JSC TOXICOLOGY AND ENVIRONMENTAL CHEMISTRY GROUP

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Memorandum Number

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SUBJECT: Toxicological Assessment of ISS Air and Water Quality: June 12, 2015 – September 11, 2015 (Increment 44), Including HTV-5 First Ingress

SUMMARY: Based on these data, air quality was acceptable on ISS for this period, and potable water remains acceptable for crew consumption.

AIR QUALITY

Seven mini grab sample containers (mGSCs) were collected on ISS during Increment 44 and were returned on 43S and SpX-8. Six mGSCs were collected as routine monthly samples in the US Laboratory (Lab) and the Russian Service Module (SM), the Japanese Pressurized Module (JPM), or Columbus (Col). Due to the loss of a formaldehyde resupply kit on 59P, nominal deployment of two pairs of passive-diffusion formaldehyde badges in the Lab and SM was not possible. Instead, one pair of passive-diffusion formaldehyde badges were deployed in the Lab in July, and a single formaldehyde badge was deployed in the Lab in August and September. A summary of the analytical results is provided in Table 1.

Data tables containing concentrations and corresponding T-values based on appropriate SMACs for compounds present at levels above the detection limit are enclosed. Complete data tables including compounds assessed but not detected are available upon request. The average relative recoveries of the 3 surrogate standards from the mGSCs were as follows: 13C-acetone, 95 ± 5%; fluorobenzene-d5, 100 ± 5%; and chlorobenzene-d5, 98 ± 7%. For the passive-diffusion formaldehyde badges, positive control recoveries (3 lab controls) were 104, 112, and 91%, respectively.

Table 1. Analytical Summary of ISS air analyses

Sample Location	Sample Date	NMVOCs[a] (mg/m^3)	Freon 218 (mg/m^3)	Alcohols[b] (mg/m^3)	T-Value[c] (units)	CO_2 (mg/m^3)	Formaldehyde ($\mu g/m^3$)
Lab	6/29/2015	7	97	7	0.2	3300	41
SM	6/29/2015	7	99	7	0.1	4300	--
Lab	8/12/2015	12	103	11	0.2	8400	38
JPM	8/12/2015	12	101	11	0.2	8300	--
HTV-5 Ingress	8/25/2015	21	4	8	(2.6) 2.9	3800	--
Lab	9/9/2015	16	72	15	0.2	5400	36
Col	9/9/2015	16	85	15	0.3	6500	--
Guideline		*<25*	---	*<5*	*<1*[d]	*<7100*[e]	*<120*

[a]Non-methane volatile organic hydrocarbons, excluding Freon 218
[b]Includes acetone
[c]Sum of the ratios of the measured concentration and the corresponding 180-day SMAC for each compound, excluding CO_2; parentheses indicate value based on 7-day SMACs and applicable to first ingress
[d]T-value <1 used to evaluate routine monthly sampling; <3 used to evaluate first ingress
[e]CO_2 to be controlled as low as reasonably achievable (ALARA) – currently 3 mmHg (7100 mg/m^3) or lower

During Increment 44, Air Quality Monitor (AQM) unit 1 (S/N 1003) remained inoperable, so data reported were obtained from AQM unit 2 (S/N 1004), which was located in the US Lab for the duration of the Increment. Automated AQM sampling sessions are scheduled every 73 hours, which results in 2-3 sampling sessions per unit per week and ensures that samples are taken on different days of the week and at different time of day over the course of an Increment. Nominally, data are received weekly. Monthly average concentrations as well as the Increment average concentrations are presented in Table 2.

Table 2. Average monthly concentrations (mg/m^3) of AQM target compounds.

	Jun	Jul	Aug	Sept	Average
2-Propanol	--	--	--	--	--
Acetone	--	--	--	--	--
Acrolein	--	--	--	--	--
Benzene	--	--	--	--	--
1,2-Dichloroethane	--	--	--	--	--
Decamethylcyclopentasiloxane &	1.5#	1.4#	1.5#	1.6#	1.5#
Hexanal	--	--	--	--	--
Hexane	--	--	--	--	--
m,p-Xylenes	ND#	ND#	ND#	ND#	ND#
Methanol	--	--	--	--	--
o-Xylene	TRACE#	TRACE#	TRACE#	TRACE#	TRACE#
Octamethylcylcotetrasiloxane	ND#	ND#	ND#	ND#	ND#
Toluene	ND#	ND#	ND#	ND#	ND#
2-Butanone	ND	ND	ND	ND	ND
Acetaldehyde	0.3	0.2	0.4	0.3	0.3
Dichloromethane	0.1	0.1	TRACE	0.1	0.1
Ethanol	3.7	4.6	7.6*	5.6	5.4
Ethyl Acetate	ND	TRACE	TRACE	TRACE	TRACE
Hexamethycyclotrisiloxane	0.8	0.9	0.9	0.8	0.9
n-Butanol	TRACE	TRACE	TRACE	TRACE	TRACE
Trimethylsilanol	TRACE	0.1	0.2	0.2	0.2

#Data reported are from the non-prime Unit 2 as available

&Decamethylcyclopentasiloxane (DMCPS) is trending only

*AQM calibration range for ethanol = 0.2 – 7.1 mg/m^3; Values exceeding the calibration range are estimates

Toxicological Evaluation of ISS Air Quality

Routine monthly mGSC sampling provides a limited set of samples but is complementary to in-flight air monitoring data collected by the AQM. **All measured values (mGSC and AQM) met T-value guideline criteria (T < 1 for monthly samples and T < 3 for first ingress sample), indicating no concern for crew health.** The average T-value for Increment 44 calculated from the routine mGSC samples was 0.2 (Figure 1). Despite the loss of AQM Unit 1, the average T-value calculated from the AQM data (Figure 2) was comparable (0.25) because the primary contributors to the T-value, hexamethylcyclotrisiloxane (HMCTS), acetaldehyde, trimethylsilanol (TMS), and decamethylcyclopentasiloxane (DMCPS), are all measured on Unit 2. This value is approximately half of historical averages, likely due to the installation of carbon filters in Node 1 in May 2015.

