REPORT

NOVEMBER 2021 GROUNDWATER MONITORING PASCO BULK FUEL TERMINALS SITE

Submitted to:

Pasco Bulk Fuel Terminals Site Coordinating Group

Submitted by:

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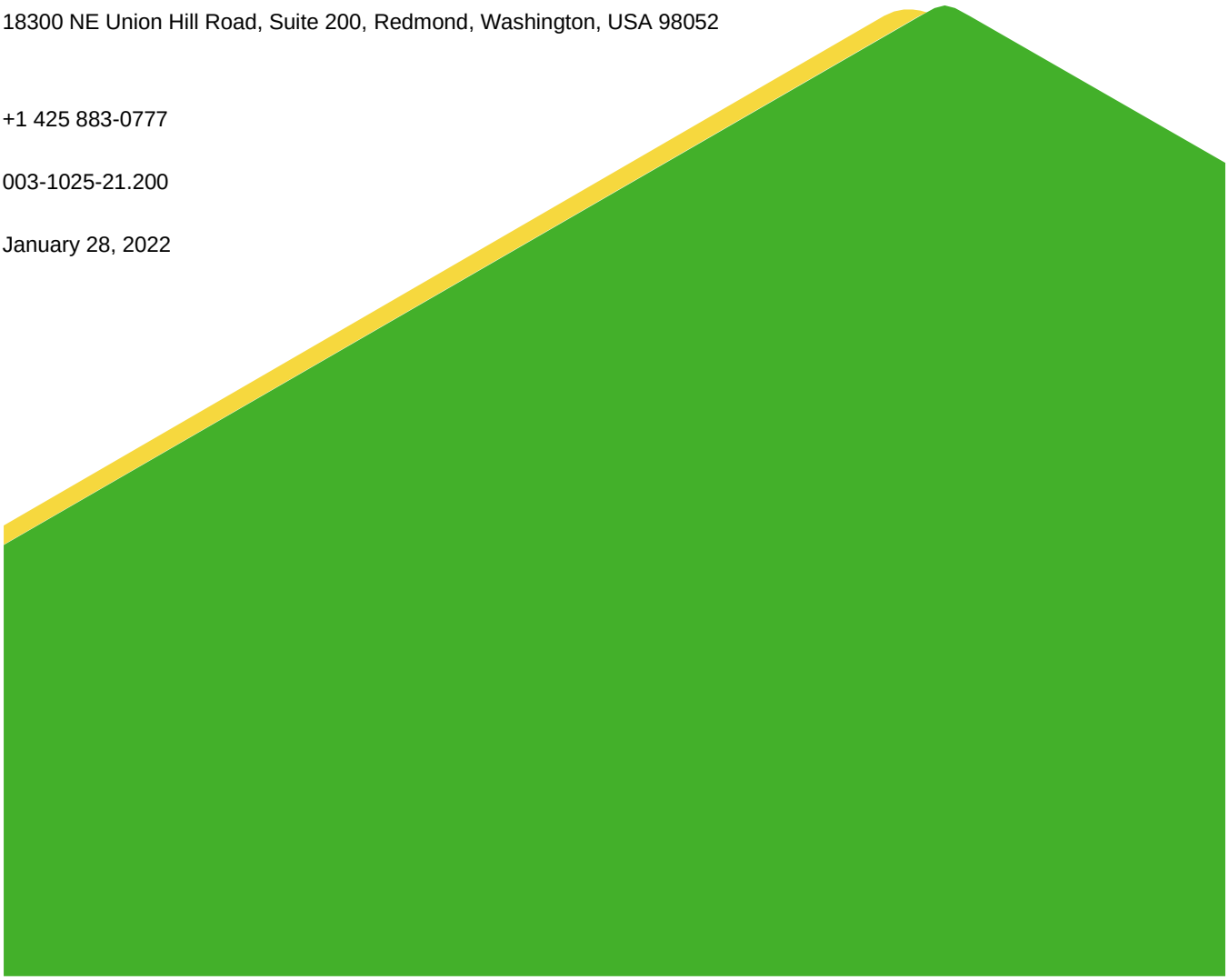

Distribution List

Pasco Bulk Fuel Terminals Site Coordinating Group

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ACRONYMS AND ABBREVIATIONS

As	Arsenic
CMP	Compliance Monitoring Plan
COE	United States Army Corps of Engineers
Ecology	Washington State Department of Ecology
EPA	United States Environmental Protection Agency
Golder	Golder Associates Inc.
HDPE	High-density polyethylene
IAS	In-situ air sparging
MCL	Maximum Contaminant Limit
MDL	Method detection limit
ml/min	Milliliters per minute
MNA	Monitored Natural Attenuation
PCE	Perchloroethylene (tetrachloroethene)
PQL	Practical quantitation limit
SAP	Sampling and Analysis Plan
SEP-OUT	Sample identification for the COE oil-water separator outlet
Site	Pasco Bulk Fuel Terminals Site
SVE	Soil vapor extraction
TCE	Trichloroethene (trichloroethylene)
TPH	Total petroleum hydrocarbons
µg/L	micrograms per liter

1.0 INTRODUCTION

This report presents the results of the November 2021 groundwater monitoring fieldwork conducted by Golder Associates USA Inc. (Golder) at the Pasco Bulk Fuel Terminals Site (the Site) in Pasco, Washington. A site map is presented in Figure 1. This work was conducted in accordance with the Monitored Natural Attenuation (MNA) Performance Monitoring Plan (Golder 2019) in conjunction with the Sampling and Analysis Plan (SAP) contained within the Compliance Monitoring Plan (CMP) for the Site dated December 20, 2000 (Golder 2000).

Remedial actions conducted at the Site from 1999 through 2014 consisted primarily of in-situ air sparging (IAS) in combination with soil vapor extraction (SVE). Groundwater extraction and treatment ("pump-and-treat") was also used in some areas. During active remediation, major progress was made towards achieving cleanup across the Site. Based on SVE offgas monitoring data, approximately 58,000 pounds of total petroleum hydrocarbons (TPH) were removed by IAS-SVE. The total TPH removal was greater because this estimate does not account for removal that occurred by pump-and-treat or for in-situ biodegradation. TPH mass removal rates using IAS-SVE reached asymptotic levels; thus, IAS-SVE was no longer effective.

Under MNA, the group evaluated the Site risk and various alternatives to achieve Site closure (Golder 2013). The results of the evaluation indicated that MNA and institutional controls (institutional controls as described in the CAP [Ecology 1999]) were protective of human health and the environment and were the preferred alternative for achieving groundwater cleanup levels throughout the Site. Ecology issued a decision letter dated September 19, 2018 (Ecology 2018) that indicated MNA as a remedial action was covered under the existing Consent Decree for the Site, such that MNA can be implemented at the Site without modifying the Consent Decree.

The MNA Performance Monitoring Plan (Golder 2019) was prepared to work in conjunction with the SAP and QAPP contained within the CMP (Golder 2000) to provide the scope, methods, and procedures that will occur to ensure natural attenuation is occurring, is effective and protective of human health and the environment and demonstrates compliance with Site cleanup standards. Groundwater monitoring conducted under the MNA Performance Monitoring Plan was started in June 2019.

1.1 Field Work

The November 2021 groundwater monitoring was performed on November 2 and 3, 2021 and included the following activities:

- Groundwater monitoring was conducted on 19 groundwater-monitoring wells (MW-06, MW-08, MW-10A, MW-11A, MW-12, MW-13, MW-17, MW-18, MW-19, MW-20, MW-31, MW-33, MW-34, MW-47, MW-48, MW-49, MW-62R, MW-63, and MW-66).
- Water level measurements were made on these wells.
- Surface water sampling of the discharge from the oil-water separator (SEP-OUT) on the United States Army Corps of Engineers' (COE) drain. In accordance with the CMP (Golder 2000), the COE drain is only sampled when there has been no measurable rain during the four days prior to sample collection. This ensures that the sample collected is predominately associated with groundwater from the COE drain.

In accordance with the MNA Performance Monitoring Plan (Golder 2019), each well was analyzed for those indicator substances that remain above cleanup levels in that well. In addition, select monitoring wells were also analyzed for geochemical parameters - dissolved oxygen, nitrate, manganese, iron, sulfate, methane, redox potential (Eh) and alkalinity. Changes in these geochemical parameters can indicate that biodegradation is

occurring. These changes can be evaluated over time within a well, or by comparing levels of these parameters in wells that are still impacted with indicator substances to wells that are located upgradient or in clean areas of the Site.

Positive evidence of biodegradation includes:

- Depressed oxygen, nitrate, or sulfate levels in source area wells as compared to background wells
- Low Oxidation-Reduction Potential (i.e., reducing conditions) in source area wells as compared to background wells
- Higher iron (Fe+2), manganese (Mn+2), and methane in source area wells as compared to background wells

During performance monitoring, natural attenuation parameters are measured in two wells (MW-18 and MW-62R) that have been below cleanup levels for more than five years, and in a selection of wells that have relatively higher petroleum hydrocarbon concentrations (MW-08, MW-11A, MW-12, MW-33, MW-34, and MW-63). The testing of these wells will allow for comparison of geochemical parameters in areas where contaminants are being biodegraded compared to clean areas of the site.

1.2 Field Equipment

Wells were sampled using peristaltic pumps with dedicated high-density polyethylene (HDPE) and silicone tubing. During previous sampling events, HDPE tubing was placed in each well at a depth approximately halfway between the bottom of the well screen and the water level in the well. A summary of monitoring well completion data, including tubing depths for each well, is presented in Table 1.

The HDPE tubing was inserted into a short (< 0.5 foot) length of silicone tubing that was inserted into the peristaltic pump. An extra length of HDPE tubing was used to connect the silicon tubing to a flow-through cell. Each length of silicon tubing and HDPE sample tubing were used only once to avoid cross-contamination between wells. The flow-through cell consisted of a 2-inch-diameter acrylic cylinder with a capped bottom that was attached to a 5-gallon bucket. The flow through cell had an inlet port near the bottom and another outlet port near the top. The sample tubing was connected to the bottom port, so the cell filled from the bottom and flowed out the top port into a purge water container. Field probes (pH, temperature, specific conductance, and dissolved oxygen) were inserted into the flow cell from the top and were monitored to determine when field parameters had stabilized in the purge water.

Once the well was purged and field parameters had stabilized, the tubing was disconnected from the flow cell and the groundwater samples were collected directly from the sample tubing. The flow cells were rinsed with deionized water between wells. The HDPE tubing dedicated to each well was capped and left hanging in the well by attaching it to the well cap using line. The thermos-type well caps were used to secure the well after sampling. Well monument covers were securely bolted.

1.3 Micropurging

Well purging was conducted following the “micropurging” procedure accepted by EPA and described in Groundwater Sampling Procedure Low Stress Purging and Sampling (EPA 1997). This procedure recommends an initial purging rate of 200 to 500 milliliters per minute (ml/min) and a sampling rate of 100 to 250 ml/min, while ensuring water level drawdown does not exceed 0.3 feet. This low-flow method minimizes well disturbances and therefore reduces turbidity, minimizes aeration of the groundwater during sample collection, and reduces the

volume of purge water generated. In some cases, the well yield was insufficient to maintain a drawdown of less than 0.3 feet while continuously pumping at the minimal purge rate. Wells were considered sufficiently purged when field parameters remained stable for three consecutive measurements taken approximately five minutes apart. The field parameters were considered stable based on the following criteria:

- +/- 0.1 for pH
- +/- 3% for specific conductance
- +/- 10% for dissolved oxygen

The stabilized field measurements for pH, temperature, specific conductance, and dissolved oxygen for each well at the time sampling was initiated are presented in Table 2.

1.4 Purge Water

Purge water was collected in 5-gallon containers at each sampling location. The purge water was then transferred into the 55-gallon drums for subsequent treatment and disposal.

2.0 DATA SUMMARY

2.1 Water Level Data

Water level data collected during November 2021 are presented in Figure 2 and Table 3.

2.2 Analytical Results

Groundwater samples were stored in coolers with ice until delivered to Eurofins (formerly Test America), an Ecology-certified laboratory in Tacoma, Washington. Chain-of-custody procedures were followed. A complete tabulation of analytical results is provided in Appendix A.

All analytical data were subject to a data validation review. Data validation was conducted in accordance with the EPA Contract Laboratory Program, National Functional Guidelines for Organic and Inorganic Data Review (EPA 2017a, b). Data reporting qualifiers are included with the analytical results in Appendix A.

2.3 Monitored Natural Attenuation Performance Assessment and Cleanup Determination

2.3.1 MNA Performance Assessment

Table 4 provides a summary of the geochemical analytical results obtained from the two background wells and from the six higher concentration wells (“impacted wells”). Evaluation of the results confirms that biodegradation is occurring in the remaining higher concentration areas. Evidence of biodegradation includes the following:

- Alkalinity is generally higher in the impacted wells, which is caused as carbon dioxide is produced during biodegradation.
- Oxygen, nitrate and sulfate concentrations are lower in the impacted wells as these electron acceptors are used up in the biodegradation process.
- Iron and manganese concentrations are higher due to the reduction of Fe^{+3} and Mn^{+4}.

- Methane concentrations are significantly higher in the impacted wells as methane is produced during biodegradation under anaerobic conditions. Methane was not detected in the clean wells.

The above noted geochemical markers of biodegradation were more pronounced in some of the higher concentration wells, but all the impacted wells tested for geochemical parameters had indications that contaminant biodegradation is occurring in those wells.

