VIA ELECTRONIC MAIL

December 29, 2022

Karen A. Cahill
Division of Environmental Remediation
New York State Department of Environmental Conservation
Region 7
615 Erie Boulevard West
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Subject: **MW-5-40 *In Situ* Remediation Completion Report**
Former Emerson Power Transmission, Ithaca, New York

Dear Karen:

On behalf of Emerson Electric Co., WSP USA Inc. prepared this MW-5-40 *In Situ Remediation Completion Report* (Completion Report) to address groundwater in the monitoring well MW-5-40 area. MW-5-40 is located in Operable Unit 1 (OU-1) of the former Emerson Power Transmission (EPT) site in Ithaca, New York (Site; Figure 1). The *Revised MW-5-40 In Situ Remediation Work Plan* (Work Plan) was implemented in accordance with the New York State Department of Environmental Conservation's (NYSDEC) conditional approval letter, dated November 5, 2020.

On March 18, 2018, NYSDEC requested that *in situ* treatment be considered to reduce elevated dissolved concentrations of chlorinated volatile organic compounds (CVOCs) present in samples collected from monitoring well MW-5-40. In a letter dated April 25, 2019, WSP responded to this request and proposed performing a focused *in situ* remediation treatment in the MW-5-40 area. The *in situ* remediation fieldwork was performed between May 20 and May 22, 2021. Subsequently, groundwater samples were collected from the MW-5-40 area to evaluate the i*n situ* remediation progress. WSP submitted a status report, *MW-5-40 In Situ Remediation Status Report #1*, on February 18, 2022 which provided a summary of the completed field activities and preliminary performance monitoring data. This Completion Report provides an update to the previously submitted status report and recommendations for next steps to address CVOCs in the MW-5-40 area.

IN SITU REMEDIATION

The Work Plan recommended *in situ* treatment to enhance naturally occurring reductive attenuation processes. The *in situ* treatment was completed over three days between May 20 and May 22, 2021. A summary of the materials injected including types, objectives, flow rates, dosages, injection methodology, injection pressures, and total amendment fluid injected into the subsurface was provided in Status Report #1.

During the MW-5-40 amendment delivery changes in groundwater evaluations and total dissolved solids/specific conductance were observed in MW-46-43C that directly correspond with the injection timeframes (Figures 2A, 2B, 3A, and 3B). Groundwater elevations and geochemical parameter changes were not observed at any other monitoring well locations (MW-5-25B, MW-5-100 MW-8B MW-12C, MW-13C, MW-15C and MW-46-72C), Outfall 001, or Seeps 1 through 3.

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GROUNDWATER MONITORING RESULTS

Groundwater samples were collected from MW-5-40, MW-46-43C, and MW-13C before amendment application (baseline) and during three post-injection performance monitoring sampling rounds (June 2021, August 202, and February 2022) to evaluate the i*n situ* treatment effects in the subsurface. Analysis included – CVOCs using EPA Method 8260D completed by SGS Laboratories of Dayton, New Jersey; Dissolved gases using Method RSK 175, Alkalinity using Standard Method (SM) 2320 B-2011, Volatile Fatty Acids (VFA) using Analytical Method (AM) 23G, Total Organic Carbon (TOC) using SM 5310 B-2014, completed by Pace Analytical of Baton Rouge, Louisiana. The phospholipid fatty acids (microbe), QuantArray®-Chlor (microbe), and The Compound Specific Isotope Analysis was completed by Microbial Insights of Knoxville, Tennessee.

The analytical program is detailed in the table below. An additional round of sampling was performed at select wells after the performance monitoring period. Analysis of samples collected after the performance monitoring period were limited to VOCs.

	MW-5-40				MW-46-43C				MW-13C			
	Baseline 12/10/19	Round 1 6/22/21	Round 2 9/22/21	Round 3 12/14/21	Baseline 12/10/19	Round 1 6/22/21	Round 2 9/22/21	Round 3 12/14/21	Baseline 12/9/19	Round1 6/22/21	Round 2 9/22/21	Round 3 12/14/21
CVOCs	•	•	•	•	•	•	•	•	•	•	•	•
Dissolved Gases	•	•	•	•			•	•				
Alkalinity	•		•	•			•	•				
VFAs and TOC	•	• (a)	•	•			•	•				
Microbial	•	•	•	•								
CSIA	•	•	•	•								

a/ Only TOC was analyzed.

In accordance with the Work Plan, the effectiveness of the remedy is assessed below based on the establishment of conditions that promote degradation along the sequential reductive pathway and ultimately CVOC mass destruction. Key indicator parameter data also defined in the work plan, include:

- generation of sequential reduction degradation products, including ethane and ethene
- decreasing CVOC mass
- viable DHC population
- detection of vinyl chloride reductase functional genes
- TOC concentrations elevated above baseline
- measurable isotopic fractionation

CVOC DESTRUCTIVE ATTENUATION

The remedial amendment formulation injected through MW-5-40 was designed to stimulate the sequential reduction pathway (hydrogenolysis). This pathway for trichloroethene (TCE) produces dichloroethane (DCE) which is in turn reduced to vinyl chloride which is ultimately reduced to the innocuous end product ethene. Accordingly, the most direct measurement of destructive attenuation is the evaluation of these products, especially accumulation of the end product ethane. Figures 4, 5, and 6 show molar concentration plots of total CVOCs, TCE and TCE reductive daughter products measured in samples collected from MW-5-40, MW-46-43C, and MW-13C. CVOC concentration data are presented in Table 1 and ethene data is presented in Table 2. The maximum ethene concentrations measured in samples collected from MW-5-40 and MW-46-43C were 943 µg/L and 2,900 µg/L, respectively. This is equivalent to 4,400 µg/L and 13,600 µg/L of TCE (molar conversion) that was completely transformed to the innocuous end product ethene.

The MW-5-40 data plot (Figure 4) shows an influx of CVOC mass caused from upgradient migration into the area or back diffusion from the bedrock primary porosity through the December 2021 sampling event. Mass influx aided by increased seepage velocity related to nearby groundwater extraction is the more likely scenario. The ratio of chlorinated daughter products changed significantly in samples following injections. The amount of total DCE present in the baseline sample was nearly five times that of vinyl chloride (5:1). By December 2021, the ratio was nearly 1:1 and by September 2022 the amount of total DCE was slightly more than a third of the vinyl chloride (1:3), all while total CVOC decreased by more than 50% from the maximum measured in December 2021. The MW-46-43 plot (Figure 5) shows CVOC mass influx beginning after the December 2021 sampling event. The ratio of total DCE to vinyl chloride also showed strong evidence of sequential reduction through 2021 but lesser treatment with mass influx experienced in 2022. The MW-13C plot shows no apparent total CVOC mass reduction but does show sequential degradation of TCE to cis-DCE. No vinyl chloride was generated. MW-13C is screened in a less transmissive area and apparently not as well connected to the MW-5-40 area as MW-46-43C. Overall, the sequential reductive degradation pathway was stimulated by the amendment application through pathway completion (i.e., significant ethene generation) in the MW-5-40 and MW-46-43C areas. However, influx of CVOC mass from upgradient areas or via back diffusion is offsetting otherwise successful CVOC treatment. Treatment in the MW-13C area was less pronounced. The MW-13 area is likely outside the area of significant influence of the MW-5-40 injection.

CSIA was used as a component of performance monitoring to distinguish between destructive bond breaking attenuation and non-destructive process that can also lead to decreasing CVOC concentrations such as dilution and dispersion. Performance monitoring of the MW-5-40 injections included measuring the isotopic signature of carbon that comprises the CVOCs of concern to identify subtle changes that occur during bond-breaking reactions. Carbon occurs in nature in two stable isotopic forms, carbon-12 (^{12}C) and carbon-13 (^{13}C), with ^{13}C comprising approximately one percent of the total carbon (the radioisotope carbon 14 [^{14}C] also occurs naturally but is not included in CSIA assessments). For CSIA, the stable carbon isotopes are measured discretely and reported as a part per thousand fraction (parts per mil, symbolized as ‰) or ratio of ^{13}C to ^{12}C relative to an international standard ratio, known as the Vienna Peedee Belemnite (see Equation 1). The difference or delta (represented as $\delta^{13}C$) between the calculated isotopic ratio and the standard is typically a negative number for chlorinated solvents. For example, the $\delta^{13}C$ range for non-degraded manufactured PCE and TCE is generally -30 ± 5‰.

Equation 1: $$\delta^{13}C\ (‰) = [(^{13}C/^{12}C_{sample}) - (^{13}C/^{12}C_{std}) \,/\, (^{13}C/^{12}C_{std})] * 1{,}000$$

where $^{13}C/^{12}C_{sample}$ and $^{13}C/^{12}C_{std}$ are the isotope ratios for the sample and the standard, respectively.

The most significant environmental factor which affects stable isotope ratios is bond breaking from contaminant degradation. Physical processes of attenuation such as dilution and diffusion do not impart significant isotopic effects. The basis of the bond breaking effect on isotopic ratios is that chemical bonds between ^{12}C-containing chemicals are slightly weaker and more reactive than bonds that include ^{13}C, resulting in a differential reaction rate. The slower reaction rate for ^{13}C bonds (including ^{12}C to ^{13}C bonds) leads to an accumulation of the ^{13}C isotope in the residual compound. This process, known as fractionation, results in a preferential enrichment of 13C in the residual pool of parent compounds relative to the initial isotopic ratio of 13C to 12C. Conversely, and in accordance with conservation of mass, the degradation products or daughter products are depleted with respect to the 13C composition. Only enrichment of daughter product carbon to an extent greater than that of the parent compound provides definitive evidence of degradation of that daughter product. Data demonstrating fractionation with time/treatment or along the path of groundwater flow provides evidence of degradation.

CSIA samples were collected from MW-5-40 (Table 2). The baseline (pre injection sample) isotopic signature of carbon comprising TCE was -32.5‰, which is consistent with the isotopic signature of non/minimally degraded TCE. Immediately after amendment application (June 2021 data), the isotopic signature increased/enriched to -26.1‰ providing definitive evidence of destructive degradation of TCE. Subsequent rounds of concentration data show in influx of TCE which is confirmed by isotopic depletion to TCE back to the baseline (non/minimally degraded) signature (32.6‰). The isotopic signatures of the CVOC daughter products showed enrichment/depletion trends typical of sequential reduction occurring in an environment with continued mass influx. The isotopic signature of cis-DCE measured in the sample collected in December 2021 is notable (-15.7%) as the isotopic signature is significantly fractionated (greater than the baseline signature of the parent TCE which definitively demonstrates cis-DCE degradation). The cis-DCE fractionation/degradation occurred simultaneous to the concentration of cis-DCE more than doubling from the baseline (4,640 µg/L) to the last round of performance monitoring (10,800 µg/L). Vinyl chloride (164 µg/L to 6,750 µg/L) and ethene (6.9 µg/L to 430 µg/L) concentration increases over this period support the cis-DCE CISIA data that definitively shows cis-DCE degradation.

ATTENUATION PATHWAY CONDITIONS

Microbes that respire TCE and its CVOC daughter products require a unique niche to efficiently degrade these contaminants along the sequential reduction pathway. The remedial amendments applied through MW-5-40 were designed to enhance existing conditions to provide ideal conditions for the attenuating microbes. The amendments included sodium lactate (a fermentable electron donor/microbial food source), nutrients (nitrogen and phosphorus), pH buffer (sodium bicarbonate), and a microbial augment containing the key halo-respiring microbe *Dehalococcoides* (DHC). Based on the ethene data that shows significant TCE mass removal, which is confirmed by the CSIA data, ideal conditions were established. An evaluation of condition changes during the performance monitoring period may inform on the in situ longevity of the amendments and potential enhancements for future treatments. Key microbial parameter data are presented in Table 3. All microbial data is presented in the laboratory report provided in Appendix A.

Microbes in the genera DHC and *Dehalogenimonas* (DHG) are uniquely capable of degrading chlorinated ethenes to the innocuous end product ethene. Other microbes are capable of partial degradation that yield CVOC daughter products. Samples to assess the abundance of DHC and DHC and the general microbial community were collected using Bio-Trap® samplers and filtered groundwater samples. Table 3 provides select microbial data un units of cells/bead (BioTrap® samplers) and cells/milliliter (filtered groundwater). Bio-Trap® samplers, a sterile matrix/soil analog for native microbes to colonize, were deployed in MW-5-40 and allowed to incubate for 30 to 45 days, as specified by Microbial Insights, Inc., before being retrieved and analyzed for microbial community structure using PLFA evaluation procedures and for key microorganisms and key functional genes of interest using qPCR procedures (CENSUS). These procedures were also performed on groundwater samples collected from MW-5-40 using bio-flo filters.

PLFA and CENSUS data collected from baseline through all performance monitoring periods show a healthy and diverse microbial population including high abundance of the key halo-respiring microbe DHC. Key enzymes (bvcA reductase and vcrA reductase) needed to fully degrade CVOCs to the end product ethene. These data don't show that the microbial augment added as a component of the amendment mix had a clear effect on the microbial population distribution. However, subtle changes that facilitate increased activity (e.g., interspecies hydrogen transfer) may not be captured by the microbial data.

DHC and many other halo-respiring microbes are obligate anaerobes – they cannot survive in the presence of dissolved oxygen. Dissolved oxygen data and oxidation reduction potential (ORP) data are provided in Table 4. Together these parameters show conditions consistent with low oxygen concentration conditions. Transient elevated dissolved oxygen concentrations were measured in a few post-injection samples, but ORP was less than -180 mV when this occurred. These elevated dissolved oxygen measurements may be an effect of water cascading within the well during purging. ORP was highly reducing in samples collected from MW-46-43C throughout the performance monitoring program. ORP in samples collected from MW-5-40 were also highly reducing in all but March 2022 sample where ORP (-35 mV) and dissolved oxygen (3.25 mg/l) were elevated outside the ideal range for DHC.

Groundwater pH is also a sensitive parameter for DHC which function optimally within a range of 6.5 to 8.0. The pH of groundwater in all samples were within this ideal range indicating that the buffer component of the amendment formulation neutralized acids generated by microbial metabolism.

Lactate was added to provide a fermentable electron donor to stimulate microbial metabolism (Table 2). Total organic carbon and volatile fatty acid analysis were performed to assess the rate of its depletion in the subsurface. These data show a significant increase in concentrations of these indicator parameters following amendment application. Concentrations decreased with each round of sampling but remained above baseline concentrations and within a range that supports bioremediation.

CONCLUSIONS AND RECOMMENDATIONS

Bioremediation pilot study injections to stimulate sequential reduction of CVOCs were performed through MW-5-40. Performance monitoring was performed after amendment application by collecting samples from MW-5-40, MW-46-43C, and MW-13C over a 6-month period. Injection monitoring at multiple area wells during injection and performance monitoring after injections demonstrated efficient amendment delivery between the MW-5-40 and MW-46-43 areas but poor delivery in the less transmissive MW-13C area. Analytical data definitively demonstrated CVOC mass removal. Based on ethene data, the equivalent of up to 13,600 µg/L of TCE was completely destroyed. The data also showed that CVOC mass flux entered the pilot test area during the performance monitoring period. The rate of mass flux was likely aided by nearby groundwater extraction.

Based on the success of the pilot test program we recommend using the information gathered during the MW-5-40 pilot test to potentially design a supplemental *in situ* remediation:

- Evaluate a targeted *in situ* remediation in the area surrounding the former fire water reservoir using the existing B-zone and C-zone monitoring/extraction wells.
- Develop a conceptual treatment plan that would include a gravity feed application of amendments similar to but longer lasting than those used for the MW-5-40 pilot test.

Sincerely,

Scott Haitz
Vice President, National Practice Lead

Jeffrey Baker
Lead Consultant

JRB:MB:GER:DAR:SPH
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Encl.

cc: Stephen Clarke, Emerson (electronic copy)
Anthony Perretta, NYSDOH (electronic copy)

FIGURES

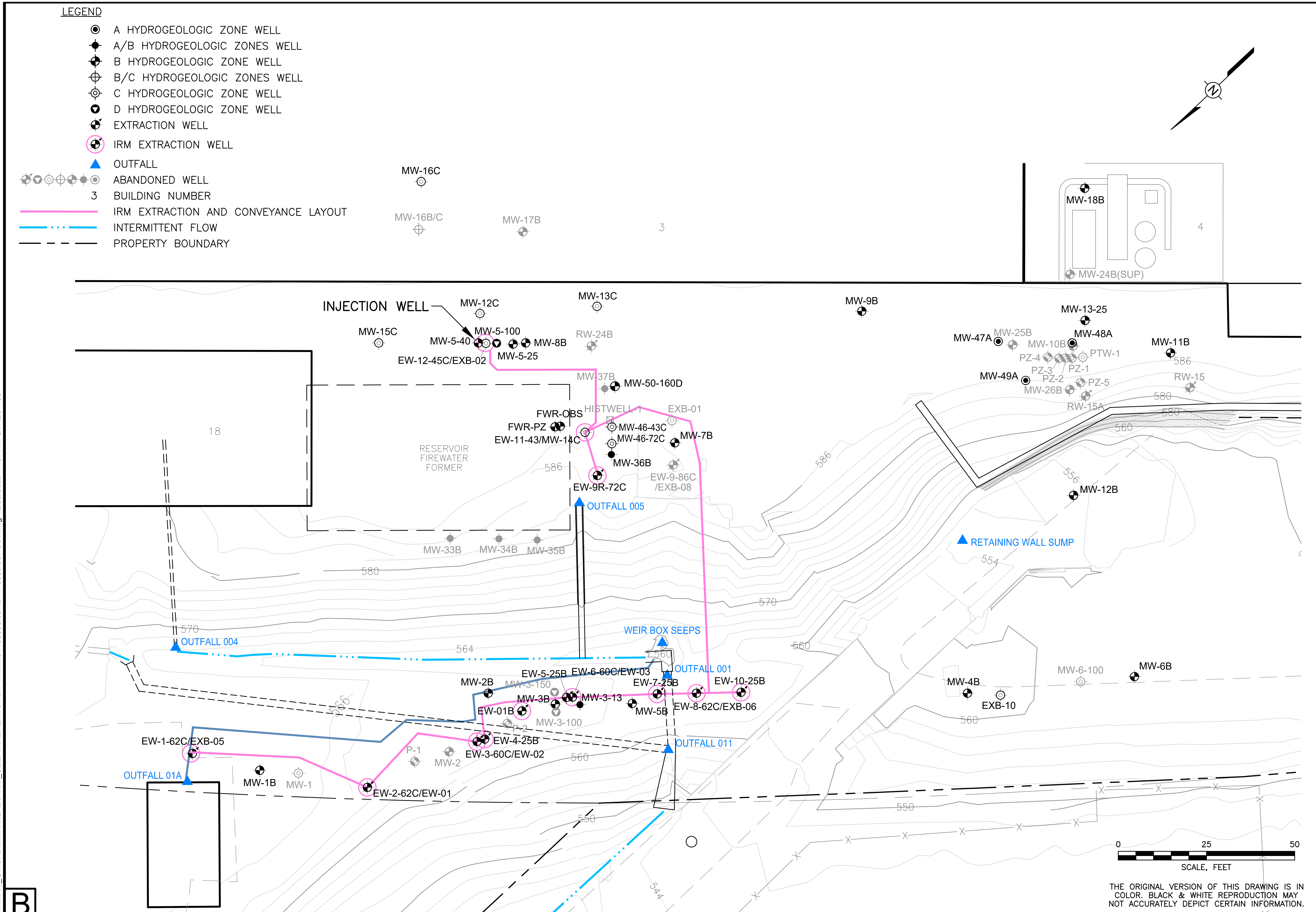

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FIGURE 1

WELL AND PIEZOMETER LOCATIONS

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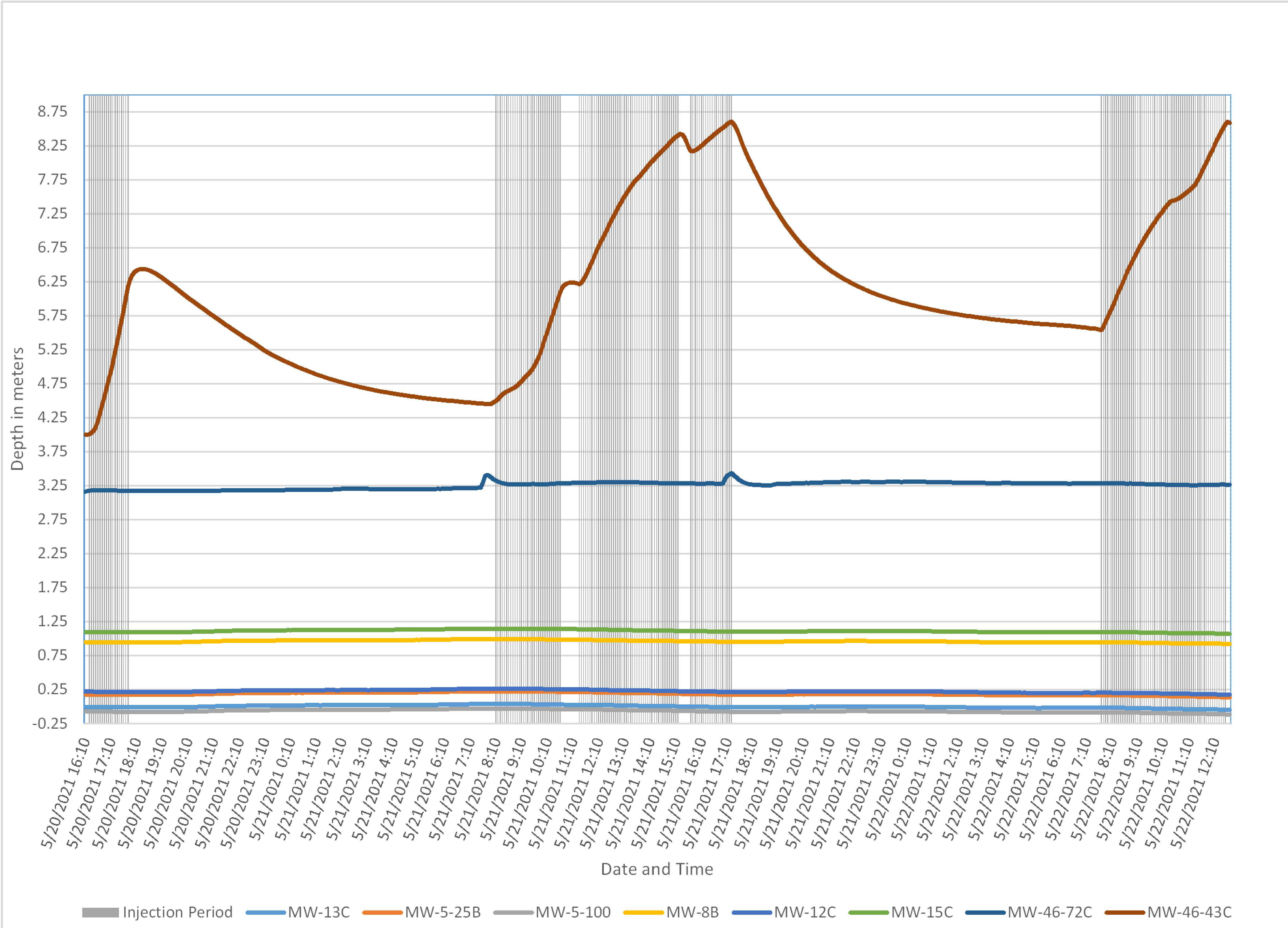