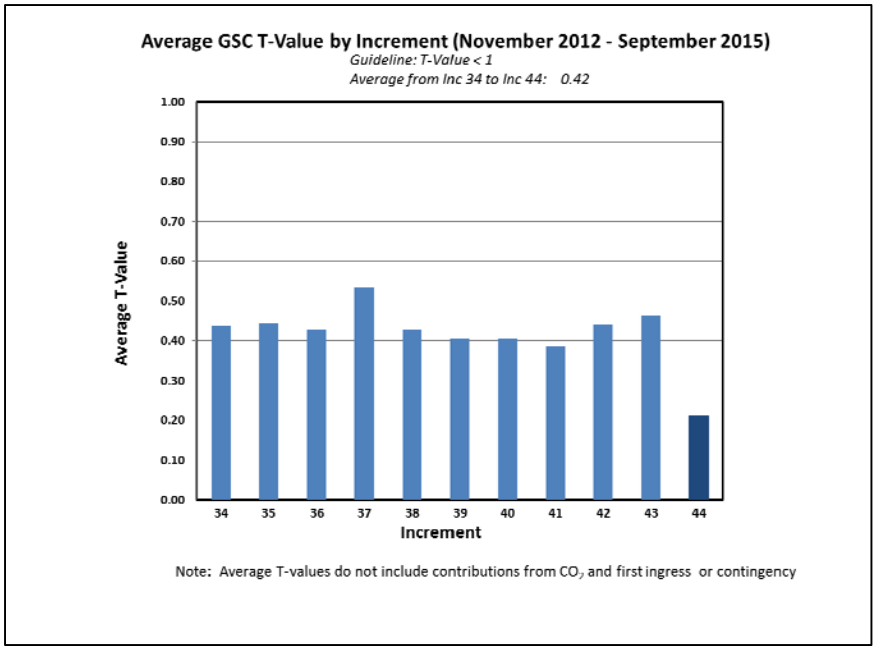

Figure 1. GSC T-values

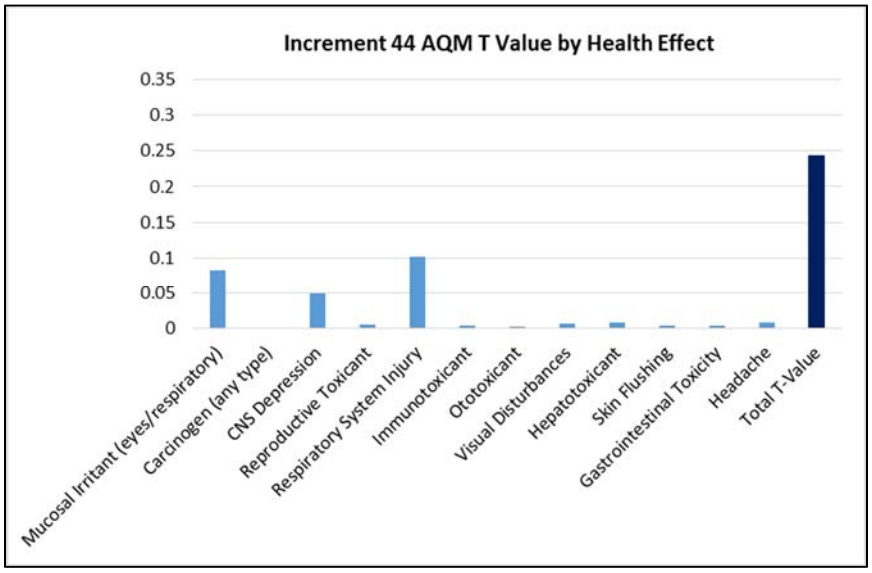

Figure 2. AQM T-values

The mGSCs provide only a snapshot of conditions and are not ideal for evaluating potential CO_2 exposures; however, reported levels in August exceeded the 3 mmHg (7100 mg/m^3) Increment limit requested in Chits 013552 and 013571. Data from the major constituent analyzer (MCA) showed that a CO_2 excursion occurred August 12-17, 2015. During this period, the Node 3 carbon dioxide removal assembly (CDRA) failed, and the CDRA in the Lab was activated until the unit in Node 3 could be recovered.

Notably, alcohol values in all routine monthly samples continue to exceed the alcohol guideline of <5 mg/m^3, which is intended to protect the water recovery system from risk of overloading. These levels are primarily due to a sustained increase in ethanol levels on ISS. Elevated ethanol levels were also detected in US water samples during this Increment (see Water Quality discussion below). Formaldehyde levels in

the US Lab (shown in Table 1 and Figure 3) are generally consistent with historic levels and remain below the SMAC of 120 μg/m^3.

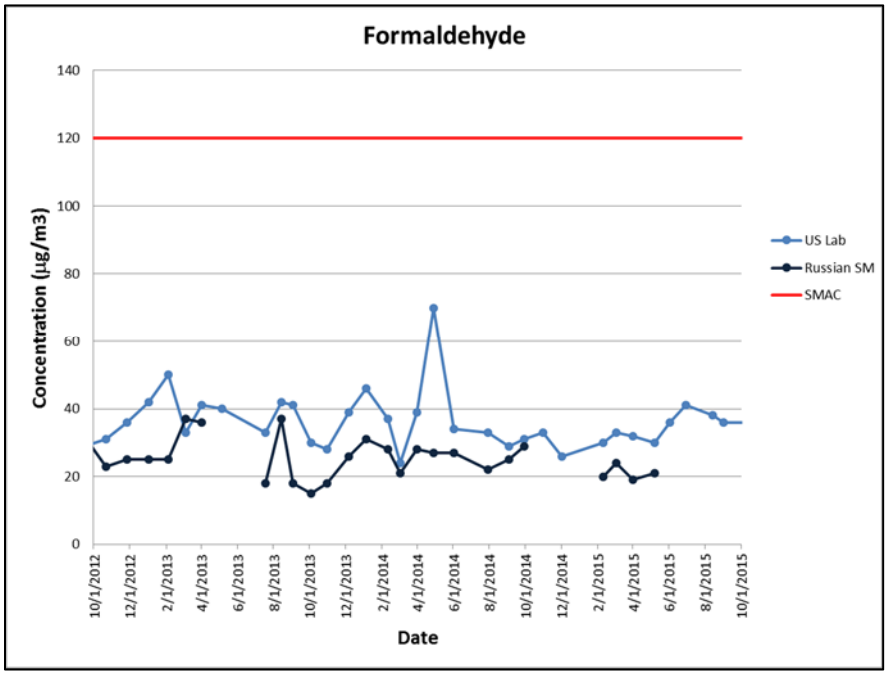

Figure 3. Formaldehyde trending in ISS air.

