



Clean Air Status and Trends Network

Second Quarter 2022 Quality Assurance Report

Summary of Quarterly Operations (April through June)

EPA Contract No. 68HERH21D0006

Introduction

This quarterly report summarizes results from the Clean Air Status and Trends Network (CASTNET) quality assurance/quality control (QA/QC) program for data collected during second quarter 2022. The various QA/QC criteria and policies are documented in the CASTNET Quality Assurance Project Plan (QAPP; Wood, 2021). The QAPP is comprehensive and includes standards and policies for all components of project operation from site selection through final data reporting. It is reviewed annually and updated as warranted.

Quarterly Summary

Wood continued incorporating comments and suggested changes made by EPA reviewers for the CASTNET Quality Assurance Project Plan (QAPP) Revision 9.5.

During mid-May 2022, Wood relocated its office, laboratories, and outdoor test site from the Newberry, FL location to its new location in Gainesville, FL. All documentation required by the American Association for Laboratory Accreditation (A2LA) to continue ISO/IEC accreditation after the move was completed and submitted to A2LA. Relocation activities included moving the analytical and field equipment laboratories separately. Perkin Elmer was hired to move select analytical instruments, and personnel from the field and laboratory groups moved smaller instruments and fragile items. A professional moving company handled the office furniture. The shelters and towers were moved by another company and were set up on the test site pad at the new office location. Operation of each of the instruments was verified prior to first use at the new location.

Preparation of the annual management review report and presentation in support of International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC) 17025:2017 accreditation continued. The management review report and presentation will include documentation of the steps taken during relocation activities.

A Level 2 transfer used for ozone performance evaluation audits and reverification of ozone Level 3 standards during the March 2022 site calibration visits had a solenoid balance failure causing the reverification of seven Level 3 transfer standards to be declared invalid. Wood restored the slope-intercept values for these Level 3 transfers and calibration factors for site analyzers back to their pre-audit values following confirmation of the solenoid balance test failure. Solenoid balance failures can be difficult to diagnose. Wood's CASTNET QA Manager began investigating the situation. In particular, the QA Manager evaluated the root cause of the continued use of the Level 2 ozone transfer after consecutive sites required adjustment. Wood's field laboratory runs a solenoid balance test prior to sending a transfer out for use in the field. While solenoid failures are hard to predict and detect, Wood does have procedures in place that should have prevented use of the transfer at multiple sites. Under Corrective Action (CA) 0115, the subcontractor field technician received follow-up training.

Additionally, under the CA-0115, if one of the affected March sites is near a site scheduled for a routine calibration trip, Wood is traveling to the March site to verify that the ozone analyzer and transfer are within criteria. For sites that do not receive a follow-up site visit, the ozone transfer will be replaced by the site operator with a verified instrument.

During Level 3 data review of atmospheric concentrations from samples analyzed from October through December 2021, several suspicious non-detects for ammonium concentrations were noted. The CASTNET LOM re-analyzed the samples and closely monitored the process. The ammonia autosampler sampling arm was failing to inject some samples. This was discovered and fixed in December 2021. The failure was sporadic. The CASTNET QA Manager and the LOM developed a corrective action plan to review previous data for anomalies.

Table 1 lists the quarters of data that were validated to Level 3 during second quarter 2022 by site calibration group. Table 2 lists the sites in each calibration group along with the calibration schedule. Table 3 presents the measurement criteria for laboratory filter pack measurements. These criteria apply to the QC samples listed in the following section of this report. Table 4 presents the critical criteria for ozone monitoring. Table 5 presents the critical criteria for trace-level gas monitoring.

Quality Control Analysis Count

The QC sample statistics presented in this report are for reference standards (RF) and continuing calibration verification spikes (CCV) used to assess accuracy and for replicate sample analyses (RP) used to assess “in-run” precision. In addition, laboratory method blanks (MB) containing reagents without a filter; laboratory blanks (LB) containing reagents and a new, unexposed filter; and field blanks (FB) containing reagents and an unexposed filter that was loaded into a filter pack assembly and shipped to and from the monitoring site while remaining in sealed packaging are also included. Table 6 presents the number of analyses in each category that were performed during second quarter.

Sample Receipt Statistics

Ninety-five percent of field samples from EPA-sponsored sites must be received by the CASTNET laboratory in Gainesville, FL no later than 14 days after removal from the sampling tower. Table 7 presents the relevant sample receipt statistics for second quarter 2022. Return shipping labels for CASTNET filter packs being returned to Wood through the U.S. Postal Service (USPS) were transitioned to priority mail during April. Each label provides Wood with a unique tracking number for each filter pack. As anticipated, priority mail is proving to be a faster level of USPS delivery. As of the end of second quarter, fewer sites are appearing on the filter pack late list.

Data Quality Indicator (DQI) Results¹

Figures 1 through 3 present the results of RF, CCV, and RP QC sample analyses for second quarter 2022. All results were within the criteria listed in Table 3.

¹ Due to the laboratory relocation noted in the quarterly summary, all figures show a two-week gap from early to late May.

Table 8 presents summary statistics of critical criteria measurements at ozone sites collected during second quarter 2022. The statistics presented contain data validated at Level 2 and Level 3. All data associated with QC checks that fail to meet the criteria listed in Table 4 were or will be invalidated unless the cause of failure has no effect on ambient data collection, and passing results still meet frequency criteria. Results in shaded cells either exceed documented criteria or are otherwise notable. Table 9 presents observations associated with the shaded cell results in Table 8.

Table 10 presents summary statistics of critical criteria measurements at trace-level gas monitoring sites collected during second quarter 2022. The statistics presented contain data validated at Level 2 and Level 3. All data associated with QC checks that fail to meet the criteria listed in Table 5 were or will be invalidated unless the cause of failure has no effect on ambient data collection, and passing results still meet frequency criteria. Results in shaded cells either exceed documented criteria or are otherwise notable. Table 11 presents observations associated with the shaded cell results in Table 10.