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FIGURE 2A

GROUNDWATER ELEVATIONS
DURING INJECTIONS

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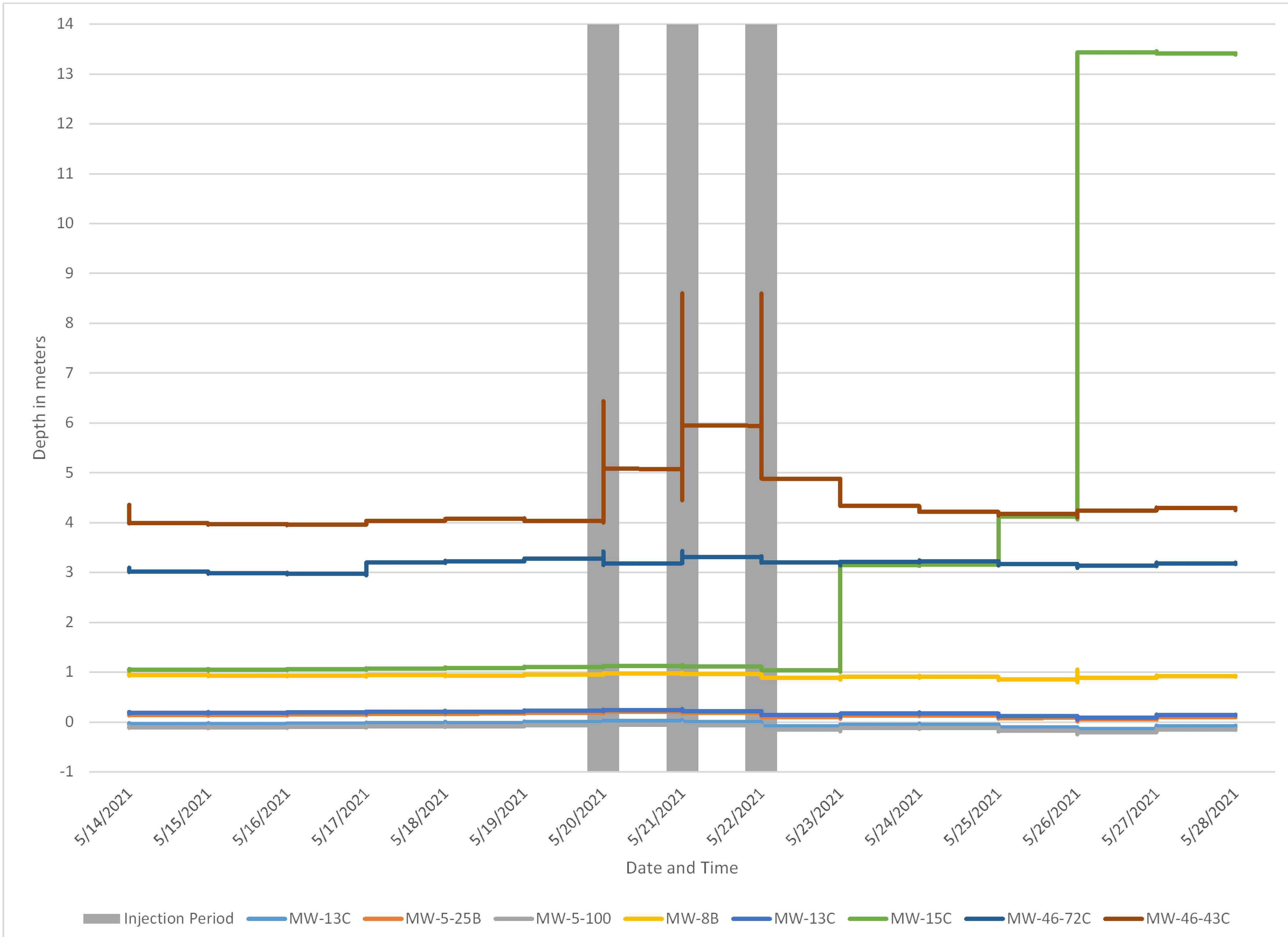

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FIGURE 2B

GROUNDWATER ELEVATIONS

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TEL: +1 412.604.1040

B

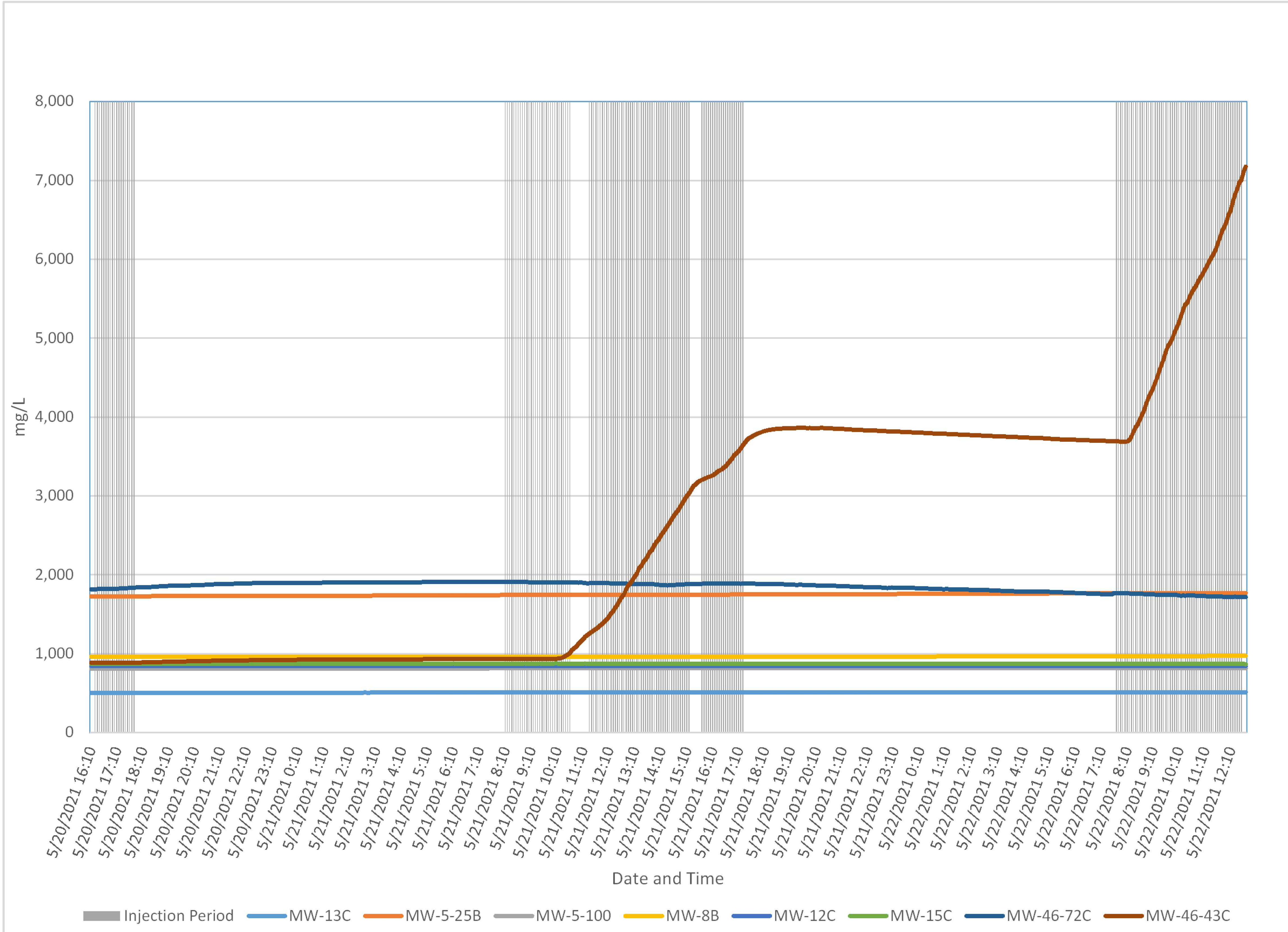

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FIGURE 3A

TOTAL DISSOLVED SOLIDS
DURING INJECTIONS

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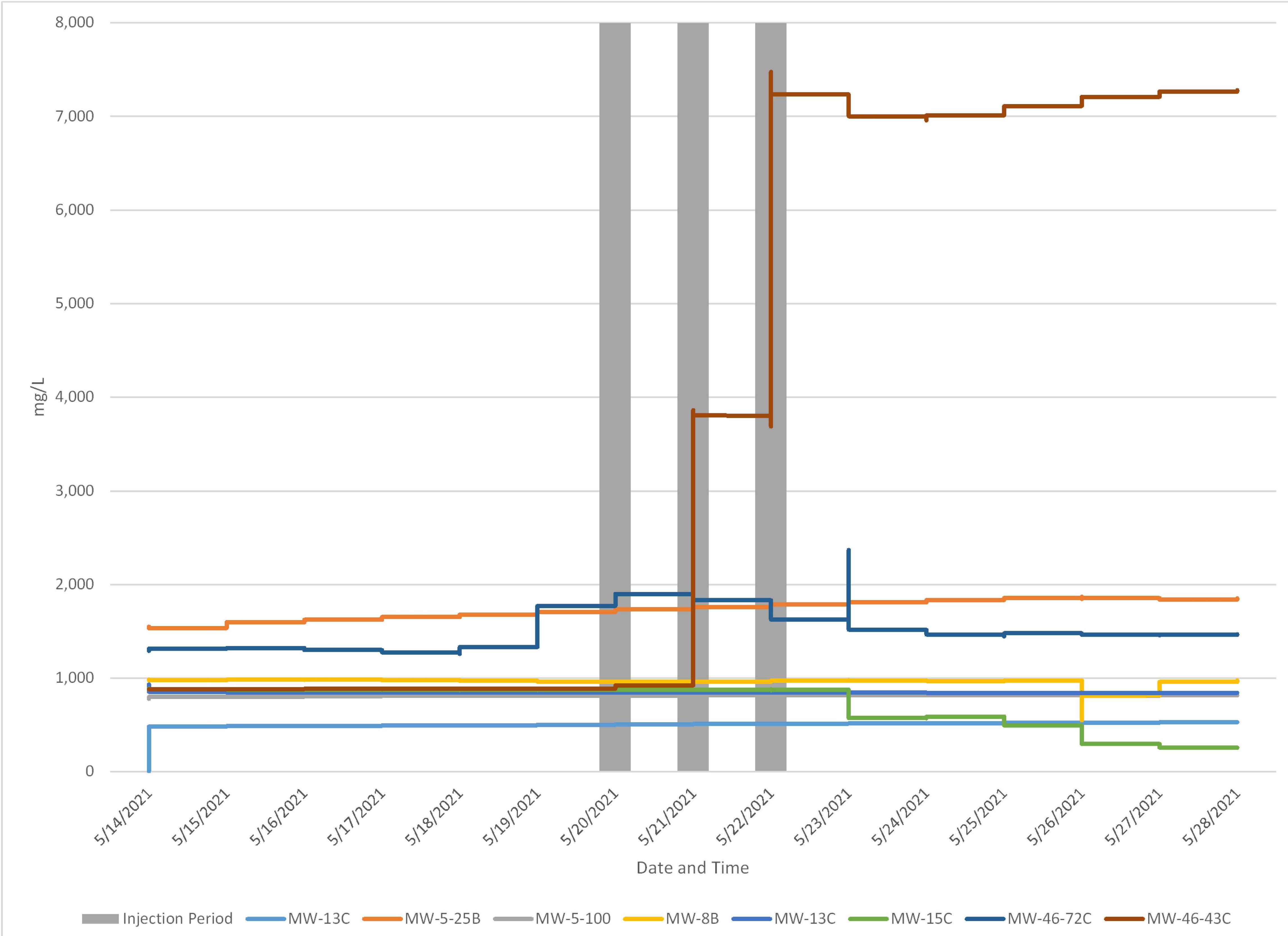

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FIGURE 3B

TOTAL DISSOLVED SOLIDS

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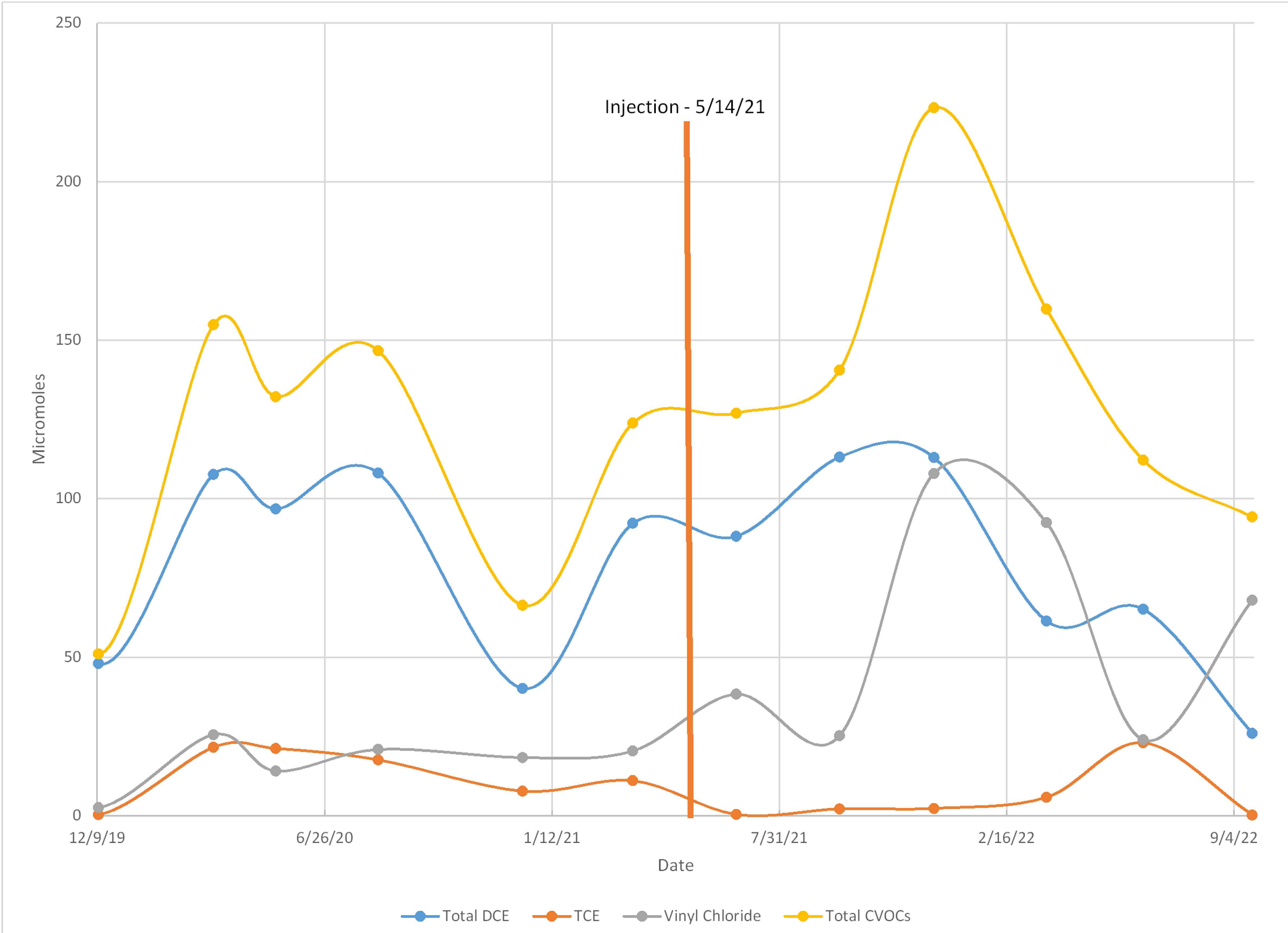

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FIGURE 4

MICROMOLES AT MW–5–40

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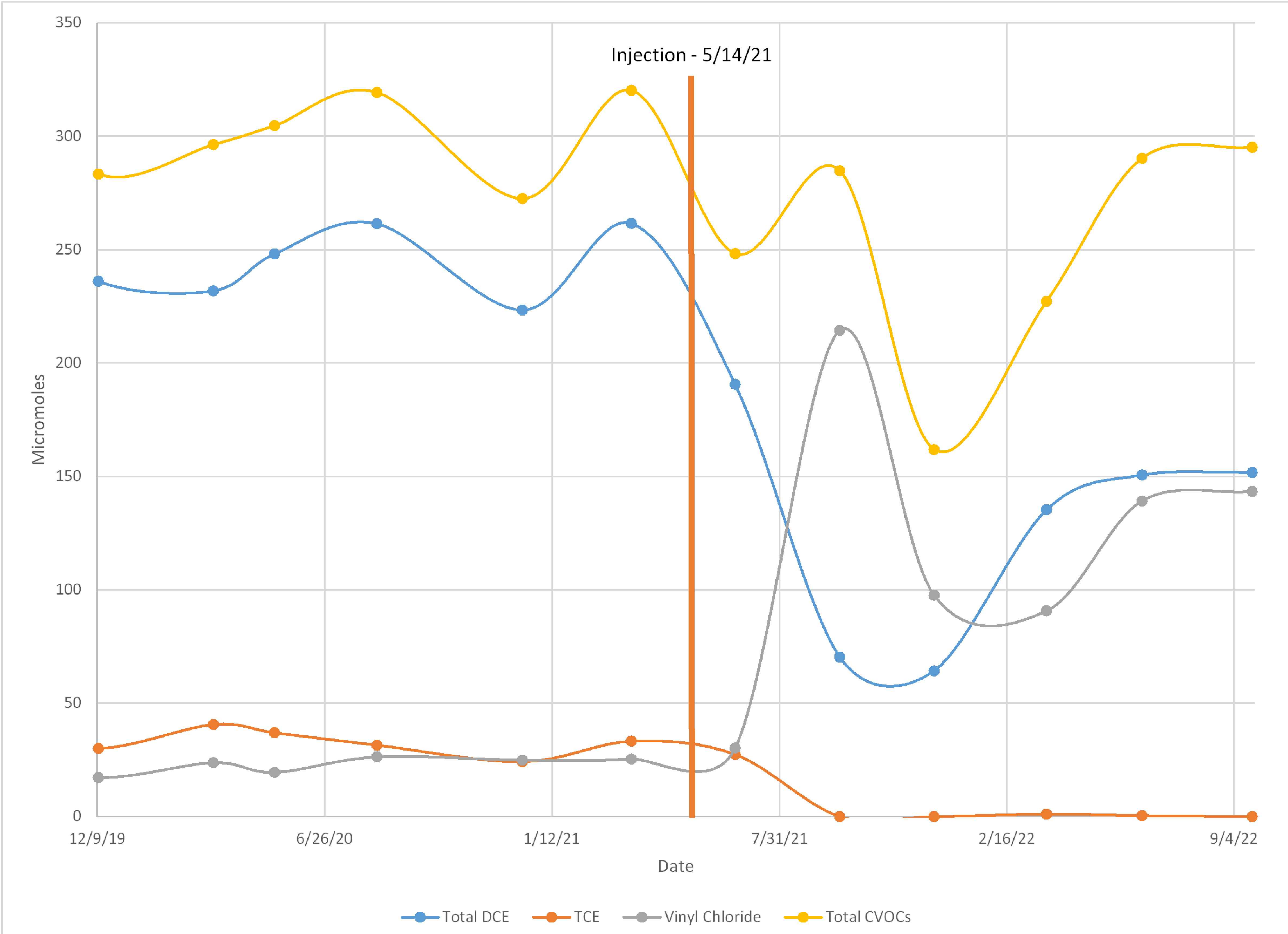

