UNITED STATES
ENVIRONMENTAL PROTECTION AGENCY
REGION 5
25063 CENTER RIDGE ROAD
WESTLAKE, OH 44145-4114

March 3, 2014

MEMORANDUM

SUBJECT: Compliance Sampling Inspection, BASF Corporation, Cleveland, Ohio

FROM: Mark Moloney, Environmental Engineer
Mark Conti, Lead Environmental Engineer

THRU: Brooke Furio, Section Chief
OECA, Cleveland Office (ME-W)

TO: Water Enforcement & Compliance Assurance Branch – Section I (WC-15J)
ATTN: Barbara Vantil, Chief

On October 25 and 29, 2013, Mark Moloney and Mark Conti sampled storm water discharge from BASF property. The inspectors also sampled groundwater from BASF's nickel recovery wells and nickel treatment system discharge to the Northeast Ohio Regional Sewer District sewage system. The inspection findings and sample results are in the attached report.

Attachment

ec: Noel Vargas (WC-15J)
Jeffery Trevino (C-14J)

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Attachment A

*****ENFORCEMENT CONFIDENTIAL*****

CLEAN WATER ACT INSPECTION SAMPLING REPORT

BASF Corporation
1000 Harvard Avenue
Cleveland, Ohio

By:

Mark Conti, USEPA Region 5, OECA – Cleveland Office
Mark Moloney, USEPA Region 5, OECA – Cleveland Office

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 5
OFFICE OF ENFORCEMENT AND COMPLIANCE ASSURANCE – CLEVELAND OFFICE

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1.1 Objective of Sampling Effort

The objective is to confirm whether metals and/or radionuclides are being discharged into the Cuyahoga River from BASF property and whether the same pollutants are present in the Cuyahoga River at the point of discharge. Sampling results will also be used to learn whether radionuclides are being drawn into BASF's recovery wells and subsequently being discharged from the nickel treatment system into the Northeast Ohio Regional Sewer District sewage system.

1.1 Facility Description

The BASF site ("Site") is located approximately 3.5 miles southwest of downtown Cleveland, Ohio. It is situated along the western bank of the Cuyahoga River, just north of its confluence with Big Creek. Harvard Avenue splits the facility into a north and south section. The BASF facility consists of approximately 24.46 acres and is comprised of four parcels (2, 3, 4 and 5) (Figure 1). Parcel 2 is approximately 4.37 acres in size and is currently a vacant lot. Parcel 3 is approximately 18.94 acres in size and includes seven remaining buildings. The current buildings within Parcel 3 include a warehouse (Building W-1), former foundry (Building F-1), former boiler house (Building B-1), groundwater recovery and treatment system building, garage, former hydrogen fluoride plant wastewater treatment system (Building H-10), and former scale house. Parcel 4 is approximately 0.87 acres in size, and Parcel 5 is approximately 0.28 acres in size; both are currently vacant lots. The BASF site also includes a structure referred to as Building G-1 and the property occupied by Building G-1, which are owned by BGD Company, which is an affiliate of Chevron USA, Inc. This building is located in the north-central portion of Parcel 3 and it is shown on Figure 1 as the area marked with cross hatch marks.

The BASF site is the subject of response action by the United States Army Corps of Engineers (USACE) under the federal government's Formerly Utilized Sites Remedial Action Program (FUSRAP) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Numerous other buildings that were once located at the facility for manufacturing have been demolished with oversight by the Nuclear Regulatory Commission (NRC), although most of the floor slabs remain. The locations of former and existing buildings are shown on Figure 1.

In 1901, the Harshaw Chemical Company (Harshaw) became the original owner and operator of a 40-acre site that included the current Site. Harshaw manufactured and processed chemicals including catalysts, inorganic fluorides, and metal finishing compounds. During the 1930s and 1940s, the U.S. government contracted with Harshaw to complete uranium research and enrichment at Building G-1 of the Site, in support of the government's Manhattan Project. Building G-1, the underlying soil, and groundwater became, and remain, heavily contaminated with uranium and other radioactive contaminants. In 1977, the Gulf Oil Corporation ("Gulf") purchased Harshaw and Gulf became parent company to subsidiary Harshaw. In 1983, Gulf and the Kaiser Aluminum and Chemical Corporation ("Kaiser") entered into a partnership, and Harshaw remained the owner of the Site and the Gulf/Kaiser Partnership became the operator of the Site. Shortly thereafter, Chevron purchased Gulf, and Chevron assumed Gulf's position in the Gulf/Kaiser Partnership. Historically, Harshaw was the permit holder of several Clean Water Act NPDES permits for the Site, including permits for process wastewater, storm water, groundwater, and about eight outfalls. In 1988, the Engelhard Corporation purchased the entire Site, except for Building G-1, which remained owned and operated by the Chevron/Kaiser Partnership. In the early 1990s, BASF purchased the Site, except for Building G-1, which remained owned and operated by the Chevron/Kaiser Partnership. BASF never conducted any operations at the Site, except for a pump and treat system to remediate nickel contamination on

the Site, pursuant to an order from the State of Ohio. On April 1, 1998, the remaining NPDES permits for the Site expired.

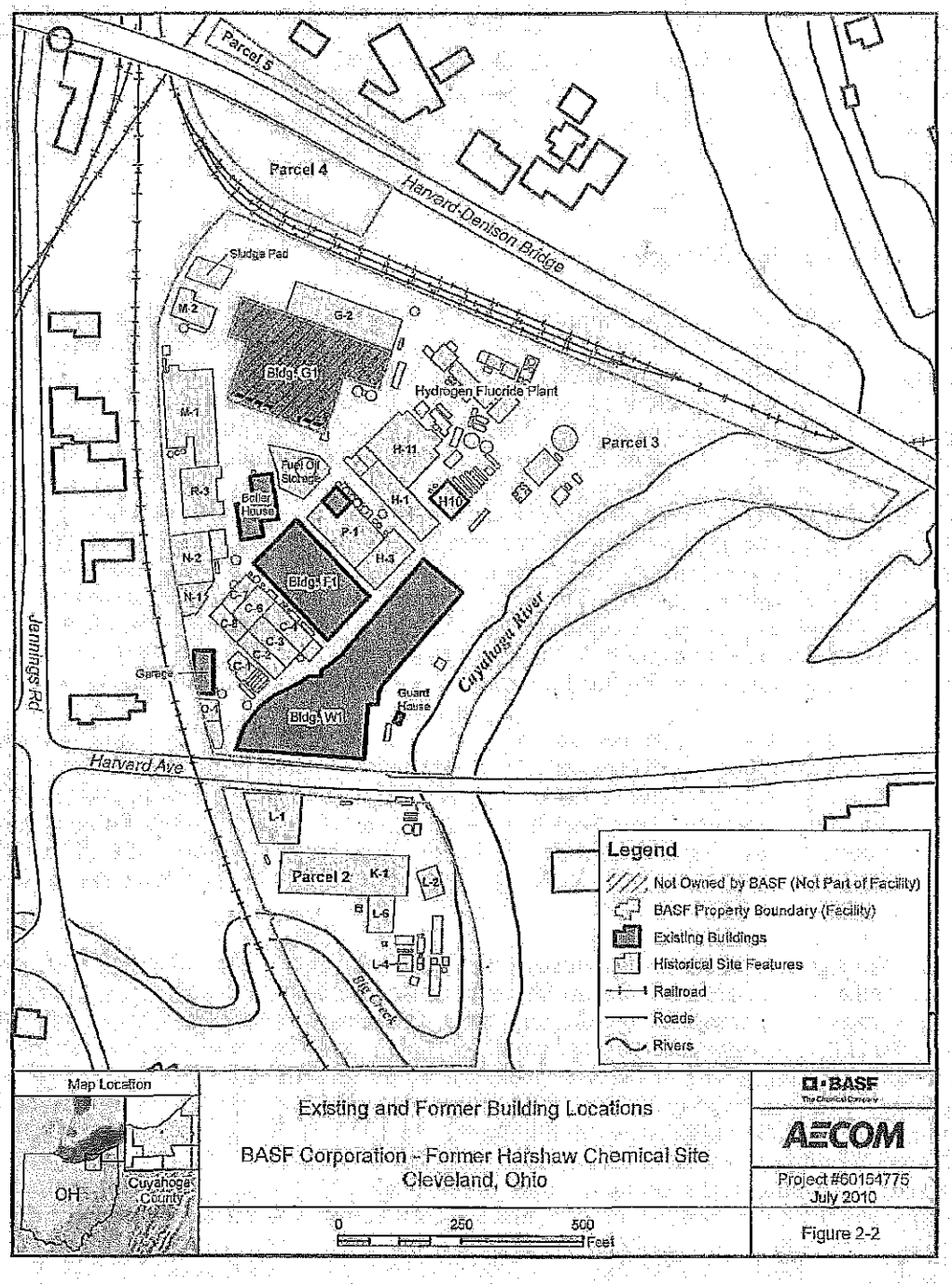


Figure 1 – Former Harshaw Chemical Site Diagram (drawing obtained from AECOM 6/17/2010 report *Draft Description of Current Conditions*)

In the early 2000s, the U.S. Congress delegated to the U.S. Army Corps of Engineers the remediation of the radioactive contamination at Building G-1 of the Site pursuant to the Formerly Utilized Sites Remedial Action Program (FUSRAP). USACE planned to begin such remediation in 5 to 15 years, but this remained subject to tight budgetary constraints.