HTV-5 First Ingress

Although CO_2 levels were slightly elevated, Freon 218 levels measured in the HTV-5 first ingress sample indicate limited mixing with the ISS atmosphere prior to sample collection. Overall, contaminant levels at first ingress were higher than levels seen for HTV-4. The difference was primarily attributable to TMS (8.2 mg/m^3 versus 3.6 mg/m^3) and isopropanol (4.7 mg/m^3 versus 1.5 mg/m^3). The T-value for first ingress exceeded the predicted value of 2.1 (based on pre-flight off-gas testing performed by JAXA) and approached the guideline limit of 3. Carbon monoxide (CO), TMS, and isopropanol were the major off-gassed compounds identified by the pre-flight test. In flight, the primary contributors to the T-value were TMS and fluorotrimethylsilane. Acetaldehyde, isopropanol, methanol, and CO also contributed. Measures to reduce the contaminant load on future HTVs are recommended.

WATER QUALITY

An archive sample was collected from the auxiliary port on the US potable water dispenser (PWD) during Increment 44 and was returned on 42S. Due to limited sample volume, total solids and semi-volatile organics were not measured on the returned sample, but all other standard organic and inorganic analyses were performed. A complete data table with results from these analyses can be found in report #2015-WFL-ISSWQ-005.1. A summary of select analytical results is provided in Table 3 below. An expanded summary table containing organic carbon recoveries and results for analytes detected in the samples at concentrations above reporting limits are included as an attachment to this report.

Table 3. Analytical Summary of ISS Water Analyses

Sample Location	Sample Date	TOC (mg/L)	DMSD (mg/L)	MMST (mg/L)	Conductivity (μS/cm)	Total Iodine (mg/L)
PWD (aux)	9/10/2015	2.5	5.5	3.8	4	3

Toxicological Evaluation of ISS Water Quality: Routine water quality monitoring is performed in-flight using the total organic carbon analyzer (TOCA) and the colorimetric water quality monitor kit (CWQMK). Results from these analyses provide a general indication of overall water quality. Archive water samples are collected during each Increment and returned for analysis in ground laboratories. Data from the ground analyses complement the in-flight data and provide a more complete understanding of water quality on the ISS.

Potable Water

Total organic carbon (TOC) data from in-flight and archival sampling of the US potable water system conducted between September 2014 and September 2015 are shown in Figure 4. Data display excellent agreement between in-flight levels measured using the TOCA and archival samples. TOC levels began to rise at the end of Increment 43 as reported in TOX-VR-2016-04, and in contrast to previous TOC rises, this increase was primarily attributable to the presence of monomethylsilanetriol (MMST) rather than dimethylsilanediol (DMSD). At the time of this increase, there were no spare MF beds available on-orbit, so modifications to WPA operations were implemented to extend the life of the installed beds. Following delivery of replacement MF beds on HTV-5, nominal WPA operations were resumed and the TOC concentration in the product water started to increase rapidly. In response to this increase, a sample of product water was collected from the PWD auxiliary port just prior to 42S return. **Despite the increase, TOC levels in the US potable water system remained below the Spacecraft Water Exposure Guideline (SWEG) of 3.0 mg/L.** Similar to results from Increment 43, the primary contributors to the TOC increase were MMST and DMSD, but in this sample, DMSD, rather than MMST, accounted for the majority of the TOC. Additionally, DMSD and MMST accounted for only 17% of the total silicon in the sample (16.5 mg/L), which was the highest concentration ever measured in a sample of WPA product water. Analysis by the Advanced Water Recovery Laboratory at JSC indicated that the majority of the total silicon was present as inorganic silicon.