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FIGURE 5

MICROMOLES AT MW–46–43C

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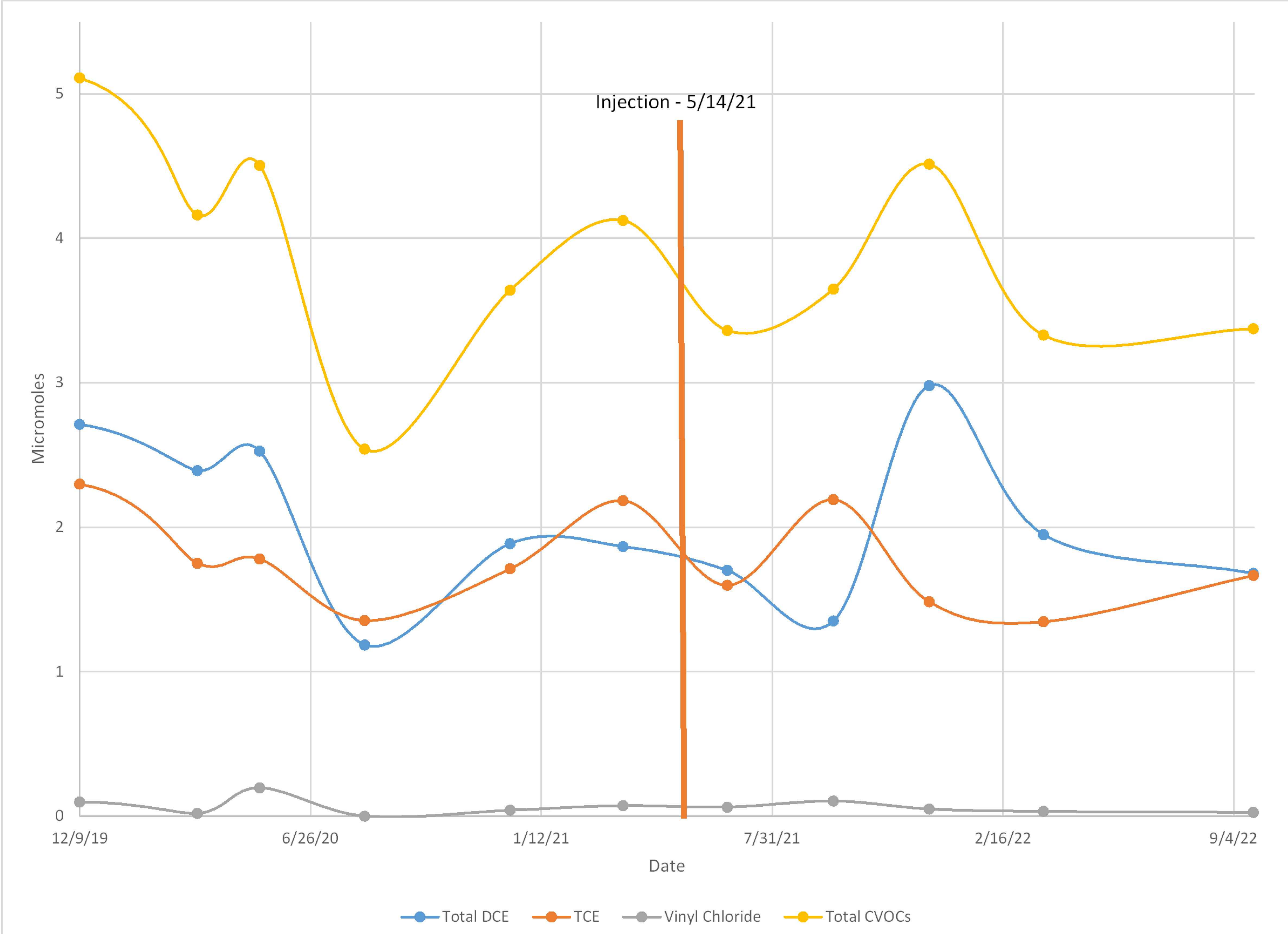

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FIGURE 6

MICROMOLES AT MW-13C

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B

TABLES

Table 1

Historical Groundwater VOC Results
Former Emerson Power Transmission
Ithaca, New York (a, b)

Well ID	Sample Date	1,1-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride	Total CVOCs (d)
Evaluation Criteria (c)		**5**	**5**	**5**	**5**	**5**	**5**	**5**	**2**	**-**
MW-5-40	4/1/09	1 U	***22.0***	***12,000*** D	***92.0*** DJ	2.0	1 U	***11,000*** D	***510*** D	23,626
	9/22/09	200 U	200 U	***16,000***	*200* U	200 U	200 U	***28,000*** D	***270***	44,270
	4/7/10	1 U	***23.2***	***13,400*** D	***177***	3.6	1 U	***6,540*** D	***390***	20,534
	10/4/10	1 U	***28.7***	***11,400***	***128***	***5.3***	1 U	***5,550***	***314***	17,426
	3/25/11	1 U	***5.7***	***18,000***	***111***	2.7	1 U	***6,390***	***774***	25,283
	10/4/11	1 U	***7.7*** J	***6,720*** J	***48.1*** J	3.8	1 U	***6,760*** J	***384*** J	13,924
	3/28/12	1 U	***11.2***	***10,200***	***89.1***	4.0	1 U	***6,600***	***314***	17,218
	10/4/12	200 U	200 U	***9,780***	200 U	200 U	200 U	***6,840***	***460***	17,080
	4/3/13	1 U	***21.6***	***8,470***	***149***	2.5	1 U	***4,050***	***452***	13,145
	10/18/13	20 U	***25.8***	***13,100***	***96.4***	20.0 U	20 U	***9,580***	***711***	23,513
	3/27/14	50 U	50 U	***10,900***	***101***	50 U	50 U	***6,080***	***657***	17,738
	8/20/14	20 U	20 U	***7,740***	***112***	20 U	20 U	***4,920***	***563*** J	13,335
	3/11/15	0.58 J	***20.2***	***6,820***	***151***	3.0	1 U	***2,320***	***565***	9,880
	8/24/15	0.63 J	***19.1***	***8,180***	***224***	4.8	1 U	***5,370***	***969***	14,768
	4/12/16	20 U	***17.7*** J	***12,700***	***237***	20 U	20 U	***1,550***	***1,140***	15,645
	9/27/16	50 U	50 U	***12,000*** J	***143***	50 U	50 U	***4,490***	***683***	17,316
	3/28/17	25 U	***22.5*** J	***12,300***	***192***	25 U	25 U	***4,430***	***505***	17,450
	6/14/17	25 U	***30.0***	***15,100***	***264***	25 U	25 U	***3,720***	***878***	19,992
	9/26/17	100 U	***47.3*** J	***19,000***	***284***	100 U	100 U	***4,600***	***939***	24,870
	12/19/17	10 U	***36.9***	***16,500***	***232***	10 U	10 U	***3,230***	***975***	20,974
	3/20/18	50 U	***29.6*** J	***15,400***	***270***	50 U	50 U	***2,500***	***1,190***	19,390
	5/9/18	50 U	***33.9*** J	***18,100***	***294***	50 U	50 U	***2,000***	***1,000***	21,428
	8/29/18	50 U	50 U	***16,500***	***256***	50 U	50 U	***3,780***	***733***	21,269
	12/12/18	50 U	50 U	***13,600***	***176***	50 U	50 U	***2,630***	***909***	17,315
	3/6/19	25 U	***22.5*** J	***9,840***	***226***	25 U	25 U	***3,910***	***852***	14,851
	6/19/19	0.75 J	***27.1***	***11,400***	***247***	1.8	1 U	***3,040***	***979***	15,696
	9/19/19	5 U	***24.0***	***12,200***	***325***	5 U	5 U	***1,310***	***1,010***	14,869
	12/10/19	25 U	25 U	***4,640***	***18.6*** J	25 U	25 U	***49.8***	***164***	4,872
	3/20/20	20 U	***20.6***	***10,100***	***318***	20 U	20 U	***2,840***	***1,600***	14,879
	5/14/20	20 U	***20.6***	***9,130***	***233***	20 U	20 U	***2,790*** J	***884***	13,058
	8/12/20	25 U	***16.7*** J	***10,200***	***263***	25 U	25 U	***2,320***	***1,310***	14,110
	12/17/20	10 U	***6.9*** J	***3,760***	***133***	10 U	10 U	***1,020***	***1,150***	6,070
	3/24/21	10 U	***16.9***	***8,600***	***327***	10 U	10 U	***1,460***	***1,280***	11,684
	6/23/21	20 U	***21.1***	***8,370***	***158***	20 U	20 U	***54.6***	***2,400***	11,004
	9/22/21	100 U	100 U	***10,900***	***68.4***	100 U	100 U	***287***	***1,580***	12,835
	12/14/21	50 U	50 U	***10,800***	***155***	50 U	50 U	***307***	***6,750***	18,012
	3/23/22	10 U	6.6	***5,830***	***123***	10 U	10 U	***766***	***5,780***	12,506
	6/16/22	50 U	50 U	***6,260***	***58.6***	50 U	50 U	***3,030***	***1,500***	10,849
	9/20/22	10 U	10 U	***2,420***	***101***	10 U	10 U	***33***	***4,250***	6,804

Table 1

Historical Groundwater VOC Results
Former Emerson Power Transmission
Ithaca, New York (a, b)

Well ID	Sample Date	1,1-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride	Total CVOCs (d)
Evaluation Criteria (c)		**5**	**5**	**5**	**5**	**5**	**5**	**5**	**2**	**-**
MW-46-43C	8/17/17	50 U	50 U	***19,800***	***106***	50 U	50 U	***8,710***	***562***	29,178
	9/26/17	50 U	***30.3*** J	***17,900***	***112***	50 U	50 U	***7,900***	***589***	26,531
	12/19/17	25 U	***34.5***	***21,500***	***107***	25 U	25 U	***3,830***	***889***	26,361
	3/20/18	100 U	100 U	***16,200***	***96.5*** J	100 U	100 U	***8,470***	***987***	25,754
	5/8/18	50 U	***36.1*** J	***18,600***	***135***	50 U	50 U	***8,220***	***944***	27,935
	8/28/18	50 U	***41.1*** J	***29,700***	***173***	50 U	50 U	***9,900***	***1,260***	41,074
	12/12/18	100 U	100 U	***22,200***	***117***	100 U	100 U	***4,750***	***1,260***	28,327
	3/5/19	200 U	200 U	***24,200***	***155*** J	200 U	200 U	***6,720***	***1,250***	32,325
	6/19/19	25 U	***34.3***	***19,100***	***115***	25 U	25 U	***6,650***	***1,110***	27,009
	9/17/19	25 U	***52.8***	***25,700***	***148***	25 U	25 U	***5,140***	***1,740***	32,781
	12/10/19	50 U	***36.1*** J	***22,700***	***145***	50 U	50 U	***3,950***	***1,080***	27,911
	3/20/20	50 U	***38.1*** J	***22,300***	***136***	50 U	50 U	***5,340***	***1,490***	29,304
	5/13/20	100 UJ	100 UJ	***23,900***	***158*** J	100 UJ	100 UJ	***4,860*** J	***1,220*** J	30,438
	8/11/20	100 U	100 U	***25,200***	***143***	100 U	100 U	***4,140***	***1,650***	31,133
	12/17/20	50 U	***32.4*** J	***21,500***	***119***	50 U	50 U	***3,180***	***1,560***	26,391
	3/23/21	50 U	***37.7*** J	***25,200***	***115***	50 U	50 U	***4,370***	***1,590***	31,313
	6/22/21	25 UJ	***39.0*** J	***18,300*** J	***137*** J	25 UJ	25 UJ	***3,600*** J	***1,890*** J	23,991
	9/22/21	100 U	100 U	***6,740***	***85.1*** J	100 U	100 U	100 U	***13,400***	20,225
	12/14/21	20 U	20 U	***6,160***	***72.3***	20 U	20 U	20 U	***6,100***	12,332
	3/23/22	25 U	23 J	***13,000***	***99.5***	25 U	25 U	***144***	***5,670***	18,936
	6/15/22	100 U	100 U	***14,500***	***104***	100 U	100 U	***57.2***	***8,700***	23,361
	9/20/22	100 U	100 U	***14,600***	***112***	100 U	100 U	100 U	***8,960***	23,672

Table 1

Historical Groundwater VOC Results
Former Emerson Power Transmission
Ithaca, New York (a, b)

Well ID	Sample Date	1,1-DCA	1,1-DCE	cis-1,2-DCE	trans-1,2-DCE	PCE	1,1,1-TCA	TCE	Vinyl Chloride	Total CVOCs (d)
Evaluation Criteria (c)		**5**	**5**	**5**	**5**	**5**	**5**	**5**	**2**	**-**
MW-13C	6/13/17	1 U	1.7	***740***	2.3	1 U	1 U	***365***	***10.2***	1,119
	9/26/17	1 U	1 U	***590***	*2*	1 U	1 U	***333***	***11***	936
	12/20/17	1 U	1 J	***460***	1 J	1 U	1 U	***333***	***5.3***	800
	3/20/18	1 U	1 U	***360***	1 U	1 U	1 U	***307***	***4.7***	672
	5/10/18	2 U	2 U	***312***	2 U	2 U	2 U	***236***	***8***	556
	8/29/18	1 U	1 U	***296***	1 U	1 U	1 U	***323***	***2.5***	622
	12/9/19	1 U	1 U	***263***	1 U	1 U	1 U	***302***	***6.2***	571
	3/20/20	1 U	1 U	***232*** J	1 U	1 U	1 U	***230*** J	***1.2*** J	463
	5/13/20	1 U	1 UJ	***245***	1 U	1 U	1 U	***234***	***12.3***	492
	8/12/20	1 U	1 U	***115***	1 U	1 U	1 U	***178***	1 U	293
	12/16/20	1 U	1 U	***183***	1 U	1 U	1 U	***225***	***2.6***	411
	3/24/21	1 U	1 U	***181***	1 U	1 U	1 U	***287***	***4.6***	473
	6/22/21	1 U	1 U	***165***	1 U	1 U	1 U	***210***	***3.9***	379
	9/22/21	2 UJ	2 UJ	***131*** J	2 UJ	2 UJ	2 UJ	***288*** J	***6.6*** J	436
	12/14/21	1 U	1 U	***289*** J	1 U	1 U	1 U	***195***	***3.1***	487
	3/23/22	1 U	1 U	***189***	1 U	1 U	1 U	***177***	***2.1***	368
	9/21/22	1 U	1 U	***163***	1 U	1 U	1 U	***219***	1.7	384

a/ Select constituents are presented above. For duplicate samples, the highest concentration of the duplicate and original sample is listed.

b/ All results are reported in micrograms per liter (µg/l). DCA = dichloroethane; DCE = dichloroethene; PCE = tetrachloroethene; TCA = trichloroethane; TCE = trichloroethene; VOCs = volatile organics compounds; ID = identification; U = analyte not detected above Reporting Limit; J = estimated concentration below the Reporting Limit and greater than or equal to the Method Detection Limit; D = concentration is from a secondary dilution analysis; UJ = non-detects with estimated quantitation limits due to failed quality control sample calibration(s) for that analyte; UR = The quality control associated with the analyte indicates uncertainty with the reported limits (spike/surrogate failed the recovery limits). **Bolded italic concentrations exceed the evaluation criteria.**

c/ Evaluation criteria are the New York State Ambient Water Quality Standards or Guidance Values for Class GA groundwater provided in the New York State Department of Environmental Conservation Division of Water Technical and Operational Guidance Series (1.1.1), dated June 1998, and the April 2000 Addendum.

d/ Total CVOCs only include the 8 site related CVOCS that include 1,1-DCA, 1,1-DCE, cis-1,2-DCE, trans-1,2-DCE, PCE, 1,1,1-TCA, TCE, and vinyl chloride.

Table 2

***In Situ* CSIA and General Chemistry Data**
Former Emerson Power Transmission
Ithaca, New York (a)

Sample ID:	MW-5-40	MW-5-40	MW-5-40	MW-5-40	MW-46-43C	MW-46-43C
Event:	Baseline	1st Period	2nd Period	3nd Period	2nd Period	3rd Period
Sample Date:	12/10/2019	6/22/2021	9/22/2021	12/14/2021	9/22/2021	12/14/2021
Dissolved Gases (µg/l)						
Carbon Dioxide	5,300	-	13,500	30,000	68,100	61,800
Methane	75	11,800	2,100	870	49	4,000
Ethane	0.54	18.7	12	12	22	20
Ethene	6.9	943	42	430	1,600	2,900
Volatile Fatty Acids (mg/l)						
Acetic Acid	4.6	-	5	16	86	44
Butyric Acid	1 U	-	0.58 U	0.58 U	2 J	0.58 U
Formic Acid	5 U	-	45	35	49	38
Hexanoic Acid	2 U	-	0.58 U	0.58 U	0.58 U	0.79 J
i-Hexanoic Acid	2 U	-	0.56 U	0.56 U	0.56 U	0.56 U
Lactic Acid	2 U	-	0.53 U	0.53 U	0.53 U	0.53 U
Pentanoic Acid	1 U	-	0.56 U	0.56 U	0.68 J	0.56 U
i-Pentanoic Acid	1 U	-	0.61 U	0.61 U	0.61 U	0.61 U
Propionic Acid	1 U	-	0.75 J	9.5	46	20
Pyruvic Acid	1 U	-	0.60 U	0.60 U	0.60 U	0.60 U
Compound Specific Isotope Analysis, δ(‰)						
cis-1,2-Dichloroethene	-26.44	-30.7	-30.00	-15.70	-	-
trans-1,2-Dichloroethene	-40.73	-41.3 J	N/A	N/A	-	-
Trichloroethene	-32.47	-26.6 J	-29.50	-32.60	-	-
Vinyl chloride	-46.64	-39.9	-51.20	-37.00	-	-
Alkalinity (mg/l)						
Total ($CaCO_3$ pH 4.5)	336	-	170	371	452	432
TOC (mg/l)						
Total Organic Carbon	11	322	10	32.6	85	48.6

a/ µg/l = micrograms per liter; mg/l = miligrams per liter; δ(‰) = stable carbon isotope ratio of corresponding dissolved chlorinated solvent; U = not detected; ND = ratio not determined; J= Estimated concentration below PQL but above LQL
N/A = not analyzed due to concentration below detection limit

Table 3

***In Situ* Microbe Study**
Former Emerson Power Transmission
Ithaca, New York (a)

Sample ID:	**MW-5-40**	**MW-5-40**	**MW-5-40**	**MW-5-40**
Event:	**Baseline**	**1st Round**	**2nd Round Post**	**3rd Round**
Sample Date:	**12/10/2019**	**6/22/2021**	**8/25/21 - 9/22/21**	**2/10/2022**
PLFA	cells/bead		cells/ml	cells/bead
Total Biomass	4.74E+05	-	6.95E+06	1.72E+06
Firmicutes/TerBrSats (% total PLFA)	3.76%	-	9.50%	5.91%
Proteobacteria/Monos (% total PLFA)	69.28%	-	49.99%	67.34%
Anaerobic metal reducers/BrMonos (% total PLFA)	1.04%	-	16.69%	3.37%
SRB/Actinomycetes/MidBrSats (% total PLFA)	0.53%	-	1.32%	0.89%
General/Nsats (% total PLFA)	21.71%	-	22.31%	22.03%
Eukaryotes/polyenoics (% total PLFA)	3.67%	-	0.19%	0.47%
Slowed Growth (ratio cy/cis)	0.10	-	0.29	1.57
Decreased Permeability (ratio trans/cis)	0.21	-	0.14	0.07
CENSUS	cells/bead	cells/ml	cells/bead	cells/bead
Dehalococcoides (DHC)	1.28E+05	5.44E+06	3.04E+04	9.10E+05
tceA Reductase (TCE)	2.38E+03	3.79E+05	1.81E+02	1.54E+05
bvcA Reductase (BVC)	2.23E+04	3.24E+05	3.15E+03	1.43E+04
vcrA Reductase (VCR)	2.22E+03	2.05E+05	3.20E+02	7.77E+04
Dehalobacter (DHBt)	3.36E+04	1.02E+06	4.15E+04	4.70E+05
Desulfuromonas (DSM)	1.69E+05	1.61E+05	4.97E+04	1.56E+06
Soluble Methane Monooxygenase (SMMO)	2.50E+02 U	1.67E+01 U	2.50E+02 U	2.50E+02 U
Sulfate Reducing Bacteria (APS)	3.61E+05	5.07E+06	1.55E+05	8.32E+05
cerA Reductase *(* CER)	2.50E+02 U	6.00E-01 J	2.50E+02 U	2.50E+02 U
Chloroform Reductase (CFR)	2.50E+02 U	1.67E+01 U	2.50E+02 U	2.50E+02 U
1,1 DCA Reductase (DCA)	2.50E+02 U	1.67E+01 U	2.50E+02 U	2.50E+02 U
1,2 DCA Reductase (DCAR)	2.50E+02 U	1.67E+01 U	2.50E+02 U	2.50E+02 U
Dehalobacter DCM (DCM)	2.50E+02 U	1.67E+01 U	1.38E+03	2.50E+02 U
Dichloromethane Dehalogenase (DCMA)	2.50E+02 U	1.67E+01 U	2.50E+02 U	2.50E+02 U
Dehalobium chlorocoercia (DECO)	2.50E+02 U	2.37E+04	5.75E+02	5.14E+04
Dehalogenimonas spp. (DHG)	2.50E+02 U	1.15E+05	2.50E+02 U	2.50E+02 U
Desulfitobacterium spp. (DSB)	4.42E+04	5.68E+05	4.90E+04	3.88E+05
Total Eubacteria (EBAC)	4.99E+07	1.94E+08	2.03E+07	3.05E+07
Ethene Monooxygenase (EtnC)	3.21E+03	1.28E+03	9.42E+02	2.50E+02 U
Epoxyalkane Transferase (EtnE)	2.50E+02 U	4.81E+03	4.36E+03	2.50E+02 U
Methanogens (MGN)	7.05 E+01 J	1.42E+04	4.83E+02	1.25E+05
PCE Reductase (PCE-1)	1.23E+04	5.14E+04	1.95E+03	2.50E+02 U
PCE Reductase (PCE-2)	8.27E+04	1.07E+05	2.85E+04	1.03E+03
Phenol Hydroxylase (PHE)	3.56E+04	1.19E+05	1.18E+05	2.50E+02 U
Toluene Monooxygenase 2 (RDEG)	2.50E+02 U	9.88E+04	5.03E+02	2.50E+02 U
Toluene Monooxygenase (RMO)	2.50E+02 U	2.12E+04	2.25E+04	2.50E+02 U
Trichlorobenzene Dioxygenase (TCBO)	2.50E+02 U	1.12E+03	2.50E+02 U	2.50E+02 U
trans-1,2-DCE Reductase (TDR)	2.50E+02 U	1.67E+01 U	2.50E+02 U	2.50E+02 U
Toluene Dioxygenase (TOD)	6.11E+03	1.67E+01 U	9.57E+03	2.50E+02 U

a/ J = estimated gene copies below Practical Quantitation Limit (PQL) but above Lower Quantitation Limit (LQL);
U = not detected

