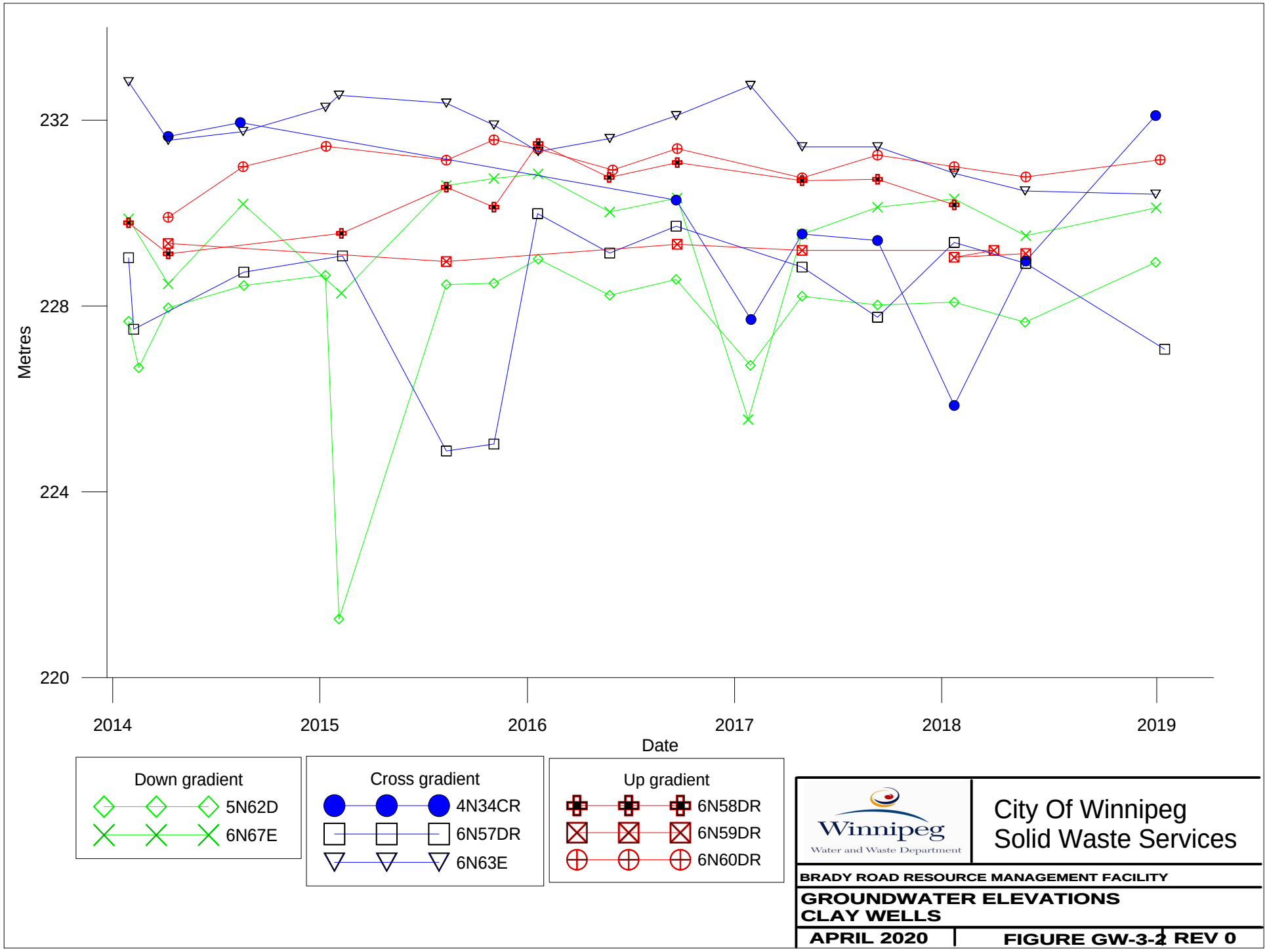
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Chromium
Clay Wells

APRIL 2020	FIGURE 18	REV 0



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Water and Waste Department

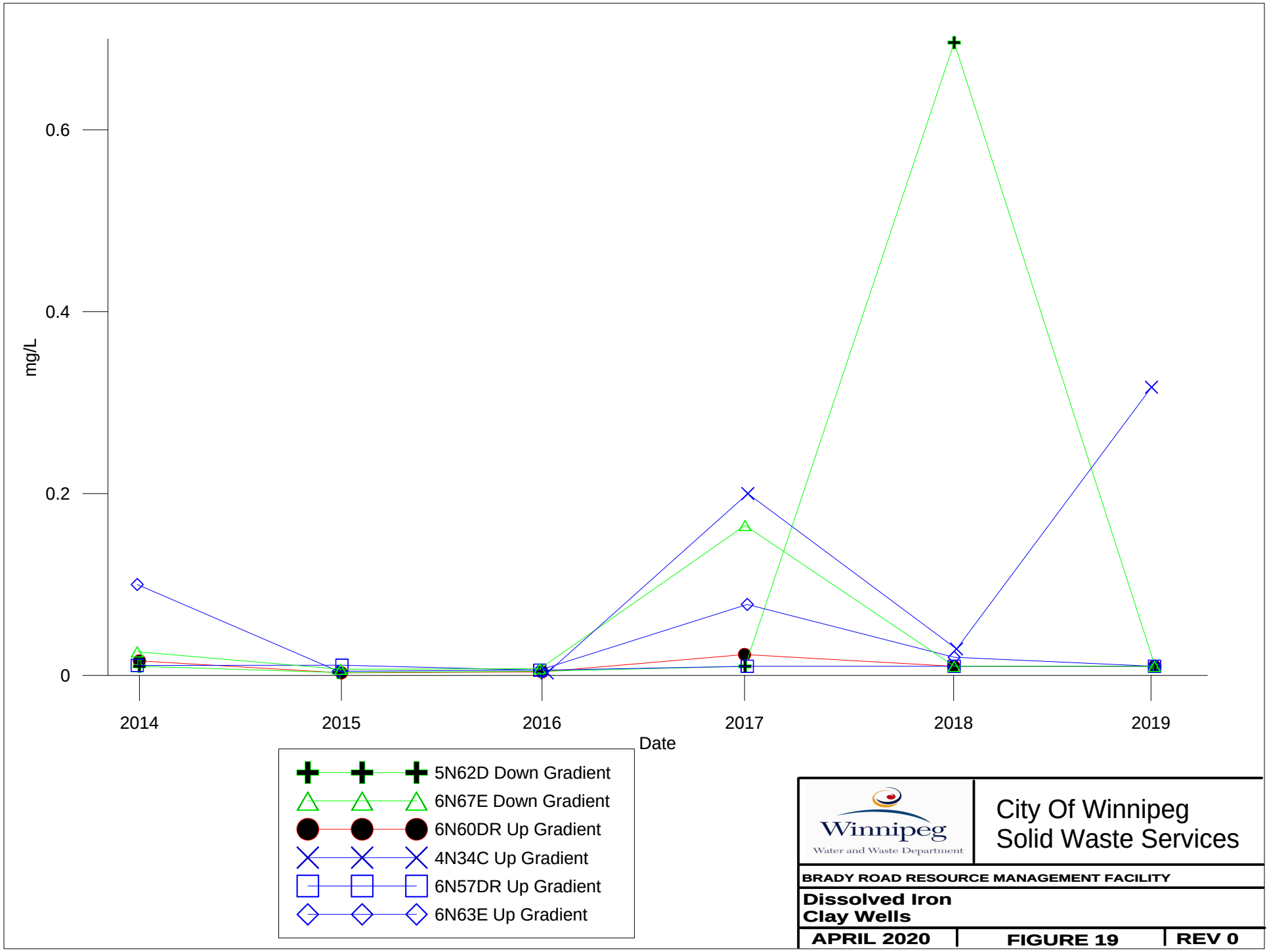
City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

GROUNDWATER ELEVATIONS
CLAY WELLS

APRIL 2020

FIGURE GW-3-2 REV 0



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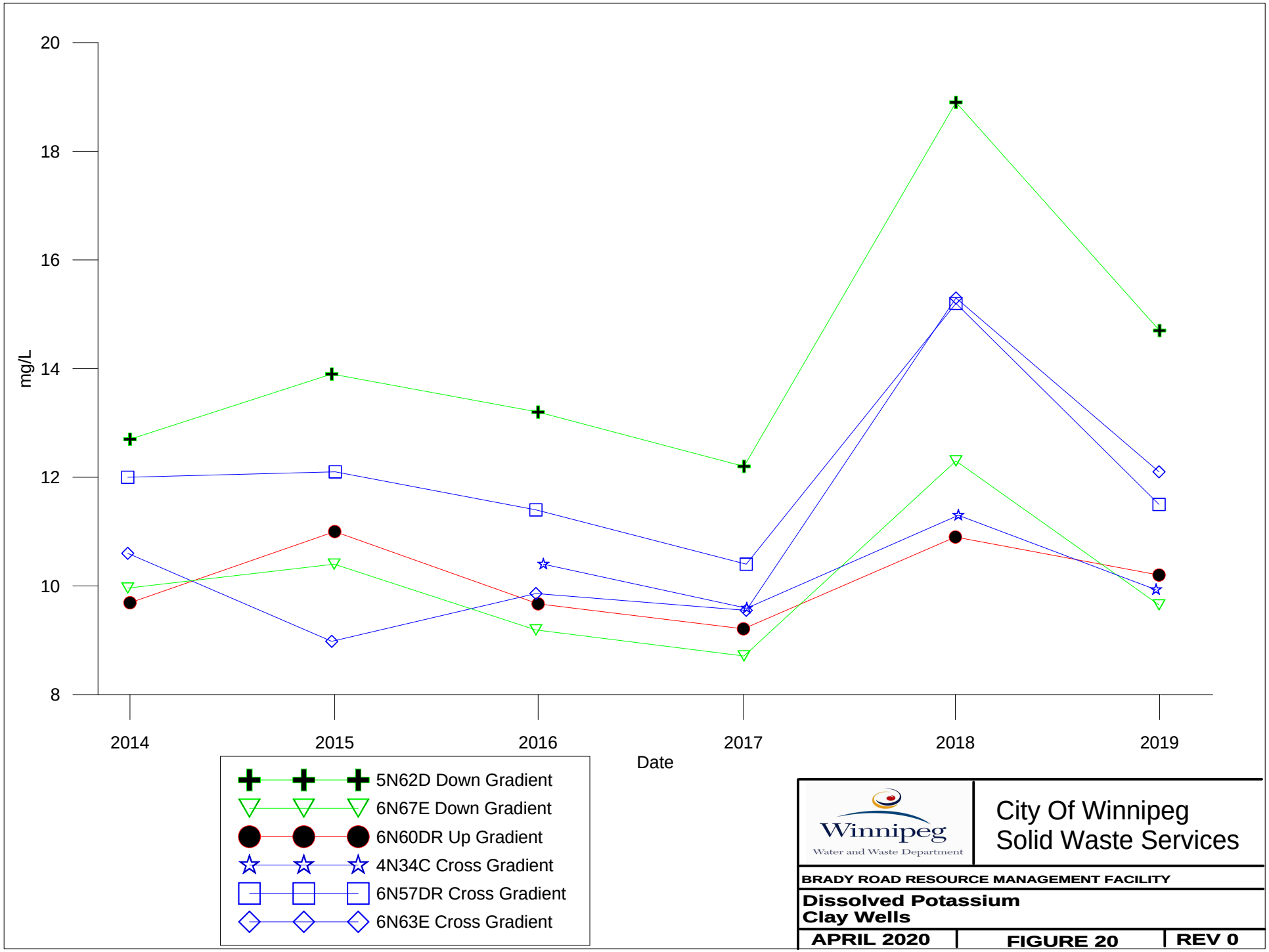
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Iron
Clay Wells

APRIL 2020	FIGURE 19	REV 0



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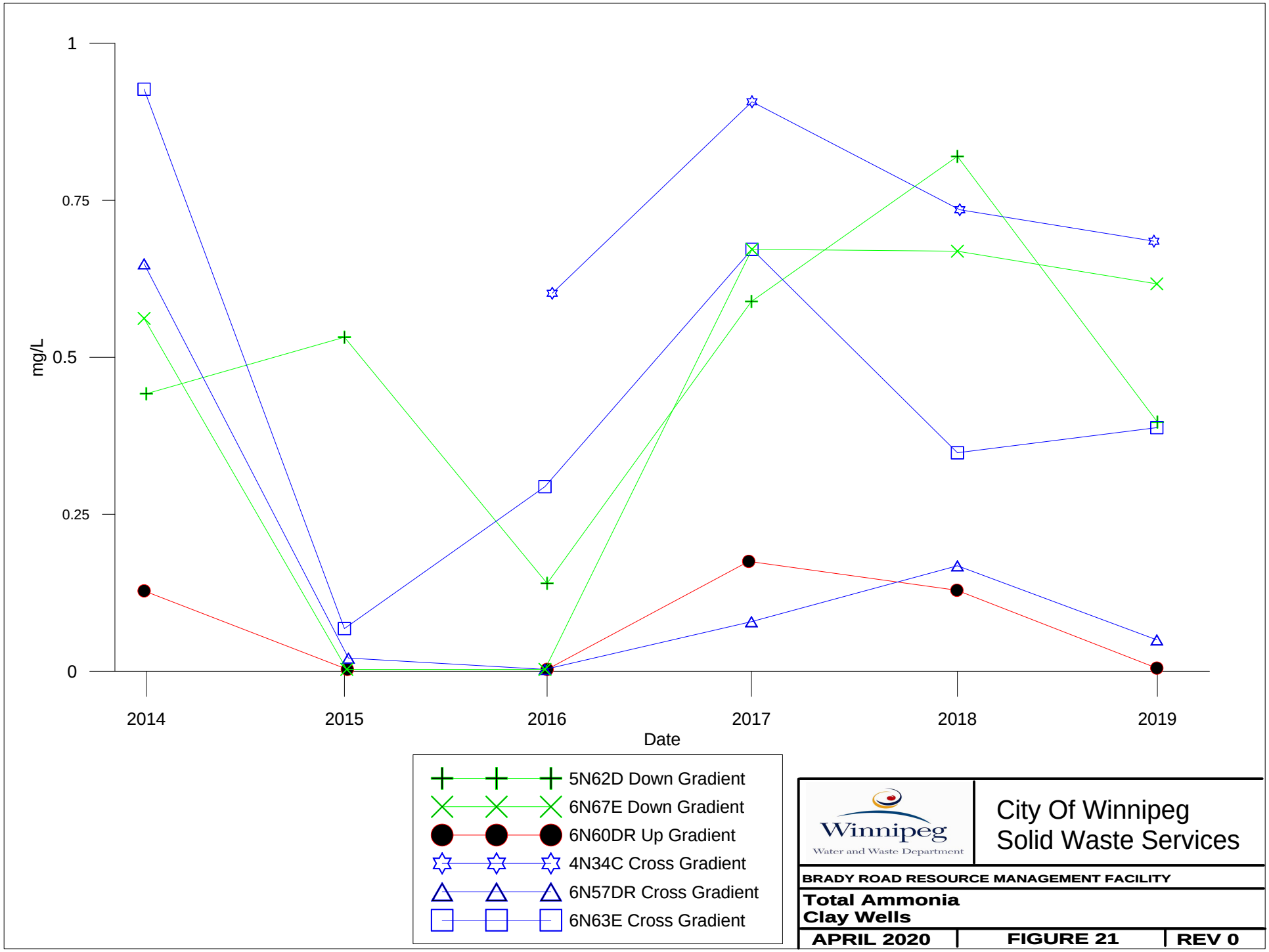
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Potassium
Clay Wells

APRIL 2020	FIGURE 20	REV 0



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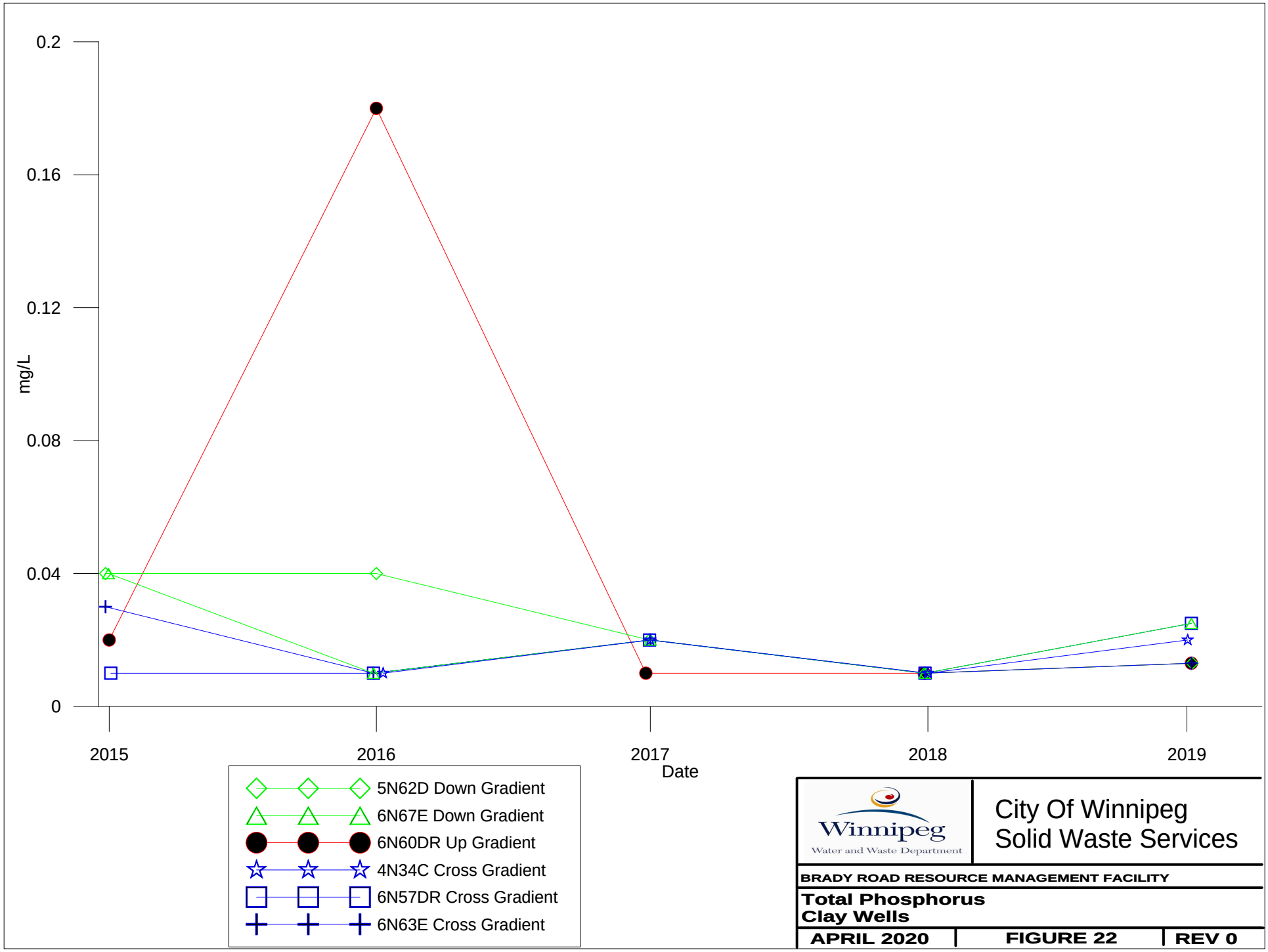
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Total Ammonia
Clay Wells

APRIL 2020	FIGURE 21	REV 0



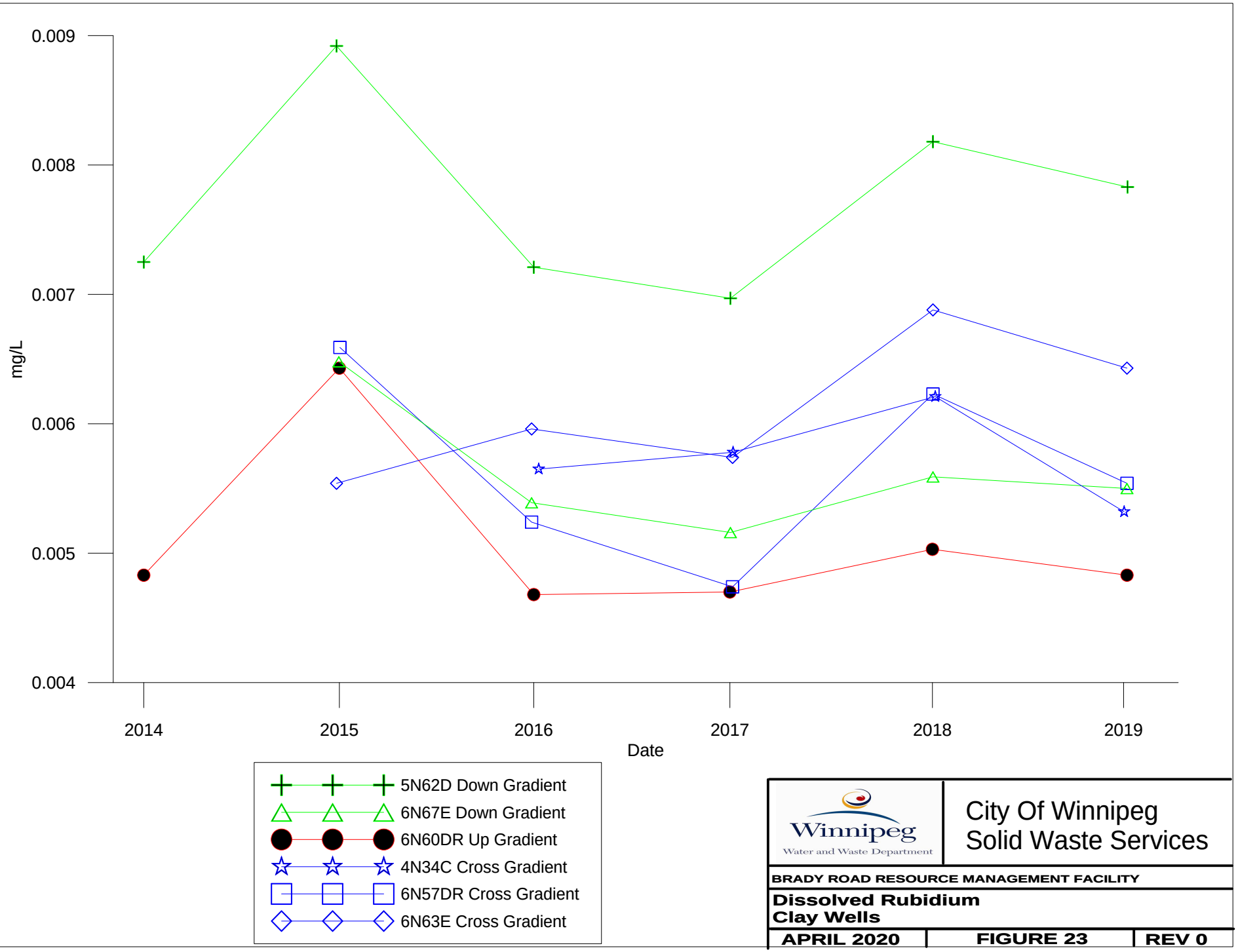
Winnipeg
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Total Phosphorus
Clay Wells

APRIL 2020	FIGURE 22	REV 0



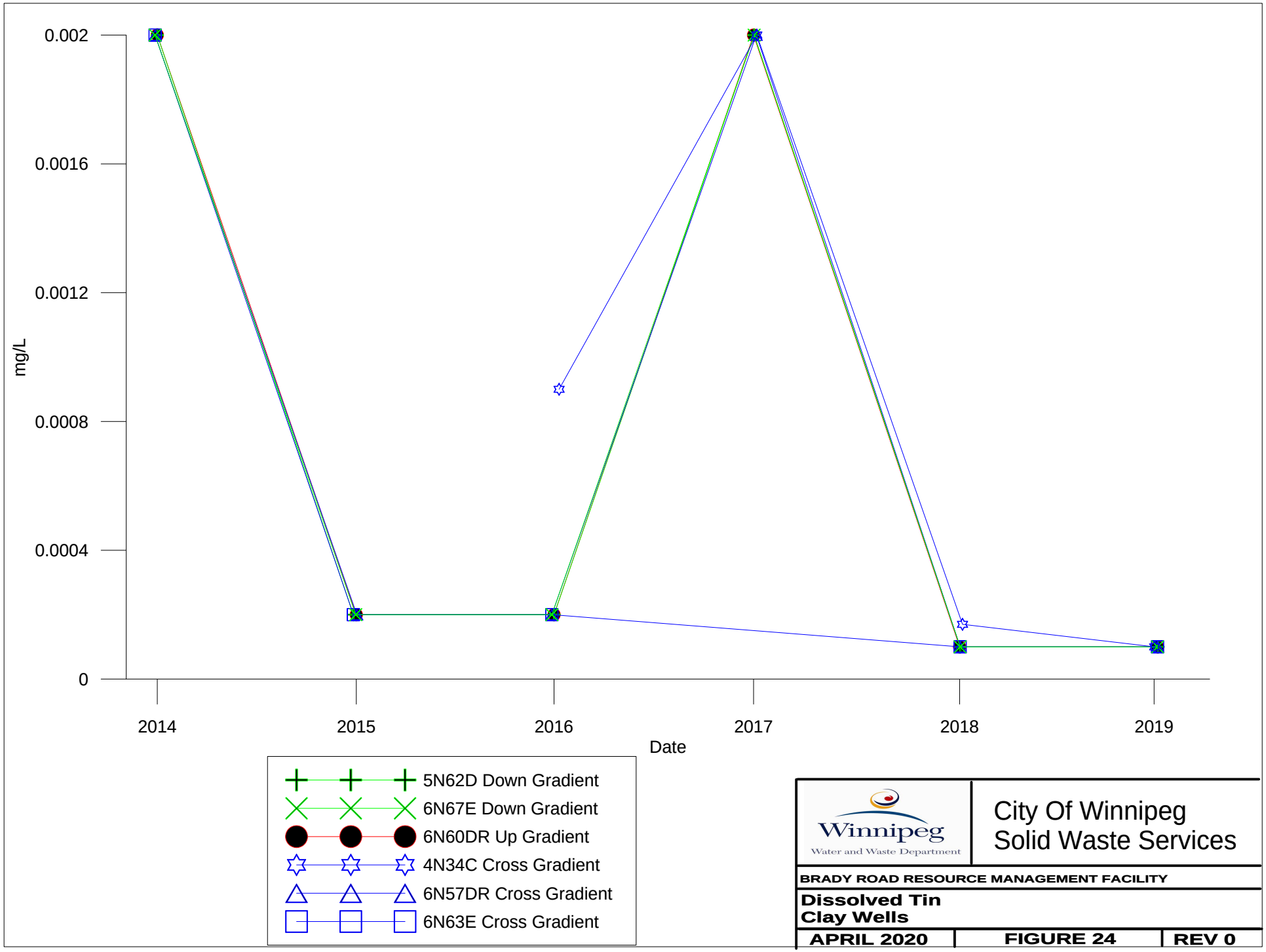
Winnipeg
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Rubidium
Clay Wells

APRIL 2020	FIGURE 23	REV 0



Winnipeg
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Tin
Clay Wells

APRIL 2020	FIGURE 24	REV 0

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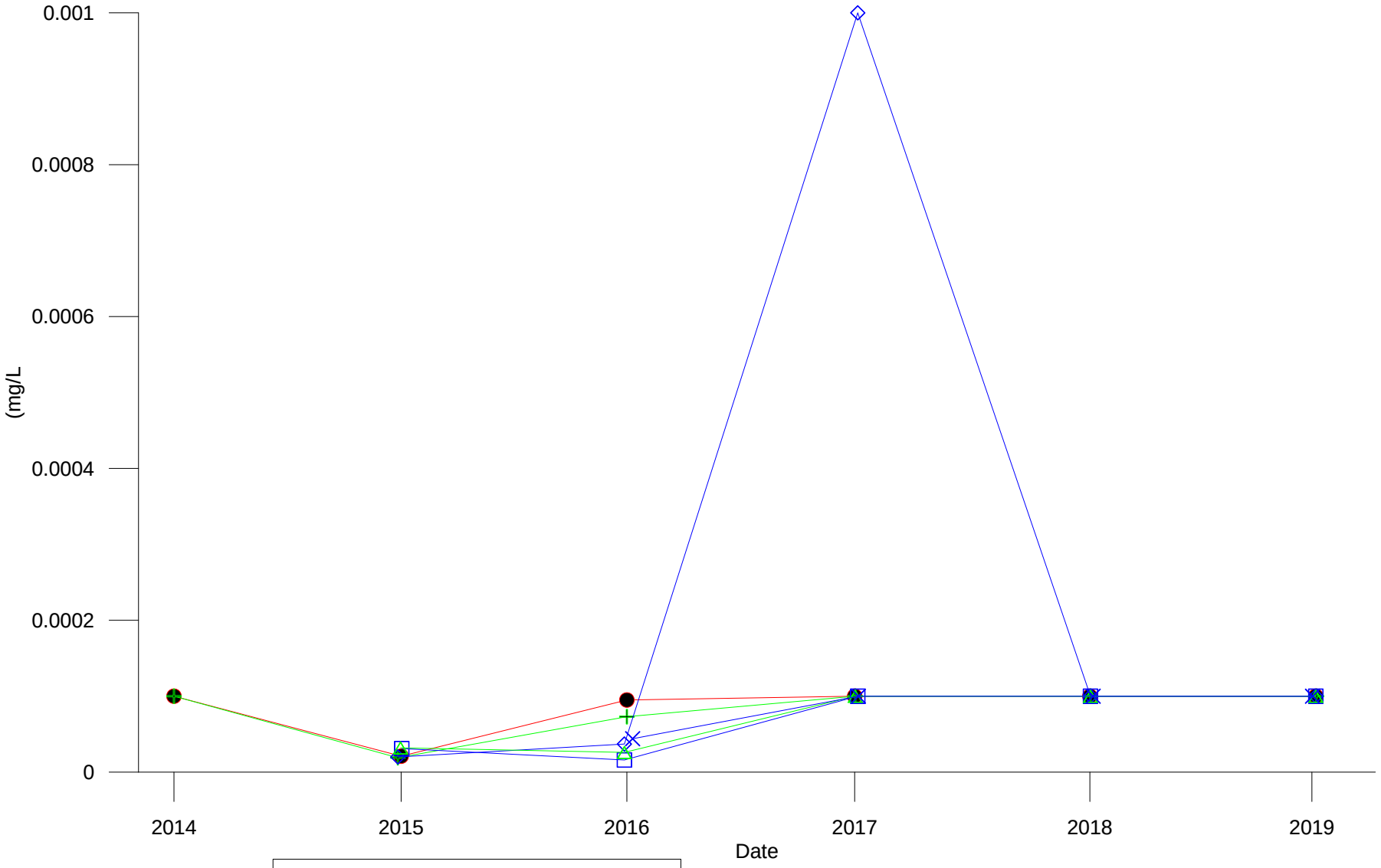
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Total Kjeldahl Nitrogen
Clay Wells

APRIL 2020	FIGURE 25	REV 0



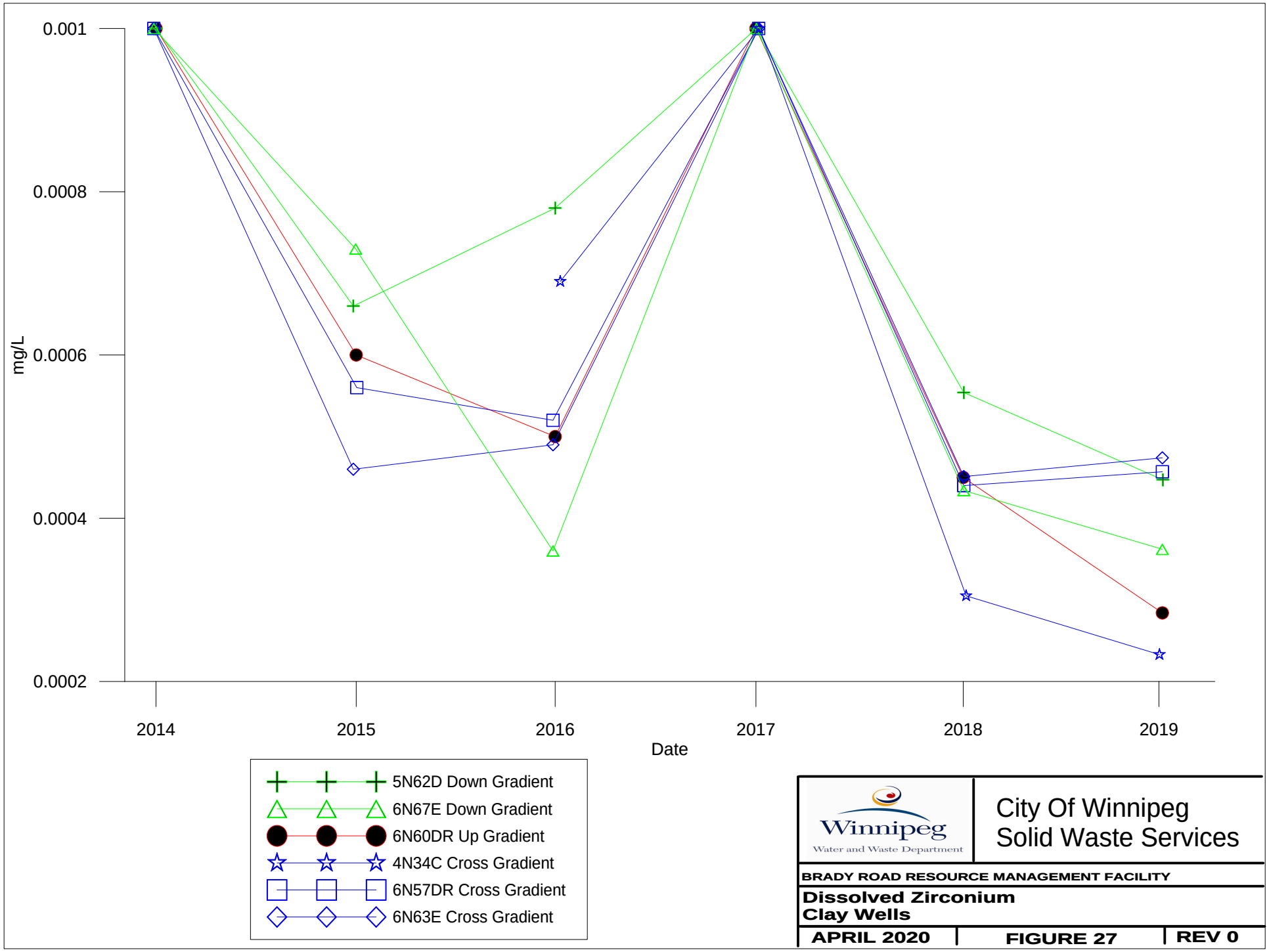
Winnipeg
Water and Waste Department

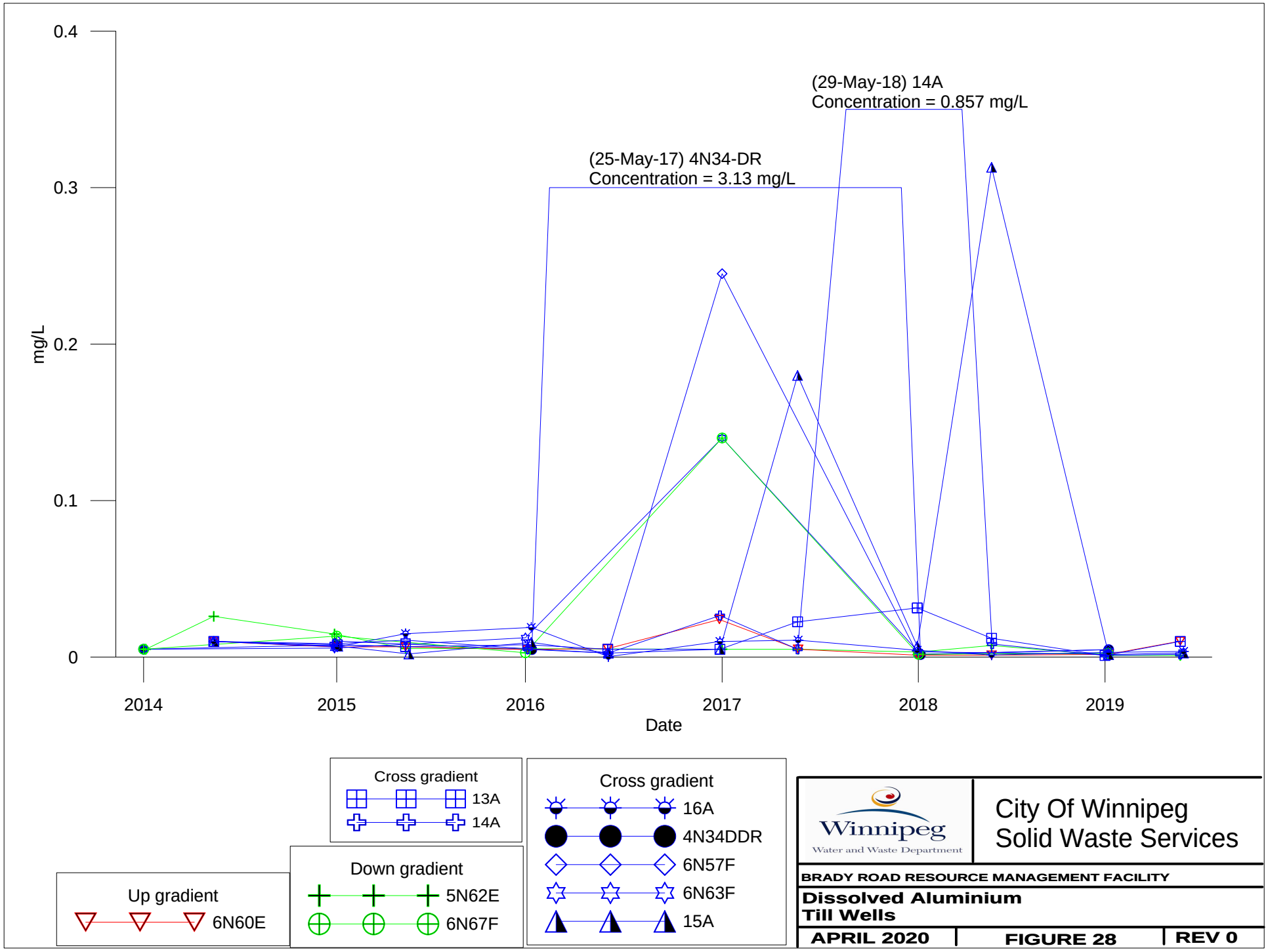
City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Tungsten
Clay Wells

APRIL 2020	FIGURE 26	REV 0


0.001
0.0008
0.0006
0.0004
0.0002
mg/L
2014
2015
2016
2017
2018
2019
Date
5N62D Down Gradient
6N67E Down Gradient
6N60DR Up Gradient
4N34C Cross Gradient
6N57DR Cross Gradient
6N63E Cross Gradient
Winnipeg
Water and Waste Department
City Of Winnipeg
Solid Waste Services
BRADY ROAD RESOURCE MANAGEMENT FACILITY
Dissolved Zirconium
Clay Wells
APRIL 2020
FIGURE 27
REV 0



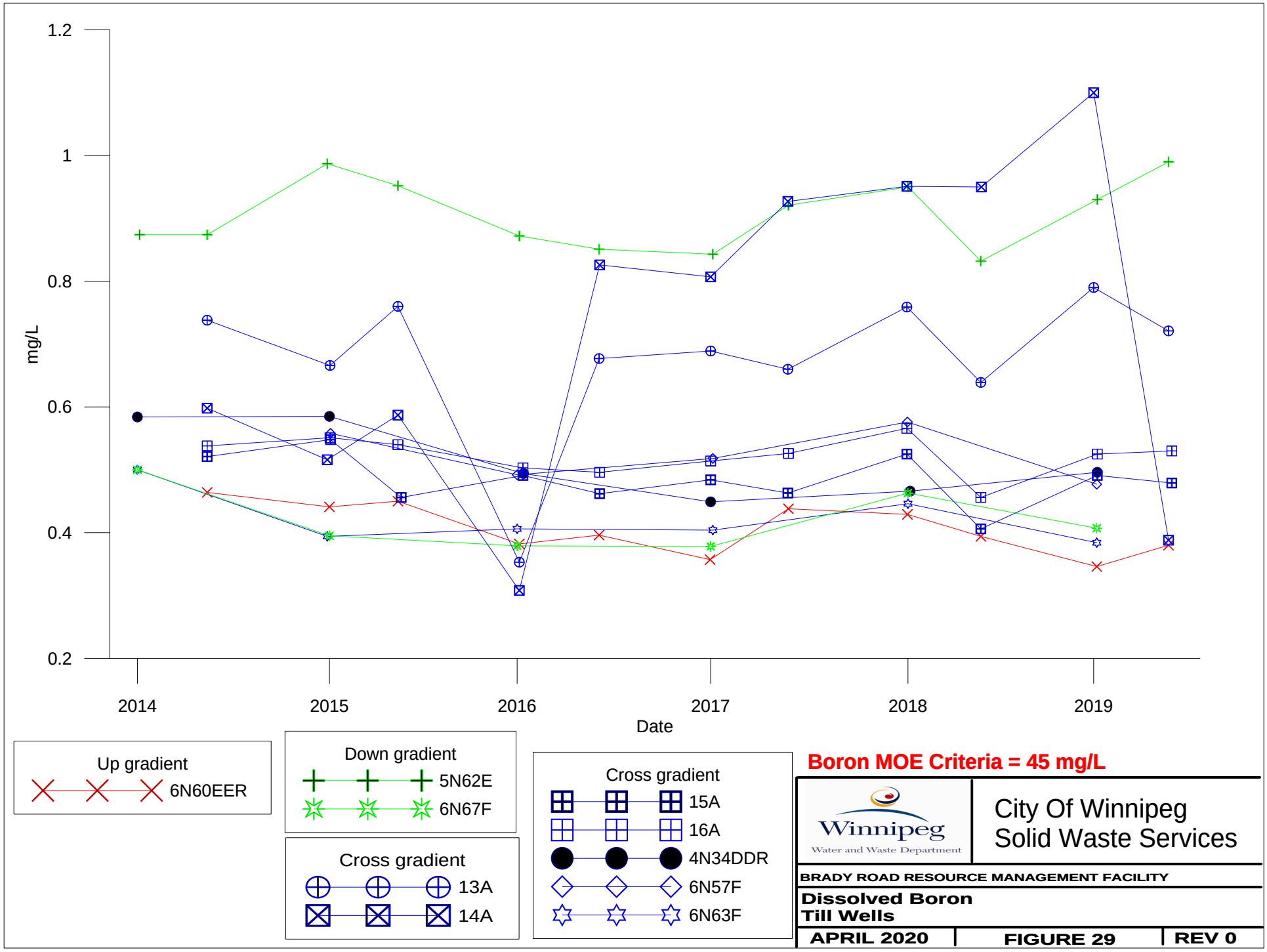
Winnipeg
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Aluminium
Till Wells

APRIL 2020	FIGURE 28	REV 0



Boron MOE Criteria = 45 mg/L

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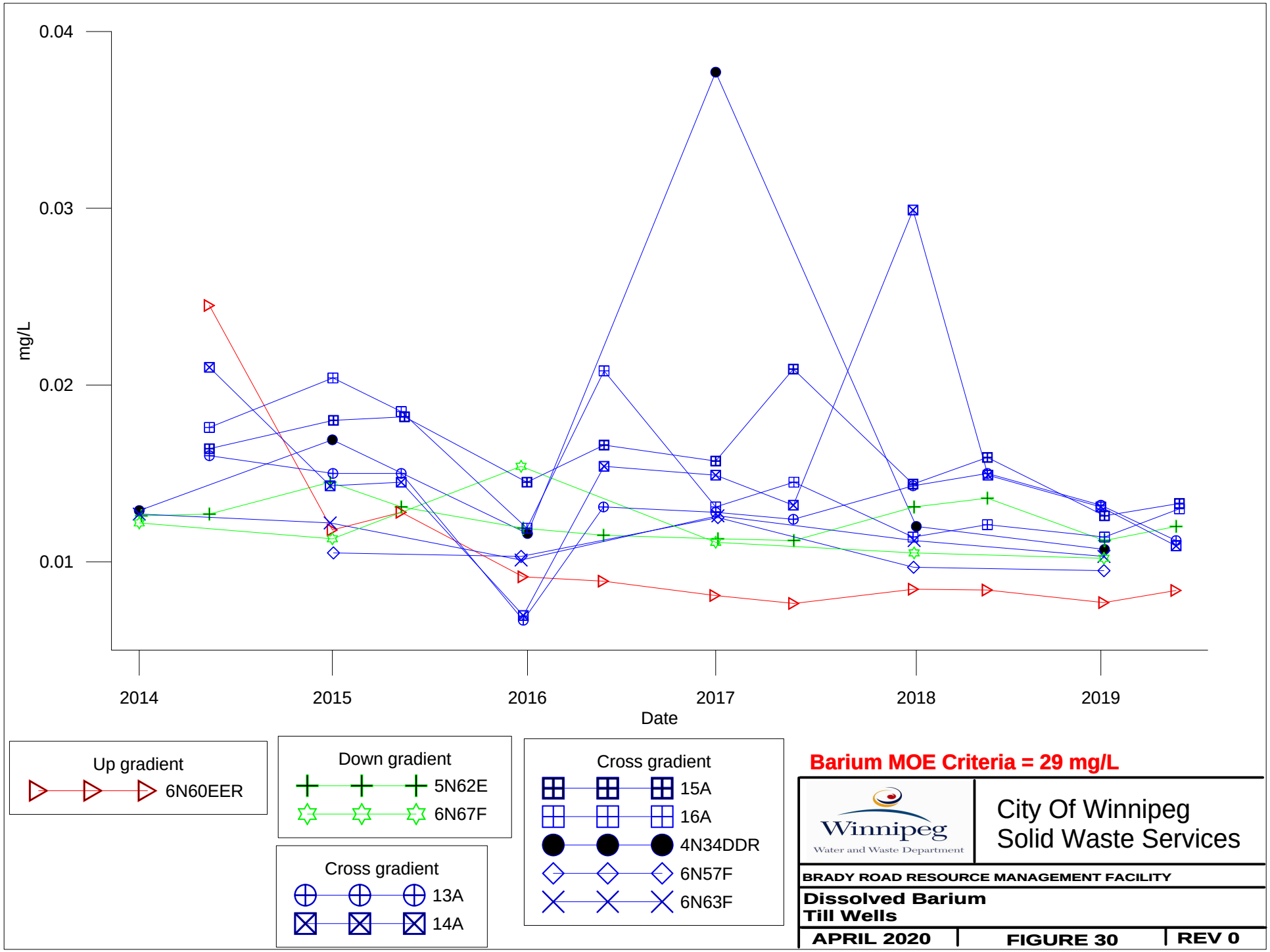
Water and Waste Department