Laboratory Control Sample Analysis

The laboratory control sample (LCS) is a reagent blank spiked with the target analytes from the established analytical methods and carried through the same extraction process that field samples must undergo. LCS analyses are performed by the laboratory to monitor for potential sample handling artifacts and provide a means to identify possible analyte loss from extraction to extraction. Figure 4 presents LCS analysis results for second quarter 2022. All recovery values were between 88.8 percent and 106.2 percent.

Blank Results

Figures 5 through 7 present the results of MB, LB, and FB QC sample analyses for second quarter 2022. All second quarter results were within criteria (two times the reporting limit) listed in Table 3.

Suspect/Invalid Filter Pack Samples

Filter pack samples that were flagged as suspect or invalid during second quarter 2022 are listed in Table 12. This table also includes associated site identification and a brief description of the reason the sample was flagged. During second quarter, 10 filter pack samples were invalidated.

Field Problem Count

Table 13 presents counts of field problems affecting continuous data collection for more than one day for second quarter 2022. The problem counts are sorted by a 30-, 60-, or 90-day time period to resolution. A category for unresolved problems is also included. Time to resolution indicates the period taken to implement corrective action.

References

American Society for Testing and Materials (ASTM). 2008. ASTM E29-08, "Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications." ASTM International, West Conshohocken, PA, DOI:10.1520/E0029-08. www.astm.org.

U.S. Environmental Protection Agency (EPA). 2020. Title 40 *Code of Federal Regulations* Part 58, "Appendix A to Part 58 – Quality Assurance Requirements for Monitors used in Evaluations of National Ambient Air Quality Standards."

Wood Environment & Infrastructure Solutions, Inc. (Wood) 2021. *Clean Air Status and Trends Network (CASTNET) Quality Assurance Project Plan (QAPP) Revision 9.4*. Prepared for U.S. Environmental Protection Agency (EPA), Office of Air and Radiation, Clean Air Markets Division, Washington, DC. Contract No. EP-W-16-015. Gainesville, FL. <https://java.epa.gov/castnet/documents.do>.

Table 1 Data Validated to Level 3 during Second Quarter 2022

Calibration Group*	Months Available	Number of Months	Complete Quarters	Number of Quarters
E-1/SE-5	August 2021 – January 2022	6	Quarter 4 2021	1
MW-7/W-9	September 2021 – February 2022	6	Quarter 4 2021	1
E-2/MW-8	October 2021 – March 2022	6	Quarter 4 2021 – Quarter 1 2022	2

Note: * The sites contained in each calibration group are listed in Table 2.

Table 2 Field Calibration Schedule for 2022

Calibration Group	Months Calibrated	Sites Calibrated			
Eastern Sites (22 Total)					
E-1 (8 Sites)	February/August	BEL116, MD BWR139, MD	WSP144, NJ CTH110, NY	ARE128, PA PSU106, PA	PED108, VA VPI120, VA
E-2 (9 Sites)	April/October	ABT147, CT ASH135, ME	WST109, NH CAT175, NY	HWF187, NY ¹ NIC001, NY	WFM105, NY UND002, VT EGB181, ON
E-3 (5 Sites)	May/November	KEF112, PA MKG113, PA	LRL117, PA PAR107, WV	CDR119, WV	
Southeastern Sites (11 Total)					
SE-4 (7 Sites)	January/July	SND152, AL GAS153, GA	BFT142, NC CND125, NC	COW137, NC DUK008, NC ¹	SPD111, TN
SE-5 (4 Sites)	February/August	CAD150, AR IRL141, FL	SUM156, FL CVL151, MS		
Midwestern Sites (19 Total)					
MW-6 (6 Sites)	January/July	CDZ171, KY CKT136, KY	MCK131, KY MCK231, KY	PNF126, NC ¹ ESP127, TN	
MW-7 (9 Sites)	March/September	ALH157, IL BVL130, IL ²	STK138, IL VIN140, IN	RED004, MN DCP114, OH	OXF122, OH PRK134, WI QAK172, OH
MW-8 (4 Sites)	April/October	SAL133, IN HOX148, MI	ANA115, MI UVL124, MI		
Western Sites (12 Total)					
W-9 (5 Sites)	March/September	KNZ184, KS KIC003, KS	CHE185, OK SAN189, NE	ALC188, TX	
W-10 (7 Sites)	May/November	GTH161, CO ROM206, CO ³	NPT006, ID PAL190, TX	UMA009, WA CNT169, WY	PND165, WY ³

Notes: ¹ Trace-level gas calibrations are performed quarterly in January, April, July, and October.

² Trace-level gas calibrations are performed quarterly in March, June, September, and December.

³ Trace-level gas calibrations are performed quarterly in February, May, August, and November.

Table 3 Data Quality Indicators for CASTNET Laboratory Measurements

Analyte	Method	Precision ¹ (MARPD)	Accuracy ² (%)	Nominal Reporting Limits	
				mg/L	µg/Filter
Ammonium (NH ₄ ⁺)	AC	20	90–110	0.020*	0.5
Sodium (Na ⁺)	ICP-OES	20	95–105	0.005	0.125
Potassium (K ⁺)	ICP-OES	20	95–105	0.006	0.15
Magnesium (Mg ²⁺)	ICP-OES	20	95–105	0.003	0.075
Calcium (Ca ²⁺)	ICP-OES	20	95–105	0.006	0.15
Chloride (Cl ⁻)	IC	20	95–105	0.020	0.5
Nitrate (NO ₃ ⁻)	IC	20	95–105	0.008*	0.2
Sulfate (SO ₄ ²⁻)	IC	20	95–105	0.040	1.0

Notes: ¹ This column lists precision goals for both network precision calculated from co-located filter samples and laboratory precision based on replicate samples for samples > five times the reporting limit. The criterion is ± the reporting limit if the sample is ≤ five times the reporting limit.