Trend graphs of the analytical results since the start of monitored natural attenuation in 2014 are presented in Appendix B. Evaluation of trend graphs indicate the following:

- Area 2 – Arsenic is above cleanup levels in MW-06, MW-12, MW-13 and MW-63, with a long-term stable to slightly decreasing trend, except for MW-13 where the arsenic concentrations slightly increased from 2016 to June 2019 and then decreased during October 2019 to 2021. Benzene is above cleanup level in MW-12 and MW-63, with a slight long-term decreasing trend. TPH is above cleanup level in MW-12 and MW-63, with a slight long-term decreasing trend since 2014.
- Area 3 – Arsenic is slightly above the cleanup level in MW-17. Arsenic concentrations in MW-17 have fluctuated during the last three sampling rounds but appear to be stable. Arsenic concentrations detected in MW-10A fluctuate around the cleanup level and have been below the cleanup level during the last three sampling rounds.
- Area 4 – Arsenic and TPH are above the cleanup level in MW-11A, with no apparent recent trend. Trichloroethene (TCE) in MW-47 has been below the cleanup level for the last three consecutive sampling rounds.
- Area 6 – TPH is above the cleanup level in MW-08 and MW-19. Arsenic is above the cleanup level in MW-19. Concentrations of arsenic and TPH are steady to slightly decreasing in MW-08 and MW-19.
- Area 7 – Tetrachlorethene (PCE) is above the cleanup level in MW-49 and has been above the cleanup level in MW-20 but dropped below the cleanup level in the November 2021 sampling round. PCE has been below the cleanup level in MW-31 for the last four sampling rounds. TCE is slightly below the cleanup level in MW-49 and has been below the cleanup for the last three sampling rounds in MW-20. TPH is above the cleanup level in MW-33 and MW-34 and has a slight decreasing trend. Arsenic is above the cleanup level in MW-34 and has a slightly decreasing long-term trend.
- Area 8 – Arsenic concentrations have been decreasing in MW-48 in the long-term and have been fluctuating around the cleanup level since 2018. Arsenic concentrations in MW-48 were below the cleanup level during the November 2021 sampling round.
- COE Drain Oil-Water Separator - PCE has historically been detected slightly above the 1.75 µg/L cleanup level, however, PCE has been below the drinking water Maximum Contaminant Limit (MCL) of 5 µg/L since October 2008. PCE concentrations have been decreasing since 2015. The concentration of PCE detected during the November 2021 sampling round was slightly above the cleanup level. Starting with the October 2019 sampling round, the COE Drain sample is collected from the oil-water separator discharge pipe. During previous rounds, samples were collected from inside of the concrete vault of the oil-water separator. Samples collected directly from the end of the discharge pipe of the oil-water separator is safer for sampling personnel and is more representative of the actual concentration contained in the water discharged from the COE Drain oil-water separator.

2.3.2 Cleanup Determination

Under the MNA Performance Monitoring Plan, groundwater cleanup for each Remediation Area will be determined as follows:

a) Within a Remediation Area, if any single well has not exceeded cleanup levels for a particular indicator substance for two consecutive annual monitoring events, then the performance monitoring for that contaminant in that well can be suspended.

b) A well that has met Condition "a" can move into confirmational monitoring. Once in confirmational monitoring, if the indicator substance remains below its cleanup level for two consecutive confirmational sampling rounds, then that well will be considered clean for that substance. Monitoring events will occur not more frequently than semi-annually.

When all wells within a Remediation Area have met Condition "b" for all indicator substances, then the Remediation Area will have met groundwater cleanup levels.

To assist in evaluating compliance with the above criteria, Table 5 presents the analytical results for each indicator substance detected during the last four sampling events. Table 5 is sorted by cleanup area, and results presented in the table indicate the following criteria have been achieved:

- Area 4 MW-47 –TCE concentration detected in MW-47 dropped below the cleanup level during the October 2019 round and remained below the cleanup level during the October 2020 and the November 2021 rounds. TCE analysis will continue in MW-47 until four consecutive rounds with reported concentrations below the cleanup level are achieved, which could occur during the 2022 sampling round.
- Area 7 MW-31 – PCE has been below cleanup level for four consecutive rounds and is now considered clean. No further sampling of MW-31 for PCE is required.

No other changes to the Performance Monitoring Plan are indicated. Annual sampling will continue in accordance with the Performance Monitoring Plan (Golder 2019).

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Tables

Table 1: Monitoring Well Completion Data

Well	Installation Date	Coordinates		Ground Elevation	Top of Casing	Stick-up	Total Boring Depth	Total Well Depth	Tubing Depth	Screened Interval			
		Northing	Easting							(ft-bgs)		(ft elevation)	
		(ft)	(ft)	(ft)	(ft elevation)	(ft-bgs)	(ft-bgs)	(ft-bgs)	(ft-bgs)	from	to	from	to
MW-06	11/22/86	326,727	2,354,911	342.31	342.10	-0.21	14.5	13	10	3.0	13.0	339.3	329.3
MW-08	11/22/86	327,200	2,354,238	339.86	339.67	-0.19	10	10	7	2.0	10.0	337.9	329.9
MW-10A	10/20/87	327,147	2,354,587	342.70	342.35	-0.35	13	12.5	10	2.5	12.5	340.2	330.2
MW-11A	10/20/87	327,031	2,354,586	342.36	342.04	-0.32	15	14.9	11	5.0	14.9	337.4	327.5
MW-12	03/03/87	327,036	2,354,771	343.07	342.74	-0.33	13	13	10	3.5	13.0	339.6	330.1
MW-13	03/03/87	326,833	2,354,689	342.31	342.15	-0.16	13.6	13.6	10	4.0	13.6	338.3	328.7
MW-17	03/03/87	327,230	2,354,567	343.68	343.32	-0.36	12.9	12.9	10	3.3	12.9	340.4	330.8
MW-18	03/04/87	327,235	2,354,422	340.98	340.68	-0.30	9.3	9.3	7	2.0	9.3	339.0	331.7
MW-19	03/04/87	327,069	2,354,360	340.58	340.17	-0.41	10.3	10.3	8	2.8	10.3	337.8	330.3
MW-20	03/04/87	326,907	2,354,277	340.23	339.93	-0.30	10.4	10.4	7	3.0	10.4	337.2	329.8
MW-21R	02/02/99	327,230	2,354,735	343.42	343.10	-0.32	14.5	14	10	3.4	13.4	340.0	330.0
MW-31	05/09/93	326,849	2,353,859	339.81	339.40	-0.41	9	8.5	7	3.0	8.0	336.8	331.8
MW-33	05/07/93	326,955	2,354,035	340.64	340.12	-0.52	10	9	7	3.5	8.5	337.1	332.1
MW-34	05/07/93	326,815	2,354,243	341.29	340.90	-0.39	9	8.75	8	3.3	8.3	338.0	333.0
MW-47	08/16/94	326,943	2,354,388	341.0	340.24	-0.76	9	8.5	6	3.5	8.5	337.5	332.5
MW-48	08/16/94	327,277	2,353,896	342.0	341.79	-0.21	13	11	9	6.0	11.0	336.0	331.0
MW-49	08/16/94	326,998	2,353,747	343.0	343.65	0.65	14	14	12	7.5	14.0	335.5	329.0
MW-62R	02/25/10	--	--	343.24	343.04	-0.2	16	15	10	5.0	15.0	338.2	328.2
MW-63	03/29/01	326,885	2,354,856	343.11	342.81	-0.30	16	15.5	11	5.5	15.5	337.6	327.6
MW-66	06/08/06	326,651	2,354,825	342.87	342.23	-0.64	26.5	24	21	4.0	24.0	338.9	318.9

Notes:
Survey data not obtained for replacement well MW-62R; elevation data relative to MW-63
ft-bgs = feet below ground surface

Table 2: Groundwater Sampling Field Parameters

Well	Date Sampled	Time Sampled	pH	Conductivity (uS/cm)	Temp. (°C)	Dissolved Oxygen (mg/L)	Eh (rel mV)
MW-06	11/2/2021	10:51	5.97	716	17.6	0.96	-66
MW-08	11/2/2021	14:25	6.98	761	16.3	0.42	5
MW-10A	11/3/2021	8:35	7.24	error	19.0	0.91	-70
MW-11A	11/2/2021	13:25	6.93	810	19.2	0.73	-78
MW-12	11/2/2021	11:30	7.12	750	18.6	0.75	-104
MW-13	11/2/2021	12:40	6.97	618	18.7	1.20	-31
MW-17	11/3/2021	9:00	6.95	error	18.9	0.80	-126
MW-18	11/2/2021	15:15	7.26	856	16.2	0.80	100
MW-19	11/3/2021	8:45	6.91	749	18.9	0.16	117
MW-20	11/2/2021	13:45	7.28	672	16.0	0.32	72
MW-31	11/2/2021	10:19	7.44	763	12.3	1.21	75
MW-33	11/2/2021	11:10	6.94	748	14.0	0.93	69
MW-34	11/2/2021	12:20	7.15	751	16.1	0.35	27
MW-47	11/2/2021	14:30	7.31	669	19.6	1.70	108
MW-48	11/2/2021	8:50	7.12	830	14.0	0.20	-154
MW-49	11/2/2021	9:31	7.07	795	14.3	0.28	65
MW-62R	11/2/2021	9:04	7.03	728	18.0	2.40	222
MW-63	11/2/2021	10:04	7.17	1,657	18.1	0.80	-28
MW-66	11/2/2021	15:07	7.15	578	17.1	0.80	-103

Notes:
NS = not sampled
nm = not measured; meter was not working properly
The field parameters on this sheet were recorded after values stabilized, just prior to sample collection
uS/cm = microsiemens per centimeter
mg/L = milligrams per liter
rel mV = relative millivolts
error = the conductivity probe on one of the multimeters was not reading correctly

Table 3: Water Levels

Well	Date	Time	Water Level (ft-bgs)	Water Level (ft elevation)	Comments
MW-06	11/2/2021	10:32	5.90	336.41	
MW-08	11/2/2021	13:59	4.95	334.91	
MW-10A	11/3/2021	7:44	7.15	335.55	
MW-11A	11/2/2021	12:58	6.73	335.63	
MW-12	11/2/2021	11:01	7.04	336.03	
MW-13	11/2/2021	12:13	6.20	336.11	
MW-17	11/3/2021	8:39	8.18	335.50	
MW-18	11/2/2021	14:50	5.78	335.20	
MW-19	11/3/2021	8:26	5.53	335.05	
MW-20	11/2/2021	13:19	5.29	334.94	
MW-31	11/2/2021	9:57	5.76	334.05	
MW-33	11/2/2021	10:47	6.12	334.52	
MW-34	11/2/2021	11:57	6.51	334.78	
MW-47	11/2/2021	14:03	5.88	335.12	
MW-48	11/2/2021				Roots obstruct well
MW-49	11/2/2021				Roots obstruct well
MW-62R	11/2/2021	8:31	6.72	336.52	
MW-63	11/2/2021	9:31	7.02	336.09	
MW-66	11/2/2021	14:41	6.85	336.02	

Notes:
Survey data is estimated for replacement wells MW-46R and MW-62R
ft-bgs = feet below ground surface

Table 4: Geochemical Evaluation of Natural Attenuation Parameters

Well	Sample Date	Total Organics (µg/L)	Alkalinity, Total as CaCO3 (mg/L)	Sulfate (mg/L)	Nitrogen, Nitrate (mg/L)	Iron (mg/L)	Man-ganese (mg/L)	Methane (µg/L)	Field DO (mg/L)	Field Redox
Background Wells (1)										
MW-18	11/2/2021	ND	240	65	4	0.2	0.88	< 5	0.80	100
MW-62R	11/2/2021	ND	170	55	9	0.1	0.009	< 5	2.40	222
Higher Concentration Wells (2)										
MW-08	11/2/2021	3600	300	< 1.5	< 0.15	2.9	2.6	2200	0.42	5
MW-11A	11/2/2021	2670	360	2.4	< 0.15	5.0	2.3	7200	0.73	-78
MW-12	11/2/2021	2672	330	2.5	< 0.15	3.5	1.4	2300	0.75	-104
MW-33	11/2/2021	4200	280	7	< 0.15	4.0	3.2	8400	0.93	69
MW-34	11/2/2021	1860	340	4.1	< 0.15	1.3	0.97	3100	0.35	27
MW-63	11/2/2021	1129	770	8	0.2	1.9	0.28	1800	0.80	-28

Notes: No organic compounds were detected in the "background" wells (ND).
(1) - Background wells are wells that have been clean for at least 10 years
(2) - Higher Concentration Wells are located either within or immediately downgradient of historical source areas.
Indications of biodegredation:

Reduced levels of sulfate and nitrate in the source area wells
Increased iron and manganese in the source area wells
Production of methane in the source area wells
Lower dissolved oxygen (DO) and lower Redox values in source area wells

Table 5: Concentrations of Compounds Detected During the Last Four Sampling Event Monitoring Wells Sorted by Area

AREA 2 WELLS

Parameter	Units	Cleanup Level	MW-06	MW-06	MW-06	MW-06
			Jun-19	Oct-19	Oct-20	Nov-21
Arsenic	µg/L	10	62	92	84	81
Parameter	**Units**	**Cleanup Level**	**MW-12**	**MW-12**	**MW-12**	**MW-12**
			Jun-19	**Oct-19**	**Oct-20**	**Nov-21**
Arsenic	µg/L	10	23	43	34	40
Benzene	µg/L	5	24	18	16	12
TPH-Total	µg/L	1000	2850	2290	2020	2660
Parameter	**Units**	**Cleanup Level**	**MW-13**	**MW-13**	**MW-13**	**MW-13**
			Jun-19	**Oct-19**	**Oct-20**	**Nov-21**
Arsenic	µg/L	10	86	63	48	44
TPH-Total	µg/L	1000	1469	600	750	830
Parameter	**Units**	**Cleanup Level**	**MW-63**	**MW-63**	**MW-63**	**MW-63**
			Jun-19	**Oct-19**	**Oct-20**	**Nov-21**
Arsenic	µg/L	10	41	85	89	84
Benzene	µg/L	5	70	59	86	99
TPH-Total	µg/L	1000	1240	760	770	1030

Notes:
"<" - indicates compound was not detected; followed by the reporting limit
µg/L = micrograms per liter
*Highlighted concentration is above the cleanup level.

Table 5: Concentrations of Compounds Detected During the Last Four Sampling Event Monitoring Wells Sorted by Area

AREA 3 WELLS

Parameter	Units	Cleanup Level	MW-10A	MW-10A	MW-10A	MW-10A
			Jun-19	Oct-19	Oct-20	Nov-21
Arsenic	µg/L	10	12	9.8	9.3	6.1
Parameter	**Units**	**Cleanup Level**	**MW-17**	**MW-17**	**MW-17**	**MW-17**
			Jun-19	Oct-19	Oct-20	Nov-21
Arsenic	µg/L	10	16	23	11	13

AREA 4 WELLS

Parameter	Units	Cleanup Level	MW-11A	MW-11A	MW-11A	MW-11A
			Jun-19	Oct-19	Oct-20	Nov-21
Arsenic	µg/L	10	100	100	110	92
TPH-Total	µg/L	1000	2649	2410	2630	2670
Parameter	**Units**	**Cleanup Level**	**MW-47**	**MW-47**	**MW-47**	**MW-47**
			Jun-19	Oct-19	Oct-20	Nov-21
Trichloroethene (TCE)	µg/L	2	2.4	1.8	< 0.2	1.1

AREA 6 WELLS

Parameter	Units	Cleanup Level	MW-08	MW-08	MW-08	MW-08
			Jun-19	Oct-19	Oct-20	Nov-21
TPH-Total	µg/L	1000	4149	2220	2430	3600
Parameter	**Units**	**Cleanup Level**	**MW-19**	**MW-19**	**MW-19**	**MW-19**
			Jun-19	Oct-19	Oct-20	Nov-21
Arsenic	µg/L	10	66	94	94	78
TPH-Total	µg/L	1000	1899	1850	1520	1790

Notes:
"<" - indicates compound was not detected; followed by the reporting limit
µg/L = micrograms per liter
*Highlighted concentration is above the cleanup level.