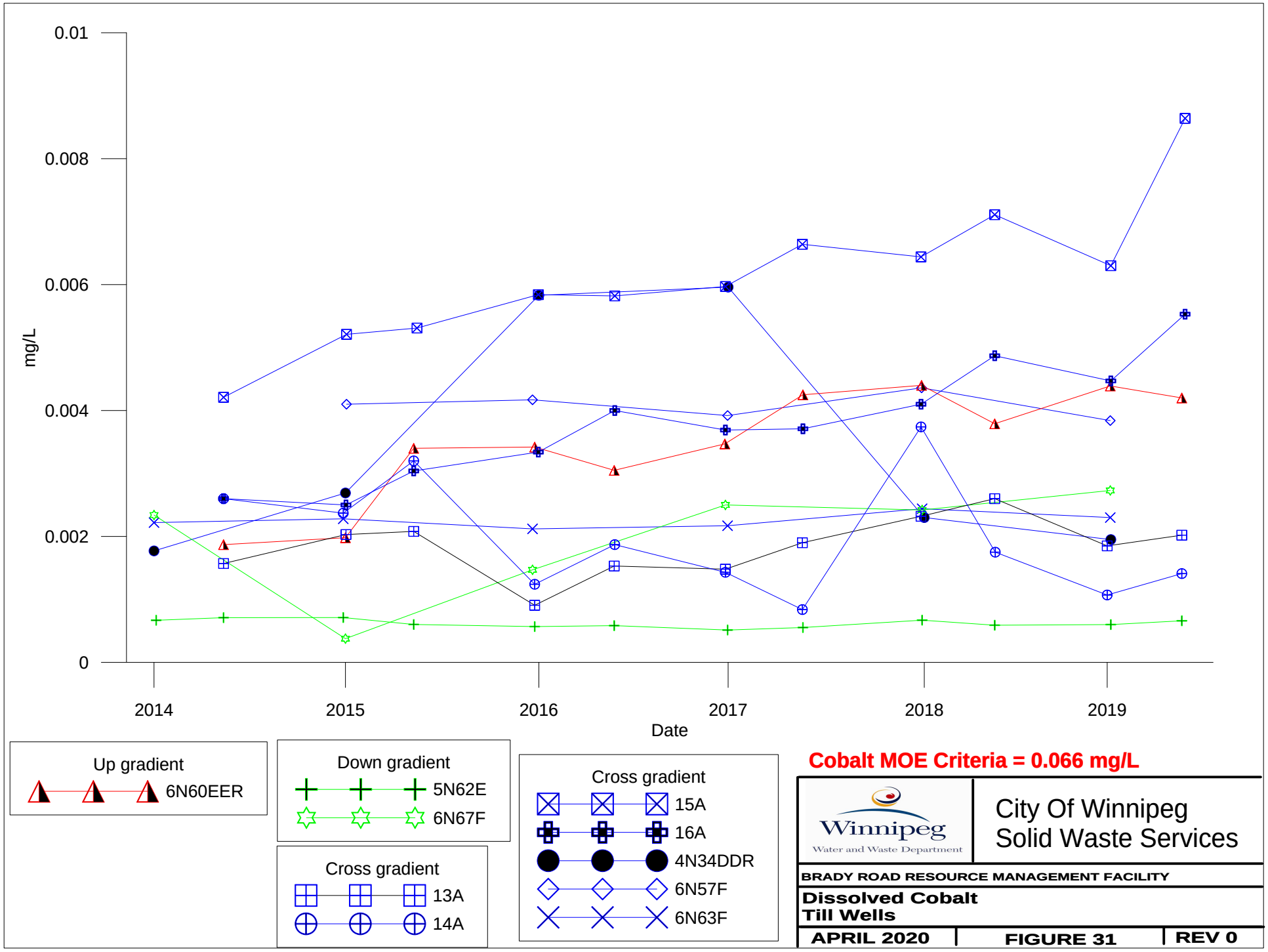
City Of Winnipeg
Solid Waste Services

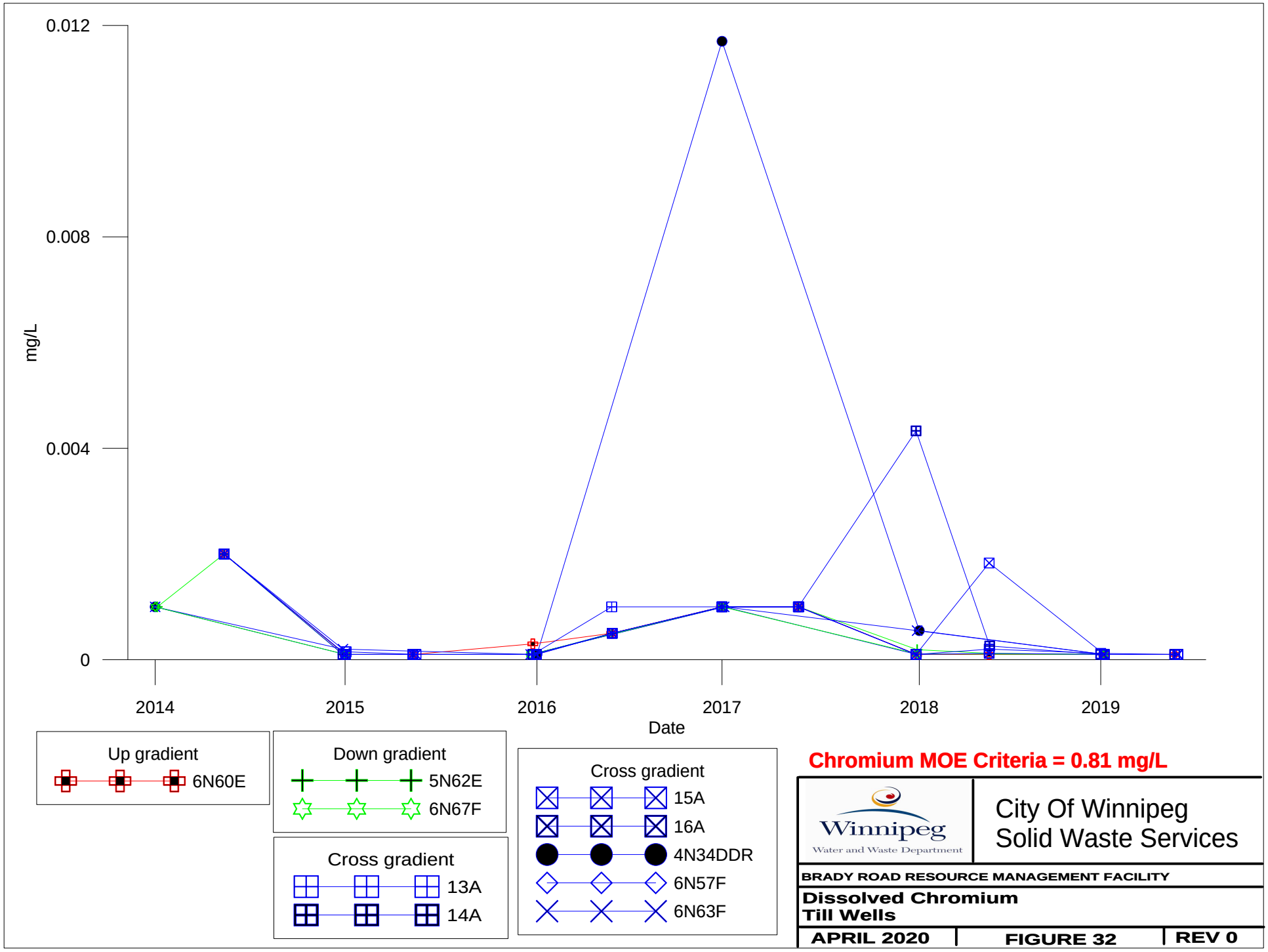
BRADY ROAD RESOURCE MANAGEMENT FACILITY

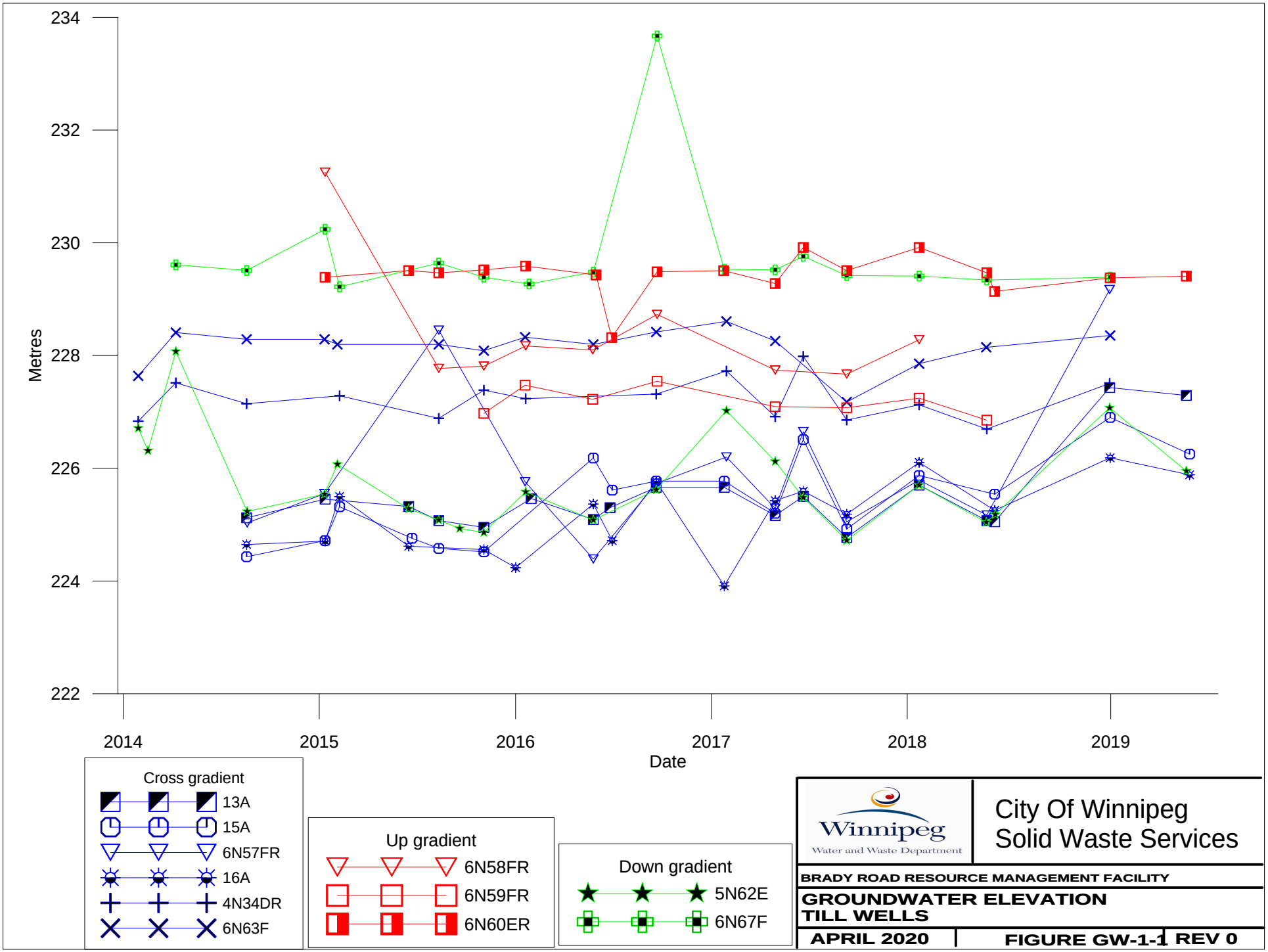
Dissolved Boron
Till Wells

APRIL 2020	FIGURE 29	REV 0


0.04
0.03
0.02
0.01
mg/L
2014
2015
2016
2017
2018
2019
Date
Up gradient
6N60EER
Down gradient
5N62E
6N67F
Cross gradient
13A
14A
Cross gradient
15A
16A
4N34DDR
6N57F
6N63F
Barium MOE Criteria = 29 mg/L
Winnipeg
Water and Waste Department
City Of Winnipeg
Solid Waste Services
BRADY ROAD RESOURCE MANAGEMENT FACILITY
Dissolved Barium
Till Wells
APRIL 2020
FIGURE 30
REV 0


0.01
0.008
0.006
0.004
0.002
0
mg/L
2014
2015
2016
2017
2018
2019
Date
Up gradient
6N60EER
Down gradient
5N62E
6N67F
Cross gradient
13A
14A
Cross gradient
15A
16A
4N34DDR
6N57F
6N63F
Cobalt MOE Criteria = 0.066 mg/L
Winnipeg
Water and Waste Department
City Of Winnipeg
Solid Waste Services
BRADY ROAD RESOURCE MANAGEMENT FACILITY
Dissolved Cobalt
Till Wells
APRIL 2020
FIGURE 31
REV 0


0.012
0.008
0.004
0
mg/L
2014
2015
2016
2017
2018
2019
Date
Up gradient
6N60E
Down gradient
5N62E
6N67F
Cross gradient
13A
14A
Cross gradient
15A
16A
4N34DDR
6N57F
6N63F
Chromium MOE Criteria = 0.81 mg/L
Winnipeg
Water and Waste Department
City Of Winnipeg
Solid Waste Services
BRADY ROAD RESOURCE MANAGEMENT FACILITY
Dissolved Chromium
Till Wells
APRIL 2020
FIGURE 32
REV 0



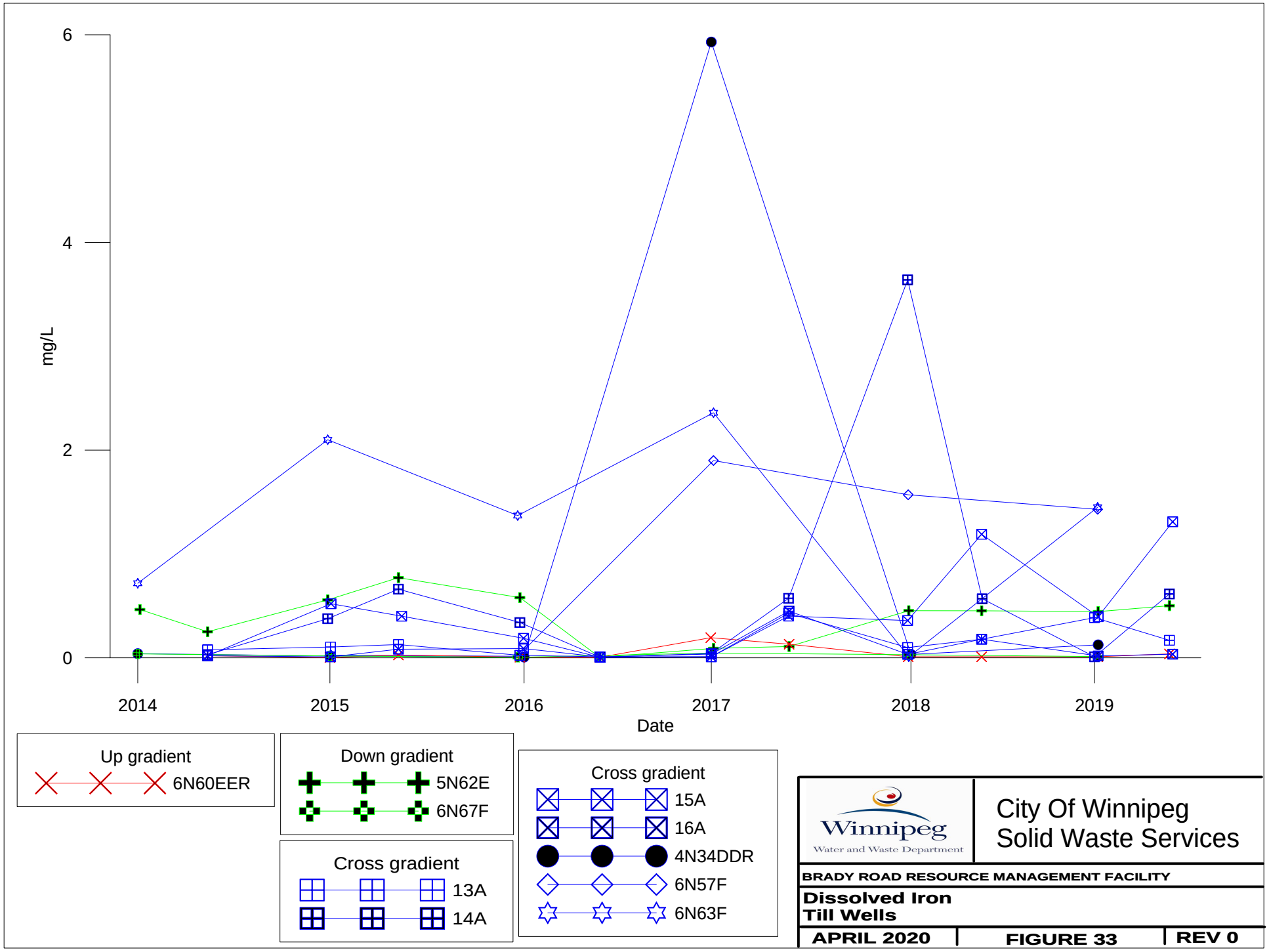
Winnipeg
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

GROUNDWATER ELEVATION
TILL WELLS

APRIL 2020 | FIGURE GW-1-1 REV 0



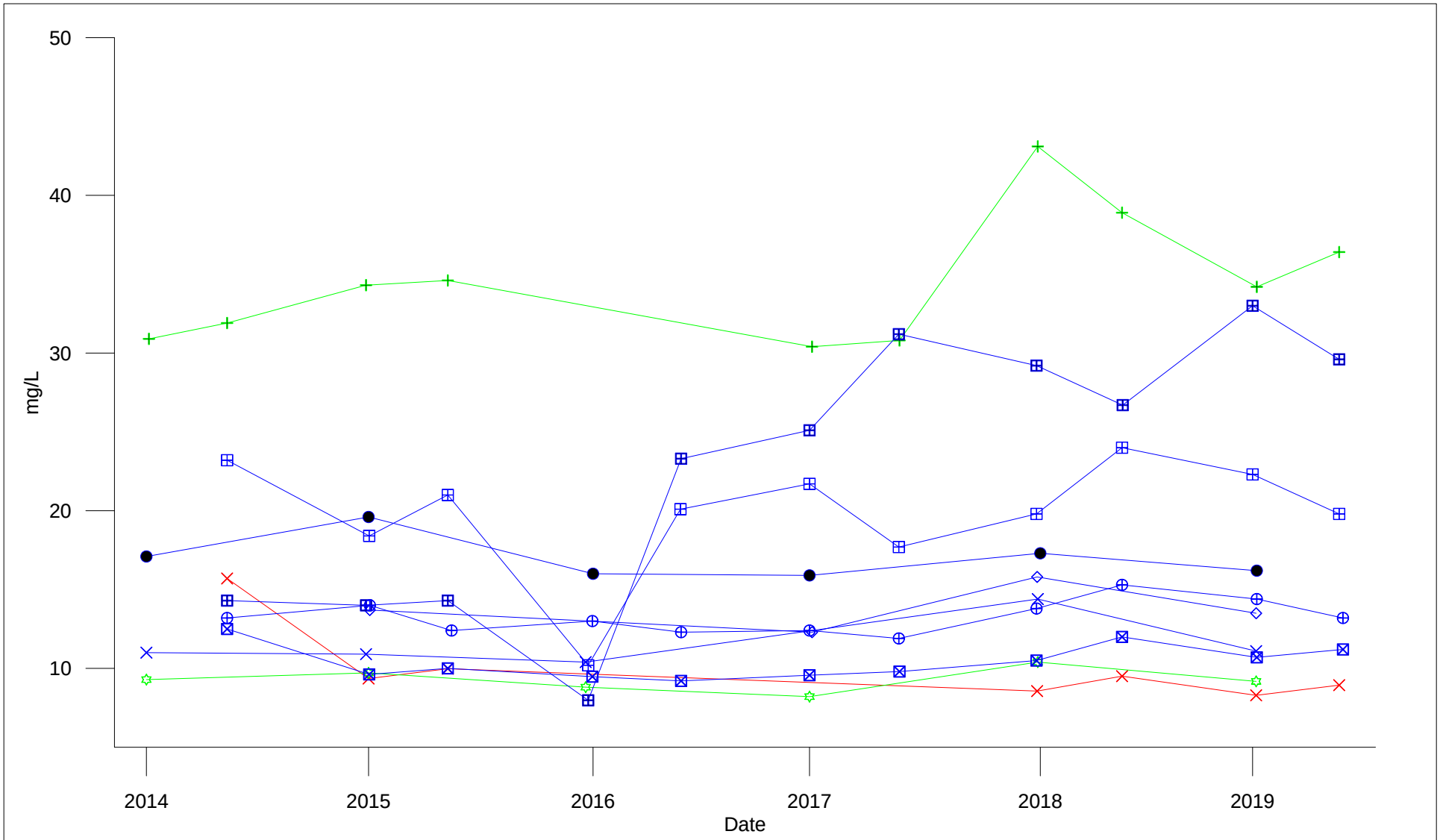
Winnipeg
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Iron
Till Wells

APRIL 2020 | FIGURE 33 | REV 0



Up gradient
6N60EER

Down gradient
5N62E
6N67F

Cross gradient
13A
14A

Cross gradient
15A
16A
4N34DDR
6N57F
6N63F

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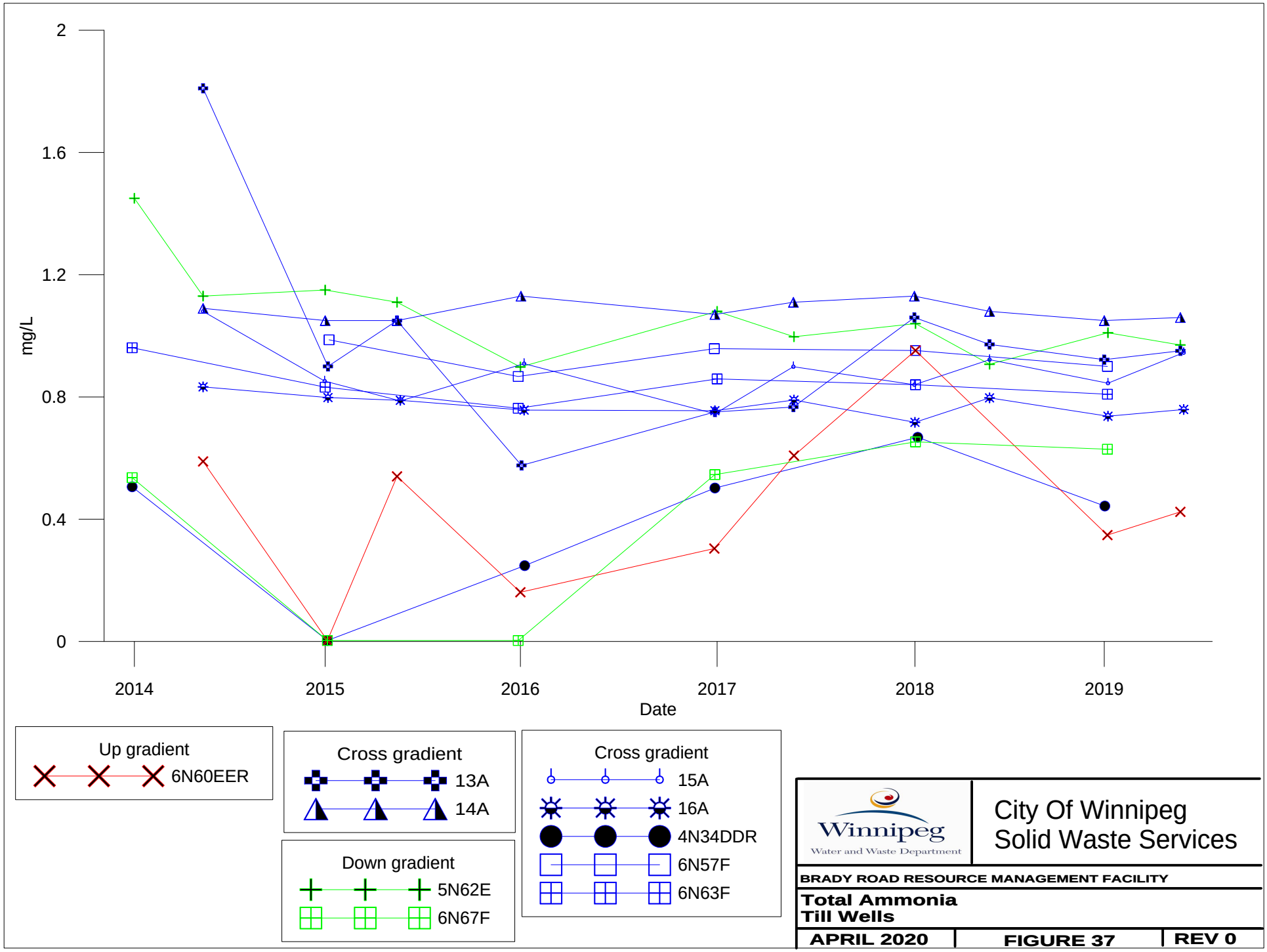
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Potassium
Till Wells

APRIL 2020	FIGURE 34	REV 0



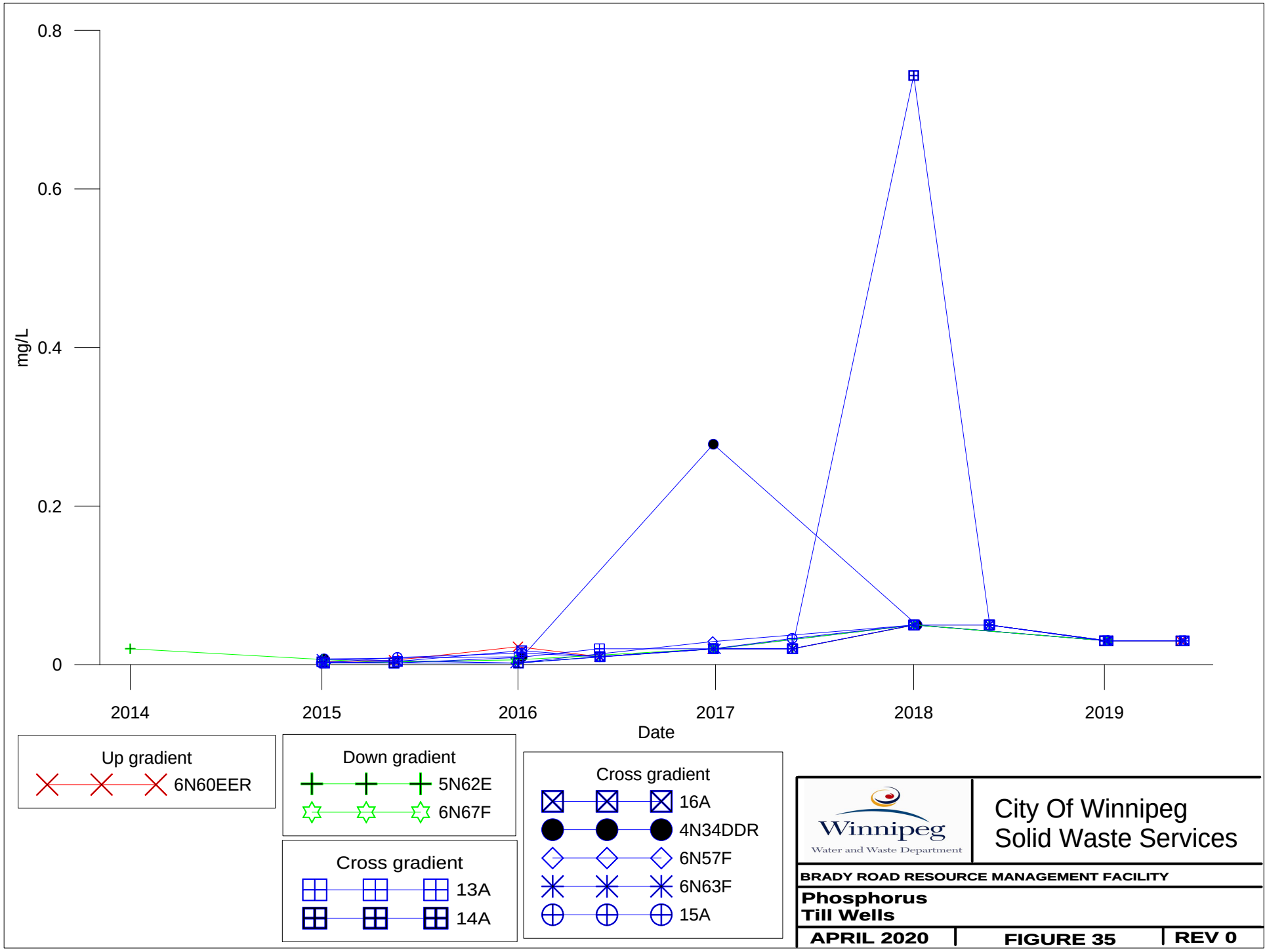
Winnipeg
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Total Ammonia
Till Wells

APRIL 2020	FIGURE 37	REV 0



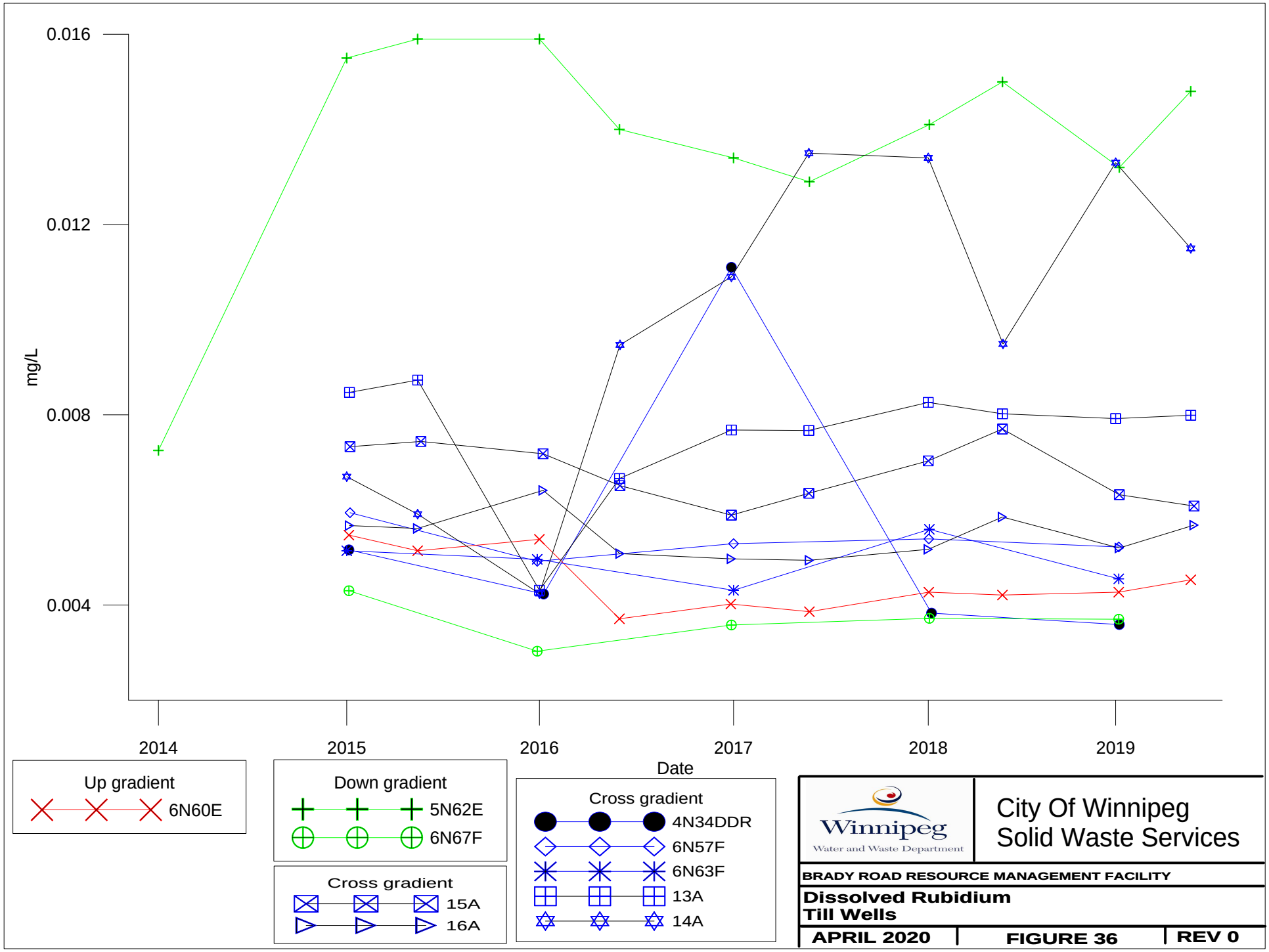
Winnipeg
Water and Waste Department

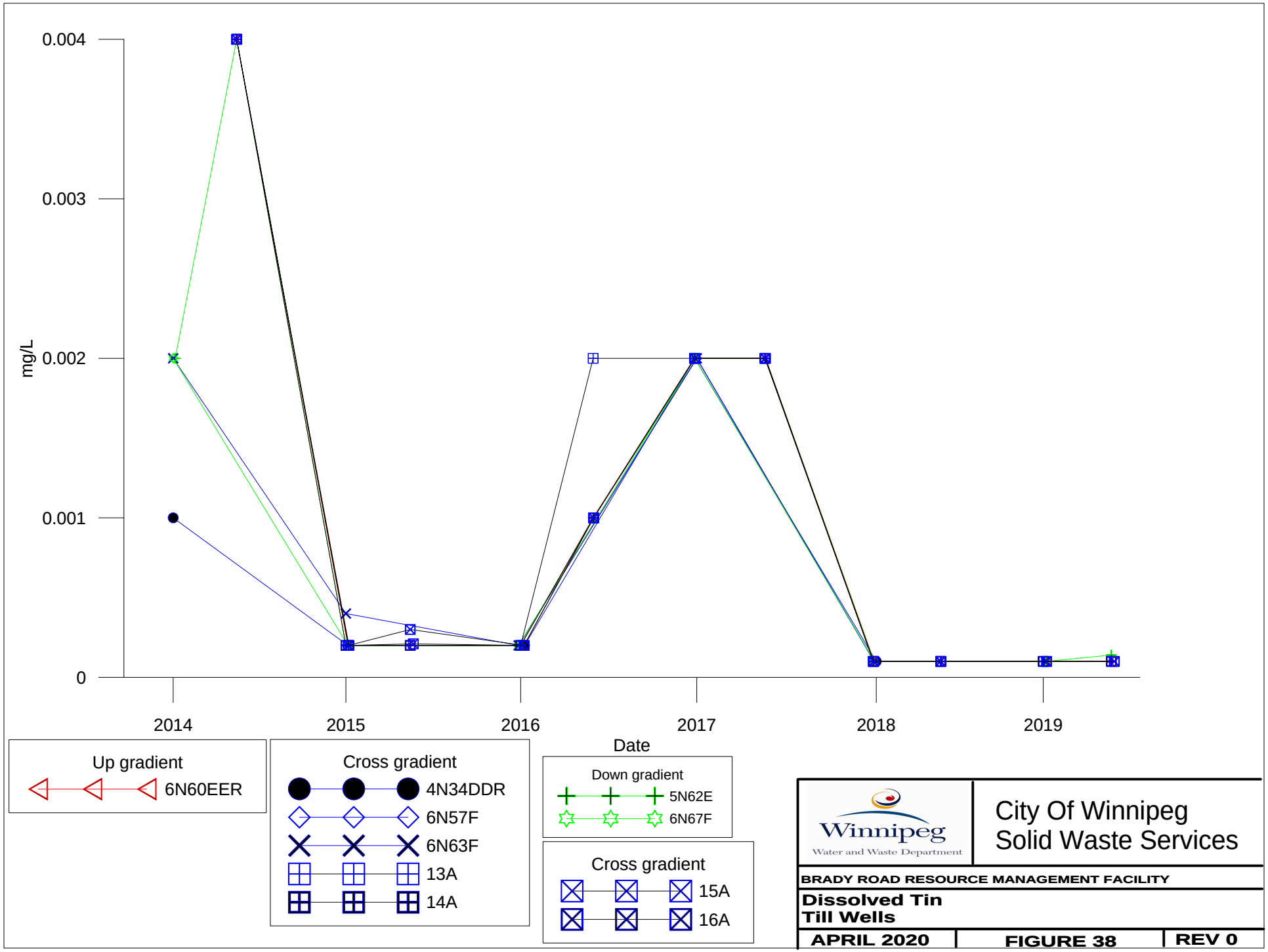
City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Phosphorus
Till Wells

APRIL 2020	FIGURE 35	REV 0


0.016
0.012
0.008
0.004
mg/L
2014
2015
2016
2017
2018
2019
Date
Up gradient
6N60E
Down gradient
5N62E
6N67F
Cross gradient
15A
16A
Cross gradient
4N34DDR
6N57F
6N63F
13A
14A
Winnipeg
Water and Waste Department
City Of Winnipeg
Solid Waste Services
BRADY ROAD RESOURCE MANAGEMENT FACILITY
Dissolved Rubidium
Till Wells
APRIL 2020
FIGURE 36
REV 0



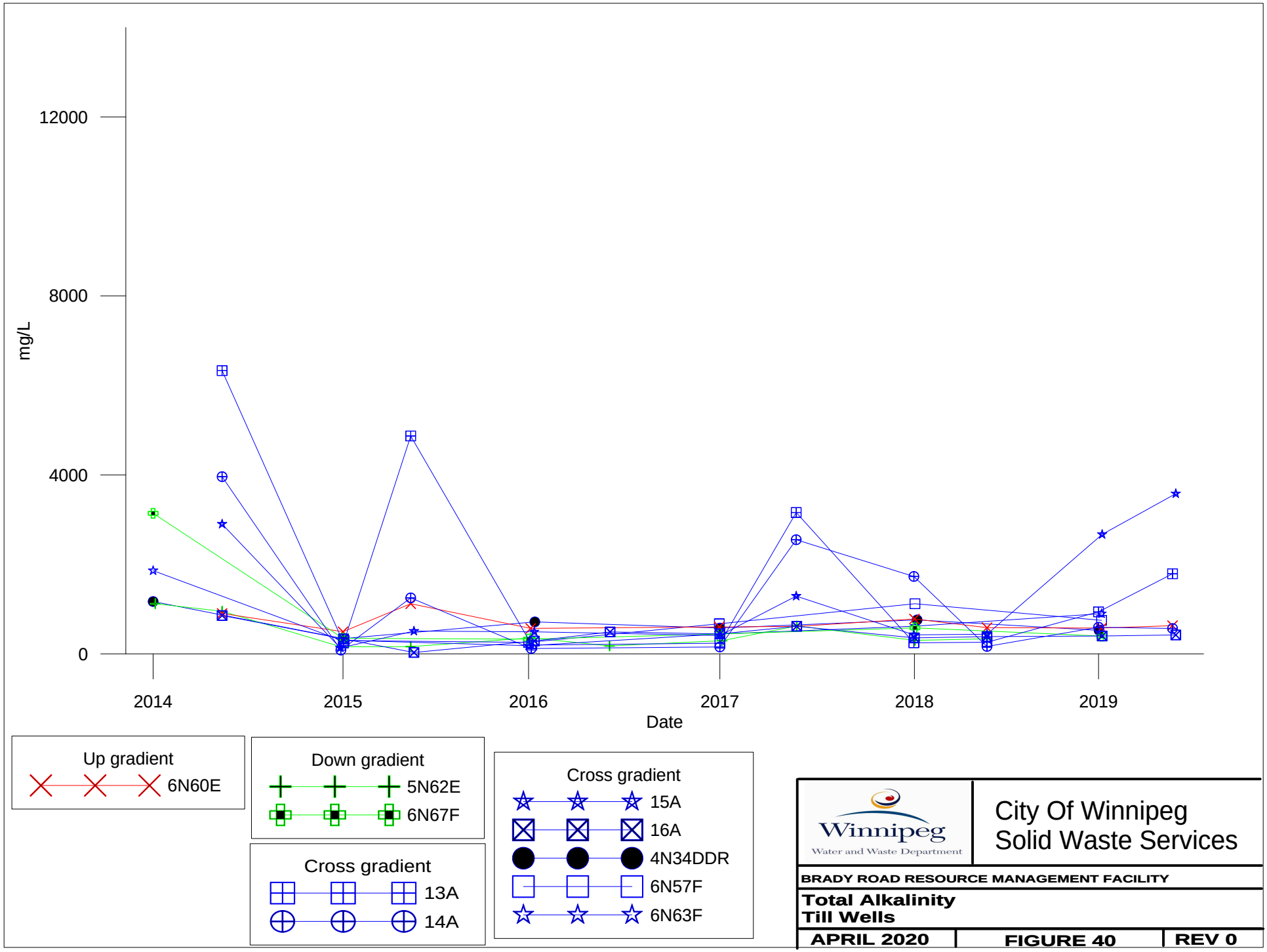
Winnipeg
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Tin
Till Wells

APRIL 2020	FIGURE 38	REV 0



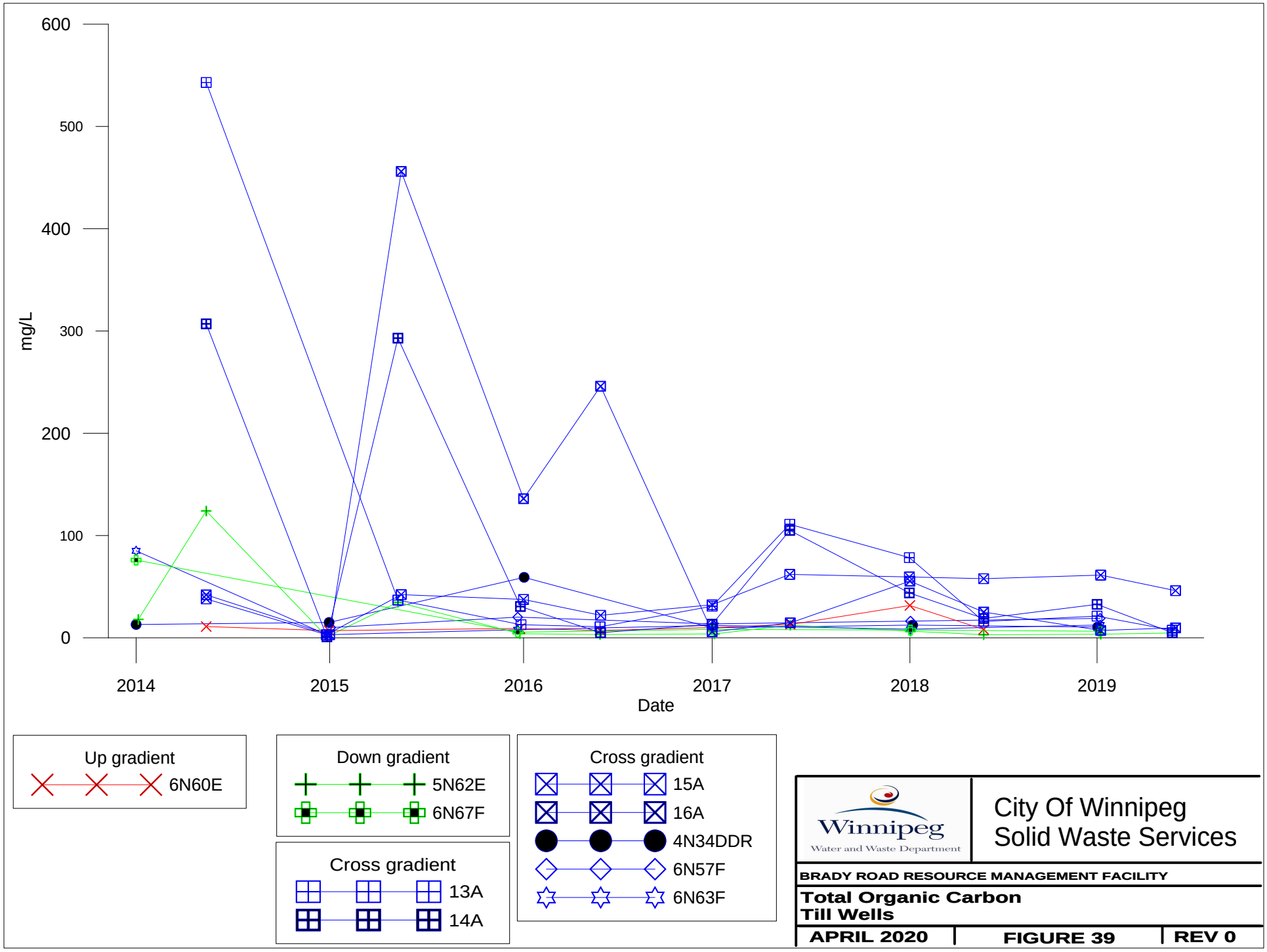
Winnipeg
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Total Alkalinity
Till Wells