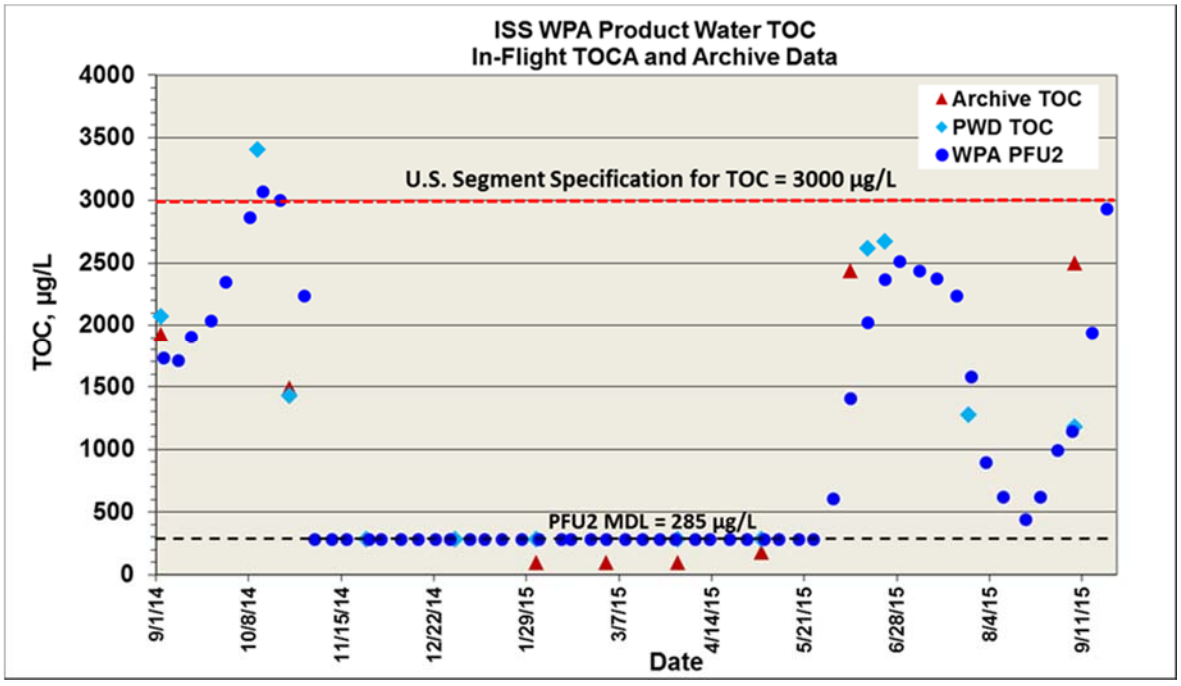

Figure 4. Total Organic Carbon (TOC) trending in US Potable Water

All compounds measured in this archive sample were below MORD limits, indicating no concern for crew consumption. Conductivity provides an indication of the total amount of inorganic contaminants present in water. While conductivity in this sample was only slightly elevated over historical levels and

likely within the range of measurement error, it is notable that there was an increase in the conductivity of the product water measured downstream of the ion exchange bed in the WPA for the first time. In addition to the inorganic silicon noted above, detectable levels of nickel and potassium were also present. While none of the contaminants were measured at levels of concern for crew health, the increased conductivity supported the conclusion that the multifiltration beds and ion exchange bed had reached end of life. The beds were replaced early in Increment 45 on October 2, 2015.

Iodine is added as a biocidal agent to the water produced by the WPA, but it is removed prior to crew consumption to avoid potential thyroid dysfunction. The sample collected from the auxiliary port is upstream of the iodine removal hardware. Total iodine in this sample was 3 mg/L, of which 1.4 mg/L was present as iodine. This is within the biocidal range of 1-4 mg/L.

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Enclosures
Tables 1 and 1A: Analytical concentrations of compounds quantified in mGSCs returned on 43S and SpX-8
Tables 2 and 2A: T-values corresponding to concentrations in Table 1, based on 180-day SMACs
Table 2B: T-values corresponding to concentrations for HTV-5 first ingress in Table 1, based on 7-day and 180-day SMACs
Table 3: Analytical concentrations of compounds quantified in US potable water sample returned on 42S

