

To: Jack Abel

From: Bob Bond and Gerald Nicholls

Info: Michael Burke

Date: April 12, 2018

Re: March 2018 Compound Specific Isotope Analysis (CSIA) Groundwater Results
J&H Holding Company
491 Wortman Avenue, Brooklyn, NY 11208
Langan Project No.: 170329301

Introduction

Langan Engineering and Environmental Services, Inc. (Langan) has prepared this technical memorandum to document our findings related to the March 2018 Compound Specific Isotope Analysis (CSIA) groundwater results. The purpose of this initial sampling event was to determine how the fractionation of specific isotopes is being affected by, and attributed to on-site sources versus off-site sources, naturally occurring bioremediation processes and the ongoing soil vapor extraction (SVE)/Air Sparging remediation.

Methodology

The CSIA method utilizes gas chromatography to separate compounds in complex mixtures, an interface that completely combusts each compound as they individually elute from the gas chromatograph, and an isotope ratio mass spectrometer to determine the stable (not radioactive) isotopic compositions of the individual compounds. The isotopic signature can be shaped by several variables such as brand of parent solvent, biodegradation and evaporation. CSIA analysis on Tetrachloroethene (PCE) measures the isotopic ratios of light and heavy carbon (C^{12} and C^{13}) and chlorine (Cl^{35} and Cl^{37}) and for Trichloroethene (TCE) the isotopic ratios of carbon, chlorine and hydrogen (H^1 and H^2). Three CSIA samples were collected on March 1, 2018 from monitoring wells MW-3AM, MW-06, and MW-08 in conjunction with a regularly scheduled groundwater monitoring event. The well locations are shown on Figure 1. The three samples were run for the following:

- $^{13}C/^{12}C$ CSIA for PCE
- $^{13}C/^{12}C$ CSIA for TCE
- $^{37}Cl/^{35}Cl$ CSIA for PCE
- $^{37}Cl/^{35}Cl$ CSIA for TCE

Hydrogen isotopes were not run on TCE because insufficient concentrations (less than 20 micrograms per liter) were present in MW-3AM and MW-08. Carbon and Chlorine isotope analyses can be accomplished with as little as 1 microgram per liter.

Technical Memorandum

March 2018 Compound Specific Isotope Analysis (CSIA) Groundwater

Results

J&H Holding Company

491 Wortman Avenue, Brooklyn, NY 11208

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Results

The data collected in March 2018 were reduced in a $d^{13}C/d^{37}Cl$ plot (Figure 2). The laboratory CSIA report is in Attachment A. The standard nomenclature for reporting is called the delta value (δ) and is the ratio expressed relative to an international standard in parts per thousand. The $d^{13}C/d^{37}Cl$ plot (Figure 2) also shows a range of values from literature for both manufactured PCE (red box) and manufactured TCE (blue box).

The dissolved PCE sampled from MW3AM plots solidly in the manufactured PCE range, which indicates that it is relatively undegraded PCE. When PCE degrades each molecule loses one chlorine atom (replaced by one hydrogen from groundwater) and becomes TCE. The small amount of daughter product TCE (1.9 ug/L) relative to PCE (11 ug/l) (see Table 1) and the plotting of TCE next to PCE on the $d^{13}C/d^{37}Cl$ plot indicate that both PCE and TCE in MW-3AM are relatively undegraded. The lack of other TCE daughter products 1,2-Dichloroethene (1,2-DCE) and Vinyl chloride (VC) is an additional indication of the relative undegraded nature of the PCE and TCE in MW3AM. Monitoring well MW3AM is located near the former on-site source area for PCE, therefore this is an expected result. The remedy in-place is SVE/air sparging, which will promote evaporation of PCE and TCE from the water table surface. Evaporation does have a minor effect on carbon and chlorine fractionation; the residual PCE and TCE will be slightly depleted in heavier C^{13} and will therefore remain fairly light and negative (in the manufactured box). Chlorine in the residual groundwater PCE and TCE, however, will become heavier with evaporation (more C^{37}), which we are not seeing in Figure 2.