APRIL 2020	FIGURE 40	REV 0



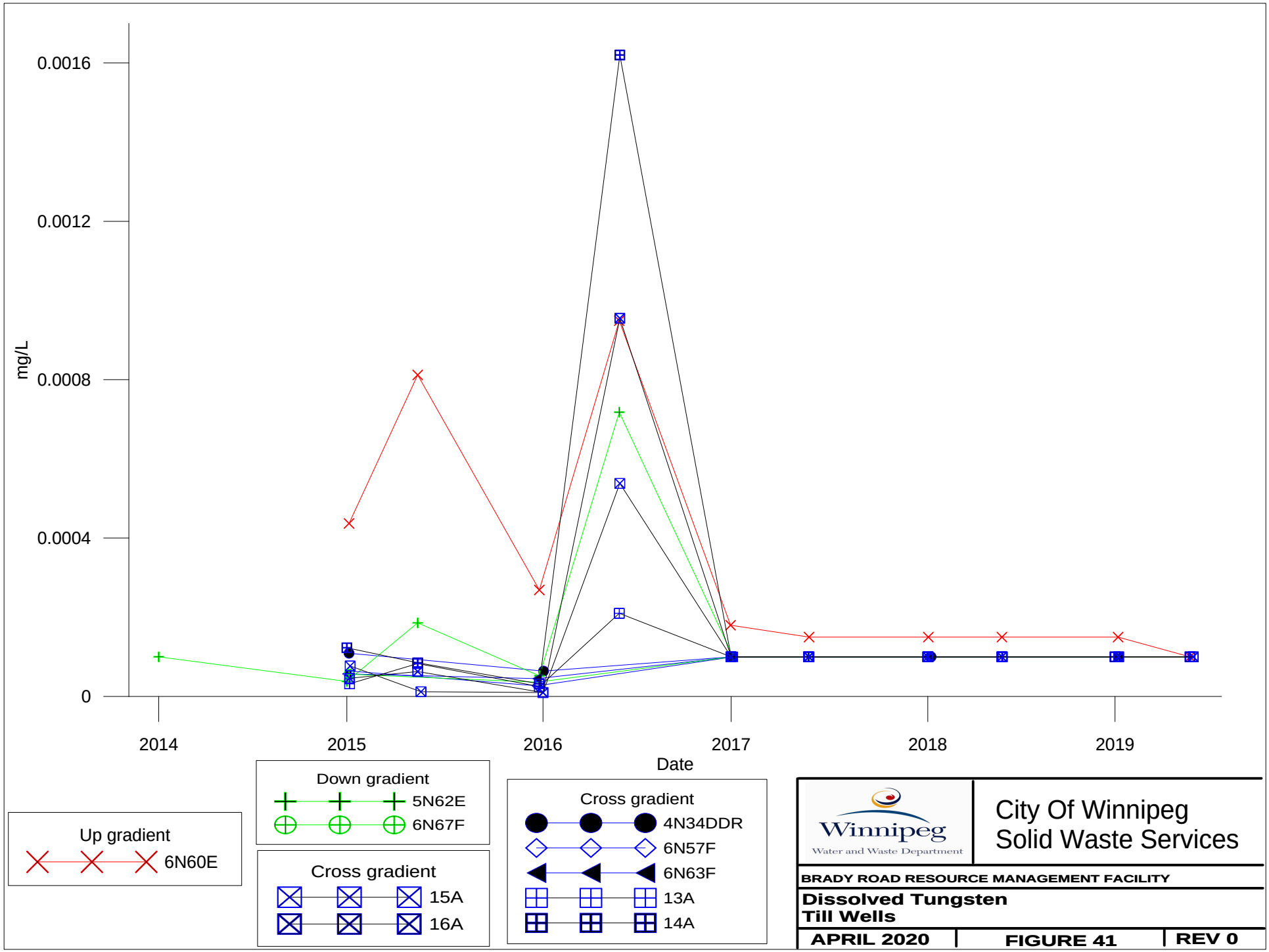
Winnipeg
Water and Waste Department

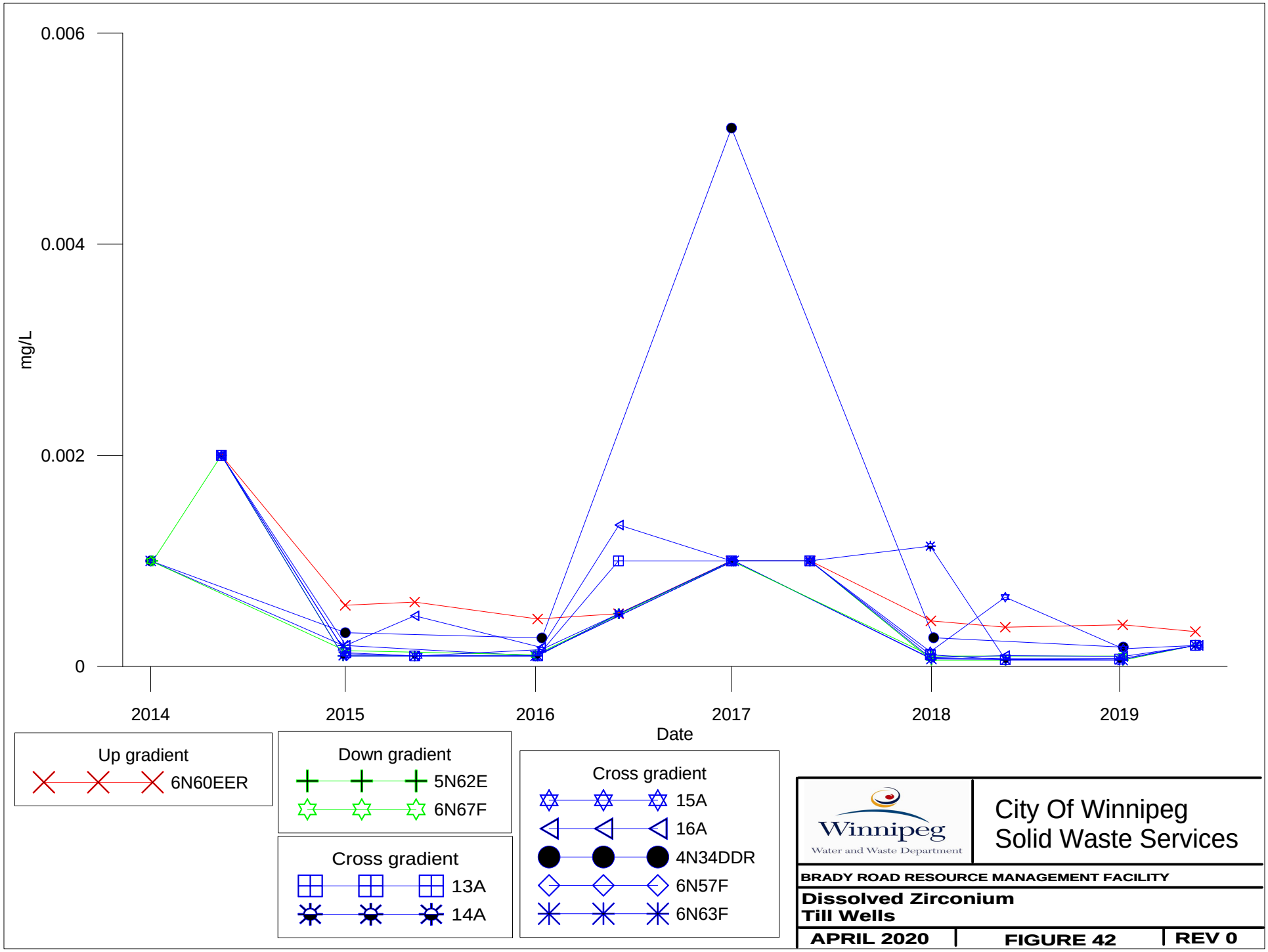
City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Total Organic Carbon
Till Wells

APRIL 2020	FIGURE 39	REV 0


0.0016
0.0012
0.0008
0.0004
0
mg/L
2014
2015
2016
2017
2018
2019
Date
Up gradient
6N60E
Down gradient
5N62E
6N67F
Cross gradient
15A
16A
Cross gradient
4N34DDR
6N57F
6N63F
13A
14A
Winnipeg
Water and Waste Department
City Of Winnipeg
Solid Waste Services
BRADY ROAD RESOURCE MANAGEMENT FACILITY
Dissolved Tungsten
Till Wells
APRIL 2020
FIGURE 41
REV 0



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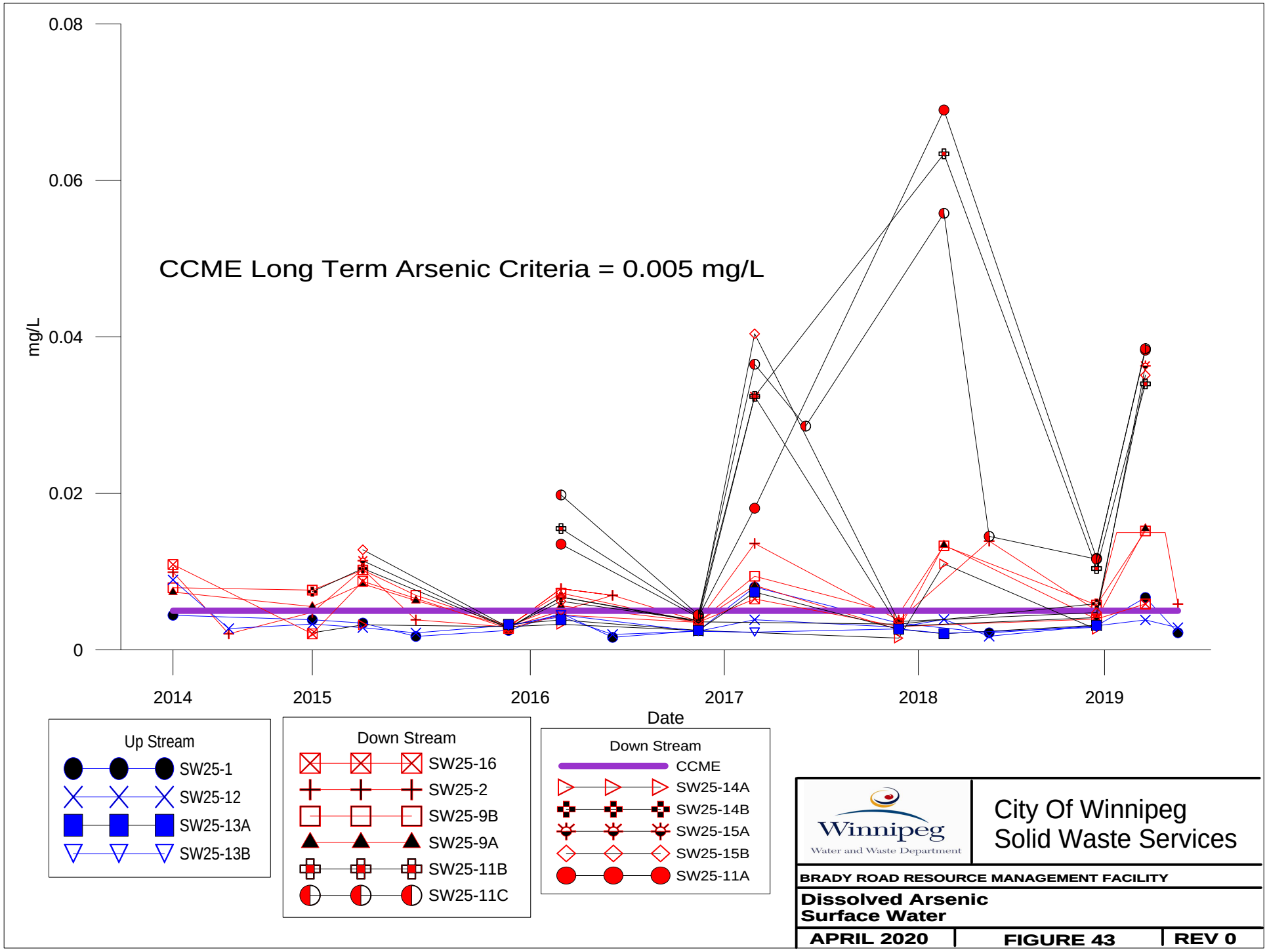
City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Zirconium
Till Wells

APRIL 2020 | FIGURE 42 | REV 0

2019 Surface Water
Time vs Concentration Graphs



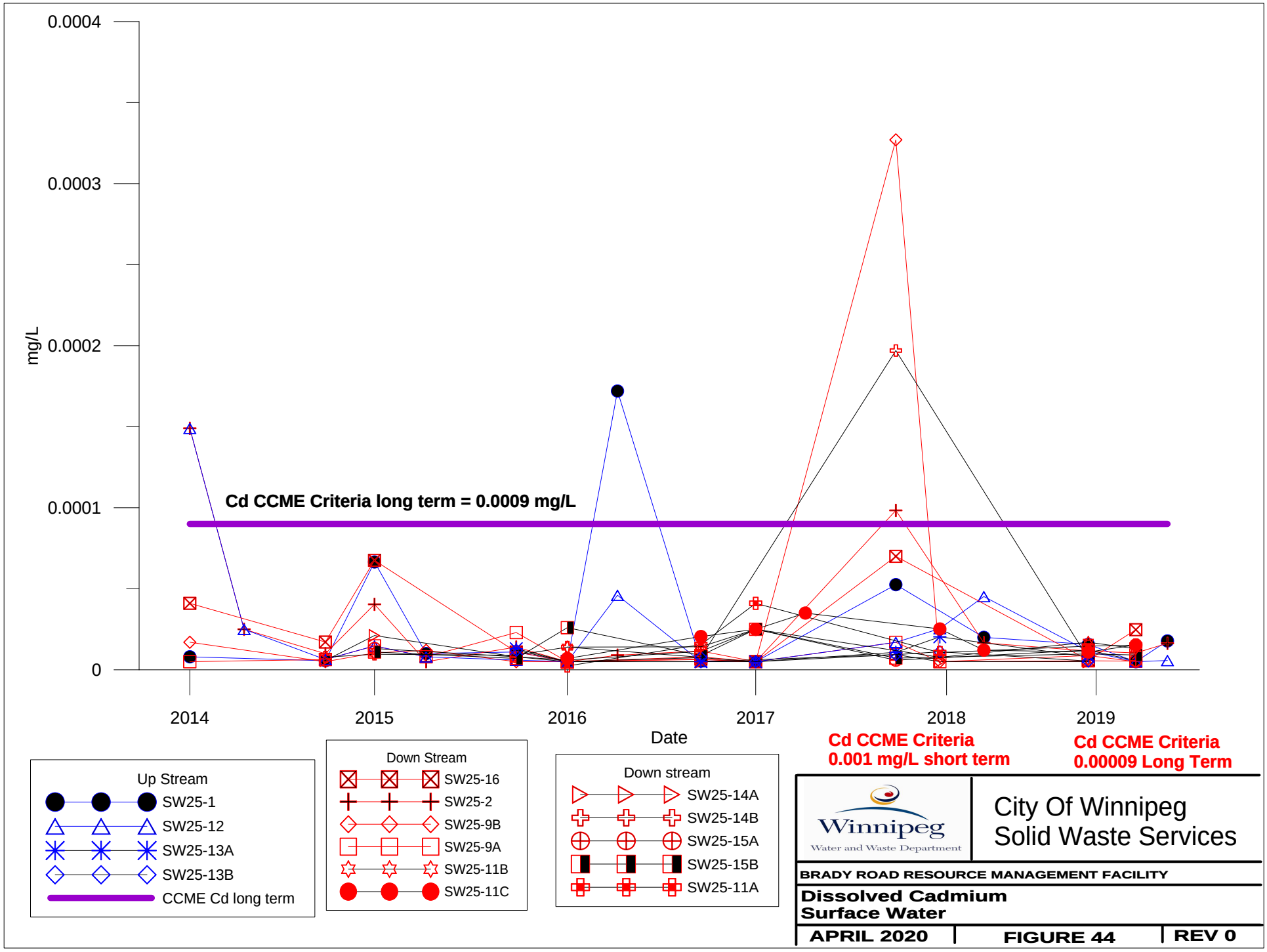
Winnipeg
Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Arsenic
Surface Water

APRIL 2020	FIGURE 43	REV 0


0.0004
0.0003
0.0002
0.0001
0
mg/L
Cd CCME Criteria long term = 0.0009 mg/L
2014
2015
2016
2017
2018
2019
Date
Cd CCME Criteria
0.001 mg/L short term
Cd CCME Criteria
0.00009 Long Term
Up Stream
SW25-1
SW25-12
SW25-13A
SW25-13B
CCME Cd long term
Down Stream
SW25-16
SW25-2
SW25-9B
SW25-9A
SW25-11B
SW25-11C
Down stream
SW25-14A
SW25-14B
SW25-15A
SW25-15B
SW25-11A
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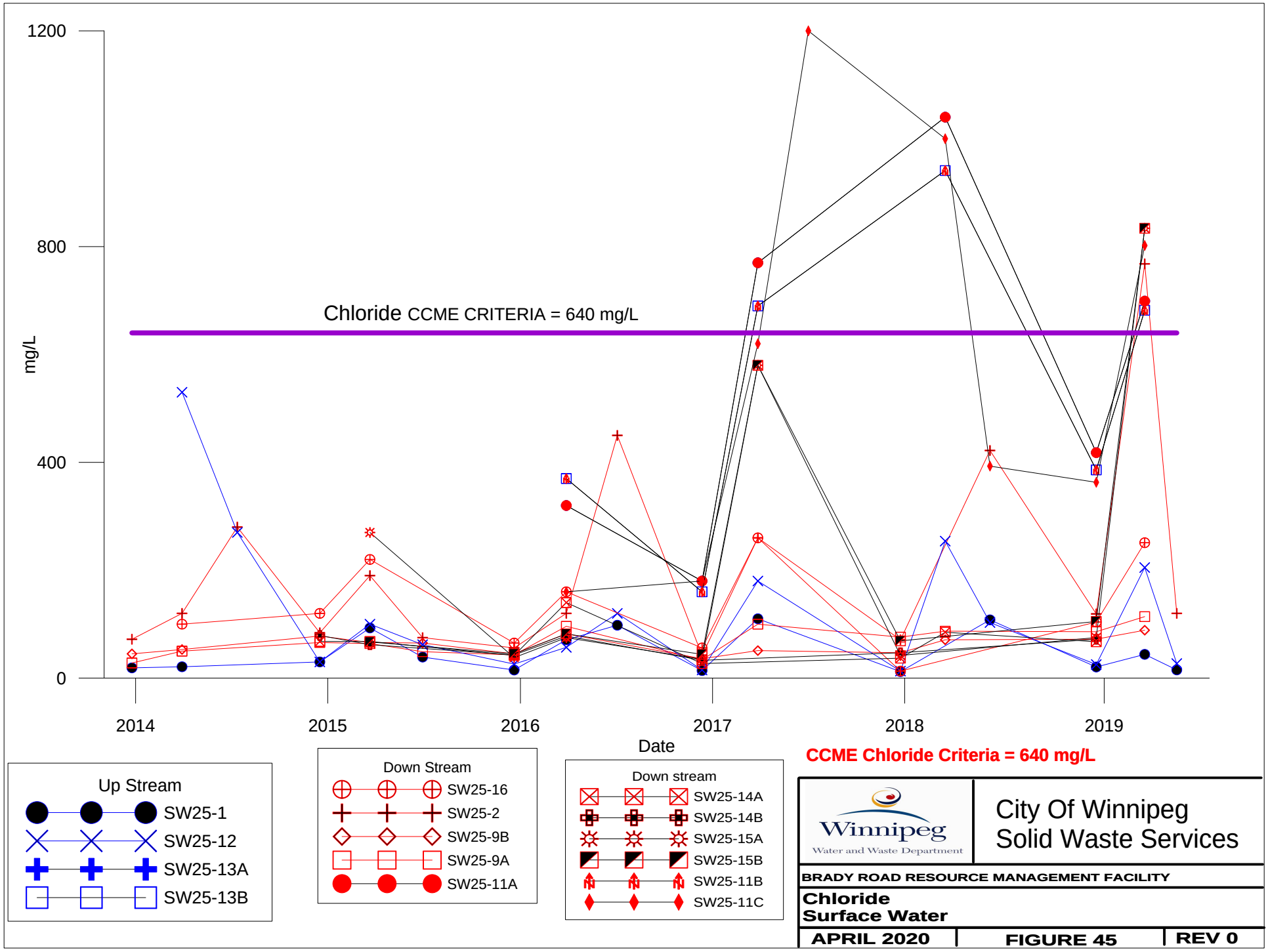
Water and Waste Department
City Of Winnipeg
Solid Waste Services
BRADY ROAD RESOURCE MANAGEMENT FACILITY
Dissolved Cadmium
Surface Water
APRIL 2020
FIGURE 44
REV 0


1200
800
400
0
mg/L
Chloride CCME CRITERIA = 640 mg/L
2014
2015
2016
2017
2018
2019
Date
Up Stream
SW25-1
SW25-12
SW25-13A
SW25-13B
Down Stream
SW25-16
SW25-2
SW25-9B
SW25-9A
SW25-11A
Down stream
SW25-14A
SW25-14B
SW25-15A
SW25-15B
SW25-11B
SW25-11C
CCME Chloride Criteria = 640 mg/L
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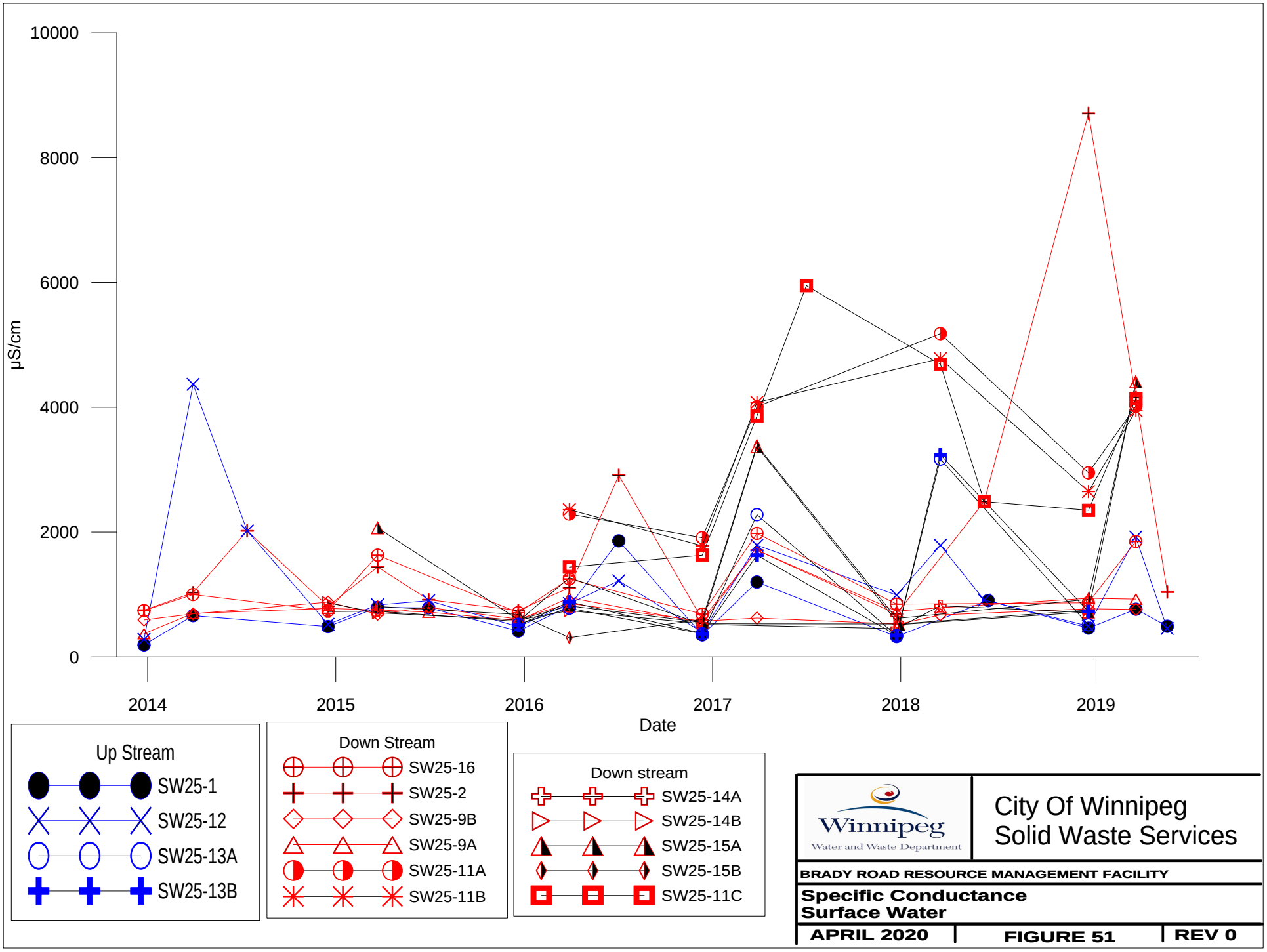
Water and Waste Department
City Of Winnipeg
Solid Waste Services
BRADY ROAD RESOURCE MANAGEMENT FACILITY
Chloride
Surface Water
APRIL 2020
FIGURE 45
REV 0



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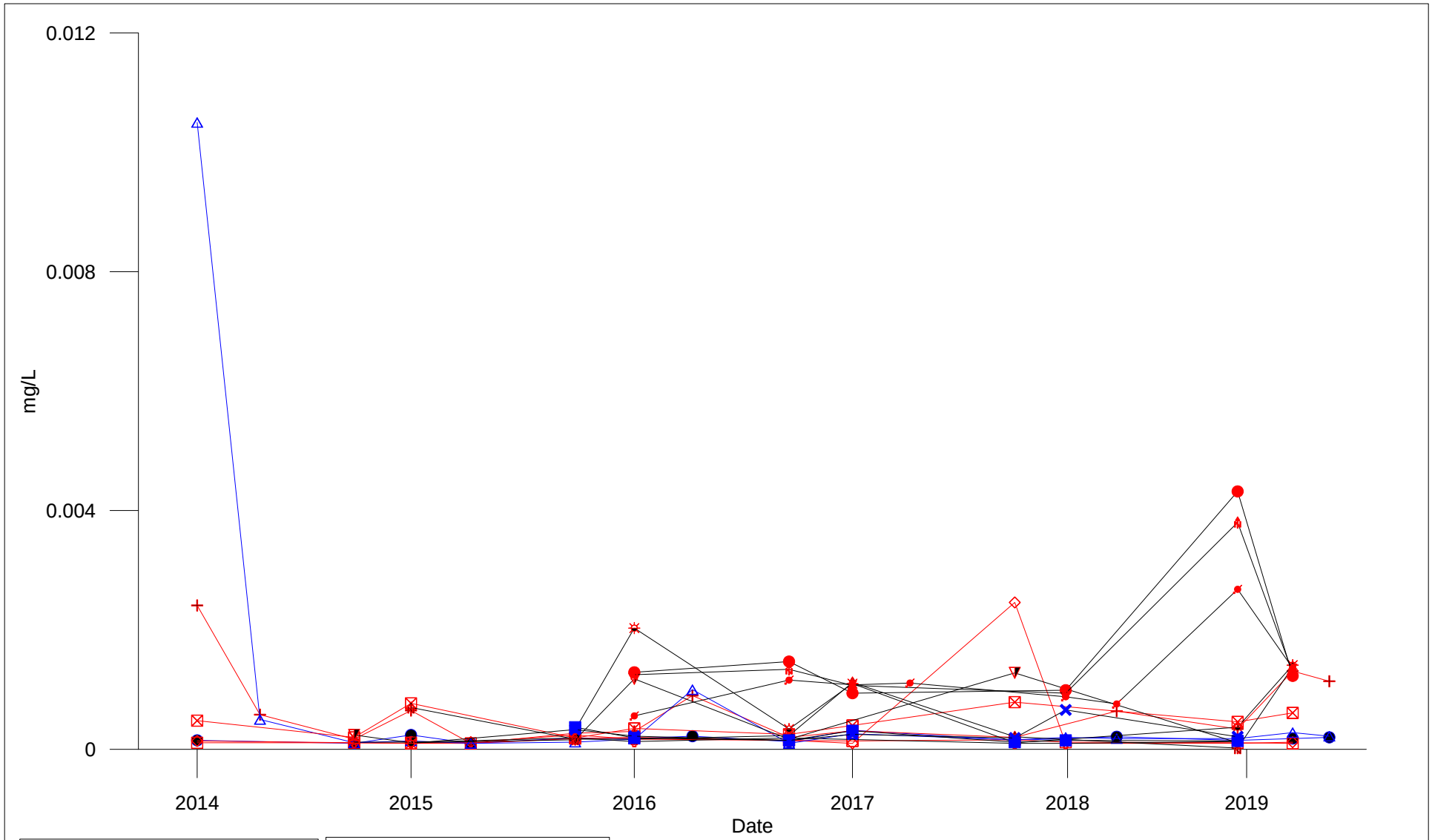
City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Specific Conductance
Surface Water

APRIL 2020 | FIGURE 51 | REV 0



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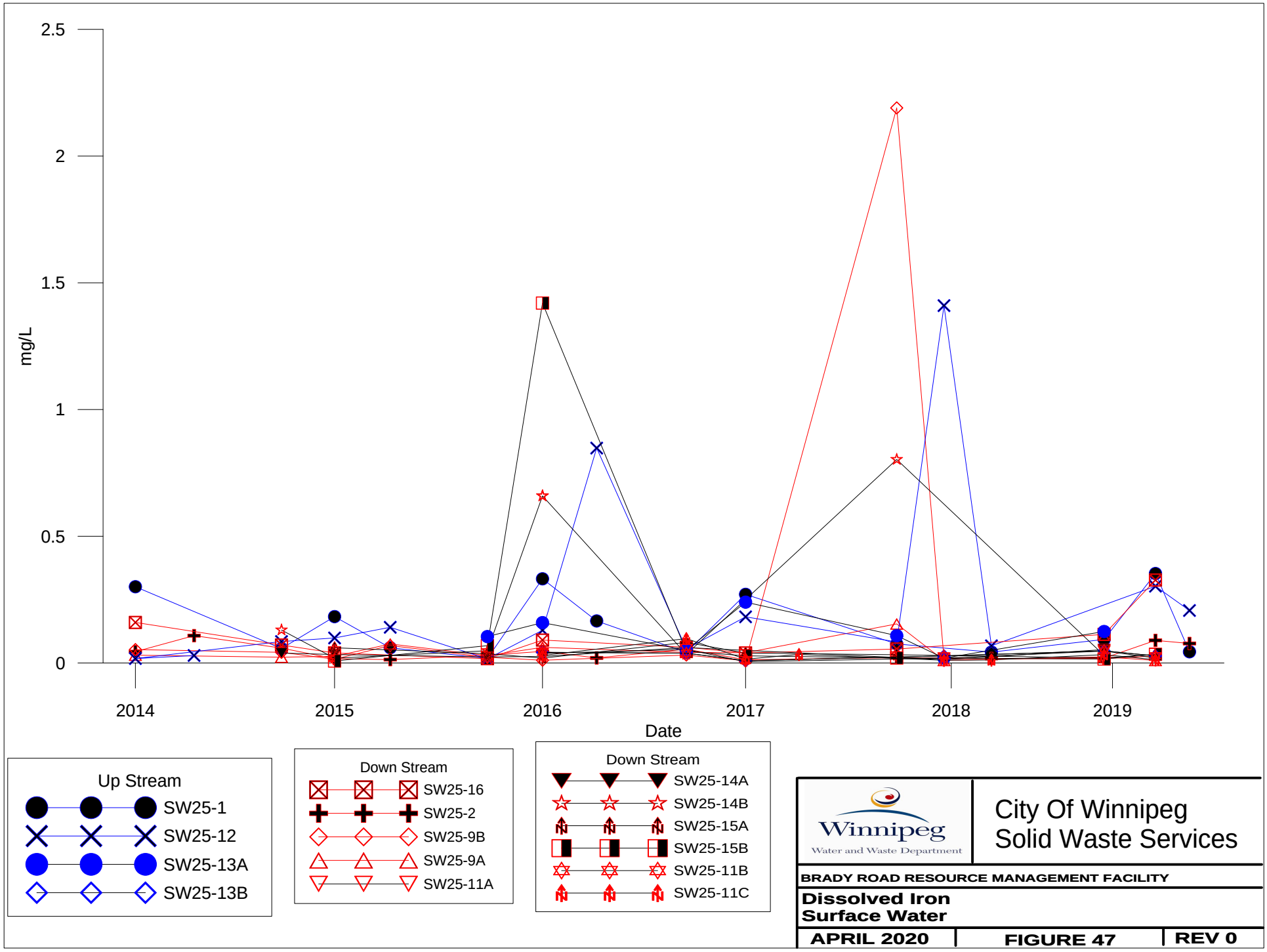
City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Chromium
Surface Water

APRIL 2020 | FIGURE 46 | REV 0



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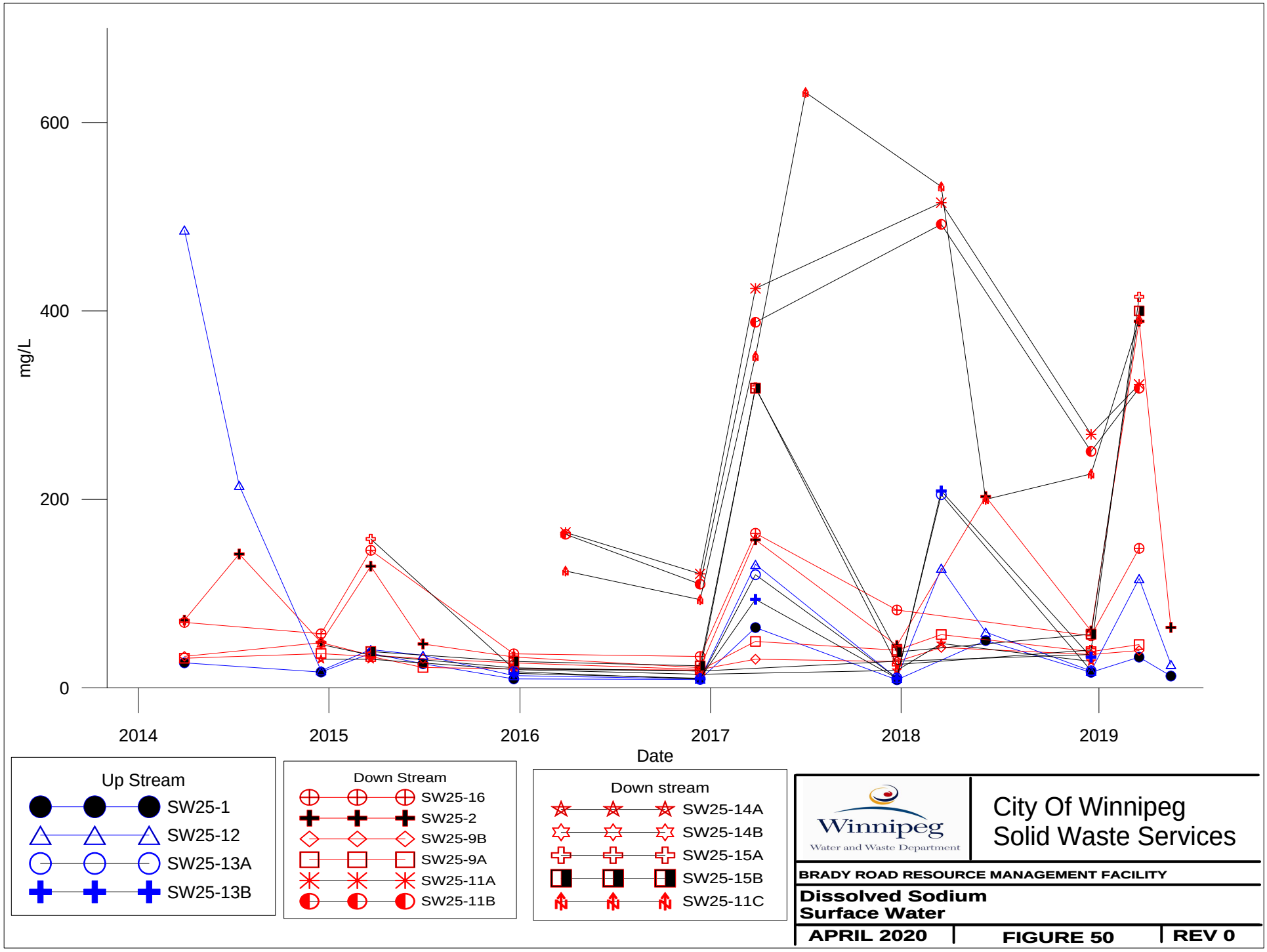
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Iron
Surface Water

APRIL 2020	FIGURE 47	REV 0


600
400
200
0
mg/L
2014
2015
2016
2017
2018
2019
Date
Up Stream
SW25-1
SW25-12
SW25-13A
SW25-13B
Down Stream
SW25-16
SW25-2
SW25-9B
SW25-9A
SW25-11A
SW25-11B
Down stream
SW25-14A
SW25-14B
SW25-15A
SW25-15B
SW25-11C
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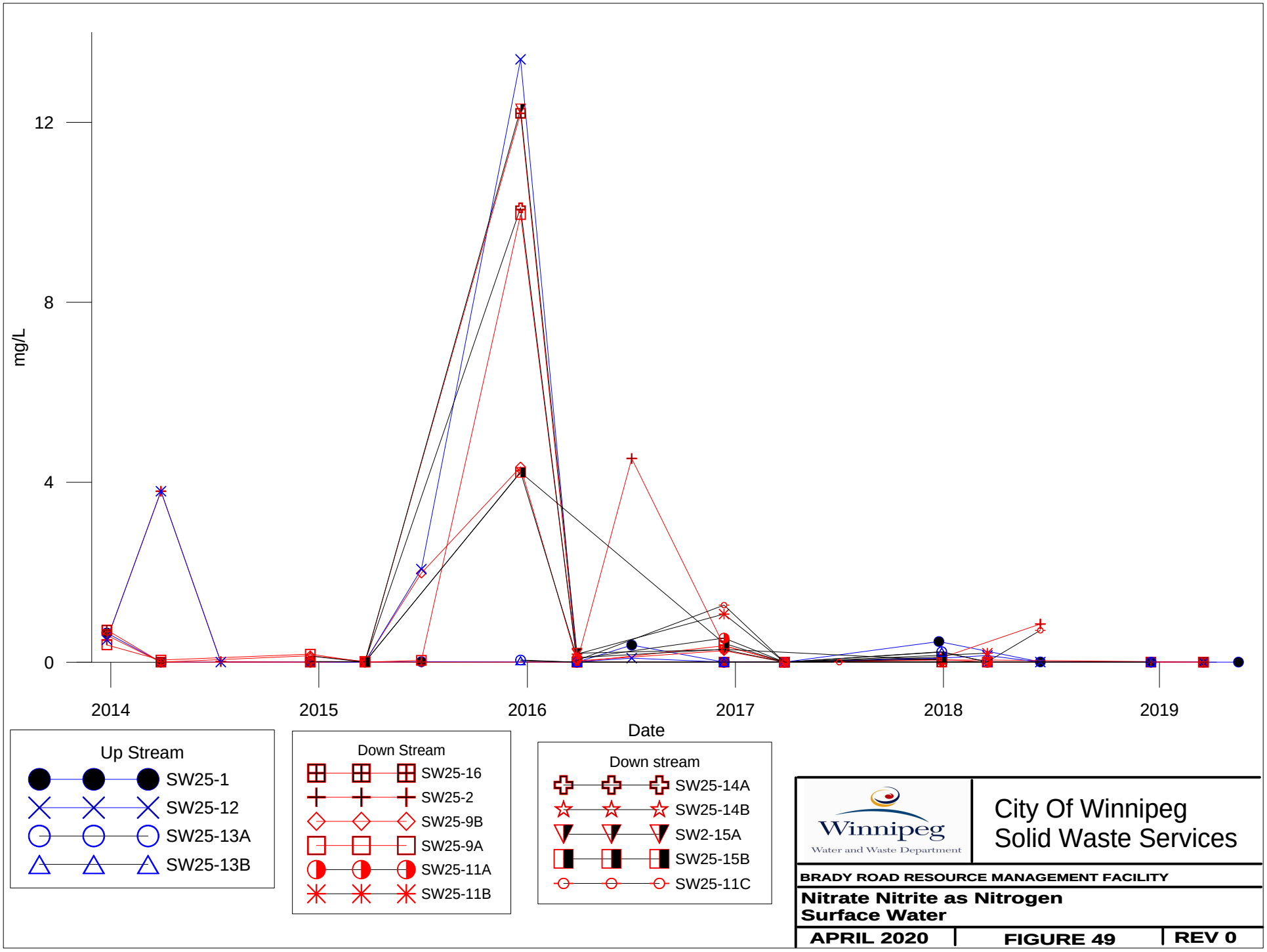
Water and Waste Department
City Of Winnipeg
Solid Waste Services
BRADY ROAD RESOURCE MANAGEMENT FACILITY
Dissolved Sodium
Surface Water
APRIL 2020
FIGURE 50
REV 0



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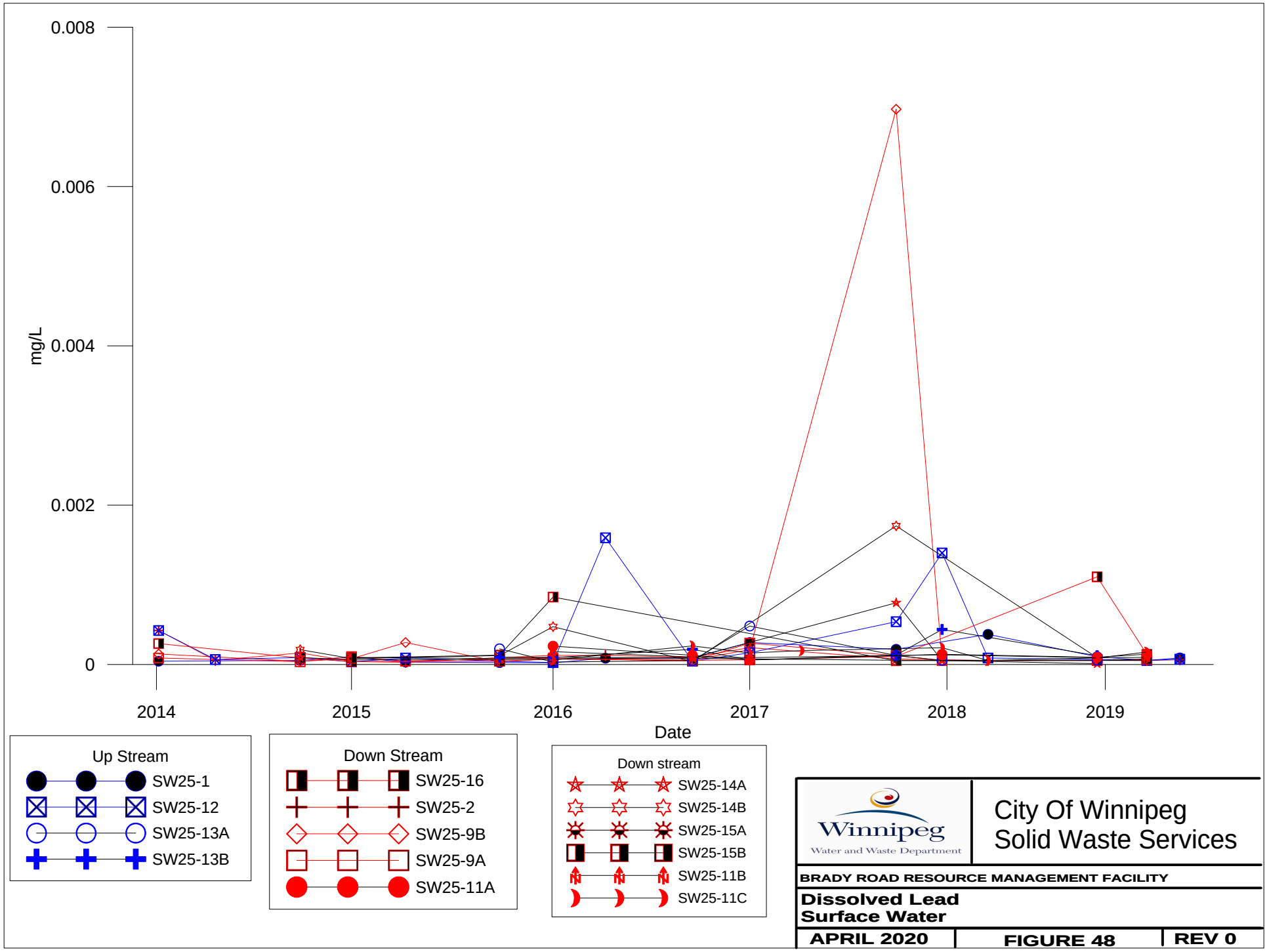
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Nitrate Nitrite as Nitrogen
Surface Water