² This column lists laboratory accuracy goals based on reference standards and continuing calibration verification spikes. The criterion is 90–110 percent for ICP-OES reference standards.

³ The reporting limit for sulfate on cellulose filters is 0.080 mg/L (2.0 µg/filter).

AC = automated colorimetry

IC = ion chromatography

ICP-OES = inductively coupled plasma-optical emission spectrometry

MARPD = mean absolute relative percent difference

mg/L = milligrams per liter

µg/Filter = micrograms per filter

* = as nitrogen

Values are rounded according to American Society for Testing and Materials (ASTM) E29-08, “Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications” (ASTM, 2008).

For more information on analytical methods and associated precision and accuracy criteria, see the CASTNET QAPP, (Wood, 2021).

Table 4 Ozone Critical Criteria*

Type of Check	Analyzer Response
Zero	Less than ± 3.1 parts per billion (ppb)
Span	Less than ± 7.1 percent between supplied and observed concentrations
Single Point QC	Less than ± 7.1 percent between supplied and observed concentrations

Notes: * Applies to CASTNET sites that are configured and operated in accordance with Part 58 of Title 40 of the *Code of Federal Regulations* (EPA, 2020). The minimum frequency for these checks is once every two weeks.

Values are rounded according to ASTM E29-08, “Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications” (ASTM, 2008).

Table 5 Trace-level Gas Monitoring Critical Criteria *

Parameter	Analyzer Response	
	Zero Check	Span Check / Single Point QC Check
SO ₂	Less than ± 1.51 ppb	Less than ± 10.1 percent between supplied and observed concentrations
NO _y	Less than ± 1.51 ppb	
CO	Less than ± 30.1 ppb	

Notes: *Applies to CASTNET sites that are configured and operated in accordance with Part 58 of Title 40 of the *Code of Federal Regulations* (EPA, 2020). The minimum frequency for these checks is once every two weeks.

Values are rounded according to ASTM E29-08, "Standard Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications" (ASTM, 2008).

SO₂ = sulfur dioxide

NO_y = total reactive oxides of nitrogen

CO = carbon monoxide

ppb = parts per billion

Table 6 QC Analysis Count for Second Quarter 2022

Filter Type	Parameter	RF Sample Count	CCV Sample Count	RP Sample Count	MB Sample Count	LB Sample Count	FB Sample Count
Teflon	SO ₄ ²⁻	59	163	66	14	22	48
	NO ₃ ⁻	59	163	66	14	22	48
	NH ₄ ⁺	28	144	66	14	22	48
	Cl ⁻	59	163	66	14	22	48
	Ca ²⁺	30	147	66	14	22	48
	Mg ²⁺	30	147	66	14	22	48
	Na ⁺	30	147	66	14	22	48
	K ⁺	30	147	66	14	22	48
Nylon	SO ₄ ²⁻	35	154	73	11	24	49
	NO ₃ ⁻	35	154	73	11	24	49
Cellulose	SO ₄ ²⁻	41	151	69	14	24	49

Table 7 Filter Pack Receipt Summary for Second Quarter 2022

Count of samples received more than 14 days after removal from tower:	22
Count of all samples received:	762
Fraction of samples received within 14 days:	0.971
Average interval in days:	5.963
First receipt date:	4/1/2022
Last receipt date:	6/30/2022

Note: Sample shipments for the Egbert, Ontario site (EGB181) are in groups of four. Samples associated with EGB181 are excluded from this statistic.

Table 8 Ozone QC Summary for Second Quarter 2022 (1 of 2)

Site ID	% Span Pass ¹	Span %D ²	% Single Point QC Pass ¹	Single Point QC %D ²	% Zero Pass ¹	Zero Average (ppb) ²
ABT147, CT	100.00	0.58	100.00	0.73	100.00	0.21
ALC188, TX	100.00	3.82	100.00	1.54	100.00	0.39
ALH157, IL	100.00	1.30	100.00	1.56	100.00	0.14
ANA115, MI	100.00	1.94	100.00	3.54	100.00	0.42
ARE128, PA	100.00	2.36	97.17	2.87	98.11	0.89
ASH135, ME	100.00	1.02	100.00	1.43	100.00	0.27
BEL116, MD	100.00	1.71	100.00	1.31	100.00	0.49
BFT142, NC	100.00	1.09	100.00	0.96	100.00	0.43
BVL130, IL	100.00	1.42	100.00	1.42	100.00	0.61
BWR139, MD	100.00	1.17	100.00	2.12	100.00	0.45
CAD150, AR	100.00	2.10	100.00	2.73	100.00	0.26
CDR119, WV	100.00	1.74	100.00	1.56	100.00	0.25
CDZ171, KY	100.00	0.56	100.00	0.61	100.00	0.20
CKT136, KY	100.00	0.67	100.00	0.80	100.00	0.14
CND125, NC	100.00	0.75	100.00	1.14	100.00	0.97
CNT169, WY	100.00	0.58	100.00	0.76	100.00	0.32
COW137, NC	100.00	0.63	100.00	1.36	100.00	0.52
CTH110, NY	100.00	0.71	100.00	0.91	100.00	0.13
CVL151, MS	100.00	2.43	100.00	2.85	100.00	0.24
DCP114, OH	100.00	1.99	100.00	1.69	100.00	0.88
DUK008, NC	100.00	1.37	100.00	1.24	100.00	0.28
ESP127, TN	100.00	2.03	100.00	1.37	100.00	0.30
GAS153, GA	100.00	3.52	100.00	3.90	100.00	0.23
GTH161, CO	100.00	1.40	100.00	1.38	100.00	0.18

Table 8 Ozone QC Summary for Second Quarter 2022 (2 of 2)