The dissolved PCE sampled from MW06 and MW08 plot outside the manufactured PCE range, which indicates that this dissolved PCE has undergone some bioremediation, which has a strong isotopic fractionation effect. Both carbon and chlorine will get heavier (enriched in C^{13} and C^{37}), which is less negative on the axes of Figure 2, when biological dechlorination is occurring. Both MW-06 and MW08 have historically shown the daughter products TCE, 1,2-DCE and VC, which is also strong evidence of natural bioremediation. The TCE in MW06 and MW08 plot more negative (lighter) than the PCE from those wells. When biological organisms respire on a chlorinated solvent molecule, such as PCE, they preferentially utilize the lighter carbon isotopes so that the heavier $d^{13}C$ content of the daughter product is depleted relative to the parent compound. So, the TCE isotope results support that the TCE is likely coming from the dechlorination of PCE.

The PCE and TCE in MW06 are relatively more degraded than any other wells tested for isotopic fractionation. This is evidenced by the carbon and chlorine CSIA data as well as the occurrence of daughter products (Table 1), specifically MW06 is the only CSIA well with reported VC in 2018, and historically has exhibited more VC than the other two wells.

Conclusions

CSIA analysis serves as a valuable tool in investigating commingled plumes and measuring bioremediation. The information obtained from the initial CSIA analysis of three monitoring wells does not provide conclusive evidence of more than one source. However, the data does indicate that the chlorinated VOC plume monitored by MW06 is potentially more degraded and