APRIL 2020	FIGURE 49	REV 0



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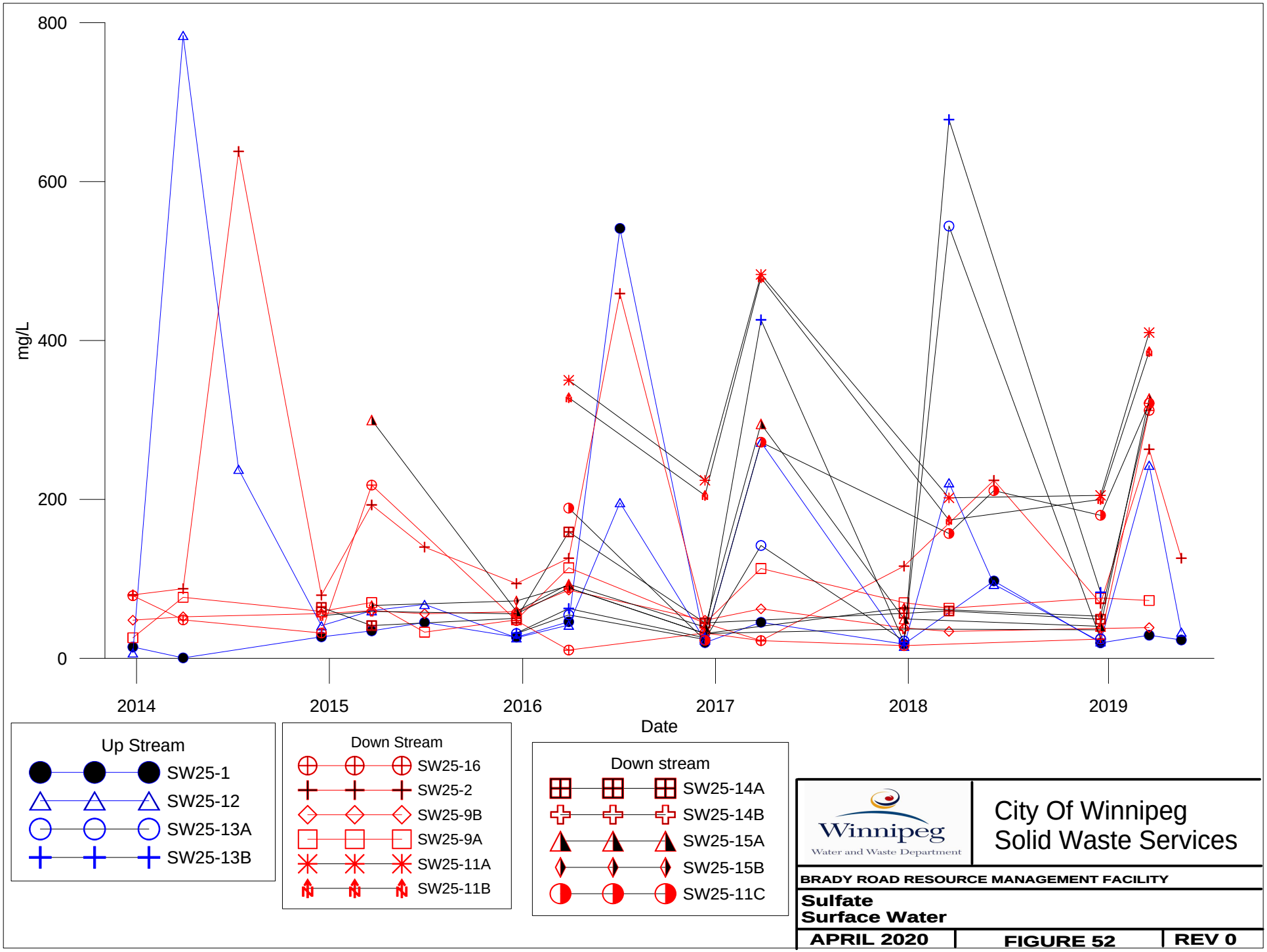
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Dissolved Lead
Surface Water

APRIL 2020	FIGURE 48	REV 0



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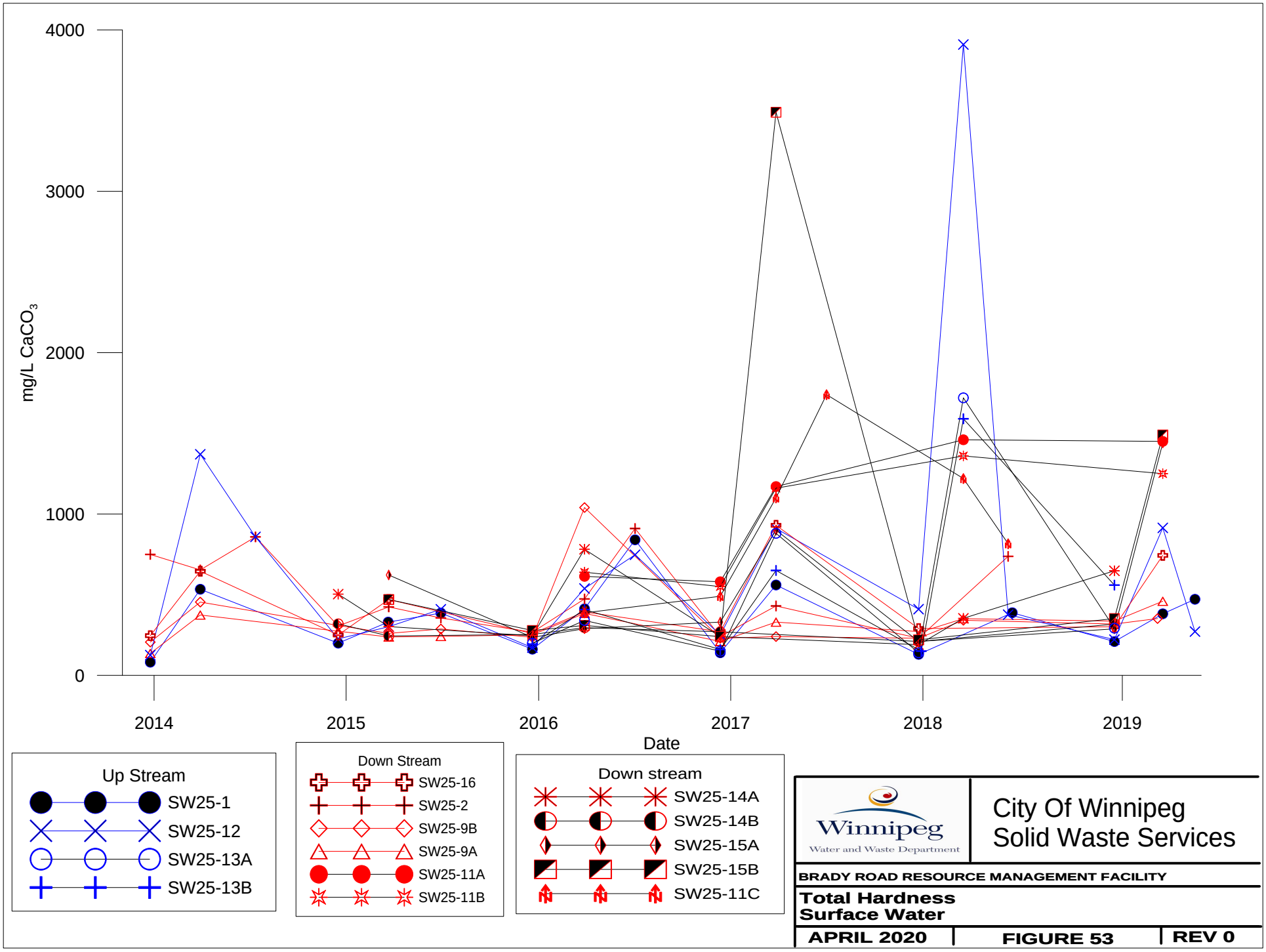
City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Sulfate
Surface Water

APRIL 2020	FIGURE 52	REV 0



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Water and Waste Department

City Of Winnipeg
Solid Waste Services

BRADY ROAD RESOURCE MANAGEMENT FACILITY

Total Hardness
Surface Water

APRIL 2020	FIGURE 53	REV 0

APPENDIX E
2019 LANDFILL GAS COLLECTION AND FLARING REPORT

2019 ANNUAL MONITORING REPORT
CITY OF WINNIPEG

BRADY ROAD RESOURCE MANAGEMENT FACILITY
LANDFILL GAS COLLECTION AND FLARING SYSTEM

Prepared for

THE CITY OF WINNIPEG

Prepared by

INTEGRATED GAS RECOVERY SERVICES INC.

March 9, 2020

2019 ANNUAL MONITORING REPORT
CITY OF WINNIPEG

BRADY ROAD RESOURCE MANAGEMENT FACILITY
LANDFILL GAS COLLECTION AND FLARING SYSTEM

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APPENDIX A Plant and Flare Data

1.0 INTRODUCTION

The City of Winnipeg operates the Landfill Gas Collection and Flaring System at the Brady Road Resource Management Facility in Winnipeg, Manitoba, which operates under Manitoba Conservation Licence 3081. After a short commissioning phase, the system became operational full time in August 2013 after approval to operate was received by the Office of the Fire Commissioner.

Operation of the system including maintenance and monitoring was completed by Comcor Environmental Limited (Comcor) on behalf of its partner Integrated Gas Recovery Services (IGRS).

This report outlines work performed and data collected during the operation of the Landfill Gas Collection and Flaring System during 2019.

2.0 LANDFILL GAS COLLECTION SYSTEM

There are two main components of the LGCFS that require monitoring. These include:

- Landfill Gas Collection Wellfield
- Mechanical System

The purpose and procedures associated with the monitoring of each of these components are discussed separately below. The recommended monitoring frequency is presented in Table 1.

Table 1: Summary of Monitoring Frequency

System Component	Monitoring Frequency
Wellfield Monitoring	Monthly
Remote Mechanical System Monitoring	Weekly
Mechanical System Monitoring	Weekly

2.1 Wellfield System Monitoring

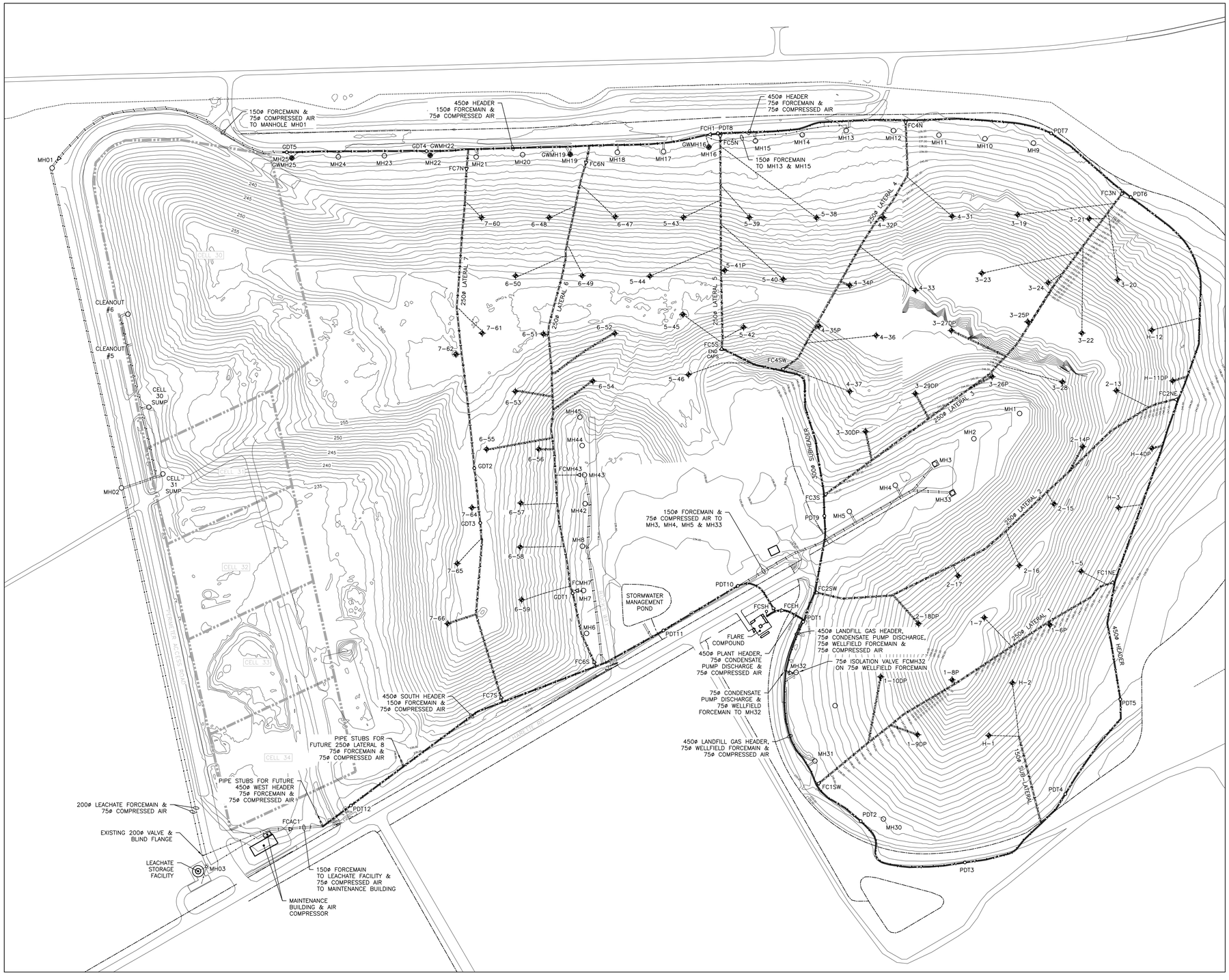
The wellfield system monitoring consists of measuring vacuum/pressure in each well and lateral pipe, as well as the percentage of methane, oxygen and carbon dioxide in the landfill gas, and parts per million of carbon monoxide and hydrogen sulphide at each location. These measurements were taken using a proper gas meter/analyzer such as a Landtec GEM-5000, or equivalent. Vacuum fluctuations were noted, as it can be an indication of water within in the piping system.

Each wellhead was monitored for the velocity of gas using an anemometer. The measured velocities were used to calculate landfill gas flow rates by multiplying the velocity by the pipe cross-sectional area.

The monitoring data collected during the monthly round is beneficial to determine if the wellfield is operating as intended. Changes to the wellhead valve position were made to ensure maximum gas collection from the landfill. The system was monitored and field balanced by a technician experienced in the operation of this type of system.

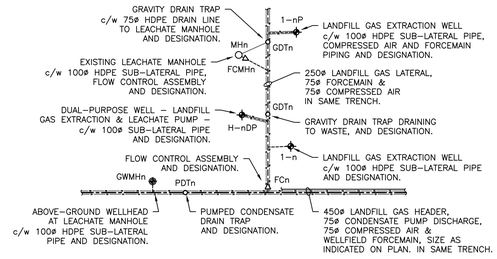
In July 2019, a tender was issued by the City of Winnipeg for an expansion of the landfill gas southern header and leachate collection system, including pump drain traps and buried valve assemblies. Figure 1 presents the approximate existing wellfield conditions at the site as as-builts including the 2019 expansion have yet to be finalized.

During 2019, there were no elevated levels of Carbon Monoxide (CO) (>500 ppm). Previous elevated levels occasionally found at GW 2-13 and GW 1-7 as noted in the 2018 Annual Report were remediated. The highest CO levels at GW 1-7 and 2-13 during the 2019 monitoring period



LEGEND

- ROADS
- HYDRO POLES
- MANHOLES
- BUILDINGS
- PERIMETER DITCHES/POND EDGE
- FENCE



Scale: 0 50 100 200 250 metres

COMCOR
ENVIRONMENTAL LIMITED
Consulting Engineers and Landfill Gas Specialists
320 Pinebush Road, Suite 12, Cambridge, Ontario N1T 1Z6
tel (519) 621-6669 • fax (519) 621-9944

INTEGRATED GAS RECOVERY SERVICES
A Landfill Gas Utilization Company

Winnipeg

City of Winnipeg
Brady Road
Resource Management
Facility

FIGURE 1
EXISTING
SITE CONDITIONS

were 316 ppm in June and 185 in April respectively. From mid 2016 to October 2017, GW1-7 was closed due to low methane levels and high CO. The CO levels dropped in late 2017 and the temperature readings were within a more typical range so the well was cracked for gas collection. The highest CO levels at 1-7 tends to occur during spring and summer. Elevated carbon monoxide within landfill gas can be an indicator of a subsurface fire within the waste. There was no indication of a subsurface fire in 2019.

An assessment of the wellfield monitoring data in late 2018 and early 2019 indicated that there were a number of wells on Lateral 6 and Lateral 7 without vacuum. As part of the 2019 Southern Header Extension project, repairs to both Lateral 6 and Lateral 7 were completed. As suspected, the Lateral 6 pipe was pinched between wells 6-55 and 6-66. The pipe was excavated, inspected for pinching or breakage, and replaced. Upon investigation of Lateral 7, it was determined that a portion of the piping had been crushed by heavy machinery and required replacement. Similar to the Lateral 6 repairs, the pipe was excavated, inspected and replaced. The repairs at Lateral 6 and Lateral 7 were finalized in October 2019 and successfully restored the loss of vacuum.

The wellfield monitoring data and valve positions can be found in Table 2.

Pump counter measurements were recorded on a monthly basis at all dual purpose gas/leachate collection wells. Due to the lack of a functioning pump counter, pump counter readings were not recorded at PDT4 throughout the 2019 reporting year, at PDT7 from June to December and at GW 3-29 from January to April. However, the pumps were checked on a monthly basis and were found to be operational at all inspections. Due to flooding, pump counter readings were not recorded at PDT5 from September to December. Included in the 2019 Southern Header Extension project, PDT10, PDT11 and PDT12 were installed and measurements were recorded beginning in October. Table 3 presents the pump counter measurements recorded at both the pump drain traps and dual purpose wells in 2019. The following wells are currently fitted with pneumatic pumps for leachate removal: H-4, 1-9, 1-10, H-11, 2-18, 3-27, 3-29 and 3-30. Dual purpose well locations were chosen based on the incidence of elevated leachate levels in the surrounding area. Additional well locations were designed with compressed air and forcemain coming up to the well which allows for pumps to be relocated, as necessary. Comcor is currently retained to complete the design for a landfill gas collection system expansion which will include retrofitting all existing wells to dual-purpose wells, as well as the installation of 19 new dual purpose wells within Cells 30 and 31.

Water level monitoring requirements are for water levels to be measured on a semi-annual basis. Table 4 presents the water levels measured quarterly in 2019. The percent of open screen available for gas collection at each well is estimated based on water levels.

Based on pump counters and water levels recorded throughout 2019, dual purpose well pumps continue to remove leachate consistently. Most of the monitored dual-purpose wells have open screen percentages on average 40%. In August and June 2018, pumps at wells 3-27 and 3-30 respectively, were reinstalled due to suspicion that they may not be functioning as designed as a result of leachate and siltation residue making the pump inoperable. The pumps operated as intended in 2019.

Table 2: Wellfield Monitoring Data

		Units	23/Jan/19	28/Feb/19	22/Mar/19	22/Apr/19	28/May/19	24/Jun/19	18/Jul/19	24/Aug/19	19/Sep/19	29/Oct/19	25/Nov/19	29/Dec/19
Weather Conditions				cloudy	clear	sunny	sunny	cloudy	cloudy	clear	cloudy	cloudy	cloudy	cloudy
Ambient Temperature		^{o}C		-21	-3	18	24	21	27	17	10	3	-21	-8
Control Panel	*Flow Rate*	*CFM*		800	800	800	800	800	800	800	900	900	800	800
	CH_4	*%*		43.1	50.0	47.5	52.2	51.4	54.0	49.4	52.3	43.0	43.1	42.9
	O_2	*%*		2.4	1.5	2.6	0.8	1.3	0.5	2.2	1.1	2.6	2.4	4.0
	Wellfield Vac	*"H_2O*		30.5	12.1	15.6	13.1	8.9	6.9	5.2	13.1	19.5	30.5	6.4
	Outlet Press.	*"H_2O*		3.0	2.6	3.2	3.2	3.2	3.2	3.3	3.0	4.1	3.0	4.6
LOCATIONS														
H-1	*Well*	*"H_2O*	0.49	0.57	0.11	-3.97	-7.11	-4.80	-3.28	-3.29	-6.38	-2.82	1.26	-2.12
well bore seal	*Lateral*	*"H_2O*	-18.48	0.00	-27.73	-11.19	-14.50	-8.90	-6.39	-4.70	-11.42	-7.95	Surging	-3.64
	CH_4	*%*	62.5	63.1	49.0	56.1	41.0	53.3	51.8	50.7	46.9	42.3	58.5	50.6
	CO_2	*%*	37.2	36.4	28.7	36.9	32.6	34.5	35.6	33.8	36.3	27.6	35.6	40.6
	O_2	*%*	0.2	0.4	4.4	0.4	0.1	0.0	0.0	1.4	1.2	3.5	1.2	7.7
	BAL (N_2)	*%*	10.0	0.0	17.8	6.5	26.3	12.2	12.7	14.0	15.7	26.6	4.6	1.1
	CO	*PPM*	3	2	4	13	13	11	16	10	10	8	8	9
	H_2S	*PPM*	-	49	23	11	17	18	19	9	14	21	12	15
	Vel Max	*m/s*	-	-	0.85	2.70	-	-	-	1.31	2.61	1.41	Surging	Surging
	Vel Min	*m/s*	-	-	0.82	2.51	-	-	-	1.83	2.82	1.30	Surging	Surging
	Flow	*CFM*	-	-	7.890280313	24.61578469	-	-	-	14.8	25.7	12.8	Surging	Surging
	Temp	*^{o}C*	-	-	-	23.1	-	-	-	20.5	19.7	3.5	Surging	Surging
	Comments		closed	closed	closed -> cracked	cracked -> 1/2T	1/2->cracked	cracked -> 1/2T	1/2T	1/2T	1/2->cracked	cracked	cracked->1/2T	1/2T
H-2	*Well*	*"H_2O*	0.84	0.10	-1.83	0.43	-1.79	-1.11	-1.44	-1.63	-3.04	-0.82	-0.25	-1.69
	Lateral	*"H_2O*	-18.66	-23.30	-25.51	-11.09	-14.20	-8.94	-6.02	-4.96	-11.27	-7.45	Surging	-4.02
	CH_4	*%*	55.0	59.7	36.8	59.3	47.4	53.5	51.0	54.2	46.7	55.8	59.3	53.4
	CO_2	*%*	34.1	40.1	28.2	40.2	36.7	38.6	37.5	38.5	36.8	37.8	40.5	42.8
	O_2	*%*	2.9	0.3	5.4	0.1	0.2	0.0	0.0	0.0	0.3	1.1	0.2	3.8
	BAL (N_2)	*%*	7.0	0.0	29.6	0.5	15.7	7.9	11.6	7.3	16.1	5.3	0.0	0.0
	CO	*PPM*	5	20	6	7	14	11	12	9	10	7	5	6
	H_2S	*PPM*		7	9	6	15	23	18	12	13	20	15	18
	Vel Max	*m/s*	0.78	5.50	4.35	2.75	-	-	-	1.99	2.20	3.50	Surging	Surging
	Vel Min	*m/s*	0.64	5.50	4.18	2.60	-	-	-	3.28	2.40	3.22	Surging	Surging
	Flow	*CFM*	6.709100625	51.97190625	40.30185094	25.27724531	-	-	-	24.9	21.7	31.8	Surging	Surging
	Temp	*^{o}C*	-10.6	8.0	10.5	22.0	-	-	-	24.9	23.4	14.5	Surging	Surging
	Comments		cracked	cracked	cracked -> closed	closed -> cracked	cracked	cracked -> 1/2T	1/2T	1/2T	1/2T -> cracked	cracked -> 1/2T	1/2->1T	1T
H-3	*Well*	*"H_2O*	-14.82	-20.10	-6.95	-7.70	-10.00	-6.68	-4.14	-3.79	-7.07	-2.84	-3.28	-0.98
	Lateral	*"H_2O*	-17.02	-23.60	-26.42	-9.78	-12.34	-8.23	-5.29	-4.79	-9.56	-6.78	-6.08	-2.93
	CH_4	*%*	48.9	23.7	54.4	54.1	50.0	51.7	53.6	55.5	52.5	58.2	57.9	54.2
	CO_2	*%*	36.3	16.1	39.9	40.0	37.9	38.8	40.1	41.1	40.2	41.0	41.9	45.8
	O_2	*%*	2.9	12.5	1.1	1.0	1.3	1.0	0.5	0.6	0.7	0.8	0.2	0.0
	BAL (N_2)	*%*	0.0	45.0	4.6	0.5	10.8	8.5	5.8	2.9	6.6	0.0	0.0	0.0
	CO	*PPM*	6	6	27	22	54	53	50	22	19	14	10	14
	H_2S	*PPM*		3	7	6	6	7	10	6	7	19	12	12
	Vel Max	*m/s*	4.96	2.00	3.53	3.33	-	-	-	1.60	2.86	2.13	2.37	2.46
	Vel Min	*m/s*	4.43	1.50	3.13	3.18	-	-	-	2.06	3.23	2.07	2.14	2.71
	Flow	*CFM*	44.36510906		31.46662688	30.75791906	-	-	-	17.3	28.8	19.8	21.3	24.4
	Temp	*^{o}C*	7.0	2.0	8.6	22.9	-	-	-	18.4	19.8	13.4	6.3	5.4
	Comments		1/2 T	1/2T	1/2T -> 1T	1T	1T	1T -> no change	1T	1T	1T	1T	1T	1T
H-4 DP	*Well*	*"H_2O*	-11.68	-0.33	-0.12	0.78	-1.94	0.40	-0.35	-2.98	-9.16	-6.18	-5.90	-0.42
	Lateral	*"H_2O*	-16.92	-28.90	-25.93	-9.80	-12.38	-8.22	-5.20	-4.42	-9.42	-6.25	-6.49	-2.61
	CH_4	*%*	24.3	35.8	53.4	58.4	41.9	57.0	56.4	57.9	54.1	58.2	58.6	56.9
	CO_2	*%*	17.2	24.6	37.7	41.2	31.0	40.5	40.7	41.1	39.8	41.9	41.0	42.9
	O_2	*%*	12.7	9.8	1.9	0.0	4.4	0.2	0.0	0.0	1.2	0.1	0.4	0.1
	BAL (N_2)	*%*	46.7	29.4	7.1	0.3	22.6	2.4	2.8	0.9	4.9	0.0	0.0	0.1
	CO	*PPM*	0	1	2	3	26	16	13	9	16	9	5	8
	H_2S	*PPM*		10	15	42	18	37	34	22	19	28	20	21
	Vel Max	*m/s*	PORT	0.90	1.46	2.84	-	-	-	1.50	2.47	2.81	2.38	1.99
	Vel Min	*m/s*	BLOCKED	0.80	1.26	2.76	-	-	-	1.81	2.82	2.69	1.83	2.62
	Flow	*CFM*	WITH		12.851235	26.458425	-	-	-	15.6	25.0	26.0	19.9	21.8
	Temp	*^{o}C*	ICE	-7.0	10.9	21.2	-	-	-	20.8	23.4	7.6	6.5	6.2
	Comments		closed	closed	closed -> cracked	cracked -> 1/2T	1/2->cracked	cracked -> 1/2T	1/2->1T	1->2T	2T	2T	2T	2T

Table 2: Wellfield Monitoring Data

		Units	23/Jan/19	28/Feb/19	22/Mar/19	22/Apr/19	28/May/19	24/Jun/19	18/Jul/19	24/Aug/19	19/Sep/19	29/Oct/19	25/Nov/19	29/Dec/19
1-5	*Well*	"H_2O	0.37	0.30	0.44	-2.56	-3.77	-1.36	-0.17	-1.57	-2.91	0.00	-0.13	-0.86
well bore seal	*Lateral*	"H_2O	-13.31	0.20	0.38	-9.92	-12.58	-8.24	-5.57	-4.37	-8.96	-7.11	-6.29	-3.24
	CH_4	%	58.0	48.0	59.9	56.3	39.1	50.6	56.2	52.7	44.0	57.7	52.3	52.9
	CO_2	%	40.3	31.3	40.0	39.2	32.8	38.5	40.3	40.6	36.6	42.1	38.0	46.1
	O_2	%	0.1	5.6	0.0	0.4	1.6	0.3	0.0	0.0	1.0	0.0	2.0	0.8
	BAL (N_2)	%	0.0	15.2	0.0	4.0	26.5	10.6	3.5	6.6	18.4	0.0	7.7	0.2
	CO	*PPM*	4	2	3	6	15	9	9	5	6	6	4	6
	H_2S	*PPM*		176	166	18	14	14	34	12	14	25	14	14
	Vel Max	*m/s*	KANAFLEX	KANAFLEX	NO LAT VAC	3.09	-	-	-	1.97	1.77	2.79	3.25	2.41
	Vel Min	*m/s*	IS	IS	NO LAT VAC	2.92	-	-	-	2.13	1.90	2.59	2.86	2.98
	Flow	*CFM*	FROZEN	FROZEN	#VALUE!	28.39555969	-	-	-	19.4	17.3	25.4	28.9	25.5
	Temp	°C	-	-	-	22.0	-	-	-	21.4	25.3	12.8	13.1	13.0
	Comments		no change	no change	closed -> 1/2T	1/2T	1/2->cracked	cracked -> no change	cracked->1/2T	1/2T	1/2->cracked	cracked -> 1/2T	1/2T	1/2T
1-6 DP	*Well*	"H_2O	0.46	-2.60	0.47	-2.29	-2.71	0.47	0.37	-1.15	-1.79	1.31	0.54	-1.44
	Lateral	"H_2O	-17.34	-22.70	-27.78	-9.47	-13.06	-8.32	-5.57	-4.48	-9.85	-6.87	-6.86	-2.44
	CH_4	%	59.9	23.0	59.5	46.8	27.5	57.9	58.6	45.2	33.1	60.3	60.1	54.6
	CO_2	%	39.8	18.7	40.4	32.0	24.7	40.3	38.6	32.9	30.4	39.7	39.0	41.2
	O_2	%	0.2	12.1	0.1	2.4	3.0	0.0	0.0	1.9	2.0	0.1	0.0	3.8
	BAL (N_2)	%	0.0	42.0	0.0	18.7	44.9	1.7	2.3	20.0	34.5	0.0	0.9	0.4
	CO	*PPM*	4	25	3	6	15	8	9.0	7	5	5	3	7
	H_2S	*PPM*		5	280	37	40	286	157.0	39	49	81	84	90
	Vel Max	*m/s*	KANAFLEX	KANAFLEX	2.06	3.32	-	-	-	1.52	-	2.56	2.21	1.42
	Vel Min	*m/s*	IS	IS	1.92	3.22	-	-	-	1.85	-	2.17	1.71	2.04
	Flow	*CFM*	FROZEN	FROZEN	18.80438063	30.89966063	-	-	-	15.9	-	22.3	18.5	16.3
	Temp	°C	-	-	5.5	22.7	-	-	-	27.8	-	-0.1	6.6	8.9
	Comments		no change	1/2T-> closed	closed -> 1/2T	1/2T	1/2->closed	closed -> cracked	cracked->1/2T	1/2->cracked	1/2->closed	closed -> cracked	cracked->1T	1T
1-7	*Well*	"H_2O	0.27	-0.87	-1.21	0.47	0.10	-0.16	-0.07	-0.16	-0.68	0.18	0.10	-0.29
	Lateral	"H_2O	-18.98	-27.10	-25.09	-9.05	-13.71	-8.44	-6.07	-4.15	-9.70	-6.20	-6.29	-3.68
	CH_4	%	54.7	34.3	29.7	56.6	53.4	51.7	51.4	54.7	41.4	55.4	46.3	54.8
	CO_2	%	44.8	34.4	32.9	43.4	42.5	42.2	43.3	43.1	41.5	44.2	35.7	44.9
	O_2	%	0.2	3.3	1.4	0.0	0.6	0.4	0.0	0.0	0.3	0.3	3.7	0.2
	BAL (N_2)	%	0.0	27.9	36.0	0.0	3.5	5.7	5.3	2.2	16.9	0.0	14.3	0.1
	CO	*PPM*	4	45	228	202	204	316	277	187	164	114	50	56
	H_2S	*PPM*		9	9	17	23	26	23	15	15	80	13	14
	Vel Max	*m/s*	0.61	7.60	2.20	1.13	-	-	-	2.47	2.46	3.07	3.37	3.12
	Vel Min	*m/s*	0.44	7.20	2.08	1.09	-	-	-	2.75	2.66	2.96	3.08	3.42
	Flow	*CFM*	4.960954688	69.9258375	20.22179625	10.48887563	-	-	-	24.7	24.2	28.5	30.5	30.9
	Temp	°C	-7.0	19.5	10.7	24.1	-	-	-	24.5	25.6	10.2	12.0	13.4
	Comments		cracked	cracked	cracked -> closed	closed -> cracked	cracked->1/2	1/2 -> no change	1/2T	1/2T	1/2->cracked	cracked -> 1/2T	1/2T	1/2T
1-8	*Well*	"H_2O	0.53	0.20	-0.99	0.02	-1.19	0.07	0.12	-0.26	-1.28	-1.56	0.11	-0.32
	Lateral	"H_2O	-18.40	-29.50	-26.00	-8.84	-13.07	-8.28	-6.06	-4.32	-10.55	-6.76	-6.43	-3.23
	CH_4	%	58.4	52.8	45.5	58.8	26.0	58.4	56.8	57.2	48.5	49.7	57.4	54.9
	CO_2	%	40.1	41.4	39.5	41.3	23.1	41.3	41.9	41.4	41.7	39.3	42.1	45.0
	O_2	%	0.8	2.3	1.0	0.0	8.3	0.2	0.0	0.3	0.7	0.6	0.4	0.1
	BAL (N_2)	%	0.0	0.0	13.9	0.0	42.6	0.0	1.3	1.1	9.0	10.4	0.0	0.0
	CO	*PPM*	0	5	29	14	16	6	31	13	20	25	6	9
	H_2S	*PPM*		145	86	108	49	263	112	79	57	63	42	41
	Vel Max	*m/s*	0.69	-	3.47	5.98	-	-	-	1.89	1.92	1.87	5.54	5.42
	Vel Min	*m/s*	0.56	-	3.32	5.80	-	-	-	2.08	2.08	2.15	5.16	6.01
	Flow	*CFM*	5.905898438	-	32.08084031	55.65718688	-	-	-	18.8	18.9	19.0	50.6	54.0
	Temp	°C	-6.8	-	6.7	26.5	-	-	-	31.0	32.7	30.6	20.1	22.4
	Comments		cracked	cracked	cracked	cracked -> 1T	1->closed	closed -> cracked	cracked	cracked->1/2T	1/2->cracked	cracked	cracked->1T	1T
1-9 DP	*Well*	"H_2O	-1.30	-1.38	0.06	-0.87	-5.60	-0.68	0.04	-0.17	-0.29	-0.37	0.70	-0.41
	Lateral	"H_2O	-18.16	-24.10	-28.22	-11.54	-14.19	-8.72	-6.09	-4.83	-10.86	-7.19	-7.32	-2.16
	CH_4	%	55.7	13.3	61.5	61.2	25.5	40.9	55.7	5.3	9.6	56.6	60.8	53.9
	CO_2	%	37.4	8.9	38.3	36.0	23.3	31.2	35.8	4.8	8.4	34.5	38.9	45.9
	O_2	%	0.7	15.0	0.1	0.8	4.3	2.0	0.1	17.1	14.5	1.6	0.1	0.2
	BAL (N_2)	%	6.3	62.8	0.0	2.2	46.9	25.9	8.5	73.0	67.4	7.3	0.0	0.0
	CO	*PPM*	13	10	5	4	48	38	25	3	4	10	8	4
	H_2S	*PPM*		8	179	6	18	3	104	1	0	52	17	17
	Vel Max	*m/s*	3.00	-	3.52	2.15	-	-	-	-	-	1.68	1.55	1.36
	Vel Min	*m/s*	2.91	-	3.10	2.05	-	-	-	-	-	1.61	1.49	1.52
	Flow	*CFM*	27.92308781	-	31.27763813	19.84381875	-	-	-	-	-	15.5	14.4	13.6
	Temp	°C	19.1	-	8.4	25.7	-	-		-	-	12.5	13.7	12.6
	Comments		no change	closed	closed -> 1/2T	1/2T -> 1T	1->closed	closed -> no change	closed->cracked	cracked->closed	closed	closed -> cracked	cracked->1T	1T

Table 2: Wellfield Monitoring Data

		Units	23/Jan/19	28/Feb/19	22/Mar/19	22/Apr/19	28/May/19	24/Jun/19	18/Jul/19	24/Aug/19	19/Sep/19	29/Oct/19	25/Nov/19	29/Dec/19
1-10 DP	*Well*	"H_2O	0.15	0.20	too tall	-6.15	-2.36	0.03	-1.82	-2.87	-8.73	-5.45	-3.96	0.24
	Lateral	"H_2O	-17.54	-22.82	-29.53	-11.14	-14.22	-8.94	-6.20	-4.94	-11.27	-7.43	-7.45	-2.67
	CH_4	%	67.2	68.5	55.2	41.0	24.8	67.7	578.0	57.2	47.9	60.6	59.3	57.9
	CO_2	%	30.8	30.4	30.9	27.1	17.9	30.7	34.6	34.8	34.9	37.6	35.3	40.4
	O_2	%	0.4	0.5	2.5	5.3	8.5	0.7	0.3	1.0	1.4	0.2	30.1	0.2
	BAL (N_2)	%	2.0	0.0	11.3	26.5	48.8	1.6	7.3	7.0	15.8	1.6	2.4	1.5
	CO	PPM	0	0	7	8	12	6.0	23	10	9	11	8	12
	H_2S	PPM		125	2	8	2	52.0	14	20	15	31	5	6
	Vel Max	m/s	-	0.44	2.39	1.03	-	-	-	1.18	2.49	2.14	3.14	2.59
	Vel Min	m/s	-	0.00	2.21	0.97	-	-	-	1.42	2.60	1.95	2.39	2.61
	Flow	CFM	-		21.73370625	9.4494375	-	-	-	12.3	24.0	19.3	26.1	24.6
	Temp	°C	-	-12.4	10.9	22.8	-	-	-	14.5	19.2	7.1	12.3	13.9
	Comments		closed no change	closed -> 1/2T	1/2T -> 1T	1T->1/2T	1/2->closed	closed -> cracked	cracked->1/2T	1/12->1T	1/2T	1/2T -> 1T	1->2T	2T
H-11 DP	*Well*	"H_2O	9.17	-28.20	-20.50	-20.08	-6.43	-2.85	-3.04	-2.69	-8.87	-5.85	-5.84	-1.69
	Lateral	"H_2O	-18.86	-29.70	-30.20	-9.66	-12.46	-8.59	-5.36	-4.49	-9.23	-6.84	-6.84	-2.87
	CH_4	%	58.0	28.0	35.1	56.6	46.7	52.5	52.0	55.6	47.7	56.9	57.3	55.3
	CO_2	%	41.7	28.1	26.7	42.8	34.6	38.8	37.7	40.8	38.8	37.8	40.5	42.6
	O_2	%	0.2	9.2	4.9	0.0	2.7	1.0	0.9	0.4	2.1	1.3	0.5	2.0
	BAL (N_2)	%	0.0	40.6	33.4	0.6	16.0	7.7	9.4	3.2	14.3	4.0	1.6	0.1
	CO	PPM	2	3	2	4	16	16	6	2	9	2	1	5
	H_2S	PPM		21	20	146	111	126	92	81	15	40	77	81
	Vel Max	m/s	KANAFLEX	1.23	1.83	4.24	-	-	-	1.83	2.49	1.84	2.69	Surging
	Vel Min	m/s	IS	0.44	1.76	3.89	-	-	-	2.06	2.60	1.68	2.15	Surging
	Flow	CFM	FROZEN	FROZEN	16.96174031	38.41196344	-	-	-	18.4	24.0	16.6	22.9	Surging
	Temp	°C	-	-13.0	13.6	21.7	-	-	-	22.4	25.3	1.6	11.4	surging
	Comments		no change	2T -> cracked	cracked -> closed	closed -> cracked	cracked	cracked -> no change	cracked->1/2T	1/2->1T	1->1/2T	1/2T -> 1T	1T	1T
H-12	*Well*	"H_2O	port frozen	-30.00	5.80	1.44	-7.42	-4.65	-1.96	-4.99	0.14	2.58	-1.65	-3.16
well bore seal	*Lateral*	"H_2O	-18.18	-29.60	-30.41	-9.06	-12.55	-8.42	-5.60	-7.18	-9.37	-6.53	Surging	-1.97
	CH_4	%	44.1	0.4	62.3	61.1	49.7	51.0	52.2	48.3	57.3	60.4	41.4	42.6
	CO_2	%	26.5	0.1	37.7	38.2	33.5	34.0	35.4	32.4	38.1	39.6	27.9	40.8
	O_2	%	6.9	21.5	0.0	0.0	2.8	2.3	1.5	3.1	0.3	0.0	5.4	5.0
	BAL (N_2)	%	22.2	78.0	0.0	0.6	13.9	12.7	10.8	16.2	4.2	0.0	25.3	11.6
	CO	PPM	3	2	5	4	3	10	6	5	9	4	2	4
	H_2S	PPM		0	101	45	12	22	30	11	39	36	16	19
	Vel Max	m/s	0.00	0.00	1.35	2.40	-	-	-	1.70	1.13	2.19	Surging	Surging
	Vel Min	m/s	0.00	0.00	1.30	2.22	-	-	-	1.83	1.26	2.08	Surging	Surging
	Flow	CFM	-11.4	-11.4	12.52050469	21.82820063	-	-	-	16.7	11.3	20.2	Surging	Surging
	Temp	°C			12.8	23.5	-	-	-	21.1	25.1	8.1	Surging	Surging
	Comments		valve is frozen	valve is frozen	frozen -> 20%	20->30%	30%	30%	30%	30->20%	20->30	30	30->20%	20%
2-13	*Well*	"H_2O	-1.79	-8.20	-0.23	-0.01	-3.35	-5.05	-4.50	-5.68	-6.98	-5.66	-5.66	-1.06
	Lateral	"H_2O	-18.72	frozen	buried	-9.18	-12.71	-8.49	-5.95	-7.24	-9.10	-6.11	-6.11	-2.62
	CH_4	%	58.0	21.9	57.7	56.4	58.3	59.2	56.4	58.1	57.9	58.2	58.20	57.5
	CO_2	%	40.6	16.3	42.2	40.2	39.8	39.9	40.0	40.1	40.3	41.1	41.60	41.6
	O_2	%	1.1	14.2	0.0	0.6	0.4	0.3	0.3	0.0	0.1	0.7	0.20	0.9
	BAL (N_2)	%	0.0	47.0	0.0	2.8	1.6	0.6	3.4	1.6	1.8	0.0	0.00	0.0
	CO	PPM	30	11	130	185	148	151	109	175	142	50	40.00	52
	H_2S	PPM		63	0	244	130	118	118	39	85	90	73.00	70
	Vel Max	m/s	3.92	-	buried	1.89	-	-	-	3.50	4.51	3.81	3.61	3.42
	Vel Min	m/s	3.60	-	buried	1.41	-	-	-	4.27	6.91	3.54	4.14	4.24
	Flow	CFM	35.529885	-	#VALUE!	15.59157188	-	-	-	36.71	53.96	34.73	36.62	36.19
	Temp	°C	16.7	-	buried	24.2	-	-	-	25.0	29.4	17.9	6.7	8.2
	Comments		1/2 T	1/2T -> closed	closed -> cracked	cracked->1/2T	1/2->3/4	3/4 -> 1T	1T	1T	1->2T	2T	2T	2T
2-14	*Well*	"H_2O	-0.16	-0.37	0.62	0.14	-0.23	-0.03	-0.08	-0.66	-0.88	-0.55	0.08	0.10
well bore seal	*Lateral*	"H_2O	-17.81	-25.30	-30.83	-9.25	13.78	-8.91	-6.40	-4.08	-8.64	-6.24	Surging	-1.62
	CH_4	%	40.0	31.0	58.3	55.0	45.3	56.5	54.6	40.7	42.2	43.6	58.5	53.8
	CO_2	%	28.7	22.6	41.8	39.4	33.4	40.2	40.2	30.5	32.8	35.0	41.5	46.2
	O_2	%	6.3	20.0	0.0	0.8	3.3	0.3	0.4	5.1	3.6	4.9	0.0	0.0
	BAL (N_2)	%	25.2	26.2	0.0	4.8	18.0	3.1	4.8	23.7	21.3	16.5	0.0	0.0
	CO	PPM	6	5	15	16	13	7	10	5	10	8	7	14
	H_2S	PPM		23	78	35	32	42	42	19	23	24	41	40
	Vel Max	m/s	5.55	-	1.28	2.40	-	-	-	4.37	3.89	1.69	Surging	Surging
	Vel Min	m/s	5.32	-	1.21	2.18	-	-	-	5.39	1.24	2.98	Surging	Surging
	Flow	CFM	51.35769281	-	11.76454969	21.63921188	-	-	-	46.11	24.24	22.06	Surging	Surging
	Temp	°C	-3.7	-	-	22.3	-	-	-	26.7	27.3	25.3	Surging	Surging
	Comments		no change	2T -> closed	closed -> 1/2T	1/2T	1/2->cracked	cracked -> 1/2T	1T	1->1/2T	1->1/2T	1/2T	1/2T	1/2T