Table 4

Historical Groundwater Field Parameters
Former Emerson Power Transmission
Ithaca, New York (a)

Well ID	Date	Total Purge Volume (gallons)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation Reduction Potential (mV)	Specific Conductance (mS/cm)	Turbidity (NTU)	pH (SU)	Depth to Water (ft-btoc)	Total Well Depth (ft-btoc)	Depth of Water (ft)
MW-5-40	4/1/09	3.5	4.69	16.35	-16	6.88	685	7.59	28.50	38.40	9.90
	9/22/09	2.0	2.45	18.09	-44	3.74	217	7.09	32.28	38.50	6.22
	4/7/10	4.0	2.27	15.13	-198	7.56	121	9.46	28.79	38.80	10.01
	10/4/10	1.0	50.00	14.60	185	1.60	4	7.70	30.00	40.00	10.00
	3/24/11	0.0	3.01	10.20	180	9.10	924	7.85	28.51	38.80	10.29
	10/3/11	0.0	4.86	16.63	314	2.18	197	6.79	28.38	38.80	10.42
	3/28/12	0.0	11.15	15.09	-58	2.54	>800	10.68	29.34	38.80	9.46
	10/4/12	3.0	23.30	17.18	5	3.45	140	6.44	33.02	43.21	10.19
	4/4/13	4.0	2.29	13.46	195	1.19	978	8.19	24.35	38.80	14.45
	10/17/13	0.0	3.47	15.10	206	2.76	10	5.97	30.85	38.50	7.65
	3/27/14	4.0	8.36	11.76	96	2.17	>1,000	7.93	28.24	38.90	10.66
	8/19/14	2.5	12.55	20.00	77	0.00	169	7.70	31.41	38.90	7.49
	3/11/15	0.0	3.13	12.96	-61	1.66	85	7.42	30.94	38.90	7.96
	8/26/15	0.0	5.70	15.43	205	0.84	602	4.28	31.99	38.90	6.91
	4/12/16	6.5	4.07	13.02	22	2.28	>1,000	7.95	28.88	38.90	10.02
	9/27/16	3.5	5.37	14.90	-24	2.43	>1,000	7.54	33.30	38.90	5.60
	3/28/17	6.0	6.07	14.23	8	2.44	253	7.19	29.87	38.90	9.03
	6/13/17	5.0	7.93	18.18	140	4.05	>1,000	6.44	30.81	38.90	8.09
	9/26/17	3.0	4.95	16.37	-10	2.25	>1,000	7.63	33.05	38.90	5.85
	12/18/17	3.0	3.97	13.16	67	1.84	286	5.83	33.00	38.90	5.90
	3/19/18	4.0	1.76	14.31	90	2.30	41	7.24	30.93	38.90	7.97
	5/8/18	3.0	0.09	15.51	46	2.49	204	7.69	31.13	38.90	7.77
	8/28/18	3.0	0.00	15.68	-38	2.27	270	7.40	32.16	38.80	6.64
	12/11/18	3.3	1.32	13.60	-21	2.12	300	6.91	32.04	38.80	6.76
	3/6/19	4.5	6.28	11.45	-50	5.10	664	8.14	31.65	38.90	7.25
	6/19/19	3.0	11.10	16.70	-87	2.13	377	7.20	30.32	38.98	8.66
	12/10/19	-	6.77	7.26	119	2.00	19	7.84	30.50	38.90	8.40
	3/20/20	6.0	2.42	14.11	-83	2.13	48	6.78	30.10	38.90	8.80
	5/14/20	4.0	0.10	12.60	111	2.35	105	6.77	29.74	38.90	9.16
	8/12/20	3.0	15.55	15.62	-78	2.03	249	7.86	31.21	38.85	7.64
	3/24/21	5.0	2.87	14.37	-105	2.13	274	7.47	29.71	39.00	9.29
	6/23/21	10.5	4.06	15.46	-326	3.41	2	6.54	30.28	39.00	8.72
	9/22/21	3.8	0.00	19.07	-273	0.80	18	7.41	30.57	39.00	8.43
	12/14/21	9.7	0.00	13.48	-158	1.59	0.00	7.51	28.03	40.30	12.27
	3/23/22	6.0	3.60	13.71	-35	2.41	>1,000	7.14	27.90	38.70	10.80

Table 4

Historical Groundwater Field Parameters
Former Emerson Power Transmission
Ithaca, New York (a)

Well ID	Date	Total Purge Volume (gallons)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation Reduction Potential (mV)	Specific Conductance (mS/cm)	Turbidity (NTU)	pH (SU)	Depth to Water (ft-btoc)	Total Well Depth (ft-btoc)	Depth of Water (ft)
MW-46-43C	6/19/19	4.0	11.40	15.35	-95	1.73	185	7.03	34.23	50.15	15.92
	9/17/19	4.0	2.16	15.51	-32	1.74	158	7.89	34.65	50.35	15.70
	3/20/20	5.0	2.08	13.78	-48	2.08	156	7.32	34.57	50.15	15.58
	5/14/20	5.0	0.00	12.84	4	1.54	161	7.71	34.45	50.10	15.65
	8/12/20	4.2	10.18	14.44	-36	1.47	170	7.80	35.73	50.16	14.43
	3/24/21	3.6	1.20	13.02	-119	1.48	109	7.26	33.73	51.80	18.07
	6/23/21	3.8	9.52	15.02	-182	5.58	114	6.95	31.64	51.80	20.00
	9/22/21	2.5	0.00	22.31	-323	2.11	6	6.93	31.61	51.80	20.19
	12/14/21	4.5	0.00	10.32	-236	2.12	2	7.29	32.09	50.00	17.91
	3/23/22	6.0	3.25	13.32	-179	2.73	304	6.60	31.37	50.12	18.75
MW-13C	8/12/20	10.0	9.82	15.52	44	0.51	644	7.72	4.11	29.65	25.54
	3/24/21	0.5	2.50	12.81	-196	0.91	518	7.40	28.39	29.74	1.35

a/ mg/l = miligrams per liter; °C = degrees celsius; mV = millivolts; mS/cm = milisiemens per centimeter; NTU = nephelometric turbidity units;
SU = standard unit; ft = feet; btoc = below top of casing; amsl = above mean sea level; - = value not recorded

ENCLOSURE A

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SITE LOGIC Report

QuantArray®-Chlor Study

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The QuantArray®-Chlor Approach

Quantification of *Dehalococcoides*, the only known bacterial group capable of complete reductive dechlorination of PCE and TCE to ethene, has become an indispensable component of assessment, remedy selection, and performance monitoring at sites impacted by chlorinated solvents. While undeniably a key group of halorespiring bacteria, *Dehalococcoides* are not the only bacteria of interest in the subsurface because reductive dechlorination is not the only potential biodegradation pathway operative at contaminated sites, and chlorinated ethenes are not always the primary contaminants of concern. The QuantArray®-Chlor not only includes a variety of halorespiring bacteria (*Dehalococcoides*, *Dehalobacter*, *Dehalogenimonas*, etc.) to assess the potential for reductive dechlorination of chloroethenes, chloroethanes, chlorobenzenes, chlorophenols, and chloroform, but also provides quantification of functional genes involved in aerobic (co)metabolic pathways for biodegradation of chlorinated solvents and even competing biological processes. Thus, the QuantArray®-Chlor will give site managers the ability to simultaneously yet economically evaluate the potential for biodegradation of a spectrum of common chlorinated contaminants through a multitude of anaerobic and aerobic (co) metabolic pathways to give a much more clear and comprehensive view of contaminant biodegradation.

The QuantArray®-Chlor is used to quantify specific microorganisms and functional genes to evaluate the following:

Anaerobic Reductive Dechlorination	Quantification of important halorespiring bacteria (e.g. *Dehalococcoides*, *Dehalobacter*, *Dehalogenimonas*, *Desulfitobacterium* spp.) and key functional genes (e.g. vinyl chloride reductases, TCE reductase, chloroform reductase) responsible for reductive dechlorination of a broad spectrum of chlorinated solvents.
Aerobic Cometabolism	Several different types of bacteria including methanotrophs and some toluene/phenol utilizing bacteria can co-oxidize TCE, DCE, and vinyl chloride. The QuantArray®-Chlor quantifies functional genes like soluble methane monooxygenase encoding enzymes capable of co-oxidation of chlorinated ethenes.
Aerobic (Co)metabolism of Vinyl Chloride	Ethene oxidizing bacteria are capable of cometabolism of vinyl chloride. In some cases, ethenotrophs can also utilize vinyl chloride as a growth supporting substrate. The QuantArray®-Chlor targets key functional genes in ethene metabolism.

How do QuantArrays® work?

The QuantArray®-Chlor in many respects is a hybrid technology combining the highly parallel detection of microarrays with the accurate and precise quantification provided by qPCR into a single platform. The key to highly parallel qPCR reactions is the nanoliter fluidics platform for low volume, solution phase qPCR reactions.

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How are QuantArray® results reported?

One of the primary advantages of the QuantArray®-Chlor is the simultaneous quantification of a broad spectrum of different microorganisms and key functional genes involved in a variety of pathways for chlorinated hydrocarbon biodegradation. However, highly parallel quantification combined with the various metabolic and cometabolic capabilities of different target organisms can complicate data presentation. Therefore, in addition to Summary Tables, QuantArray® results will be presented as Microbial Population Summary and Comparison Figures to aid in data interpretation and subsequent evaluation of site management activities.

Types of Tables and Figures:

Microbial Population Summary	Figure presenting the concentrations of QuantArray®-Chlor target populations (e.g. *Dehalococcoides*) and functional genes (e.g. vinyl chloride reductase) relative to typically observed values.
Summary Tables	Tables of target population concentrations grouped by biodegradation pathway and contaminant type.
Comparison Figures	Depending on the project, sample results can be presented to compare changes over time or examine differences in microbial populations along a transect of the dissolved plume.

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Results

Table 1: Summary of the QuantArray®-Chlor results obtained for sample MW-5-40.

Sample Name	MW-5-40
Sample Date	02/10/2022
Reductive Dechlorination	cells/bead
Dehalococcoides (DHC)	**9.10E+05**
tceA Reductase (TCE)	**1.54E+05**
BAV1 Vinyl Chloride Reductase (BVC)	**1.43E+04**
Vinyl Chloride Reductase (VCR)	**7.77E+04**
Dehalobacter spp. (DHBt)	**4.70E+05**
Dehalobacter DCM (DCM)	<2.50E+02
Dehalogenimonas spp. (DHG)	<2.50E+02
cerA Reductase (CER)	<2.50E+02
trans-1,2-DCE Reductase (TDR)	<2.50E+02
Desulfitobacterium spp. (DSB)	**3.88E+05**
Dehalobium chlorocoercia (DECO)	**5.14E+04**
Desulfuromonas spp. (DSM)	**1.56E+06**
PCE Reductase (PCE-1)	<2.50E+02
PCE Reductase (PCE-2)	**1.03E+03**
Chloroform Reductase (CFR)	<2.50E+02
1,1 DCA Reductase (DCA)	<2.50E+02
1,2 DCA Reductase (DCAR)	<2.50E+02
Aerobic (Co)Metabolic	
Soluble Methane Monooxygenase (SMMO)	<2.50E+02
Toluene Dioxygenase (TOD)	<2.50E+02
Phenol Hydroxylase (PHE)	<2.50E+02
Trichlorobenzene Dioxygenase (TCBO)	<2.50E+02
Toluene Monooxygenase 2 (RDEG)	<2.50E+02
Toluene Monooxygenase (RMO)	<2.50E+02
Ethene Monooxygenase (EtnC)	<2.50E+02
Epoxyalkane Transferase (EtnE)	<2.50E+02
Dichloromethane Dehalogenase (DCMA)	<2.50E+02
Other	
Total Eubacteria (EBAC)	**3.05E+07**
Sulfate Reducing Bacteria (APS)	**8.32E+05**
Methanogens (MGN)	**1.25E+05**

Legend:

NA = Not Analyzed	NS = Not Sampled	J = Estimated Gene Copies Below PQL but Above LQL
I = Inhibited	< = Result Not Detected	

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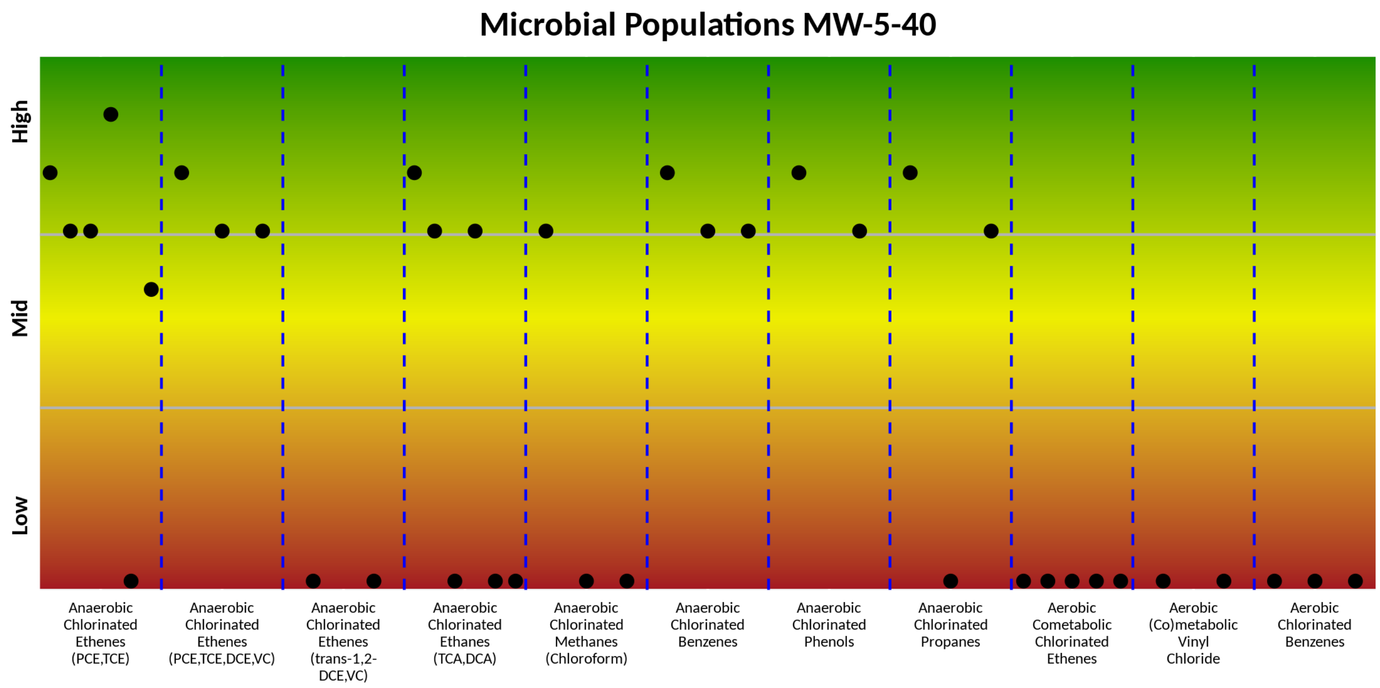

Figure 1: Microbial population summary to aid in evaluating potential pathways and biodegradation of specific contaminants.

Anaerobic - Reductive Dechlorination or Dichloroelimination		Aerobic - (Co)metabolism	
Chlorinated Ethenes (PCE, TCE)	DHC, DHBt, DSB, DSM, PCE-1, PCE-2	Chlorinated Ethenes (TCE,DCE,VC)	sMMO, TOD, PHE, RDEG, RMO
Chlorinated Ethenes (PCE, TCE, DCE, VC)	DHC, BVC, VCR	(Co)metabolic Vinyl Chloride	etnC, etnE
Chlorinated Ethenes (trans-1,2-DCE, VC)	TDR, CER	Chlorinated Benzenes	TOD, TCBO, PHE
Chlorinated Ethanes (TCA and 1,2-DCA)	DHC, DHBt, DHG, DSB[1], DCA, DCAR		
Chlorinated Methanes (Chloroform)	DHBt, DCM, CFR		
Chlorinated Benzenes	DHC, DHBt[2], DECO		
Chlorinated Phenols	DHC, DSB		
Chlorinated Propanes	DHC, DHG, DSB[1]		

[1] *Desulfitobacterium dichloroeliminans* DCA1. [2] Implicated in reductive dechlorination of dichlorobenzene and potentially chlorobenzene.

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Table 2: Summary of the QuantArray®-Chlor results for microorganisms responsible for reductive dechlorination for samples MW-5-40.

Sample Name	MW-5-40
Sample Date	02/10/2022
Reductive Dechlorination	cells/bead
Dehalococcoides (DHC)	**9.10E+05**
tceA Reductase (TCE)	**1.54E+05**
BAV1 Vinyl Chloride Reductase (BVC)	**1.43E+04**
Vinyl Chloride Reductase (VCR)	**7.77E+04**
Dehalobacter spp. (DHBt)	**4.70E+05**
Dehalobacter DCM (DCM)	<2.50E+02
Dehalogenimonas spp. (DHG)	<2.50E+02
Desulfitobacterium spp. (DSB)	**3.88E+05**
Dehalobium chlorocoercia (DECO)	**5.14E+04**
Desulfuromonas spp. (DSM)	**1.56E+06**

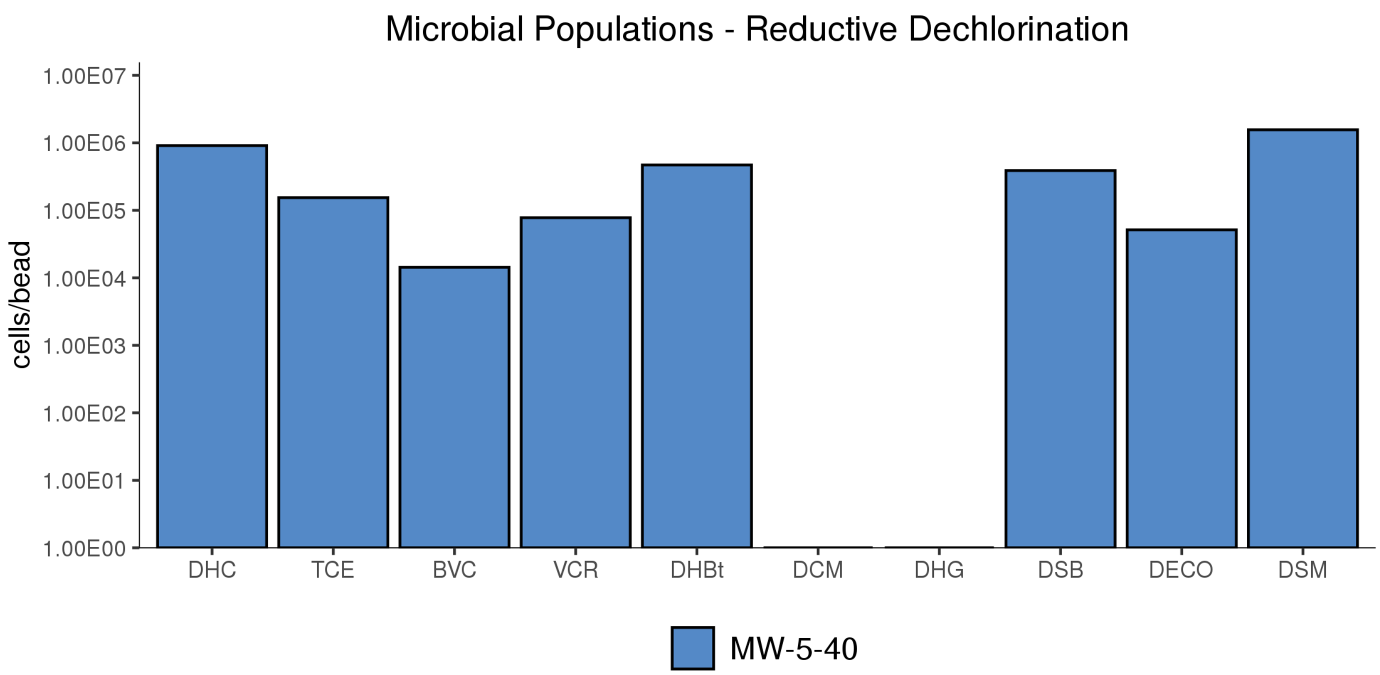

Figure 2: Comparison - microbial populations involved in reductive dechlorination.