On March 30, 2010, Region 5 of EPA issued to BASF a RCRA 3008(h) Administrative Corrective Action Order ("Order") to remediate heavy metals in the soil and groundwater at the Site. The Order excluded Building G-1 of the Site, since it was owned by Chevron/Kaiser. The Order also excluded Building G-1 since RCRA contaminants did not include radioactive contaminants, and since the U.S. Congress delegated to USACE the radioactive remediation of the Site. There was also no evidence that the radioactive contamination of Building G-1, or its underlying soil or groundwater, had migrated from those origins. (BASF provided EPA with its RCRA Facility Investigation workplan pursuant to EPA's Order, and EPA is completing its review.)

On or about April 2010, BASF notified EPA it found radioactive contamination in the pump and treat system it employed to remediate nickel contamination on the Site, pursuant to the State of Ohio order. BASF attempts to adjust its Pump and Treat System to reduce radioactive contamination in the system were unsuccessful.

In 2011, the Land and Chemicals Division (Christine McConaghy) discovered a pipe (Outfall 007) on the Site discharging water into the Cuyahoga River. BASF and USACE were surprised to learn of the discharge, and stated they knew absolutely nothing about it. In May of 2011, USACE sampled the water from the pipe (Outfall 007) and found the discharge to be approximately 25 – 30 gallons per minute, and "polished," meaning it appeared to have undergone some treatment process, and also found uranium at approximately 170 micrograms per liter. In July of 2012, USACE sampled water in the storm sewer from Building G-1 to the Cuyahoga River and found high levels of uranium in the storm sewer water near Building G-1 (2079 ug/L total, 1855 ug/L filtered), a decreased level of uranium in the storm sewer water at Outfall 007 (77.4 ug/L total, 75.3 ug/L filtered), and a further decreased level in the Cuyahoga River (41 ug/L total, 18 ug/L filtered).

USACE recently stated to EPA that it sampled the water from the pipe (Outfall 007) annually since at least 2008. However, USACE had not shared with EPA any details of any of its water samples or any of its underlying data, notwithstanding repeated requests, and notwithstanding USACE's oral agreements to do so. Therefore, to date, EPA has no separate and independent information to confirm USACE's findings or to provide factual or legal conclusions with necessary confidence.

1.3 Sampling Description

Wastewater grab samples were collected at five different locations at the BASF Cleveland, Ohio site on October 25, 2013 and at two locations on October 29, 2013. The sampling locations are shown in Figure 2. Beginning the morning of October 25, 2013, grab samples were collected by U. S. EPA personnel at the following locations: influent to BASF's groundwater pump and treat system, effluent discharge from BASF's groundwater pump and treat system, Outfall 007 (former) monitoring location, Outfall 007 discharge location and the Cuyahoga River at a point where it mixed with the Outfall 007 discharge. Samples were collected for metals and radionuclide analyses. Measurements for temperature, pH and conductivity were also performed at each sampling location by the U.S. EPA team, which consisted of Mark Conti and Mark Moloney. The weather during the sampling was overcast and raining.

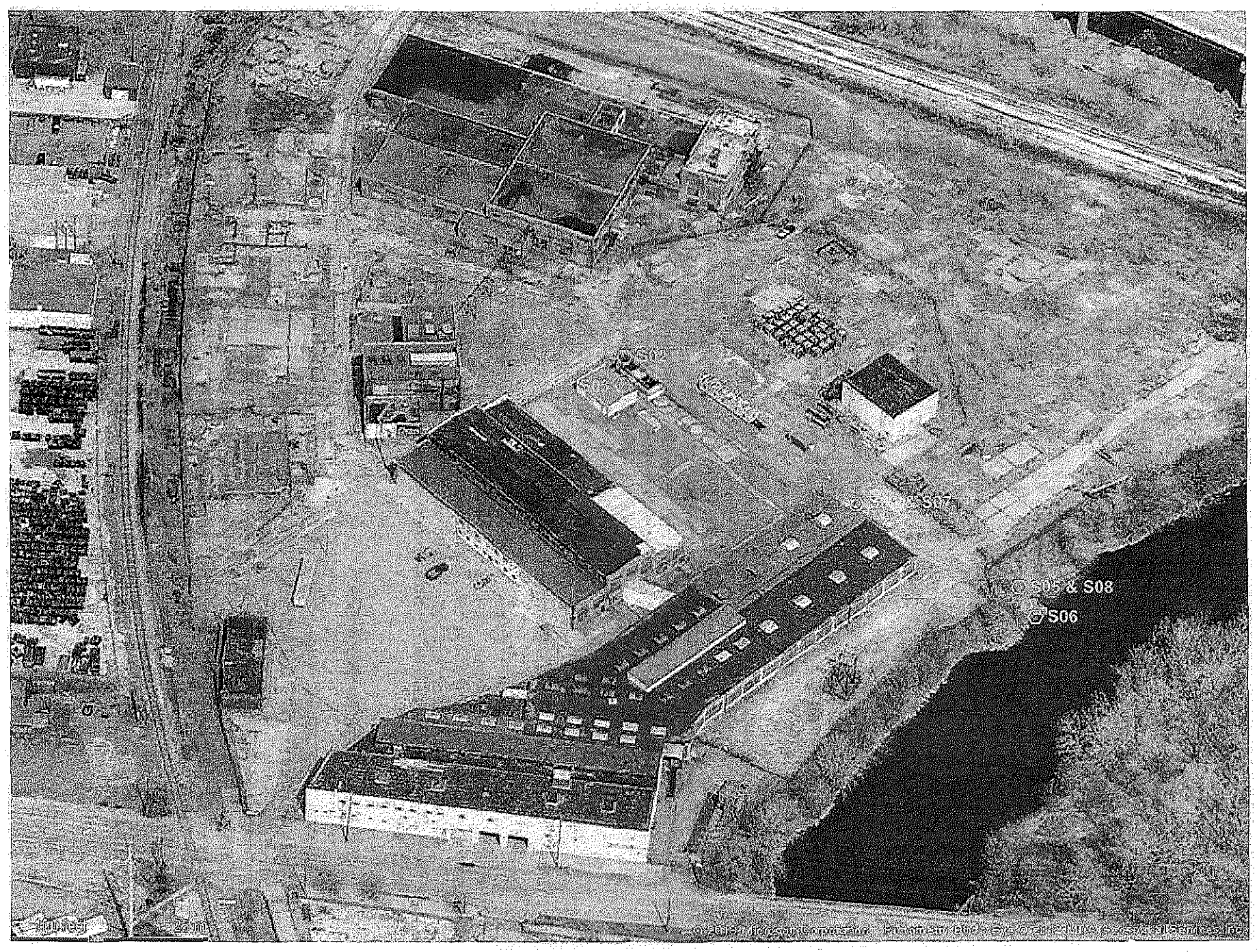


Figure 2 – Map of October 25 and 29, 2013 Sample Locations

On the morning of October 29, 2013, U. S. EPA personnel returned to the site and collected grab samples at the Outfall 007 monitoring location and the Outfall 007 discharge location. Measurements for temperature, pH and conductivity were also performed at both sampling locations by the U.S. EPA team which consisted of Mark Conti and Mark Moloney. The weather during the sampling was sunny and dry.

Laboratory analysis for metals and radionuclide were performed by USEPA National Air and Radiation Environmental Laboratory (NAREL) in Montgomery, Alabama. Radionuclide analyses included Radium 226 and 228; Uranium 234, 235, and 238; and Thorium 227, 228, 230 and 232.

A summary of the sampling information for this project is presented in Table 1. The sampling time identified for a grab sample in the table is the time at which sampling began at that location. Table 2 lists the types of sample bottles and preservatives used during this sampling project for each analysis. Photographs of the five sampling locations are included as Appendix A.

1.4 Sample Custody and Shipping Information

Sampling was performed by Mark Moloney, U.S. EPA Region 5, OECA - Cleveland Office and Mark Conti, U.S. EPA Region 5, OECA - Cleveland Office. All samples were tagged, put in a sealed plastic bag and placed in a cooler. After being sealed in coolers with a custody tag, the samples were shipped via United Parcel Service to U.S. EPA NAREL for analysis. Copies of the chain-of-custody forms are included as Appendix B.

2. SAMPLING RESULTS

The samples were analyzed by the U.S. EPA National Air and Radiation Environmental Laboratory in Montgomery, Alabama. The methods used by this laboratory to analyze the samples collected during this project are shown below.

Actinides (Uranium) by Extraction Chromatography – Analysis Procedure: NAREL U-EICHROM
Radium-228 in Environmental Matrices – Prep Procedure: NAREL RA-03; Analysis Procedure: NAREL Ra-05
Radium-226 in Environmental Matrices – Analysis Procedure: NAREL Ra226-EICHROM
Actinides (Thorium) by Extraction Chromatography – Analysis Procedure: NAREL TH-EICHROM
Total Metals – SW846 6020A

Table 3 contains field measurements (temperature, pH and conductivity) made by U.S. EPA personnel during this sampling project. Table 4 contains metals results. Table 5 contains radionuclide results. Further information regarding the sample analyses can be found in the laboratory analysis reports included in Appendix C. Radionuclide results are presented graphically in Appendix D.