TABLE 1
ANALYTICAL RESULTS OF
SOYUZ 43 RETURN GSC AIR SAMPLES

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M^3)												
	AQ160012 SN 2104 LAB 6/2/15 @ 10:30 GMT	AQ160013 SN 2105 COL 6/2/15 @ 10:30 GMT	AQ160014 SN 2101 LAB 6/29/15 @ 12:30 GMT	AQ160015 SN 2102 SM 6/29/15 @ 12:40 GMT	AQ160016 SN 2093 HTV-5 Ingress 08/25/15 @ 10:26 GMT	AQ160017 SN 2007 LAB 09/09/15 @ 17:05 GMT	AQ160018 SN 2012 COL 09/09/15 @ 17:09 GMT	AQ160019 SN 2004 LAB 10/05/15 @ 14:45 GMT	AQ160020 SN 2005 SM 10/05/15 @ 14:48 GMT	AQ160021 SN 2006 LAB 10/29/15 @ 14:43 GMT	AQ160022 SN 2010 JPM 10/29/15 @ 14:44 GMT	AQ160023 SN 2011 LAB 11/30/15 @ 11:48 GMT	AQ160024 SN 2094 COL 11/30/15 @ 11:51 GMT
TARGET COMPOUNDS (TO-15) **													
Octafluoropropane (Perfluoropropane) *	**107**	**83**	**97**	**99**	4.0	**72**	**85**	**89**	**73**	**76**	**77**	**45**	**43**
Perfluoro(2-methylpentane)	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	0.24	<0.050	<0.050	<0.050	<0.050
Carbonyl sulfide (Carbon oxide sulfide)	<0.025	<0.025	<0.025	<0.025	0.076	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Chloromethane	<0.025	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Isobutane	<0.025	<0.025	<0.025	<0.025	0.13	<0.025	<0.025	<0.025	0.049	<0.025	<0.025	<0.025	<0.025
Methanol	0.36	0.39	0.34	0.33	1.2	0.66	0.63	0.59	0.40	0.41	0.62	0.40	0.61
Acetaldehyde	0.18	0.24	0.22	0.20	0.21	0.26	0.27	0.21	0.22	0.18	0.19	0.20	0.23
2-Methyl-1-propene	<0.025	<0.025	<0.025	<0.025	0.049	TRACE	TRACE	<0.025	0.054	<0.025	<0.025	<0.025	<0.025
Ethanol *	**8.2**	**8.5**	**5.9**	**5.5**	**1.7**	**14**	**14**	**7.3**	**7.4**	**6.7**	**6.8**	**6.0**	**6.1**
Acetone	0.25	0.27	0.27	0.28	0.40	0.47	0.45	0.44	0.36	0.39	0.37	0.42	0.44
Propanal (Propionaldehyde)	<0.025	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2-Propanol (Isopropanol) *	0.25	0.12	0.33	0.42	**4.7**	0.37	0.40	0.35	1.0	0.30	0.24	0.35	0.39
Isoprene (2-Methyl-1,3-butadiene)	<0.050	<0.050	<0.050	<0.050	<0.050	TRACE	TRACE	TRACE	<0.050	TRACE	TRACE	TRACE	TRACE
2-Methyl-2-propanol	<0.025	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	0.026	<0.025	<0.025	<0.025	<0.025
Methyl acetate	<0.025	<0.025	<0.025	<0.025	<0.025	TRACE	TRACE	0.039	0.034	TRACE	TRACE	TRACE	TRACE
Methylene chloride (Dichloromethane)	<0.025	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Carbon disulfide	<0.025	<0.025	<0.025	<0.025	0.081	<0.025	<0.025	TRACE	TRACE	<0.025	<0.025	<0.025	<0.025
1-Propanol	TRACE	TRACE	TRACE	TRACE	TRACE	0.034	0.039	TRACE	0.031	0.025	0.025	TRACE	TRACE
Trimethylsilanol	0.044	0.059	0.043	0.026	8.2	0.077	0.12	0.089	0.73	0.069	0.13	0.072	0.13
Butanal (Butyraldehyde)	<0.025	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025
2-Butanone (Methyl ethyl ketone)	<0.025	<0.025	<0.025	<0.025	0.15	<0.025	TRACE	TRACE	TRACE	<0.025	<0.025	TRACE	TRACE
Ethyl acetate	TRACE	<0.025	<0.025	<0.025	0.064	TRACE	0.027	0.068	0.081	0.027	0.027	0.029	0.031
1,2-Dichloroethane	<0.025	<0.025	<0.025	<0.025	TRACE	TRACE	TRACE	TRACE	<0.025	TRACE	TRACE	TRACE	TRACE
1-Butanol	TRACE	TRACE	TRACE	0.025	0.075	TRACE	0.027	TRACE	0.050	TRACE	0.026	0.029	0.032
2-Methylhexane	<0.025	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
2,3-Dimethylpentane	<0.025	<0.025	<0.025	<0.025	0.038	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
3-Methylhexane	TRACE	TRACE	TRACE	TRACE	0.090	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE	TRACE
2-Pentanone	<0.025	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Pentanal	<0.025	<0.025	<0.025	<0.025	0.030	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025
n-Heptane	<0.025	<0.025	<0.025	<0.025	0.23	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
4-Methyl-2-pentanone (MIBK)	<0.025	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025
Toluene	<0.025	<0.025	<0.025	TRACE	0.054	<0.025	TRACE	TRACE	TRACE	<0.025	TRACE	TRACE	TRACE
Hexanal	<0.025	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
Butyl acetate	<0.025	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	<0.025
Ethylbenzene	<0.025	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	TRACE	TRACE
m & p-Xylene	<0.050	<0.050	<0.050	<0.050	TRACE	<0.050	<0.050	<0.050	TRACE	<0.050	<0.050	<0.050	<0.050
o-Xylene	<0.025	<0.025	<0.025	<0.025	TRACE	<0.025	<0.025	0.033	0.072	<0.025	<0.025	<0.025	<0.025
Octamethylcyclotetrasiloxane	<0.075	<0.075	<0.075	<0.075	TRACE	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075	<0.075
Decamethylcyclopentasiloxane	0.65	0.38	<0.15	<0.15	0.68	<0.15	0.23	<0.15	<0.15	<0.15	<0.15	<0.15	0.15
SPECIAL INTEREST COMPOUNDS ***													
Hexamethylcyclotrisiloxane #	0.11	0.14	0.11	<0.10	0.70	<0.10	TRACE	<0.10	<0.10	<0.10	<0.10	<0.10	TRACE
NON-TARGET COMPOUNDS ***													
1,1-Difluoroethane	<0.050	<0.050	<0.050	<0.050	0.50	<0.050	<0.050	<0.050	0.12	<0.050	<0.050	<0.050	<0.050
Fluorotrimethylsilane	<0.050	<0.050	<0.050	<0.050	0.28	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Carbonic acid, dimethyl ester	<0.050	<0.050	<0.050	<0.050	0.085	TRACE	TRACE	TRACE	<0.050	TRACE	TRACE	TRACE	TRACE
Pentamethyldisiloxane-1-ol	<0.050	<0.050	<0.050	<0.050	0.091	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
C12-Alkane	<0.050	<0.050	<0.050	<0.050	0.052	<0.050	<0.050	<0.050	0.18	<0.050	<0.050	<0.050	<0.050
C12-Alkane	<0.050	<0.050	<0.050	<0.050	0.054	<0.050	<0.050	<0.050	0.15	<0.050	<0.050	<0.050	<0.050
C12-Alkane	<0.050	<0.050	<0.050	<0.050	0.070	<0.050	<0.050	<0.050	0.18	<0.050	<0.050	<0.050	<0.050
C12-Alkane	<0.050	<0.050	<0.050	<0.050	0.055	<0.050	<0.050	<0.050	0.13	<0.050	<0.050	<0.050	<0.050
C12-Alkane	<0.050	<0.050	<0.050	<0.050	0.053	<0.050	<0.050	<0.050	0.11	<0.050	<0.050	<0.050	<0.050
C12-Alkane	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	TRACE	<0.050	<0.050	<0.050	<0.050
Dodecamethylpentasiloxane	<0.050	<0.050	<0.050	<0.050	0.68	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
TOTAL ALCOHOLS PLUS ACETONE	**9.1**	**9.3**	**6.9**	**6.5**	**8.0**	**15**	**15**	**8.7**	**9.2**	**7.8**	**8.1**	**7.2**	**7.6**
TARGET COMPOUNDS (GC)													
Carbon Monoxide	1.0	1.1	0.83	0.78	3.5	1.2	1.2	1.1	1.1	1.0	1.0	1.0	1.0
Methane	8.5	8.5	8.7	9.1	1.9	11	11	7.4	6.5	5.5	5.4	4.8	4.8
Hydrogen	5.8	6.0	3.0	2.9	0.59	6.3	6.3	5.2	4.4	6.5	6.6	6.7	6.7
Carbon Dioxide	6000	6700	3300	4300	3800	5400	6500	6800	5500	5600	6000	6800	6800
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	**118**	**94**	**105**	**106**	**25**	**88**	**101**	**98**	**85**	**84**	**85**	**52**	**51**
TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	**10**	**10**	**7.3**	**6.8**	**21**	**16**	**16**	**9.2**	**12**	**8.2**	**8.5**	**7.7**	**8.3**

* GC/FID data results are in bold

** Quantified using a multi-point calibration

*** Quantified using "B" response factor except where noted; concentrations are estimates only.

Response factor generated from an internal study

< : Value is less than the laboratory report detection limit.