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Results

J&H Holding Company

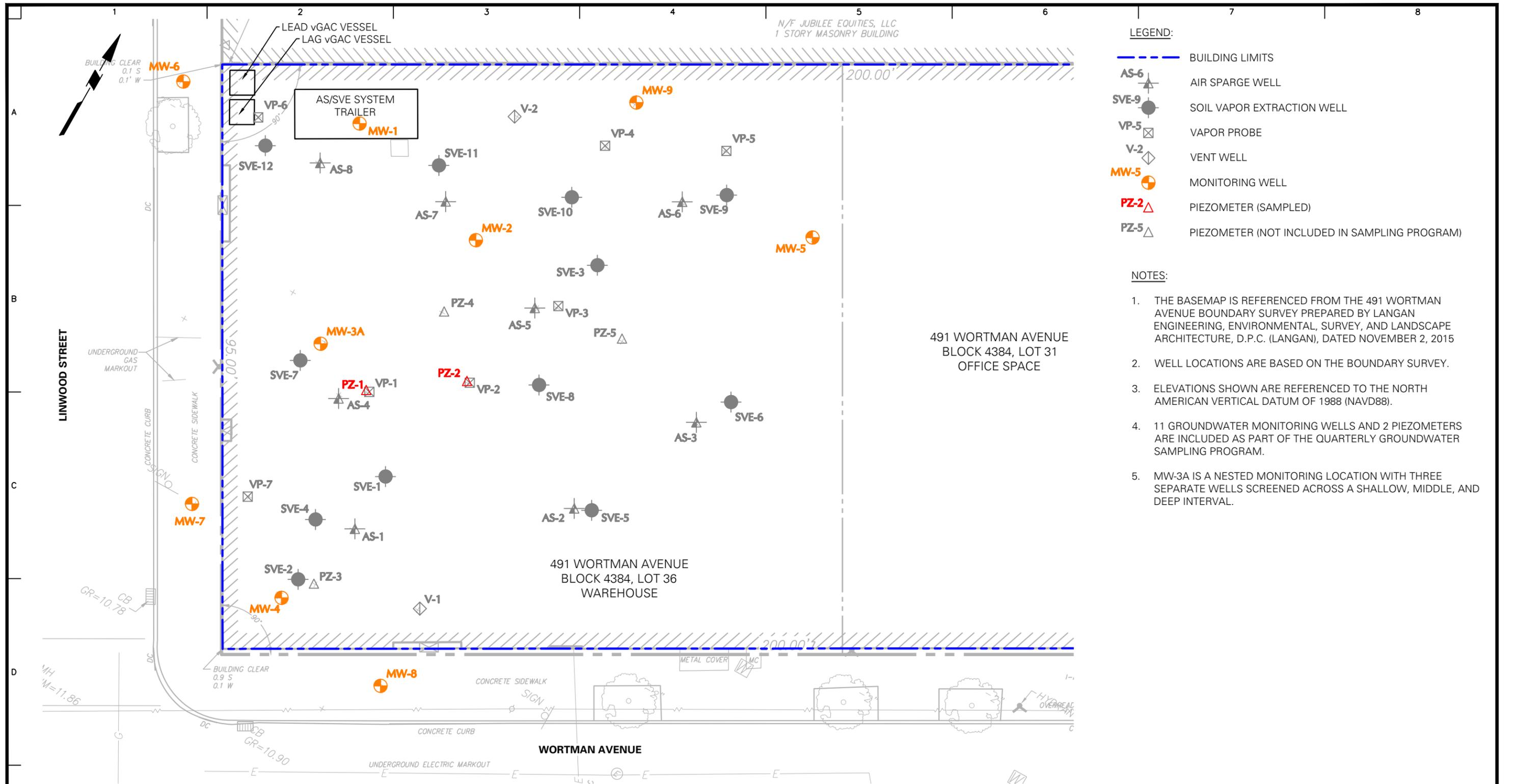
491 Wortman Avenue, Brooklyn, NY 11208

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therefore is possibly older. A more degraded plume can indicate a more distal source or an older spill or better conditions for bioremediation. This information should be incorporated into the hydrogeological conceptual site model to develop a holistic model of site conditions.

Figure 1 – Well Location Map



- LEGEND:**
- BUILDING LIMITS
 - AIR SPARGE WELL
 - SOIL VAPOR EXTRACTION WELL
 - VAPOR PROBE
 - VENT WELL
 - MONITORING WELL
 - PIEZOMETER (SAMPLED)
 - PIEZOMETER (NOT INCLUDED IN SAMPLING PROGRAM)

- NOTES:**
1. THE BASEMAP IS REFERENCED FROM THE 491 WORTMAN AVENUE BOUNDARY SURVEY PREPARED BY LANGAN ENGINEERING, ENVIRONMENTAL, SURVEY, AND LANDSCAPE ARCHITECTURE, D.P.C. (LANGAN), DATED NOVEMBER 2, 2015
 2. WELL LOCATIONS ARE BASED ON THE BOUNDARY SURVEY.
 3. ELEVATIONS SHOWN ARE REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
 4. 11 GROUNDWATER MONITORING WELLS AND 2 PIEZOMETERS ARE INCLUDED AS PART OF THE QUARTERLY GROUNDWATER SAMPLING PROGRAM.
 5. MW-3A IS A NESTED MONITORING LOCATION WITH THREE SEPARATE WELLS SCREENED ACROSS A SHALLOW, MIDDLE, AND DEEP INTERVAL.

WARNING: IT IS A VIOLATION OF THE NYS EDUCATION LAW ARTICLE 145 FOR ANY PERSON, UNLESS HE IS ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, TO ALTER THIS ITEM IN ANY WAY.



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 Langan Engineering and Environmental Services, Inc.
 Langan CT, Inc.
 Langan International LLC
 Collectively known as Langan

Project
491 WORTMAN AVENUE
BLOCK No. 4384, LOT Nos. 31 & 36
BROOKLYN
KINGS NEW YORK

Figure Title
ON-SITE GROUNDWATER MONITORING LOCATIONS

Project No. 170329301	Figure No. 1
Date 01/21/2016	
Scale AS SHOWN	
Drawn By TCS	Checked By GN
Submission Date	Sheet 3 of 3