Table 1 - USEPA Sample Collection Information for BASF Cleveland, Ohio Site

Sample No. 14CM01	Sample Type	Collection Date Time	Sample Description	Sampling Method
R01	Grab	10/25/13 0810	**Field Blank Sample** – Blank Samples were prepared for Total Metals and RAD analyses.	Distilled deionized water from the Region 5 Cleveland Office was collected in a quart glass jar and poured into total metals and RAD sample containers. These samples were placed in a cooler with the other samples for delivery to U.S. EPA NAREL.
S02	Grab	10/25/13 0926	**Influent to BASF Pump and Treat Groundwater System** – Samples were collected from the pipe discharging groundwater to the influent tank at BASF's groundwater treatment plant. Samples were collected for Total Metals and RAD analyses.	A 1 liter glass jar was used to collect waster from a discharge pipe on top of the influent tank at BASF's groundwater treatment plant. Water was poured into total metals and RAD sample containers.
S03	Grab	10/25/13 1000	**Effluent from the BASF Pump and Treat Groundwater System** – Samples were collected from the effluent tank at BASF's groundwater treatment plant. Samples were collected for Total Metals and RAD analyses.	A 1 liter glass jar was used to collect water from a discharge pipe on top of the influent tank at BASF's groundwater treatment plant. Water was poured into total metals and RAD sample containers.
S04	Grab	10/25/13 1028	**Outfall 007 Monitoring Station** – Samples were collected from the wet well containing a flow meter formerly used to monitor the Outfall 007 discharge. Samples were collected for Total Metals and RAD analyses.	A 1 liter glass jar attached to a pole was used to collect water from the end of the Outfall 007 flow measurement flume. Water was poured into total metals and RAD sample containers.
S05	Grab	10/25/13 1055	**Outfall 007 Discharge** - Samples were collected from the Outfall 007 discharge structure located along the Cuyahoga River. Samples were collected for Total Metals and RAD analyses.	A 1 liter glass jar attached to a pole was used to collect water discharging from the top of the Outfall 007 discharge structure located along the Cuyahoga River. Water was poured from the glass jar into total metals and RAD sample containers.
S06	Grab	10/25/13 1120	**Cuyahoga River at Outfall 007** - Samples were collected from the area where outfall 007 discharge mixed with river water. Samples were collected for Total Metals and RAD analyses.	A 1 liter glass jar attached to a pole was used to collect water from the area where the Outfall 007 discharge mixed with river water. Water was poured from the glass jar into total metals and RAD sample containers.
S07	Grab	10/29/13 0950	**Outfall 007 Monitoring Station** – Samples were collected from the wet well containing a flow meter formerly used to monitor the Outfall 007 discharge. Samples were collected for Total Metals and RAD analyses.	A 1 liter glass jar attached to a pole was used to collect water discharging from the top of the Outfall 007 discharge structure located along the Cuyahoga River. Water was poured from the glass jar into total metals and RAD sample containers.
S08	Grab	10/29/13 1020	**Outfall 007 Discharge** - Samples were collected from the Outfall 007 discharge structure located along the Cuyahoga River. Samples were collected for Total Metals and RAD analyses.	A 1 liter glass jar attached to a pole was used to collect water discharging from the top of the Outfall 007 discharge structure located along the Cuyahoga River. Water was poured from the glass jar into total metals and RAD sample containers.
D09	Grab	10/29/13 1020	**Outfall 007 Discharge** - Samples were collected from the Outfall 007 discharge structure located along the Cuyahoga River. Samples were collected for Total Metals and RAD analyses. This sample is a duplicate of the S08 sample.	A 1 liter glass jar attached to a pole was used to collect water discharging from the top of the Outfall 007 discharge structure located along the Cuyahoga River. Water was poured from the glass jar into total metals and RAD sample containers.

Table 2 – Sample Bottle and Preservative Information

Sample Bottle Type	Analyses Performed	Sample Preservative Used
1 L glass wide-mouth bottle	Field Parameters -- pH, temperature & conductivity	None – analyzed in field
500 mL polyethylene bottle	Total metals	None – preserved at the laboratory
4 L plastic cubitainer	Radium 228 & 226; Uranium 238, 235, and 234; and Thorium 232, 232, 228 and 227	None

Table 3 – Summary of USEPA Field Measurement for BASF Cleveland, Ohio Site

Sample Location/ Description	BASF Pump and Treat Influent	BASF Pump and Treat Effluent	Outfall 007 Monitoring Station	Outfall 007 Discharge to Cuyahoga R.	Cuyahoga R. at Outfall 007	Outfall 007 Monitoring Station	Outfall 007 Discharge to Cuyahoga R.
Sample No.	**S02**	**S03**	**S04**	**S05**	**S06**	**S07**	**S08**
Date **Time**	10/25/13 0926	10/25/13 1000	10/25/13 1028	10/25/13 1055	10/25/13 1120	10/29/13 0950	10/29/13 1020
Temperature (°C)	15.6	17.6	16.8	15.2	10.7	18.4	17.0
pH (S.U.)	6.80	10.54	7.53	7.48	7.60	8.20	8.38
Conductivity (µmhos/cm)	2228	2300	618	404	832	590	590

Table 4 – Summary of USEPA Metals Results for BASF Cleveland, Ohio Site

Sample Location/ Description	Field Blank	BASF Pump and Treat Influent	BASF Pump and Treat Effluent	Outfall 007 Monitoring Station	Outfall 007 Discharge to Cuyahoga R.	Cuyahoga R. at Outfall 007	Outfall 007 Monitoring Station	Outfall 007 Discharge to Cuyahoga R.	Outfall 007 Discharge to Cuyahoga R (duplicate)
Sample No.	R01	S02	S03	S04	S05	S06	S07	S08	D09
Date	10/25/13	10/25/13	10/25/13	10/25/13	10/25/13	10/25/13	10/29/13	10/29/13	10/29/13
Time	0810	0926	1000	1028	1055	1120	0950	1020	1020
Total Metals	Conc., ug/L	Conc., ug/L	Conc., ug/L	Conc., ug/L	Conc., ug/L	Conc., ug/L	Conc., ug/L	Conc., ug/L	Conc., ug/L
T. Aluminum	21.6	14.7	< 12.3	560	510	1130	306	331	335
T. Antimony	< 1.23	< 1.23	< 1.23	13.7	13.0	< 1.23	11.0	11.0	11.0
T. Arsenic	< 1.23	2.74	< 1.23	5.58	4.96	1.68	3.07	3.26	3.16
T. Barium	< 1.23	34.4	2.81	55.3	54.0	39.5	46.3	47.4	47.1
T. Beryllium	< 1.23	< 1.23	< 1.23	< 1.23	< 1.23	< 1.23	< 1.23	< 1.20	< 1.23
T. Cadmium	< 1.23	< 1.23	< 1.23	16.2	17.5	< 1.23	21.2	19.9	19.6
T. Calcium	< 123	187000	4610	91800	85100	63100	81700	82300	84700
T. Chromium	< 1.23	< 1.23	< 1.23	22.0	19.0	2.87	17.9	17.1	17.0
T. Cobalt	< 1.23	1090	3.91	27.0	28.7	< 1.23	26.9	28.6	28.5
T. Copper	< 1.23	< 1.23	< 1.23	22.3	24.0	4.82	25.3	21.9	21.6
T. Iron	ND	2580	919	161	204	1190	194	252	249
T. Lead	< 1.23	< 1.23	< 1.23	49.1	43.2	3.51	43.1	40.1	39.0
T. Magnesium	< 123	34600	11300	13700	13100	13300	13400	13500	13400
T. Manganese	ND	33900	173	30.9	28.5	60.8	30.8	49.8	48.6
T. Molybdenum	< 1.23	< 1.23	2.46	10.4	11.6	9.14	12.4	12.1	12.3
T. Nickel	< 1.23	40900	594	496	457	6.74	401	401	413
T. Potassium	ND	10700	4170	17300	16500	6650	15600	15700	15500
T. Selenium	< 1.23	1.71	< 1.23	9.05	8.96	< 1.23	6.76	6.91	7.06
T. Silver	ND	< 1.23	ND	ND	6.65	ND	ND	ND	< 1.23
T. Sodium	123	262000	516000	20600	20700	115000	23600	23700	24600
T. Thallium	< 1.23	< 1.23	< 1.23	< 1.23	< 1.23	< 1.23	< 1.23	< 1.23	< 1.23
T. Vanadium	< 1.23	< 1.23	< 1.23	1.43	1.48	2.98	< 1.23	< 1.23	< 1.23
T. Zinc	< 1.23	26.2	1.8	59.5	86.4	20.8	66	66.7	66.4
T. Uranium	< 1.23	2.99	< 1.23	104	93.9	< 1.23	115	118	118