TRACE: Amount detected is sufficient for compound identification only.

OFP - Octafluoropropane

TABLE 1A
ANALYTICAL RESULTS OF SPACEX-8 RETURN GRAB AIR SAMPLES
(AUGUST 2015 SAMPLING)

CHEMICAL CONTAMINANT	CONCENTRATION (mg/M^3)	
	AQ160098 SN 2097 LAB 08/12/15 @ 12:19 GMT	**AQ160099 SN 2098 JPM 08/12/15 @ 12:22 GMT**
TARGET COMPOUNDS (TO-15) **		
Octafluoropropane (Perfluoropropane) *	**103**	**101**
Isobutane	TRACE	<0.025
Methanol	**0.51**	**0.47**
Acetaldehyde	0.32	0.27
2-Methyl-1-propene	TRACE	TRACE
Ethanol	**9.1**	**9.7**
Acetone	0.47	0.42
Propanal (Propionaldehyde)	TRACE	TRACE
2-Propanol (Isopropanol)	0.58	0.29
Isoprene (2-Methyl-1,3-butadiene)	TRACE	TRACE
Methyl acetate	TRACE	TRACE
1-Propanol	0.032	0.043
Trimethylsilanol	0.051	0.080
Ethyl acetate	TRACE	0.028
1-Butanol	TRACE	0.027
o-Xylene	TRACE	TRACE
Decamethylcyclopentasiloxane	0.23	TRACE
SPECIAL INTEREST COMPOUNDS ***		
Hexamethylcyclotrisiloxane #	0.27	0.33
NON-TARGET COMPOUNDS ***		
1,1,2,2-Tetrafluoroethane	0.077	0.077
2-Ethyl-1-hexanol	<0.050	TRACE
TOTAL ALCOHOLS PLUS ACETONE	**10.7**	**11**
TARGET COMPOUNDS (GC)		
Carbon monoxide	1.1	1.1
Methane	7.7	7.9
Hydrogen	4.7	4.7
Carbon dioxide	8400	8300
TOTAL CONCENTRATION (NON-METHANE HYDROCARBONS)	**110**	**110**
TOTAL CONCENTRATION - OFP (NON-METHANE HYDROCARBONS)	**12**	**12**

* GC/FID data results are in bold
** Quantified using a multi-point calibration
*** Quantified using "B" response factor except where noted; concentrations are estimates only.
# Response factor generated from an internal study
< : Value is less than the laboratory report detection limit.
TRACE: Amount detected is sufficient for compound identification only.
OFP - Octafluoropropane