Table 5: Concentrations of Compounds Detected During the Last Four Sampling Event Monitoring Wells Sorted by Area

AREA 7 WELLS

Parameter	Units	Cleanup Level	MW-20	MW-20	MW-20	MW-20
			Jun-19	Oct-19	Oct-20	Nov-21
Tetrachloroethene (PCE)	µg/L	1.75	4.3	3.2	2.3	1.1
Trichloroethene (TCE)	µg/L	2	3.1	2.0	0.89	0.82
Parameter	**Units**	**Cleanup Level**	**MW-31**	**MW-31**	**MW-31**	**MW-31**
			Jun-19	**Oct-19**	**Oct-20**	**Nov-21**
Tetrachloroethene (PCE)	µg/L	1.75	0.68	0.57	1.3	0.6
Parameter	**Units**	**Cleanup Level**	**MW-33**	**MW-33**	**MW-33**	**MW-33**
			Jun-19	**Oct-19**	**Oct-20**	**Nov-21**
TPH-Total	µg/L	1000	5850	5620	4700	4200
Parameter	**Units**	**Cleanup Level**	**MW-34**	**MW-34**	**MW-34**	**MW-34**
			Jun-19	**Oct-19**	**Oct-20**	**Nov-21**
Arsenic	µg/L	10	12	19	25	20
TPH-Total	µg/L	1000	1470	1790	1460	1860
Parameter	**Units**	**Cleanup Level**	**MW-49**	**MW-49**	**MW-49**	**MW-49**
			Jun-19	**Oct-19**	**Oct-20**	**Nov-21**
Tetrachloroethene (PCE)	µg/L	1.75	14	17	19	18
Trichloroethene (TCE)	µg/L	2	2.4	3.0	2.1	1.8

Notes:
"<" - indicates compound was not detected; followed by the reporting limit
µg/L = micrograms per liter
*Highlighted concentration is above the cleanup level. PCE below cleanup levels for last 4 rounds.

Table 5: Concentrations of Compounds Detected During the Last Four Sampling Event Monitoring Wells Sorted by Area

AREA 8 WELL

Parameter	Units	Cleanup Level	MW-48	MW-48	MW-48	MW-48
			Jun-19	Oct-19	Oct-20	Nov-21
Arsenic	µg/L	10	8.8	12	17	6.5

AREA 9 WELL

Parameter	Units	Cleanup Level	MW-66	MW-66	MW-66	MW-66
			Jun-19	Oct-19	Oct-20	Nov-21
Arsenic	µg/L	10	7.5	27	17	na
TPH-Total	µg/L	1000	335	540	790	1020

COE Drain Oil Water Separator

Parameter	Units	Cleanup Level	SEP-OUT	SEP-OUT	SEP-OUT	SEP-OUT
			Jun-19	Oct-19	Oct-20	Nov-21
Tetrachloroethene (PCE)	µg/L	1.75	2.7	0.33	0.33	2.2

Notes:
"<" - indicates compound was not detected; followed by the reporting limit
µg/L = micrograms per liter
*Highlighted concentration is above the cleanup level.
na - arsenic analysis in MW-66 was inadvertantly omitted from the requested analyses

Figures

AINSWORTH AVENUE

AREA 1

AREA 8

AREA 6

AREA 3

AREA 2

AREA 4

AREA 7

AREA 9

AREA 5

SO. 12TH AVE.

SO. 11TH AVE.

SO. 10TH AVE.

WASHINGTON ST.

RIVER ST.

BURIED PRODUCT PIPING

BURIED PRODUCT PIPELINE

CABLE BRIDGE

CORPS OF ENGINEERS DIKE (TOP)

MW-17

MW-18

MW-10A

MW-8

MW-48

MW-11A

MW-19

MW-47

MW-46R

MW-20

MW-33

MW-49

MW-34

MW-31

MW-12

MW-62R

MW-63

MW-13

MW-06

MW-66

LEGEND

MW-48 MONITORING WELL LOCATION

REMEDIATION AREA BOUNDARY

NOTES:
1) BASE MAP MODIFIED FROM UNDATED USCOE DRAWING FILES TITLED "93-S1.DWG" AND "93-S2.DWG", AND ON DRAWING TITLED "PROPOSED TRENCH RECOVERY SYSTEM", BY ASSOCIATED EARTH SCIENCES, INC., UNDATED, AND ON DRAWING BY HDR ENGINEERS, FILE NAME "WASHST.DWG", DATED 1/22/99.

N

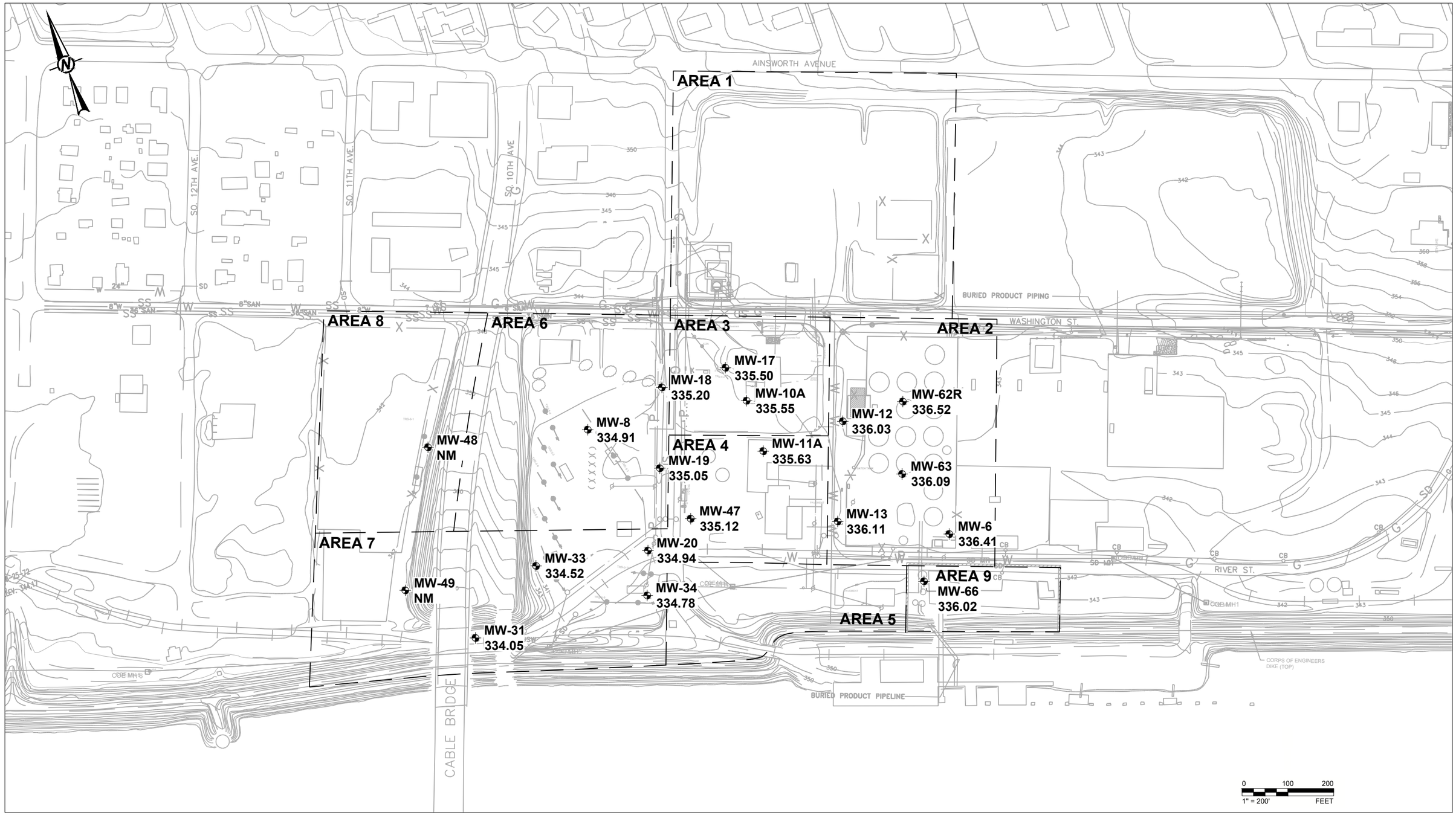
0 200 400

FEET

FIGURE 1

SITE MAP

PASCO BULK FUEL TERMINALS SITE/WA



LEGEND

MW-63 336.09	MONITORING WELL LOCATION AND GROUNDWATER ELEVATION (FEET)
——— ———	REMEDIATION AREA BOUNDARY
NM	NOT MEASURED (SEE TABLE 3)

NOTE(S)

1. BASE MAP MODIFIED FROM UNDATED USCOE DRAWING FILES TITLED "93-S1.DWG" AND "93-S2.DWG", AND ON DRAWING TITLED "PROPOSED TRENCH RECOVERY SYSTEM", BY ASSOCIATED EARTH SCIENCES, INC., UNDATED, AND ON DRAWING BY HDR ENGINEERS, FILE NAME "WASHST.DWG", DATED 1/22/99.

CLIENT
PASCO BULK FUEL TERMINALS SITE COORDINATING GROUP

CONSULTANT
GOLDER
MEMBER OF WSP

YYYY-MM-DD	2022-01-28
DESIGNED	GZ
PREPARED	REDMOND
REVIEWED	GZ
APPROVED	GZ

PROJECT
SITE CLEANUP
PASCO BULK FUEL TERMINALS SITE

TITLE
MNA PERFORMANCE MONITORING WELL GROUNDWATER ELEVATIONS - NOVEMBER 2021

PROJECT NO.	PHASE	REV.	FIGURE
003102521	200	A	2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

APPENDIX A

Complete Tabulated Results for Groundwater Samples – November 2021

Appendix A: Complete Tabulated Results for Groundwater Samples - November 2021

Sample Location	Date Sampled	Parameter	Result	Qualifier	PQL	MDL	Units
FBMW-12	02-Nov-21	Arsenic	0.005	U	0.005	0.001	mg/L
FBMW-12	02-Nov-21	Benzene	0.2	U	0.2	0.03	ug/L
FBMW-12	02-Nov-21	TPH-diesel	0.11	U	0.11	0.065	mg/L
FBMW-12	02-Nov-21	TPH-gas	0.25	U	0.25	0.1	mg/L
FBMW-12	02-Nov-21	TPH-Oil	0.35	U	0.35	0.096	mg/L
FBMW-20	02-Nov-21	Tetrachloroethene (PCE)	0.5	U	0.5	0.084	ug/L
FBMW-20	02-Nov-21	Trichloroethene (TCE)	0.2	U	0.2	0.066	ug/L
MW-06	02-Nov-21	Arsenic	0.081		0.005	0.001	mg/L
MW-08	02-Nov-21	Alkalinity	300		7	7	mg/L
MW-08	02-Nov-21	Iron	2.9		0.5	0.067	mg/L
MW-08	02-Nov-21	Manganese	2.6		0.01	0.0023	mg/L
MW-08	02-Nov-21	Methane	2200		5	0.63	ug/L
MW-08	02-Nov-21	Nitrate + Nitrite (as N)	0.15	U	0.15	0.06	mg/L
MW-08	02-Nov-21	Sulfate	1.5	U	1.5	0.8	mg/L
MW-08	02-Nov-21	TPH-diesel	1		0.12	0.068	mg/L
MW-08	02-Nov-21	TPH-gas	2.6	J+	0.25	0.1	mg/L
MW-08	02-Nov-21	TPH-Oil	0.37	U	0.37	0.1	mg/L
MW-10A	03-Nov-21	Arsenic	0.0061		0.005	0.001	mg/L
MW-11A	02-Nov-21	Alkalinity	360		7	7	mg/L
MW-11A	02-Nov-21	Arsenic	0.092		0.005	0.001	mg/L
MW-11A	02-Nov-21	Iron	5		0.5	0.067	mg/L
MW-11A	02-Nov-21	Manganese	2.3		0.01	0.0023	mg/L
MW-11A	02-Nov-21	Methane	7200		5	0.63	ug/L
MW-11A	02-Nov-21	Nitrate + Nitrite (as N)	0.15	U	0.15	0.06	mg/L
MW-11A	02-Nov-21	Sulfate	2.4		1.5	0.8	mg/L
MW-11A	02-Nov-21	TPH-diesel	0.67		0.11	0.066	mg/L
MW-11A	02-Nov-21	TPH-gas	2	J+	0.25	0.1	mg/L
MW-11A	02-Nov-21	TPH-Oil	0.36	U	0.36	0.097	mg/L
MW-11A dup-75A	02-Nov-21	Alkalinity	350		7	7	mg/L
MW-11A dup-75A	02-Nov-21	Arsenic	0.091		0.005	0.001	mg/L
MW-11A dup-75A	02-Nov-21	Iron	5.1		0.5	0.067	mg/L
MW-11A dup-75A	02-Nov-21	Manganese	2.4		0.01	0.0023	mg/L
MW-11A dup-75A	02-Nov-21	Methane	6800		5	0.63	ug/L
MW-11A dup-75A	02-Nov-21	Nitrate + Nitrite (as N)	0.063	J	0.15	0.06	mg/L
MW-11A dup-75A	02-Nov-21	Sulfate	2.7		1.5	0.8	mg/L
MW-11A dup-75A	02-Nov-21	TPH-diesel	0.74		0.11	0.065	mg/L
MW-11A dup-75A	02-Nov-21	TPH-gas	2.2	J+	0.25	0.1	mg/L
MW-11A dup-75A	02-Nov-21	TPH-Oil	0.35	U	0.35	0.096	mg/L
MW-12	02-Nov-21	Alkalinity	330		7	7	mg/L
MW-12	02-Nov-21	Arsenic	0.04		0.005	0.001	mg/L
MW-12	02-Nov-21	Benzene	12		0.2	0.03	ug/L
MW-12	02-Nov-21	Iron	3.5		0.5	0.067	mg/L
MW-12	02-Nov-21	Manganese	1.4		0.01	0.0023	mg/L
MW-12	02-Nov-21	Methane	2300		5	0.63	ug/L
MW-12	02-Nov-21	Nitrate + Nitrite (as N)	0.15	U	0.15	0.06	mg/L
MW-12	02-Nov-21	Sulfate	2.5		1.5	0.8	mg/L
MW-12	02-Nov-21	TPH-diesel	0.66		0.11	0.065	mg/L
MW-12	02-Nov-21	TPH-gas	2	J+	0.25	0.1	mg/L
MW-12	02-Nov-21	TPH-Oil	0.35	U	0.35	0.096	mg/L
MW-13	02-Nov-21	Arsenic	0.044		0.005	0.001	mg/L
MW-13	02-Nov-21	TPH-diesel	0.18		0.11	0.065	mg/L
MW-13	02-Nov-21	TPH-gas	0.65		0.25	0.1	mg/L
MW-13	02-Nov-21	TPH-Oil	0.35	U	0.35	0.096	mg/L
MW-17	03-Nov-21	Arsenic	0.013		0.005	0.001	mg/L
MW-18	02-Nov-21	Alkalinity	240		7	7	mg/L
MW-18	02-Nov-21	Iron	0.16	J	0.5	0.067	mg/L
MW-18	02-Nov-21	Manganese	0.88		0.01	0.0023	mg/L
MW-18	02-Nov-21	Methane	5	U	5	0.63	ug/L
MW-18	02-Nov-21	Nitrate + Nitrite (as N)	4.3		1.5	0.6	mg/L
MW-18	02-Nov-21	Sulfate	65		1.5	0.8	mg/L
MW-19	03-Nov-21	Arsenic	0.078		0.005	0.001	mg/L
MW-19	03-Nov-21	TPH-diesel	0.59		0.12	0.07	mg/L
MW-19	03-Nov-21	TPH-gas	1.2	J+	0.25	0.1	mg/L
MW-19	03-Nov-21	TPH-Oil	0.37	U	0.37	0.1	mg/L
MW-20	02-Nov-21	Tetrachloroethene (PCE)	1.1		0.5	0.084	ug/L
MW-20	02-Nov-21	Trichloroethene (TCE)	0.82		0.2	0.066	ug/L
MW-31	02-Nov-21	Tetrachloroethene (PCE)	0.6		0.5	0.084	ug/L
MW-33	02-Nov-21	Alkalinity	280		7	7	mg/L