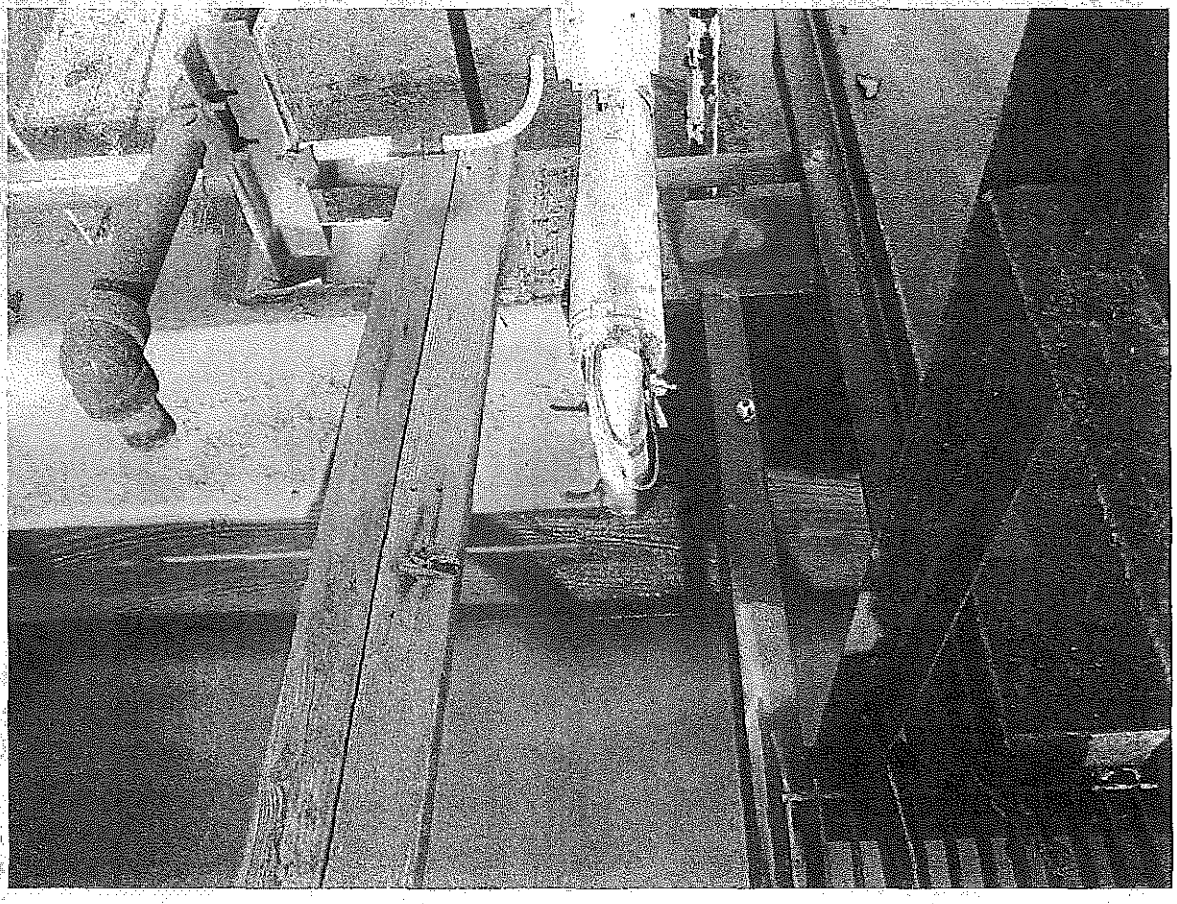
U - Indicates compound was analyzed for but not detected

< - The value is less than the Reporting Limit but greater than or equal to the instrument detection limit. The number shown is the Reporting Limit. The estimated concentration is in the attached lab data package.

Table 5 – Summary of USEPA Radionuclide Results for BASF Cleveland, Ohio Site

Sample Location/ Description	Field Blank	BASF Pump and Treat Influent	BASF Pump and Treat Effluent	Outfall 007 Monitoring Station	Outfall 007 Discharge to Cuyahoga R.	Cuyahoga R. at Outfall 007	Outfall 007 Monitoring Station	Outfall 007 Discharge to Cuyahoga R.	Outfall 007 Discharge to Cuyahoga R (duplicate)
Sample No.	**R01**	**S02**	**S03**	**S04**	**S05**	**S06**	**S07**	**S08**	**D09**
Date	10/25/13	10/25/13	10/25/13	10/25/13	10/25/13	10/25/13	10/29/13	10/29/13	10/29/13
Time	0810	0926	1000	1028	1055	1120	0950	1020	1020
Radionuclides	**Activity pCi/L**	**Activity pCi/L**	**Activity pCi/L**	**Activity pCi/L**	**Activity pCi/L**	**Activity pCi/L**	**Activity pCi/L**	**Activity pCi/L**	**Activity pCi/L**
Radium 226	0.0533	0.414	0.101	0.134	0.137	0.0796	0.153	0.151	0.077
Radium 228	-0.143	0.745	0.0182	0.318	-0.196	0.750	0.231	0.538	0.467
Uranium 234	0.0685	1.17	0.00364	34.4	27.7	3.27	36.8	38.8	36.8
Uranium 235	0.00966	0.102	-0.00436	1.70	1.69	0.173	1.87	1.81	1.64
Uranium 238	0.0685	0.883	0.00	33.7	29.0	3.20	37.7	40.5	36.2
Thorium 232	0.00418	0.0301	-0.00783	0.00923	0.00	0.0249	0.00865	0.00555	0.00
Thorium 230	0.00	-0.0151	-0.00784	-0.00308	0.00658	-0.0166	0.0144	0.00	0.00
Thorium 228	0.0294	0.101	0.106	0.0865	0.0858	0.00	0.113	0.0752	0.0738
Thorium 227	0.00	0.00	0.0243	0.00	-0.0136	-0.0344	0.00	0.00574	0.00585

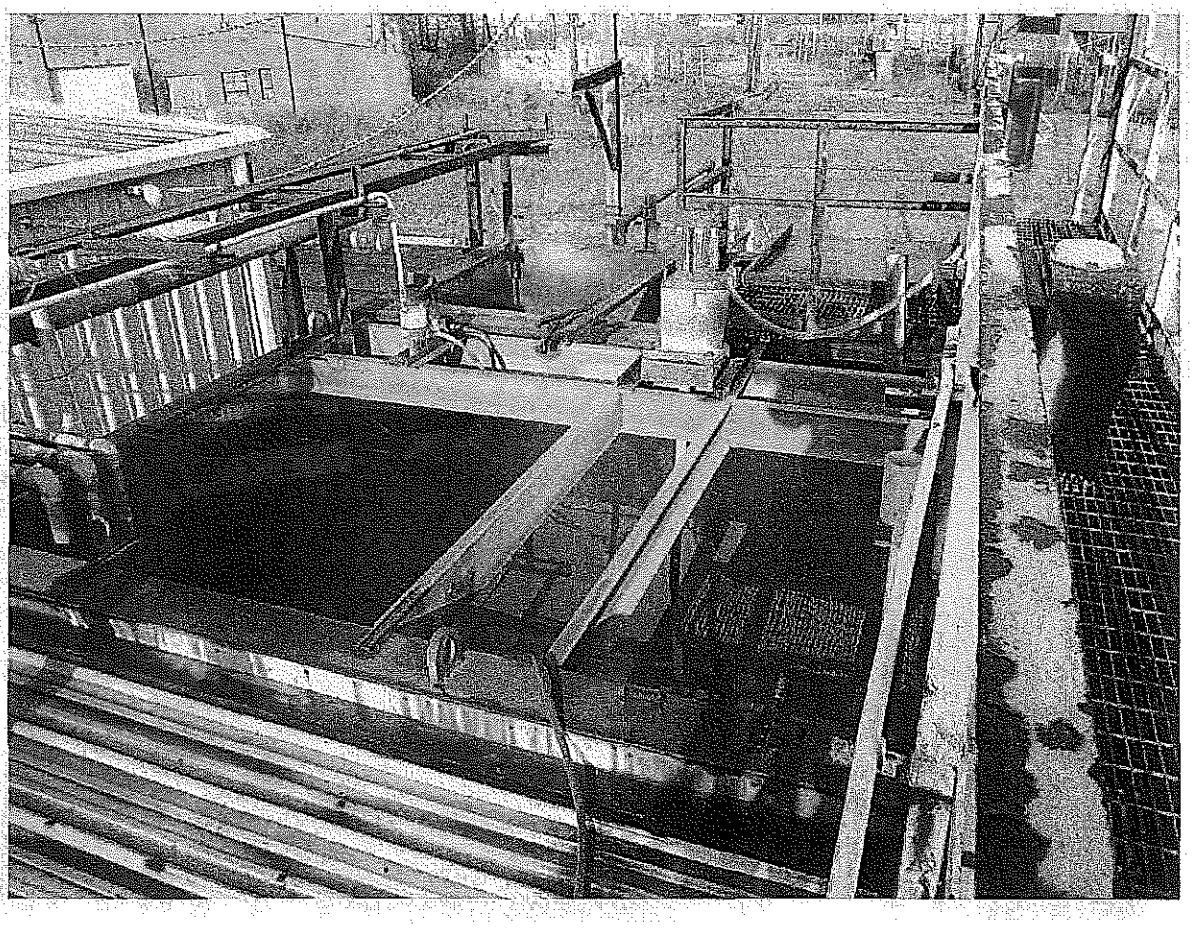
APPENDIX A



PHOTOGRAPH 1 of 9

FACILITY/SITE NAME: BASF Cleveland (formerly Harshaw Chemical Company)
CITY, STATE: Cleveland, Ohio
DATE: October 25, 2013
TIME: 9:50 a.m.
CAMERA, FILM: Canon PowerShot SD1400 IS (S/N 212065043418)
PHOTOGRAPHER: Mark Conti
USEPA OFFICE: OECA, Cleveland Office