Site ID	% Span Pass ¹	Span %D ²	% Single Point QC Pass ¹	Single Point QC %D ²	% Zero Pass ¹	Zero Average (ppb) ²
HOX148, MI	100.00	2.09	100.00	2.88	100.00	0.73
HWF187, NY	100.00	1.51	100.00	1.67	100.00	0.41
IRL141, FL	100.00	1.08	100.00	1.13	100.00	1.25
KEF112, PA	100.00	0.80	100.00	0.71	100.00	0.28
LRL117, PA	100.00	1.09	100.00	0.92	100.00	0.21
MCK131, KY	100.00	1.29	100.00	1.36	100.00	0.18
MCK231, KY	100.00	0.42	100.00	0.46	100.00	0.20
MKG113, PA	100.00	0.92	100.00	1.24	100.00	0.22
NPT006, ID	100.00	3.16	100.00	1.47	100.00	0.23
OXF122, OH	100.00	2.27	100.00	2.41	100.00	0.54
PAL190, TX	90.91	2.62	79.82	3.57	82.57	1.52
PAR107, WV	100.00	0.84	100.00	0.89	100.00	0.16
PED108, VA	100.00	0.46	100.00	0.67	100.00	0.20
PND165, WY	100.00	0.78	100.00	0.91	100.00	0.24
PNF126, NC	100.00	0.43	100.00	0.77	100.00	0.41
PRK134, WI	100.00	2.00	100.00	1.96	100.00	0.23
PSU106, PA	100.00	1.53	100.00	1.56	100.00	0.43
QAK172, OH	100.00	1.32	100.00	1.35	100.00	0.33
ROM206, CO	100.00	1.27	100.00	1.48	100.00	0.48
SAL133, IN	100.00	0.38	100.00	0.33	100.00	0.23
SAN189, NE	100.00	3.22	100.00	3.27	100.00	0.60
SND152, AL	100.00	3.89	100.00	4.31	100.00	0.66
SPD111, TN	100.00	3.86	100.00	4.09	100.00	0.40
STK138, IL	100.00	2.07	100.00	1.71	100.00	0.41
SUM156, FL	91.11	10.37	91.11	10.17	100.00	0.29
UMA009, WA	100.00	1.68	100.00	1.45	100.00	0.29
UVL124, MI	100.00	1.65	100.00	1.50	100.00	0.75
VIN140, IN	100.00	2.53	100.00	2.53	100.00	0.19
VPI120, VA	100.00	0.94	100.00	0.95	100.00	0.15
WSP144, NJ	100.00	1.06	100.00	1.02	100.00	0.34
WST109, NH	100.00	0.55	100.00	0.51	100.00	0.43

Notes: ¹Percentage of comparisons that pass the criteria listed in Table 4. Values falling below 90 percent are addressed in Table 9.

²Absolute value of the average percent differences between the on-site transfer standard and the site monitor. Values exceeding the criteria listed in Table 4 are addressed in Table 9.

%D = percent difference

ppb = parts per billion

Table 9 Ozone QC Observations for Second Quarter 2022

Site ID	QC Criterion	Comments
PAL190, TX	% Single Point QC Pass % Zero Pass	The site analyzer malfunctioned in June and was replaced.
SUM156, FL	Span %D Single Point QC %D	The site analyzer malfunctioned in June and was replaced.

Note: %D = percent difference

Table 10 Trace-level Gas QC Summary for Second Quarter 2022

Parameter	% Span Pass ¹	Span %D ²	% Single Point QC Pass ¹	Single Point QC %D ²	% Zero Pass ¹	Zero Average (ppb) ²
BVL130, IL						
SO ₂	100.00	0.84	100.00	5.37	100.00	0.72
NO _y	100.00	2.13	100.00	1.74	100.00	1.01
CO	100.00	1.41	79.25	7.07	69.09	23.79
DUK008, NC						
NO _y	97.67	2.49	97.67	4.81	97.67	1.36
HWF187, NY						
NO _y	100.00	1.16	100.00	2.81	100.00	0.10
PND165, WY						
NO _y	100.00	1.92	97.83	4.34	100.00	0.25
PNF126, NC						
NO _y	95.24	7.11	100.00	1.79	100.00	0.46
ROM206, CO						
NO _y	100.00	1.84	100.00	1.90	100.00	0.52

Notes: ¹Percentage of comparisons that pass the criteria listed in Table 5. Values falling below 90 percent are addressed in Table 11.

²Absolute value of the average percent differences between the supplied and observed concentrations. Values exceeding the criteria listed in Table 5 are addressed in Table 11.

%D = percent difference

ppb = parts per billion

Table 11 Trace-level Gas QC Observations for Second Quarter 2022

Site ID	Parameter	QC Criterion	Comments
BVL130, IL	CO	% Single Point QC Pass % Zero Pass	The CO analyzer had QC check failures in May and June. A loose ethernet cable was fixed in July and resolved the issue.

Table 12 Filter Packs Flagged as Suspect or Invalid during Second Quarter 2022

Site ID	Sample No.	Reason
ASH135, ME	2216001-05	Power failure
BUF603, WY	2218005-02	The flow channel was offline for three days.
CDR119, WV	2215001-12	A power failure caused the mass flow controller to not communicate with the data logger.
DEN417, AK	2216003-05	There was a leak in the flow system.
FOR605, WY	2217005-03	The flow pump malfunctioned.
JOT403, CA	2217003-12	Flow data were missing after the first four days of the sampling week.
MCK131, KY	2214001-32	A wet Teflon filter upon receipt indicated the filter pack was compromised.
MCK231, KY	2214001-33	A wet Teflon filter upon receipt indicated the filter pack was compromised.
NIC001, NY	2219001-35	Communications issue
ROM206, CO	2219001-45	Communications issue

Table 13 Field Problems Affecting Data Collection

Days to Resolution	Problem Count
30	245
60	18
90	2
Unresolved by End of Quarter	7

Figure 1 Reference Standard Results for Second Quarter 2022 (percent recovery)