Appendix A: Complete Tabulated Results for Groundwater Samples - November 2021

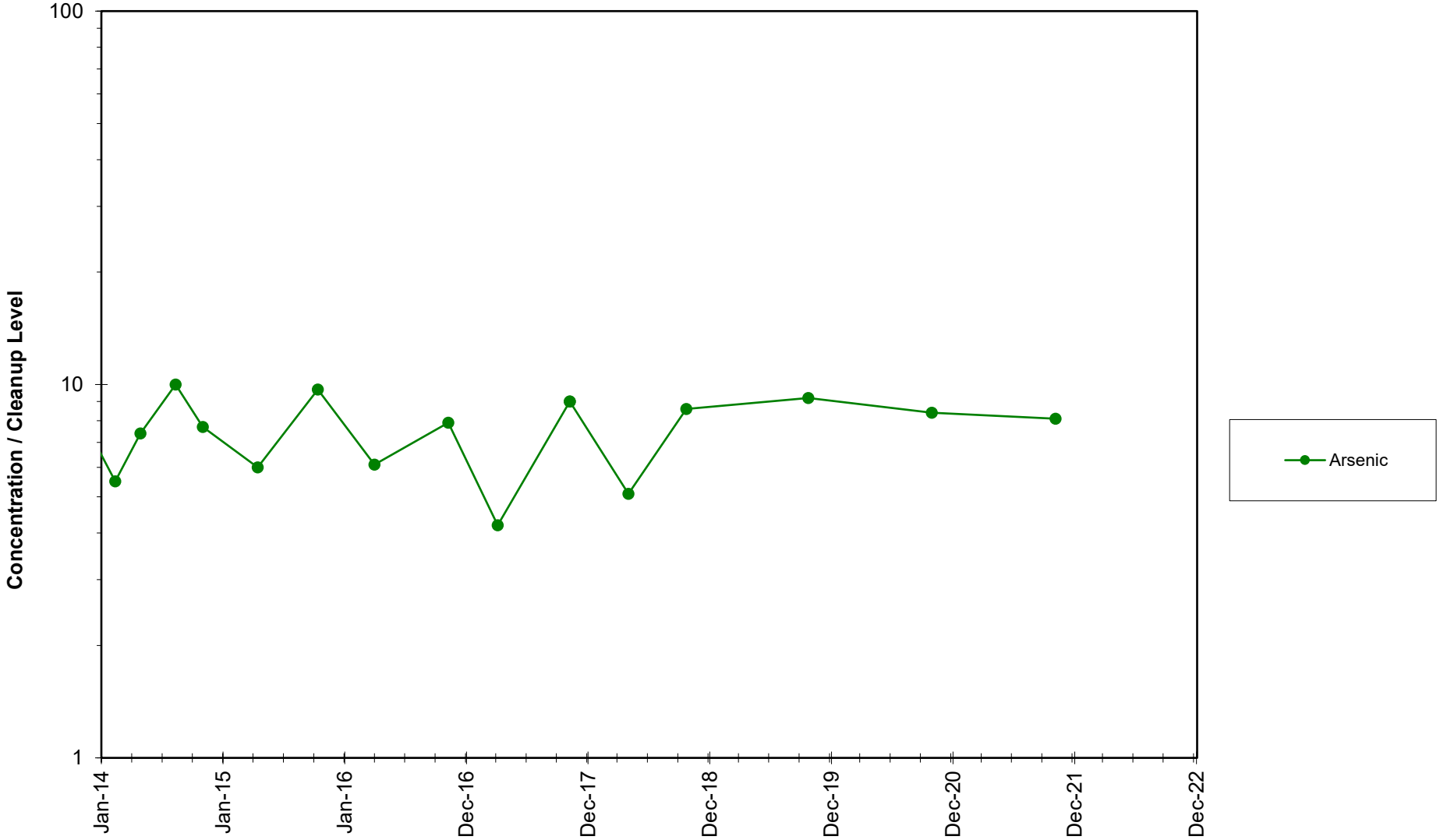
Sample Location	Date Sampled	Parameter	Result	Qualifier	PQL	MDL	Units
MW-33	02-Nov-21	Iron	4		0.5	0.067	mg/L
MW-33	02-Nov-21	Manganese	3.2		0.01	0.0023	mg/L
MW-33	02-Nov-21	Methane	8400		5	0.63	ug/L
MW-33	02-Nov-21	Nitrate + Nitrite (as N)	0.15	U	0.15	0.06	mg/L
MW-33	02-Nov-21	Sulfate	7.1		1.5	0.8	mg/L
MW-33	02-Nov-21	TPH-diesel	1.1		0.12	0.074	mg/L
MW-33	02-Nov-21	TPH-gas	3.1	J+	0.25	0.1	mg/L
MW-33	02-Nov-21	TPH-Oil	0.4	U	0.4	0.11	mg/L
MW-34	02-Nov-21	Alkalinity	340		7	7	mg/L
MW-34	02-Nov-21	Arsenic	0.02		0.005	0.001	mg/L
MW-34	02-Nov-21	Iron	1.3		0.5	0.067	mg/L
MW-34	02-Nov-21	Manganese	0.97		0.01	0.0023	mg/L
MW-34	02-Nov-21	Methane	3100		5	0.63	ug/L
MW-34	02-Nov-21	Nitrate + Nitrite (as N)	0.15	UJ	0.15	0.06	mg/L
MW-34	02-Nov-21	Sulfate	4.1		1.5	0.8	mg/L
MW-34	02-Nov-21	TPH-diesel	0.56		0.12	0.073	mg/L
MW-34	02-Nov-21	TPH-gas	1.3		0.25	0.1	mg/L
MW-34	02-Nov-21	TPH-Oil	0.39	U	0.39	0.11	mg/L
MW-47	02-Nov-21	Trichloroethene (TCE)	1.1		0.2	0.066	ug/L
MW-48	02-Nov-21	Arsenic	0.0065		0.005	0.001	mg/L
MW-49	02-Nov-21	Tetrachloroethene (PCE)	18		0.5	0.084	ug/L
MW-49	02-Nov-21	Trichloroethene (TCE)	1.8		0.2	0.066	ug/L
MW-49 dup-79	02-Nov-21	Tetrachloroethene (PCE)	21		0.5	0.084	ug/L
MW-49 dup-79	02-Nov-21	Trichloroethene (TCE)	1.9		0.2	0.066	ug/L
MW-62R	02-Nov-21	Alkalinity	170		7	7	mg/L
MW-62R	02-Nov-21	Iron	0.077	J	0.5	0.067	mg/L
MW-62R	02-Nov-21	Manganese	0.0091	J	0.01	0.0023	mg/L
MW-62R	02-Nov-21	Methane	5	U	5	0.63	ug/L
MW-62R	02-Nov-21	Nitrate + Nitrite (as N)	9.1		1.5	0.6	mg/L
MW-62R	02-Nov-21	Sulfate	55		1.5	0.8	mg/L
MW-63	02-Nov-21	Alkalinity	770		7	7	mg/L
MW-63	02-Nov-21	Arsenic	0.084		0.005	0.001	mg/L
MW-63	02-Nov-21	Benzene	99		2	0.3	ug/L
MW-63	02-Nov-21	Iron	1.9		0.5	0.067	mg/L
MW-63	02-Nov-21	Manganese	0.28		0.01	0.0023	mg/L
MW-63	02-Nov-21	Methane	1800		5	0.63	ug/L
MW-63	02-Nov-21	Nitrate + Nitrite (as N)	0.23		0.15	0.06	mg/L
MW-63	02-Nov-21	Sulfate	8.1		1.5	0.8	mg/L
MW-63	02-Nov-21	TPH-diesel	0.32		0.11	0.065	mg/L
MW-63	02-Nov-21	TPH-gas	0.71	J+	0.25	0.1	mg/L
MW-63	02-Nov-21	TPH-Oil	0.35	U	0.35	0.096	mg/L
MW-66	02-Nov-21	TPH-diesel	0.21		0.11	0.066	mg/L
MW-66	02-Nov-21	TPH-gas	0.81	J+	0.25	0.1	mg/L
MW-66	02-Nov-21	TPH-Oil	0.35	U	0.35	0.097	mg/L
MW-66	02-Nov-21	Trichloroethene (TCE)	0.2	U	0.2	0.066	ug/L
SEP-OUT	03-Nov-21	Tetrachloroethene (PCE)	2.2		0.5	0.084	ug/L
TRIP BLANKs	03-Nov-21	Benzene	0.2	U	0.2	0.03	ug/L
TRIP BLANKs	03-Nov-21	Tetrachloroethene (PCE)	0.5	U	0.5	0.084	ug/L
TRIP BLANKs	03-Nov-21	TPH-gas	0.25	U	0.25	0.1	mg/L
TRIP BLANKs	03-Nov-21	Trichloroethene (TCE)	0.2	U	0.2	0.066	ug/L

Notes:
dupl = duplicate, PQL = practical quantitation limit, MDL = method detection limit, TPH = total petroleum hydrocarbons
FB = Field Blank, mg/L = milligrams per liter, ug/L = micrograms per liter TB = Trip Blanks
SEP-OUT is the outlet of the COE drain oil-water separator
U qualifier: Compound was not detected
UJ qualifier: Compound was not detected, the reporting limit is approximate due to minor data validation issue
J+ qualifier: The result is an estimated quantity; the result may be biased high
J qualifier: The result is an estimated quantity
J- qualifier: The result is an estimated quantity; the result may be biased low