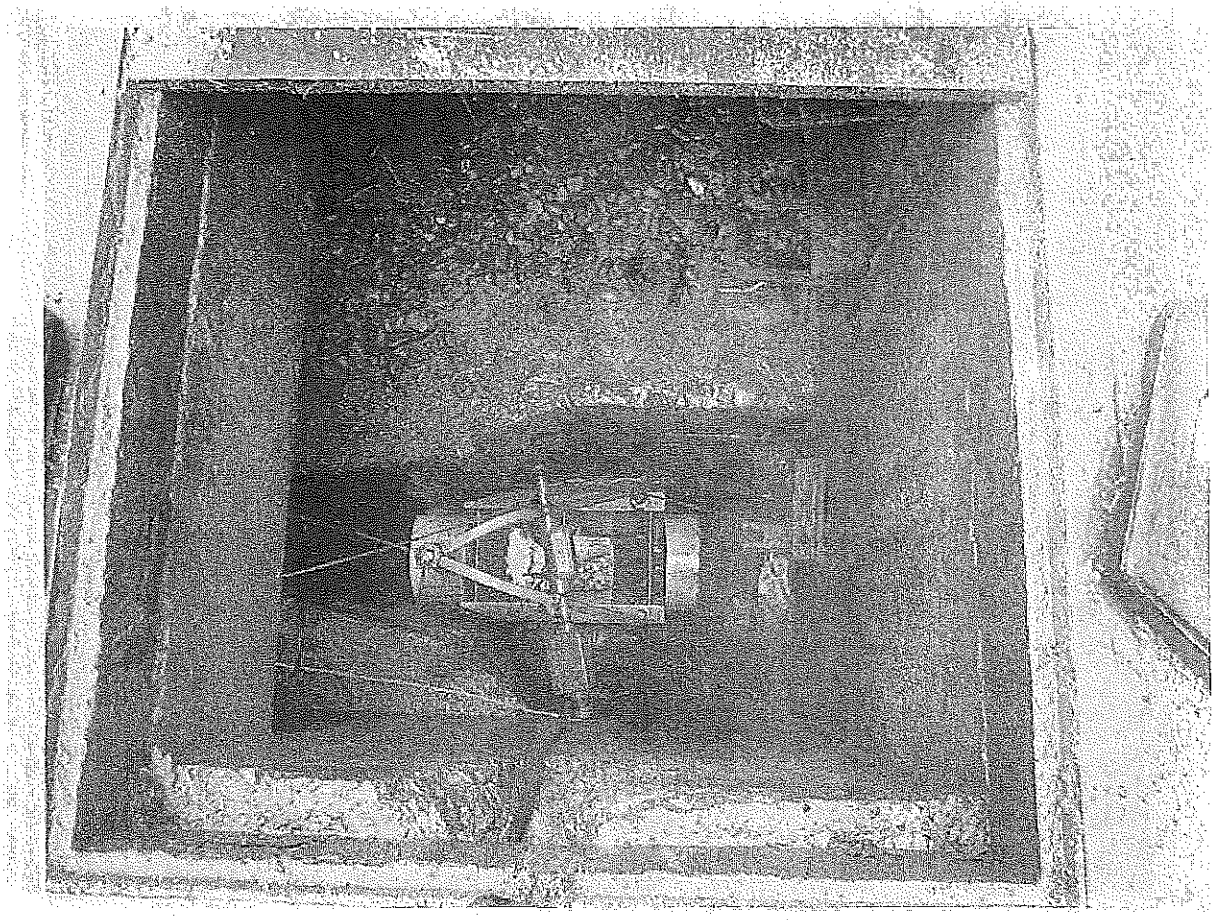
DESCRIPTION: BASF operates a pump and treat system to recover nickel from groundwater. Groundwater is pumped from wells into this holding tank through the pipe at the center of the photograph. A sample of water (14CM01S02) was collected from the flowing pipe for analysis.



PHOTOGRAPH 2 of 9

FACILITY/SITE NAME: BASF Cleveland (formerly Harshaw Chemical Company)
CITY, STATE: Cleveland, Ohio
DATE: October 25, 2013
TIME: 9:50 a.m.
CAMERA, FILM: Canon PowerShot SD1400 IS (S/N 212065043418)
PHOTOGRAPHER: Mark Conti
USEPA OFFICE: OECA, Cleveland Office

DESCRIPTION: BASF operates a pump and treat system to recover nickel from groundwater. This is a wider view of the groundwater holding tank shown in Photograph 1.



PHOTOGRAPH 7 of 9

FACILITY/SITE NAME: BASF Cleveland (formerly Harshaw Chemical Company)
CITY, STATE: Cleveland, Ohio
DATE: October 25, 2013
TIME: 10:37 a.m.
CAMERA, FILM: Canon PowerShot SD1400 IS (S/N 212065043418)
PHOTOGRAPHER: Mark Conti
USEPA OFFICE: OECA, Cleveland Office

DESCRIPTION: This is a vault about 20 feet from the northwest corner of the warehouse. There is a Palmer Bowlus flume positioned within a larger Parshall flume. The direction of flow is left to right (northwest to southeast). The discharge point is the Cuyahoga River (about 150 feet from this location). According to the Fred Newman (inspection contact), Harshaw Chemical Company monitored Outfall 007 at this location. A sample of water (14CM01S04) was collected from the exit end of the Palmer Bowlus flume for analysis.

PHOTOGRAPH 8 of 9

FACILITY/SITE NAME: BASF Cleveland (formerly Harshaw Chemical Company)
CITY, STATE: Cleveland, Ohio
DATE: October 25, 2013
TIME: 11:49 a.m.
CAMERA, FILM: Canon PowerShot SD1400 IS (S/N 212065043418)
PHOTOGRAPHER: Mark Conti
USEPA OFFICE: OECA, Cleveland Office

DESCRIPTION: This is the point where effluent from Outfall 007 mixes with the Cuyahoga River. The Cuyahoga River flows from right to left (southeast to northeast) at this location. A sample of effluent mixed with river water (14CM01S06) was collected for analysis.

PHOTOGRAPH 9 of 9

FACILITY/SITE NAME: BASF Cleveland (formerly Harshaw Chemical Company)
CITY, STATE: Cleveland, Ohio
DATE: October 25, 2013
TIME: 11:49 a.m.
CAMERA, FILM: Canon PowerShot SD1400 IS (S/N 212065043418)
PHOTOGRAPHER: Mark Conti
USEPA OFFICE: OECA, Cleveland Office

DESCRIPTION: This is Outfall 007. The storm water discharge pipe comes through the river bank sheet piling into a concrete and metal structure. The structure is covered with a grate (and overgrown with plants). Water flows up through the structure, cascades out of the top of it, and then flows down the river bank into the Cuyahoga River. A sample of the water (14CM01S05) discharging from the structure was collected for analysis.

The following photographs are not shown. After taking these photographs, Fred Newman stated that he thought BASF would prohibit photographs inside the nickel recovery treatment building. The photographs show some of the equipment in the building. The photographs are being handled as confidential business information and are available upon request.

Photograph 3 of 9
Time: 10:02 a.m.

Photograph 4 of 9
Time: 10:03 a.m.

Photograph 5 of 9
Time: 10:03 a.m.

Photograph 6 of 9
Time: 10:03 a.m.

APPENDIX B

ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

REGION 5
77 West Jackson Boulevard
Chicago, Illinois 60604

CHAIN OF CUSTODY RECORD

PROJ. NO.: HCM01

PROJECT NAME: Hatchard/CASF Cleveland Samples

Activity Code:

SAMPLERS: (Print Name and Sign)
M. McCONNEY
M. BONTI

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	Analyte: RAD	Analyte: Metals					TAG NUMBERS
001	[illegible]	0900		✓	Block Sample	2	•	•					
002	[illegible]	0930		✓	CASF Pump+Treat Influent	2	•	•					
003	[illegible]	1000		✓	CASF Pump+Treat Effluent	2	•	•					
004	[illegible]	1020		✓	007 monitoring station	2	•	•					
005	[illegible]	1055		✓	007 discharge to river	2	•	•					
006	[illegible]	1120		✓	Cuyahoga R. at 007	2	•	•					
													Seal # 53432
													RAD → Ra-226
													Ra-228
													Uranium - 234, 235, 238
													Thorium - 230, 232

Relinquished by: (Signature)	Date / Time	Received by: (Signature)	Ship To:
[illegible]	10/6/03	[illegible] UPS	
Relinquished by: (Signature)	Date / Time	Received by: (Signature)	ATTN:
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature) / Date / Time	Airbill Number
			Chain of Custody Seal Numbers

Distribution: White - Accompanies Shipment; Pink - Coordinator Field Files; Yellow - Laboratory File

Printed on Recycled Paper/Printed with Soy-Based Ink

5-39677

ENVIRONMENTAL PROTECTION AGENCY
Office of Enforcement

REGION 5
77 West Jackson Boulevard
Chicago, Illinois 60604

CHAIN OF CUSTODY RECORD

PROJ. NO.: 143M01

PROJECT NAME: HARSHAW/BASF CLEVELAND SAMPLING

Activity Code:

SAMPLERS: (Print Name and Sign) M. MOLONEY, Mark E. Molloy, C. CUTI, Mark Conte

STA. NO.	DATE	TIME	COMP.	GRAB	STATION LOCATION	NO. OF CONTAINERS	Analyte: RAD	T. Metals					TAG NUMBERS
007	10/29/13	0950		✓	007 monitoring station	2	•	•					
008	10/29/13	1020		✓	007 discharge to river	2	•	•					
009	10/29/13	1020		✓	007 discharge to river	2	•	•					
													seal # 124350
													RAD → Ra-226
													Ra-228
													Uranium-234, 235, 238
													Thorium-230, 232

Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Mark E. Molloy	10/29/13 PM	Via UPS
Relinquished by: (Signature)	Date / Time	Received by: (Signature)
Relinquished by: (Signature)	Date / Time	Received for Laboratory by: (Signature) / Date / Time

Ship To:

ATTN:

Airbill Number

Chain of Custody Seal Numbers

Distribution: White - Accompanies Shipment; Pink - Coordinator Field Files; Yellow - Laboratory File

Printed on Recycled Paper/Printed with Soy-Based Ink

5-39753

APPENDIX C

U.S.ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY
540 S. MORRIS AVE., MONTGOMERY, AL 36115
U ANALYSES

REPORT OF SAMPLE DELIVERY GROUP #1300090

Project:	Region 5 - BASF Corp, Cleveland, OH
Analysis method:	Actinides (Uranium) by Extraction Chromatography
Report ID:	1300090-U
Report type:	Original
Date reported:	12/12/2013
Total pages in report:	17

SAMPLES

NAREL Sample #	Client Sample ID	Location	Matrix	Date Collected	Date Received
B3.11217E	RO1	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11218F	SO2	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11219G	SO3	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11220Z	SO4	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11221A	SO5	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11222B	SO6	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11223C	SO7	OH:CLEVELAND	WATER	10/29/2013	10/30/2013
B3.11224D	SO8	OH:CLEVELAND	WATER	10/29/2013	10/30/2013
B3.11225E	DO9	OH:CLEVELAND	WATER	10/29/2013	10/30/2013

EXCEPTIONS

1. **Packaging and shipping** – No problems were observed.
2. **Documentation** – The dates and times of collection were recorded on the chain of custody and the removable sample tags but were not recorded on the sample containers.
3. **Sample preparation** – Samples were not preserved in the field. NAREL preserved the samples with nitric acid to a pH of 2.
4. **Analysis** – No problems were encountered.
5. **Holding times** – No holding times were specified.