TABLE 2
T-VALUES FOR 43S RETURN GSC AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)											
	AQ160012 SN 2104 LAB 6/2/15 @ 10:30 GMT	AQ160013 SN 2105 COL 6/2/15 @ 10:30 GMT	AQ160014 SN 2101 LAB 6/29/15 @ 12:30 GMT	AQ160015 SN 2102 SM 6/29/15 @ 12:40 GMT	AQ160017 SN 2007 LAB 09/09/15 @ 17:05 GMT	AQ160018 SN 2012 COL 09/09/15 @ 17:09 GMT	AQ160019 SN 2004 LAB 10/05/15 @ 14:45 GMT	AQ160020 SN 2005 SM 10/05/15 @ 14:48 GMT	AQ160021 SN 2006 LAB 10/29/15 @ 14:43 GMT	AQ160022 SN 2010 JPM 10/29/15 @ 14:44 GMT	AQ160023 SN 2011 LAB 11/30/15 @ 11:48 GMT	AQ160024 SN 2094 COL 11/30/15 @ 11:51 GMT
TARGET COMPOUNDS (TO-15)												
Octafluoropropane (Perfluoropropane)	0.00126	0.00098	0.00114	0.00117	0.00085	0.00100	0.00105	0.00086	0.00089	0.00090	0.00052	0.00050
Perfluoro(2-methylpentane) &	ND	ND	ND	ND	ND	ND	ND	0.00000	ND	ND	ND	ND
Isobutane	ND	ND	ND	ND	ND	ND	ND	0.00020	ND	ND	ND	ND
Methanol	0.00404	0.00432	0.00383	0.00370	0.00730	0.00705	0.00661	0.00446	0.00460	0.00689	0.00443	0.00676
Acetaldehyde	0.04557	0.06122	0.05616	0.05012	0.06604	0.06744	0.05334	0.05402	0.04561	0.04852	0.04932	0.05803
2-Methyl-1-propene	ND	ND	ND	ND	0.00001	0.00001	ND	0.00005	ND	ND	ND	ND
Ethanol	0.00410	0.00423	0.00296	0.00273	0.00690	0.00691	0.00363	0.00368	0.00334	0.00338	0.00301	0.00305
Acetone	0.00476	0.00517	0.00514	0.00534	0.00908	0.00865	0.00847	0.00701	0.00752	0.00717	0.00803	0.00844
2-Propanol (Isopropanol)	0.00168	0.00083	0.00220	0.00280	0.00243	0.00266	0.00231	0.00693	0.00201	0.00162	0.00232	0.00261
Isoprene (2-Methyl-1,3-butadiene)	ND	ND	ND	ND	0.00833	0.00833	0.00833	ND	0.00833	0.00833	0.00833	0.00833
2-Methyl-2-propanol	ND	ND	ND	ND	ND	ND	ND	0.00022	ND	ND	ND	ND
Methyl acetate	ND	ND	ND	ND	0.00010	0.00010	0.00032	0.00029	0.00010	0.00010	0.00010	0.00010
Carbon disulfide	ND	ND	ND	ND	ND	ND	0.00078	0.00078	ND	ND	ND	ND
1-Propanol	0.00013	0.00013	0.00013	0.00013	0.00034	0.00040	0.00013	0.00032	0.00026	0.00026	0.00013	0.00013
Trimethylsilanol	0.01100	0.01480	0.01064	0.00641	0.01930	0.03098	0.02236	0.18198	0.01720	0.03195	0.01793	0.03333
Butanal (Butyraldehyde)	ND	ND	ND	ND	ND	ND	ND	0.00096	ND	ND	ND	ND
2-Butanone (Methyl ethyl ketone)	ND	ND	ND	ND	ND	0.00042	0.00042	0.00042	ND	ND	0.00042	0.00042
Ethyl acetate	0.00007	ND	ND	ND	0.00007	0.00015	0.00038	0.00045	0.00015	0.00015	0.00016	0.00017
1,2-Dichloroethane	ND	ND	ND	ND	0.00781	0.00781	0.00781	ND	0.00781	0.00781	0.00781	0.00781
1-Butanol	0.00031	0.00031	0.00031	0.00063	0.00031	0.00067	0.00031	0.00124	0.00031	0.00064	0.00073	0.00080
3-Methylhexane	0.00104	0.00104	0.00104	0.00104	0.00104	0.00104	0.00104	0.00104	0.00104	0.00104	0.00104	0.00104
Pentanal	ND	ND	ND	ND	ND	ND	ND	0.00078	ND	ND	ND	ND
4-Methyl-2-pentanone (MIBK)	ND	ND	ND	ND	ND	ND	ND	0.00009	ND	ND	ND	ND
Toluene	ND	ND	ND	0.00083	ND	0.00083	0.00083	0.00083	ND	0.00083	0.00083	0.00083
Butyl acetate	ND	ND	ND	ND	ND	ND	ND	0.00007	ND	ND	ND	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND	ND	0.00025	ND	ND	0.00025	0.00025
m & p-Xylene	ND	ND	ND	ND	ND	ND	ND	0.00068	ND	ND	ND	ND
o-Xylene	ND	ND	ND	ND	ND	ND	0.00090	0.00196	ND	ND	ND	ND
Decamethylcyclopentasiloxane	0.04321	0.02521	ND	ND	ND	0.01537	ND	ND	ND	ND	ND	0.01020
SPECIAL INTEREST COMPOUNDS												
Hexamethylcyclotrisiloxane	0.01249	0.01511	0.01261	ND	ND	0.00556	ND	ND	ND	ND	ND	0.00556
NON-TARGET COMPOUNDS												
1,1-Difluoroethane	ND	ND	ND	ND	ND	ND	ND	0.00181	ND	ND	ND	ND
Carbonic acid, dimethyl ester	ND	ND	ND	ND	0.00250	0.00250	0.00250	ND	0.00250	0.00250	0.00250	0.00250
C12-Alkane	ND	ND	ND	ND	ND	ND	ND	0.00341	ND	ND	ND	ND
C12-Alkane	ND	ND	ND	ND	ND	ND	ND	0.00287	ND	ND	ND	ND
C12-Alkane	ND	ND	ND	ND	ND	ND	ND	0.00352	ND	ND	ND	ND
C12-Alkane	ND	ND	ND	ND	ND	ND	ND	0.00242	ND	ND	ND	ND
C12-Alkane	ND	ND	ND	ND	ND	ND	ND	0.00220	ND	ND	ND	ND
C12-Alkane	ND	ND	ND	ND	ND	ND	ND	0.00048	ND	ND	ND	ND
TARGET COMPOUNDS (GC)												
CARBON MONOXIDE	0.06042	0.06177	0.04861	0.04592	0.07141	0.07236	0.06293	0.06293	0.06005	0.06037	0.05888	0.06158
METHANE	0.00242	0.00244	0.00248	0.00261	0.00313	0.00312	0.00212	0.00186	0.00158	0.00156	0.00137	0.00137
HYDROGEN	0.01698	0.01777	0.00878	0.00856	0.01850	0.01857	0.01516	0.01300	0.01906	0.01927	0.01984	0.01984
CARBON DIOXIDE	0.46079	0.51534	0.25500	0.32994	0.41418	0.50031	0.52491	0.42611	0.43155	0.46329	0.52432	0.52432
TOTAL T-VALUE	**0.67028**	**0.73066**	**0.41104**	**0.46194**	**0.63965**	**0.76224**	**0.72664**	**0.79014**	**0.61394**	**0.66660**	**0.71230**	**0.75800**
TOTAL T-VALUE - CO2	**0.20950**	**0.21532**	**0.15604**	**0.13199**	**0.22547**	**0.26193**	**0.20173**	**0.36403**	**0.18239**	**0.20331**	**0.18798**	**0.23367**

ND : Value is less than the laboratory report detection limit.
Note: Number of decimal places in T-Values do not represent significant figures of measurements.

TABLE 2A
T-VALUES FOR SPACEX-8 RETURN GSC AIR SAMPLES
(INCREMENT 44 ONLY - AUGUST 2015)

CHEMICAL CONTAMINANT	T-VALUE (180-d SMAC)	
	AQ160098 SN 2097 LAB 08/12/15 @ 12:19 GMT	**AQ160099 SN 2098 JPM 08/12/15 @ 12:22 GMT**
TARGET COMPOUNDS (TO-15)		
Octafluoropropane (Perfluoropropane)	0.00121	0.00118
Isobutane	0.00005	ND
Methanol	0.00566	0.00521
Acetaldehyde	0.07988	0.06694
2-Methyl-1-propene	0.00001	0.00001
Ethanol	0.00455	0.00486
Acetone	0.00901	0.00799
Propanal (Propionaldehyde)	0.00114	0.00114
2-Propanol (Isopropanol)	0.00386	0.00190
Isoprene (2-Methyl-1,3-butadiene)	0.00417	0.00417
Methyl acetate	0.00010	0.00010
1-Propanol	0.00033	0.00044
Trimethylsilanol	0.01271	0.01997
Ethyl acetate	0.00007	0.00016
1-Butanol	0.00031	0.00066
o-Xylene	0.00068	0.00068
Decamethylcyclopentasiloxane	0.01551	0.00583
SPECIAL INTEREST COMPOUNDS		
Hexamethylcyclotrisiloxane	0.02976	0.03639
NON-TARGET COMPOUNDS		
1,1,2,2-Tetrafluoroethane	0.00074	0.00074
2-Ethyl-1-hexanol	ND	0.00047
TARGET COMPOUNDS (GC)		
Carbon monoxide	0.06306	0.06415
Methane	0.00220	0.00226
Hydrogen	0.01388	0.01380
Carbon dioxide	0.64591	0.64008
TOTAL T-VALUE	**0.89480**	**0.87866**
TOTAL T-VALUE - CO2	**0.24889**	**0.23858**

ND : Value is less than the laboratory report detection limit.
Note: Number of decimal places in T-Values do not represent significant figures of measurements.