APPENDIX B

Trend Graphs

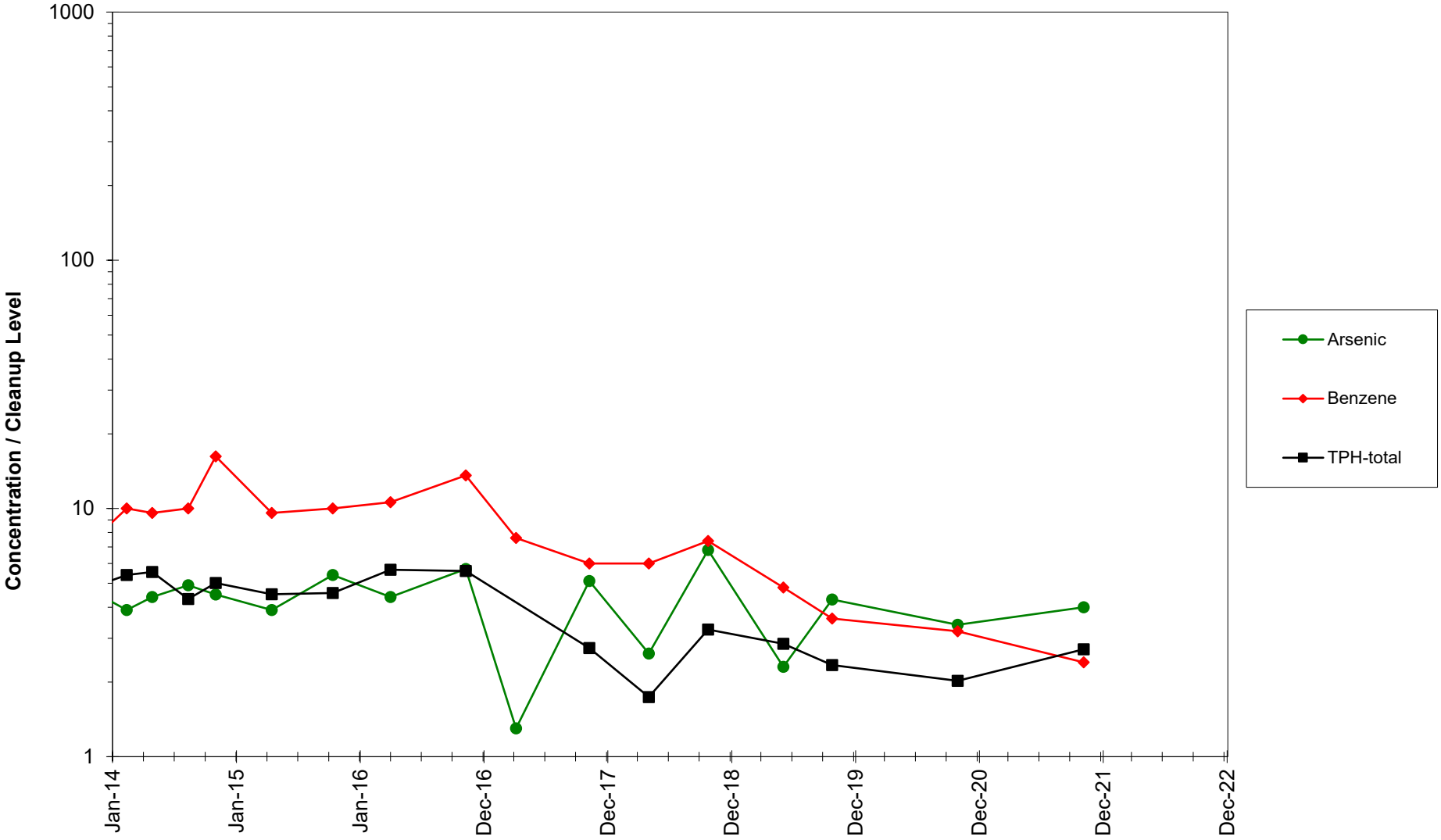
Area 2 MW-06



Golder Associates

Area2.xlsx, Area 2 MW-06

Area 2 MW-12


1000
100
10
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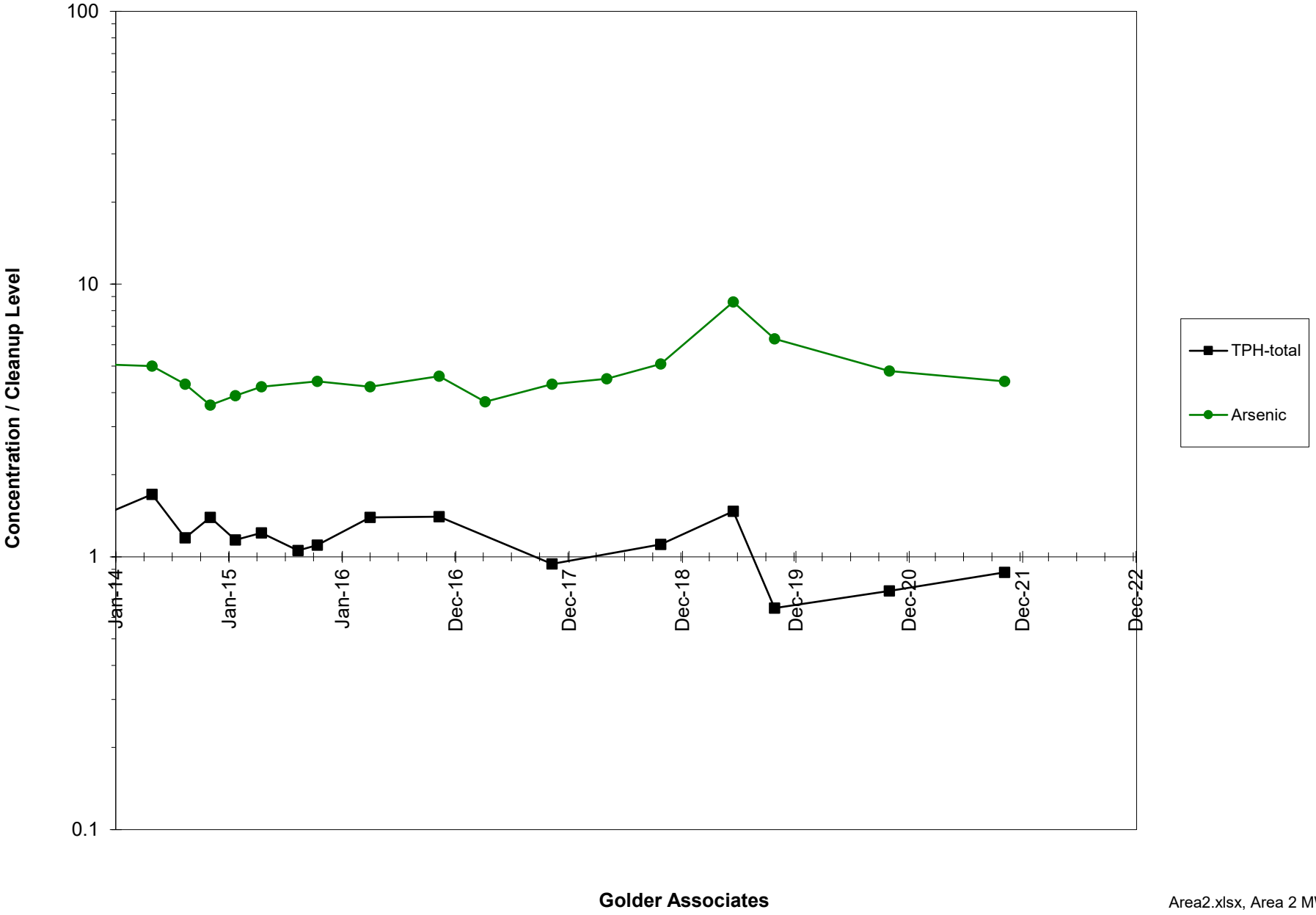
Concentration / Cleanup Level
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Dec-21
Dec-22
Arsenic
Benzene
TPH-total

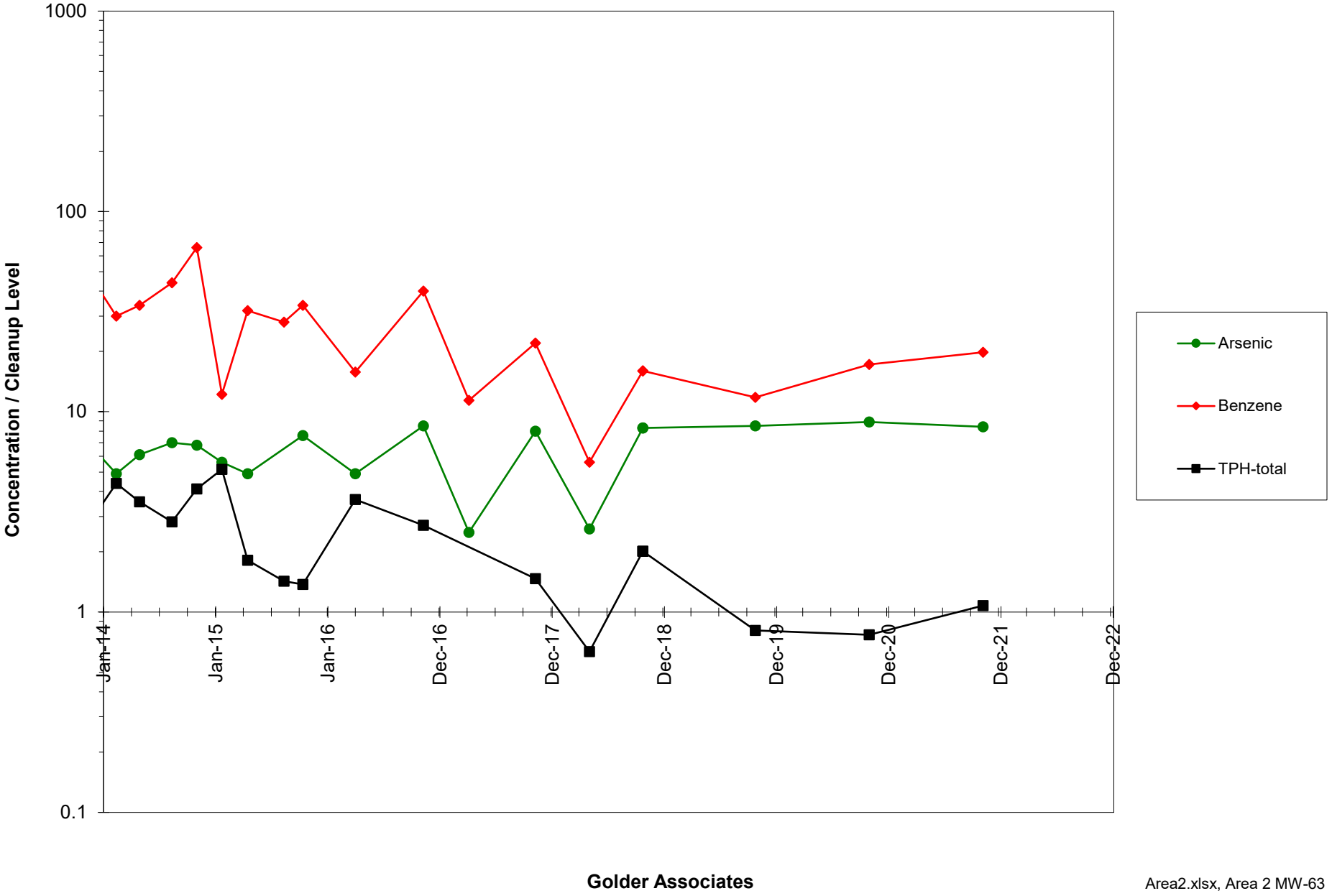
Area 2 MW-13



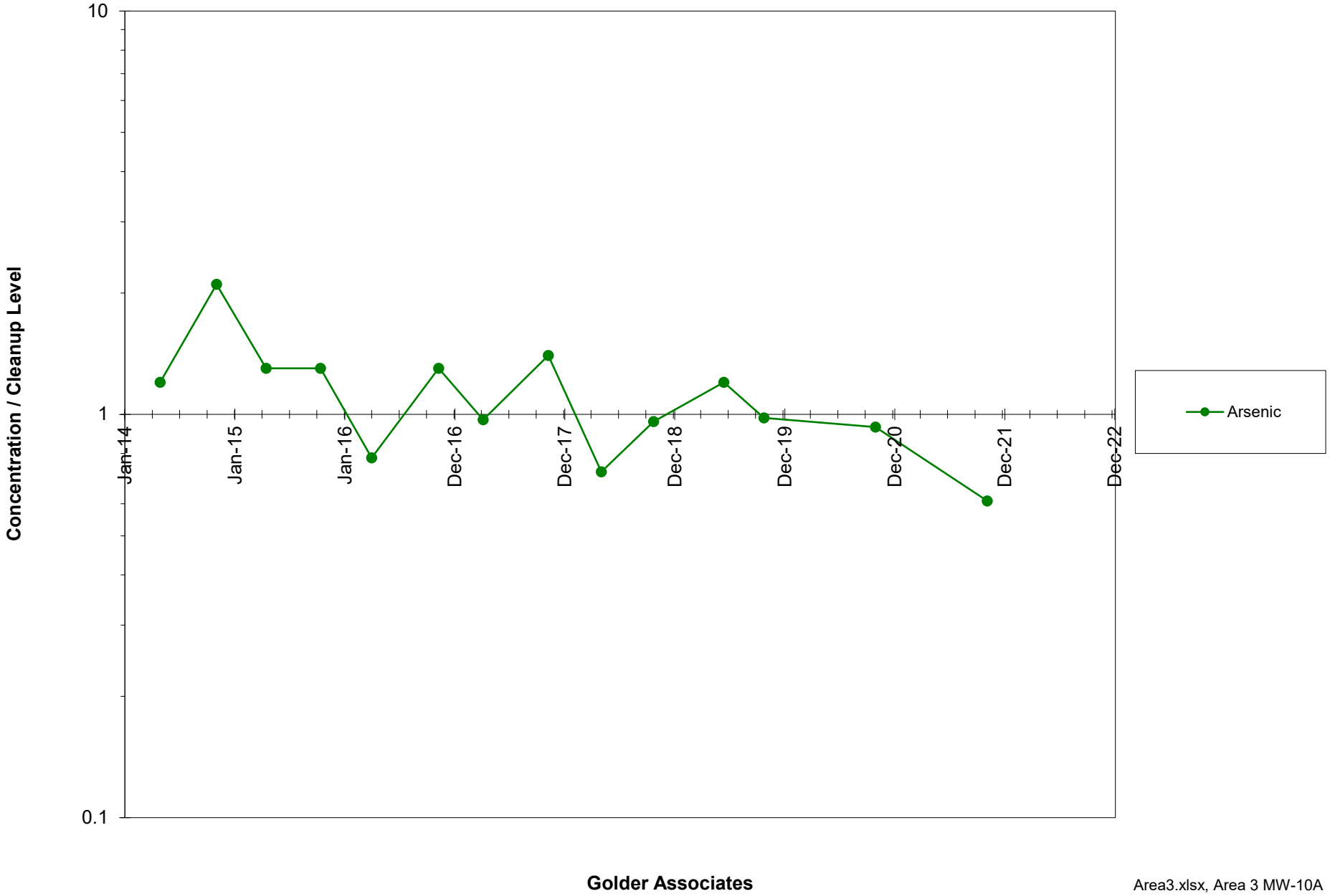
Golder Associates

Area2.xlsx, Area 2 MW-13

Area 2 MW-63


1000
100
10
1
0.1
Concentration / Cleanup Level
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Dec-21
Dec-22
Arsenic
Benzene
TPH-total