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Table 3: Summary of the QuantArray®-Chlor results for microorganisms responsible for reductive dechlorination for samples MW-5-40.

Sample Name	MW-5-40
Sample Date	02/10/2022
Reductive Dechlorination	cells/bead
Chloroform Reductase (CFR)	<2.50E+02
1,1 DCA Reductase (DCA)	<2.50E+02
1,2 DCA Reductase (DCAR)	<2.50E+02
PCE Reductase (PCE-1)	<2.50E+02
PCE Reductase (PCE-2)	**1.03E+03**
Dehalogenimonas trans-1,2-DCE Reductase (TDR)	<2.50E+02
Dehalogenimonas cerA Reductase (CER)	<2.50E+02

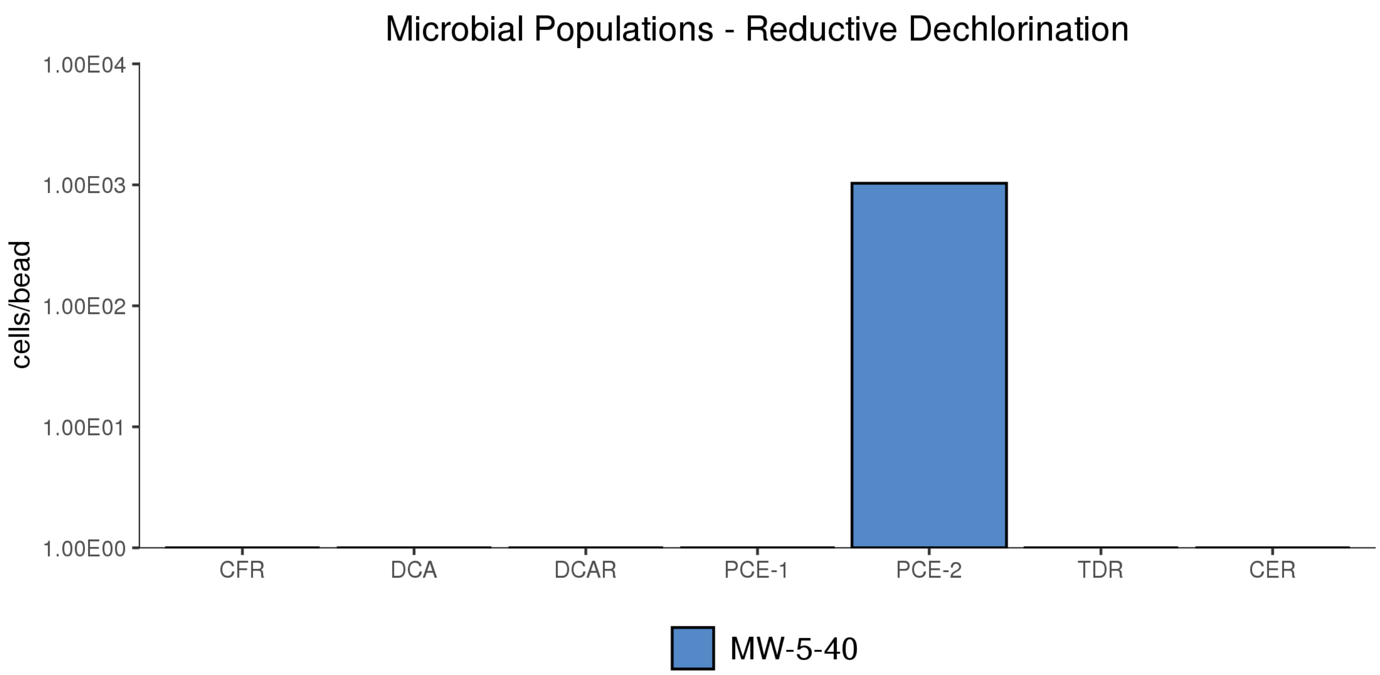

Figure 3: Comparison - microbial populations involved in reductive dechlorination.

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Table 4: Summary of the QuantArray®-Chlor results for microorganisms responsible for aerobic (co)metabolism for samples MW-5-40.

Sample Name	**MW-5-40**
Sample Date	**02/10/2022**
Aerobic (Co)Metabolic	cells/bead
Soluble Methane Monooxygenase (SMMO)	<2.50E+02
Toluene Dioxygenase (TOD)	<2.50E+02
Phenol Hydroxylase (PHE)	<2.50E+02
Trichlorobenzene Dioxygenase (TCBO)	<2.50E+02
Toluene Monooxygenase 2 (RDEG)	<2.50E+02
Toluene Monooxygenase (RMO)	<2.50E+02
Ethene Monooxygenase (EtnC)	<2.50E+02
Epoxyalkane Transferase (EtnE)	<2.50E+02
Dichloromethane Dehalogenase (DCMA)	<2.50E+02

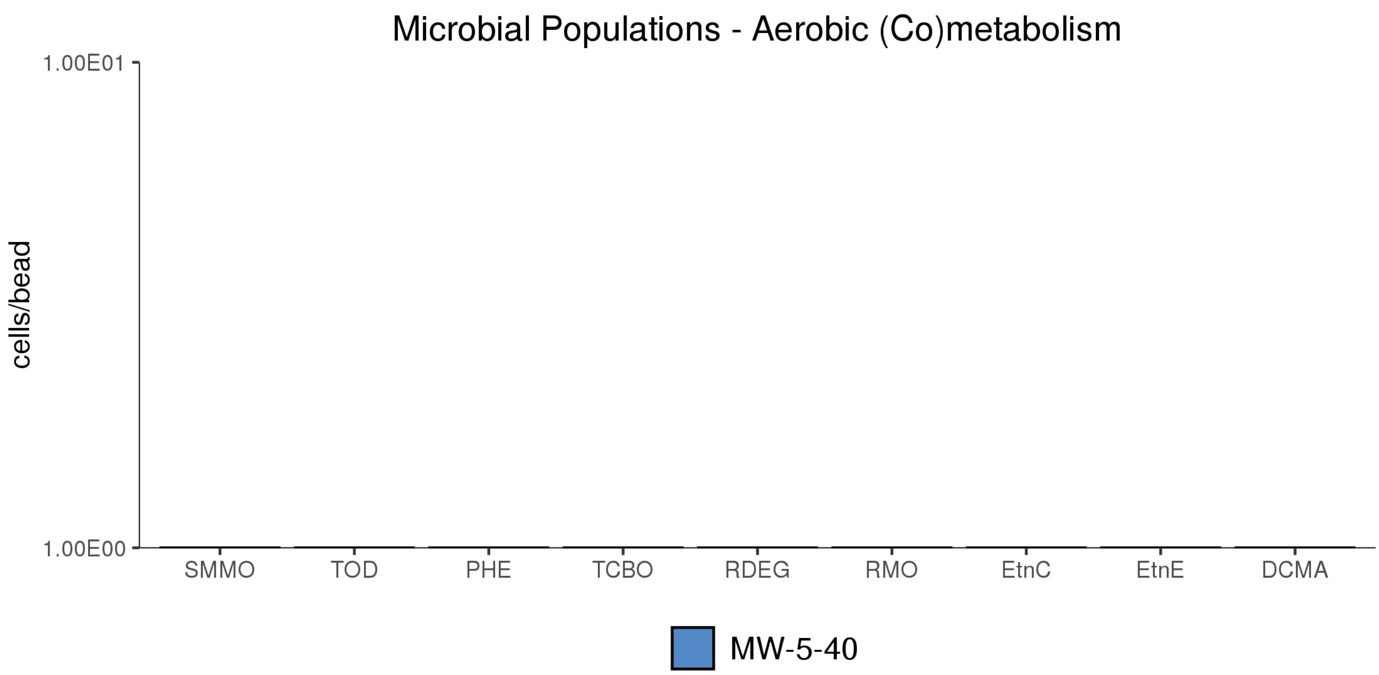

Figure 4: Comparison - microbial populations involved in aerobic (co)metabolism.

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Table 5: Summary of the QuantArray®-Chlor results for total bacteria and other populations for samples MW-5-40.

Sample Name	**MW-5-40**
Sample Date	**02/10/2022**
Other	cells/bead
Total Eubacteria (EBAC)	**3.05E+07**
Sulfate Reducing Bacteria (APS)	**8.32E+05**
Methanogens (MGN)	**1.25E+05**

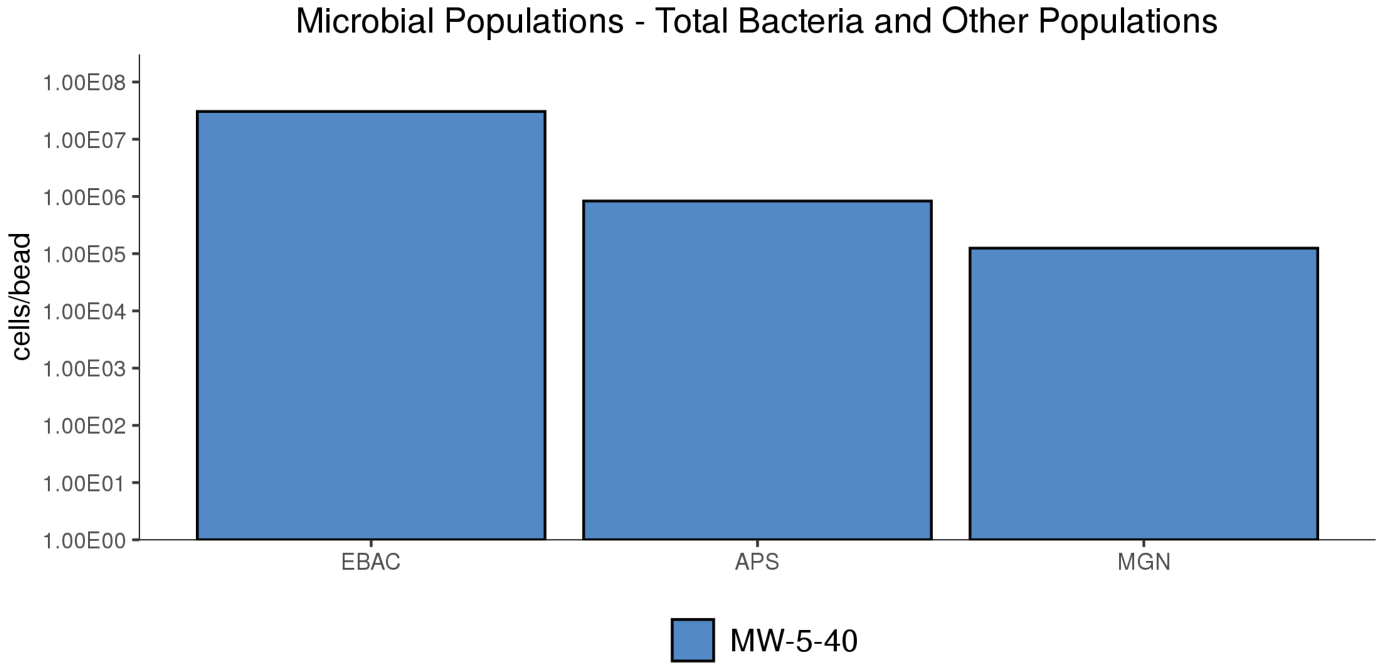

Figure 5: Comparison - microbial populations.

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Interpretation

The overall purpose of the QuantArray®-Chlor is to give site managers the ability to simultaneously yet economically evaluate the potential for biodegradation of a spectrum of common chlorinated contaminants through a multitude of anaerobic and aerobic (co)metabolic pathways in order to provide a clearer and more comprehensive view of contaminant biodegradation. The following discussion describes the interpretation of results in general terms and is meant to serve as a guide.

Reductive Dechlorination - Chlorinated Ethenes: While a number of bacterial cultures including *Dehalococcoides*, *Dehalobacter*, *Desulfitobacterium*, and *Desulfuromonas* spp. capable of utilizing PCE and TCE as growth-supporting electron acceptors have been isolated [1–5], *Dehalococcoides* may be the most important because they are the only bacterial group that has been isolated to date which is capable of complete reductive dechlorination of PCE to ethene [6]. In fact, the presence of *Dehalococcoides* has been associated with complete reductive dechlorination to ethene at sites across North America and Europe [7], and Lu et al. [8] have proposed using a *Dehalococcoides* concentration of 1×10^4 cells/mL as a screening criterion to identify sites where biological reductive dechlorination is predicted to proceed at "generally useful" rates.

At chlorinated ethene sites, any "stall" leading to the accumulation of daughter products, especially vinyl chloride, would be a substantial concern. While *Dehalococcoides* concentrations greater than 1×10^4 cells/mL correspond to ethene production and useful rates of dechlorination, the range of chlorinated ethenes degraded varies by strain within the *Dehalococcoides* genus [6, 9], and the presence of co-contaminants and competitors can have complex impacts on the halorespiring microbial community [10–15]. Therefore, QuantArray®-Chlor also provides quantification of a suite of reductive dehalogenase genes (PCE, TCE, BVC, VCR, CER, and TDR) to more definitively confirm the potential for reductive dechlorination of all chlorinated ethene compounds including vinyl chloride.

Perhaps most importantly, QuantArray®-Chlor quantifies TCE reductase (TCE) and both known vinyl chloride reductase genes (BVC, VCR) from *Dehalococcoides* to conclusively evaluate the potential for complete reductive dechlorination of chlorinated ethenes to nontoxic ethene [16–18]. In addition, the analysis also includes quantification of reductive dehalogenase genes from *Dehalogenimonas* spp. capable of reductive dechlorination of chlorinated ethenes. More specifically, these are the trans-1,2-DCE dehalogenase gene (TDR) from strain WBC-2 [19] and the vinyl chloride reductase gene (CER) from GP, the only known organisms other than *Dehalococcoides* capable of vinyl chloride reduction [20]. Finally, PCE reductase genes responsible for sequential reductive dechlorination of PCE to *cis*-DCE by *Sulfurospirillum* and *Geobacter* spp. are also quantified. In mixed cultures, evidence increasingly suggests that partial dechlorinators like *Sulfurospirillum* and *Geobacter* may be responsible for the majority of reductive dechlorination of PCE to TCE and *cis*-DCE while *Dehalococcoides* functions more as *cis*-DCE and vinyl chloride reducing specialists [10, 21].

Reductive Dechlorination - Chlorinated Ethanes: Under anaerobic conditions, chlorinated ethanes are susceptible to reductive dechlorination by several groups of halorespiring bacteria including *Dehalobacter*, *Dehalogenimonas*, and *Dehalococcoides*. While the reported range of chlorinated ethanes utilized varies by genus, species, and sometimes at the strain level, several general observations can be made regarding biodegradation pathways and daughter product formation. *Dehalobacter* spp. have been isolated that are capable of sequential reductive dechlorination of 1,1,1-TCA through 1,1-DCA to chloroethane [13]. Biodegradation of 1,1,2-TCA by several halorespiring bacteria including *Dehalobacter* and *Dehalogenimonas* spp. proceeds via dichloroelimination producing vinyl chloride [22–24]. Similarly, 1,2-DCA biodegradation by *Dehalobacter*, *Dehalogenimonas*, and *Dehalococcoides* occurs via dichloroelimination producing ethene. While not utilized by many *Desulfitobacterium* isolates, at least one strain, *Desulfitobacterium dichloroeliminans* strain DCA1, is also capable of dichloroelimination of 1,2-DCA [25]. The 1,2-dichloroethane reductive dehalogenase gene (DCAR) from members of *Desulfitobacterium* and *Dehalobacter* is known to dechlorinate 1,2-DCA to ethene, while the 1,1-dichloroethane reductive dehalogenase (DCA) targets the gene responsible for 1,1-DCA dechlorination in some strains of *Dehalobacter*. In addition to chloroform,chloroform reductase (CFR) has also been shown to be responsible for reductivedechlorination of 1,1,1-TCA [26].

Reductive Dechlorination - Chlorinated Methanes: Chloroform is a common co-contaminant at chlorinated solvent sites and can inhibit reductive dechlorination of chlorinated ethenes. Grostern et al. demonstrated that a *Dehalobacter* population was capable of reductive dechlorination of chloroform to produce dichloromethane [27]. The *cfrA* gene encodes the reductase which catalyzes this initial step in chloroform biodegradation [26]. Justicia-Leon et al. have since shown that dichloromethane can support growth of a distinct group of *Dehalobacter* strains via fermentation [28]. The *Dehalobacter* DCM assay targets the 16S rRNA gene of these strains.

Reductive Dechlorination - Chlorinated Benzenes: Chlorinated benzenes are an important class of industrial solvents and chemical intermediates in the production of drugs, dyes, herbicides, and insecticides. The physical-chemical properties of chlorinated benzenes as well as susceptibility to biodegradation are functions of their degree of chlorination and the positions of chlorine substituents. Under anaerobic conditions, reductive dechlorination of higher chlorinated benzenes including hexachlorobenzene (HCB),

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pentachlorobenzene (PeCB), tetrachlorobenzene (TeCB) isomers, and trichlorobenzene (TCB) isomers has been well documented [29], although biodegradation of individual compounds and isomers varies between isolates. For example, *Dehalococcoides* strain CBDB1 reductively dechlorinats HCB, PeCB, all three TeCB isomers, 1,2,3-TCB, and 1,2,4-TCB [9, 30]. *Dehalobium chlorocoercia* DF-1 has been shown to be capable of reductive dechlorination of HCB, PeCB, and 1,2,3,5-TeCB [31]. The dichlorobenzene (DCB) isomers and chlorobenzene (CB) were considered relatively recalcitrant under anaerobic conditions. However, new evidence has demonstrated reductive dechlorination of DCBs to CB and CB to benzene [32] with corresponding increases in concentrations of *Dehalobacter* spp. [33].

Reductive Dechlorination - Chlorinated Phenols: Pentachlorophenol (PCP) was one of the most widely used biocides in the U.S. and despite residential use restrictions, is still extensively used industrially as a wood preservative. Along with PCP, the tetrachlorophenol and trichlorophenol isomers were also used as fungicides in wood preserving formulations. 2,4-Dichlorophenol and 2,4,5-TCP were used as chemical intermediates in herbicide production (e.g. 2,4-D) and chlorophenols are known byproducts of chlorine bleaching in the pulp and paper industry. While the range of compounds utilized varies by strain, some *Dehalococcoides* isolates are capable of reductive dechlorination of PCP and other chlorinated phenols. For example, *Dehalococcoides* strain CBDB1 is capable of utilizing PCP, all three tetrachlorophenol (TeCP) congeners, all six trichlorophenol (TCP) congeners, and 2,3-dichlorophenol (2,3-DCP). PCP dechlorination by strain CBDB1 produces a mixture of 3,5-DCP, 3,4-DCP, 2,4-DCP, 3-CP, and 4-CP [34]. In the same study, however, *Dehalococcoides* strain 195 dechlorinated a more narrow spectrum of chlorophenols which included 2,3-DCP, 2,3,4-TCP, and 2,3,6-TCP, but no other TCPs or PCP. Similar to *Dehalococcoides*, some species and strains of *Desulfitobacterium* are capable of utilizing PCP and other chlorinated phenols. *Desulfitobacterium hafniense* PCP-1 is capable of reductive dechlorination of PCP to 3-CP [35]. However, the ability to biodegrade PCP is not universal among *Desulfitobacterium* isolates. *Desulfitobacterium* sp. strain PCE1 and *D. chlororespirans* strain Co23, for example, can utilize some TCP and DCP isomers, but not PCP for growth [2, 36].

Reductive Dechlorination - Chlorinated Propanes: *Dehalogenimonas* is a recently described bacterial genus of the phylum Chloroflexi which also includes the well-known chloroethene-respiring *Dehalococcoides* [23]. The *Dehalogenimonas* isolates characterized to date are also halorespiring bacteria, but utilize a rather unique range of chlorinated compounds as electron acceptors including chlorinated propanes (1,2,3-TCP and 1,2-DCP) and a variety of other vicinally chlorinated alkanes including 1,1,2,2-tetrachloroethane, 1,1,2-trichloroethane, and 1,2-dichloroethane [23].