TABLE 2B
T-VALUES FOR HTV-5 INGRESS GSC AIR SAMPLES

CHEMICAL CONTAMINANT	T-VALUE (7-d SMAC)	T-VALUE (180-d SMAC)
	AQ160016 SN 2093 HTV-5 Ingress 08/25/15 @ 10:26 GMT	**AQ160016 SN 2093 HTV-5 Ingress 08/25/15 @ 10:26 GMT**
TARGET COMPOUNDS (TO-15)		
Octafluoropropane (Perfluoropropane)	0.00005	0.00005
Carbonyl sulfide (Carbon oxide sulfide)	0.00636	0.00636
Chloromethane	0.00030	0.00030
Isobutane	0.00053	0.00053
Methanol	0.01310	0.01310
Acetaldehyde	0.05338	0.05338
2-Methyl-1-propene	0.00004	0.00004
Ethanol	0.00084	0.00084
Acetone	0.00764	0.00764
Propanal (Propionaldehyde)	0.00114	0.00114
2-Propanol (Isopropanol)	0.03106	0.03106
2-Methyl-2-propanol	0.00008	0.00010
Methylene chloride (Dichloromethane)	0.00026	0.00125
Carbon disulfide	0.00509	0.00509
1-Propanol	0.00013	0.00013
Trimethylsilanol	2.05453	2.05453
Butanal (Butyraldehyde)	0.00096	0.00096
2-Butanone (Methyl ethyl ketone)	0.00491	0.00491
Ethyl acetate	0.00035	0.00035
1,2-Dichloroethane	0.00781	0.00781
1-Butanol	0.00094	0.00188
2-Methylhexane	0.00005	0.00104
2,3-Dimethylpentane	0.00015	0.00317
3-Methylhexane	0.00036	0.00752
2-Pentanone	0.00018	0.00018
Pentanal	0.00186	0.00186
n-Heptane	0.00093	0.01938
4-Methyl-2-pentanone (MIBK)	0.00009	0.00009
Toluene	0.00362	0.00362
Hexanal	0.00069	0.00069
Butyl acetate	0.00007	0.00007
Ethylbenzene	0.00010	0.00025
m & p-Xylene	0.00034	0.00068
o-Xylene	0.00017	0.00034
Octamethylcyclotetrasiloxane	0.00013	0.00313
Decamethylcyclopentasiloxane	0.00681	0.04539
SPECIAL INTEREST COMPOUNDS		
Hexamethylcyclotrisiloxane	0.00780	0.07797
NON-TARGET COMPOUNDS		
1,1-Difluoroethane	0.00751	0.00751
Fluorotrimethylsilane	0.35218	0.35218
Carbonic acid, dimethyl ester	0.00855	0.00855
Pentamethyldisiloxane-1-ol	0.00182	0.00182
C12-Alkane	0.00100	0.00100
C12-Alkane	0.00104	0.00104
C12-Alkane	0.00135	0.00135
C12-Alkane	0.00106	0.00106
C12-Alkane	0.00103	0.00103
Dodecamethylpentasiloxane	0.00342	0.00342
TARGET COMPOUNDS (GC)		
CARBON MONOXIDE	0.05541	0.20535
METHANE	0.00053	0.00053
HYDROGEN	0.00174	0.00174
CARBON DIOXIDE	0.29056	0.29056
TOTAL T-VALUE	**2.93662**	**3.23053**
TOTAL T-VALUE - CO2	**2.64606**	**2.93997**

Note: Number of decimal places in T-Values do not represent significant figures of measurements.

Table 3. Expedition 44 Water Sample Summary Report
US Product Water Sample

Mission				**Soyuz 42/Exp. 44**
Sample Location		**Potable Water**		PWD Aux Port
Sample Description		**Maximum Contaminant**	**Maximum Contaminant**	Product Water
Sample Date		**Level**	**Level**	9/10/2015
Analysis/Sample ID	**Units**	**(MCL)**	**Source**	**20150919001**
Physical Characteristics				
pH	pH units	4.5-8.5	41000	6.72
Conductivity	µS/cm			4
Iodine (LCV)				
Total I	mg/L	6/0.2	41000 (tl I max/tl I at pt of consumption)	3.00
Iodine	mg/L			1.42
Iodide	mg/L			1.58
Metals (ICP/MS)				
Calcium	mg/L	30	41000	0.10
Potassium	mg/L	340	41000	0.11
Sodium	mg/L			0.05
Chromium	µg/L	230	41000	24
Nickel	µg/L	300	SWEG&41000	101
Zinc	µg/L	2,000	SWEG&41000	4
Silicon (ICP/MS)				
Silicon (ICP/MS)	µg/L			16,500
Total Organic Carbon (Sievers)				
Inorganic Carbon	mg/L			0.37
Organic Carbon	mg/L	3	41000	2.50
Silanols (LC/RI) (R & D Method -NIST traceable standard not available)				
Dimethylsilanediol (DMSD)	µg/L	35,000	SWEG	5500
Monomethylsilanetriol (MMST)	µg/L	110,000	SWEG	3800
Amines (CE/IC)				
Trimethylamine	µg/L	Trialkylamines 400	SWEG	289
Organic Carbon Recovery	percent			**83.71**
Unaccounted Organic Carbon	mg/L			**0.41**

NA=Not analyzed;
MI=Matrix interference
SWEG - 1000 days (11-2008)
Pb added 2014