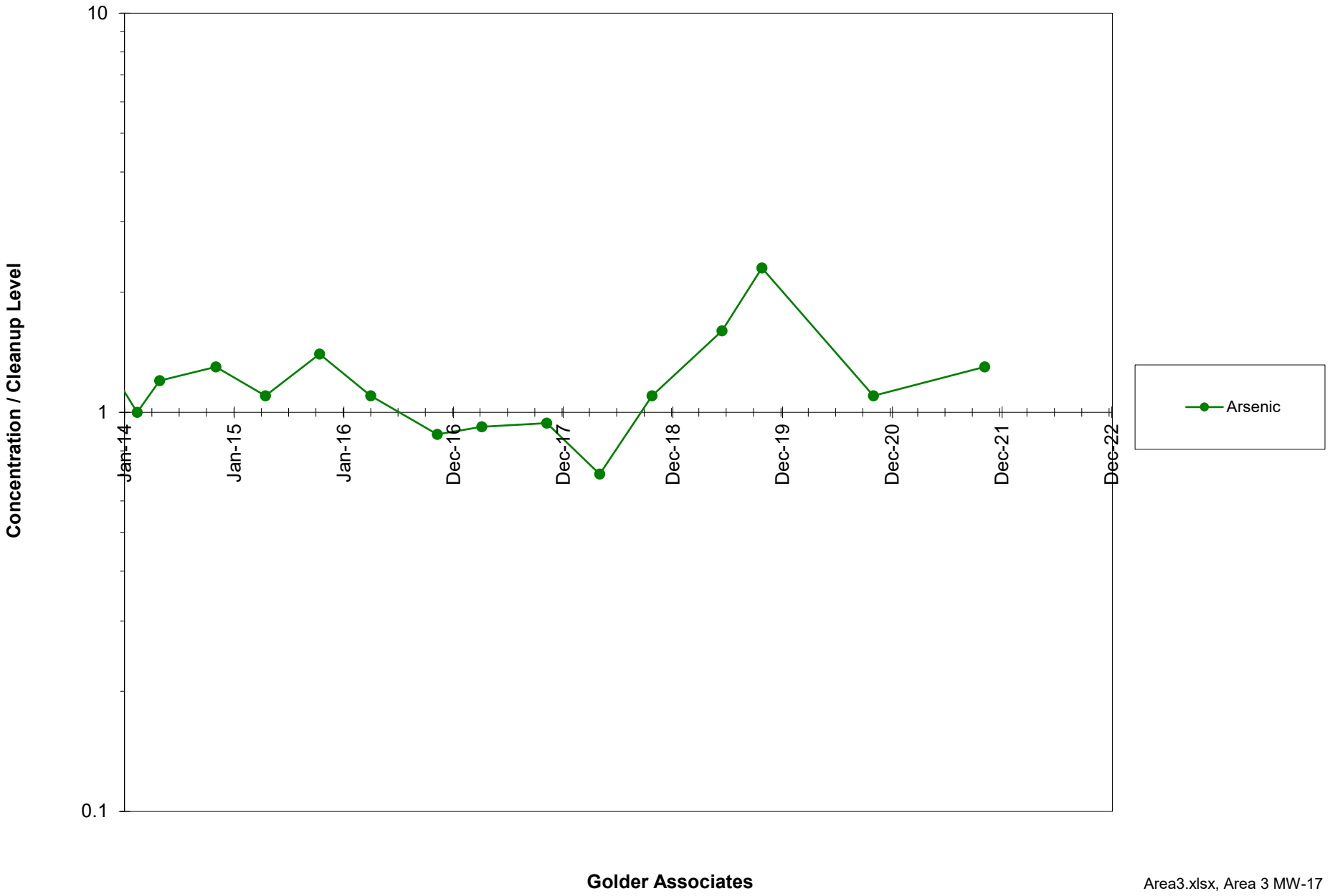
Area 3 MW-10A



Golder Associates

Area3.xlsx, Area 3 MW-10A

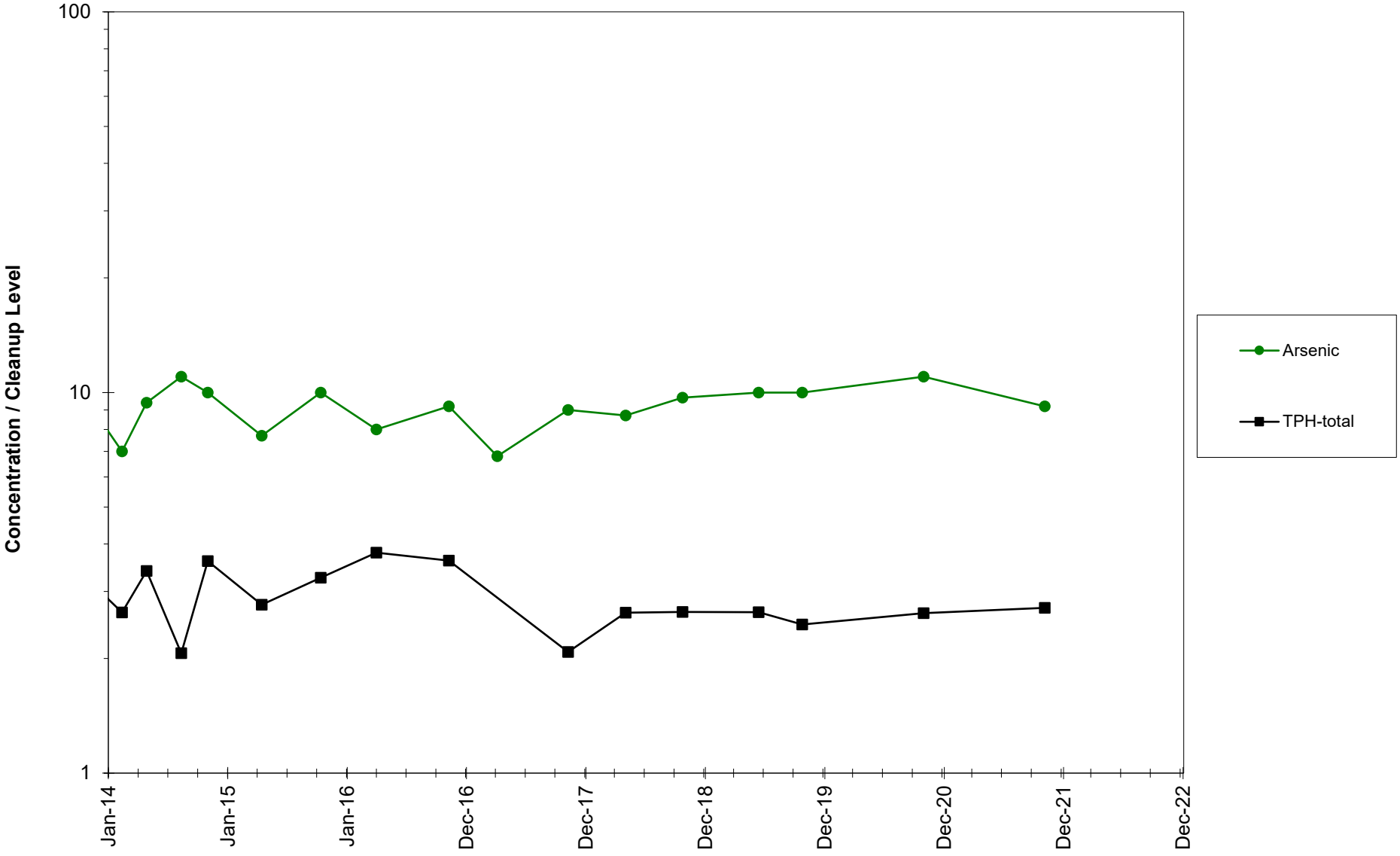
Area 3 MW-17



Golder Associates

Area3.xlsx, Area 3 MW-17

Area 4 MW-11A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10
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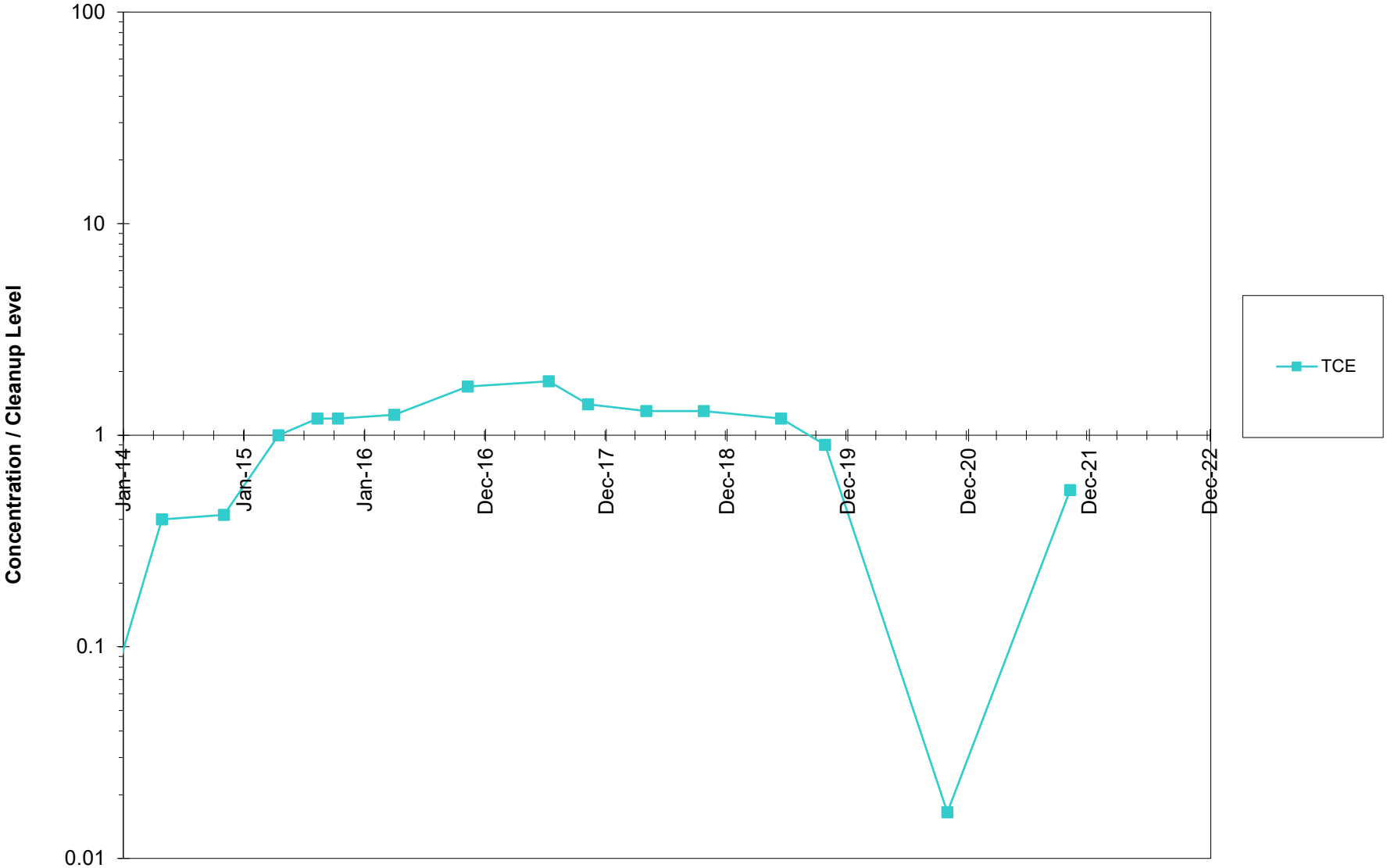
Concentration / Cleanup Level
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Dec-21
Dec-22
Arsenic
TPH-total

Area 4 MW-47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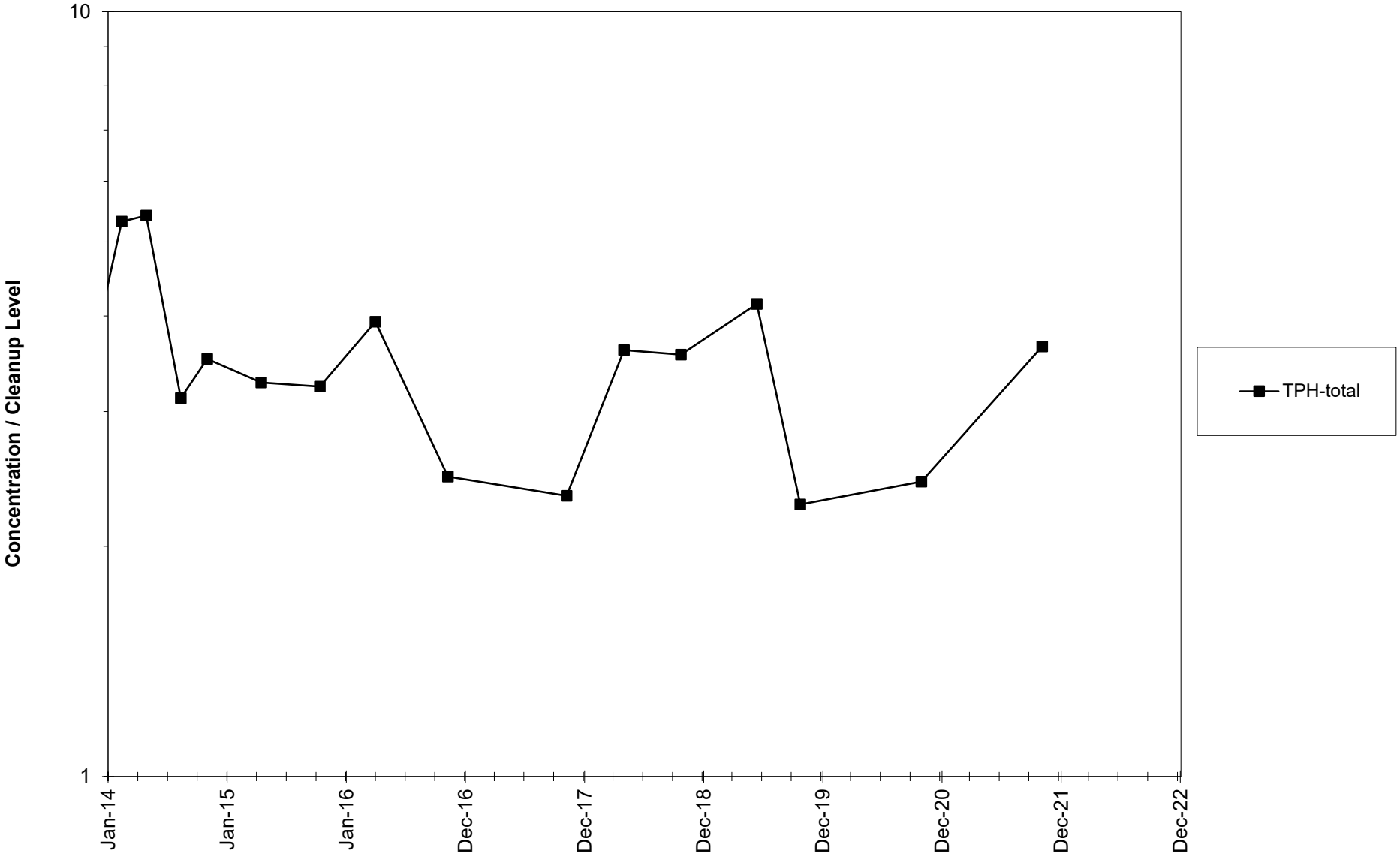
Concentration / Cleanup Level
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Dec-21
Dec-22
TCE