QUALITY CONTROL

1. **QC samples** – All QC analysis results met NAREL acceptance criteria.
2. **Yields** – All chemical yields were within acceptance limits.
3. **Instruments** – Response and background checks for all instruments used in these analyses met NAREL acceptance criteria.

ACCREDITATION

All analyses included in this data package are accredited by the Oregon Environmental Laboratory Accreditation Program (ORELAP) to the TNI standard.

CERTIFICATION

I certify that this data report complies with the terms and conditions of the Quality Assurance Project Plan, except as noted above. Release of the data contained in this report has been authorized by the Director of the Center for Environmental Radioanalytical Laboratory Science and the NAREL Quality Assurance Manager, or their designees, as verified by the following signatures.

for Mary F. Wisdom — Date: 12/19/13
Quality Assurance Manager, NAREL

Cynthia White — Date: 12-23-13
Director, Center for Environmental Radioanalytical Laboratory Science

GENERAL INFORMATION

SAMPLE TYPES

BLD	Blind sample
FBK	Field blank
SAM	Normal sample

ANALYSIS QC TYPES

ANA	Normal analysis
DUP	Laboratory duplicate
LCS	Laboratory control sample, or blank spike
MS	Matrix spike
MSD	Matrix spike duplicate (not currently analyzed)
RBK	Method blank
STD	External standard (used for ^{228}Ra yield determination)

QUALITY INDICATORS

RPD	Relative Percent Difference
%R	Percent Recovery
Z	Number of standard deviations by which a QC measurement differs from the expected value

RADIOCHEMICAL DATA

Radiochemical analyses usually require the subtraction of an instrument background measurement result from a gross sample measurement result. Both values are positive, but when the sample activity is low, random variations in the two measurements can cause the gross value to be less than the background, resulting in a measured activity less than zero. Although negative activities have no physical significance, they do have statistical importance, as for example in the evaluation of trends or the comparison of two groups of samples.

To the extent practical, it is the policy of NAREL to report results as generated, whether positive, negative, or zero, together with the "2-sigma" measurement uncertainty and a sample-specific estimate of the minimum detectable concentration (MDC). The measurement result, uncertainty, and MDC are always expressed in the same unit of measurement.

EVALUATION OF QC ANALYSES

A method blank result is considered unacceptable if it is more than 3 standard deviations below zero or more than 3 standard deviations above a predetermined upper control limit. For some analyses NAREL has set the upper control limit at zero. For others the control limit is a small positive number.

NAREL evaluates the results of duplicate and spike analyses using "Z scores." A Z score is the number of standard deviations by which the QC result differs from its ideal value. Generally the score is considered acceptable if its absolute value is not greater than 3.

The Z score for a spiked sample is computed by dividing the difference between the measured value and the target value by the combined standard uncertainty of the difference. The Z score for a duplicate analysis is computed by dividing the difference between the two measured values by the combined standard uncertainty of the difference.

NAREL reports the "relative percent difference," or RPD, between duplicate results and the "percent recovery," or %R, for spiked analyses, but does not use these values for evaluation of most analyses. An exception is the use of %R in the evaluation of gross alpha matrix spike results. A gross alpha matrix spike result is considered acceptable if either $|Z| \leq 3$ or $60 \leq \%R \leq 110$.

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

ANALYSIS SUMMARY

Analysis method: NAREL U-EICHROM
Title: Actinides (Uranium) by Extraction Chromatography

NAREL Sample #	Client Sample ID	QC Type	Date Completed	Preparation Batch #	Assay Batch #
B3.11217E	RO1		11/26/2013	0010527Z	0017572V
B3.11218F	SO2		11/26/2013	0010527Z	0017572V
B3.11218F	SO2	DUP	11/26/2013	0010527Z	0017572V
B3.11219G	SO3		11/26/2013	0010527Z	0017572V
B3.11220Z	SO4		11/26/2013	0010527Z	0017572V
B3.11221A	SO5		11/26/2013	0010527Z	0017572V
B3.11222B	SO6		11/26/2013	0010527Z	0017572V
B3.11223C	SO7		11/26/2013	0010527Z	0017572V
B3.11224D	SO8		11/26/2013	0010527Z	0017572V
B3.11225E	DO9		11/26/2013	0010527Z	0017572V
LCS-00679390W *		LCS	11/26/2013	0010527Z	0017572V
RBK-00679389D *		RBK	11/26/2013	0010527Z	0017572V

* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11217E	Amount analyzed:	4.000e-01 L
Client sample ID:	RO1	Preparation batch #:	0010527Z
Matrix:	WATER	Assay batch #:	0017572V
Collected:	2013-10-25 08:10 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL U-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/25/2013 17:04	1000.0	AS34	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
U234	6.85e-02	6.5e-02	7.5e-02	PCI/L	11/25/2013 17:04 CST
U235	9.66e-03	4.3e-02	8.9e-02	PCI/L	11/25/2013 17:04 CST
U238	6.85e-02	6.5e-02	7.5e-02	PCI/L	11/25/2013 17:04 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11218F	Amount analyzed:	2.000e-01 L
Client sample ID:	SO2	Preparation batch #:	0010527Z
Matrix:	WATER	Assay batch #:	0017572V
Collected:	2013-10-25 09:26 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL U-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/25/2013 17:04	1000.0	AS36	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
U234	1.17e+00	2.9e-01	1.0e-01	PCI/L	11/25/2013 17:04 CST
U235	1.02e-01	9.7e-02	1.1e-01	PCI/L	11/25/2013 17:04 CST
U238	8.83e-01	2.4e-01	7.5e-02	PCI/L	11/25/2013 17:04 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11218E	Amount analyzed:	2.000e-01 L
Client sample ID:	SO2	Preparation batch #:	0010527Z
Matrix:	WATER	Assay batch #:	0017572V
Collected:	2013-10-25 09:26 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL U-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	DUP
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/25/2013 17:04	1000.0	AS37	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
U234	8.14e-01	2.4e-01	1.0e-01	PCI/L	11/25/2013 17:04 CST
U235	2.99e-02	6.5e-02	1.1e-01	PCI/L	11/25/2013 17:04 CST
U238	9.54e-01	2.5e-01	9.2e-02	PCI/L	11/25/2013 17:04 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11219G	Amount analyzed:	4.000e-01 L
Client sample ID:	SO3	Preparation batch #:	0010527Z
Matrix:	WATER	Assay batch #:	0017572V
Collected:	2013-10-25 10:00 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL U-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/25/2013 17:04	1000.0	AS38	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
U234	3.64e-03	4.2e-02	9.4e-02	PCI/L	11/25/2013 17:04 CST
U235	-4.36e-03	2.9e-02	8.1e-02	PCI/L	11/25/2013 17:04 CST
U238	0.00e+00	3.4e-02	8.3e-02	PCI/L	11/25/2013 17:04 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3:11220Z	Amount analyzed:	4.000e-01 L
Client sample ID:	SO4	Preparation batch #:	0010527Z
Matrix:	WATER	Assay batch #:	0017572V
Collected:	2013-10-25 10:28 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL U-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/25/2013 17:04	1000.0	AS40	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
U234	3.44e+01	3.6e+00	8.3e-02	PCI/L	11/25/2013 17:04 CST
U235	1.70e+00	4.0e-01	8.8e-02	PCI/L	11/25/2013 17:04 CST
U238	3.37e+01	3.5e+00	7.3e-02	PCI/L	11/25/2013 17:04 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11221A	Amount analyzed:	4.000e-01 L
Client sample ID:	SO5	Preparation batch #:	0010527Z
Matrix:	WATER	Assay batch #:	0017572V
Collected:	2013-10-25 10:55 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL U-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/25/2013 17:04	1000.0	AS65	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
U234	2.77e+01	3.0e+00	1.5e-01	PCI/L	11/25/2013 17:04 CST
U235	1.69e+00	4.3e-01	1.9e-01	PCI/L	11/25/2013 17:04 CST
U238	2.90e+01	3.2e+00	1.7e-01	PCI/L	11/25/2013 17:04 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11222B	Amount analyzed:	2.000e-01 L
Client sample ID:	SO6	Preparation batch #:	0010527Z
Matrix:	WATER	Assay batch #:	0017572V
Collected:	2013-10-25 11:20 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL U-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/25/2013 17:04	1000.0	AS66	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
U234	3.27e+00	5.5e-01	1.2e-01	PCI/L	11/25/2013 17:04 CST
U235	1.73e-01	1.4e-01	1.6e-01	PCI/L	11/25/2013 17:04 CST
U238	3.20e+00	5.4e-01	8.4e-02	PCI/L	11/25/2013 17:04 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11223C	Amount analyzed:	4.000e-01 L
Client sample ID:	SO7	Preparation batch #:	0010527Z
Matrix:	WATER	Assay batch #:	0017572V
Collected:	2013-10-29 09:50 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL U-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/25/2013 17:04	1000.0	AS67	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
U234	3.68e+01	3.8e+00	7.5e-02	PCI/L	11/25/2013 17:04 CST
U235	1.87e+00	4.4e-01	9.0e-02	PCI/L	11/25/2013 17:04 CST
U238	3.77e+01	3.9e+00	6.1e-02	PCI/L	11/25/2013 17:04 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11224D	Amount analyzed:	4.000e-01 L
Client sample ID:	SO8	Preparation batch #:	0010527Z
Matrix:	WATER	Assay batch #:	0017572V
Collected:	2013-10-29 10:20 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL U-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/25/2013 17:04	1000.0	AS68	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
U234	3.88e+01	4.2e+00	8.3e-02	PCI/L	11/25/2013 17:04 CST
U235	1.81e+00	4.4e-01	8.1e-02	PCI/L	11/25/2013 17:04 CST
U238	4.05e+01	4.3e+00	6.7e-02	PCI/L	11/25/2013 17:04 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11225E	Amount analyzed:	4.000e-01 L
Client sample ID:	DO9	Preparation batch #:	0010527Z
Matrix:	WATER	Assay batch #:	0017572V
Collected:	2013-10-29 10:20 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL U-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/25/2013 17:04	1000.0	AS69	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
U234	3.69e+01	3.8e+00	7.3e-02	PCI/L	11/25/2013 17:04 CST
U235	1.64e+00	3.9e-01	7.1e-02	PCI/L	11/25/2013 17:04 CST
U238	3.62e+01	3.7e+00	8.2e-02	PCI/L	11/25/2013 17:04 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	LCS-00679390W	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0010527Z
Matrix:	N/A	Assay batch #:	0017572V
Collected:	N/A	Prep procedure:	N/A
Sample type:	N/A	Analysis method:	NAREL U-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	LCS
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/25/2013 17:04	1000.0	AS70	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
U234	2.20e+00	2.6e-01	2.2e-02	PCI	11/25/2013 17:04 CST
U235	1.40e-01	5.4e-02	2.6e-02	PCI	11/25/2013 17:04 CST
U238	2.20e+00	2.6e-01	2.7e-02	PCI	11/25/2013 17:04 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	RBK-00679389D	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0010527Z
Matrix:	N/A	Assay batch #:	0017572V
Collected:	N/A	Prep procedure:	N/A
Sample type:	N/A	Analysis method:	NAREL U-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	RBK
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/25/2013 17:04	1000.0	AS71	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
U234	5.74e-03	1.7e-02	3.3e-02	PCI	11/25/2013 17:04 CST
U235	4.13e-03	1.5e-02	3.1e-02	PCI	11/25/2013 17:04 CST
U238	1.95e-02	2.2e-02	3.3e-02	PCI	11/25/2013 17:04 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG 1300090