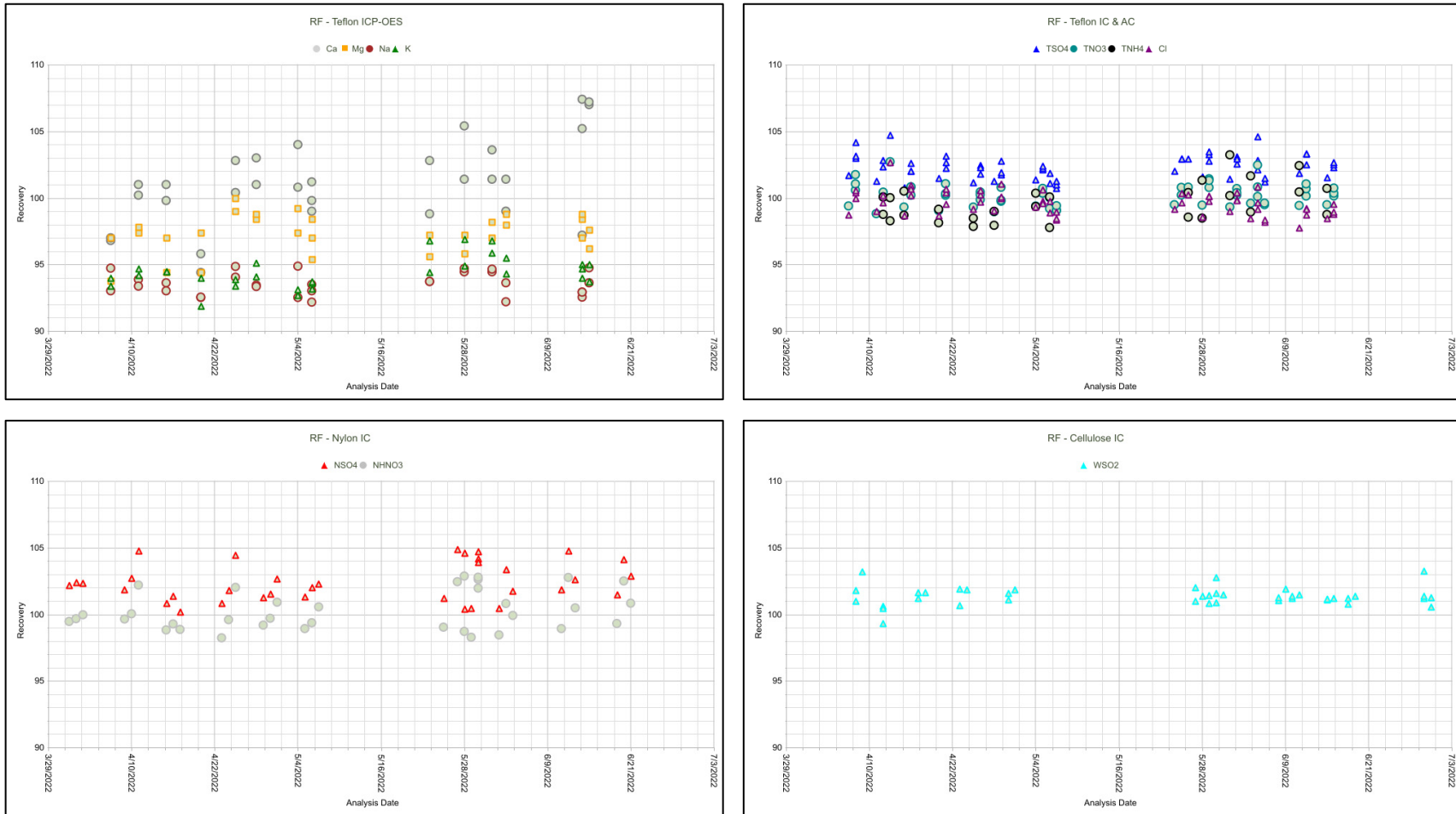


Figure 2 Continuing Calibration Spike Results for Second Quarter 2022 (percent recovery)