Table 2: Wellfield Monitoring Data

		Units	23/Jan/19	28/Feb/19	22/Mar/19	22/Apr/19	28/May/19	24/Jun/19	18/Jul/19	24/Aug/19	19/Sep/19	29/Oct/19	25/Nov/19	29/Dec/19
2-15	*Well*	"H_2O	0.15	0.30	-1.68	0.39	-0.29	-0.69	-0.51	-0.82	-1.48	-0.98	-0.10	0.3
	Lateral	"H_2O	FROZEN	0.20	-28.74	-9.18	-14.54	-8.93	-6.74	-4.07	-10.99	-6.50	-5.80	-3.5
	CH_4	%	58.4	58.6	26.9	58.5	53.7	52.1	54.8	43.1	51.0	50.2	58.8	55.1
	CO_2	%	41.2	41.3	22.4	40.8	39.6	39.0	40.5	32.3	38.5	39.3	41.0	44.9
	O_2	%	0.3	0.1	8.6	0.0	0.7	0.9	0.2	4.2	1.0	1.5	0.1	0.0
	BAL (N_2)	%	0.0	0.0	42.1	0.6	6.1	7.9	4.5	20.4	9.4	9.0	0.0	0.0
	CO	PPM	6	7	37	14	31	32	22	20	22	26	12	10.0
	H_2S	PPM		13	5	18	17	11	13	10	17	12	18	18.0
	Vel Max	m/s	KANAFLEX	KANAFLEX	7.53	1.26	-	-	-	1.03	1.90	1.68	4.62	4.9
	Vel Min	m/s	IS	IS	7.01	1.20	-	-	-	1.24	1.71	1.72	5.48	5.2
	Flow	CFM	FROZEN	FROZEN	68.69741063	11.62280813	-	-	-	10.73	17.06	16.06	47.72	47.72
	Temp	°C	-	-	6.9	21.3	-	-	-	19.8	21.0	22.6	14.1	16.2
	Comments		1/2T -> no change	1/2T	1/2T -> closed	closed -> cracked	cracked->1/2	1/2T -> 3/4T	3/4->1T	1->1/2T	1->1/2T	1/2T	1/2->1T	1T
2-16	*Well*	"H_2O	-0.77	-0.10	-0.32	0.95	-0.03	-0.32	-0.09	-0.65	-1.59	0.56	-0.06	-0.69
	Lateral	"H_2O	-17.61	-27.60	-27.45	-9.11	-12.92	-7.77	-5.56	-3.54	-9.39	-5.67	-6.50	-3.86
	CH_4	%	41.1	41.3	41.3	58.3	56.7	31.0	55.6	52.1	44.4	58.3	58.0	57.2
	CO_2	%	29.6	29.8	31.7	41.4	41.0	38.4	40.9	38.9	36.3	41.8	41.3	40.2
	O_2	%	5.9	6.6	4.5	0.0	0.1	0.8	0.4	0.9	1.3	0.0	0.7	0.2
	BAL (N_2)	%	22.9	26.6	22.4	0.3	2.3	9.8	3.1	8.2	18.0	0.0	0.0	2.4
	CO	PPM	0	0	13	31	14	31	32	12	14	10	9	6
	H_2S	PPM		29	26	43	44	32	39	19	26	35	24	25
	Vel Max	m/s	4.39	11.50	6.08	3.65	-	-	-	4.74	5.84	6.07	5.12	6.62
	Vel Min	m/s	4.26	10.20	5.70	3.38	-	-	-	5.28	4.27	5.04	7.11	7.83
	Flow	CFM	40.86881719	102.5263969	55.65718688	33.21477281	-	-	-	47.34	47.77	52.49	57.78	68.27
	Temp	°C	9.7	7.0	8.4	23.4	-	-	-	24.4	27.1	17.7	16.5	19.6
	Comments			1T	1T -> cracked	cracked->1/2T	1/2->3/4	3/4T -> no change	3/4->1T	1T	1->1/2T	1/2T -> 1T	1->2T	2T
2-17	*Well*	"H_2O	-2.29	-2.84	-2.65	1.84	-0.12	-1.24	-2.47	-1.11	-1.50	-2.68	-1.81	1.42
	Lateral	"H_2O	-18.64	-25.00	-27.44	-9.28	-14.43	-9.74	-7.01	-4.14	-10.75	-5.14	-5.55	-2.64
	CH_4	%	57.2	47.0	38.5	59.6	56.3	56.3	56.3	31.7	55.2	54.1	58.1	54.1
	CO_2	%	38.0	34.2	29.1	39.9	39.3	39.3	40.9	22.8	40.0	38.4	40.2	40.2
	O_2	%	1.6	3.6	5.7	0.5	0.2	0.6	1.1	8.6	0.3	3.6	0.8	5.0
	BAL (N_2)	%	2.7	15.0	26.8	0.0	4.2	3.8	1.7	36.9	45.0	3.9	0.9	0.7
	CO	PPM	4	3	10	7	9	5	6	4	6	5	5	5
	H_2S	PPM		6	3	72	16	11	10	9	10	5	7	7
	Vel Max	m/s	2.63	-	5.81	1.83	-	-	-	2.73	1.88	2.47	3.61	4.02
	Vel Min	m/s	2.40	-	5.51	1.75	-	-	-	2.85	1.41	2.82	4.33	4.49
	Flow	CFM	23.76533531	-	53.48381625	16.91449313	-	-	-	26.4	15.5	25.0	37.5	40.2
	Temp	°C	-2.9	-	8.9	16.6	-	-	-	19.0	22.9	23.1	12.7	14.2
	Comments		1.25T->no change	1T	1T -> closed	closed -> cracked	cracked->1/2	1/2T -> 1T	1T	1->1/2T	1/2->1T	1T	1T	1T
2-18	*Well*	"H_2O	-1.03	-1.04	-0.71	0.28	-0.30	-0.17	-0.48	-0.47	-1.04	-0.59	-0.12	-0.32
	Lateral	"H_2O	-17.54	-23.27	-29.11	-11.46	-14.36	-10.18	-7.18	-4.20	-10.65	-6.11	Surging	-2.22
	CH_4	%	47.8	16.4	28.7	60.2	45.9	51.0	42.0	51.5	33.8	48.5	37.9	34.8
	CO_2	%	33.6	14.8	24.6	39.3	34.8	36.8	34.7	38.0	31.9	36.2	33.4	40.6
	O_2	%	3.5	11.5	5.6	0.4	1.1	1.0	1.4	0.6	2.5	1.1	1.1	6.4
	BAL (N_2)	%	14.9	57.0	41.2	0.0	18.2	11.2	22.0	9.9	31.8	14.2	27.5	18.2
	CO	PPM	10	23	25	5	21	11	14	10	19	21	15	16
	H_2S	PPM		15	28	121	39	41	32	31	20	48	40	42
	Vel Max	m/s	5.63	-	3.45	2.30	-	-	-	1.51	-	0.45	-	Surging
	Vel Min	m/s	3.63	-	2.96	2.10	-	-	-	1.79	-	0.96	-	Surging
	Flow	CFM	43.75089563	-	30.28544719	20.7887625	-	-	-	15.59	-	6.66	-	Surging
	Temp	°C	-3.7	-	7.8	21.5	-	-	-	29.0	-	31.4	-	Surging
	Comments		1T->no change	1T-> 1/2T	1/2T -> closed	closed -> cracked	cracked	cracked -> 1/2T	1/2->cracked	cracked->1/2T	1/2T->cracked	cracked	cracked->closed	closed
3-19	*Well*	"H_2O	-5.29	-26.20	1.84	2.62	1.55	-3.73	-1.95	-2.21	6.17	4.16	0.98	0.41
	Lateral	"H_2O	-17.37	-26.50	-20.90	-9.04	-11.45	-6.92	-4.92	-6.54	-8.77	-4.32	-2.81	-4.46
	CH_4	%	42.3	0.9	58.9	58.7	57.7	53.1	55.7	41.4	57.9	58.9	58.1	58.5
	CO_2	%	29.2	5.0	41.7	41.2	40.6	37.3	39.7	29.7	40.7	40.9	41.9	40.1
	O_2	%	6.4	21.7	0.0	0.1	0.0	1.6	0.4	5.0	0.1	0.3	0.0	1.2
	BAL (N_2)	%	22.2	76.9	0.0	0.0	1.7	7.9	4.2	23.9	1.3	0.0	0.0	0.2
	CO	PPM	4	4	4	6	5	6	8	6	8	9	6	6
	H_2S	PPM		2	32.0	46	29	26	36	13	37	39	25	25
	Vel Max	m/s	3.28	-	5.51	4.21	-	-	-	1.34	4.23	6.00	5.90	6.17
	Vel Min	m/s	3.10	-	5.30	4.08	-	-	-	1.58	4.10	5.73	7.10	7.20
	Flow	CFM	30.14370563	-	51.07420969	39.16791844	-	-	-	13.80	39.36	55.42	61.42	63.17
	Temp	°C	6.0	-	-	22.1	-	-	-	21.4	15.5	11.2	12.9	13.1
	Comments		1T->1/4T	cracked->closed	closed -> 1/2T	1/2T	1/2->1	1T -> no change	1T	1->cracked	cracked->1/2T	1/2T -> 1T	1->2T	2T

Table 2: Wellfield Monitoring Data

		Units	23/Jan/19	28/Feb/19	22/Mar/19	22/Apr/19	28/May/19	24/Jun/19	18/Jul/19	24/Aug/19	19/Sep/19	29/Oct/19	25/Nov/19	29/Dec/19
3-20	*Well*	"H_2O	8.03	-10.90	-8.68	17.57	6.74	1.78	1.66	-0.34	-1.66	-3.76	-2.44	0.62
	Lateral	"H_2O	FROZEN	-23.30	-25.78	-9.13	-12.09	-7.11	-5.02	-7.79	-8.36	-5.59	-3.76	-3.41
	CH_4	%	56.8	46.9	36.2	56.4	57.1	57.3	55.4	54.5	55.2	57.3	56.7	57.9
	CO_2	%	42.5	34.0	27.6	43.3	42.4	42.5	41.7	39.9	41.7	42.7	43.3	41.9
	O_2	%	0.4	5.0	7.3	0.4	0.2	0.2	0.0	0.3	0.1	0.0	0.0	0.2
	BAL (N_2)	%	0.0	12.3	28.9	0.0	0.3	0.0	2.8	6.1	2.9	0.0	0.0	0.0
	CO	PPM	15	12	16	17	24	22	34	30	29	17	18	22
	H_2S	PPM		4	3	5	6	5	7	4	6	9	11	12
	Vel Max	m/s	KANAFLEX	5.60	9.80	2.73	-	-	-	4.41	7.19	5.19	4.06	3.84
	Vel Min	m/s	IS	5.30	9.34	2.58	-	-	-	5.07	6.83	4.96	5.57	4.99
	Flow	CFM	FROZEN	FROZEN	90.43111688	25.08825656	-	-	-	44.79	66.24	47.96	45.50	41.72
	Temp	°C	-	-16.0	9.9	18.8	-	-	-	19.8	16.2	8.1	8.0	6.6
	Comments		1//4T	1/4T	1/4T -> closed	closed -> cracked	cracked->1/2	1/2T -> 1T	1T	1T	1->2T	2T	2T	2T
3-21	*Well*	"H_2O	0.10	-25.90	1.74	-3.41	0.21	0.04	0.37	-0.10	0.75	0.05	0.05	-2.14
	Lateral	"H_2O	-18.63	-26.30	-21.35	-9.27	-11.89	-7.37	-5.33	-8.05	-8.76	-5.29	-3.82	-2.72
	CH_4	%	53.4	23.7	57.0	17.8	54.0	40.0	55.2	42.2	55.8	52.0	56.2	53.6
	CO_2	%	39.2	17.2	42.7	13.9	41.7	31.2	42.7	32.9	43.3	39.6	43.8	44.6
	O_2	%	2.5	13.0	0.3	13.2	0.3	5.3	0.0	4.2	0.1	2.0	0.0	1.4
	BAL (N_2)	%	1.3	45.2	0.0	55.2	3.9	23.5	2.1	20.7	0.8	6.4	0.0	0.4
	CO	PPM	3	4	4	0	5	1	7	5	5	7	2	2
	H_2S	PPM		7	12	0	25	1	27	2	23	16	16	16
	Vel Max	m/s	1.63	-	0.54	-	-	-	-	0.00	0.00	0.46	1.58	1.24
	Vel Min	m/s	1.53	-	0.42	-	-	-	-	0.56	0.00	0.00	1.90	1.82
	Flow	CFM	14.93011125	-	4.53573	-	-	-	-	2.6	0.0	2.2	16.4	14.5
	Temp	°C	-10.5	-	18.3	-	-	-	-	28.6	13.6	2.0	3.7	3.9
	Comments		cracked	cracked->closed	closed -> cracked	cracked->closed	closed->cracked	cracked -> closed	closed->cracked	cracked->closed	closed->cracked	cracked	cracked->1T	1T
3-22	*Well*	"H_2O	-12.74	-15.50	-15.83	0.01	-2.20	-3.76	-4.41	-5.60	-6.38	-5.98	-2.55	-3.04
well bore seal	*Lateral*	"H_2O	-15.96	23.20	-23.88	-13.69	-12.19	-7.02	-4.88	-6.46	-7.43	-6.70	-3.48	-3.24
	CH_4	%	55.1	34.6	39.7	58.2	58.1	57.5	56.9	56.6	56.6	57.1	58.0	56.9
	CO_2	%	40.1	31.3	35.6	40.7	41.3	41.1	41.1	40.8	41.3	39.9	42.0	42.4
	O_2	%	0.1	2.9	0.4	0.0	0.0	0.0	0.1	0.1	0.0	0.3	0.0	0.7
	BAL (N_2)	%	4.5	30.3	24.3	0.0	0.5	1.5	1.9	2.4	2.0	2.7	0.0	0.0
	CO	PPM	11	17	23	0	56	64	40	41	59	68	19	6
	H_2S	PPM		42	35	63	44	92	99	44	59	51	71	65
	Vel Max	m/s	7.99	11.20	12.40	-	-	-	-	4.96	7.49	5.21	Surging	Surging
	Vel Min	m/s	7.47	10.20	11.60	-	-	-	-	7.07	5.86	6.33	Surging	Surging
	Flow	CFM	73.04415188	101.1089813	113.39325	-	-	-	-	56.84	63.07	54.52	Surging	Surging
	Temp	°C	-2.4	-11.0	5.8	-	-	-	-	24.9	27.3	29.5	Surging	Surging
	Comments		1T	1T	1T-> closed	closed->1/2T	1/2->1	1T -> 2T	2T	2T	2T	2T	2T	2T
3-23	*Well*	"H_2O	-10.58	-18.30	-18.25	-10.01	-4.68	-3.33	-3.27	-5.52	-6.25	-6.10	-2.00	0.24
	Lateral	"H_2O	-14.12	-24.90	-24.64	-11.05	-10.88	-7.44	-3.72	-6.14	-6.59	-6.53	Surging	-2.63
	CH_4	%	37.9	13.5	34.9	51.0	54.0	55.4	57.7	59.1	58.3	57.7	59.4	57.1
	CO_2	%	25.2	13.8	35.4	40.0	40.3	39.9	40.4	39.5	37.5	38.2	40.3	41.2
	O_2	%	2.4	16.2	1.5	1.0	0.4	0.1	0.0	0.0	0.0	0.3	0.3	1.2
	BAL (N_2)	%	23.8	53.6	28.1	8.0	5.2	4.6	2.0	1.4	4.2	3.8	0.0	0.5
	CO	PPM	3	0	5	4	14	16	20	7	5	6	4	22
	H_2S	PPM		4	15	11	14	40	68	49	41	59	62	70
	Vel Max	m/s	4.54	7.36	6.50	-	-	-	-	2.14	2.48	3.11	Surging	Surging
	Vel Min	m/s	4.26	6.34	5.50	-	-	-	-	3.26	3.55	3.43	Surging	Surging
	Flow	CFM	41.577525	64.72864688	56.696625	-	-	-	-	25.51	28.49	30.90	Surging	Surging
	Temp	°C	20.5	-20.6	12.2	-	-	-	-	27.7	24.3	25.6	Surging	Surging
	Comments		1/4T no change	1/4T	1/4T -> closed	closed->1/2T	1/2T	1/2T -> 1T	1T	1->2T	2T	2T	2T	2T
3-24	*Well*	"H_2O	0.10	-0.10	0	0.59	0.30	-0.03	0.40	12.12	-0.24	-0.13	0.41	-0.32
	Lateral	"H_2O	-15.84	-26.00	-25.27	-13.65	-11.67	-7.27	-5.13	-7.1	-7.26	-6.20	-4.18	-3.10
	CH_4	%	0.4	0.3	0	57.1	57.9	22.3	58.1	55.8	37.9	41.5	56.9	51.2
	CO_2	%	0.3	0.1	0.1	42.8	42.1	16.3	41.9	40.9	28.3	34.1	43.1	39.6
	O_2	%	17.0	21.9	21.8	0.1	0.0	11.5	0.0	0.2	6.1	8.6	0.0	0.0
	BAL (N_2)	%	81.5	77.7	78.1	0.0	0.0	49.9	0.0	3	27.7	15.8	0.0	9.2
	CO	PPM	0	0	1	47	81	28	61.0	64	38	44	36	40
	H_2S	PPM	-	0	0	22	54	46	104.0	63	76	91	57	55
	Vel Max	m/s	-	-	1.15	-	-	-	-	1.64	-	-	0.73	0.49
	Vel Min	m/s	-	-	0.95	-	-	-	-	1.86	-	-	0.98	1.24
	Flow	CFM	-	-	9.921909375	-	-	-	-	16.54	-	-	8.08	8.17
	Temp	°C	-	-	4.4	-	-	-	-	29.9	-	-	0.7	0.9
	Comments		closed no change	closed	closed	closed->cracked	cracked->1/2	1/2T -> closed	closed->cracked	cracked->1/2T	1/2->closed	closed	closed->cracked	cracked

Table 2: Wellfield Monitoring Data

		Units	23/Jan/19	28/Feb/19	22/Mar/19	22/Apr/19	28/May/19	24/Jun/19	18/Jul/19	24/Aug/19	19/Sep/19	29/Oct/19	25/Nov/19	29/Dec/19
3-25	*Well*	"H_2O	-15.87	-27.90	-24.50	-8.58	-10.89	-6.93	-5.32	-2.87	-6.57	-5.97	-3.80	0.72
	Lateral	"H_2O	-16.69	FROZEN	-25.90	-14.01	-1148.00	-7.86	-5.66	-3.25	-6.77	-6.12	-3.32	-2.94
	CH_4	%	53.2	29.9	45.1	56.6	55.1	54.0	53.9	57.3	53.1	54.3	58.2	56.9
	CO_2	%	38.9	25.1	38.3	39.4	38.4	37.8	38.7	39.7	37.8	36.9	39.1	41.7
	O_2	%	1.7	9.2	1.3	1.6	1.1	1.1	0.9	0.1	1.7	0.9	1.2	1.2
	BAL (N_2)	%	6.2	34.8	15.3	2.4	5.4	7.1	6.5	2.8	7.3	7.9	1.5	0.2
	CO	PPM	1.25T->no change	0	4	3	10	14	0	4	17	12	2	2
	H_2S	PPM		19	20	8	16	25	35	25	29	25	32	26
	Vel Max	m/s	6.70	-	6.70	-	-	-	-	-	SURGING	2.55	SURGING	Surging
	Vel Min	m/s	6.28	-	1.30	-	-	-	-	-	SURGING	2.74	SURGING	Surging
	Flow	CFM	61.32684938	-	37.79775	-	-	-	-	-	SURGING	25.0	SURGING	Surging
	Temp	°C	2.4	-	-	-	-	-	-	SURGING		16.3	SURGING	Surging
	Comments		1T -> no change	1T	1T -> 1/2T	1/2->1T	1T	1T -> 2T	2T	2T	2T	2T	2T	2T
3-26	*Well*	"H_2O	8.56	-28.90	-25.43	-8.55	-12.82	-7.87	-5.50	-3.66	-5.25	-5.70	-4.33	0.06
	Lateral	"H_2O	-14.17	-29.40	-26.73	-8.70	-12.87	-8.03	-5.74	-3.69	-5.62	-6.04	-4.42	-2.67
	CH_4	%	59.4	0.3	58.6	59.2	57.0	57.8	56.4	50.8	55.8	57.1	57.6	58.7
	CO_2	%	39.9	0.1	38.5	393.0	38.2	38.8	38.6	35.0	38.5	36.1	37.8	38.6
	O_2	%	0.3	22.0	0.9	0.4	0.6	0.4	0.7	2.1	0.8	1.8	1.5	1.0
	BAL (N_2)	%	0.0	77.6	2.0	1.1	4.1	3.0	4.3	12.1	4.9	5.0	3.1	1.6
	CO	PPM	6	0	6	4	3	5	4	9	23	14	4	4
	H_2S	PPM		0	61	54	24	43	40	26	37	36	37	40
	Vel Max	m/s	KANAFLEX	3.20	1.25	0.92	-	-	-	0.56	SURGING	4.21	0.71	0.46
	Vel Min	m/s	IS	0.98	0.79	0.87	-	-	-	1.09	SURGING	4.53	0.63	0.99
	Flow	CFM	FROZEN	FROZEN	9.63842625	8.457246563	-	-	-	7.80	SURGING	41.29	6.33	6.85
	Temp	°C	-	-20.1	6.6	16.2	-	-	-	24.5		26.3	5.7	7.4
	Comments		3T no change	3T	3T -> 2T	2T	2T	2T -> no change	2T	2T	2T	2T	2T	2T
3-27 DP	*Well*	"H_2O	-12.53	-26.90	-6.90	-9.68	-9.95	-6.87	-3.75	-1.10	-3.89	-0.68	-4.06	-0.44
	Lateral	"H_2O	-15.62	-31.00	-7.92	-11.39	-11.46	-7.60	-5.24	-3.30	-6.10	-5.47	-3.95	-2.61
	CH_4	%	49.3	51.1	51.5	49.6	48.0	50.3	41.5	51.2	50.1	51.2	54.3	52.4
	CO_2	%	37.6	40.5	41.4	42.2	42.4	41.4	39.8	41.8	48.7	43.0	41.0	42.6
	O_2	%	2.9	2.0	0.7	1.4	0.2	0.2	0.5	0.6	0.2	0.9	0.0	0.0
	BAL (N_2)	%	9.4	5.5	6.4	6.8	9.4	7.6	18.3	6.4	1.0	4.9	4.7	5.0
	CO	PPM	1	3	5	4	13	10	19	5	2	6	4	5
	H_2S	PPM		34	20	31	18	48	31	44	29	31	80	26
	Vel Max	m/s	PORT	0.81	0.59	-	-	-	-	-	-	0.86	SURGING	Surging
	Vel Min	m/s	BLOCKED	0.44	0.48	-	-	-	-	-	-	1.25	SURGING	Surging
	Flow	CFM	WITH		5.055449063	-	-	-	-	-	-	9.97	SURGING	Surging
	Temp	°C	ICE	-13.2	7.2	-	-	-	-	SURGING	-	10.5	SURGING	Surging
	Comments		1/2T -> no change	1/2T	1/2T	1/2T	1/2T	1/2T -> no change	1/2->cracked	cracked	cracked	cracked	cracked->1/2T	1/2T
3-28	*Well*	"H_2O	-2.52	1.30	-0.66	1.88	-0.31	-0.15	-1.84	-0.26	-0.08	-2.45	1.12	-0.24
	Lateral	"H_2O	-17.69	-28.87	-26.71	-8.42	-12.47	-7.77	-5.31	-3.34	-5.29	-5.99	-3.83	-1.85
	CH_4	%	32.9	57.4	49.3	58.5	53.8	57.2	52.6	45.5	56.5	53.8	58.1	54.3
	CO_2	%	23.2	41.4	35.1	41.3	38.1	40.5	37.7	33.3	40.6	39.7	41.9	40.4
	O_2	%	9.1	0.6	3.3	0.2	1.2	0.0	1.3	3.4	0.0	1.1	0.0	2.3
	BAL (N_2)	%	30.7	0.0	12.2	0.0	6.9	2.2	8.3	17.9	2.9	5.4	0.0	3.0
	CO	PPM	5	7	8	9	8	9	9	9	32	21	9	10
	H_2S	PPM	-	117	94	110	33	90	89	38	84	81	87	90
	Vel Max	m/s	2.50	5.00	4.71	2.97	-	-	-	2.65	SURGING	1.55	SURGING	Surging
	Vel Min	m/s	2.40	4.20	4.45	2.72	-	-	-	3.56	SURGING	1.81	SURGING	Surging
	Flow	CFM	23.15112188	43.4674125	43.27842375	26.88364969	-	-	-	29.34	SURGING	15.9	SURGING	Surging
	Temp	°C	-4.2	-7.0	9.9	17.4	-	-	-	24.7		22.6	SURGING	Surging
	Comments		cracked	cracked	cracked	cracked->1/2T	1/2T	1/2T -> 1T	1->3/4T	3/4->cracked	cracked->1/2T	1/2T	1/2->1T	1T
3-29 DP	*Well*	"H_2O	-6.80	-15.70	-12.54	-6.89	-10.80	-6.56	-3.75	-2.47	-3.64	-3.20	-3.48	1.02
	Lateral	"H_2O	-15.74	-30.20	-26.25	-8.59	-12.97	-7.82	-5.77	-3.77	-4.54	-5.63	-4.02	-2.74
	CH_4	%	47.3	27.2	56.6	58.8	54.7	57.3	57.7	54.3	53.0	55.4	58.9	57.2
	CO_2	%	35.2	20.9	36.9	38.2	36.1	37.5	38.3	36.4	36.3	36.3	38.5	42.8
	O_2	%	1.0	8.3	1.0	0.6	1.4	0.5	1.7	0.2	1.4	1.2	0.7	0.0
	BAL (N_2)	%	16.6	44.1	5.0	2.3	7.8	4.8	2.3	8.2	9.4	7.1	1.9	0.0
	CO	PPM	6	5	4	4	3	5	4	8	17	8	5	6
	H_2S	PPM	-	2	62	8	37	77	82	38	55	60	86	54
	Vel Max	m/s	3.44	1.13	3.42	3.21	-	-	-	2.54	SURGING	1.14	3.41	3.01
	Vel Min	m/s	3.31	0.79	3.17	2.95	-	-	-	3.76	SURGING	1.16	2.82	3.62
	Flow	CFM	31.89185156	9.07146	31.13589656	29.1042675	-	-	-	29.77	SURGING	10.87	29.43	31.32
	Temp	°C	0.5	-	6.1	16.5	-	-	-	23.8		19.5	12.2	14.9
	Comments		1/4T no change	1/4T	1/4 -> 1T	1T	1T	1T -> no change	1T	1T	1T	1T	1->2T	2T

Table 2: Wellfield Monitoring Data

		Units	23/Jan/19	28/Feb/19	22/Mar/19	22/Apr/19	28/May/19	24/Jun/19	18/Jul/19	24/Aug/19	19/Sep/19	29/Oct/19	25/Nov/19	29/Dec/19
3-30 DP	*Well*	*"H_2O*	-1.47	-0.70	-0.52	-2.21	-0.48	-1.27	-0.06	-0.47	-0.59	-1.23	-1.77	-0.10
	Lateral	*"H_2O*	-15.43	-30.70	-26.34	-11.58	-13.36	-7.91	-5.81	-3.55	-4.22	-6.03	-4.05	-3.22
	CH_4	*%*	34.6	43.3	55.0	59.4	55.2	42.5	58.1	55.5	54.6	53.8	51.7	54.1
	CO_2	*%*	28.6	31.4	37.2	39.9	38.8	31.9	39.6	38.9	39.0	37.6	36.6	45.9
	O_2	*%*	5.1	3.9	0.7	0.7	0.3	2.7	0.5	0.1	0.1	0.5	1.7	0.0
	BAL (N_2)	*%*	31.8	20.8	7.1	0.0	5.6	22.9	1.9	5.5	6.3	8.1	10.0	0.0
	CO	*PPM*	7	3	3	3	4	5	5	7	14	4	5	5
	H_2S	*PPM*	-	22	35	64	60	20	63	22	25	22	29	26
	Vel Max	*m/s*	0.89	3.19	2.63	-	-	-	-	3.54	SURGING	1.98	5.23	5.01
	Vel Min	*m/s*	0.71	3.00	2.51	-	-	-	-	3.84	SURGING	2.31	4.68	5.24
	Flow	*CFM*	7.55955	29.24600906	24.28505438	-	-	-	-	34.9	SURGING	20.3	46.8	48.4
	Temp	*°C*	-7.1	-11.6	4.8	-	-	-	-	34.1		28.7	26.6	28.9
	Comments		1/4T -> cracked	cracked	cracked -> 1T	1T->cracked	cracked->1/2	1/2T -> cracked	cracked->1/2T	1/2T	1/2->1T	1T	1T	1T
4-31	*Well*	*"H_2O*	1.30	-1.30	-1.20	-1.11	-2.33	-5.47	-3.89	-1.17	-1.45	0.04	0.80	-2.49
	Lateral	*"H_2O*	-18.92	-26.34	-21.25	-8.72	-12.05	-6.99	-4.83	-1.58	-2.26	-4.86	-3.54	-2.42
	CH_4	*%*	57.7	40.6	56.9	56.2	56.4	56.2	56.0	56.7	53.1	58.3	57.8	56.3
	CO_2	*%*	41.2	28.0	39.9	40.5	40.2	39.8	40.1	40.2	38.7	41.6	42.3	42.1
	O_2	*%*	0.5	7.7	0.8	0.7	0.8	0.5	0.3	0.0	3.1	0.0	0.0	0.4
	BAL (N_2)	*%*	0.0	23.2	2.4	2.6	2.6	3.5	3.6	3.0	5.1	0.0	0.0	1.2
	CO	*PPM*	5	3	4	6	5	6	7	6	5	8	5	8
	H_2S	*PPM*	-	74	47	87	82	58	81	37	47	84	64	90
	Vel Max	*m/s*	3.48	1.54	3.98	4.86	-	-	-	3.11	4.72	3.95	4.41	3.54
	Vel Min	*m/s*	3.45	0.72	3.73	4.60	-	-	-	4.96	4.38	3.82	3.79	4.07
	Flow	*CFM*	32.74230094	10.67786438	36.42758156	44.69583938	-	-	-	38.1	43.0	36.7	38.7	36.0
	Temp	*°C*	12.7	-22.2	16.6	23.0	-	-	-	23.2	20.0	12.3	16.2	17.0
	Comments		1/4T -> 1/2T	1/2T	1/2 -> 1T	1T	1->2	2T -> no change	2T	2T	2T	2T	2T	2T
4-32	*Well*	*"H_2O*	61.92	77.42	-11.05	-0.19	-1.95	-5.08	-2.93	-0.56	-0.84	-4.82	-3.65	0.12
	Lateral	*"H_2O*	NO VAC	FROZEN	-21.04	-9.14	-11.69	-7.68	-5.34	-3.19	-2.65	-5.13	-3.67	-2.58
	CH_4	*%*	56.9	56.2	45.0	51.1	56.2	56.4	55.0	54.7	55.1	57.4	56.6	58.2
	CO_2	*%*	42.7	43.5	34.1	39.3	42.4	42.3	41.8	41.3	42.1	42.4	43.4	40.7
	O_2	*%*	0.2	0.3	4.0	1.8	0.1	0.1	0.0	0.3	0.5	0.2	0.0	1.0
	BAL (N_2)	*%*	0.0	0.0	16.9	7.8	1.3	1.2	3.2	3.8	2.3	0.0	0.0	0.1
	CO	*PPM*	4	4	3	5	4	6	6	7	5	6	4	4
	H_2S	*PPM*	-	168	53	137	150	121	159	53	122	106	79	110
	Vel Max	*m/s*	FROZEN	FROZEN	4.06	2.72	-	-	-	SURGING	4.88	2.54	2.70	2.19
	Vel Min	*m/s*	-	FROZEN	3.81	2.61	-	-	-	SURGING	4.64	2.48	2.63	2.32
	Flow	*CFM*	-	-	37.18353656	25.18275094	-	-	-	SURGING	45.0	23.7	25.2	21.3
	Temp	*°C*	-	FROZEN	18.7	17.7	-	-	-	SURGING	18.8	8.1	12.8	13.4
	Comments		1/4T -> 1/2T	1/2T	1/2T	1/2T	1/2->1	1T -> no change	1T	1T	1->2T	2T	2T	2T
4-33	*Well*	*"H_2O*	-12.25	-23.50	-4.68	-12.32	-7.43	-5.77	-4.32	-1.51	-3.47	-2.56	-2.18	-1.26
	Lateral	*"H_2O*	-14.87	-25.90	-5.77	-13.27	-10.51	-7.10	-4.81	-2.26	-5.74	-6.12	SURGING	-1.62
	CH_4	*%*	45.6	51.8	39.1	58.6	57.3	57.1	57.1	59.0	56.3	57.6	59.5	54.8
	CO_2	*%*	31.3	35.0	40.0	40.9	39.2	39.3	39.9	39.6	40.0	38.4	40.4	42.4
	O_2	*%*	4.8	3.0	0.4	0.5	0.3	0.0	0.0	0.0	0.0	0.1	20.0	0.0
	BAL (N_2)	*%*	14.1	10.7	0.5	0.0	3.1	3.5	3.1	1.4	3.7	3.9	0.0	2.8
	CO	*PPM*	3	6	6	5	11	8	15	15	19	12	4.0	2
	H_2S	*PPM*	-	77	331	130	154	500	>>>>	311	259	250	>>>>	243
	Vel Max	*m/s*	3.38	3.51	4.70	-	-	-	-	SURGING	SURGING	1.54	SURGING	SURGING
	Vel Min	*m/s*	3.12	2.10	2.10	-	-	-	-	SURGING	SURGING	1.59	SURGING	SURGING
	Flow	*CFM*	30.71067188	26.50567219	32.1280875	-	-	-	-	SURGING	SURGING	14.79	SURGING	SURGING
	Temp	*°C*	-12.2	-9.5	16.4	-	-	-	-	SURGING	SURGING	14.8	SURGING	SURGING
	Comments		1/4T, needs kanaflex	1/4T, needs kanaflex	1/4T	cracked->1/2T	1/2->3/4	3/4T -> 1T	1T	1T	1T	1T	1T	1T
4-34	*Well*	*"H_2O*	6.95	-10.30	2.80	-7.07	4.22	-1.11	-0.43	2.06	-1.86	-0.58	-2.76	-0.57
	Lateral	*"H_2O*	-15.15	-25.20	-6.12	-13.29	-12.16	-7.49	-5.06	-3.11	-5.74	-5.45	-3.86	-2.81
	CH_4	*%*	58.1	7.3	58.9	43.4	56.6	50.0	53.1	57.9	55.2	54.2	53.2	54.4
	CO_2	*%*	41.6	5.4	41.1	32.0	40.6	36.2	38.3	40.2	41.9	40.9	41.3	37.5
	O_2	*%*	0.2	17.7	0.1	4.7	0.0	1.6	1.1	0.0	0.6	0.4	2.1	2.3
	BAL (N_2)	*%*	0.0	69.1	0.0	19.9	2.7	12.1	7.6	1.9	2.3	4.5	3.4	5.7
	CO	*PPM*	2	1	5	3	5	5	10	13	15	12	6	4
	H_2S	*PPM*	-	16	145	44	253	255	297	177	184	193	170	97
	Vel Max	*m/s*	BLOCKED	2.43	4.05	-	-	-	-	SURGING	SURGING	0.48	1.65	SURGING
	Vel Min	*m/s*	WITH	2.34	2.84	-	-	-	-	SURGING	SURGING	0.96	1.22	SURGING
	Flow	*CFM*	ICE		32.55331219	-	-	-	-	SURGING	SURGING	6.80	13.56	SURGING
	Temp	*°C*	-	-14.0	8.0	-	-	-	-	SURGING	SURGING	6.8	10.4	SURGING
	Comments		1T -> 1 1/2T	1 1/2T -> cracked	cracked -> 1/2T	1/2->closed	closed->cracked	cracked -> no change	cracked	cracked->1/2T	1/2T	1/2T	1/2T	1/2->1T

Table 2: Wellfield Monitoring Data

		Units	23/Jan/19	28/Feb/19	22/Mar/19	22/Apr/19	28/May/19	24/Jun/19	18/Jul/19	24/Aug/19	19/Sep/19	29/Oct/19	25/Nov/19	29/Dec/19
4-35	*Well*	"H_2O	-0.79	0.80	-0.15	-3.29	1.44	0.58	-0.56	-0.33	-2.45	-3.96	-1.85	-1.32
well bore seal	*Lateral*	"H_2O	-13.70	-1.60	-6.64	-11.36	-12.01	-8.75	-5.14	-3.87	-5.91	-6.47	-3.60	-3.14
	CH_4	%	49.0	56.0	56.1	39.8	56.8	57.4	53.0	56.3	54.3	55.2	46.9	52.4
	CO_2	%	34.3	41.1	39.6	30.9	40.4	41.1	38.8	40.1	42.6	39.1	33.3	46.9
	O_2	%	3.5	0.5	1.1	5.0	0.0	0.0	0.8	0.3	0.6	1.7	4.0	0.4
	BAL (N_2)	%	13.3	0.0	3.3	24.4	2.7	1.5	7.4	3.3	2.5	4.0	158.0	0.3
	CO	PPM	8	9	6	6	10	11	10	10	14	10	5	8
	H_2S	PPM	-	426	67	60	264	373	156	147	124	158	93	162
	Vel Max	m/s	2.30	0.00	2.59	-	-	-	-	SURGING	SURGING	2.55	1.81	0.98
	Vel Min	m/s	2.23	0.00	2.27	-	-	-	-	SURGING	SURGING	2.66	1.52	1.86
	Flow	CFM	21.40297594	0	22.96213313	-	-	-	-	SURGING	SURGING	24.62	15.73	13.42
	Temp	°C	3.0	-18.0	7.8	-	-	-	-	SURGING	SURGING	6.1	9.8	9.6
	Comments		1/2T -> no change	1/2T	1/2 -> 1T	1->closed	closed->cracked	cracked -> 1/2T	1/2T	1/2->1T	1T	1T	1->1/2T	1/2T
4-36	*Well*	"H_2O	32.24	34.80	too tall	Too Tall	Too Tall	-	-	-	Too Tall	Too Tall	TOO TALL	TOO TALL
	Lateral	"H_2O	FROZEN	FROZEN	22.64	NLV	NLV	-	NLV	NLV	NLV	NLV	NLV	NLV
	CH_4	%	58.6	59.3	-	-	-	-	-	-	-	-	-	-
	CO_2	%	39.6	40.7	-	-	-	-	-	-	-	-	-	-
	O_2	%	0.0	0.0	-	-	-	-	-	-	-	-	-	-
	BAL (N_2)	%	0.0	0.0	-	-	-	-	-	-	-	-	-	-
	CO	PPM	8	9	-	-	-	-	-	-	-	-	-	-
	H_2S	PPM	-	77	-	-	-	-	-	-	-	-	-	-
	Vel Max	m/s	FROZEN	FROZEN	-	-	-	-	-	-	-	-	-	-
	Vel Min	m/s	-	-	-	-	-	-	-	-	-	-	-	-
	Flow	CFM	-	-	-	-	-	-	-	-	-	-	-	-
	Temp	°C	-	-	-	-	-	-	-	-	-	-	-	-
	Comments		FROZEN	FROZEN	No Lat Vac	NLV	NLV	NLV	NLV	NLV	NLV	NLV	NLV	NLV
4-37	*Well*	"H_2O	0.16	0.20	1.04	-0.37	0.25	-0.49	0.48	-0.08	-0.32	-0.97	-0.74	-1.98
	Lateral	"H_2O	-14.58	-30.10	.22.92	-11.24	-13.27	-8.97	-5.43	-1.50	-4.12	-5.81	-3.99	-2.86
	CH_4	%	58.9	59.0	59.0	40.2	59.1	34.3	57.8	57.9	55.0	56.0	34.7	31.4
	CO_2	%	40.6	40.9	40.9	29.6	40.4	25.0	40.3	40.4	41.3	42.6	25.2	26.6
	O_2	%	0.2	0.2	0.1	5.3	0.0	6.0	0.0	0.4	0.7	0.3	7.6	5.9
	BAL (N_2)	%	0.0	0.0	0.0	24.9	0.5	32.7	1.9	1.2	3.0	1.1	32.4	36.1
	CO	PPM	7	4	8	5	5	7	6	11	4	9	6	9
	H_2S	PPM	-	285	128	35	113	72	396	86	94	2	51	102
	Vel Max	m/s	-	0.44	2.40	-	-	-	-	SURGING	SURGING	0.95	-	-
	Vel Min	m/s	-	0.00	2.22	-	-	-	-	SURGING	SURGING	1.24	-	-
	Flow	CFM	-	-	21.82820063	-	-	-	-	SURGING	SURGING	10.35	-	-
	Temp	°C	-	-14.5	4.1	-	-	-	-	SURGING	SURGING	3.6	-	-
	Comments		closed no change	closed-> cracked	cracked	1/2->closed	closed->cracked	cracked -> closed	closed->cracked	cracked->1/2T	1/2T	1/2T	1/2->CLOSED	closed
5-38	*Well*	"H_2O	0.20	2.70	2.58	-8.54	-10.24	0.19	-4.71	0.13	-2.93	0.06	-3.42	0.84
	Lateral	"H_2O	-18.72	-27.79	-20.60	-10.14	-11.14	-7.31	-5.06	-3.32	-3.11	-5.15	-3.68	-2.47
	CH_4	%	58.5	56.2	58.0	48.9	10.1	54.4	52.5	56.3	8.8	53.9	8.0	30.7
	CO_2	%	41.3	43.3	41.8	37.7	7.6	41.5	39.7	40.7	6.6	38.2	5.0	22.5
	O_2	%	0.2	0.3	0.1	2.8	16.2	15.0	0.8	0.7	12.3	1.9	16.0	10.1
	BAL (N_2)	%	0.0	0.0	0.0	10.6	66.1	3.6	7.0	2.2	66.8	5.9	72.0	36.7
	CO	PPM	3	2	2	3	2	5	19	4	2	4	2	2
	H_2S	PPM		181	60	106	10	89	29	89	14	91	6	21
	Vel Max	m/s	2.26	2.18	0.87	0.70	-	-	-	0.60	-	-	-	-
	Vel Min	m/s	2.12	1.95	0.73	0.58	-	-	-	0.65	-	-	-	-
	Flow	CFM	20.69426813	19.51308844	7.55955	6.04764	-	-	-	5.91	-	-	-	-
	Temp	°C	-9.2	-23.6	17.5	-	-	-	-	25.9	-	-	-	-
	Comments		Closed ->cracked	cracked	cracked	1/2->cracked	cracked->closed	closed -> cracked	cracked	cracked->1/2T	1/2->closed	closed	closed	closed
5-39	*Well*	"H_2O	39.90	12.11	-20.76	19.56	-0.77	-5.19	-3.54	-1.69	-2.85	-3.92	-2.80	0.94
well bore seal	*Lateral*	"H_2O	FROZEN	FROZEN	-20.61	-8.56	-10.52	-7.20	-5.11	-3.32	-3.04	-6.71	-3.22	-2.49
	CH_4	%	58.5	57.6	56.6	58.0	56.9	57.3	56.2	57.0	56.8	58.0	57.1	58.7
	CO_2	%	41.5	41.9	41.4	41.9	41.2	41.5	41.2	41.3	41.4	41.4	42.4	40.6
	O_2	%	0.0	0.2	0.6	0.1	0.3	0.1	0.0	0.1	1.1	0.6	0.1	0.2
	BAL (N_2)	%	0.0	0.0	1.4	0.0	1.7	1.1	2.5	1.6	0.7	0.0	0.0	0.5
	CO	PPM	11	17	19	15	18	18	26.0	21	17	16	15	15
	H_2S	PPM	-	69	31	68	58	46	76.0	50	53	45	29	50
	Vel Max	m/s	FROZEN	FROZEN	1.91	1.52	-	-	-	2.06	4.22	2.64	2.03	2.42
	Vel Min	m/s	-	-	1.77	1.39	-	-	-	2.19	4.09	2.06	2.27	3.01
	Flow	CFM	-	-	17.386965	13.74893156	-	-	-	20.1	39.3	22.2	20.3	25.7
	Temp	°C	-	-	16.7	-	-	-	-	21.0	15.2	4.0	8.2	9.3
	Comments		FROZEN	FROZEN	frozen -> cracked	cracked->1/2T	1/2->1	1T -> no change	1T	1->2T	2T	2T	2T	2T