Figure 2 – d13C/d37Cl Plot

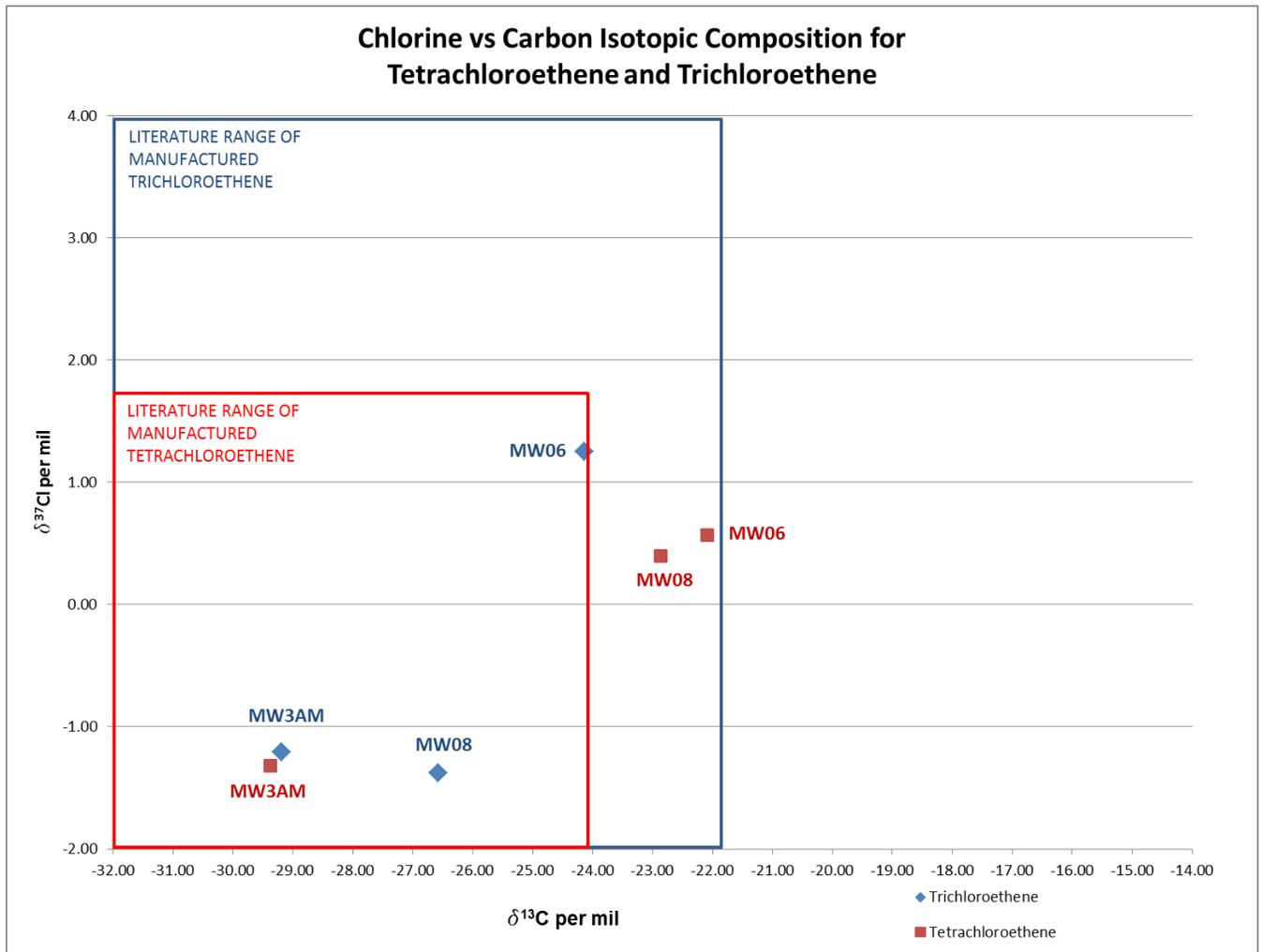


Table 1 – Tabulated VOC Concentration Data (March 1, 2018)

Monitoring Well	Trichloroethene				Tetrachloroethene			
	Concentration µg/L	Natural Log Concentration	$\delta^{13}\text{C}$	$\delta^{37}\text{Cl}$	Concentration µg/L	Natural Log Concentration	$\delta^{13}\text{C}$	$\delta^{37}\text{Cl}$
March 01, 2018								
MW3AM	1.9	0.64	-29.18	-1.21	11.0	2.40	-29.37	-1.32
MW06	72.0	4.28	-24.13	1.25	140.0	4.94	-22.09	0.57
MW08	2.8	1.03	-26.58	-1.38	1.9	0.64	-22.86	0.40

Attachment A – CSIA Laboratory Report



March 29, 2018

Gerry Nicholls
Langan Engineers
21 Penn Plaza
New York, NY 10011

RE: **491 WORTMAN AVE / 170329301**

Pace Workorder: 25852

Dear Gerry Nicholls:

Enclosed are the analytical results for sample(s) received by the laboratory on Friday, March 02, 2018. Results reported herein conform to the most current NELAC standards, where applicable, unless otherwise narrated in the body of the report.

If you have any questions concerning this report, please feel free to contact me.

Sincerely,

Lauren McGrath 03/29/2018
Lauren.McGrath@pacelabs.com

Customer Service Representative

Enclosures

As a valued client we would appreciate your comments on our service.
Please email PAESfeedback@pacelabs.com.