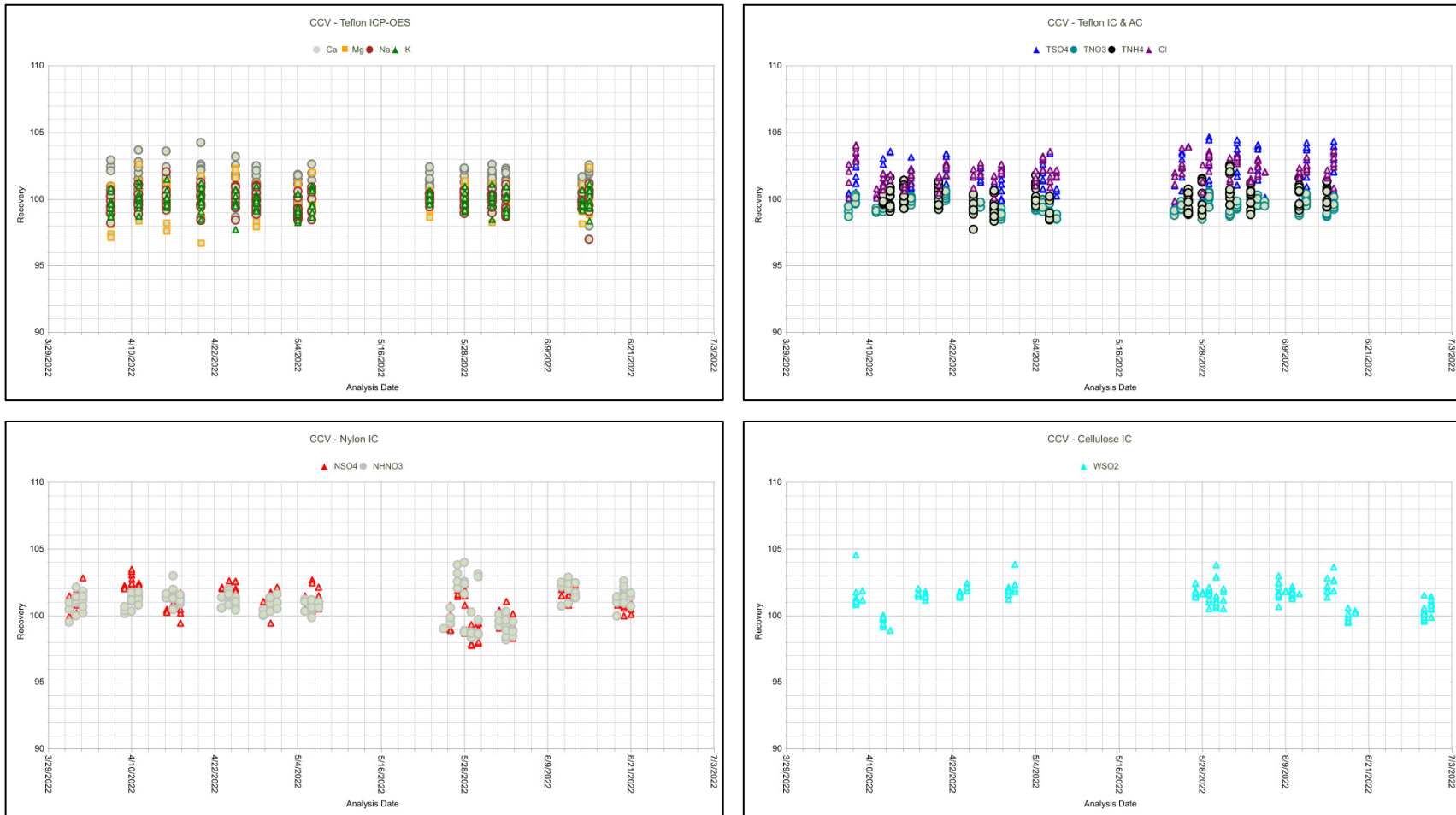


Figure 3 Replicate Sample Analysis Results for Second Quarter 2022 (percent difference)

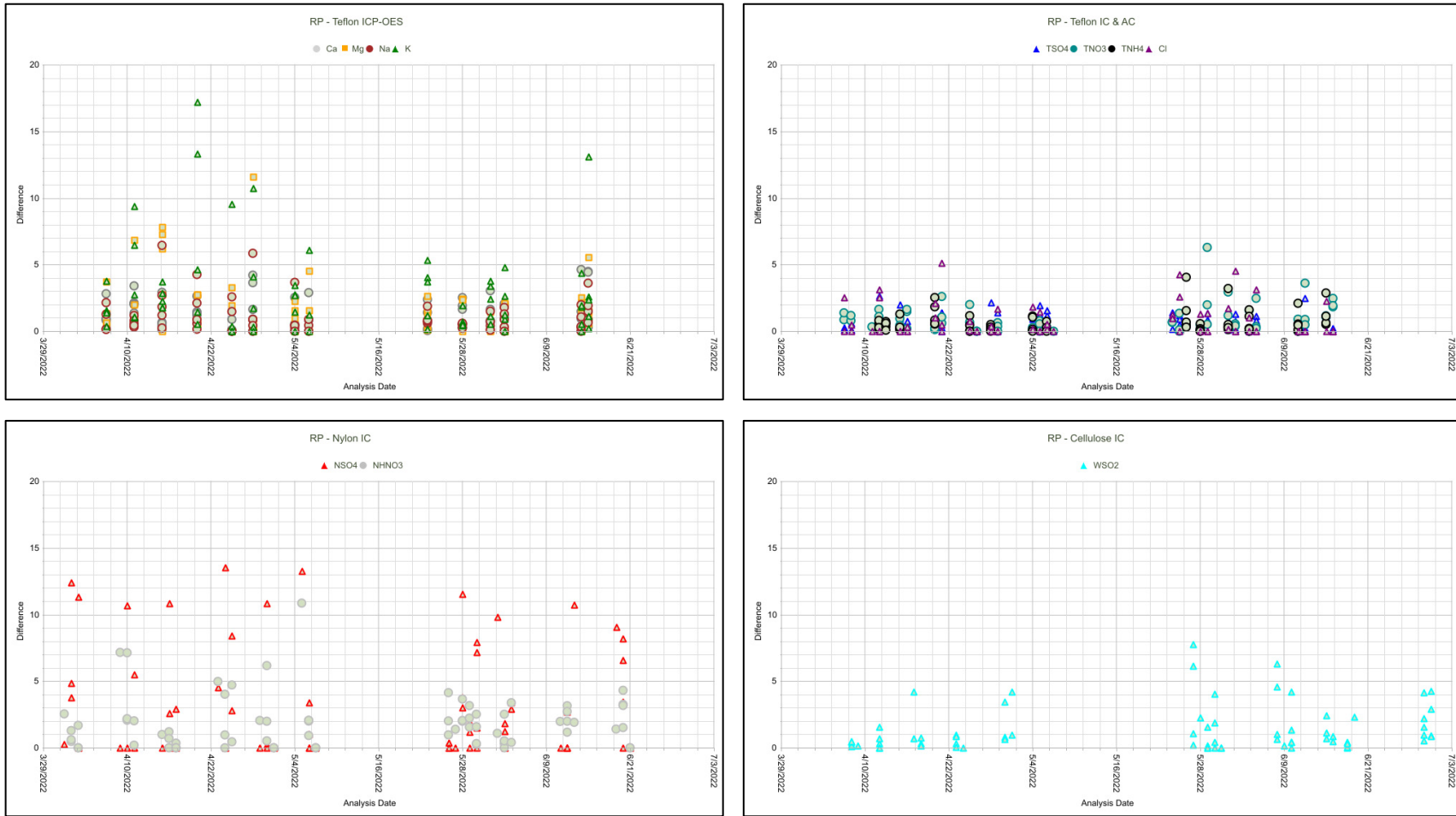


Figure 4 Laboratory Control Sample Results for Second Quarter 2022 (percent recovery)