Aerobic - Chlorinated Ethene Cometabolism: Under aerobic conditions, several different types of bacteria including methane-oxidizing bacteria (methanotrophs), and many benzene, toluene, ethylbenzene, xylene, and (BTEX)-utilizing bacteria can cometabolize or co-oxidize TCE, DCE, and vinyl chloride [37]. In general, cometabolism of chlorinated ethenes is mediated by monooxygenase enzymes with "relaxed' specificity that oxidize a primary (growth supporting) substrate (*e.g.* methane) and co-oxidize the chlorinated compound (*e.g.*TCE). QuantArray®-Chlor provides quantification of a suite of genes encoding oxygenase enzymes capable of co-oxidation of chlorinated ethenes including soluble methane monooxygenase (sMMO). Soluble methane monooxygenases co-oxidize a broad range of chlorinated compounds [38–41] including TCE, *cis*-DCE, and vinyl chloride. Furthermore, soluble methane monooxygenases are generally believed to support greater rates of aerobic cometabolism [40]. QuantArray®-Chlor also quantifies aromatic oxygenase genes encoding ring hydroxylating toluene monooxygenase genes (RMO, RDEG), toluene dioxygenase (TOD) and phenol hydroxylases (PHE) capable of TCE co-oxidation [42–46]. TCE or a degradation product has been shown to induce expression of toluene monooxygenases in some laboratory studies [43, 47] raising the possibility of TCE cometabolism with an alternative (non-aromatic) growth substrate. Moreover, while a number of additional factors must be considered, recent research under ESTCP Project 201584 has shown positive correlations between concentrations of monooxygenase genes (soluble methane monooxygenase, ring hydroxylating monooxygenases, and phenol hydroxylase) and the rate of TCE degradation [48].

Aerobic - Chlorinated Ethane Cometabolism: While less widely studied than cometabolism of chlorinated ethenes, some chlorinated ethanes are also susceptible to co-oxidation. As mentioned previously, soluble methane monooxygenases (sMMO) exhibit very relaxed specificity. In laboratory studies, sMMO has been shown to co-oxidize a number of chlorinated ethanes including 1,1,1-TCA and 1,2-DCA [38, 40].

Aerobic - Vinyl Chloride Cometabolism: Beginning in the early 1990s, numerous microcosm studies demonstrated aerobic oxidation of vinyl chloride under MNA conditions without the addition of exogenous primary substrates. Since then, strains of

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Mycobacterium, *Nocardioides*, *Pseudomonas*, *Ochrobactrum*, and *Ralstonia* species have been isolated which are capable of aerobic growth on both ethene and vinyl chloride (see Mattes et al. [49] for a review). The initial steps in the pathway are the monooxygenase (*etn*ABCD) catalyzed conversion of ethene and vinyl chloride to their respective epoxyalkanes (epoxyethane and chlorooxirane), followed by epoxyalkane:CoM transferase (*etn*E) mediated conjugation and breaking of the epoxide [50].

Aerobic - Chlorinated Benzenes: In general, chlorobenzenes with four or less chlorine groups are susceptible to aerobic biodegradation and can serve as growth-supporting substrates. Toluene dioxygenase (TOD) has a relatively relaxed substrate specificity and mediates the incorporation of both atoms of oxygen into the aromatic ring of benzene and substituted benzenes (toluene and chlorobenzene). Comparison of TOD levels in background and source zone samples from a CB-impacted site suggested that CBs promoted growth of TOD-containing bacteria [51]. In addition, aerobic biodegradation of some trichlorobenzene and even tetrachlorobenzene isomers is initiated by a group of related trichlorobenzene dioxygenase genes (TCBO). Finally, phenol hydroxylases catalyze the continued oxidation and in some cases, the initial oxidation of a variety of monoaromatic compounds. In an independent study, significant increases in numbers of bacteria containing PHE genes corresponded to increases in biodegradation of DCB isomers [51].

Aerobic - Chlorinated Methanes: Many aerobic methylotrophic bacteria, belonging to diverse genera (*Hyphomicrobium*, *Methylobacterium*, *Methylophilus*, *Pseudomonas*, *Paracoccus*, and *Alibacter*) have been isolated which are capable of utilizing dichloromethane (DCM) as a growth substrate. The DCM metabolic pathway in methylotrophic bacteria is initiated by a dichloromethane dehalogenase (DCMA) gene. DCMA is responsible for aerobic biodegradation of dichloromethane by methylotrophs by first producing formaldehyde which is then further oxidized [52]. As discussed in previous sections, soluble methane monooxygenase (sMMO) exhibits relaxed specificity and co-oxidizes a broad spectrum of chlorinated hydrocarbons. In addition to chlorinated ethenes, sMMO has been shown to co-oxidize chloroform in laboratory studies [38, 41].

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LELAP CERTIFICATE NUMBER: 01955
DOD-ELAP ACCREDITATION NUMBER: 74960

ANALYTICAL RESULTS

PERFORMED BY

Pace Analytical Gulf Coast
7979 Innovation Park Dr.
Baton Rouge, LA 70820
(225) 769-4900

Report Date 01/10/2022

Report # 221121590

Project Fomer EPT 31401545.001.05

Samples Collected 12/14/21

Deliver To	***Additional Recipients***
Jeffrey Baker WSP Environment & Energy 7000 East Genessee Building D, 2nd Floor Fayetteville, NY 13066 724-882-7923	Erik Reinert, WSP Environment & Energy Environmental Payable, WSP USA Corp

PJLA
Testing
DoD ELAP

Laboratory Endorsement

Sample analysis was performed in accordance with approved methodologies provided by the Environmental Protection Agency or other recognized agencies. The samples and their corresponding extracts will be maintained for a period of 30 days unless otherwise arranged. Following this retention period the samples will be disposed in accordance with Pace Gulf Coast's Standard Operating Procedures.

Common Abbreviations that may be Utilized in this Report

ND	Indicates the result was Not Detected at the specified reporting limit
NO	Indicates the sample did not ignite when preliminary test performed for EPA Method 1030
DO	Indicates the result was Diluted Out
MI	Indicates the result was subject to Matrix Interference
TNTC	Indicates the result was Too Numerous To Count
SUBC	Indicates the analysis was Sub-Contracted
FLD	Indicates the analysis was performed in the Field
DL	Detection Limit
LOD	Limit of Detection
LOQ	Limit of Quantitation
RE	Re-analysis
CF	HPLC or GC Confirmation
00:01	Reported as a time equivalent to 12:00 AM

Reporting Flags that may be Utilized in this Report

J or I	Indicates the result is between the MDL and LOQ
J	DOD flag on analyte in the parent sample for MS/MSD outside acceptance criteria
U	Indicates the compound was analyzed for but not detected
B or V	Indicates the analyte was detected in the associated Method Blank
Q	Indicates a non-compliant QC Result (See Q Flag Application Report)
*****	Indicates a non-compliant or not applicable QC recovery or RPD – see narrative
E	Organics **-** The result is estimated because it exceeded the instrument calibration range
E	Metals - % diference for the serial dilution is > 10%
L	Reporting Limits adjusted to meet risk-based limit.
P	RPD between primary and confirmation result is greater than 40
DL	Diluted analysis – when appended to Client Sample ID

Sample receipt at Pace Gulf Coast is documented through the attached chain of custody. In accordance with NELAC, this report shall be reproduced only in full and with the written permission of Pace Gulf Coast. The results contained within this report relate only to the samples reported. The documented results are presented within this report.

This report pertains only to the samples listed in the Report Sample Summary and should be retained as a permanent record thereof. The results contained within this report are intended for the use of the client. Any unauthorized use of the information contained in this report is prohibited.

I certify that this data package is in compliance with The NELAC Institute (TNI) Standard 2009 and terms and conditions of the contract and Statement of Work both technically and for completeness, for other than the conditions in the case narrative. Release of the data contained in this hardcopy data package and in the computer readable data submitted has been authorized by the Quality Assurance Manager or his/her designee, as verified by the following signature.

Estimated uncertainty of measurement is available upon request. This report is in compliance with the DOD QSM as specified in the contract if applicable.

Authorized Signature
Pace Gulf Coast Report 221121590

Certifications

Certification	Certification Number
DOD ELAP	74960
Alabama	01955
Arkansas	88-0655
Colorado	01955
Delaware	01955
Florida	E87854
Georgia	01955
Hawaii	01955
Idaho	01955
Illinois	200048
Indiana	01955
Kansas	E-10354
Kentucky	95
Louisiana	01955
Maryland	01955
Massachusetts	01955
Michigan	01955
Mississippi	01955
Missouri	01955
Montana	N/A
Nebraska	01955
New Mexico	01955
North Carolina	618
North Dakota	R-195
Oklahoma	9403
South Carolina	73006001
South Dakota	01955
Tennessee	01955
Texas	T104704178
Vermont	01955
Virginia	460215
Washington	C929
USDA Soil Permit	P330-16-00234

Case Narrative

Client: WSP Environmental & Energy **Report:** 221121590

Pace Analytical Gulf Coast received and analyzed the sample(s) listed
on the Report Sample Summary page of this report. Receipt of the sample(s) is documented
by the attached chain of custody. This applies only to the sample(s) listed in this report.
No sample integrity or quality control exceptions were identified unless noted below.

PROJECT MANAGER COMMENTS

Project Manager Comments - The analyst reported on 12-27-21 that he was unable to locate the Trip Blank for this project. The client was emailed and the sample removed from the project. (Ruth Welsh(Do Not 12/28/2021 16:10)

VOLATILES MASS SPECTROMETRY

In the EPA 8260C analysis for analytical batch 730486, Methylene chloride was detected at an estimated concentration in the method blank. This is probable laboratory contamination.

Sample Summary

Lab ID	Client ID	Matrix	Collect Date	Receive Date
22112159001	MW-5-40	Water	12/14/21 10:15	12/15/21 11:00
22112159002	MW-46-43C	Water	12/14/21 09:35	12/15/21 11:00

Detect Summary

Results and Detection Limits are adjusted for dilution and moisture when applicable

AM23G

Lab ID	Client ID	Parameter	Units	Result	Dil.	%Moist
22112159001	MW-5-40	Acetic Acid	mg/L	16	10	NA
22112159001	MW-5-40	Formic Acid	mg/L	35	10	NA
22112159001	MW-5-40	Propionic Acid	mg/L	9.5	10	NA
22112159002	MW-46-43C	Acetic Acid	mg/L	44	10	NA
22112159002	MW-46-43C	Formic Acid	mg/L	38	10	NA
22112159002	MW-46-43C	Hexanoic Acid	mg/L	0.79J	10	NA
22112159002	MW-46-43C	Propionic Acid	mg/L	20	10	NA

SM 2320 B-2011

Lab ID	Client ID	Parameter	Units	Result	Dil.	%Moist
22112159001	MW-5-40	Total Alkalinity	mg/L CaCO3	371	1	NA
22112159002	MW-46-43C	Total Alkalinity	mg/L CaCO3	432	1	NA

SM 5310 B-2014

Lab ID	Client ID	Parameter	Units	Result	Dil.	%Moist
22112159001	MW-5-40	Total Organic Carbon	mg/L	32.6	1	NA
22112159002	MW-46-43C	Total Organic Carbon	mg/L	48.6	2	NA

EPA 8260C

Lab ID	Client ID	Parameter	Units	Result	Dil.	%Moist
22112159001	MW-5-40	1,1-Dichloroethene	ug/L	20.0J	100	NA
22112159001	MW-5-40	cis-1,2-Dichloroethene	ug/L	9610	100	NA
22112159001	MW-5-40	trans-1,2-Dichloroethene	ug/L	119	100	NA
22112159001	MW-5-40	Trichloroethene	ug/L	363	100	NA
22112159001	MW-5-40	Vinyl chloride	ug/L	5890	100	NA
22112159002	MW-46-43C	cis-1,2-Dichloroethene	ug/L	6260	100	NA
22112159002	MW-46-43C	Methylene chloride	ug/L	89.7J	100	NA
22112159002	MW-46-43C	Trichloroethene	ug/L	36.7J	100	NA
22112159002	MW-46-43C	Vinyl chloride	ug/L	6460	100	NA

EPA RSK175

Lab ID	Client ID	Parameter	Units	Result	Dil.	%Moist
22112159001	MW-5-40	Ethane	ug/L	12	1	NA
22112159001	MW-5-40	Ethene	ug/L	430	1	NA
22112159001	MW-5-40	Methane	ug/L	870	1	NA
22112159002	MW-46-43C	Ethane	ug/L	20	1	NA
22112159002	MW-46-43C	Ethene	ug/L	2900	1	NA
22112159002	MW-46-43C	Methane	ug/L	4000	1	NA

EPA RSK-175

Lab ID	Client ID	Parameter	Units	Result	Dil.	%Moist
22112159001	MW-5-40	Carbon Dioxide	ug/L	30000	5	NA

Detect Summary (Continued)

Results and Detection Limits are adjusted for dilution and moisture when applicable

EPA RSK-175						
Lab ID	**Client ID**	**Parameter**	**Units**	**Result**	**Dil.**	**%Moist**
22112159002	MW-46-43C	Carbon Dioxide	ug/L	61800	10	NA

Sample Results

MW-5-40	**Collect Date**	12/14/2021 10:15	**Lab ID**	22112159001
	Receive Date	12/15/2021 11:00	**Matrix**	Water

EPA 8260C

*Results And limits are adjusted for dilution.

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	100	12/28/21 16:20	730486	CJR	NA

CAS#	Parameter	Result	DL	LOQ	Units
630-20-6	1,1,1,2-Tetrachloroethane	20.0U	20.0	100	ug/L
71-55-6	1,1,1-Trichloroethane	20.0U	20.0	100	ug/L
79-34-5	1,1,2,2-Tetrachloroethane	20.0U	20.0	100	ug/L
79-00-5	1,1,2-Trichloroethane	20.0U	20.0	100	ug/L
75-34-3	1,1-Dichloroethane	20.0U	20.0	100	ug/L
75-35-4	**1,1-Dichloroethene**	**20.0J**	20.0	100	ug/L
563-58-6	1,1-Dichloropropene	20.0U	20.0	100	ug/L
96-18-4	1,2,3-Trichloropropane	20.0U	20.0	100	ug/L
120-82-1	1,2,4-Trichlorobenzene	20.0U	20.0	100	ug/L
95-63-6	1,2,4-Trimethylbenzene	20.0U	20.0	100	ug/L
96-12-8	1,2-Dibromo-3-chloropropane	20.0U	20.0	100	ug/L
106-93-4	1,2-Dibromoethane	20.0U	20.0	100	ug/L
95-50-1	1,2-Dichlorobenzene	20.0U	20.0	100	ug/L
107-06-2	1,2-Dichloroethane	20.0U	20.0	100	ug/L
78-87-5	1,2-Dichloropropane	20.0U	20.0	100	ug/L
108-67-8	1,3,5-Trimethylbenzene	20.0U	20.0	100	ug/L
541-73-1	1,3-Dichlorobenzene	20.0U	20.0	100	ug/L
142-28-9	1,3-Dichloropropane	20.0U	20.0	100	ug/L
106-46-7	1,4-Dichlorobenzene	20.0U	20.0	100	ug/L
594-20-7	2,2-Dichloropropane	20.0U	20.0	100	ug/L
78-93-3	2-Butanone	20.0U	20.0	500	ug/L
110-75-8	2-Chloroethylvinyl ether	100U	100	500	ug/L
95-49-8	2-Chlorotoluene	20.0U	20.0	100	ug/L
591-78-6	2-Hexanone	50.0U	50.0	500	ug/L
106-43-4	4-Chlorotoluene	20.0U	20.0	100	ug/L
99-87-6	4-Isopropyltoluene	20.0U	20.0	100	ug/L
108-10-1	4-Methyl-2-pentanone	20.0U	20.0	500	ug/L
67-64-1	Acetone	50.0U	50.0	500	ug/L
107-02-8	Acrolein	250U	250	2500	ug/L
107-13-1	Acrylonitrile	100U	100	2500	ug/L
71-43-2	Benzene	20.0U	20.0	100	ug/L
108-86-1	Bromobenzene	20.0U	20.0	100	ug/L
74-97-5	Bromochloromethane	20.0U	20.0	100	ug/L
75-27-4	Bromodichloromethane	20.0U	20.0	100	ug/L
75-25-2	Bromoform	25.0U	25.0	100	ug/L
74-83-9	Bromomethane	50.0U	50.0	100	ug/L
75-15-0	Carbon disulfide	20.0U	20.0	100	ug/L
56-23-5	Carbon tetrachloride	25.0U	25.0	100	ug/L
108-90-7	Chlorobenzene	20.0U	20.0	100	ug/L
75-00-3	Chloroethane	25.0U	25.0	100	ug/L
67-66-3	Chloroform	20.0U	20.0	100	ug/L
74-87-3	Chloromethane	20.0U	20.0	100	ug/L
156-59-2	**cis-1,2-Dichloroethene**	**9610**	20.0	100	ug/L
10061-01-5	cis-1,3-Dichloropropene	20.0U	20.0	100	ug/L
124-48-1	Dibromochloromethane	20.0U	20.0	100	ug/L
74-95-3	Dibromomethane	25.0U	25.0	100	ug/L
75-71-8	Dichlorodifluoromethane	20.0U	20.0	100	ug/L
100-41-4	Ethylbenzene	20.0U	20.0	100	ug/L
87-68-3	Hexachlorobutadiene	50.0U	50.0	500	ug/L
98-82-8	Isopropylbenzene (Cumene)	20.0U	20.0	100	ug/L
m,p-Xylene	m,p-Xylene	20.0U	20.0	200	ug/L
74-88-4	Methyl iodide	50.0U	50.0	500	ug/L
75-09-2	Methylene chloride	20.0U	20.0	500	ug/L

Sample Results

MW-5-40	**Collect Date**	12/14/2021 10:15	**Lab ID**	22112159001
	Receive Date	12/15/2021 11:00	**Matrix**	Water

EPA 8260C (Continued)

*Results And limits are adjusted for dilution.

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	100	12/28/21 16:20	730486	CJR	NA

CAS#	Parameter	Result	DL	LOQ		Units
91-20-3	Naphthalene	20.0U	20.0	500		ug/L
104-51-8	n-Butylbenzene	20.0U	20.0	100		ug/L
103-65-1	n-Propylbenzene	100U	100	500		ug/L
95-47-6	o-Xylene	20.0U	20.0	100		ug/L
135-98-8	sec-Butylbenzene	20.0U	20.0	100		ug/L
100-42-5	Styrene	20.0U	20.0	100		ug/L
1634-04-4	tert-Butyl methyl ether (MTBE)	20.0U	20.0	100		ug/L
98-06-6	tert-Butylbenzene	20.0U	20.0	100		ug/L
127-18-4	Tetrachloroethene	20.0U	20.0	100		ug/L
108-88-3	Toluene	20.0U	20.0	100		ug/L
156-60-5	**trans-1,2-Dichloroethene**	**119**	20.0	100		ug/L
10061-02-6	trans-1,3-Dichloropropene	20.0U	20.0	100		ug/L
110-57-6	trans-1,4-Dichloro-2-butene	50.0U	50.0	500		ug/L
79-01-6	**Trichloroethene**	**363**	20.0	100		ug/L
75-69-4	Trichlorofluoromethane	20.0U	20.0	100		ug/L
76-13-1	Trichlorotrifluoroethane	20.0U	20.0	100		ug/L
108-05-4	Vinyl acetate	20.0U	20.0	100		ug/L
75-01-4	**Vinyl chloride**	**5890**	20.0	100		ug/L

CAS#	Surrogate	Conc Spiked	Conc Rec	Units	%Recovery	%Rec Limits
460-00-4	4-Bromofluorobenzene	5000	5010	ug/L	100	78 - 130
1868-53-7	Dibromofluoromethane	5000	5280	ug/L	106	77 - 127
2037-26-5	Toluene d8	5000	5030	ug/L	101	76 - 134
17060-07-0	1,2-Dichloroethane-d4	5000	5170	ug/L	103	71 - 127

EPA RSK-175

*Results And limits are adjusted for dilution.

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	5	12/28/21 15:55	730506	BMR	NA

CAS#	Parameter	Result	DL	LOQ	Units
124-38-9	**Carbon Dioxide**	**30000**	635	4500	ug/L

AM23G

*Results And limits are adjusted for dilution.

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	10	01/06/22 02:20	730991	SLL2	NA

CAS#	Parameter	Result	DL	LOQ	Units
64-19-7	**Acetic Acid**	**16**	1.2	5.0	mg/L
107-92-6	Butyric Acid	0.58U	0.58	5.0	mg/L
64-18-6	**Formic Acid**	**35**	0.55	5.0	mg/L
142-62-1	Hexanoic Acid	0.58U	0.58	5.0	mg/L
646-07-1	i-Hexanoic Acid	0.56U	0.56	5.0	mg/L
503-74-2	i-Pentanoic Acid	0.61U	0.61	5.0	mg/L
50-21-5	Lactic Acid	0.53U	0.53	5.0	mg/L
109-52-4	Pentanoic Acid	0.56U	0.56	5.0	mg/L
79-09-4	**Propionic Acid**	**9.5**	0.53	5.0	mg/L

Sample Results

MW-5-40	Collect Date	12/14/2021 10:15	Lab ID	22112159001
	Receive Date	12/15/2021 11:00	Matrix	Water

AM23G (Continued)

*Results And limits are adjusted for dilution.