PREPARATION BATCH SUMMARY

Preparation batch #: 0010527Z
Analysis method: NAREL U-EICHROM
Preparation procedure: N/A

NAREL Sample #	Client Sample ID	Analysis #	QC Type	Yield	± 2 σ Uncertainty	Analyst
B3.11217E	RO1	00677695C		56.33 %	5.63 %	SPK
B3.11218F	SO2	00677701G		90.87 %	7.91 %	SPK
B3.11218F	SO2	00679391X	DUP	94.87 %	8.26 %	SPK
B3.11219G	SO3	00677707N		65.58 %	6.37 %	SPK
B3.11220Z	SO4	00677713L		56.78 %	5.66 %	SPK
B3.11221A	SO5	00677719T		49.12 %	4.97 %	SPK
B3.11222B	SO6	00677725Q		80.53 %	7.07 %	SPK
B3.11223C	SO7	00677731N		52.82 %	5.20 %	SPK
B3.11224D	SO8	00677737V		47.65 %	4.85 %	SPK
B3.11225E	DO9	00677743T		55.09 %	5.37 %	SPK
LCS-00679390W *		00679390W	LCS	75.61 %	6.77 %	SPK
RBK-00679389D *		00679389D	RBK	74.93 %	6.63 %	SPK

* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

QC RESULTS FOR BATCH 0010527Z

NAREL Sample #	Analysis #	QC Type	Analyte	%R	RPD	Z	Evaluation
B3.11218F	00679391X	DUP	U234		36.1	-1.94	PASS
B3.11218F	00679391X	DUP	U235		109.0	-1.23	PASS
B3.11218F	00679391X	DUP	U238		7.7	0.40	PASS
LCS-00679390W	00679390W	LCS	U234	111.8		1.77	PASS
LCS-00679390W	00679390W	LCS	U235	149.4		1.71	PASS
LCS-00679390W	00679390W	LCS	U238	107.8		1.20	PASS
RBK-00679389D	00679389D	RBK	U234				PASS
RBK-00679389D	00679389D	RBK	U235				PASS
RBK-00679389D	00679389D	RBK	U238				PASS

U.S.ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY
540 S. MORRIS AVE., MONTGOMERY, AL 36115
TH ANALYSES

REPORT OF SAMPLE DELIVERY GROUP #1300090

Project:	Region 5 - BASF Corp, Cleveland, OH
Analysis method:	Actinides (Thorium) by Extraction Chromatography
Report ID:	1300090-TH
Report type:	Original
Date reported:	12/12/2013
Total pages in report:	17

SAMPLES

NAREL Sample #	Client Sample ID	Location	Matrix	Date Collected	Date Received
B3.11217E	RO1	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11218F	SO2	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11219G	SO3	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11220Z	SO4	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11221A	SO5	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11222B	SO6	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11223C	SO7	OH:CLEVELAND	WATER	10/29/2013	10/30/2013
B3.11224D	SO8	OH:CLEVELAND	WATER	10/29/2013	10/30/2013
B3.11225E	DO9	OH:CLEVELAND	WATER	10/29/2013	10/30/2013

EXCEPTIONS

1. **Packaging and shipping** – No problems were observed.
2. **Documentation** – The dates and times of collection were recorded on the chain of custody and the removable sample tags but were not recorded on the sample containers.
3. **Sample preparation** – Samples were not preserved in the field. NAREL preserved the samples with nitric acid to a pH of 2.
4. **Analysis** – No problems were encountered.
5. **Holding times** – No holding times were specified.

QUALITY CONTROL

1. **QC samples** – All QC analysis results met NAREL acceptance criteria.
2. **Yields** – All chemical yields were within acceptance limits.
3. **Instruments** – Response and background checks for all instruments used in these analyses met NAREL acceptance criteria.

ACCREDITATION

All analyses included in this data package are accredited by the Oregon Environmental Laboratory Accreditation Program (ORELAP) to the TNI standard.

CERTIFICATION

I certify that this data report complies with the terms and conditions of the Quality Assurance Project Plan, except as noted above. Release of the data contained in this report has been authorized by the Director of the Center for Environmental Radioanalytical Laboratory Science and the NAREL Quality Assurance Manager, or their designees, as verified by the following signatures.

for Mary F. Wisdom — 12/19/13
Quality Assurance Manager, NAREL — Date

Cynthia White — 12-23-13
Director, Center for Environmental Radioanalytical Laboratory Science — Date

GENERAL INFORMATION

SAMPLE TYPES

BLD	Blind sample
FBK	Field blank
SAM	Normal sample

ANALYSIS QC TYPES

ANA	Normal analysis
DUP	Laboratory duplicate
LCS	Laboratory control sample, or blank spike
MS	Matrix spike
MSD	Matrix spike duplicate (not currently analyzed)
RBK	Method blank
STD	External standard (used for ^{228}Ra yield determination)

QUALITY INDICATORS

RPD	Relative Percent Difference
%R	Percent Recovery
Z	Number of standard deviations by which a QC measurement differs from the expected value

RADIOCHEMICAL DATA

Radiochemical analyses usually require the subtraction of an instrument background measurement result from a gross sample measurement result. Both values are positive, but when the sample activity is low, random variations in the two measurements can cause the gross value to be less than the background, resulting in a measured activity less than zero. Although negative activities have no physical significance, they do have statistical importance, as for example in the evaluation of trends or the comparison of two groups of samples.

To the extent practical, it is the policy of NAREL to report results as generated, whether positive, negative, or zero, together with the "2-sigma" measurement uncertainty and a sample-specific estimate of the minimum detectable concentration (MDC). The measurement result, uncertainty, and MDC are always expressed in the same unit of measurement.

EVALUATION OF QC ANALYSES

A method blank result is considered unacceptable if it is more than 3 standard deviations below zero or more than 3 standard deviations above a predetermined upper control limit. For some analyses NAREL has set the upper control limit at zero. For others the control limit is a small positive number.

NAREL evaluates the results of duplicate and spike analyses using "Z scores." A Z score is the number of standard deviations by which the QC result differs from its ideal value. Generally the score is considered acceptable if its absolute value is not greater than 3.

The Z score for a spiked sample is computed by dividing the difference between the measured value and the target value by the combined standard uncertainty of the difference. The Z score for a duplicate analysis is computed by dividing the difference between the two measured values by the combined standard uncertainty of the difference.

NAREL reports the "relative percent difference," or RPD, between duplicate results and the "percent recovery," or %R, for spiked analyses, but does not use these values for evaluation of most analyses. An exception is the use of %R in the evaluation of gross alpha matrix spike results. A gross alpha matrix spike result is considered acceptable if either $|Z| \leq 3$ or $60 \leq \%R \leq 110$.