Area 6 MW-08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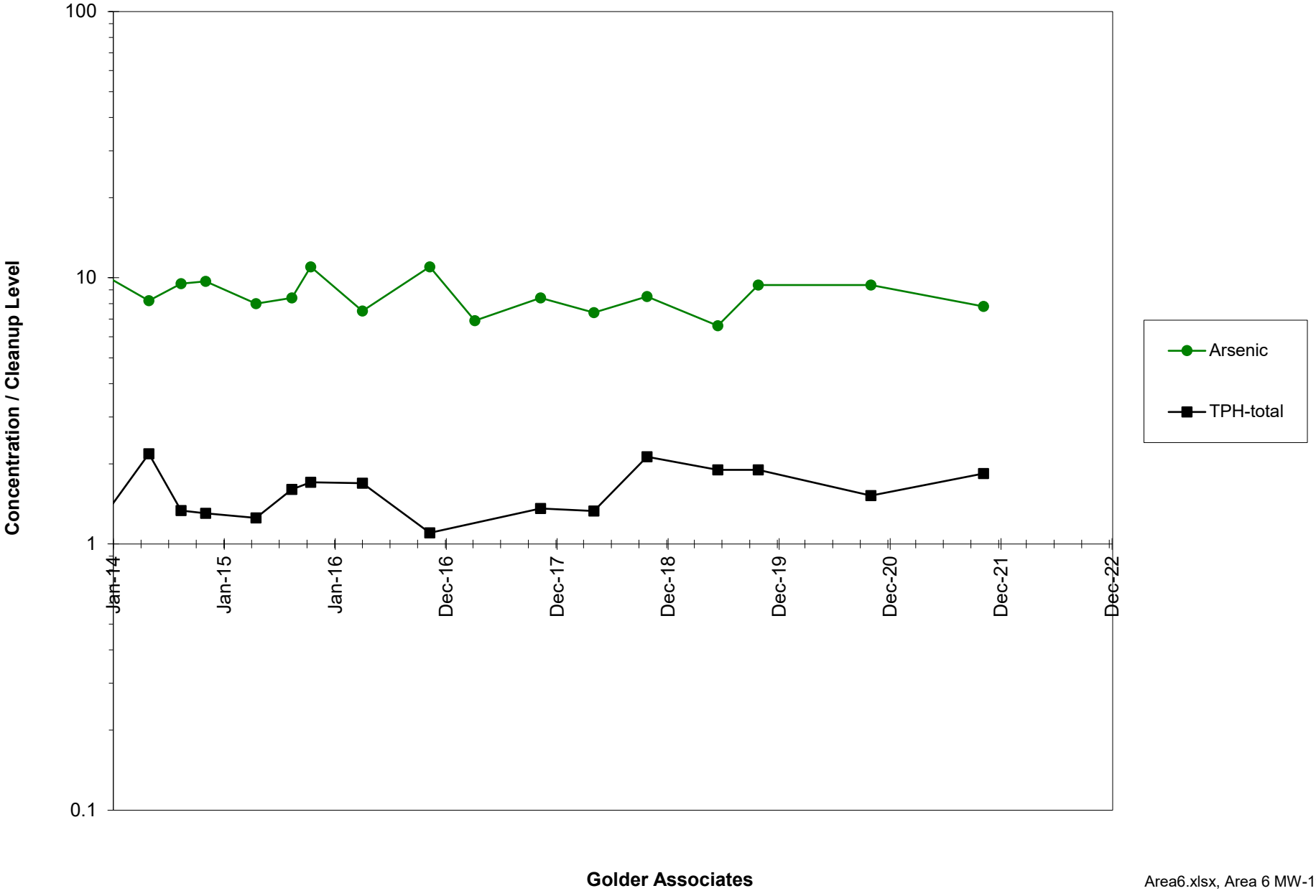
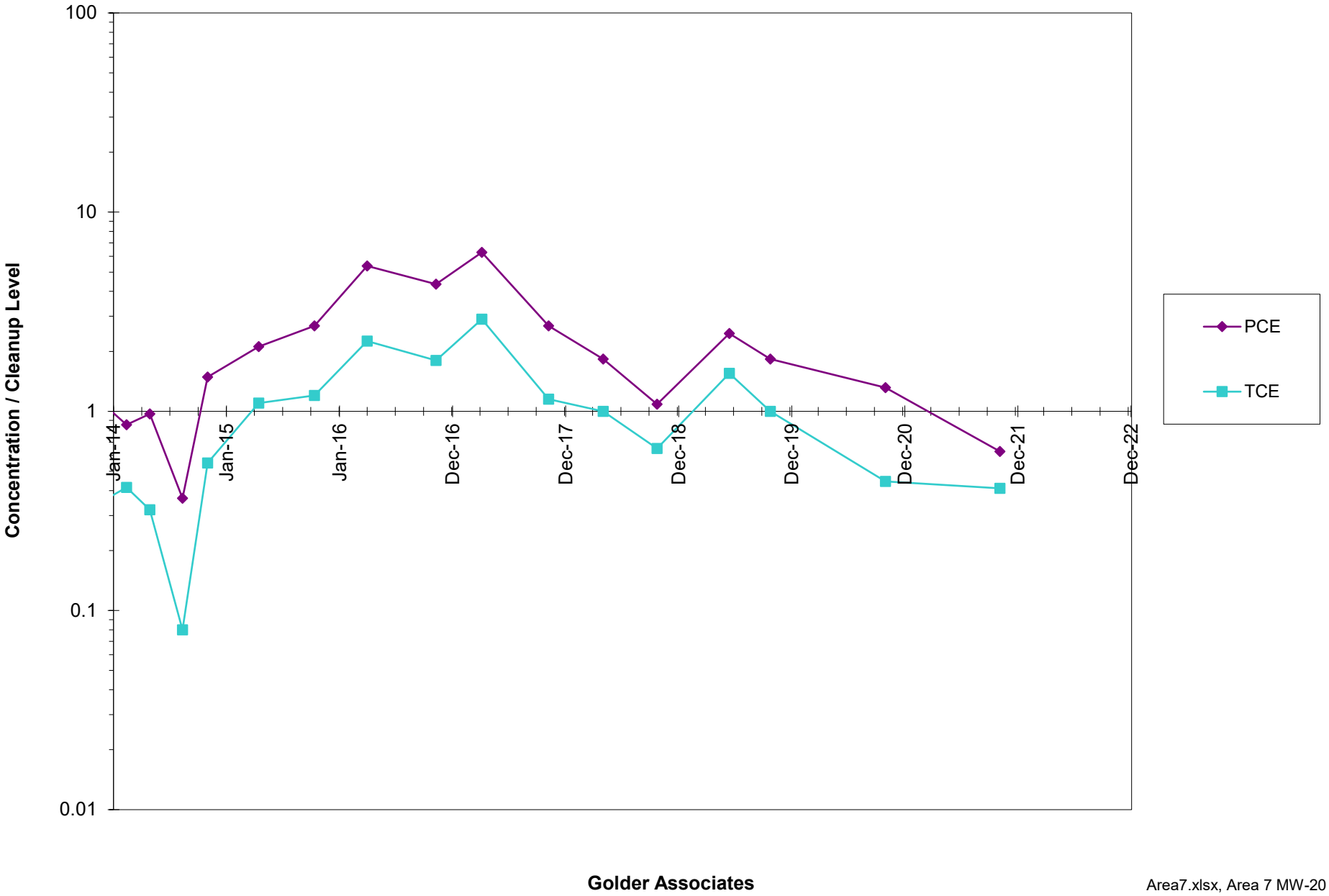
Concentration / Cleanup Level
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Dec-21
Dec-22
TPH-total

Area 6 MW-19


100
10
1
0.1
Concentration / Cleanup Level
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Dec-21
Dec-22
Arsenic
TPH-total

Area 7 MW-20



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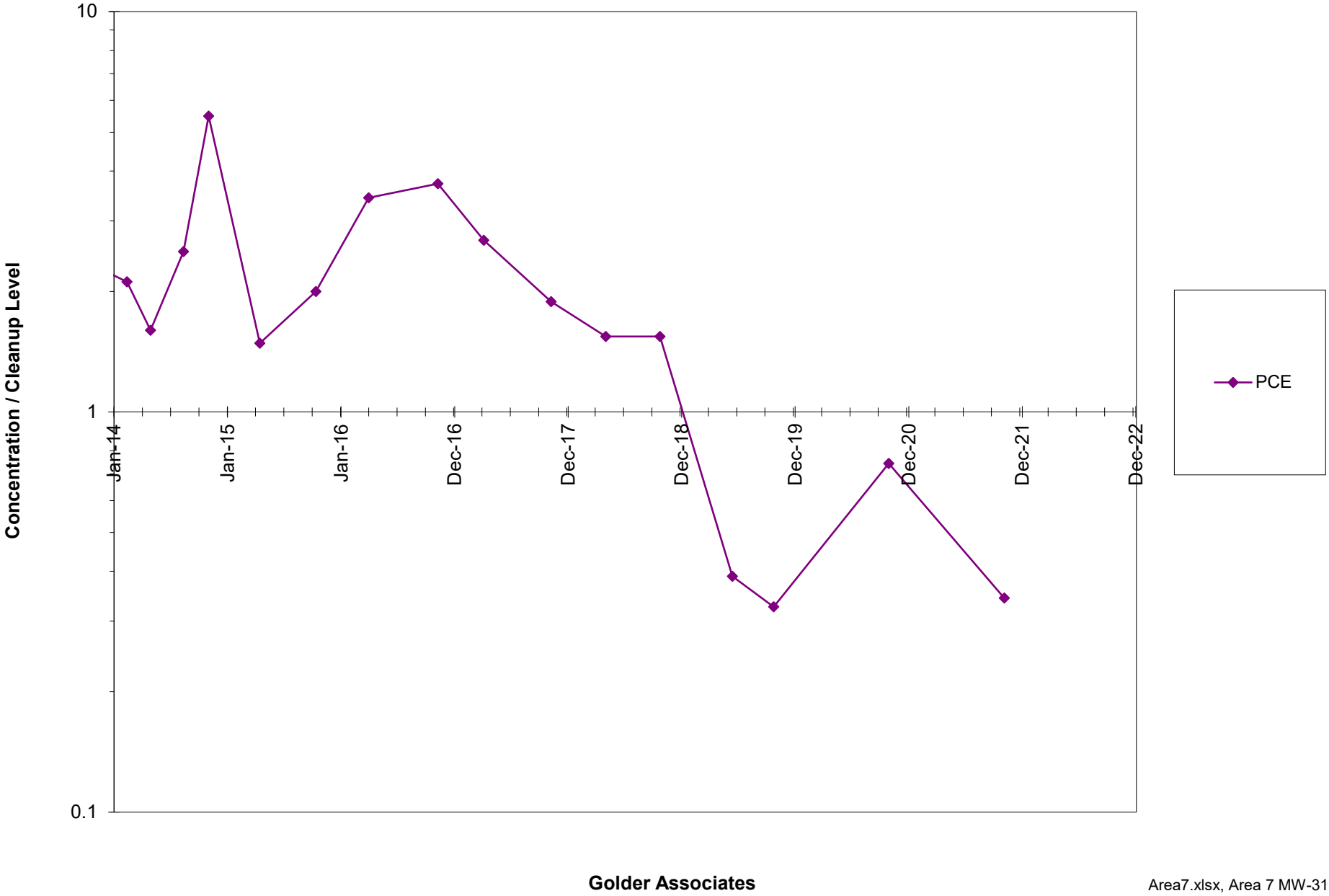
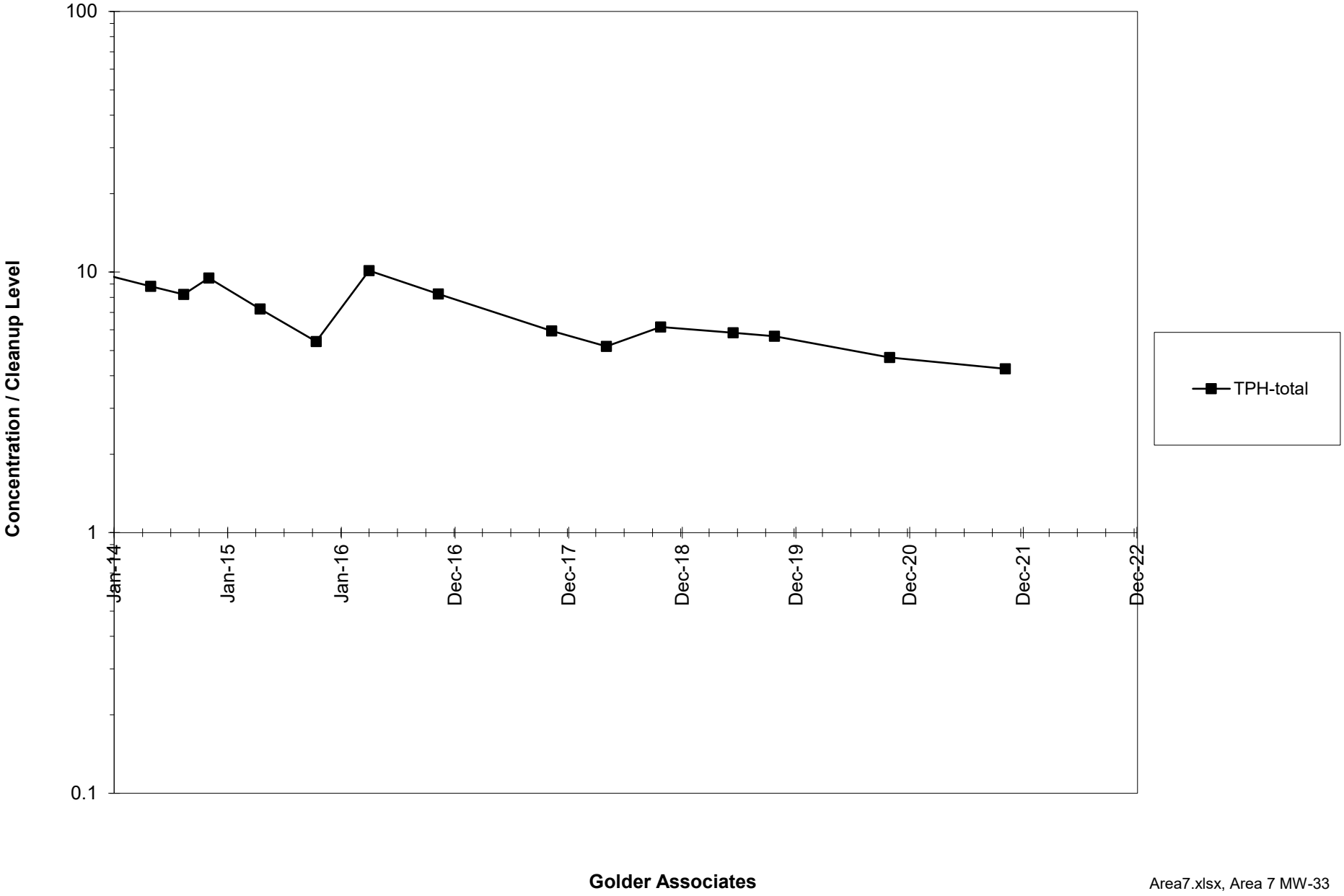
Area7.xlsx, Area 7 MW-20

Area 7 MW-31


10
1
0.1
Concentration / Cleanup Level
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Dec-21
Dec-22
PCE