Table 2: Wellfield Monitoring Data

		Units	23/Jan/19	28/Feb/19	22/Mar/19	22/Apr/19	28/May/19	24/Jun/19	18/Jul/19	24/Aug/19	19/Sep/19	29/Oct/19	25/Nov/19	29/Dec/19
5-40	*Well*	"H_2O	0.90	1.30	-3.53	-2.96	-2.90	-1.99	-1.29	-0.55	-1.36	-1.45	-0.92	1.29
	Lateral	"H_2O	FROZEN	0.10	-6.23	-12.63	-11.72	-7.43	-5.03	-2.68	-4.89	-6.32	-4.16	-2.46
	CH_4	%	59.0	59.6	46.8	45.0	46.6	47.2	50.4	56.8	54.2	54.1	55.2	58.8
	CO_2	%	40.3	40.1	35.1	35.4	36.2	36.7	37.7	40.9	39.9	38.6	41.2	41.2
	O_2	%	0.5	0.1	1.9	3.7	2.2	1.6	1.6	0.0	2.5	1.5	0.0	0.0
	BAL (N_2)	%	0.0	0.0	16.2	15.9	15.0	14.5	10.4	2.3	3.1	5.8	3.6	0.0
	CO	*PPM*	2	3	3	3	4	9	8	10	2	4	5	5
	H_2S	*PPM*	-	388	65	63	179	195	263	151	145	171	151	157
	Vel Max	*m/s*	FROZEN	FROZEN	1.52	-	-	-	-	SURGING	SURGING	2.69	1.63	FROZEN
	Vel Min	*m/s*	-	-	1.39	-	-	-	-	SURGING	SURGING	2.73	1.05	AT
	Flow	*CFM*	-	-	13.74893156	-	-	-	-	SURGING	SURGING	25.6	12.7	WELL HEAD
	Temp	°C	-	-	9.8	-	-	-	-	SURGING	SURGING	10.4	8.5	
	Comments		FROZEN	FROZEN	frozen -> cracked	cracked	cracked	cracked -> no change	cracked	cracked->1T	1T	1T	1T	1->closed
5-41	*Well*	"H_2O	-1.65	-7.45	3.17	-6.77	0.12	-1.00	-0.77	1.51	-4.20	-5.12	0.74	-1.89
well bore seal	*Lateral*	"H_2O	-16.53	-32.19	-6.40	-12.44	-11.51	-6.62	-4.78	-2.42	-5.31	-6.33	-3.87	-2.25
	CH_4	%	52.0	33.2	60.3	47.0	43.3	55.5	55.5	58.8	56.2	57.9	59.4	59.9
	CO_2	%	33.1	21.0	39.6	32.2	29.7	37.0	37.4	38.9	34.8	40.6	40.6	39.9
	O_2	%	2.9	9.8	0.1	4.2	4.5	0.7	0.7	0.0	0.2	0.5	0.0	0.1
	BAL (N_2)	%	10.5	32.0	0.0	16.5	22.5	6.8	6.5	2.3	8.8	1.0	0.0	0.0
	CO	*PPM*	2	2	4	3	3	4	7	4	4	5	3	6
	H_2S	*PPM*	5	146	102	84	178	62	215	138	165	158	164	95
	Vel Max	*m/s*	4.64	5.69	6.79	-	-	-	-	4.18	4.10	4.36	4.98	3.98
	Vel Min	*m/s*	4.58	5.39	5.67	-	-	-	-	4.51	4.15	4.55	4.51	3.10
	Flow	*CFM*	43.56190688	52.34988375	58.86999563	-	-	-	-	41.1	39.0	42.1	44.8	33.5
	Temp	°C	-12.8	-12.3	11.8	-	-	-	-	30.4	31.2	32.1	29.5	17.4
	Comments		cracked no change	CRACKED	cracked -> 1/2T	1/2->cracked	cracked	cracked -> 1/2T	1/2T	1/2->2T	2T	2T	2T	2T
5-42	*Well*	"H_2O	-0.86	-0.10	0.82	-0.62	-0.19	0.48	0.55	-0.53	-1.45	-2.54	0.03	-1.62
	Lateral	"H_2O	-13.85	-24.95	-8.24	-11.84	-13.31	-8.84	-4.97	-3.30	-4.11	-5.98	-4.09	-3.93
	CH_4	%	43.6	23.3	58.2	40.4	46.9	57.1	56.0	57.2	56.9	58.1	58.2	56.7
	CO_2	%	32.1	15.2	41.7	30.3	34.9	41.2	40.6	41.7	39.5	39.3	41.8	41.4
	O_2	%	4.6	13.2	0.1	5.3	3.2	0.0	0.0	0.4	0.5	0.6	0.0	1.5
	BAL (N_2)	%	19.6	47.6	0.0	24.0	14.9	1.7	3.3	0.0	3.1	2.0	0.0	0.4
	CO	*PPM*	8	2	18	8	12	25	25	14	21	19	9	10
	H_2S	*PPM*	-	18	124	8	134	>>>	253	385	267	357	163	345
	Vel Max	*m/s*	3.64	-	1.80	-	-	-	-	2.33	2.17	2.14	2.82	2.41
	Vel Min	*m/s*	3.51	-	1.63	-	-	-	-	2.82	2.55	2.77	2.36	2.96
	Flow	*CFM*	33.78173906	#VALUE!	16.20578531	-	-	-	-	24.33	22.30	23.20	24.47	25.37
	Temp	°C	11.0	-	-	-	-	-	-	25.6	24.1	23.2	17.3	19.4
	Comments		closed to 25T	25T -> 20T	20% -> 30%	30->20%	20->10%	10% -> 20%	20->30%	30%	30%	30%	30->40%	40%
5-43	*Well*	"H_2O	-17.85	-26.70	-3.84	-8.36	-10.88	-6.81	-4.65	-3.09	-2.53	-4.40	-3.13	1.93
	Lateral	"H_2O	-17.89	-27.20	-6.87	-8.88	-11.04	-6.96	-5.25	-3.25	-2.92	-4.88	-3.32	-2.41
	CH_4	%	58.5	41.5	60.2	59.3	58.7	59.3	58.8	58.6	58.9	60.0	59.8	60.4
	CO_2	%	36.8	27.7	39.6	39.5	39.2	39.3	39.3	38.8	39.5	40.0	40.2	39.6
	O_2	%	1.9	9.6	0.2	0.3	0.1	0.0	0.0	0.3	0.0	0.0	0.1	0.0
	BAL (N_2)	%	2.4	18.8	0.0	0.9	2.1	1.4	1.9	2.2	1.6	0.0	0.0	0.0
	CO	*PPM*	3T no change	3	6	3	3	4	6	6	4	5	4	5
	H_2S	*PPM*	-	73	28	85	79	80	101	79	70	63	41	70
	Vel Max	*m/s*	5.95	1.35	1.71	1.77	-	-	-	3.47	2.82	3.99	3.97	3.52
	Vel Min	*m/s*	5.67	1.20	1.42	1.67	-	-	-	3.57	3.65	3.60	3.04	3.98
	Flow	*CFM*	54.90123188	12.04803281	14.78836969	16.2530325	-	-	-	33.3	30.6	35.9	33.1	35.4
	Temp	°C	-9.0	-23.9	-	-	-	-	-	22.1	15.5	10.0	10.3	11.1
	Comments		1T	1T -> 2T	2T -> 3T	3T	3T	3T -> no change	3T	3T	3T	3T	3T	3T
5-44	*Well*	"H_2O	-0.40	-1.23	0.75	-0.58	-0.49	-0.19	0.44	0.23	-1.51	-2.50	-1.92	0.62
	Lateral	"H_2O	-16.08	-29.25	-6.52	-12.93	-12.00	-6.72	-4.71	-2.50	-2.46	-6.02	-4.20	-2.43
	CH_4	%	41.1	27.7	58.2	51.5	47.4	50.2	53.4	57.3	45.6	48.3	55.8	57.8
	CO_2	%	31.2	20.6	41.7	39.1	37.2	38.7	37.1	40.4	37.2	39.6	39.6	41.9
	O_2	%	5.2	11.2	0.1	1.4	1.0	0.2	1.3	0.0	1.0	1.2	2.2	0.3
	BAL (N_2)	%	2.4	39.7	0.0	8.1	14.4	11.0	8.2	2.2	16.3	10.9	2.4	0.0
	CO	*PPM*	3	3	4	3	4	5	5	5	7	4	3	6
	H_2S	*PPM*	-	316	268	215	500	336	336	>>>>	43	130	189	>>>>
	Vel Max	*m/s*	3.94	-	5.72	-	-	-	-	4.70	3.09	1.84	2.41	1.15
	Vel Min	*m/s*	3.19	-	5.40	-	-	-	-	4.99	2.93	1.96	2.13	1.11
	Flow	*CFM*	33.68724469	#VALUE!	52.5388725	-	-	-	-	45.78	28.44	17.95	21.45	10.68
	Temp	°C	-21.6	-	12.8	-	-	-	-	30.9	24.1	22.5	21.9	-0.1
	Comments		1/4T no change	1/4T -> closed	closed -> 1/2T	1/2T	1/2T	1/2T -> cracked	cracked	cracked->2T	2->1T	1T	1T	1T->cracked

Table 2: Wellfield Monitoring Data

		Units	23/Jan/19	28/Feb/19	22/Mar/19	22/Apr/19	28/May/19	24/Jun/19	18/Jul/19	24/Aug/19	19/Sep/19	29/Oct/19	25/Nov/19	29/Dec/19
5-45	*Well*	*"H_2O*	0.07	0.03	0.03	0.01	-0.03	-0.02	-0.05	-6.00	-1.56	-1.14	-0.99	FROZEN
	Lateral	*"H_2O*	-14.51	-33.91	-25.77	-12.52	-13.78	-7.32	-4.86	-2.89	-4.11	-5.65	-3.67	-2.44
	CH_4	*%*	54.8	45.5	52.5	37.7	55.5	48.1	52.2	51.9	52.3	51.4	53.4	44.6
	CO_2	*%*	44.1	38.5	42.6	32.5	42.8	38.4	42.0	44.2	42.9	39.0	44.9	33.9
	O_2	*%*	0.6	1.4	0.4	3.7	0.0	1.2	0.4	0.0	0.6	0.3	1.7	3.6
	BAL (N_2)	*%*	0.2	17.1	4.5	26.0	1.8	12.3	5.3	3.9	4.2	9.3	0.0	17.9
	CO	*PPM*	4	2	3	1	1	3	6.0	5	1	2	4	5
	H_2S	*PPM*	-	123	118	5	117	68	120.0	156	135	140	152	68
	Vel Max	*m/s*	-	-	2.77	-	-	-	-	0.61	0.48	0.55	0.87	1.20
	Vel Min	*m/s*	-	-	2.40	-	-	-	-	0.68	0.85	0.63	0.66	1.05
	Flow	*CFM*	-	-	24.42679594	-	-	-	-	6.09	6.28	5.58	7.23	10.63
	Temp	*°C*	-	-	6.7	-	-	-	-	21.7	20.1	18.7	15.4	-1.8
	Comments		closed no change	closed	closed -> cracked	cracked->closed	closed->cracked	cracked	cracked	cracked->1/2T	1/2T	1/2T	1/2T	1/2->cracked
5-46	*Well*	*"H_2O*	0.09	0.00	0.24	-0.22	-0.43	0.12	-0.44	-0.09	-0.02	0.03	0.02	-2.18
	Lateral	*"H_2O*	-15.01	-30.76	-25.71	12.70	-13.79	-7.11	-5.06	-3.23	-5.69	-5.91	-4.10	-2.84
	CH_4	*%*	57.6	56.0	57.9	39.8	38.6	57.2	48.6	28.3	36.8	25.8	59.3	55.1
	CO_2	*%*	42.2	41.0	42.0	32.1	34.3	40.7	39.2	21.1	24.6	36.9	40.7	44.4
	O_2	*%*	0.1	1.8	0.1	4.7	1.9	0.0	0.4	9.1	8.4	7.1	0.0	0.2
	BAL (N_2)	*%*	0.0	0.0	0.0	23.4	24.9	2.1	11.7	41.5	30.2	30.2	0.0	0.3
	CO	*PPM*	5	4	4.0	17	16	5	34	4	6	4	5	5
	H_2S	*PPM*	-	123	102.0	10	14	63	60	15	12	19	66	65
	Vel Max	*m/s*	0.61	-	3.5	-	-	-	-	1.26	-	-	2.05	1.61
	Vel Min	*m/s*	0.55	-	3.4	-	-	-	-	1.40	-	-	1.71	2.32
	Flow	*CFM*	5.48067375	-	32.36432344	-	-	-	-	12.57	-	-	17.8	18.6
	Temp	*°C*	-6.9	-	7.8	-	-	-	-	21.6	-	-	1.8	2.1
	Comments		cracked		? ->cracked	cracked->closed	cracked->closed	closed -> cracked	cracked	cracked->closed	closed	closed	closed->1T	1T
6-47	*Well*	*"H_2O*	-3.93	-5.90	-4.22	8.32	-10.15	-7.09	-4.87	-3.16	-2.42	-1.95	-3.35	-2.79
	Lateral	*"H_2O*	-18.87	-6.60	-4.94	-8.63	-11.69	-7.20	-4.98	-3.24	-2.09	-2.19	-3.86	-4.02
	CH_4	*%*	57.5	19.8	0.0	63.6	59.0	60.9	58.5	54.0	60.9	61.3	61.2	56.8
	CO_2	*%*	34.9	12.1	0.1	36.3	37.7	38.2	37.5	34.7	37.9	38.1	38.3	40.1
	O_2	*%*	2.1	17.1	21.0	0.1	0.6	0.0	0.2	1.8	0.3	0.5	0.5	0.1
	BAL (N_2)	*%*	3.1	49.9	8.8	0.0	2.8	0.9	3.7	9.5	0.9	0.0	0.0	3.0
	CO	*PPM*	3T no change	0	1	2	4	4	5	4	4	4	4	4
	H_2S	*PPM*	-	13	1	32	18	22	26	23	20	20	14	10
	Vel Max	*m/s*	2.48	0.60	-	0.44	-	-	-	0.44	0.00	0.68	0.75	0.22
	Vel Min	*m/s*	2.40	0.44	-	0.00	-	-	-	0.44	0.00	0.00	0.46	0.96
	Flow	*CFM*	23.0566275	4.9137075	-	2.07887625	-	-	-	4.2	0	3.21	5.72	5.58
	Temp	*°C*	-8.3	-22.0	-	18.0	-	-	-	25.6	15.2	2.6	0.5	0.0
	Comments		full open, no change	FULL OPEN -> 4T	4T -> closed	closed->cracked	cracked->1	1T -> no change	1T	1T	1->2T	2T	2T	2T
6-48	*Well*	*"H_2O*	0.65	-0.10	-5.14	-8.17	1.27	-2.34	-4.65	-2.86	-2.01	-1.70	-2.84	1.44
	Lateral	*"H_2O*	-18.44	-5.80	-4.83	-8.91	-11.68	-7.23	-4.78	-3.05	-2.11	-2.12	-3.08	-2.94
	CH_4	*%*	61.2	62.9	52.6	42.8	63.1	53.9	55.2	55.8	60.9	63.0	62.3	59.6
	CO_2	*%*	33.9	35.7	30.7	25.7	35.8	32.2	33.2	33.1	37.1	36.4	37.3	39.2
	O_2	*%*	1.25T->no change	1.2	3.5	6.1	0.2	1.5	1.6	1.3	0.1	0.2	0.3	1.1
	BAL (N_2)	*%*	1.6	0.0	13.3	25.4	0.9	12.4	10.0	9.8	1.9	0.0	0.0	0.1
	CO	*PPM*	2	2	3	2	3	4	4	4	3	4	3	9
	H_2S	*PPM*		27	7	4	35	9	16	20	22	18	11	9
	Vel Max	*m/s*	0.44	0.63	1.43	-	-	-	-	0.44	0.47	0.81	1.50	0.75
	Vel Min	*m/s*	0.00	0.44	0.81	-	-	-	-	0.44	0.00	0.58	0.82	1.60
	Flow	*CFM*	2.07887625	5.055449063	10.58337	-	-	-	-	4.2	2.2	6.6	11.0	11.1
	Temp	*°C*	-9.8	-20.9	5.7	-	-	-	-	25.4	16.3	1.9	0.2	2.4
	Comments		3/4T	3/4T	3/4T	3/4->closed	closed->cracked	cracked -> 1/2T	1/2T	1/2->1T	1->2T	2T	2T	2T
6-49	*Well*	*"H_2O*	0.85	-7.64	0.27	-0.73	0.05	0.18	0.10	0.22	-0.19	-0.85	0.09	-0.56
	Lateral	*"H_2O*	-10.72	-9.29	-4.80	-12.03	-12.20	-6.67	-4.46	-2.98	-2.47	-2.35	-4.08	-2.62
	CH_4	*%*	57.6	36.8	60.2	48.5	56.5	59.5	58.8	58.7	58.3	58.3	59.8	58.6
	CO_2	*%*	39.7	23.6	39.8	35.4	40.1	38.4	38.3	39.1	40.3	40.8	40.2	41.0
	O_2	*%*	1.3	9.7	0.0	2.9	0.2	0.0	0.0	0.0	0.1	0.4	0.0	0.4
	BAL (N_2)	*%*	0.0	30.4	0.0	13.2	3.2	2.1	2.4	2.2	1.3	0.5	0.0	0.0
	CO	*PPM*	0	1	3	7	6	3	4	4	7	6	5	5
	H_2S	*PPM*	-	228	109	134	321	339	172	371	283	293	247	24
	Vel Max	*m/s*	KANAFLEX	0.83	2.68	-	-	-	-	2.71	3.98	5.11	4.12	5.93
	Vel Min	*m/s*	IS	0.79	2.50	-	-	-	-	2.83	3.67	3.95	3.58	5.07
	Flow	*CFM*	FROZEN	7.654044375	24.47404313	-	-	-	-	26.17	36.14	42.81	36.38	51.97
	Temp	*°C*	-	-	6.5	-	-	-	-	27.4	21.2	18.9	17.6	17.9
	Comments		FROZEN	FROZEN	frozen -> 1/2T	1/2->cracked	cracked->1/2	1/2T -> no change	1/2T	1/2->1T	1->2T	2T	2T	2T

Table 2: Wellfield Monitoring Data

		Units	23/Jan/19	28/Feb/19	22/Mar/19	22/Apr/19	28/May/19	24/Jun/19	18/Jul/19	24/Aug/19	19/Sep/19	29/Oct/19	25/Nov/19	29/Dec/19
6-50	*Well*	"H_2O	0.13	0.13	-0.10	0.13	-0.23	0.05	0.04	0.07	0.14	0.23	-2.98	0.32
	Lateral	"H_2O	-10.97	-9.95	-4.54	-11.92	-10.10	-6.69	-4.15	-2.89	-1.73	-2.29	-3.69	-2.30
	CH_4	%	55.7	56.4	14.7	57.5	19.4	57.9	45.8	28.7	55.7	47.7	49.9	56.7
	CO_2	%	43.0	43.0	12.3	42.0	16.3	40.6	38.9	27.9	43.1	43.1	39.1	42.3
	O_2	%	0.2	0.5	16.0	0.5	11.7	0.1	1.6	6.1	0.3	1.0	6.0	0.0
	BAL (N_2)	%	0.0	0.0	57.1	0.0	52.6	1.6	13.7	37.3	0.9	8.1	5.0	0.0
	CO	PPM	4	4	5	4	5	6	9	4	5	5	4	5
	H_2S	PPM	-	172	6	207	12	255.0	128	3	398	30	156	13
	Vel Max	m/s	KANAFLEX	-	-	-	-	-	-	0.44	0.00	0.83	0.98	1.13
	Vel Min	m/s	IS	-	-	-	-	-	-	0.44	0.00	0.74	0.84	1.00
	Flow	CFM	FROZEN		-	-	-	-	-	4.2	0.0	7.4	8.6	10.1
	Temp	°C	-	-	-	-	-	-	-	26.4	17.8	2.7	5.8	-9.5
	Comments		-	-	? -> closed	closed->cracked	cracked->closed	closed -> cracked	cracked	cracked->closed	closed->cracked	cracked	cracked	FROZEN
6-51	*Well*	"H_2O	0.24	0.28	-1.16	-2.71	0.23	0.04	0.10	0.12	-0.10	-0.25	-3.60	0.03
	Lateral	"H_2O	-15.26	0.23	-4.50	-11.23	-14.70	-6.55	-4.42	-2.17	-2.14	-2.64	-4.23	-2.69
	CH_4	%	54.1	53.0	39.8	31.8	55.8	53.4	52.9	53.8	21.1	42.1	52.4	52.8
	CO_2	%	45.8	46.5	36.5	31.1	44.3	45.0	44.6	46.0	43.8	45.2	46.2	47.2
	O_2	%	0.2	0.2	3.2	4.0	0.0	0.0	0.1	0.0	0.4	0.3	1.2	0.0
	BAL (N_2)	%	0.0	0.0	20.6	33.2	0.0	1.6	2.5	0.3	4.8	12.4	0.2	0.0
	CO	PPM	4	2	27	11	4	9	10	9	11	5	6	10
	H_2S	PPM	-	159	65	15	258	81	95	92	15	56	74	37
	Vel Max	m/s	KANAFLEX	NO LAT VAC	5.73	-	-	-	-	1.24	1.41	1.45	2.14	0.00
	Vel Min	m/s	IS	NO LAT VAC	4.08	-	-	-	-	1.72	1.25	1.59	1.87	0.00
	Flow	CFM	FROZEN		46.34949094	-	-	-	-	14.0	12.6	14.4	18.9	0.0
	Temp	°C	-	NO LAT VAC	-	-	-	-	-	19.0	18.2	15.2	13.4	-1.0
	Comments		-	CRACKED	cracked	cracked->closed	closed->cracked	cracked -> no change	cracked	cracked->1/2T	1/2T	1/2T	1/2T	1/2T
6-52	*Well*	"H_2O	0.04	0.15	0.01	-0.03	0.00	0	-0.11	-0.08	0.02	-1.51	-1.91	0.03
	Lateral	"H_2O	-12.96	-9.35	NLV	-12.44	-13.95	-6.02	-4.51	-2.44	-1.72	-2.33	-3.72	-2.27
	CH_4	%	9.2	25.3	18.5	19.7	23.1	11.1	1.5	16.1	15.5	0.6	57.6	18.9
	CO_2	%	13.9	30.4	24.8	28.9	31.9	23.5	2.5	28.3	28.0	0.8	38.2	19.2
	O_2	%	15.1	7.1	9.1	3.4	2.2	5.3	18.1	2.4	4.0	20.7	3.2	13.8
	BAL (N_2)	%	60.3	37.2	47.6	48.0	42.9	60.1	78.0	53.1	52.5	77.9	1.0	48.1
	CO	PPM	-6	2	3	3	3	2	2	4	5	0	1	2
	H_2S	PPM	-	5	1	11	40	19	7	5	2	2	2	2
	Vel Max	m/s	-	-	NO LAT VAC	-	-	-	-	-	-	SURGING	-	-
	Vel Min	m/s	-	-	NO LAT VAC	-	-	-	-	-	-	SURGING	-	-
	Flow	CFM	-	-	#VALUE!	-	-	-	-	-	-	SURGING	-	-
	Temp	°C	-	-	NO LAT VAC	-	-	-	-	-	-	SURGING	-	-
	Comments		closed no change	closed	closed	closed	closed	closed -> no change	cracked->closed	closed	closed	2T -> closed	closed	closed
6-53	*Well*	"H_2O	-4.25	-2.10	-1.63	-0.35	-0.70	-1.2	-0.89	0.21	-0.55	-5.45	0.02	-0.63
	Lateral	"H_2O	-9.03	FROZEN	-4.81	-9.55	-15.25	-4.8	-3.53	-4.24	-1.31	-6.12	-3.99	-1.52
	CH_4	%	48.4	61.6	58.1	59.4	61.2	58.0	60.3	57.2	61.1	59.8	59.4	60.1
	CO_2	%	34.7	37.8	38.7	38.6	38.7	37.6	37.5	40.5	38.3	40.2	39.7	37.9
	O_2	%	0.4	0.5	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.4
	BAL (N_2)	%	16.5	0.1	3.2	1.8	0.0	4.4	2.1	2.3	0.7	0.0	0.2	1.5
	CO	PPM	4	3	5	3	7	7.0	8	6	5	5	5	6
	H_2S	PPM	-	53	77	63	293	193.0	398	264	192	212	241	274
	Vel Max	m/s	25.91	FROZEN	3.47	6.91	-	-	-	7.33	6.00	6.10	5.29	6.07
	Vel Min	m/s	25.41	FROZEN	3.02	6.59	-	-	-	8.25	5.32	6.25	5.10	5.30
	Flow	CFM	242.4725663	#VALUE!	30.66342469	63.78370313	-	-	-	73.61	53.48	58.35	49.09	53.72
	Temp	°C	35.8	FROZEN	5.1	-	-	-	-	30.7	32.7	33.9	32.3	26.4
	Comments		full open, no change	FULL OPEN	full -> 1/2T	1/2->1T	1->2	2T -> no change	2T	2->3T	3T	3T	3T	3T -> 2T
6-54	*Well*	"H_2O	-0.92	0.39	0.52	-1.04	0.35	0.05	-0.11	0.07	0.54	-0.98	-0.72	-0.07
	Lateral	"H_2O	-11.79	0.05	NO LAT VAC	-9.13	-14.08	-5.90	-1.61 Surging	-0.37	-1.42	-6.87	-4.43	SURGING
	CH_4	%	45.5	60.1	60.2	37.1	60.4	58.5	58.3	59.2	59.4	58.0	53.2	59.7
	CO_2	%	31.0	37.6	39.7	26.0	39.6	39.2	38.2	39.6	39.1	40.3	46.8	40.2
	O_2	%	4.5	1.4	0.1	4.7	0.0	0.0	0.9	0.1	0.8	0.3	0.0	0.1
	BAL (N_2)	%	18.9	1.6	0.0	32.2	0.0	2.3	2.6	1.1	0.6	1.4	0.0	0.0
	CO	PPM	12	1	3	4	3	5	5	5	4	3	5	3
	H_2S	PPM	-	37	116	18	64	34	52	96	126	98	102	8
	Vel Max	m/s	2.85	FROZEN	NO LAT VAC	-	-	-	-	SURGING	SURGING	2.31	2.56	SURGING
	Vel Min	m/s	2.75	FROZEN	NO LAT VAC	-	-	-	-	SURGING	SURGING	2.58	2.14	SURGING
	Flow	CFM	26.458425	-	-	-	-	-	-	SURGING	SURGING	23.10	22.21	SURGING
	Temp	°C	14.8	FROZEN	NO LAT VAC	-	-	-	-	SURGING	SURGING	37.1	34.6	SURGING
	Comments		cracked	cracked	cracked	cracked->closed	closed->cracked	cracked -> 1/2T	1/2T	1/2->1T	1T	1T	1T	1T -> 2T

Table 2: Wellfield Monitoring Data

		Units	23/Jan/19	28/Feb/19	22/Mar/19	22/Apr/19	28/May/19	24/Jun/19	18/Jul/19	24/Aug/19	19/Sep/19	29/Oct/19	25/Nov/19	29/Dec/19
6-55	*Well*	"H_2O	0.18	0.30	0.26	-1.07	0.12	0.12	0.16	0.16	-0.23	-5.87	-0.01	-0.25
	Lateral	"H_2O	-15.35	-7.80	NO LAT VAC	-3.38	-14.74	-6.23	-2.34 Surging	-3.22	-0.81	-6.55	-3.18	-1.96
	CH_4	%	62.9	62.5	62.7	56.3	0.0	62.1	62.3	62.0	58.8	59.9	58.7	59.3
	CO_2	%	36.9	37.1	37.3	39.2	0.2	36.2	36.4	36.8	40.2	35.6	41.3	40.7
	O_2	%	0.2	0.3	0.0	0.0	18.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	BAL (N_2)	%	0.0	0.0	0.0	4.5	81.1	1.7	1.3	1.2	1.1	4.5	0.0	0.0
	CO	*PPM*	6	4	2.0	4	3	6	7	7	6	7	6	8
	H_2S	*PPM*	-	36	236.0	261	140	253	>>>>	410	310	321	385	TOO BIG
	Vel Max	*m/s*	KANAFLEX	FROZEN	NO LAT VAC	0.75	-	-	-	8.49	SURGING	6.36	5.68	4.43
	Vel Min	*m/s*	IS	FROZEN	NO LAT VAC	0.71	-	-	-	9.60	SURGING	6.97	5.41	2.70
	Flow	*CFM*	FROZEN		-	6.898089375	-	-	-	85.47	SURGING	63.0	52.4	33.7
	Temp	°C	-	FROZEN	NO LAT VAC	-	-	-	-	32.0	SURGING	30.5	28.5	15.6
	Comments		-	FROZEN	FROZEN -> ?	cracked	cracked->closed	closed -> cracked	cracked->1/2T	1/2->3T	3T	3T	3T	3T ->2T
6-56	*Well*	"H_2O	0.10	0.07	0.60	0.11	0.04	0.03	0.04	-0.06	-0.31	-3.34	-1.61	0.03
	Lateral	"H_2O	NO VAC	NO VAC	NO LAT VAC	NLV	NLV	NLV	NLV	-1.24	-1.11	-6.98	-3.41	FROZEN
	CH_4	%	63.9	63.8	44.2	61.7	56.3	61.1	61.40	61.0	17.7	62.4	56.2	50.0
	CO_2	%	35.9	34.9	31.8	36.4	36.1	36.6	35.80	37.3	17.9	35.8	43.8	36.1
	O_2	%	0.0	0.8	0.0	0.0	0.2	0.0	0.00	0.0	7.5	0.0	0.0	0.1
	BAL (N_2)	%	0.2	0.8	24.0	1.9	7.5	2.9	2.90	1.7	57.0	1.8	0.0	13.8
	CO	*PPM*	6	4	3	5	5	6	7.00	7	16	19	22	5
	H_2S	*PPM*	-	182	20	67	323	138	244	414	11	303	361	102
	Vel Max	*m/s*	no	no	NO LAT VAC	NLV	-	-	-	SURGING	SURGING	2.45	1.56	FROZEN
	Vel Min	*m/s*	lateral vacuum	lateral vacuum	NO LAT VAC	NLV	-	-	-	SURGING	SURGING	2.69	1.05	FROZEN
	Flow	*CFM*	-	-	-	-	-	-	-	SURGING	SURGING	24.3	12.3	FROZEN
	Temp	°C	-	-	NO LAT VAC	NLV	-	-	-	SURGING	SURGING	30.1	28.7	FROZEN
	Comments		closed -> no change	closed -> no change	closed	closed	closed	NLV	NLV	2T	2T	2T	2T	2->closed
6-57	*Well*	"H_2O	0.10	0.20	0.28	0.19	0.41	0.16	0.05	0.02	0.01	-0.24	-2.96	0.19
	Lateral	"H_2O	NO VAC	NO VAC	NO LAT VAC	NLV	NLV	NLV	NLV	-1.19	-1.39	-6.89	-3.11	-3.01
	CH_4	%	60.2	59.5	57.1	59.8	60.9	59.1	59.3	59.4	56.0	55.3	54.7	52.4
	CO_2	%	36.2	35.4	36.3	36.8	39.1	38.3	37.7	39.9	39.6	37.1	40.0	36.8
	O_2	%	0.1	1.1	1.0	0.0	0.0	0.0	0.0	0.0	1.3	1.5	0.3	0.0
	BAL (N_2)	%	3.6	4.1	5.3	3.4	0.0	2.6	3.0	0.7	3.0	6.1	5.0	10.8
	CO	*PPM*	4	3	6	4	6	6	7	7	6	5	1	6
	H_2S	*PPM*	-	20	11	29	142	43	82	52	18	45	66	13
	Vel Max	*m/s*	no	no	NO LAT VAC	NLV	-	-	-	3.62	7.11	3.01	2.41	6.71
	Vel Min	*m/s*	lateral vacuum	lateral vacuum	NO LAT VAC	NLV	-	-	-	4.21	5.36	3.26	2.17	6.39
	Flow	*CFM*	-	-	-	-	-	-	-	37.0	58.9	29.6	21.6	61.9
	Temp	°C	-	-	NO LAT VAC	NLV	-	-	-	31.0	30.2	28.7	25.0	21.7
	Comments		no lat vac	no lat vac	NO LAT VAC	closed	closed	NLV	NLV	2T	2T	2T	2T	2T
6-58	*Well*	"H_2O	0.11	0.12	0.17	0.13	0.10	0.04	0.02	0.00	0.07	-0.65	-3.18	-0.02
	Lateral	"H_2O	NO VAC	NO VAC	NO LAT VAC	NLV	NLV	NLV	NLV	-0.69	-1.01	-6.02	-4.01	-2.62
	CH_4	%	62.7	30.2	59.6	61.5	63.5	61.4	62.0	62.5	53.5	52.4	55.9	48.8
	CO_2	%	37.3	21.9	40.4	36.8	36.3	38.8	34.9	35.8	35.6	33.1	41.9	33.8
	O_2	%	0.0	9.8	0.0	0.0	0.1	0.0	0.0	0.0	0.4	0.5	2.1	0.6
	BAL (N_2)	%	0.0	37.4	0.0	1.6	0.2	2.8	3.0	1.7	10.5	14.0	0.1	16.9
	CO	*PPM*	4	4	27	4	4	4	5	4	6	4	1	5
	H_2S	*PPM*	-	11	27	125	>>>	232	274	>>>>	56	66	78	15
	Vel Max	*m/s*	no	no	NO LAT VAC	NLV	-	-	-	SURGING	SURGING	2.74	1.86	2.04
	Vel Min	*m/s*	lateral vacuum	lateral vacuum	NO LAT VAC	NLV	-	-	-	SURGING	SURGING	2.98	1.53	1.87
	Flow	*CFM*	-	-	-	-	-	-	-	SURGING	SURGING	27.03	16.02	18.47
	Temp	°C	-	-	NO LAT VAC	NLV	-	-	-	SURGING	SURGING	27.3	24.1	16.0
	Comments		no lat vac	no lat vac	NO LAT VAC	closed	closed	NLV	NLV	2T	2T	2T	2T	2->1T
6-59	*Well*	"H_2O	0.12	0.20	0.14	0.19	0.18	0.16	0.01	-0.03	0.03	0.04	0.02	0.12
	Lateral	"H_2O	NO VAC	NO VAC	NO LAT VAC	NLV	NLV	NLV	NLV	-0.78	NLV	NLV	NLV	-3.90
	CH_4	%	61.4	59.0	59.3	58.8	59.7	59.5	60.3	58.5	58.4	58.1	57.6	47.3
	CO_2	%	37.9	40.3	40.7	40.5	40.1	38.2	38.6	39.6	39.9	38.7	39.5	32.6
	O_2	%	0.0	0.5	0.0	0.6	0.2	0.4	0.6	1.7	0.2	0.6	1.2	1.9
	BAL (N_2)	%	0.0	0.0	0.0	0.0	0.0	1.0	0.6	0.0	1.5	2.6	1.7	18.2
	CO	*PPM*	6	9	31	7	10	12	11	7	8	6	3	21
	H_2S	*PPM*	-	15	28	227	129	70	121	109	119	120	142	4
	Vel Max	*m/s*	no	no	NO LAT VAC	NLV	-	-	-	2.94	-	-	-	0.00
	Vel Min	*m/s*	lateral vacuum	lateral vacuum	NO LAT VAC	NLV	-	-	-	3.51	-	-	-	0.00
	Flow	*CFM*	-	-	-	-	-	-	-	30.47	-	-	-	0
	Temp	°C	-	-	NO LAT VAC	NLV	-	-	-	25.1	-	-	-	-9.3
	Comments		no lat vac	no lat vac	NO LAT VAC	closed	closed	NLV	NLV	2T	NLV	NLV	NLV	2T

Table 2: Wellfield Monitoring Data

		Units	23/Jan/19	28/Feb/19	22/Mar/19	22/Apr/19	28/May/19	24/Jun/19	18/Jul/19	24/Aug/19	19/Sep/19	29/Oct/19	25/Nov/19	29/Dec/19
7-60	*Well*	"H_2O	4.41	-2.10	-4.63	-8.11	0.77	-4.49	-4.84	-3.10	-2.10	-1.96	-3.64	-2.19
	Lateral	"H_2O	-18.57	-5.90	-5.26	-8.53	NLV	-7.09	-5.02	-3.32	-2.23	-2.63	-3.76	-2.74
	CH_4	%	64.6	29.9	62.7	52.6	64.4	62.3	62.4	55.8	64.2	58.4	56.8	46.8
	CO_2	%	34.5	16.4	32.9	30.2	33.8	34.5	34.4	30.8	33.6	29.8	41.2	24.5
	O_2	%	0.4	12.8	1.2	2.4	0.0	0.0	0.1	1.8	0.2	2.9	2.0	6.1
	BAL (N_2)	%	0.0	33.5	3.3	14.8	1.7	3.2	3.1	11.6	2.0	9.0	0.0	22.6
	CO	PPM	2	0	3	3	4	4	5	4	4	4	3	3
	H_2S	PPM	-	23	19	28	50	38	56	43	44	50	52	4
	Vel Max	m/s	-	0.44	0.63	0.44	-	-	-	0.44	0.00	SURGING	SURGING	0.00
	Vel Min	m/s	-	0.00	0.56	0.00	-	-	-	0.47	0.00	SURGING	SURGING	0.00
	Flow	CFM	-	2.07887625	5.622415313	2.07887625	-	-	-	4.30	0	SURGING	SURGING	0
	Temp	°C	-	-22.0	5.6	17.9	-	-	-	25.6	14.7	SURGING	SURGING	-9.3
	Comments		valve is frozen	valve is frozen	frozen -> 1/2T	1/2T	closed	closed -> 1T	1->2T	2T	2T	2T	2T	2T (FROZEN)
7-61	*Well*	"H_2O	0.56	0.50	0.49	0.38	Goose	0.45	0.85	0.19	-0.61	-3.56	-3.82	1.27
	Lateral	"H_2O	NO VAC	NO VAC	NO LAT VAC	GOOSE	NLV	NLV	NLV	-2.34	-2.19	-6.35	-4.34	-3.22
	CH_4	%	55.7	55.6	55.9	55.8	-	56.1	56.8	55.7	52.5	51.4	58.5	57.7
	CO_2	%	44.1	44.3	44.9	44.2	-	43.2	42.6	41.9	44.7	42.8	40.6	42.3
	O_2	%	0.1	0.0	0.2	0.0	-	0.0	0.0	0.1	0.1	0.1	0.7	0.0
	BAL (N_2)	%	0.0	0.0	0.0	0.0	-	0.7	0.6	2.3	2.6	5.7	0.2	0.0
	CO	PPM	6	5	16	27	-	6	6	6	19	12	15	5
	H_2S	PPM	-	171	7	252	-	314	>>>>	>>>>	>>>>	>>>>	>>>>	253
	Vel Max	m/s	no	no	NO LAT VAC	GOOSE	-	-	-	4.02	4.75	4.22	4.86	0.72
	Vel Min	m/s	lateral vacuum	lateral vacuum	NO LAT VAC	GOOSE	-	-	-	5.01	4.21	4.60	4.51	0.59
	Flow	CFM	-	-	-	-	-	-	-	42.7	42.3	41.7	44.3	6.2
	Temp	°C	-	-	NO LAT VAC	GOOSE	-	-	-	24.7	13.1	12.0	11.6	-8.8
	Comments		no lat vac	no lat vac	NO LAT VAC	closed	closed	NLV	NLV	2T	2T	2T	2T	2T
7-62	*Well*	"H_2O	0.60	1.00	0.59	0.57	0.69	0.52	0.71	0.44	0.17	0.02	0.09	1.16
	Lateral	"H_2O	no vac	no vac	NO LAT VAC	NLV	NLV	NLV	NLV	-3.20	NLV	-4.12	NLV	BURIED
	CH_4	%	59.7	59.9	59.6	5934.0	58.6	58.4	59.2	60.0	58.9	61.5	60.4	58.1
	CO_2	%	40.2	40.1	40.0	39.9	39.0	38.4	38.3	39.0	40.4	37.1	38.5	41.9
	O_2	%	0.2	0.0	0.4	0.0	0.2	0.0	0.0	0.2	0.5	0.6	1.0	0.0
	BAL (N_2)	%	0.0	0.0	0.0	0.7	2.2	3.2	2.4	0.8	0.1	0.8	0.1	0.0
	CO	PPM	4	3	4.0	3	6	4	5	5	7	3	4	4
	H_2S	PPM	-	352	7.0	289	>>>	474	>>>>	>>>>	>>>>	>>>>	>>>>	155
	Vel Max	m/s	no	no	NO LAT VAC	NLV	-	-	-	0.00	-	3.65	-	BURIED
	Vel Min	m/s	lateral vacuum	lateral vacuum	NO LAT VAC	NLV	-	-	-	0.00	-	4.87	-	BURIED
	Flow	CFM	-	-	-	-	-	-	-	0	-	40.25	-	BURIED
	Temp	°C	-	-	NO LAT VAC	NLV	-	-	-	26.8	-	24.0	-	BURIED
	Comments		no lat vac	no lat vac	NO LAT VAC	closed	closed	NLV	NLV	3T	NLV	3T	NLV	3T -> 1T
7-64	*Well*	"H_2O	0.20	0.30	0.08	0.23	0.10	0.06	0.13	0.02	0	0.23	-2.39	0.29
	Lateral	"H_2O	no vac	no vac	NO LAT VAC	NLV	NLV	NLV	NLV	-0.07	NLV	-5.98	-4.19	-3.67
	CH_4	%	52.4	55.0	55.6	55.7	58.3	59.5	60.2	59.3	58.2	57.6	56.6	53.3
	CO_2	%	33.1	44.3	44.6	44.3	38.8	38.5	38.4	40.5	40.4	39.1	39.4	35.3
	O_2	%	0.4	0.4	0.0	0.0	0.3	0.0	0.0	0.0	0.8	0.5	2.0	0.9
	BAL (N_2)	%	14.2	0.0	0.0	0.0	2.6	2.0	1.4	0.2	0.6	2.8	2.0	10.5
	CO	PPM	4	4	14	22	5	4	5	6	6	4	3	5
	H_2S	PPM	-	332	7	>>>	135	86	242	89	263	222	254	99
	Vel Max	m/s	no	no	NO LAT VAC	NLV	-	-	-	0.52	-	4.51	3.50	6.38
	Vel Min	m/s	lateral vacuum	lateral vacuum	NO LAT VAC	NLV	-	-	-	0.67	-	4.88	0.41	5.77
	Flow	CFM	-	-	-	-	-	-	-	5.62	-	44.4	18.5	57.4
	Temp	°C	-	-	NO LAT VAC	NLV	-	-	-	24.1	-	22.6	21.5	3.9
	Comments		no vac	no vac	NO LAT VAC	closed	closed	NLV	NLV	NLV	NLV	2T	2T	2T
7-65	*Well*	"H_2O	0.16	0.20	0.26	0.30	0.12	0.07	0.02	-0.03	0.03	0.06	-1.06	0.10
	Lateral	"H_2O	no vac	no vac	NO LAT VAC	NLV	NLV	NLV	NLV	NLV	NLV	-5.86	-4.14	-3.59
	CH_4	%	59.3	60.6	60.4	60.2	59.1	60.1	61.3	59.5	59.7	59.6	55.3	58.9
	CO_2	%	37.6	37.8	38.6	39.5	38.5	38.3	37.8	38.3	38.7	36.6	38.6	37.2
	O_2	%	0.5	0.7	0.0	0.1	0.0	0.0	0.3	0.0	0.0	0.0	0.1	0.1
	BAL (N_2)	%	2.5	0.9	1.0	0.0	2.5	1.7	0.7	2.2	1.6	3.8	6.0	3.8
	CO	PPM	6	3	3	4	7	5	6	5	4	3	8	8
	H_2S	PPM	-	153	263	275	236	139	347	171	78	67	86	193
	Vel Max	m/s	no	no	NO LAT VAC	NLV	-	-	-	-	-	3.05	3.52	SURGING
	Vel Min	m/s	lateral vacuum	lateral vacuum	NO LAT VAC	NLV	-	-	-	-	-	3.41	3.96	SURGING
	Flow	CFM	-	-	-	-	-	-	-	-	-	30.5	35.3	SURGING
	Temp	°C	-	-	NO LAT VAC	NLV	-	-	-	-	-	15.3	12.5	SURGING
	Comments		no lat vac	no lat vac	NO LAT VAC	closed	closed	NLV	NLV	NLV	NLV	2T	2T	2T -> 1T