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	10	01/06/22 02:20	730991	SLL2	NA

CAS#	Parameter	Result	DL	LOQ	Units
127-17-3	Pyruvic Acid	0.60U	0.60	5.0	mg/L

SM 2320 B-2011

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	1	12/27/21 11:12	730442	RYC	NA

CAS#	Parameter	Result	DL	LOQ	Units
000000-00-5	**Total Alkalinity**	**371**	0.26	1.0	mg/L CaCO3

SM 5310 B-2014

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	1	12/23/21 18:13	730256	JGD	NA

CAS#	Parameter	Result	DL	LOQ	Units
C-012	**Total Organic Carbon**	**32.6**	0.300	2.00	mg/L

EPA RSK175

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	1	12/26/21 21:03	730335	AWE	NA

CAS#	Parameter	Result	DL	LOQ	Units
74-84-0	**Ethane**	**12**	0.17	1.0	ug/L
74-85-1	**Ethene**	**430**	0.24	1.0	ug/L
74-82-8	**Methane**	**870**	2.0	5.0	ug/L

MW-46-43C	Collect Date	12/14/2021 09:35	Lab ID	22112159002
	Receive Date	12/15/2021 11:00	Matrix	Water

EPA 8260C

*Results And limits are adjusted for dilution.

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	100	12/28/21 16:41	730486	CJR	NA

CAS#	Parameter	Result	DL	LOQ	Units
630-20-6	1,1,1,2-Tetrachloroethane	20.0U	20.0	100	ug/L
71-55-6	1,1,1-Trichloroethane	20.0U	20.0	100	ug/L
79-34-5	1,1,2,2-Tetrachloroethane	20.0U	20.0	100	ug/L

Sample Results

MW-46-43C	**Collect Date**	12/14/2021 09:35	**Lab ID**	22112159002
	Receive Date	12/15/2021 11:00	**Matrix**	Water

EPA 8260C (Continued)

*Results And limits are adjusted for dilution.

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	100	12/28/21 16:41	730486	CJR	NA

CAS#	Parameter	Result	DL	LOQ	Units
79-00-5	1,1,2-Trichloroethane	20.0U	20.0	100	ug/L
75-34-3	1,1-Dichloroethane	20.0U	20.0	100	ug/L
75-35-4	1,1-Dichloroethene	20.0U	20.0	100	ug/L
563-58-6	1,1-Dichloropropene	20.0U	20.0	100	ug/L
96-18-4	1,2,3-Trichloropropane	20.0U	20.0	100	ug/L
120-82-1	1,2,4-Trichlorobenzene	20.0U	20.0	100	ug/L
95-63-6	1,2,4-Trimethylbenzene	20.0U	20.0	100	ug/L
96-12-8	1,2-Dibromo-3-chloropropane	20.0U	20.0	100	ug/L
106-93-4	1,2-Dibromoethane	20.0U	20.0	100	ug/L
95-50-1	1,2-Dichlorobenzene	20.0U	20.0	100	ug/L
107-06-2	1,2-Dichloroethane	20.0U	20.0	100	ug/L
78-87-5	1,2-Dichloropropane	20.0U	20.0	100	ug/L
108-67-8	1,3,5-Trimethylbenzene	20.0U	20.0	100	ug/L
541-73-1	1,3-Dichlorobenzene	20.0U	20.0	100	ug/L
142-28-9	1,3-Dichloropropane	20.0U	20.0	100	ug/L
106-46-7	1,4-Dichlorobenzene	20.0U	20.0	100	ug/L
594-20-7	2,2-Dichloropropane	20.0U	20.0	100	ug/L
78-93-3	2-Butanone	20.0U	20.0	500	ug/L
110-75-8	2-Chloroethylvinyl ether	100U	100	500	ug/L
95-49-8	2-Chlorotoluene	20.0U	20.0	100	ug/L
591-78-6	2-Hexanone	50.0U	50.0	500	ug/L
106-43-4	4-Chlorotoluene	20.0U	20.0	100	ug/L
99-87-6	4-Isopropyltoluene	20.0U	20.0	100	ug/L
108-10-1	4-Methyl-2-pentanone	20.0U	20.0	500	ug/L
67-64-1	Acetone	50.0U	50.0	500	ug/L
107-02-8	Acrolein	250U	250	2500	ug/L
107-13-1	Acrylonitrile	100U	100	2500	ug/L
71-43-2	Benzene	20.0U	20.0	100	ug/L
108-86-1	Bromobenzene	20.0U	20.0	100	ug/L
74-97-5	Bromochloromethane	20.0U	20.0	100	ug/L
75-27-4	Bromodichloromethane	20.0U	20.0	100	ug/L
75-25-2	Bromoform	25.0U	25.0	100	ug/L
74-83-9	Bromomethane	50.0U	50.0	100	ug/L
75-15-0	Carbon disulfide	20.0U	20.0	100	ug/L
56-23-5	Carbon tetrachloride	25.0U	25.0	100	ug/L
108-90-7	Chlorobenzene	20.0U	20.0	100	ug/L
75-00-3	Chloroethane	25.0U	25.0	100	ug/L
67-66-3	Chloroform	20.0U	20.0	100	ug/L
74-87-3	Chloromethane	20.0U	20.0	100	ug/L
156-59-2	**cis-1,2-Dichloroethene**	**6260**	20.0	100	ug/L
10061-01-5	cis-1,3-Dichloropropene	20.0U	20.0	100	ug/L
124-48-1	Dibromochloromethane	20.0U	20.0	100	ug/L
74-95-3	Dibromomethane	25.0U	25.0	100	ug/L
75-71-8	Dichlorodifluoromethane	20.0U	20.0	100	ug/L
100-41-4	Ethylbenzene	20.0U	20.0	100	ug/L
87-68-3	Hexachlorobutadiene	50.0U	50.0	500	ug/L
98-82-8	Isopropylbenzene (Cumene)	20.0U	20.0	100	ug/L
m,p-Xylene	m,p-Xylene	20.0U	20.0	200	ug/L
74-88-4	Methyl iodide	50.0U	50.0	500	ug/L
75-09-2	**Methylene chloride**	**89.7J**	20.0	500	ug/L
91-20-3	Naphthalene	20.0U	20.0	500	ug/L
104-51-8	n-Butylbenzene	20.0U	20.0	100	ug/L
103-65-1	n-Propylbenzene	100U	100	500	ug/L

Sample Results

MW-46-43C	**Collect Date**	12/14/2021 09:35	**Lab ID**	22112159002
	Receive Date	12/15/2021 11:00	**Matrix**	Water

EPA 8260C (Continued)

*Results And limits are adjusted for dilution.

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	100	12/28/21 16:41	730486	CJR	NA

CAS#	Parameter	Result	DL	LOQ		Units
95-47-6	o-Xylene	20.0U	20.0	100		ug/L
135-98-8	sec-Butylbenzene	20.0U	20.0	100		ug/L
100-42-5	Styrene	20.0U	20.0	100		ug/L
1634-04-4	tert-Butyl methyl ether (MTBE)	20.0U	20.0	100		ug/L
98-06-6	tert-Butylbenzene	20.0U	20.0	100		ug/L
127-18-4	Tetrachloroethene	20.0U	20.0	100		ug/L
108-88-3	Toluene	20.0U	20.0	100		ug/L
156-60-5	trans-1,2-Dichloroethene	20.0U	20.0	100		ug/L
10061-02-6	trans-1,3-Dichloropropene	20.0U	20.0	100		ug/L
110-57-6	trans-1,4-Dichloro-2-butene	50.0U	50.0	500		ug/L
79-01-6	**Trichloroethene**	**36.7J**	20.0	100		ug/L
75-69-4	Trichlorofluoromethane	20.0U	20.0	100		ug/L
76-13-1	Trichlorotrifluoroethane	20.0U	20.0	100		ug/L
108-05-4	Vinyl acetate	20.0U	20.0	100		ug/L
75-01-4	**Vinyl chloride**	**6460**	20.0	100		ug/L
CAS#	**Surrogate**	**Conc Spiked**	**Conc Rec**	**Units**	**%Recovery**	**%Rec Limits**
460-00-4	4-Bromofluorobenzene	5000	5600	ug/L	112	78 - 130
1868-53-7	Dibromofluoromethane	5000	5410	ug/L	108	77 - 127
2037-26-5	Toluene d8	5000	5720	ug/L	114	76 - 134
17060-07-0	1,2-Dichloroethane-d4	5000	5110	ug/L	102	71 - 127

EPA RSK-175

*Results And limits are adjusted for dilution.

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	10	12/28/21 16:02	730506	BMR	NA

CAS#	Parameter	Result	DL	LOQ	Units
124-38-9	**Carbon Dioxide**	**61800**	1270	9000	ug/L

AM23G

*Results And limits are adjusted for dilution.

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	10	01/06/22 02:54	730991	SLL2	NA

CAS#	Parameter	Result	DL	LOQ	Units
64-19-7	**Acetic Acid**	**44**	1.2	5.0	mg/L
107-92-6	Butyric Acid	0.58U	0.58	5.0	mg/L
64-18-6	**Formic Acid**	**38**	0.55	5.0	mg/L
142-62-1	**Hexanoic Acid**	**0.79J**	0.58	5.0	mg/L
646-07-1	i-Hexanoic Acid	0.56U	0.56	5.0	mg/L
503-74-2	i-Pentanoic Acid	0.61U	0.61	5.0	mg/L
50-21-5	Lactic Acid	0.53U	0.53	5.0	mg/L
109-52-4	Pentanoic Acid	0.56U	0.56	5.0	mg/L
79-09-4	**Propionic Acid**	**20**	0.53	5.0	mg/L
127-17-3	Pyruvic Acid	0.60U	0.60	5.0	mg/L

Sample Results

MW-46-43C	Collect Date	12/14/2021 09:35	Lab ID	22112159002
	Receive Date	12/15/2021 11:00	Matrix	Water

SM 2320 B-2011

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	1	12/27/21 11:12	730442	RYC	NA

CAS#	Parameter	Result	DL	LOQ	Units
000000-00-5	**Total Alkalinity**	**432**	0.26	1.0	mg/L CaCO3

SM 5310 B-2014

*Results And limits are adjusted for dilution.

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	2	12/23/21 18:31	730256	JGD	NA

CAS#	Parameter	Result	DL	LOQ	Units
C-012	**Total Organic Carbon**	**48.6**	0.600	4.00	mg/L

EPA RSK175

Prep Date	Prep Batch	Prep Method	Dilution	Run Date	Run Batch	Analyst	%Moisture
NA	NA	NA	1	12/26/21 21:15	730335	AWE	NA

CAS#	Parameter	Result	DL	LOQ	Units
74-84-0	**Ethane**	**20**	0.17	1.0	ug/L
74-85-1	**Ethene**	**2900**	0.24	1.0	ug/L
74-82-8	**Methane**	**4000**	2.0	5.0	ug/L

GC/MS Volatiles QC Summary

Analytical Batch 730486												
	Client ID	MB730486		LCS730486				LCSD730486				
	Lab ID	2291441		2291442				2291443				
	Sample Type	MB		LCS				LCSD				
	Prep Date	NA		NA				NA				
	Analysis Date	12/28/21 10:31		12/28/21 08:21				12/28/21 08:42				
	Matrix	Water		Water				Water				
EPA 8260C		Units Result	ug/L DL	Spike Added	Result	%R	Control Limits%R	Spike Added	Result	%R	RPD	RPD Limit
1,1,1,2-Tetrachloroethane	630-20-6	0.200U	0.200	50.0	51.3	103	75 - 124	50.0	50.9	102	1	30
1,1,1-Trichloroethane	71-55-6	0.200U	0.200	50.0	51.6	103	76 - 126	50.0	48.7	97	6	30
1,1,2,2-Tetrachloroethane	79-34-5	0.200U	0.200	50.0	43.4	87	70 - 122	50.0	42.5	85	2	30
1,1,2-Trichloroethane	79-00-5	0.200U	0.200	50.0	45.7	91	72 - 121	50.0	47.2	94	3	30
1,1-Dichloroethane	75-34-3	0.200U	0.200	50.0	50.7	101	74 - 127	50.0	48.7	97	4	30
1,1-Dichloroethene	75-35-4	0.200U	0.200	50.0	53.2	106	69 - 129	50.0	49.2	98	8	20
1,1-Dichloropropene	563-58-6	0.200U	0.200	50.0	54.4	109	72 - 131	50.0	50.8	102	7	30
1,2,3-Trichloropropane	96-18-4	0.200U	0.200	50.0	45.9	92	70 - 120	50.0	42.9	86	7	30
1,2,4-Trichlorobenzene	120-82-1	0.200U	0.200	50.0	52.5	105	61 - 135	50.0	44.8	90	16	30
1,2,4-Trimethylbenzene	95-63-6	0.200U	0.200	50.0	52.9	106	74 - 125	50.0	46.8	94	12	30
1,2-Dibromo-3-chloropropane	96-12-8	0.200U	0.200	50.0	52.3	105	57 - 121	50.0	48.3	97	8	30
1,2-Dibromoethane	106-93-4	0.200U	0.200	50.0	49.3	99	70 - 124	50.0	48.5	97	2	30
1,2-Dichlorobenzene	95-50-1	0.200U	0.200	50.0	48.0	96	71 - 126	50.0	44.2	88	8	30
1,2-Dichloroethane	107-06-2	0.200U	0.200	50.0	45.7	91	71 - 129	50.0	43.6	87	5	30
1,2-Dichloropropane	78-87-5	0.200U	0.200	50.0	47.7	95	72 - 128	50.0	47.4	95	1	30
1,3,5-Trimethylbenzene	108-67-8	0.200U	0.200	50.0	52.0	104	71 - 132	50.0	45.1	90	14	30
1,3-Dichlorobenzene	541-73-1	0.200U	0.200	50.0	48.1	96	74 - 126	50.0	44.2	88	8	30
1,3-Dichloropropane	142-28-9	0.200U	0.200	50.0	46.5	93	74 - 122	50.0	46.3	93	0	30
1,4-Dichlorobenzene	106-46-7	0.200U	0.200	50.0	46.5	93	72 - 122	50.0	44.4	89	5	30
2,2-Dichloropropane	594-20-7	0.200U	0.200	50.0	58.5	117	77 - 124	50.0	54.4	109	7	30
2-Butanone	78-93-3	0.200U	0.200	250	287	115	58 - 137	250	273	109	5	30
2-Chloroethylvinyl ether	110-75-8	1.00U	1.00	250	191	76	56 - 124	250	192	77	1	30
2-Chlorotoluene	95-49-8	0.200U	0.200	50.0	52.5	105	72 - 127	50.0	45.7	91	14	30
2-Hexanone	591-78-6	0.500U	0.500	250	256	102	50 - 135	250	252	101	2	30
4-Chlorotoluene	106-43-4	0.200U	0.200	50.0	50.5	101	75 - 126	50.0	45.2	90	11	30
4-Isopropyltoluene	99-87-6	0.200U	0.200	50.0	53.4	107	71 - 129	50.0	45.8	92	15	30
4-Methyl-2-pentanone	108-10-1	0.200U	0.200	250	213	85	57 - 132	250	240	96	12	30
Acetone	67-64-1	0.500U	0.500	250	354	142	44 - 156	250	328	131	8	30
Acrolein	107-02-8	2.50U	2.50	250	244	98	30 - 160	250	246	98	1	30
Acrylonitrile	107-13-1	1.00U	1.00	250	259	104	64 - 137	250	260	104	0	30
Benzene	71-43-2	0.200U	0.200	50.0	50.8	102	70 - 129	50.0	48.4	97	5	20
Bromobenzene	108-86-1	0.200U	0.200	50.0	46.4	93	71 - 120	50.0	42.4	85	9	30
Bromochloromethane	74-97-5	0.200U	0.200	50.0	50.4	101	76 - 130	50.0	47.4	95	6	30
Bromodichloromethane	75-27-4	0.200U	0.200	50.0	50.0	100	74 - 125	50.0	50.8	102	2	30
Bromoform	75-25-2	0.250U	0.250	50.0	49.3	99	64 - 122	50.0	49.8	100	1	30
Bromomethane	74-83-9	0.500U	0.500	50.0	36.5	73	47 - 138	50.0	42.3	85	15	30
Carbon disulfide	75-15-0	0.200U	0.200	50.0	53.3	107	69 - 136	50.0	48.8	98	9	30
Carbon tetrachloride	56-23-5	0.250U	0.250	50.0	54.4	109	76 - 128	50.0	50.9	102	7	30
Chlorobenzene	108-90-7	0.200U	0.200	50.0	51.0	102	74 - 123	50.0	49.1	98	4	20
Chloroethane	75-00-3	0.250U	0.250	50.0	51.3	103	62 - 141	50.0	53.1	106	3	30
Chloroform	67-66-3	0.200U	0.200	50.0	50.7	101	75 - 122	50.0	48.2	96	5	30
Chloromethane	74-87-3	0.200U	0.200	50.0	46.4	93	59 - 132	50.0	45.5	91	2	30
cis-1,2-Dichloroethene	156-59-2	0.200U	0.200	50.0	50.9	102	73 - 130	50.0	50.5	101	1	30
cis-1,3-Dichloropropene	10061-01-5	0.200U	0.200	50.0	52.7	105	71 - 132	50.0	50.8	102	4	30
Dibromochloromethane	124-48-1	0.200U	0.200	50.0	49.0	98	71 - 123	50.0	49.5	99	1	30
Dibromomethane	74-95-3	0.250U	0.250	50.0	47.6	95	72 - 129	50.0	48.5	97	2	30
Dichlorodifluoromethane	75-71-8	0.200U	0.200	50.0	58.1	116	58 - 140	50.0	58.2	116	0	30
Ethylbenzene	100-41-4	0.200U	0.200	50.0	49.9	100	74 - 126	50.0	47.7	95	5	30
Hexachlorobutadiene	87-68-3	0.500U	0.500	50.0	57.3	115	61 - 144	50.0	48.3	97	17	30
Isopropylbenzene (Cumene)	98-82-8	0.200U	0.200	50.0	51.8	104	71 - 125	50.0	48.9	98	6	30
m,p-Xylene	m,p-Xylene	0.200U	0.200	100	105	105	74 - 126	100	98.3	98	7	30
Methyl iodide	74-88-4	0.500U	0.500	50.0	42.1	84	57 - 141	50.0	40.9	82	3	30
Methylene chloride	75-09-2	0.476J	0.200	50.0	42.5	85	68 - 132	50.0	47.9	96	12	30
Naphthalene	91-20-3	0.200U	0.200	50.0	50.5	101	57 - 138	50.0	47.5	95	6	35
n-Butylbenzene	104-51-8	0.200U	0.200	50.0	46.6	93	69 - 134	50.0	43.6	87	7	30
n-Propylbenzene	103-65-1	1.00U	1.00	50.0	49.6	99	75 - 129	50.0	42.6	85	15	30
o-Xylene	95-47-6	0.200U	0.200	50.0	50.4	101	73 - 130	50.0	49.1	98	3	30
sec-Butylbenzene	135-98-8	0.200U	0.200	50.0	49.3	99	70 - 136	50.0	45.6	91	8	30

GC/MS Volatiles QC Summary

Analytical Batch	Client ID	MB730486		LCS730486				LCSD730486				
730486	Lab ID	2291441		2291442				2291443				
	Sample Type	MB		LCS				LCSD				
	Prep Date	NA		NA				NA				
	Analysis Date	12/28/21 10:31		12/28/21 08:21				12/28/21 08:42				
	Matrix	Water		Water				Water				
EPA 8260C		Units Result	ug/L DL	Spike Added	Result	%R	Control Limits%R	Spike Added	Result	%R	RPD	RPD Limit
Styrene	100-42-5	0.200U	0.200	50.0	50.4	101	71 - 127	50.0	49.1	98	3	30
tert-Butyl methyl ether (MTBE)	1634-04-4	0.200U	0.200	50.0	51.0	102	71 - 125	50.0	49.7	99	3	30
tert-Butylbenzene	98-06-6	0.200U	0.200	50.0	52.0	104	72 - 126	50.0	46.4	93	11	30
Tetrachloroethene	127-18-4	0.200U	0.200	50.0	50.7	101	68 - 128	50.0	48.4	97	5	30
Toluene	108-88-3	0.200U	0.200	50.0	43.7	87	72 - 120	50.0	46.1	92	5	20
trans-1,2-Dichloroethene	156-60-5	0.200U	0.200	50.0	50.5	101	69 - 132	50.0	46.5	93	8	30
trans-1,3-Dichloropropene	10061-02-6	0.200U	0.200	50.0	56.1	112	71 - 131	50.0	55.0	110	2	30
trans-1,4-Dichloro-2-butene	110-57-6	0.500U	0.500	50.0	47.4	95	56 - 132	50.0	45.9	92	3	30
Trichloroethene	79-01-6	0.200U	0.200	50.0	52.3	105	76 - 129	50.0	48.8	98	7	20
Trichlorofluoromethane	75-69-4	0.200U	0.200	50.0	51.5	103	72 - 136	50.0	53.3	107	3	30
Trichlorotrifluoroethane	76-13-1	0.200U	0.200	50.0	58.8	118	72 - 136	50.0	52.7	105	11	30
Vinyl acetate	108-05-4	0.200U	0.200	50.0	50.6	101	54 - 147	50.0	50.6	101	0	30
Vinyl chloride	75-01-4	0.200U	0.200	50.0	50.1	100	68 - 132	50.0	52.7	105	5	30
Surrogate	**CAS#**	**Rec**	**%R**	**Added**	**Rec**	**%R**	**Limits**	**Added**	**Rec**	**%**	**RPD**	**Limit**
1,2-Dichloroethane-d4	17060-07-0	50	100	50	48.9	98	71 - 127	50	48.9	98	NA	NA
4-Bromofluorobenzene	460-00-4	50.5	101	50	51.3	103	78 - 130	50	51.7	103	NA	NA
Dibromofluoromethane	1868-53-7	50.7	101	50	52.2	104	77 - 127	50	50.6	101	NA	NA
Toluene d8	2037-26-5	49.5	99	50	46.6	93	76 - 134	50	50	100	NA	NA