Area 7 MW-33



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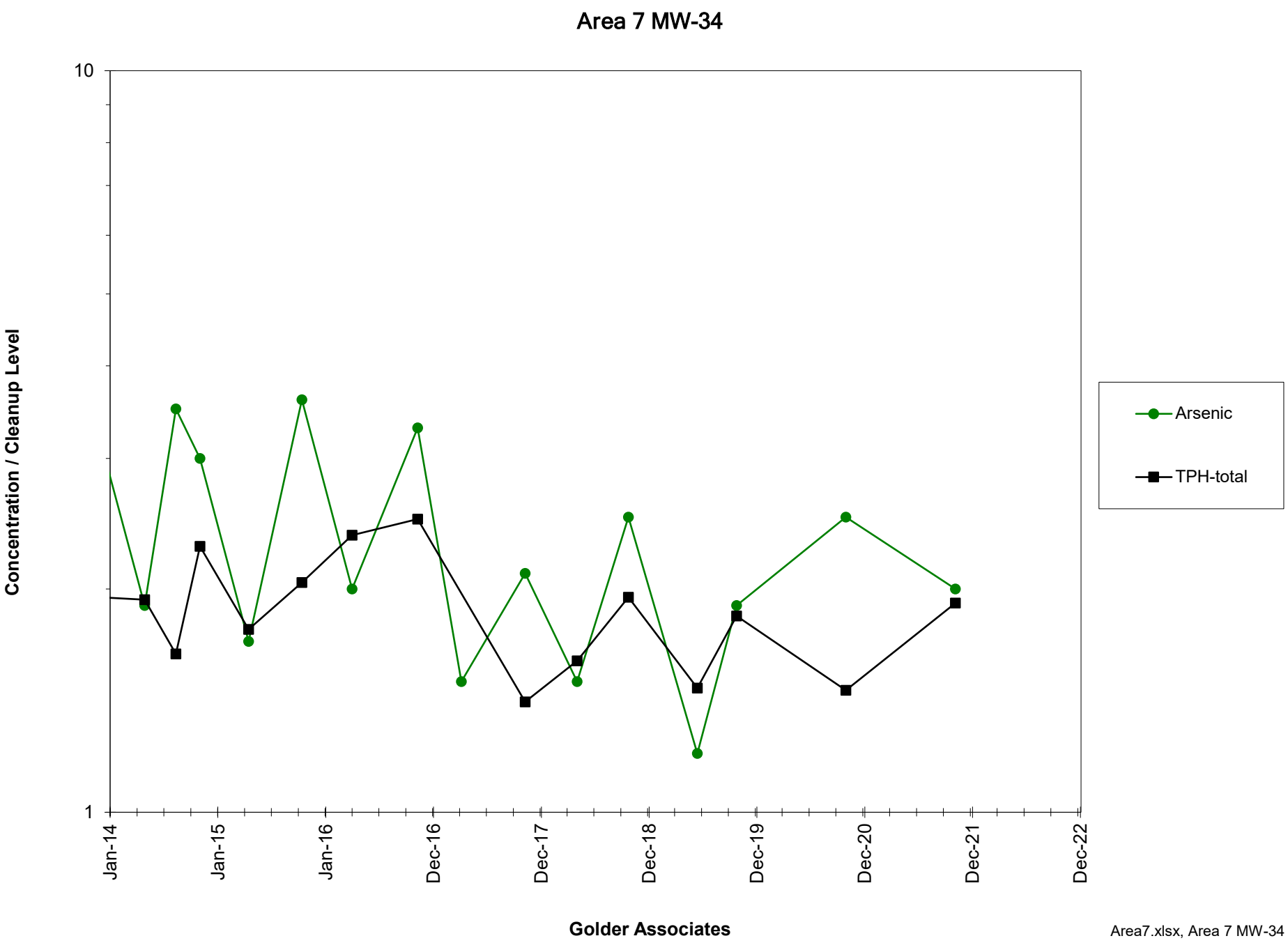
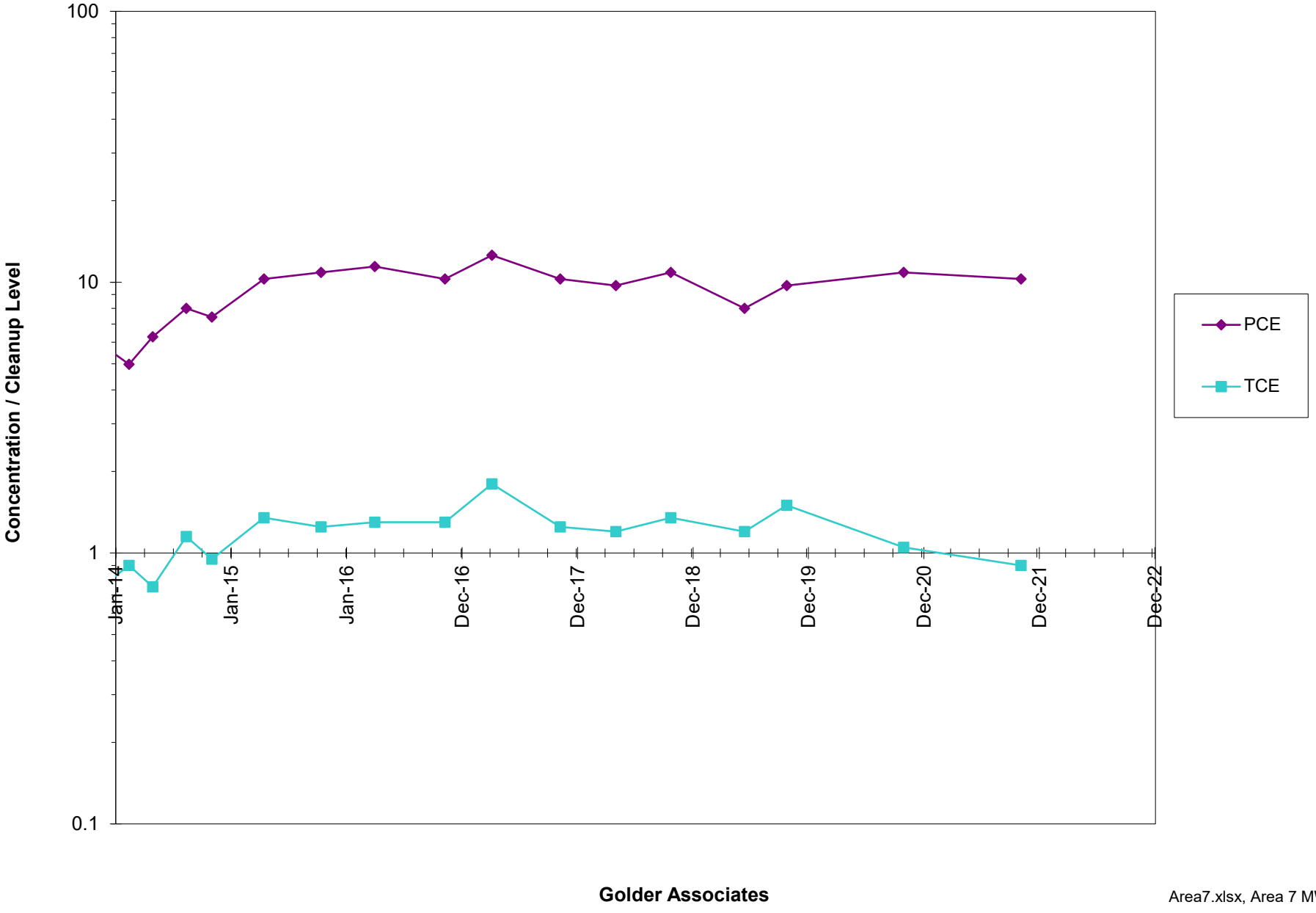
Area7.xlsx, Area 7 MW-33


Area 7 MW-34
10
1
Concentration / Cleanup Level
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Dec-21
Dec-22
Arsenic
TPH-total
Golder Associates
Area7.xlsx, Area 7 MW-34

Area 7 MW-49



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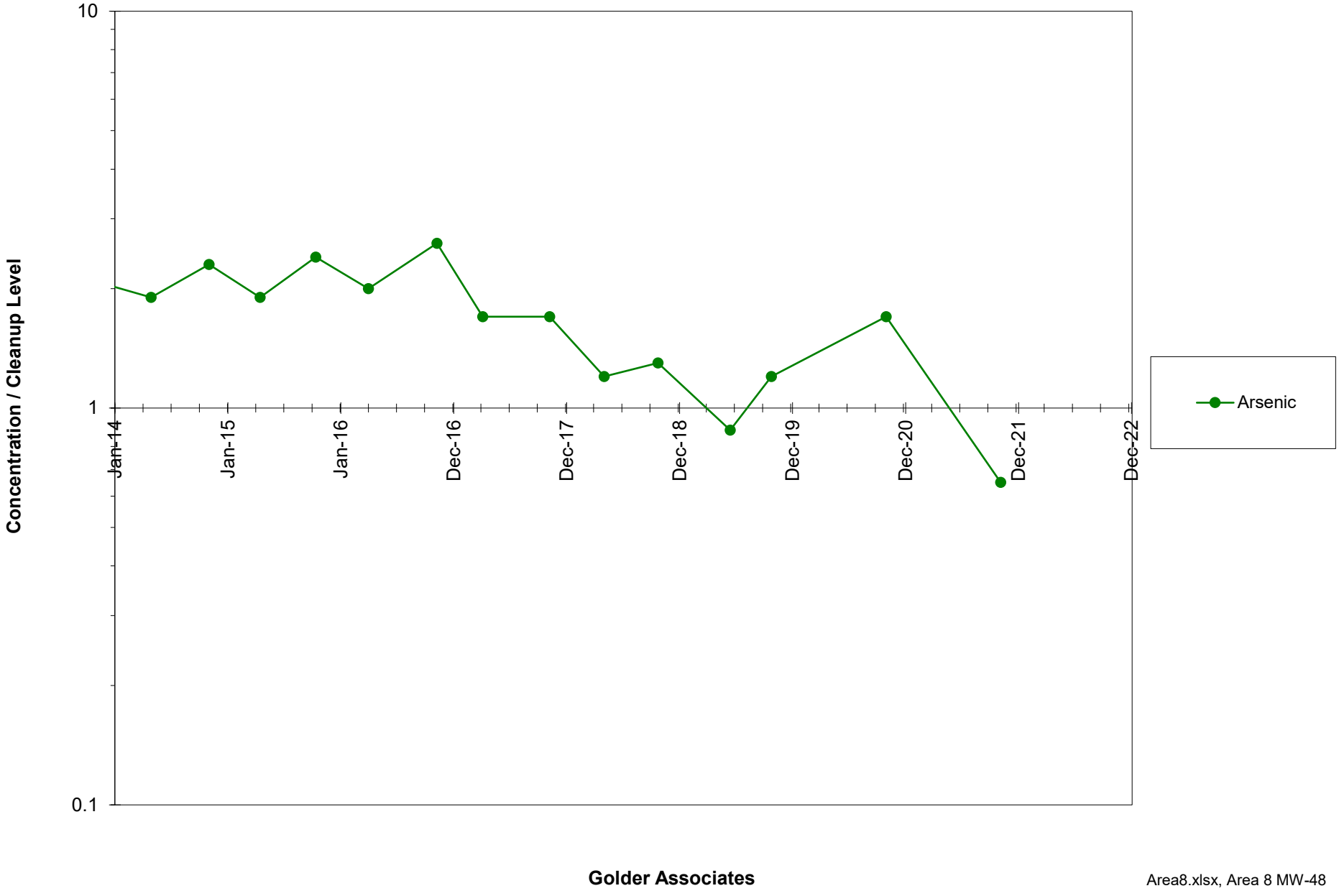
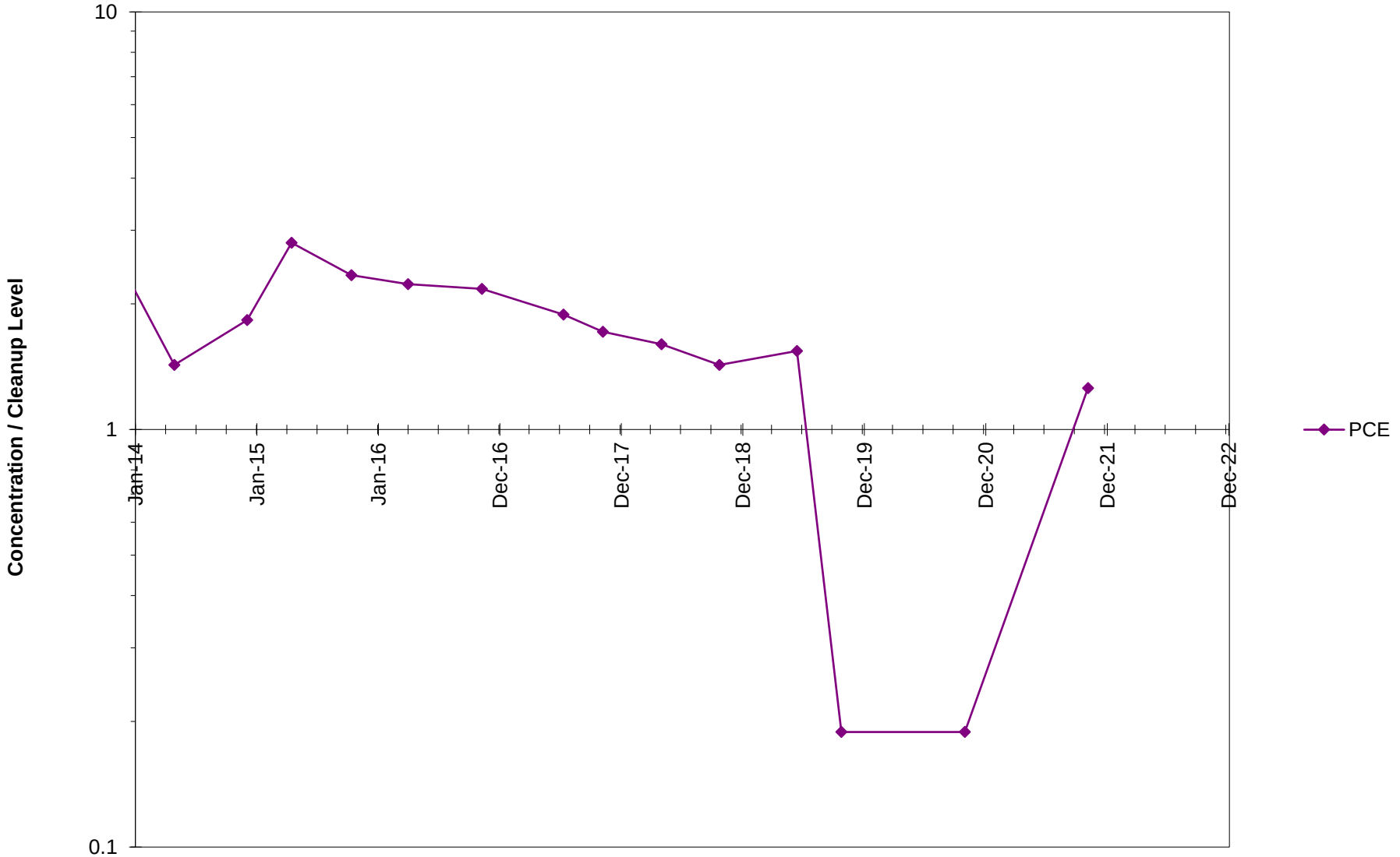
Area7.xlsx, Area 7 MW-49

Area 8 MW-48


10
1
0.1
Concentration / Cleanup Level
Jan-14
Jan-15
Jan-16
Dec-16
Dec-17
Dec-18
Dec-19
Dec-20
Dec-21
Dec-22
Arsenic

COE Separator Out (1)

OWS — Separator Out



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