Table 2: Wellfield Monitoring Data

		Units	23/Jan/19	28/Feb/19	22/Mar/19	22/Apr/19	28/May/19	24/Jun/19	18/Jul/19	24/Aug/19	19/Sep/19	29/Oct/19	25/Nov/19	29/Dec/19
7-66	*Well*	"H_2O										-	-	0.2
	Lateral	"H_2O										-	-	NLV
	CH_4	%										-	-	60.7
	CO_2	%										-	-	39.1
	O_2	%										-	-	0.2
	BAL (N_2)	%										-	-	0
	CO	PPM										-	-	11
	H_2S	PPM										-	-	242
	Vel Max	m/s										-	-	-
	Vel Min	m/s										-	-	-
	Flow	CFM										-	-	
	Temp	°C										-	-	-
	Comments											CNF	CNF	NLV
MH-16	*Well*	"H_2O		0.02	0.02	0.10	-0.09	0.00	-0.06	-0.10	-0.02	0.03	0.02	0.06
	Lateral	"H_2O		NO VAC	-5.43	-9.01	-11.78	-9.09	-4.97	-2.90	-2.54	NLV	NLV	-5.32
	CH_4	%		55.7	26.4	56.3	9.2	56.0	43.8	25.9	48.7	58.5	56.3	56.2
	CO_2	%		43.7	21.2	42.3	6.6	43.0	36.5	19.2	39.3	40.6	41.2	24.8
	O_2	%		0.5	10.7	0.3	15.9	0.4	3.9	10.1	2.5	0.8	2.1	1.6
	BAL (N_2)	%		0.0	41.7	1.2	58.4	0.5	15.7	44.8	9.6	0.0	0.4	17.4
	CO	PPM		3	2	2	0	3	3	1	2	3	4	2
	H_2S	PPM		42	7	39	6	59	32	42	27	26	30	26
	Vel Max	m/s		-	NO PORT	NO PORT	No Port	-	-	-	-	-	-	-
	Vel Min	m/s		-	NO PORT	NO PORT	No Port	-	-	-	-	-	-	-
	Flow	CFM		-				-	-	-	-	-	-	-
	Temp	°C		-	NO PORT	NO PORT		-	-	-	-	-	-	-
	Comments			NO LAT VAC	closed	closed->cracked	cracked->closed	closed - > cracked	cracked	cracked->closed	closed	NLV	NLV	closed
MH-19	*Well*	"H_2O							0.01	-0.07	0.01	0.06	0.07	0.03
	Lateral	"H_2O							-4.97	-2.81	-1.99	NLV	NLV	-5.47
	CH_4	%							55.4	49.1	27.5	55.2	51.9	54.3
	CO_2	%							43.2	38.7	22.4	37.4	48.1	35.7
	O_2	%							0.0	1.6	9.6	2.1	0.0	1.4
	BAL (N_2)	%							1.4	10.7	40.5	7.4	0.0	8.6
	CO	PPM							3	2	1	2	3	3
	H_2S	PPM							91	19	19	18	24	21
	Vel Max	m/s							-	-	-	-	-	-
	Vel Min	m/s							-	-	-	-	-	-
	Flow	CFM							-	-		-		
	Temp	°C							-	-	-	-	-	-
	Comments								cracked	cracked->1/2T	1/2->closed	closed->cracked	cracked ->closed	closed
MH-22	*Well*	"H_2O							-0.04	-0.07	-0.05	-0.01	-0.02	0.02
	Lateral	"H_2O							-5.13	-1.38	-3.11	NLV	NLV	-5.19
	CH_4	%							14.2	46.3	26.0	52.5	54.7	55.5
	CO_2	%							10.8	35.2	14.8	39.9	42.7	37.4
	O_2	%							14.7	2.8	11.4	1.8	2.0	2.2
	BAL (N_2)	%							60.3	15.1	47.8	5.9	0.6	4.9
	CO	PPM							2	2	2	2	1	5
	H_2S	PPM							6	28	12	16	20	40
	Vel Max	m/s							-	-	-	-	-	-
	Vel Min	m/s							-	-	-	-	-	-
	Flow	CFM							-	-		-		
	Temp	°C							-	-	-	-	-	-
	Comments								closed	closed->cracked	1/4->closed	NLV	NLV	closed
MH-25	*Well*	"H_2O							0.01	-0.04	-0.03	-0.03	0.01	-
	Lateral	"H_2O							NLV	NLV	NLV	NLV	NLV	NLV
	CH_4	%							59.5	58.8	61.4	56.4	58.2	-
	CO_2	%							38.9	35.8	37.4	39.5	40.6	-
	O_2	%							0.5	0.3	0.2	2.8	0.1	-
	BAL (N_2)	%							1.1	5.1	1.0	1.3	1.1	-
	CO	PPM							3	3	4	3	5	-
	H_2S	PPM							233	60	67	35	15	-
	Vel Max	m/s							-	-	-	-	-	-
	Vel Min	m/s							-	-	-	-	-	-
	Flow	CFM							-	-		-		
	Temp	°C							-	-	-	-	-	-
	Comments								NLV	NLV	NLV	NLV	NLV	NLV

Table 2: Wellfield Monitoring Data

		Units	23/Jan/19	28/Feb/19	22/Mar/19	22/Apr/19	28/May/19	24/Jun/19	18/Jul/19	24/Aug/19	19/Sep/19	29/Oct/19	25/Nov/19	29/Dec/19
MH-7	*Well*	*"H_2O*		0.03										
	Lateral	*"H_2O*		NO VAC										
	CH_4	*%*		0.6										
	CO_2	*%*		1.9										
	O_2	*%*		15.9										
	BAL (N_2)	*%*		81.6										
	CO	*PPM*		0										
	H_2S	*PPM*		2										
	Comments			NO LAT VAC										
MH-43	*Well*	*"H_2O*												
	Lateral	*"H_2O*												
	CH_4	*%*												
	CO_2	*%*												
	O_2	*%*												
	BAL (N_2)	*%*												
	CO	*PPM*												
	H_2S	*PPM*												
	Comments													

Table 3: Pump Counters

	December 2018	January 2019			February 2019			March 2019			April 2019			May 2019			June 2019		
Location	Counter	Counter	Counts / mo	Litres / mo	Counter	Counts / mo	Litres / mo	Counter	Counts / mo	Litres / mo	Counter	Counts / mo	Litres / mo	Counter	Counts / mo	Litres / mo	Counter	Counts / mo	Litres / mo
PDT 1	4647	4647	0	0	4647	0	0	4647	0	0	4647	0	0	4647	0	0	4647	0	0
PDT 2	57628	57628	0	0	57628	0	0	57628	0	0	9159	-48469	-126019.4	10439	1280	3328	10692	253	657.8
PDT 3	13407	13407	0	0	14080	673	1749.8	14080	0	0	14164	84	218.4	14166	2	5.2	14186	20	52
PDT 4	no counter	no counter	-	-	no counter	-	-	no counter	-	-	no counter	-	-	no counter	-	-	no counter	-	-
PDT 5	32274	32274	0	0	32274	0	0	32274	0	0	58015	25741	66926.6	58330	315	819	58502	172	447.2
PDT 6	94165	96915	2750	7150	96918	3	7.8	96919	1	2.6	100980	4061	10558.6	100989	9	23.4	102780	1791	4656.6
PDT 7	8256	8256	0	0	8256	0	0	8256	0	0	8256	0	0	8256	0	0	no counter	-	-
PDT 8	18063	19174	1111	2888.6	19174	0	0	22996	3822	9937.2	24567	1571	4084.6	26828	2261	5878.6	29540	2712	7051.2
PDT 9	197611	205609	7998	20794.8	205609	0	0	210577	4968	12916.8	212900	2323	6039.8	215240	2340	6084	217546	2306	5995.6
PDT 10																			
PDT 11																			
PDT 12																			
H-4	264395	264395	0	0	284372	19977	51940.2	284372	0	0	293603	9231	24000.6	301440	7837	20376.2	307897	6457	16788.2
1-9	694088	694088	0	0	707567	13479	35045.4	707571	4	10.4	724845	17274	44912.4	732187	7342	19089.2	736949	4762	12381.2
1-10	531092	531092	0	0	538482	7390	19214	538489	7	18.2	552545	14056	36545.6	556860	4315	11219	560909	4049	10527.4
H-11	49336	49336	0	0	99391	50055	130143	99395	4	10.4	194039	94644	246074.4	247600	53561	139258.6	282384	34784	90438.4
2-18	109333	109333	0	0	414299	304966	792911.6	414321	22	57.2	547088	132767	345194.2	663535	116447	302762.2	761127	97592	253739.2
3-27	238279	238279	0	0	238279	0	0	238279	0	0	238279	0	0	238279	0	0	238279	0	0
3-29	no counter	no counter	-	-	no counter	-	-	no counter	-	-	no counter	-	-	829973	-	-	829977	4	10.4
3-30	69255	69255	0	0	69289	34	88.4	69297	8	20.8	69304	7	18.2	69310	6	15.6	69312	2	5.2

	July 2019			August 2019			September 2019			October 2019			November 2019			December 2019		
Location	Counter	Counts / mo	Litres / mo	Counter	Counts / mo	Litres / mo	Counter	Counts / mo	Litres / mo	Counter	Counts / mo	Litres / mo	Counter	Counts / mo	Litres / mo	Counter	Counts / mo	Litres / mo
PDT 1	4665	18	46.8	4676	11	28.6	4884	208	540.8	4931	47	122.2	4931	0	0	4931	0	0
PDT 2	10898	206	535.6	11232	334	868.4	11391	159	413.4	11599	208	540.8	12121	522	1357.2	12192	71	184.6
PDT 3	14228	42	109.2	14351	123	319.8	14487	136	353.6	16229	1742	4529.2	16255	26	67.6	16268	13	33.8
PDT 4	no counter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PDT 5	58591	89	231.4	58897	306	795.6	Flooded	-	-	-	-	-	-	-	-	-	-	-
PDT 6	103477	697	1812.2	104105	628	1632.8	105304	1199	3117.4	136139	30835	80171	136145	6	15.6	136201	56	145.6
PDT 7	no counter	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PDT 8	31201	1661	4318.6	32394	1193	3101.8	34031	1637	4256.2	42392	8361	21738.6	45923	3531	9180.6	46173	250	650
PDT 9	220701	3155	8203	224763	4062	10561.2	No Reg	-	-	1150	-	-	1769	619	1609.4	1911	142	369.2
PDT 10										19	19	49.4	22	3	7.8	23	1	2.6
PDT 11										17	17	44.2	741	724	1882.4	855	114	296.4
PDT 12										17	17	44.2	22	5	13	22	0	0
H-4	313962	6065	15769	324606	10644	27674.4	330938	6332	16463.2	348298	17360	45136	355441	7143	18571.8	363145	7704	20030.4
1-9	740678	3729	9695.4	746461	5783	15035.8	749337	2876	7477.6	756701	7364	19146.4	761258	4557	11848.2	765504	4246	11039.6
1-10	563092	2183	5675.8	568981	5889	15311.4	572756	3775	9815	581221	8465	22009	583024	1803	4687.8	585541	2517	6544.2
H-11	282384	0	0	331942	49558	128850.8	369418	37476	97437.6	457125	87707	228038.2	478964	21839	56781.4	498024	19060	49556
2-18	840219	79092	205639.2	962977	122758	319170.8	992784	29807	77498.2	999999	7215	18759	25	-999974	-2599932.4	25	0	0
3-27	238279	0	0	238279	0	0	238279	0	0	238279	0	0	-	-	-	-	-	-
3-29	829977	0	0	829995	18	46.8	829999	4	10.4	829999	0	0	830071	72	187.2	830071	0	0
3-30	69321	9	23.4	69329	8	20.8	69333	4	10.4	69340	7	18.2	69405	65	169	69497	92	239.2

Table 4: Water Levels

			Mar 14/15, 2019			May 3/14, 2019			Jul 29/15,2019			Sept 29/30,2019			Nov 29/30,2019		
Units	meters	meters	meters	meters	%	meters	meters	%	meters	meters	%	meters	meters	%	meters	meters	%
Locations	Screen Length	Installed Well Depth	Depth to Water	Depth to Bottom	Open Screen	Depth to Water	Depth to Bottom	Open Screen	Depth to Water	Depth to Bottom	Open Screen	Depth to Water	Depth to Bottom	Open Screen	Depth to Water	Depth to Bottom	Open Screen
H-1	12	14.63	7.70	14.10	43.14	7.00	14.90	37.40	7.50	14.50	41.50	7.40	14.50	40.68	7.30	14.40	39.86
H-2	14	16.77	8.90	17.50	42.65	8.50	18.50	39.73	9.00	18.10	43.38	8.90	18.10	42.65	8.70	18.10	41.19
H-3	12	15.24	7.10	15.80	33.22	7.00	16.10	32.40	7.10	16.40	33.22	7.10	16.50	33.22	7.00	16.10	32.40
H-4*	11	14.02	NM	blocked	-	8.20	9.80	46.93	7.20	9.80	37.82	8.40	10.00	48.76	5.60	9.90	23.24
1-5	11	13.72	NM	blocked	-	7.70	14.80	43.59	8.20	14.60	48.27	8.00	14.70	46.40	7.80	14.20	44.53
1-6	12	15.55	10.30	15.30	56.96	10.60	16.60	59.42	10.90	16.60	61.88	11.20	16.80	64.34	10.70	16.30	60.24
1-7	18	21.34	12.60	19.50	52.21	13.90	20.20	59.32	14.80	20.00	64.24	14.60	20.00	63.15	12.90	18.30	53.85
1-8	21	24.39	15.60	22.70	58.81	11.20	23.90	38.19	15.70	23.50	59.28	15.20	24.00	56.94	15.10	23.70	56.47
1-9*	12	14.63	9.00	13.40	53.80	12.60	14.70	83.32	10.10	14.70	62.82	12.90	14.90	85.78	12.80	15.00	84.96
1-10*	9	12.20	7.70	11.10	50.85	10.20	11.80	78.19	10.60	11.50	82.56	10.00	11.90	76.00	9.30	11.60	68.35
H-11*	9	12.80	4.20	6.60	5.92	FOAM	12.50	-	6.40	11.20	29.97	FOAM	12.30	-	FOAM	12.40	-
H-12	13	16.16	NM	no port	-	NM	no port	-	NM	no port	-	NM	no port	-	NM	no port	-
2-13	21	25.00	9.40	19.50	26.90	7.60	19.00	18.47	7.60	9.70	18.47	6.80	9.80	14.72	7.10	10.10	16.13
2-14	20	22.56	10.40	21.80	38.63	9.20	22.20	32.58	8.90	22.10	31.06	6.70	22.20	19.96	8.30	22.00	28.04
2-15	18	21.65	12.70	21.10	51.09	15.60	21.70	66.95	13.20	22.30	53.83	12.50	22.20	50.00	11.90	21.80	46.72
2-16	26	28.35	21.80	29.00	74.71	22.70	29.30	78.18	22.30	30.00	76.64	21.70	29.70	74.32	21.80	29.70	74.71
2-17	15	18.29	12.70	18.00	63.31	13.30	18.60	67.25	13.90	18.30	71.18	13.10	18.30	65.94	13.30	18.10	67.25
2-18*	15	18.29	14.50	19.30	75.12	16.00	18.50	84.96	16.40	18.90	87.58	16.00	18.70	84.96	15.80	18.50	83.65
3-19	12	14.94	8.70	14.20	48.84	6.20	14.20	28.34	8.80	14.50	49.66	8.60	14.40	48.02	8.80	14.50	49.66
3-20	11	13.26	9.20	9.20	61.93	8.90	9.50	59.12	9.10	9.90	60.99	9.00	9.80	60.06	8.90	9.90	59.12
3-21	5	7.62	NM	blocked	-	4.20	7.40	25.17	4.20	8.00	25.17	4.10	7.60	22.99	4.10	7.80	22.99
3-22	24	26.68	0.00	17.90	0.00	5.40	22.50	11.66	5.70	16.90	12.91	5.60	17.20	12.49	16.30	23.00	56.92
3-23	23	25.91	7.80	18.20	20.78	8.10	26.10	22.09	7.90	24.50	21.22	8.00	23.40	21.65	7.50	14.50	19.47
3-24	21	23.48	9.10	20.60	32.64	8.90	21.50	31.70	9.30	21.10	33.58	9.00	20.90	32.17	9.10	21.00	32.64
3-25	18	21.34	0.70	23.60	0.00	7.90	24.20	26.52	5.30	17.80	12.31	4.20	20.40	6.29	8.70	24.10	30.89
3-26	9	12.20	1.50	12.90	0.00	1.40	12.40	0.00	3.40	14.80	3.84	0.00	16.20	0.00	0.00	15.80	0.00
3-27*	21	24.09	8.00	14.60	24.63	8.40	26.60	26.50	9.00	17.80	29.31	8.70	18.80	27.91	7.90	26.30	24.16
3-28	12	15.24	2.50	14.20	0.00	1.20	14.70	0.00	3.10	14.80	0.42	3.40	15.20	2.88	2.50	15.00	0.00
3-29*	12	14.63	5.80	12.10	27.56	4.70	13.60	18.54	6.00	14.00	29.20	4.60	12.50	17.72	5.80	13.50	27.56
3-30*	7	9.76	5.50	8.40	41.83	5.00	8.70	35.00	5.30	7.10	39.10	4.40	9.00	26.80	5.10	8.80	36.37
4-31	16	18.75	9.50	18.00	42.75	6.80	19.10	26.05	8.60	18.20	37.18	7.60	18.60	31.00	7.10	18.50	27.90
4-32	10	12.50	7.60	10.40	49.78	5.80	12.80	31.33	6.10	10.90	34.40	7.10	11.40	44.65	7.20	11.70	45.68
4-33	24	26.68	6.30	29.40	16.46	6.90	29.80	18.92	6.60	29.60	17.69	6.80	28.90	18.51	6.50	21.20	17.28
4-34	20	22.56	4.70	17.40	9.87	5.00	20.50	11.38	5.20	20.90	12.39	6.70	29.50	19.96	6.80	20.60	20.47
4-35	15	17.38	4.00	17.10	12.24	7.20	17.40	33.23	5.10	16.70	19.46	5.10	17.60	19.46	5.80	16.70	24.05
4-36	15	18.29	NM	Too Tall	-	NM	Too Tall	-	NM	Too Tall	-	NM	Too Tall	-	NM	Too Tall	-
4-37	12	14.94	8.30	14.20	45.56	6.20	14.30	28.34	7.20	13.90	36.54	7.40	13.80	38.18	7.40	14.00	38.18
5-38	8	10.67	NM	blocked	-	4.10	11.70	13.79	4.20	11.80	15.10	4.10	11.70	13.79	4.30	11.80	16.42
5-39	8	10.67	4.00	12.70	12.48	4.70	12.40	21.66	4.50	12.50	19.04	4.30	12.60	16.42	4.80	12.50	22.98
5-40	18	21.95	NM	blocked	-	6.40	12.20	14.99	6.20	22.20	13.89	6.30	16.70	14.44	6.70	17.80	16.63
5-41	17	18.90	12.70	16.70	63.01	12.10	17.10	59.43	11.40	17.20	55.26	12.10	16.90	59.43	12.20	16.70	60.03
5-42	12	16.16	NM	no port	-	NM	no port	-	9.80	15.20	47.86	9.60	15.40	46.22	9.40	15.40	44.58
5-43	14	16.16	6	12	25.96	5.4	12.3	21.58	5.8	12.3	24.50	5.9	12.1	25.23	5.5	12.2	22.31
5-44	19	21.95	15.8	21.6	67.46	14.5	16.2	60.58	14.7	22.5	61.64	14.9	19.4	62.70	14.9	19.6	62.70
5-45	15	16.77	6	15.7	29.36	6.5	15.3	32.64	6.3	13.8	31.33	6.2	14.8	30.67	6.2	14.1	30.67
5-46	16	18.90	NM	blocked	-	7.4	16.7	27.45	7.5	13.8	28.08	7.3	14.4	26.82	7.6	17.1	28.71
6-47	14	15.85	NM	blocked	-	4.8	13.6	19.43	5.3	14	23.08	5	13.9	20.89	5.2	13.9	22.35
6-48	15	17.68	5.3	15	15.38	5.1	15.3	14.02	5.3	15.5	15.38	5.3	15.3	15.38	5.3	15.3	15.38
6-49	20	23.48	NM	blocked	-	12	23.2	43.82	12.7	23.2	47.25	12.5	23.1	46.27	12.2	23.1	44.80
6-50	14	17.38	13.6	16.6	73.63	13.6	16.9	73.63	13.3	16.8	71.54	13.5	16.9	72.94	13.9	16.9	75.73
6-51	12	14.94	4.9	6.2	17.68	4.9	5.9	17.68	4.8	5.2	16.86	4.6	5.5	15.22	4.8	5.5	16.86
6-52	6	9.15	4	7.4	15.60	3.5	7.1	7.40	3.2	7.5	2.48	3.8	7.3	12.32	3.9	7.4	13.96
6-53	22	23.63	14.3	21.3	57.80	14.3	21.6	57.80	14.6	22.6	59.16	14.4	22.4	58.25	15	22.5	60.97
6-54	13	15.85	6.7	14.6	30.18	7.1	14.8	33.23	6.8	15.1	30.94	6	14.8	24.84	6.5	14.9	28.65
6-55	18	21.34	NM	blocked	-	3.3	22.3	1.37	16	22	70.80	10.5	22	40.73	12.5	22.1	51.67
6-56	10	12.80	5	12	22.42	5.1	12	23.42	4.8	12.2	20.44	4.9	12.1	21.43	4.5	12.2	17.45
6-57	21	24.39	11.8	14.5	40.05	NM	Goose	-	11.5	14.5	38.62	11.6	14.6	39.10	11.8	14.6	40.05
6-58	17	22.50	9.5	21.1	23.53	9.4	21.3	22.94	9.9	21	25.88	9.6	21.1	24.12	8.5	21.2	17.65
6-59	17	20.12	16.3	20.9	77.61	15.8	21.4	74.69	16.3	22.2	77.61	16.5	21.3	78.79	16.5	22	78.79
7-60	13	15.55	NM	blocked	-	5.3	14	18.01	5.3	14.1	18.01	5.2	14.4	17.21	5.3	14.3	18.01
7-61	13	15.24	NM	blocked	-	9.8	13.9	57.49	10.6	13.8	63.73	10.1	13.2	59.83	10.3	13.5	61.39
7-62	17	18.29	NM	blocked	-	12.6	16.8	66.05	12.6	16.8	66.05	12.4	16.5	64.86	12.5	16.6	65.45
7-64	22	24.09	NM	blocked	-	17.2	25.9	68.63	17.7	26.5	70.91	17.5	26.1	70.00	17.5	26.2	70.00
7-65	24	26.22	17	27.3	61.23	17.1	28.5	61.65	17.1	28.1	61.65	17.2	28.6	62.07	17.2	28.4	62.07

*** Dual Pupose Wells**
NM = Not Monitored

2.2 Surface Emission Monitoring

As required by the City, surface emission monitoring is requested to be carried out semi-annually, weather conditions permitting, by Comcor. This monitoring is performed using a portable flame ionization detector (FID) and a GPS, marking locations where concentrations of hydrocarbons were greater than 500 ppm. The surface emission monitoring was completed in April and July for the 2019 reporting year. Several areas were noted where there were significant volumes of gas detected, including areas where cap was weak, pipe emanated from the landfill surface, uncovered manholes and/or manholes lacking proper sealing.

2.3 Mechanical System Monitoring

The main operational control of the mechanical system is carried out by the Programmable Logic Controller (PLC). The PLC also provides information on the operating status of the system, and records all data electronically which can be downloaded when required. Specific details on these items are included in the Flare Operation and Maintenance Manual. At a minimum the PLC records:

- Landfill gas composition and temperature
- Flare operating times
- Blower operating times
- Landfill gas flow rate
- Volume of landfill gas collected and flared
- Greenhouse Gas Emission Reduction in CO_2 equivalents.

These items were also monitored remotely and were reviewed at minimum on a weekly basis to ensure that all parameters outlined above are being recorded and that all system data indicates that the overall system is operating properly. The system review was carried out by a technician experienced in the operation of such systems.

Comcor staff also carried out the maintenance of the system as outlined by the Operations and Maintenance Manual. No other major repairs had to be made to the mechanical system during 2019.

Data for 2019 has been compiled, and is found in Appendix A.

2.3.1 System Pressure Measurements

Monitoring ports at the inlet and outlet to the blower were measured and recorded on a monthly frequency, using a suitably scaled pressure gauge. Gauge fluctuations were noted, as it can be an indication of water within the system.

Data for 2019 has been compiled, and is found in Table 2.

2.3.2 System Gas Measurements

The purpose of the main blower skid gas analyzer system is to monitor the oxygen and methane concentrations of the landfill gas being transferred by the LGFCS to the flare. As a safety precaution, if either the oxygen concentration gets too high, or the methane concentration gets too low, an alarm is sent to the main computer control panel PLC to shut the system down. Having records of the gas concentrations also allows for better analysis of the system and aids in troubleshooting when problems arise.

A pump, located within the gas analyzer system cabinet in the control room, is used to draw a continuous sample of process gas from the header pipe on the blower discharge side. After entering the analyzer, the sample is drawn through a de-mister and a series of filters to remove any particulate or moisture that may affect the monitoring equipment. The methane and oxygen concentrations of the sample are then measured by an infra-red methane analyzer and oxygen analyzer. The methane and oxygen concentrations are displayed on separate LED display screens mounted on the front face of the gas analyzer panel. The gas analyzer system will send signals to the PLC that will trigger a number of system alarms/warnings including low methane and high oxygen.

All system failures and/or alarms are displayed on the main control circuit panel. Any alarms that shut down the system are relayed by the auto messaging to the system operator.

During 2019, the system operated as intended with the analyzer data recorded at an interval of five minutes or better and any system alarms were sent to the operator. This data was recorded and summarized into a daily value and can be found in Appendix A.

In addition to the main system analyser, concentrations of methane (CH_4), carbon dioxide (CO_2) and oxygen (O_2) were measured manually, recorded monthly at the blower inlet and blower outlet, and compared to the insitu monitoring devices to ensure accuracy. These measurements were taken using a proper gas meter/analyzer such as a Landtec GEM-5000+, or equivalent.

2.3.3 System Flow Rate Measurements

Landfill gas velocities and temperatures at each landfill gas extraction well in the wellfield were measured and recorded on a monthly basis using an anemometer. These velocities were used to calculate landfill gas flow rates by multiplying by the pipe's cross sectional area.

A thermal mass flow meter continuously calculates flows to the flare and this data was recorded on an interval of 5 minutes or less.

The monitoring completed in 2019 is found in Table 2 and a summary of daily plant data can be found in Appendix A.

3.0 FLARE AND GREENHOUSE GAS EMISSIONS

3.1 Flare Emissions

The flare stack is equipped with four thermocouples that measure the temperature in the flare stack. These thermocouples are monitored by the system control panel PLC at intervals of 5 minutes or better. The control system is continuously monitoring the flame conditions and will shut down the LGCFS system immediately if flame is lost.

If the system shuts down for any reason, the fail safe valve will close and prevent any non-combusted landfill gas from being released to the atmosphere, thereby controlling the emissions from the flare.

3.2 Greenhouse Gas Emissions

The landfill gas comprises primarily methane and carbon dioxide in approximately equal amounts. In addition there are other trace amounts of a large number of compounds. Methane and carbon dioxide are greenhouse gases but methane has a global warming potential 25 times that of carbon dioxide. By combusting the methane in the flare the resultant products are carbon dioxide and water vapour which reduces its global warming potential by approximately 95 percent.

The control panel records both flow and methane gas concentration being collected from the system and sent to be combusted in the flare. These quantities are measured and recorded at intervals of 5 minutes or less. The data collected can be readily processed to calculate the greenhouse gas emission reduction expressed as carbon dioxide equivalents.

For the Brady Road Landfill, greenhouse gas emissions have been calculated based on operational data and can be found in Appendix A.

4.0 CONDENSATE COLLECTION SYSTEM

The purpose of the Condensate Collection System component of the LGCFS is to remove moisture from the landfill gas and to collect condensate from the collection laterals/header pipes. Collection and removal of the condensate increases the efficiency of the landfill gas collection in the wellfield and minimizes the moisture being passed through the mechanical system.

Condensate and moisture are removed from the system at three main locations. First, relative low points have been provided in the gas collection header to allow any free moisture to drain by gravity out of the underground gas collection system. In the wellfield, this moisture drains into condensate gravity style and pump style drain traps which have pneumatic pumps installed inside the sump. Next, prior to the gas entering the blowers, a condensate moisture separator removes most of the residual water droplets remaining in the gas. At this stage the residual water drains by gravity into the condensate chamber.

The condensate chamber stores the water until the pump at the bottom of the chamber is activated either manually or automatically through a series of floats. The water is then pumped through a 75 mm diameter HDPE forcemain and is discharged into the leachate collection system.

In July 2019, the Southern Header and Leachate Collection System was expanded. Forcemain and compressed air was brought to MH3, MH4, MH5, MH8, MH17, MH19, MH31, MH32, MH42, MH43, the stormwater management pond, and tied in to the leachate storage facility. Lateral 6 and 7 were extended to tie in to the Southern header and stubs for future lateral 8 were installed. Various buried valve assemblies and pump drain traps were also included as part of the design.

The Condensate Collection System operated as intended during 2019.

5.0 CONCLUSIONS AND RECOMMENDATIONS

1. During operation in 2019, the Brady Road Resource Management Facility Gas Collection and Flaring System operated as was intended.

2. During surface emission monitoring, some areas were noted where gas was escaping. These areas included open manholes and areas of weak surface cap. In order to get maximum efficiency from the LGCFS, these issues should be looked at in the future.

3. The system should continue to operate on a full-time basis and be monitored according to the Operation and Maintenance Manual for the site.

All of which is Respectfully Submitted,

INTEGRATED GAS RECOVERY SERVICES

Christine Grant, EIT
Engineering Project Coordination

Shannan McGarr, B.Sc.
Wellfield Operations Manager

APPENDIX A

PLANT AND FLARE DATA

Date	CO2 Equivalents			Landfill Gas Flow						Methane	Oxygen	Flare	Flare	Temperature			Blower 1		Blower 2	
	Yearly	Monthly	Daily							Avg	Avg	Run	Starts	Min.	Avg.	Max.	Daily	Cumu.	Daily	Cumu.
	Tonnes CO2	Tonnes CO2	Tonnes CO2	scf	scf	scf	meter3	scfm	MMBTU	(%)	(%)	Hours		℃	℃	℃	Hours	Hours	Hours	Hours
Jan 1 2019	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0
Jan 2 2019	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0
Jan 3 2019	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0
Jan 4 2019	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0
Jan 5 2019	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0
Jan 6 2019	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	0	0	0
Jan 7 2019	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	23832.8	23832.8	21000.7	21000.7
Jan 8 2019	0	0	0	0	0	0	0	0	0	0	0	0.0	0	0	0	0	0	23832.8	0	21000.7
Jan 9 2019	185	185	185	821206	821206	821206	23263	850	408	49.1	2.2	16.1	3	-8	893	973	15.6	23848.4	0	21000.7
Jan 10 2019	454	454	269	2045258	2045258	1224052	34675	850	592	47.8	2.4	24	0	883	900	916	24.3	23872.8	0	21000.7
Jan 11 2019	714	714	260	3269437	3269437	1224179	34679	850	572	46.2	2.8	24	0	891	900	915	23.3	23896.1	0	21000.7
Jan 12 2019	975	975	261	4494355	4494355	1224918	34699	851	573	46.3	2.6	24	0	886	900	917	24.4	23920.5	0	21000.7
Jan 13 2019	1238	1238	263	5718863	5718863	1224508	34688	850	579	46.7	2.6	24	0	877	900	918	23.4	23943.9	0	21000.7
Jan 14 2019	1500	1500	262	6943352	6943352	1224489	34687	850	575	46.4	2.6	24	0	867	900	926	24.3	23968.2	0	21000.7
Jan 15 2019	1757	1757	257	8167510	8167510	1224158	34678	850	566	45.7	2.8	24	0	875	900	933	23.4	23991.6	0	21000.7
Jan 16 2019	2012	2012	255	9391418	9391418	1223908	34671	850	560	45.2	2.8	24	0	866	900	924	24.5	24016.1	0	21000.7
Jan 17 2019	2266	2266	254	10615300	10615300	1223882	34670	850	558	45	3	24	0	856	900	934	23.4	24039.5	0	21000.7
Jan 18 2019	2516	2516	250	11839796	11839796	1224496	34688	850	551	44.4	3	24	0	866	900	934	24.5	24064	0	21000.7
Jan 19 2019	2613	2613	97	13064999	13064999	1225203	34708	851	214	17.3	14	24	0	873	900	932	23.4	24087.4	0	21000.7
Jan 20 2019	2620	2620	7	13341493	13341493	276494	7833	815	14	5.1	18.6	5.6	0	675	891	929	6.4	24093.8	0	21000.7
Jan 21 2019	2736	2736	116	13853923	13853923	512430	14516	849	256	49.3	2	10.1	1	-15	890	963	9.5	24103.2	0	21000.7
Jan 22 2019	3004	3004	268	15078207	15078207	1224284	34682	850	588	47.5	1.9	24	0	871	900	924	23.5	24126.8	0	21000.7
Jan 23 2019	3277	3277	273	16302584	16302584	1224377	34684	850	600	48.5	1.4	24	0	864	900	933	24.5	24151.3	0	21000.7
Jan 24 2019	3542	3542	265	17527240	17527240	1224656	34692	850	582	47	1.5	24	0	874	900	930	23.4	24174.7	0	21000.7
Jan 25 2019	3799	3799	257	18703668	18703668	1176428	33326	817	565	47.4	1.2	24	0	870	900	938	24.5	24199.2	0	21000.7
Jan 26 2019	4026	4026	227	19855564	19855564	1151896	32631	800	499	42.8	3.8	24	0	858	900	927	23.5	24222.7	0	21000.7
Jan 27 2019	4065	4065	39	20503360	20503360	647796	18351	799	85	13	20.1	13.5	0	853	900	928	14.2	24236.9	0	21000.7
Jan 28 2019	4188	4188	123	21024691	21024691	521331	14768	798	270	51.2	1.1	10.9	1	-19	893	952	10.3	24247.2	0	21000.7
Jan 29 2019	4438	4438	250	22176848	22176848	1152157	32638	800	549	47.1	1.6	24	0	865	900	934	23.5	24270.7	0	21000.7
Jan 30 2019	4678	4678	240	23329381	23329381	1152533	32649	800	529	45.3	1.6	24	0	861	900	944	24.5	24295.2	0	21000.7
Jan 31 2019	4918	4918	240	24480939	24480939	1151558	32621	800	527	45.2	1.7	24	0	883	900	925	23.5	24318.7	0	21000.7
Feb 1 2019	5156	238	238	25632138	1151199	1151199	32611	799	523	44.9	1.8	24	0	870	900	931	24.5	24343.2	0	21000.7
Feb 2 2019	5391	473	235	26782604	2301665	1150466	32590	799	517	44.4	1.9	24	0	879	900	921	23.5	24366.7	0	21000.7
Feb 3 2019	5620	702	229	27934482	3453543	1151878	32630	800	503	43.2	2.3	24	0	870	900	920	23.4	24390.1	0	21000.7
Feb 4 2019	5833	915	213	29026709	4545770	1092227	30941	799	469	42.5	2.4	22.8	2	4	890	980	23.3	24413.4	0	21000.7
Feb 5 2019	6051	1133	218	30160722	5679783	1134013	32124	799	480	41.8	2.6	23.6	1	140	898	983	23.2	24436.6	0	21000.7
Feb 6 2019	6270	1352	219	31312148	6831209	1151426	32618	800	482	41.4	2.8	24	0	886	900	914	24.5	24461.1	0	21000.7
Feb 7 2019	6488	1570	218	32464590	7983651	1152442	32646	800	479	41.1	2.9	24	0	886	900	914	23.5	24484.7	0	21000.7
Feb 8 2019	6523	1605	35	33616547	9135608	1151957	32633	800	76	6.5	17.3	24	0	882	900	915	23.5	24508.2	0	21000.7
Feb 9 2019	6550	1632	27	34768747	10287808	1152200	32640	800	59	5	17.8	24	0	883	900	920	24.6	24532.8	0	21000.7
Feb 10 2019	6558	1640	8	35119476	10638537	350729	9935	755	18	5	17.8	7.7	0	708	894	920	8.2	24540.9	0	21000.7
Feb 11 2019	6558	1640	0	35119476	10638537	0	0	0	0	0	0	0.0	0	0	0	0	0	24540.9	0	21000.7
Feb 12 2019	6733	1815	175	35910725	11429786	791249	22414	800	385	48.1	2.1	16.5	1	3	897	936	15.7	24556.7	0	21000.7
Feb 13 2019	6973	2055	240	37060135	12579196	1149410	32560	800	529	45.4	2.6	23.9	1	0	899	916	24.4	24581.1	0	21000.7
Feb 14 2019	7201	2283	228	38211489	13730550	1151354	32616	800	502	43.1	3	24	0	884	900	918	24.1	24605.2	0	21000.7
Feb 15 2019	7422	2504	221	39363572	14882633	1152083	32636	800	486	41.7	3.2	24	0	877	900	924	23.2	24628.4	0	21000.7
Feb 16 2019	7540	2622	118	39988808	15507869	625236	17712	797	259	40.9	3.6	13	0	870	900	919	13.8	24642.1	0	21000.7
Feb 17 2019	7662	2744	122	40555556	16074617	566748	16055	798	268	46.7	2.3	11.9	1	-16	895	918	11.6	24653.7	0	21000.7
Feb 18 2019	7888	2970	226	41705702	17224763	1150146	32581	799	497	42.7	3	24	0	881	900	920	23.2	24676.9	0	21000.7
Feb 19 2019	8070	3152	182	42618321	18137382	912619	25853	798	401	43.4	2.8	19	1	15	896	922	19.3	24696.2	0	21000.7
Feb 20 2019	8296	3378	226	43769560	19288621	1151239	32612	800	496	42.6	3.1	24	0	889	900	914	24.2	24720.4	0	21000.7
Feb 21 2019	8511	3593	215	44919574	20438635	1150014	32578	799	474	40.7	3.6	24	0	882	900	915	23.2	24743.6	0	21000.7
Feb 22 2019	8724	3806	213	46069938	21588999	1150364	32588	799	469	40.3	3.6	24	0	883	900	918	24.3	24767.9	0	21000.7
Feb 23 2019	8944	4026	220	47221751	22740812	1151813	32629	800	484	41.5	3.3	24	0	874	900	919	24.3	24792.2	0	21000.7
Feb 24 2019	9158	4240	214	48373387	23892448	1151636	32624	800	470	40.3	3.6	24	0	885	900	917	23.2	24815.5	0	21000.7
Feb 25 2019	9369	4451	211	49523997	25043058	1150610	32594	799	465	39.9	3.6	24	0	884	900	930	24.3	24839.8	0	21000.7
Feb 26 2019	9576	4658	207	50593313	26112374	1069316	30292	800	455	42.1	2.8	21	1	41	896	926	23.1	24862.9	0	21000.7
Feb 27 2019	9809	4891	233	51744526	27263587	1151213	32612	799	513	44	2	24	0	883	900	924	24.2	24887.1	0	21000.7
Feb 28 2019	10038	5120	229	52895500	28414561	1150974	32605	799	503	43.2	2.4	24	0	827	900	987	24.2	24911.3	0	21000.7

Date	CO2 Equivalents			Landfill Gas Flow						Methane	Oxygen	Flare	Flare	Temperature			Blower 1		Blower 2	
	Yearly	Monthly	Daily							Avg	Avg	Run	Starts	Min.	Avg.	Max.	Daily	Cumu.	Daily	Cumu.
	Tonnes CO2	Tonnes CO2	Tonnes CO2	scf	scf	scf	meter3	scfm	MMBTU	(%)	(%)	Hours		℃	℃	℃	Hours	Hours	Hours	Hours
Mar 1 2019	10259	221	221	54048376	1152876	1152876	32659	801	487	41.7	2.8	24	0	849	900	934	24.1	24935.4	0	21000.7
Mar 2 2019	10480	442	221	55200308	2304808	1151932	32632	800	485	41.6	2.7	24	0	876	900	916	23.1	24958.5	0	21000.7
Mar 3 2019	10703	665	223	56352051	3456551	1151743	32627	800	490	42.1	2.6	24	0	871	900	919	24	24982.5	0	21000.7
Mar 4 2019	10928	890	225	57500680	4605180	1148629	32538	799	495	42.6	2.4	23.9	1	0	899	914	24.6	25007.1	0	21000.7
Mar 5 2019	11135	1097	207	58570898	5675398	1070218	30317	799	454	42	2.6	22.3	1	14	897	938	21.6	25028.7	0	21000.7
Mar 6 2019	11350	1312	215	59722624	6827124	1151726	32626	800	474	40.6	3	24	0	878	900	920	24.2	25052.9	0	21000.7
Mar 7 2019	11566	1528	216	60873309	7977809	1150685	32597	799	476	40.9	2.9	24	0	883	900	922	23.3	25076.2	0	21000.7
Mar 8 2019	11782	1744	216	62025349	9129849	1152040	32635	800	476	40.8	3.1	24	0	884	900	918	24.3	25100.5	0	21000.7
Mar 9 2019	11806	1768	24	62152657	9257157	127308	3606	798	52	40.6	3.2	2.6	0	895	899	907	3.3	25103.8	0	21000.7
Mar 10 2019	11806	1768	0	62152657	9257157	0	0	0	0	0	0	0.0	0	0	0	0	0	25103.8	0	21000.7
Mar 11 2019	11806	1768	0	62152657	9257157	0	0	0	0	0	0	0.0	0	0	0	0	0	25103.8	0	21000.7
Mar 12 2019	11900	1862	94	62561731	9666231	409074	11588	797	206	49.9	1.9	8.6	1	-4	891	919	8.2	25112	0.1	21000.8
Mar 13 2019	12143	2105	243	63713811	10818311	1152080	32636	800	535	45.9	2.8	24	0	862	900	935	24.4	25136.4	0	21000.8
Mar 14 2019	12376	2338	233	64867226	11971726	1153415	32674	801	513	43.9	3	24	0	886	900	914	23.3	25159.7	0	21000.8
Mar 15 2019	12600	2562	224	66018365	13122865	1151139	32609	799	492	42.2	3.3	24	0	853	900	935	24.3	25184	0	21000.8
Mar 16 2019	12822	2784	222	67167617	14272117	1149252	32556	798	489	42.1	3.2	24	0	880	900	927	23.4	25207.4	0	21000.8
Mar 17 2019	13042	3004	220	68318920	15423420	1151303	32614	800	483	41.5	3.4	24	0	880	900	923	24.4	25231.8	0	21000.8
Mar 18 2019	13266	3228	224	69471833	16576333	1152913	32660	801	492	42.2	3.2	24	0	886	900	916	23.4	25255.2	0	21000.8
Mar 19 2019	13490	3452	224	70621427	17725927	1149594	32566	798	493	42.4	3.2	24	0	885	900	914	24.5	25279.7	0	21000.8
Mar 20 2019	13712	3674	222	71774180	18878680	1152753	32655	801	489	41.9	3.3	24	0	884	900	920	23.4	25303.1	0	21000.8
Mar 21 2019	13949	3911	237	72927673	20032173	1153493	32676	801	521	44.6	2.5	24	0	876	900	920	23.5	25326.7	0	21000.8
Mar 22 2019	14192	4154	243	74081082	21185582	1153409	32674	801	534	45.8	2.2	24	0	879	900	917	24.4	25351.1	0	21000.8
Mar 23 2019	14437	4399	245	75233391	22337891	1152309	32643	800	540	46.3	2.3	24	0	871	900	918	23.4	25374.5	0	21000.8
Mar 24 2019	14694	4656	257	76384537	23489037	1151146	32610	799	564	48.4	2	24	0	885	900	913	24.4	25398.9	0	21000.8
Mar 25 2019	14955	4917	261	77535994	24640494	1151457	32618	800	574	49.3	1.8	24	0	886	900	913	23.4	25422.3	0	21000.8
Mar 26 2019	15210	5172	255	78632397	25736897	1096403	31059	800	561	50.6	1.4	22.8	0	888	900	916	23.7	25446	0	21000.8
Mar 27 2019	15343	5305	133	79197221	26301721	564824	16000	798	294	51.4	1.4	11.8	1	3	895	935	10.9	25456.8	0	21000.8
Mar 28 2019	15603	5565	260	80349050	27453550	1151829	32629	800	571	49	1.9	24	0	854	900	949	24.5	25481.3	0	21000.8
Mar 29 2019	15864	5826	261	81500883	28605383	1151833	32629	800	574	49.2	1.8	24	0	852	900	941	23.5	25504.9	0	21000.8
Mar 30 2019	16121	6083	257	82652212	29756712	1151329	32615	799	565	48.5	2	24	0	873	900	932	24.5	25529.4	0	21000.8
Mar 31 2019	16381	6343	260	83803865	30908365	1151653	32624	800	572	49.1	1.9	24	0	879	900	925	23.5	25552.9	0	21000.8
Apr 1 2019	16643	262	262	84955479	1151614	1151614	32623	800	576	49.4	1.8	24	0	883	900	925	23.4	25576.3	0	21000.8
Apr 2 2019	16899	518	256	86107935	2304070	1152456	32647	800	563	48.3	2.1	24	0	826	900	949	24.5	25600.8	0	21000.8
Apr 3 2019	17148	767	249	87260079	3456214	1152144	32638	800	548	47	2.4	24	0	870	900	932	23.5	25624.3	0	21000.8
Apr 4 2019	17403	1022	255	88411985	4608120	1151906	32631	800	561	48.2	2.1	24	0	867	900	921	24.5	25648.8	0	21000.8
Apr 5 2019	17656	1275	253	89563439	5759574	1151454	32618	800	556	47.7	2.3	24	0	861	900	923	23.4	25672.2	0	21000.8
Apr 6 2019	17912	1531	256	90715398	6911533	1151959	32633	800	562	48.2	2.1	24	0	885	900	915	24.5	25696.7	0	21000.8
Apr 7 2019	18173	1792	261	91868048	8064183	1152650	32652	800	573	49.1	1.8	24	0	870	900	930	23.5	25720.2	0	21000.8
Apr 8 2019	18427	2046	254	93020728	9216863	1152680	32653	800	560	48	2.2	24	0	777	900	975	23.5	25743.7	0	21000.8
Apr 9 2019	18683	2302	256	94188245	10384380	1167517	33073	864	563	47.7	2.3	22.5	1	27	898	969	8.9	25752.6	14.2	21015.1
Apr 10 2019	18935	2554	252	95333485	11529620	1145240	32442	899	554	47.8	2.3	21.2	4	12	889	930	0	25752.6	20.8	21035.9
Apr 11 2019	19218	2837	283	96629922	12826057	1296437	36725	900	622	47.4	2.4	24	0	846	900	990	0	25752.6	23.6	21059.5
Apr 12 2019	19457	3076	239	97722159	13918294	1092237	30941	899	527	47.7	2.4	20.2	0	880	900	921	0	25752.6	21	21080.5
Apr 13 2019	19457	3076	0	97722159	13918294	0	0	0	0	0	0	0.0	0	0	0	0	0	25752.6	0	21080.5
Apr 14 2019	19596	3215	139	98317779	14513914	595620	16873	898	305	50.7	1.9	11.1	1	5	892	926	0	25752.6	11	21091.5
Apr 15 2019	19884	3503	288	99613934	15810069	1296155	36717	900	633	48.3	2.4	24	0	861	900	932	0	25752.6	23.6	21115.1
Apr 16 2019	20166	3785	282	100909670	17105805	1295736	36706	900	619	47.2	2.6	24	0	872	900	937	0	25752.6	23.6	21138.7
Apr 17 2019	20448	4067	282	102205718	18401853	1296048	36714	900	619	47.2	2.5	24	0	858	900	938	0	25752.6	23.7	21162.4
Apr 18 2019	20728	4347	280	103501796	19697931	1296078	36715	900	615	46.9	2.6	24	0	852	900	951	0	25752.6	24.7	21187.1
Apr 19 2019	21012	4631	284	104797748	20993883	1295952	36712	900	624	47.6	2.4	24	0	878	900	917	0	25752.6	23.7	21210.8
Apr 20 2019	21263	4882	251	105964126	22160261	1166378	33041	900	552	46.7	2.7	21.6	0	849	900	938	0	25752.6	21.8	21232.6
Apr 21 2019	21263	4882	0	105964126	22160261	0	0	0	0	0	0	0.0	0	0	0	0	0	25752.6	0	21232.6
Apr 22 2019	21447	5066	184	106750911	22947046	786785	22288	899	406	51	1.8	14.6	1	9	897	961	0	25752.6	13.7	21246.3
Apr 23 2019	21744	5363	297	108046267	24242402	1295356	36695	900	653	49.8	1.8	24	0	876	900	923	0	25752.6	24.7	21271
Apr 24 2019	22034	5653	290	109342104	25538239	1295837	36708	900	637	48.6	2.3	24	0	830	900	963	0	25752.6	23.7	21294.7
Apr 25 2019	22294	5913	260	110553788	26749923	1211684	34325	841	573	46.8	2.8	24	0	857	900	938	0	25752.6	23.7	21318.4
Apr 26 2019	22543	6162	249	111705122	27901257	1151334	32615	800	547	47	2.7	24	0	847	900	935	0	25752.6	23.7	21342.1
Apr 27 2019	22791	6410	248	112857188	29053323	1152066	32636	800	546	46.8	2.7	24	0	829	900	941	0	25752.6	23.8	21365.9
Apr 28 2019	23038	6657	247	114007670	30203805	1150482	32591	799	543	46.6	2.7	24	0	864	900	930	0	25752.6	23.7	21389.6