Total Number of Pages 11



CERTIFICATE OF ANALYSIS

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LABORATORY ACCREDITATIONS & CERTIFICATIONS

Accreditor:	Pennsylvania Department of Environmental Protection, Bureau of Laboratories
Accreditation ID:	02-00538
Scope:	NELAP Non-Potable Water
Accreditor:	West Virginia Department of Environmental Protection, Division of Water and Waste Management
Accreditation ID:	395
Scope:	Non-Potable Water
Accreditor:	South Carolina Department of Health and Environmental Control, Office of Environmental Laboratory Certification
Accreditation ID:	89009003
Scope:	Clean Water Act (CWA); Resource Conservation and Recovery Act (RCRA)
Accreditor:	State of Virginia
Accreditation ID:	460201
Scope:	Non-Potable Water
Accreditor:	NELAP: New Jersey, Department of Environmental Protection
Accreditation ID:	PA026
Scope:	Non-Potable Water
Accreditor:	NELAP: New York, Department of Health Wadsworth Center
Accreditation ID:	11815
Scope:	Non-Potable Water
Accreditor:	State of Connecticut, Department of Public Health, Division of Environmental Health
Accreditation ID:	PH-0263
Scope:	Clean Water Act (CWA) Resource Conservation and Recovery Act (RCRA)
Accreditor:	NELAP: Texas, Commission on Environmental Quality
Accreditation ID:	T104704453-09-TX
Scope:	Non-Potable Water
Accreditor:	State of New Hampshire
Accreditation ID:	299409
Scope:	Non-potable water
Accreditor:	State of Georgia
Accreditation ID:	Chapter 391-3-26
Scope:	As per the Georgia EPD Rules and Regulations for Commercial Laboratories, PAES is accredited by the Pennsylvania Department of Environmental Protection Bureau of Laboratories under the National Environmental Laboratory Approval Program (NELAC).



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SAMPLE SUMMARY

Workorder: 25852 491 WORTMAN AVE / 170329301

Lab ID	Sample ID	Matrix	Date Collected	Date Received
258520001	MW08-030118	Water	3/1/2018 09:35	3/2/2018 11:30
258520002	MW06-030118	Water	3/1/2018 10:45	3/2/2018 11:30
258520003	MW3AM-030118	Water	3/1/2018 12:20	3/2/2018 11:30



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ANALYTICAL RESULTS

Workorder: 25852 491 WORTMAN AVE / 170329301

Lab ID: **258520001** Date Received: 3/2/2018 11:30 Matrix: Water
 Sample ID: **MW08-030118** Date Collected: 3/1/2018 09:35

Parameters	Results	Units	PQL	MDL	DF	Analyzed	By	Qualifiers
------------	---------	-------	-----	-----	----	----------	----	------------

Compound Specific Isotopic - PAES

Analysis Desc: AM24		Analytical Method: AM24						
Carbon 13 Isotope	Complete			1		3/26/2018 00:00	JT	n
Chlorine 37 Isotope	Complete			1		3/26/2018 00:00	JT	n



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ANALYTICAL RESULTS

Workorder: 25852 491 WORTMAN AVE / 170329301

Lab ID: **258520002** Date Received: 3/2/2018 11:30 Matrix: Water
 Sample ID: **MW06-030118** Date Collected: 3/1/2018 10:45

Parameters	Results	Units	PQL	MDL	DF	Analyzed	By	Qualifiers
------------	---------	-------	-----	-----	----	----------	----	------------

Compound Specific Isotopic - PAES

Analysis Desc: AM24 Analytical Method: AM24

Carbon 13 Isotope	Complete				1	3/26/2018 00:00	JT	n
Chlorine 37 Isotope	Complete				1	3/26/2018 00:00	JT	n



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ANALYTICAL RESULTS

Workorder: 25852 491 WORTMAN AVE / 170329301

Lab ID: **258520003** Date Received: 3/2/2018 11:30 Matrix: Water
 Sample ID: **MW3AM-030118** Date Collected: 3/1/2018 12:20

Parameters	Results	Units	PQL	MDL	DF	Analyzed	By	Qualifiers
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Compound Specific Isotopic - PAES

Analysis Desc: AM24		Analytical Method: AM24						
Carbon 13 Isotope	Complete			1		3/26/2018 00:00	JT	n
Chlorine 37 Isotope	Complete			1		3/26/2018 00:00	JT	n



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ANALYTICAL RESULTS QUALIFIERS