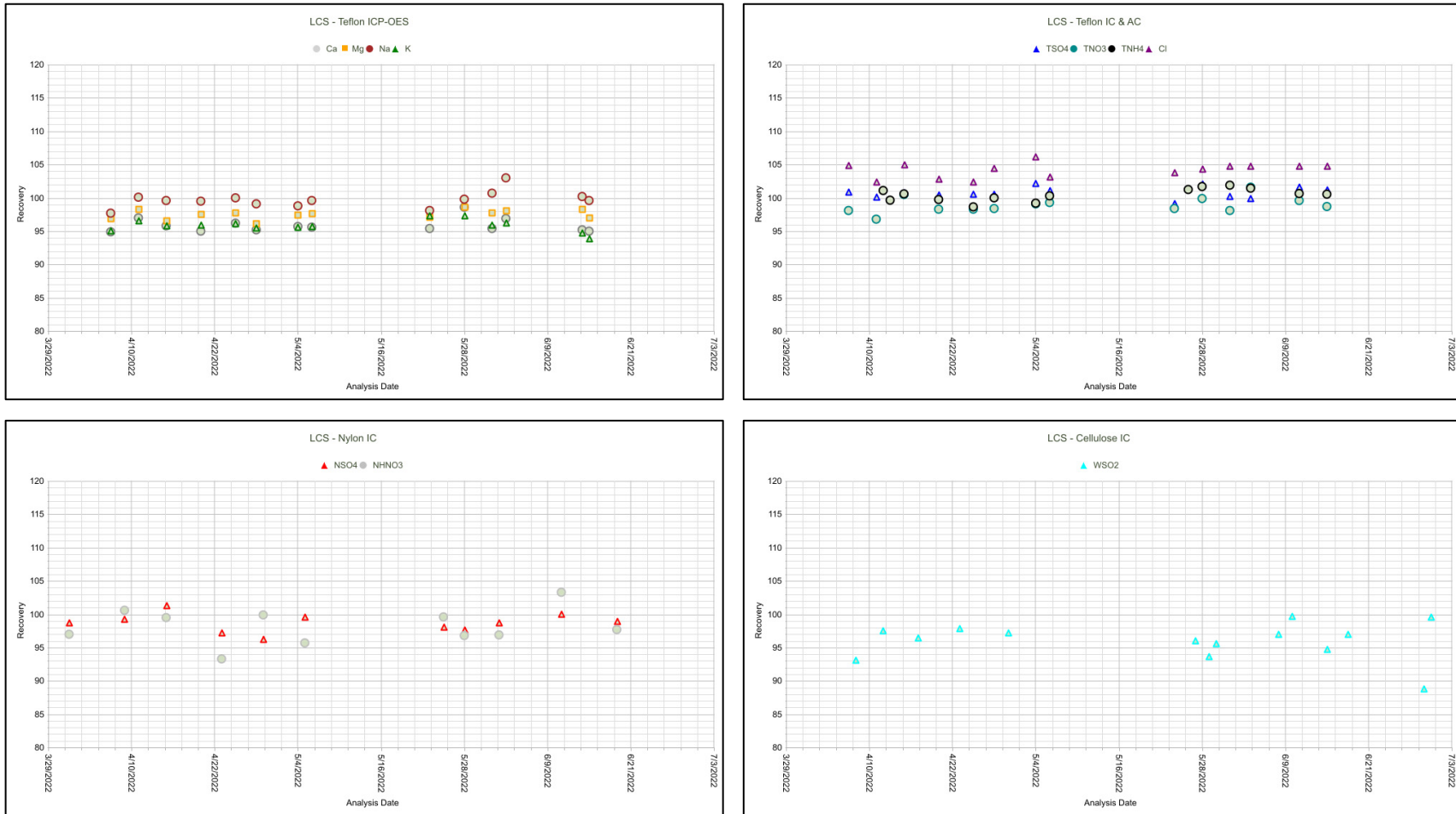


Figure 5 Method Blank Analysis Results for Second Quarter 2022 (total micrograms)