Date	CO2 Equivalents			Landfill Gas Flow						Methane	Oxygen	Flare	Flare	Temperature			Blower 1		Blower 2	
	Yearly	Monthly	Daily							Avg	Avg	Run	Starts	Min.	Avg.	Max.	Daily	Cumu.	Daily	Cumu.
	Tonnes CO2	Tonnes CO2	Tonnes CO2	scf	scf	scf	meter3	scfm	MMBTU	(%)	(%)	Hours		℃	℃	℃	Hours	Hours	Hours	Hours
Apr 29 2019	23286	6905	248	115159670	31355805	1152000	32634	800	545	46.8	2.6	24	0	879	900	928	0	25752.6	24.8	21414.4
Apr 30 2019	23538	7157	252	116310998	32507133	1151328	32615	800	555	47.6	2.2	24	0	867	900	922	0	25752.6	23.7	21438.1
May 1 2019	23793	255	255	117463102	1152104	1152104	32637	800	561	48.1	2	24	0	882	900	920	0	25752.6	23.8	21461.9
May 2 2019	24046	508	253	118614981	2303983	1151879	32630	800	557	47.7	2.1	24	0	870	900	939	0	25752.6	23.6	21485.5
May 3 2019	24298	760	252	119767644	3456646	1152663	32653	800	554	47.5	2.2	24	0	884	900	919	0	25752.6	23.8	21509.3
May 4 2019	24546	1008	248	120918965	4607967	1151321	32615	800	546	46.9	2.3	24	0	844	900	965	0	25752.6	23.7	21533
May 5 2019	24789	1251	243	122070670	5759672	1151705	32625	800	535	45.9	2.6	24	0	839	900	933	0	25752.6	24.8	21557.8
May 6 2019	25030	1492	241	123222775	6911777	1152105	32637	800	531	45.5	2.7	24	0	864	900	934	0	25752.6	23.8	21581.6
May 7 2019	25274	1736	244	124375013	8064015	1152238	32641	800	537	46.1	2.5	24	0	861	900	932	0	25752.6	23.7	21605.3
May 8 2019	25460	1922	186	125221192	8910194	846179	23971	799	409	47.7	2.1	17.6	1	8	897	948	0	25752.6	17.4	21622.8
May 9 2019	25705	2167	245	126373464	10062466	1152272	32642	800	540	46.3	2.5	24	0	870	900	934	0	25752.6	23.8	21646.6
May 10 2019	25951	2413	246	127524385	11213387	1150921	32603	799	542	46.5	2.4	24	0	860	900	939	0	25752.6	23.7	21670.3
May 11 2019	26197	2659	246	128675576	12364578	1151191	32611	799	542	46.5	2.5	24	0	870	900	940	0	25752.6	23.9	21694.2
May 12 2019	26442	2904	245	129828132	13517134	1152556	32650	800	538	46.1	2.5	24	0	871	900	923	0	25752.6	23.8	21718
May 13 2019	26688	3150	246	130977268	14666270	1149136	32553	800	540	46.5	2.4	23.9	1	0	899	934	0	25752.6	24	21742
May 14 2019 *	26928	3390	240	132128743	15817745	1151475	32619	800	527	45.2	2.8	24	0	851	900	945	0	25752.6	24.3	21766.3
May 15 2019	27175	3637	247	133279610	16968612	1150867	32602	799	542	46.6	2.4	24	0	854	900	946	0	25752.6	24.2	21790.5
May 16 2019	27414	3876	239	134430813	18119815	1151203	32611	799	527	45.2	2.8	24	0	854	900	935	0	25752.6	23.2	21813.7
May 17 2019	27656	4118	242	135582502	19271504	1151689	32625	800	532	45.7	2.6	24	0	865	900	937	0	25752.6	24.3	21838
May 18 2019	27897	4359	241	136733152	20422154	1150650	32596	799	530	45.6	2.6	24	0	872	900	918	0	25752.6	24.3	21862.3
May 19 2019	28139	4601	242	137883901	21572903	1150749	32598	799	532	45.7	2.5	24	0	835	900	946	0	25752.6	23.3	21885.6
May 20 2019	28298	4760	159	138641403	22330405	757502	21459	799	350	45.6	2.6	15.8	0	835	900	935	0	25752.6	16.3	21902
May 21 2019	28409	4871	111	139127070	22816072	485667	13758	797	244	49.6	1.8	10.2	2	77	892	935	0	25752.6	9.2	21911.1
May 22 2019	28660	5122	251	140278739	23967741	1151669	32624	800	552	47.3	2.3	24	0	881	900	923	0	25752.6	24.3	21935.5
May 23 2019	28778	5240	118	140841443	24530445	562704	15940	800	260	45.6	2.8	11.7	0	866	900	924	0	25752.6	12.3	21947.7
May 24 2019	28932	5394	154	141557931	25246933	716488	20297	800	338	46.6	3.2	14.9	1	91	898	933	0	25752.6	14.1	21961.8
May 25 2019	29164	5626	232	142709645	26398647	1151714	32626	800	511	43.8	3.9	24	0	860	900	933	0	25752.6	24.5	21986.4
May 26 2019	29393	5855	229	143860627	27549629	1150982	32605	799	504	43.2	4	24	0	886	900	920	0	25752.6	23.3	22009.7
May 27 2019	29637	6099	244	145012463	28701465	1151836	32629	800	538	46.1	3	24	0	840	900	937	0	25752.6	24.4	22034.1
May 28 2019	29888	6350	251	146163177	29852179	1150714	32597	799	552	47.4	2.4	24	0	825	900	961	0	25752.6	23.4	22057.5
May 29 2019	30138	6600	250	147315478	31004480	1152301	32642	800	549	47.1	2.5	24	0	866	900	936	0	25752.6	24.4	22081.9
May 30 2019	30394	6856	256	148466482	32155484	1151004	32606	799	564	48.4	2.2	24	0	829	900	946	0	25752.6	23.4	22105.3
May 31 2019	30656	7118	262	149617634	33306636	1151152	32610	799	577	49.5	1.8	24	0	837	900	950	0	25752.6	24.4	22129.7
Jun 1 2019	30924	268	268	150769348	1151714	1151714	32626	800	590	50.6	1.4	24	0	831	900	954	0	25752.6	23.3	22153
Jun 2 2019	31189	533	265	151921160	2303526	1151812	32629	800	584	50.1	1.5	24	0	874	900	937	0	25752.6	24.4	22177.4
Jun 3 2019	31459	803	270	153072180	3454546	1151020	32606	799	593	51	1.3	24	0	815	900	957	0	25752.6	23.4	22200.8
Jun 4 2019	31728	1072	269	154223476	4605842	1151296	32614	800	592	50.8	1.3	24	0	849	900	960	0	25752.6	24.4	22225.2
Jun 5 2019	31996	1340	268	155375183	5757549	1151707	32626	800	590	50.7	1.3	24	0	852	900	940	0	25752.6	23.4	22248.6
Jun 6 2019	32265	1609	269	156526301	6908667	1151118	32609	799	592	50.8	1.3	24	0	877	900	927	0	25752.6	24.4	22273
Jun 7 2019	32495	1839	230	157487529	7869895	961228	27230	800	506	52	0.9	20	0	836	900	945	0	25752.6	20.2	22293.2
Jun 8 2019	32495	1839	0	157487529	7869895	0	0	0	0	0	0	0.0	0	0	0	0	0	25752.6	0	22293.2
Jun 9 2019	32495	1839	0	157487529	7869895	0	0	0	0	0	0	0.0	0	0	0	0	0	25752.6	0	22293.2
Jun 10 2019	32656	2000	161	158135419	8517785	647890	18353	799	355	54.2	0.7	13.6	2	0	895	963	0	25752.6	13.3	22306.5
Jun 11 2019	32808	2152	152	158764415	9146781	628996	17818	801	335	52.6	1	13.1	0	807	900	984	0	25752.6	13.4	22319.8
Jun 12 2019	32808	2152	0	158764415	9146781	0	0	0	0	0	0	0.0	0	0	0	0	0	25752.6	0	22319.8
Jun 13 2019	32912	2256	104	159175546	9557912	411131	11647	798	228	54.7	0.6	8.6	1	34	895	925	0	25752.6	8.1	22327.9
Jun 14 2019	33194	2538	282	160327365	10709731	1151819	32629	800	620	53.2	0.9	24	0	853	900	930	0	25752.6	24.2	22352.1
Jun 15 2019	33382	2726	188	161116882	11499248	789517	22365	800	414	51.8	1.3	16.4	0	874	900	933	0	25752.6	16.6	22368.8
Jun 16 2019	33382	2726	0	161116882	11499248	0	0	0	0	0	0	0.0	0	0	0	0	0	25752.6	0	22368.8
Jun 17 2019	33550	2894	168	161797019	12179385	680137	19267	799	369	53.6	0.9	14.2	1	14	897	939	0	25752.6	13	22381.8
Jun 18 2019	33830	3174	280	162948988	13331354	1151969	32633	800	615	52.8	1	24	0	868	900	932	0	25752.6	24.4	22406.2
Jun 19 2019	34110	3454	280	164100875	14483241	1151887	32631	800	616	52.8	1	24	0	874	900	937	0	25752.6	24.3	22430.5
Jun 20 2019	34388	3732	278	165253230	15635596	1152355	32644	800	611	52.4	1.1	24	0	861	900	940	0	25752.6	23.4	22453.9
Jun 21 2019	34654	3998	266	166359495	16741861	1106265	31338	799	585	52.3	1.1	23.1	1	52	897	929	0	25752.6	23.4	22477.3
Jun 22 2019	34930	4274	276	167510822	17893188	1151327	32615	800	608	52.2	1.1	24	0	881	900	926	0	25752.6	23.4	22500.7
Jun 23 2019	35208	4552	278	168662485	19044851	1151663	32624	800	611	52.4	1	24	0	858	900	932	0	25752.6	24.3	22525
Jun 24 2019	35485	4829	277	169813505	20195871	1151020	32606	799	610	52.4	1	24	0	876	900	934	0	25752.6	23.4	22548.4
Jun 25 2019	35759	5103	274	170965895	21348261	1152390	32645	800	603	51.7	1.2	24	0	827	900	942	0	25752.6	24.3	22572.8
Jun 26 2019	36031	5375	272	172117291	22499657	1151396	32617	800	599	51.4	1.3	24	0	848	900	944	0	25752.6	23.3	22596.1

Date	CO2 Equivalents			Landfill Gas Flow						Methane	Oxygen	Flare	Flare	Temperature			Blower 1		Blower 2	
	Yearly	Monthly	Daily							Avg	Avg	Run	Starts	Min.	Avg.	Max.	Daily	Cumu.	Daily	Cumu.
	Tonnes CO2	Tonnes CO2	Tonnes CO2	scf	scf	scf	meter3	scfm	MMBTU	(%)	(%)	Hours		℃	℃	℃	Hours	Hours	Hours	Hours
Jun 27 2019	36306	5650	275	173269900	23652266	1152609	32651	800	604	51.8	1.2	24	0	861	900	938	0	25752.6	24.4	22620.5
Jun 28 2019	36582	5926	276	174421490	24803856	1151590	32622	800	608	52.2	1.1	24	0	863	900	938	0	25752.6	24.4	22644.9
Jun 29 2019	36861	6205	279	175573889	25956255	1152399	32645	800	613	52.6	1	24	0	867	900	927	0	25752.6	23.3	22668.2
Jun 30 2019	37139	6483	278	176726135	27108501	1152246	32641	800	612	52.5	1	24	0	866	900	940	0	25752.6	24.5	22692.7
Jul 1 2019	37417	278	278	177878241	1152106	1152106	32637	800	611	52.4	1	24	0	861	900	932	0	25752.6	23.2	22715.9
Jul 2 2019	37682	543	265	178976645	2250510	1098404	31116	800	583	52.4	1.1	21.9	2	874	900	929	0	25752.6	23.4	22739.3
Jul 3 2019	37899	760	217	179872152	3146017	895507	25368	798	477	52.7	1	18.6	4	23	896	933	0	25752.6	18.4	22757.7
Jul 4 2019	38162	1023	263	180963690	4237555	1091538	30921	800	578	52.3	1.1	22.7	1	193	899	932	0	25752.6	23	22780.7
Jul 5 2019	38435	1296	273	182115592	5389457	1151902	32631	800	600	51.4	1.3	24	0	860	900	928	0	25752.6	24.3	22805
Jul 6 2019	38709	1570	274	183266823	6540688	1151231	32612	799	602	51.6	1.2	24	0	863	900	926	0	25752.6	23.3	22828.3
Jul 7 2019	38984	1845	275	184418930	7692795	1152107	32637	800	606	52	1.2	24	0	872	900	926	0	25752.6	24.3	22852.7
Jul 8 2019	39259	2120	275	185571001	8844866	1152071	32636	800	604	51.8	1.2	24	0	865	900	935	0	25752.6	24.3	22877
Jul 9 2019	39532	2393	273	186722645	9996510	1151644	32624	800	600	51.5	1.3	24	0	864	900	932	0	25752.6	23.3	22900.3
Jul 10 2019	39809	2670	277	187864173	11138038	1141528	32337	800	610	52.8	0.8	23.8	1	183	898	932	0	25752.6	24.1	22924.4
Jul 11 2019	40026	2887	217	188737770	12011635	873597	24747	799	477	54	0.6	18.2	1	30	897	968	0	25752.6	17.5	22941.9
Jul 12 2019	40308	3169	282	189889006	13162871	1151236	32612	799	621	53.3	0.8	24	0	867	900	943	0	25752.6	24.4	22966.3
Jul 13 2019	40591	3452	283	191041305	14315170	1152299	32642	800	622	53.3	0.8	24	0	871	900	921	0	25752.6	23.4	22989.7
Jul 14 2019	40714	3575	123	192193651	15467516	1152346	32644	800	270	23.2	11.9	24	0	840	900	938	0	25752.6	24.5	23014.2
Jul 15 2019	40873	3734	159	193345183	16619048	1151532	32621	800	351	30.1	9.1	24	0	844	900	950	0	25752.6	23.4	23037.6
Jul 16 2019	41157	4018	284	194497140	17771005	1151957	32633	800	624	53.5	0.7	24	0	856	900	940	0	25752.6	24.4	23062
Jul 17 2019	41443	4304	286	195649402	18923267	1152262	32641	800	629	54	0.5	24	0	860	900	937	0	25752.6	23.5	23085.5
Jul 18 2019	41730	4591	287	196801356	20075221	1151954	32633	800	630	54.1	0.5	24	0	878	900	925	0	25752.6	24.4	23109.9
Jul 19 2019	42013	4874	283	197952278	21226143	1150922	32603	799	623	53.5	0.5	24	0	854	900	950	0	25752.6	23.4	23133.4
Jul 20 2019	42292	5153	279	199103393	22377258	1151115	32609	799	615	52.8	0.6	24	0	840	900	936	0	25752.6	24.5	23157.9
Jul 21 2019	42570	5431	278	200254995	23528860	1151602	32623	800	612	52.5	0.6	24	0	852	900	944	0	25752.6	23.4	23181.3
Jul 22 2019	42850	5711	280	201405947	24679812	1150952	32604	799	616	52.9	0.5	24	0	861	900	939	0	25752.6	23.4	23204.7
Jul 23 2019	43132	5993	282	202558025	25831890	1152078	32636	800	619	53.1	0.4	24	0	868	900	928	0	25752.6	24.5	23229.2
Jul 24 2019	43416	6277	284	203710555	26984420	1152530	32649	800	624	53.5	0.4	24	0	883	900	932	0	25752.6	23.5	23252.7
Jul 25 2019	43699	6560	283	204862674	28136539	1152119	32637	800	622	53.3	0.5	24	0	862	900	945	0	25752.6	24.5	23277.2
Jul 26 2019	43977	6838	278	206014680	29288545	1152006	32634	800	612	52.5	0.7	24	0	840	900	959	0	25752.6	23.4	23300.6
Jul 27 2019	44255	7116	278	207166857	30440722	1152177	32639	800	610	52.4	0.7	24	0	846	900	941	0	25752.6	24.5	23325.1
Jul 28 2019	44534	7395	279	208317743	31591608	1150886	32602	799	613	52.7	0.7	24	0	864	900	935	0	25752.6	23.5	23348.6
Jul 29 2019	44803	7664	269	209469250	32743115	1151507	32620	800	592	50.8	1.2	24	0	858	900	943	0	25752.6	23.5	23372.1
Jul 30 2019	45073	7934	270	210621177	33895042	1151927	32632	800	595	51	1.1	24	0	861	900	941	0	25752.6	24.5	23396.6
Jul 31 2019	45345	8206	272	211772651	35046516	1151474	32619	800	598	51.3	1.1	24	0	874	900	928	0	25752.6	23.5	23420.1
Aug 1 2019	45614	269	269	212924563	1151912	1151912	32631	800	593	50.8	1.2	24	0	856	900	943	0	25752.6	24.5	23444.6
Aug 2 2019	45884	539	270	214076779	2304128	1152216	32640	800	593	50.9	1.3	24	0	871	900	934	0	25752.6	23.5	23468.1
Aug 3 2019	46154	809	270	215228802	3456151	1152023	32635	800	594	51	1.3	24	0	877	900	924	0	25752.6	23.6	23491.7
Aug 4 2019	46422	1077	268	216381716	4609065	1152914	32660	801	591	50.6	1.4	24	0	849	900	939	0	25752.6	24.6	23516.4
Aug 5 2019	46687	1342	265	217534321	5761670	1152605	32651	800	584	50	1.6	24	0	856	900	937	0	25752.6	23.6	23540
Aug 6 2019	46951	1606	264	218687001	6914350	1152680	32653	800	581	49.8	1.8	24	0	853	900	934	0	25752.6	23.5	23563.5
Aug 7 2019	47209	1864	258	219838448	8065797	1151447	32618	800	567	48.7	2.1	24	0	852	900	954	0	25752.6	24.6	23588.1
Aug 8 2019	47464	2119	255	220990128	9217477	1151680	32625	800	561	48.2	2.3	24	0	856	900	945	0	25752.6	23.6	23611.7
Aug 9 2019	47711	2366	247	222101077	10328426	1110949	31471	799	542	48.2	2.3	23.2	3	127	896	936	1	25753.6	21.8	23633.5
Aug 10 2019	47962	2617	251	223253029	11480378	1151952	32633	800	552	47.4	2.7	24	0	869	900	925	0	25753.6	24.5	23658
Aug 11 2019	48211	2866	249	224404791	12632140	1151762	32627	800	548	47	2.8	24	0	866	900	928	0	25753.6	23.5	23681.5
Aug 12 2019	48460	3115	249	225556467	13783816	1151676	32625	800	548	47	2.9	24	0	868	900	930	0	25753.6	23.4	23704.9
Aug 13 2019	48545	3200	85	225952218	14179567	395751	11211	800	186	46.5	3.1	8.2	0	880	900	919	0	25753.6	9.2	23714.1
Aug 14 2019	48593	3248	48	226195559	14422908	243341	6893	797	105	42.5	5.1	5.1	1	12	882	932	0	25753.6	5.1	23719.2
Aug 15 2019	48748	3403	155	226917230	15144579	721671	20443	799	342	46.8	3.3	15.1	1	15	896	934	0	25753.6	14.5	23733.7
Aug 16 2019	48987	3642	239	228068986	16296335	1151756	32627	800	526	45.1	3.7	24	0	872	900	930	0	25753.6	23.5	23757.2
Aug 17 2019	49219	3874	232	229220958	17448307	1151972	32633	800	510	43.7	4	24	0	863	900	924	0	25753.6	24.5	23781.7
Aug 18 2019	49446	4101	227	230373107	18600456	1152149	32638	800	500	42.9	4.2	24	0	852	900	930	0	25753.6	23.5	23805.2
Aug 19 2019	49671	4326	225	231525126	19752475	1152019	32634	800	495	42.5	4.3	24	0	866	899	924	0	25753.6	23.6	23828.8
Aug 20 2019	49901	4556	230	232677148	20904497	1152022	32634	800	507	43.5	4	24	0	832	900	928	0	25753.6	24.6	23853.4
Aug 21 2019	50135	4790	234	233829147	22056496	1151999	32634	800	514	44.1	3.8	24	0	870	900	924	0	25753.6	23.6	23877
Aug 22 2019	50381	5036	246	234980751	23208100	1151604	32623	800	541	46.4	3.1	24	0	875	900	929	0	25753.6	23.6	23900.6
Aug 23 2019	50640	5295	259	236133111	24360460	1152360	32644	800	570	48.9	2.2	24	0	880	900	918	0	25753.6	24.7	23925.3
Aug 24 2019	50732	5387	92	236538246	24765595	405135	11477	800	201	49.1	2.1	8.4	0	884	900	916	0	25753.6	8.5	23933.8

Date	CO2 Equivalents			Landfill Gas Flow						Methane	Oxygen	Flare	Flare	Temperature			Blower 1		Blower 2	
	Yearly	Monthly	Daily							Avg	Avg	Run	Starts	Min.	Avg.	Max.	Daily	Cumu.	Daily	Cumu.
	Tonnes CO2	Tonnes CO2	Tonnes CO2	scf	scf	scf	meter3	scfm	MMBTU	(%)	(%)	Hours		℃	℃	℃	Hours	Hours	Hours	Hours
Aug 25 2019	50732	5387	0	236538246	24765595	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	23933.8
Aug 26 2019	50914	5569	182	237275063	25502412	736817	20873	798	401	53.8	0.8	15.4	1	96	896	931	0	25753.6	15	23948.9
Aug 27 2019	51168	5823	254	238325554	26552903	1050491	29758	799	559	52.5	1	21.9	1	12	896	937	0	25753.6	21.5	23970.4
Aug 28 2019	51447	6102	279	239477295	27704644	1151741	32627	800	614	52.7	1	24	0	865	900	940	0	25753.6	23.6	23994
Aug 29 2019	51722	6377	275	240627366	28854715	1150071	32579	799	606	52	1	24	0	843	900	957	0	25753.6	24.6	24018.6
Aug 30 2019	51999	6654	277	241799012	30026361	1171646	33190	814	610	51.5	1	24	0	840	900	976	0	25753.6	23.6	24042.2
Aug 31 2019	52276	6931	277	242951056	31178405	1152044	32635	800	609	52.2	0.7	24	0	870	900	931	0	25753.6	23.6	24065.8
Sep 1 2019	52379	103	103	243377877	426821	426821	12091	800	227	52.6	0.6	8.9	0	860	900	924	0	25753.6	9.7	24075.5
Sep 2 2019	52379	103	0	243377877	426821	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	24075.5
Sep 3 2019	52574	298	195	244174952	1223896	797075	22580	800	430	53.3	0.6	16.6	1	19	897	930	0	25753.6	16.3	24091.8
Sep 4 2019	52752	476	178	244895423	1944367	720471	20410	799	392	53.8	0.4	15	1	43	897	932	0	25753.6	14.5	24106.3
Sep 5 2019	53043	767	291	246097134	3146078	1201711	34042	835	639	52.6	0.7	24	0	867	900	942	0	25753.6	23.6	24129.9
Sep 6 2019	53347	1071	304	247392684	4441628	1295550	36700	900	669	51	1	24	0	858	900	937	0	25753.6	24.6	24154.5
Sep 7 2019	53392	1116	45	247586545	4635489	193861	5492	899	98	50	1.2	3.6	0	885	901	921	0	25753.6	3.8	24158.3
Sep 8 2019	53542	1266	150	248191476	5240420	604931	17136	899	329	53.7	0.6	11.2	1	16	894	936	0	25753.6	11.1	24169.4
Sep 9 2019	53853	1577	311	249487031	6535975	1295555	36700	900	685	52.3	0.8	24	0	840	900	956	0	25753.6	23.6	24193
Sep 10 2019	54157	1881	304	250783022	7831966	1295991	36713	900	670	51.1	0.9	24	0	879	900	922	0	25753.6	23.6	24216.6
Sep 11 2019	54457	2181	300	252078436	9127380	1295414	36696	900	661	50.4	1	24	0	873	900	924	0	25753.6	24.6	24241.2
Sep 12 2019	54763	2487	306	253374054	10422998	1295618	36702	900	672	51.3	0.7	24	0	866	900	933	0	25753.6	23.6	24264.8
Sep 13 2019	55012	2736	249	254414994	11463938	1040940	29488	899	549	52.1	0.6	19.3	1	16	896	941	0	25753.6	18.9	24283.7
Sep 14 2019	55318	3042	306	255712162	12761106	1297168	36746	901	674	51.3	0.7	24	0	865	900	933	0	25753.6	23.6	24307.3
Sep 15 2019	55621	3345	303	257007646	14056590	1295484	36698	900	667	50.8	0.8	24	0	864	900	939	0	25753.6	24.6	24332
Sep 16 2019	55925	3649	304	258304242	15353186	1296596	36730	900	669	51	0.8	24	0	877	900	926	0	25753.6	23.7	24355.7
Sep 17 2019	56229	3953	304	259599817	16648761	1295575	36701	900	669	51	0.8	24	0	873	900	925	0	25753.6	23.6	24379.3
Sep 18 2019	56532	4256	303	260895509	17944453	1295692	36704	900	666	50.8	0.9	24	0	861	900	939	0	25753.6	23.6	24402.9
Sep 19 2019	56833	4557	301	262191439	19240383	1295930	36711	900	662	50.5	1.1	24	0	867	900	941	0	25753.6	24.7	24427.6
Sep 20 2019	57116	4840	283	263360738	20409682	1169299	33124	900	622	52.6	0.6	21.7	1	34	897	968	0	25753.6	21.3	24448.9
Sep 21 2019	57432	5156	316	264656995	21705939	1296257	36720	900	696	53	0.7	24	0	850	900	941	0	25753.6	23.6	24472.5
Sep 22 2019	57743	5467	311	265952945	23001889	1295950	36712	900	684	52.2	0.9	24	0	858	900	946	0	25753.6	23.7	24496.2
Sep 23 2019	58056	5780	313	267249769	24298713	1296824	36736	901	688	52.4	0.9	24	0	874	900	925	0	25753.6	24.7	24520.9
Sep 24 2019	58367	6091	311	268544411	25593355	1294642	36675	899	684	52.2	0.9	24	0	855	900	951	0	25753.6	23.6	24544.5
Sep 25 2019	58674	6398	307	269840336	26889280	1295925	36711	900	674	51.4	1.1	24	0	855	900	947	0	25753.6	23.6	24568.1
Sep 26 2019	58984	6708	310	271136285	28185229	1295949	36712	900	681	51.9	1	24	0	868	900	942	0	25753.6	23.7	24591.8
Sep 27 2019	59291	7015	307	272432374	29481318	1296089	36716	900	675	51.4	1.1	24	0	858	900	939	0	25753.6	24.6	24616.4
Sep 28 2019	59594	7318	303	273729113	30778057	1296739	36734	901	667	50.8	1.3	24	0	852	900	950	0	25753.6	23.7	24640.1
Sep 29 2019	59906	7630	312	275024762	32073706	1295649	36703	900	686	52.3	0.9	24	0	865	900	942	0	25753.6	23.7	24663.9
Sep 30 2019	60205	7929	299	276277287	33326231	1252525	35482	870	659	51.9	0.9	24	0	855	899	932	0	25753.6	23.6	24687.5
Oct 1 2019	60283	78	78	276635500	358213	358213	10147	802	172	47.5	1.7	7.4	0	809	888	913	0	25753.6	8.4	24695.8
Oct 2 2019	60283	78	0	276635500	358213	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	24695.8
Oct 3 2019	60283	78	0	276635500	358213	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	24695.8
Oct 4 2019	60283	78	0	276635500	358213	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	24695.8
Oct 5 2019	60283	78	0	276635500	358213	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	24695.8
Oct 6 2019	60283	78	0	276635500	358213	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	24695.8
Oct 7 2019	60409	204	126	277185736	908449	550236	15587	695	278	49.9	2.5	13.2	2	1	890	967	0	25753.6	13.1	24708.9
Oct 8 2019	60683	478	274	278301602	2024315	1115866	31610	775	602	53.5	0.8	24	0	858	900	982	0	25753.6	23.7	24732.6
Oct 9 2019	60953	748	270	279461373	3184086	1159771	32854	945	593	50.6	1.6	20.4	1	2	897	939	0	25753.6	20	24752.6
Oct 10 2019	61189	984	236	280462372	4185085	1000999	28356	900	519	51.3	1.4	18.5	0	865	900	935	0	25753.6	19.2	24771.8
Oct 11 2019	61216	1011	27	280569845	4292558	107473	3044	898	60	55.4	0.4	2.0	1	-3	874	934	0	25753.6	2.1	24773.9
Oct 12 2019	61216	1011	0	280569845	4292558	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	24773.9
Oct 13 2019	61216	1011	0	280569845	4292558	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	24773.9
Oct 14 2019	61216	1011	0	280569845	4292558	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	24773.9
Oct 15 2019	61216	1011	0	280569845	4292558	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	24773.9
Oct 16 2019	61395	1190	179	281313511	5036224	743666	21067	899	393	52.2	1.4	13.8	1	12	897	945	0	25753.6	13.5	24787.4
Oct 17 2019	61694	1489	299	282609065	6331778	1295554	36700	900	657	50.1	1.7	24	0	878	900	925	0	25753.6	23.3	24810.7
Oct 18 2019	61988	1783	294	283905511	7628224	1296446	36726	900	646	49.3	1.7	24	0	878	900	919	0	25753.6	24.2	24834.9
Oct 19 2019	62264	2059	276	285200953	8923666	1295442	36697	900	606	46.3	2.3	24	0	877	900	938	0	25753.6	24.3	24859.2
Oct 20 2019	62528	2323	264	286496031	10218744	1295078	36687	899	580	44.2	2.5	24	0	868	900	938	0	25753.6	23.3	24882.5
Oct 21 2019	62710	2505	182	287401207	11123920	905176	25642	898	400	43.6	2.4	16.8	0	815	892	926	0	25753.6	17.4	24899.9
Oct 22 2019	62812	2607	102	287857456	11580169	456249	12925	896	224	48.6	1.7	8.5	1	6	895	943	0	25753.6	7.6	24907.5

Date	CO2 Equivalents			Landfill Gas Flow						Methane	Oxygen	Flare	Flare	Temperature			Blower 1		Blower 2	
	Yearly	Monthly	Daily							Avg	Avg	Run	Starts	Min.	Avg.	Max.	Daily	Cumu.	Daily	Cumu.
	Tonnes CO2	Tonnes CO2	Tonnes CO2	scf	scf	scf	meter3	scfm	MMBTU	(%)	(%)	Hours		℃	℃	℃	Hours	Hours	Hours	Hours
Oct 23 2019	63072	2867	260	289152683	12875396	1295227	36691	899	573	43.7	2.5	24	0	858	900	931	0	25753.6	24.4	24931.9
Oct 24 2019	63323	3118	251	290448835	14171548	1296152	36717	900	553	42.2	2.4	24	0	872	900	923	0	25753.6	23.4	24955.3
Oct 25 2019	63584	3379	261	291745145	15467858	1296310	36722	900	573	43.7	1.8	24	0	884	900	917	0	25753.6	24.4	24979.7
Oct 26 2019	63845	3640	261	293041185	16763898	1296040	36714	900	573	43.7	2	24	0	858	900	941	0	25753.6	23.4	25003.1
Oct 27 2019	64122	3917	277	294336809	18059522	1295624	36702	900	610	46.5	1.6	24	0	864	900	944	0	25753.6	24.4	25027.5
Oct 28 2019	64403	4198	281	295632876	19355589	1296067	36715	900	619	47.2	1.6	24	0	879	900	919	0	25753.6	23.5	25051
Oct 29 2019	64684	4479	281	296928983	20651696	1296107	36716	900	617	47.1	1.7	24	0	843	900	948	0	25753.6	24.4	25075.4
Oct 30 2019	64968	4763	284	298225194	21947907	1296211	36719	900	625	47.7	1.6	24	0	860	900	934	0	25753.6	23.4	25098.8
Oct 31 2019	65262	5057	294	299521907	23244620	1296713	36733	901	646	49.2	1.2	24	0	862	900	928	0	25753.6	24.4	25123.2
Nov 1 2019	65549	287	287	300817615	1295708	1295708	36705	900	632	48.2	1.5	24	0	845	900	941	0	25753.6	23.4	25146.7
Nov 2 2019	65840	578	291	302112121	2590214	1294506	36671	899	641	48.9	1.3	24	0	862	900	933	0	25753.6	24.5	25171.2
Nov 3 2019	66135	873	295	303408836	3886929	1296715	36733	900	649	49.4	1.2	24	0	860	900	926	0	25753.6	24.4	25195.6
Nov 4 2019	66218	956	83	303777974	4256067	369138	10457	900	182	48.8	1.4	6.8	0	856	900	937	0	25753.6	7.6	25203.1
Nov 5 2019	66218	956	0	303777974	4256067	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	25203.1
Nov 6 2019	66218	956	0	303777974	4256067	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	25203.1
Nov 7 2019	66218	956	0	303777974	4256067	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	25203.1
Nov 8 2019	66218	956	0	303777974	4256067	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	25203.1
Nov 9 2019	66218	956	0	303777974	4256067	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	25203.1
Nov 10 2019	66218	956	0	303777974	4256067	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	25203.1
Nov 11 2019	66218	956	0	303777974	4256067	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	25203.1
Nov 12 2019	66248	986	30	303894119	4372212	116145	3290	884	65	55.4	0.4	2.2	3	-11	827	935	0	25753.6	2.2	25205.3
Nov 13 2019	66335	1073	87	304256739	4734832	362620	10272	893	192	52.4	1.3	6.8	5	-12	847	947	0	25753.6	5.8	25211.1
Nov 14 2019	66635	1373	300	305552016	6030109	1295277	36693	899	660	50.3	1.7	24	0	863	900	934	0	25753.6	24.7	25235.8
Nov 15 2019	66939	1677	304	306848702	7326795	1296686	36733	900	669	51	1.3	24	0	875	900	929	0	25753.6	23.6	25259.4
Nov 16 2019	67250	1988	311	308143504	8621597	1294802	36679	899	683	52.1	1	24	0	874	900	925	0	25753.6	23.5	25282.9
Nov 17 2019	67555	2293	305	309439154	9917247	1295650	36703	900	670	51.1	1.2	24	0	859	900	930	0	25753.6	24.7	25307.6
Nov 18 2019	67855	2593	300	310703913	11182006	1264759	35828	900	660	51.6	1.1	23.4	0	871	900	930	0	25753.6	23.3	25330.9
Nov 19 2019 *	68031	2769	176	311431256	11909349	727343	20604	900	386	52.5	1	13.5	1	-1	893	946	0	25753.6	12.7	25343.6
Nov 20 2019	68334	3072	303	312725339	13203432	1294083	36659	899	667	51	1.3	24	0	874	900	921	0	25753.6	24.6	25368.2
Nov 21 2019	68642	3380	308	314022191	14500284	1296852	36737	901	678	51.6	1.2	24	0	874	900	930	0	25753.6	23.6	25391.8
Nov 22 2019	68918	3656	276	315151393	15629486	1129202	31988	899	607	53.1	0.7	20.9	1	-3	896	929	0	25753.6	20.6	25412.4
Nov 23 2019	69228	3966	310	316448277	16926370	1296884	36738	901	682	52	0.9	24	0	880	900	925	0	25753.6	23.6	25436
Nov 24 2019	69536	4274	308	317743833	18221926	1295556	36701	900	676	51.6	0.9	24	0	871	900	926	0	25753.6	24.7	25460.7
Nov 25 2019	69838	4576	302	319040038	19518131	1296205	36719	900	664	50.6	1.1	24	0	865	900	938	0	25753.6	23.6	25484.3
Nov 26 2019	70138	4876	300	320336877	20814970	1296839	36737	901	661	50.3	1.1	24	0	864	900	933	0	25753.6	23.6	25507.9
Nov 27 2019	70436	5174	298	321634756	22112849	1297879	36766	901	656	50	1.2	24	0	874	900	928	0	25753.6	24.7	25532.6
Nov 28 2019	70735	5473	299	322929714	23407807	1294958	36684	899	659	50.3	1	24	0	880	900	932	0	25753.6	23.6	25556.3
Nov 29 2019	71041	5779	306	324226163	24704256	1296449	36726	900	674	51.4	0.7	24	0	873	900	920	0	25753.6	23.6	25579.9
Nov 30 2019	71349	6087	308	325521597	25999690	1295434	36697	900	677	51.7	0.7	24	0	877	900	919	0	25753.6	23.6	25603.5
Dec 1 2019	71652	303	303	326817188	1295591	1295591	36701	900	666	50.8	0.9	24	0	857	900	950	0	25753.6	24.7	25628.2
Dec 2 2019	71961	612	309	328112272	2590675	1295084	36687	900	680	51.9	0.7	24	0	874	900	929	0	25753.6	23.7	25651.9
Dec 3 2019	72264	915	303	329395922	3874325	1283650	36363	900	667	51.3	0.8	23.7	1	876	900	924	0	25753.6	23.8	25675.7
Dec 4 2019	72564	1215	300	330692715	5171118	1296793	36736	901	660	50.3	1.2	24	0	868	900	935	0	25753.6	24.2	25699.9
Dec 5 2019	72857	1508	293	331987524	6465927	1294809	36679	899	644	49.2	1.4	24	0	874	900	937	0	25753.6	23.3	25723.2
Dec 6 2019	73039	1690	182	332781532	7259935	794008	22493	899	399	49.7	1.2	14.7	0	858	900	935	0	25753.6	15.3	25738.5
Dec 7 2019	73039	1690	0	332781532	7259935	0	0	0	0	0	0	0.0	0	0	0	0	0	25753.6	0	25738.5
Dec 8 2019	73226	1877	187	333551559	8029962	770027	21813	899	410	52.6	1	14.3	1	-15	894	936	0	25753.6	13.4	25751.9
Dec 9 2019	73531	2182	305	334847057	9325460	1295498	36699	900	670	51.1	1.3	24	0	870	900	937	0	25753.6	24.3	25776.2
Dec 10 2019	73828	2479	297	336141887	10620290	1294830	36680	899	652	49.8	1.5	24	0	865	900	940	0	25753.6	24.3	25800.5
Dec 11 2019	74119	2770	291	337437777	11916180	1295890	36710	900	641	48.9	1.7	24	0	873	900	923	0	25753.6	23.4	25823.9
Dec 12 2019	74413	3064	294	338733872	13212275	1296095	36716	900	647	49.3	1.4	24	0	869	900	921	0	25753.6	24.3	25848.2
Dec 13 2019	74707	3358	294	340030337	14508740	1296465	36726	900	646	49.2	1.4	24	0	869	900	927	0	25753.6	23.4	25871.6
Dec 14 2019	74994	3645	287	341325772	15804175	1295435	36697	900	632	48.2	1.5	24	0	853	900	934	0	25753.6	24.3	25895.9
Dec 15 2019	75287	3938	293	342622070	17100473	1296298	36722	900	643	49	1.1	24	0	869	900	926	0	25753.6	23.2	25919.1
Dec 16 2019	75572	4223	285	343918031	18396434	1295961	36712	900	627	47.8	1.4	24	0	866	900	941	0	25753.6	24.2	25943.3
Dec 17 2019	75847	4498	275	345213278	19691681	1295247	36692	899	605	46.2	1.7	24	0	867	900	930	0	25753.6	24.1	25967.4
Dec 18 2019	76126	4777	279	346509471	20987874	1296193	36719	900	614	46.8	1.6	24	0	867	900	924	0	25753.6	24.2	25991.6
Dec 19 2019	76388	5039	262	347804398	22282801	1294927	36683	899	577	44	2.4	24	0	870	900	918	0	25753.6	24.1	26015.7
Dec 20 2019	76656	5307	268	349101032	23579435	1296634	36731	900	590	45	2.1	24	0	880	900	918	0	25753.6	23.1	26038.9

Date	CO2 Equivalents			Landfill Gas Flow						Methane	Oxygen	Flare	Flare	Temperature			Blower 1		Blower 2	
	Yearly	Monthly	Daily							Avg	Avg	Run	Starts	Min.	Avg.	Max.	Daily	Cumu.	Daily	Cumu.
	Tonnes CO2	Tonnes CO2	Tonnes CO2	scf	scf	scf	meter3	scfm	MMBTU	(%)	(%)	Hours		℃	℃	℃	Hours	Hours	Hours	Hours
Dec 21 2019	76926	5577	270	350397551	24875954	1296519	36728	900	594	45.3	2.1	24	0	868	900	946	0	25753.6	24.2	26063.1
Dec 22 2019	77199	5850	273	351693010	26171413	1295459	36698	900	601	45.8	2.1	24	0	857	900	940	0	25753.6	24.2	26087.3
Dec 23 2019	77474	6125	275	352988417	27466820	1295407	36696	900	604	46.1	2.2	24	0	860	900	929	0	25753.6	23.1	26110.4
Dec 24 2019	77753	6404	279	354283594	28761997	1295177	36690	899	615	46.9	2.1	24	0	856	900	946	0	25753.6	24.2	26134.6
Dec 25 2019	78032	6683	279	355579836	30058239	1296242	36720	900	614	46.8	2.2	24	0	874	900	923	0	25753.6	24.2	26158.8
Dec 26 2019	78312	6963	280	356876793	31355196	1296957	36740	901	615	46.9	2.2	24	0	853	900	937	0	25753.6	24.1	26182.9
Dec 27 2019	78588	7239	276	358172102	32650505	1295309	36694	900	608	46.4	2.5	24	0	879	900	920	0	25753.6	23.2	26206.1
Dec 28 2019	78860	7511	272	359468989	33947392	1296887	36738	901	598	45.6	2.8	24	0	861	900	929	0	25753.6	24.2	26230.3
Dec 29 2019	79136	7787	276	360763902	35242305	1294913	36682	899	608	46.4	2.6	24	0	880	900	920	0	25753.6	24.2	26254.5
Dec 30 2019	79408	8059	272	362059890	36538293	1295988	36713	900	598	45.6	3	24	0	870	900	925	0	25753.6	24.2	26278.7
Dec 31 2019	79692	8343	284	363355798	37834201	1295908	36710	900	624	47.6	2.2	24	0	860	900	936	0	25753.6	23.1	26301.8