Workorder: 25852 491 WORTMAN AVE / 170329301

DEFINITIONS/QUALIFIERS

- MDL Method Detection Limit. Can be used synonymously with LOD; Limit Of Detection.
- PQL Practical Quantitation Limit. Can be used synonymously with LOQ; Limit Of Quantitation.
- ND Not detected at or above reporting limit.
- DF Dilution Factor.
- S Surrogate.
- RPD Relative Percent Difference.
- % Rec Percent Recovery.
- U Indicates the compound was analyzed for, but not detected at or above the noted concentration.
- J Estimated concentration greater than the set method detection limit (MDL) and less than the set reporting limit (PQL).
-
- n The laboratory does not hold NELAP/TNI accreditation for this method or analyte.



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Client: Langan Engineering
 21 Plenn Plaza
 New York, NY 10011
 Project: 491 Wortman Ave
 Project # 170329301
 Report to: Gerry Nicholls
 gnicholls@langan.com

Pace Analytical Energy Services
 220 William Pitt Way
 Pittsburgh, PA 15238

412-826-5245

Report of Isotope Analysis

Water samples for $\delta^{13}\text{C}$ (‰, PDB) and $\delta^{37}\text{Cl}$ (‰, SMOC) isotopic ratios

Lab Sample Number	Client's Sample ID	$\delta^{13}\text{C}$		$\delta^{37}\text{Cl}$	
		TCE	PCE	TCE	PCE
258520001	MW08-030118	-26.58	-22.86	-1.38	0.40
258520002	MW06-030118	-24.13	-22.09	1.25	0.57
258520003	MW3AM-030118	-29.18	-29.37	-1.21	-1.32

ND: Ratio Not Determined

N/A: Sample Not Analyzed

TCE: Trichloroethene

PCE: Tetrachloroethene

Method: Compound Specific Isotope Analysis for ^{13}C and ^2H by GC-IRMS, for ^{37}Cl by GC-qMS

Quality Control STDs	$\delta^{13}\text{C}$		$\delta^{37}\text{Cl}$	
	TCE	PCE	TCE	PCE
QC-1	-27.12	-27.97	-0.36	0.90
QC-2	-26.75	-27.90	-0.30	1.20
Mean	-26.93	-27.93	-0.33	1.05
Analytical Precision (1σ)	0.26	0.05	0.04	0.21

Cooler Receipt Form

Client Name: Langan Project: 491 Wartman Ave Lab Work Order: 25852

A. Shipping/Container Information (circle appropriate response)

Courier: FedEx UPS USPS Client Other: _____ Air bill Present: Yes No

Tracking Number: 7716 7116 8066

Custody Seal on Cooler/Box Present: Yes No Seals Intact: Yes No

Cooler/Box Packing Material: Bubble Wrap Absorbent Foam Other: _____

Type of Ice: Wet Blue None Ice Intact: Yes Melted

Cooler Temperature: 2.5°C Radiation Screened: Yes No Chain of Custody Present: Yes No

Comments: _____

B. Laboratory Assignment/Log-in (check appropriate response)

	YES	NO	N/A	Comment Reference non-Conformance
Chain of Custody properly filled out	✓			
Chain of Custody relinquished	✓			
Sampler Name & Signature on COC	✓			
Containers intact		✓		
Were samples in separate bags	✓			
Sample container labels match COC Sample name/date and time collected		✓		
Sufficient volume provided	✓			
PAES containers used	✓			
Are containers properly preserved for the requested testing? (as labeled)	✓			
If an unknown preservation state, were containers checked? Exception: VOA's coliform			✓	If yes, see pH form.
Was volume for dissolved testing field filtered, as noted on the COC? Was volume received in a preserved container?			✓	
Headspace present?		✓		

Comments: _____

Cooler contents examined/received by: ly Date: 3.2.18

Project Manager Review: EW Date: 3.2.18

NON-CONFORMANCE FORM

PAES Work Order #: 25852

Date: 3-2-18 Time of Receipt: 11:30 Receiver: LY

Client: Langan

REASON FOR NON-CONFORMANCE:

1. No date & time of collection on vials.
 2. MW08-030118: One vial broke.
-
-
-
-
-
-
-
-
-
-

ACTION TAKEN:

Client name: _____ Date: _____ Time: _____

Client called about broken vial.
OK to log per COC

Customer Service Initials: LW

Date: 3-2-18