GC Volatiles QC Summary

Analytical Batch 730506	Client ID	MB730506		LCS730506				LCSD730506				
	Lab ID	2291492		2291493				2291494				
	Sample Type	MB		LCS				LCSD				
	Prep Date	NA		NA				NA				
	Analysis Date	12/28/21 15:28		12/28/21 15:34				12/28/21 15:41				
	Matrix	Water		Water				Water				
EPA RSK-175		Units Result	ug/L DL	Spike Added	Result	%R	Control Limits%R	Spike Added	Result	%R	RPD	RPD Limit
Carbon Dioxide	124-38-9	127U	127	8700	9060	104	38 - 147	8700	10300	118	13	40

General Chemistry QC Summary

Analytical Batch 730442			
Client ID	MB730442	LCS730442	LCSD730442
Lab ID	2291327	2291328	2291329
Sample Type	MB	LCS	LCSD
Prep Date	NA	NA	NA
Analysis Date	12/27/21 11:12	12/27/21 11:12	12/27/21 11:12
Matrix	Water	Water	Water

SM 2320 B-2011		Units Result	mg/L CaCO3 DL	Spike Added	Result	%R	Control Limits%R	Spike Added	Result	%R	RPD	RPD Limit
Total Alkalinity	000000-00-5	0.26U	0.26	200	195	98	90 - 110	200	194	97	1	11

Analytical Batch 730991			
Client ID	MB730991	LCS730991	LCSD730991
Lab ID	2293496	2293497	2294437
Sample Type	MB	LCS	LCSD
Prep Date	NA	NA	NA
Analysis Date	01/05/22 22:18	01/05/22 21:43	01/05/22 21:43
Matrix	Water	Water	Water

AM23G		Units Result	mg/L DL	Spike Added	Result	%R	Control Limits%R	Spike Added	Result	%R	RPD	RPD Limit
Acetic Acid	64-19-7	0.12U	0.12	2.0	1.8	89	70 - 130	2.0	1.8	89	0	20
Butyric Acid	107-92-6	0.058U	0.058	2.0	1.6	83	70 - 130	2.0	1.6	83	0	20
Formic Acid	64-18-6	0.055U	0.055	2.0	1.9	95	70 - 130	2.0	1.9	95	0	20
Hexanoic Acid	142-62-1	0.058U	0.058	2.0	1.9	94	70 - 130	2.0	1.9	94	0	20
i-Hexanoic Acid	646-07-1	0.056U	0.056	2.0	2.5	123	70 - 130	2.0	2.5	123	0	20
i-Pentanoic Acid	503-74-2	0.061U	0.061	2.0	2.3	117	70 - 130	2.0	2.3	117	0	20
Lactic Acid	50-21-5	0.053U	0.053	2.0	2.4	119	70 - 130	2.0	2.4	119	0	20
Pentanoic Acid	109-52-4	0.056U	0.056	2.0	2.6	128	70 - 130	2.0	2.6	128	0	20
Propionic Acid	79-09-4	0.053U	0.053	2.0	1.9	96	70 - 130	2.0	1.9	96	0	20
Pyruvic Acid	127-17-3	0.060U	0.060	2.0	1.8	89	70 - 130	2.0	1.8	89	0	20

Analytical Batch 730256			
Client ID	MB730256	LCS730256	LCSD730256
Lab ID	2290628	2290629	2290630
Sample Type	MB	LCS	LCSD
Prep Date	NA	NA	NA
Analysis Date	12/23/21 14:39	12/23/21 13:44	12/23/21 20:35
Matrix	Water	Water	Water

SM 5310 B-2014		Units Result	mg/L DL	Spike Added	Result	%R	Control Limits%R	Spike Added	Result	%R	RPD	RPD Limit
Total Organic Carbon	C-012	0.300U	0.300	50.0	49.6	99	90 - 110	50.0	49.8	100	0	20

General Chromatography QC Summary

Analytical Batch 730335	Client ID	MB730335		LCS730335					LCSD730335				
	Lab ID	2290955		2290956					2290957				
	Sample Type	MB		LCS					LCSD				
	Prep Date	NA		NA					NA				
	Analysis Date	12/26/21 17:27		12/26/21 16:53					12/26/21 17:05				
	Matrix	Water		Water					Water				
EPA RSK175		Units Result	ug/L DL	Spike Added	Result	%R	Control Limits%R		Spike Added	Result	%R	RPD	RPD Limit
Ethane	74-84-0	0.17U	0.17	97	100	103	70 - 130		97	100	105	2	30
Ethene	74-85-1	0.24U	0.24	120	120	103	70 - 130		120	130	106	2	30
Methane	74-82-8	2.2J	2.0	380	360	93	70 - 130		380	360	94	1	30

CHAIN-OF-CUSTODY Analytical Request Document

Pace Analytical®

Chain-of-Custody is a LEGAL DOCUMENT - Complete all relevent fields

LAB USE ONLY- Affix Workorder/Login Label Here

Client ID: wsp-c - WSP Environmental & Energy
SDG: 221121590
PM: RWe

ALL SHADED AREAS are for LAB USE ONLY

Company: WSP USA
Address:
Billing Information:
Report To: JEFFREY.BAKER@WSP.COM
Email To:
Copy To:
Site Collection Info/Address:
Customer Project Name/Number: FORMER EPT 31401545.001-05
State: / County/City: Time Zone Collected: [ ] PT [ ] MT [ ] CT [ ] ET
Phone: 724-882-9973
Email:
Site/Facility ID #:
Compliance Monitoring? [ ] Yes [ ] No
Collected By (print): NATE WINSTON
Purchase Order #:
Quote #:
DW PWS ID #:
DW Location Code:
Collected By (signature): [signature]
Turnaround Date Required: STANDARD
Immediately Packed on Ice: [ ] Yes [ ] No
Sample Disposal: [X] Dispose as appropriate [ ] Return [ ] Archive: ______ [ ] Hold: ______
Rush: [ ] Same Day [ ] Next Day [ ] 2 Day [ ] 3 Day [ ] 4 Day [ ] 5 Day (Expedite Charges Apply)
Field Filtered (if applicable): [ ] Yes [ ] No
Analysis: ______

Container Preservative Type **

** Preservative Types: (1) nitric acid, (2) sulfuric acid, (3) hydrochloric acid, (4) sodium hydroxide, (5) zinc acetate, (6) methanol, (7) sodium bisulfate, (8) sodium thiosulfate, (9) hexane, (A) ascorbic acid, (B) ammonium sulfate, (C) ammonium hydroxide, (D) TSP, (U) Unpreserved, (O) Other ______

* Matrix Codes (Insert in Matrix box below): Drinking Water (DW), Ground Water (GW), Wastewater (WW), Product (P), Soil/Solid (SL), Oil (OL), Wipe (WP), Air (AR), Tissue (TS), Bioassay (B), Vapor (V), Other (OT)

Customer Sample ID	Matrix *	Comp / Grab	Collected (or Composite Start) Date	Time	Composite End Date	Time	Res Cl	# of Ctns	CO_2 AM20GAX	Ethane, Ethene, Methane RSK175	Volatile Fatty Acids AM23G	TOC SM 5310C-2011	Alkalinity SM2320B-2011	VOCs 8260D	Lab Sample # / Comments
MW-5-40	AQ	G	12/14/21	1015	—			13	X	X	X	X	X	X	1
MW-46-43C	AQ	G	12/14/21	0935	—			13	X	X	X	X	X	X	2
TRIP BLANK	—	—	—	—	—			2						X	3

Lab Profile/Line:
Lab Sample Receipt Checklist:
Custody Seals Present/Intact Y N NA
Custody Signatures Present Y N NA
Collector Signature Present Y N NA
Bottles Intact Y N NA
Correct Bottles Y N NA
Sufficient Volume Y N NA
Samples Received on Ice Y N NA
VOA - Headspace Acceptable Y N NA
USDA Regulated Soils Y N NA
Samples in Holding Time Y N NA
Residual Chlorine Present Y N NA
Cl Strips: ______
Sample pH Acceptable Y N NA
pH Strips: ______
Sulfide Present Y N NA
Lead Acetate Strips: ______

LAB USE ONLY:
Lab Sample # / Comments:

Customer Remarks / Special Conditions / Possible Hazards:

Type of Ice Used: Wet Blue Dry None
Packing Material Used: 5484 1197 9450
Radchem sample(s) screened (<500 cpm): Y N NA

SHORT HOLDS PRESENT (<72 hours): Y N N/A
Lab Tracking #: 2739134
Samples received via: FEDEX UPS Client Courier Pace Courier

Lab Sample Temperature Info:
Temp Blank Received: Y N NA
Therm ID#: ______
Cooler 1 Temp Upon Receipt: ____oC
Cooler 1 Therm Corr. Factor: ____oC
Cooler 1 Corrected Temp: ____oC
Comments: 3.7 E38

Relinquished by/Company: (Signature)	Date/Time:	Received by/Company: (Signature)	Date/Time:	MTJL LAB USE ONLY
[signature]	12/14/21 1600			Table #: Acctnum:
FedEx	12/15/21 1100	[signature]	12/15/21 1100	Template: Prelogin:
				PM: PB:

Trip Blank Received: Y N NA
HCL MeOH TSP Other

Non Conformance(s): YES / NO
Page: ______ of: ______

SAMPLE RECEIVING CHECKLIST

Pace Analytical®

221121590

SAMPLE DELIVERY GROUP 221121590	
Client **PM** RWe wsp-c - WSP Environmental & Energy	**Transport Method** FEDEX
Profile Number 284637	**Received By** Roberts, George S.
Line Item(s) 1 - water	**Receive Date(s)** 12/15/21

CHECKLIST	YES	NO
Samples received with proper thermal preservation?	☑	☐
Radioactivity is <1600 cpm? If no, record cpm value in notes section.	☑	☐
COC relinquished and complete (including sampleIDs, collect times, and sampler)?	☑	☐
All containers received in good condition and within hold time?	☑	☐
All sample labels and containers received match the chain of custody?	☑	☐
Preservative added to any containers?	☐	☑
If received, was headspace for VOC water containers < 6mm?	☑	☐
Samples collected in containers provided by Pace Gulf Coast?	☑	☐

COOLERS

Airbill	Thermometer ID: E38	Temp °C
548411979450		3.7

DISCREPANCIES

None

LAB PRESERVATIONS

None

NOTES

Revision 1.6

Page 1 of 1

microbialinsights

10515 Research Drive
Knoxville, TN 37932
Phone: (865) 573-8188
Fax: (865) 573-8133

Client:	Jeffrey Baker WSP USA Buildings Inc. 2202 N West Shore Blvd Suite 300 Tampa, FL 33607	**Phone:** **Fax:**	724-882-9723

Identifier: 077SL **Date Rec:** 12/15/2021 **Report Date:** 02/15/2022

Client Project #: 31401545.001 - 05 **Client Project Name:** Former EPT Ithaca

Purchase Order #:

Test results provided for: CSIA

Reviewed By:

MICROBIAL INSIGHTS, INC.

10515 Research Dr., Knoxville, TN 37932
Tel. (865) 573-8188 Fax. (865) 573-8133

CSIA

Client:	**WSP USA Buildings Inc.**	**MI Project Number:**	**077SL**
Project:	Former EPT Ithaca	Date Received:	12/15/2021

Sample Information

Client Sample ID:	**MW-5-40**
Sample Date:	12/14/2021
Analyst/Reviewer:	MW/KK

Carbon	Units	
$^{13}C/^{12}C$ 1,1-DCE (‰)	$\delta^{13}C$, VPDB (‰)	**NA**
$^{13}C/^{12}C$ cis-DCE (‰)	$\delta^{13}C$, VPDB (‰)	**-15.7**
$^{13}C/^{12}C$ PCE (‰)	$\delta^{13}C$, VPDB (‰)	**NA**
$^{13}C/^{12}C$ TCE (‰)	$\delta^{13}C$, VPDB (‰)	**-32.6**
$^{13}C/^{12}C$ Trans-DCE (‰)	$\delta^{13}C$, VPDB (‰)	**NA**
$^{13}C/^{12}C$ Vinyl Chloride (‰)	$\delta^{13}C$, VPDB (‰)	**-37.0**

Legend:

NA= Not Analyzed NS=Not Sampled J= Estimated concentration below PQL but above LQL ND= Not Detected

Quality Assurance/Quality Control Data

Samples Received **12/15/2021**

Component	Date Prepared	Date Analyzed	Arrival Temperature	Positive Control (‰ Std. Dev.)*	Blank
$^{13}C/^{12}C$ TCE (‰)	12/15/2021	02/15/2022	5 °C	0.1	Pass
$^{13}C/^{12}C$ PCE (‰)	12/15/2021	02/15/2022	5 °C	0.1	Pass
$^{13}C/^{12}C$ cis-DCE (‰)	12/15/2021	02/15/2022	5 °C	0.1	Pass
$^{13}C/^{12}C$ Vinyl Chloride (‰)	12/15/2021	02/15/2022	5 °C	0.3	Pass

* $\delta^{13}C$ positive control values are within +- 0.5‰ of true value.

microbialinsights

10515 Research Drive
Knoxville, TN 37932
Phone: (865) 573-8188
Fax: (865) 573-8133

Client: Jeffrey Baker
WSP USA Buildings Inc.
2202 N West Shore Blvd
Suite 300
Tampa, FL 33607

Phone: 724-882-9723

Fax:

Identifier: 034TB **Date Rec:** 02/11/2022 **Report Date:** 02/17/2022

Client Project #: 31401545.001 - 05 **Client Project Name:** Former EPT

Purchase Order #:

Test results provided for: PLFA

Reviewed By:

Kate Clark

Results relate only to the items tested and the sample(s) as received by the laboratory.

MICROBIAL INSIGHTS, INC.

10515 Research Dr., Knoxville, TN 37932
Tel. (865) 573-8188 Fax. (865) 573-8133

PLFA

Client:	**WSP USA Buildings Inc.**	**MI Project Number:**	**034TB**
Project:	Former EPT	Date Received:	02/11/2022

Sample Information

Sample Name:	**MW-5-40**
Sample Date:	02/10/2022
Sample Matrix:	Std. Bio-Trap
Analyst/Reviewer:	AT/KC

Biomass Concentrations

Total Biomass (cells/bead)	**1.72E+06**

Community Structure (% total PLFA)

Firmicutes (TerBrSats)	**5.91**
Proteobacteria (Monos)	**67.34**
Anaerobic metal reducers (BrMonos)	**3.37**
SRB/Actinomycetes (MidBrSats)	**0.89**
General (Nsats)	**22.03**
Eukaryotes (polyenoics)	**0.47**

Physiological Status (Proteobacteria only)

Slowed Growth	**1.57**
Decreased Permeability	**0.07**

Legend:
NA = Not Analyzed NS = Not Sampled

PLFA

Client: **WSP USA Buildings Inc.**
Project: Former EPT

MI Project Number: **034TB**
Date Received: 02/11/2022

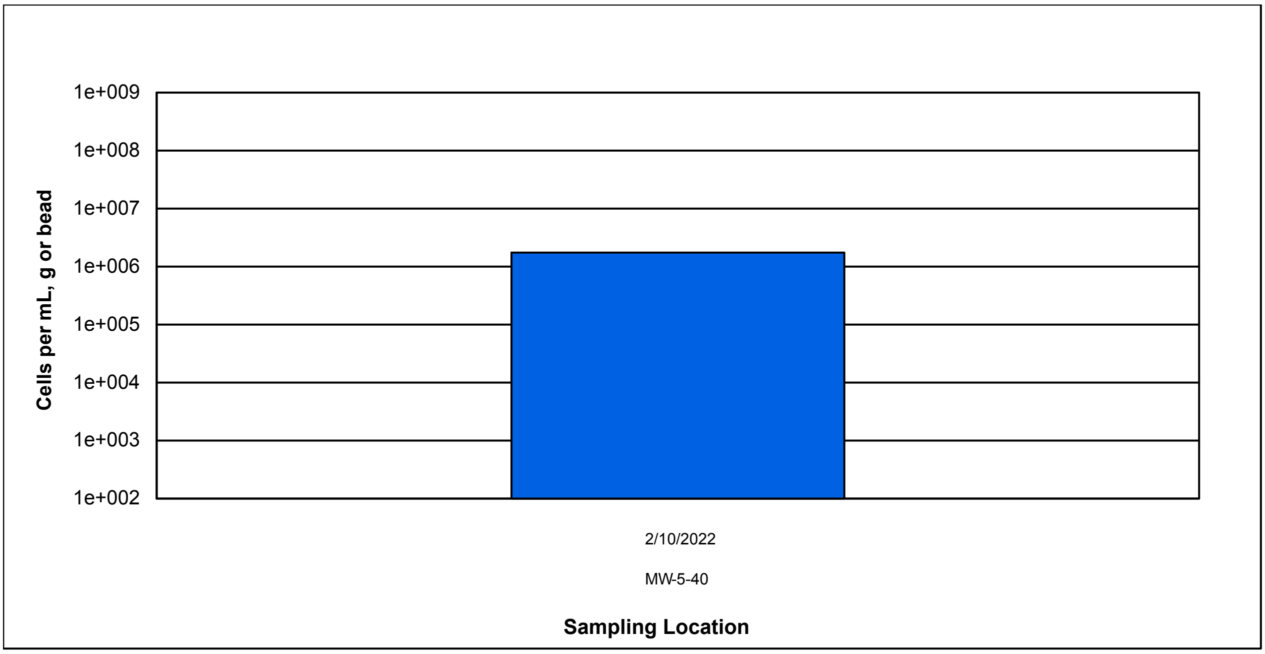

Figure 1. Biomass content is presented as a cell equivalent based on the total amount of phospholipid fatty acids (PLFA) extracted from a given sample. Total biomass is calculated based upon PLFA attributed to bacterial and eukaryotic biomass

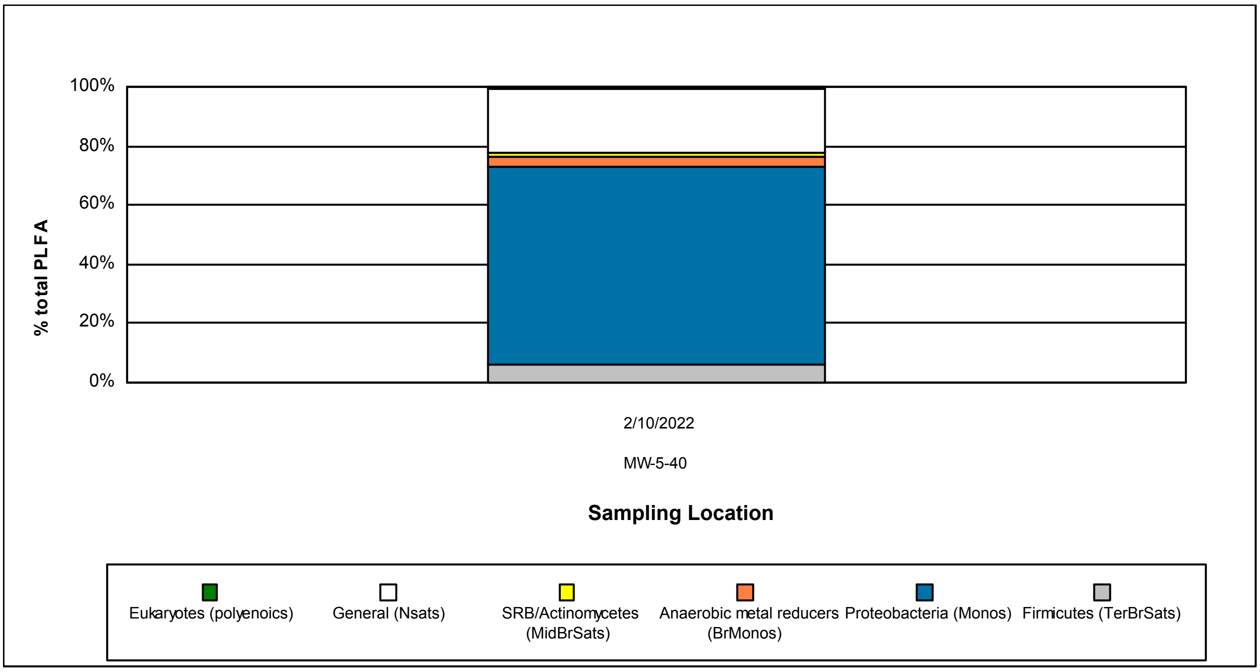

Figure 2. Relative percentages of total PLFA structural groups in the samples analyzed. Structural groups are assigned according to PLFA chemical structure, which is related to fatty acid biosynthesis.

Quality Assurance/Quality Control Data

Samples Received **2/11/2022**

Component	Date Prepared	Date Analyzed	Arrival Temperature	Positive Control	Extraction Blank	Negative Control
PLFA	02/11/2022	02/17/2022	0 °C	117%	non-detect	non-detect