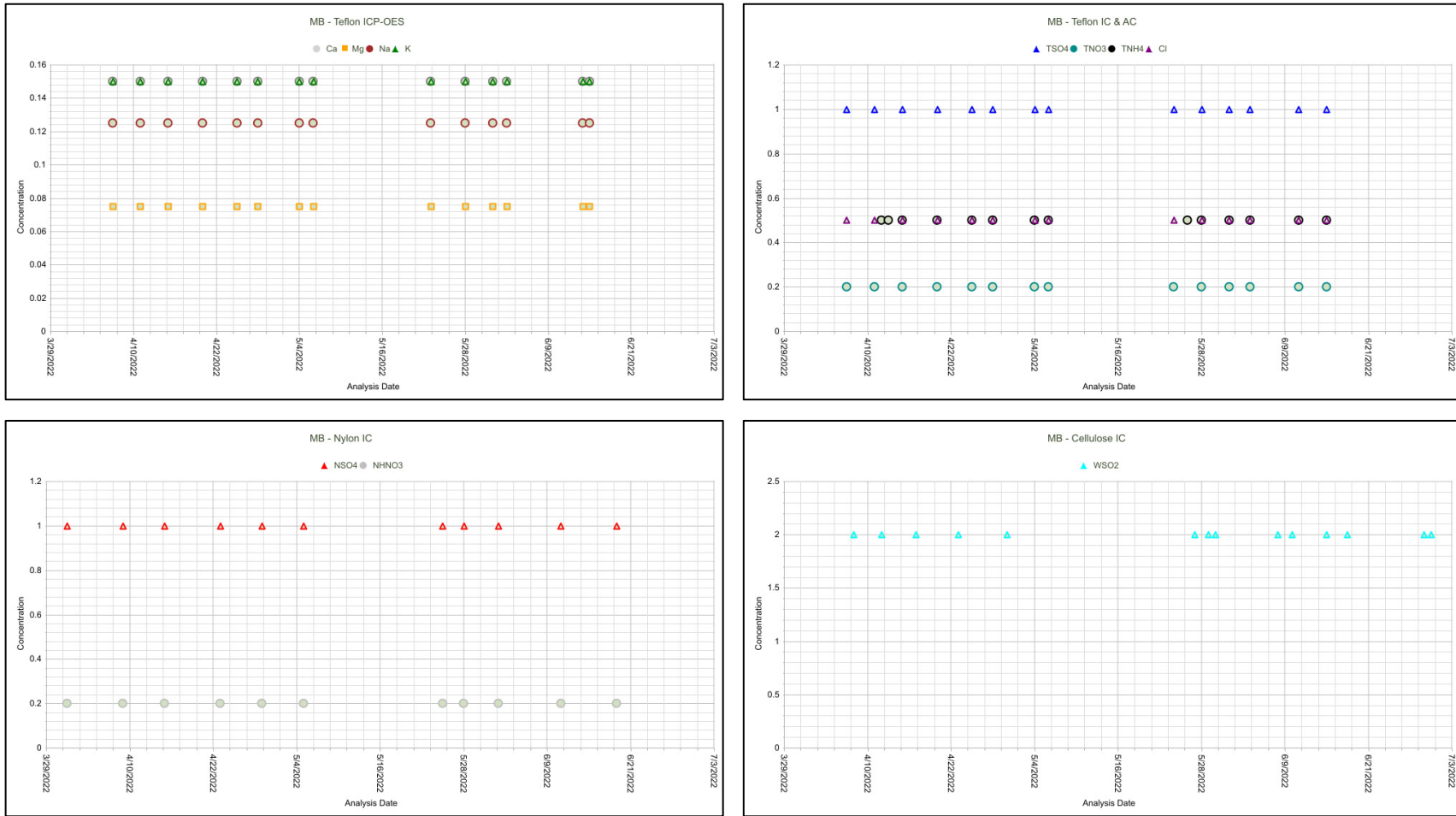


Figure 6 Laboratory Blank Analysis Results for Second Quarter 2022 (total micrograms)

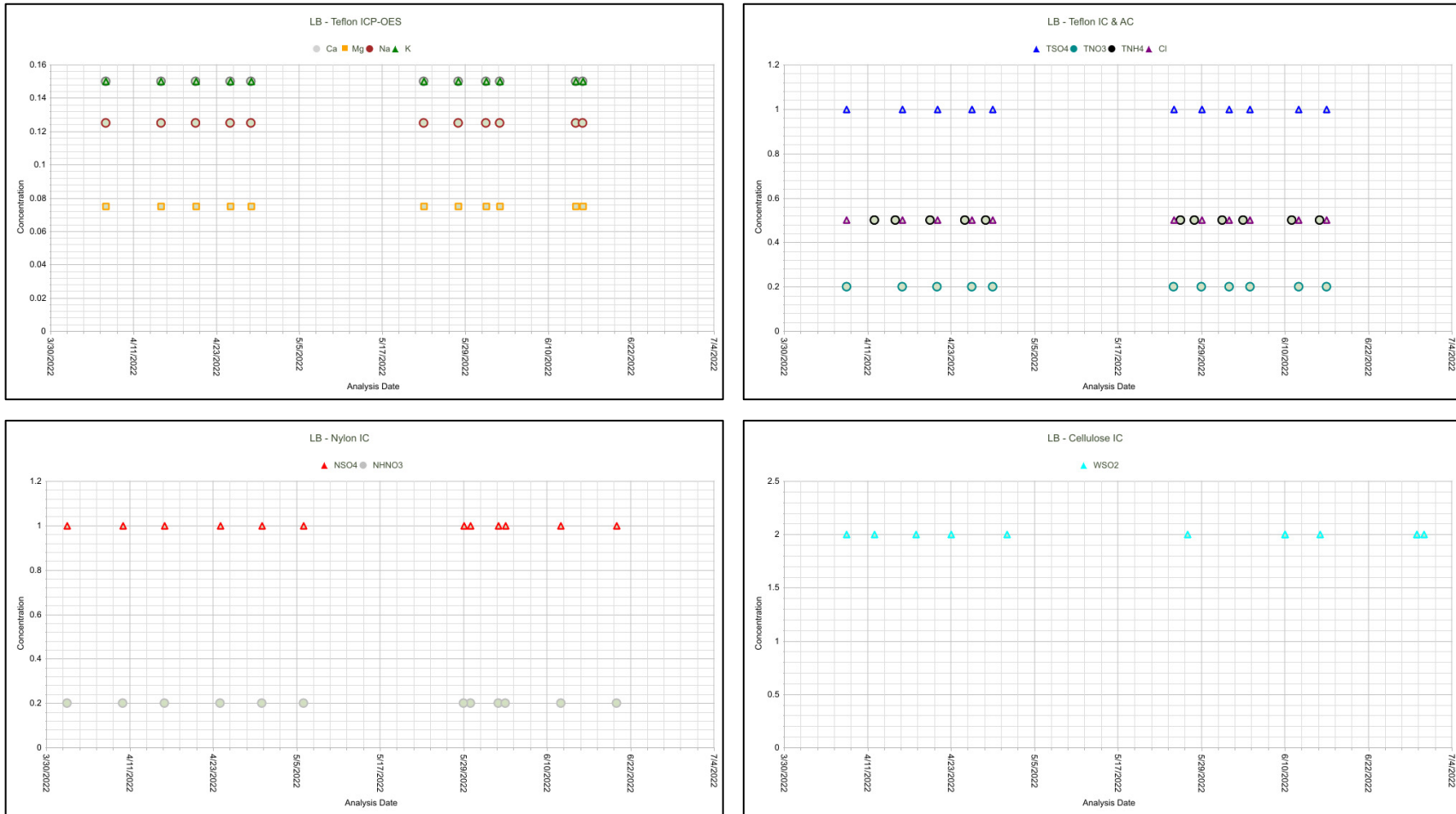


Figure 7 Field Blank Analysis Results for Second Quarter 2022 (total micrograms)