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

ANALYSIS SUMMARY

Analysis method: NAREL TH-EICHROM
Title: Actinides (Thorium) by Extraction Chromatography

NAREL Sample #	Client Sample ID	QC Type	Date Completed	Preparation Batch #	Assay Batch #
B3.11217E	RO1		11/27/2013	0010525X	0017571U
B3.11218F	SO2		11/27/2013	0010525X	0017571U
B3.11218F	SO2	DUP	11/27/2013	0010525X	0017571U
B3.11219G	SO3		11/27/2013	0010525X	0017571U
B3.11220Z	SO4		11/27/2013	0010525X	0017571U
B3.11221A	SO5		11/27/2013	0010525X	0017571U
B3.11222B	SO6		11/27/2013	0010525X	0017571U
B3.11223C	SO7		11/27/2013	0010525X	0017571U
B3.11224D	SO8		11/27/2013	0010525X	0017571U
B3.11225E	DO9		11/27/2013	0010525X	0017571U
LCS-00679285W *		LCS	11/27/2013	0010525X	0017571U
RBK-00679284V *		RBK	11/27/2013	0010525X	0017571U

* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11217E	Amount analyzed:	4.000e-01 L
Client sample ID:	RO1	Preparation batch #:	0010525X
Matrix:	WATER	Assay batch #:	0017571U
Collected:	2013-10-25 08:10 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL TH-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/26/2013 15:38	1000.0	AS86	JEA

ANALYTICAL RESULTS

Analyte	Activity	±2 σ Uncertainty	MDC	Unit	Reference Date
Th227	0.00e+00	5.5e-02	1.3e-01	PCI/L	11/22/2013 11:00 CST
Th228	2.94e-02	6.0e-02	1.1e-01	PCI/L	11/22/2013 11:00 CST
Th230	0.00e+00	2.7e-02	6.3e-02	PCI/L	11/22/2013 11:00 CST
Th232	4.18e-03	3.8e-02	8.7e-02	PCI/L	11/22/2013 11:00 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
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SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11218F	Amount analyzed:	2.000e-01 L
Client sample ID:	SO2	Preparation batch #:	0010525X
Matrix:	WATER	Assay batch #:	0017571U
Collected:	2013-10-25 09:26 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL TH-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/26/2013 15:38	1000.0	AS87	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Th227	0.00e+00	6.6e-02	1.6e-01	PCI/L	11/22/2013 11:00 CST
Th228	1.01e-01	1.0e-01	1.4e-01	PCI/L	11/22/2013 11:00 CST
Th230	-1.51e-02	3.6e-02	1.1e-01	PCI/L	11/22/2013 11:00 CST
Th232	3.01e-02	5.3e-02	7.5e-02	PCI/L	11/22/2013 11:00 CST

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SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11218F	Amount analyzed:	2.000e-01 L
Client sample ID:	SO2	Preparation batch #:	0010525X
Matrix:	WATER	Assay batch #:	0017571U
Collected:	2013-10-25 09:26 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL TH-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	DUP
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/26/2013 15:38	1000.0	AS88	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Th227	-1.10e-02	7.3e-02	2.0e-01	PCI/L	11/22/2013 11:00 CST
Th228	1.07e-01	1.2e-01	2.0e-01	PCI/L	11/22/2013 11:00 CST
Th230	0.00e+00	3.4e-02	8.0e-02	PCI/L	11/22/2013 11:00 CST
Th232	7.44e-02	8.0e-02	9.8e-02	PCI/L	11/22/2013 11:00 CST

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SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11219G	Amount analyzed:	4.000e-01 L
Client sample ID:	SO3	Preparation batch #:	0010525X
Matrix:	WATER	Assay batch #:	0017571U
Collected:	2013-10-25 10:00 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL TH-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/26/2013 15:38	1000.0	AS97	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Th227	2.43e-02	7.1e-02	1.2e-01	PCI/L	11/22/2013 11:00 CST
Th228	1.06e-01	8.0e-02	8.9e-02	PCI/L	11/22/2013 11:00 CST
Th230	-7.84e-03	2.7e-02	8.2e-02	PCI/L	11/22/2013 11:00 CST
Th232	-7.83e-03	2.7e-02	8.1e-02	PCI/L	11/22/2013 11:00 CST

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SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11220Z	Amount analyzed:	4.000e-01 L
Client sample ID:	SO4	Preparation batch #:	0010525X
Matrix:	WATER	Assay batch #:	0017571U
Collected:	2013-10-25 10:28 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL TH-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/26/2013 15:38	1000.0	AS99	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Th227	0.00e+00	4.0e-02	9.6e-02	PCI/L	11/22/2013 11:00 CST
Th228	8.65e-02	6.6e-02	8.0e-02	PCI/L	11/22/2013 11:00 CST
Th230	-3.08e-03	2.0e-02	5.7e-02	PCI/L	11/22/2013 11:00 CST
Th232	-9.23e-03	2.2e-02	7.0e-02	PCI/L	11/22/2013 11:00 CST

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SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11221A	Amount analyzed:	4.000e-01 L
Client sample ID:	SO5	Preparation batch #:	0010525X
Matrix:	WATER	Assay batch #:	0017571U
Collected:	2013-10-25 10:55 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL TH-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/26/2013 15:38	1000.0	AS101	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Th227	-1.36e-02	4.7e-02	1.4e-01	PCI/L	11/22/2013 11:00 CST
Th228	8.58e-02	6.3e-02	6.1e-02	PCI/L	11/22/2013 11:00 CST
Th230	6.58e-03	2.9e-02	6.1e-02	PCI/L	11/22/2013 11:00 CST
Th232	0.00e+00	3.1e-02	7.5e-02	PCI/L	11/22/2013 11:00 CST

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SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11222B	Amount analyzed:	2.000e-01 L
Client sample ID:	SO6	Preparation batch #:	0010525X
Matrix:	WATER	Assay batch #:	0017571U
Collected:	2013-10-25 11:20 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL TH-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/26/2013 15:38	1000.0	AS104	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Th227	-3.44e-02	1.2e-01	3.6e-01	PCI/L	11/22/2013 11:00 CST
Th228	0.00e+00	1.4e-01	3.0e-01	PCI/L	11/22/2013 11:00 CST
Th230	-1.66e-02	5.8e-02	1.7e-01	PCI/L	11/22/2013 11:00 CST
Th232	2.49e-02	7.2e-02	1.2e-01	PCI/L	11/22/2013 11:00 CST

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SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11223C	Amount analyzed:	4.000e-01 L
Client sample ID:	SO7	Preparation batch #:	0010525X
Matrix:	WATER	Assay batch #:	0017571U
Collected:	2013-10-29 09:50 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL TH-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/26/2013 15:38	1000.0	AS121	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Th227	0.00e+00	3.8e-02	9.0e-02	PCI/L	11/22/2013 11:00 CST
Th228	1.13e-01	7.1e-02	7.9e-02	PCI/L	11/22/2013 11:00 CST
Th230	1.44e-02	3.1e-02	5.3e-02	PCI/L	11/22/2013 11:00 CST
Th232	8.65e-03	2.5e-02	4.3e-02	PCI/L	11/22/2013 11:00 CST

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SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3-11224D	Amount analyzed:	4.000e-01 L
Client sample ID:	SO8	Preparation batch #:	0010525X
Matrix:	WATER	Assay batch #:	0017571U
Collected:	2013-10-29 10:20 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL TH-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/26/2013 15:38	1000.0	AS122	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Th227	5.74e-03	5.3e-02	1.2e-01	PCI/L	11/22/2013 11:00 CST
Th228	7.52e-02	6.0e-02	7.6e-02	PCI/L	11/22/2013 11:00 CST
Th230	0.00e+00	1.8e-02	4.2e-02	PCI/L	11/22/2013 11:00 CST
Th232	5.55e-03	2.5e-02	5.1e-02	PCI/L	11/22/2013 11:00 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
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SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11225E	Amount analyzed:	4.000e-01 L
Client sample ID:	DO9	Preparation batch #:	0010525X
Matrix:	WATER	Assay batch #:	0017571U
Collected:	2013-10-29 10:20 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL TH-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/26/2013 15:38	1000.0	AS123	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Th227	-5.85e-03	3.9e-02	1.1e-01	PCI/L	11/22/2013 11:00 CST
Th228	7.38e-02	6.7e-02	9.8e-02	PCI/L	11/22/2013 11:00 CST
Th230	0.00e+00	1.8e-02	4.3e-02	PCI/L	11/22/2013 11:00 CST
Th232	0.00e+00	1.8e-02	4.2e-02	PCI/L	11/22/2013 11:00 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	LCS-00679285W	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0010525X
Matrix:	N/A	Assay batch #:	0017571U
Collected:	N/A	Prep procedure:	N/A
Sample type:	N/A	Analysis method:	NAREL TH-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	LCS
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/26/2013 15:38	1000.0	AS124	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Th227	-2.05e-03	1.4e-02	3.8e-02	PCI	11/22/2013 11:00 CST
Th228	1.79e-02	1.7e-02	2.3e-02	PCI	11/22/2013 11:00 CST
Th230	2.00e+00	1.8e-01	1.8e-02	PCI	11/22/2013 11:00 CST
Th232	2.97e-03	1.1e-02	2.2e-02	PCI	11/22/2013 11:00 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
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SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	RBK-00679284V	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0010525X
Matrix:	N/A	Assay batch #:	0017571U
Collected:	N/A	Prep procedure:	N/A
Sample type:	N/A	Analysis method:	NAREL TH-EICHROM
Dry/wet weight:	N/A	Analyst:	SPK
Ash/dry weight:	N/A	QC type:	RBK
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
11/26/2013 15:38	1000.0	AS125	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Th227	-2.10e-03	1.4e-02	3.9e-02	PCI	11/22/2013 11:00 CST
Th228	1.33e-02	1.7e-02	2.6e-02	PCI	11/22/2013 11:00 CST
Th230	0.00e+00	6.4e-03	1.5e-02	PCI	11/22/2013 11:00 CST
Th232	2.03e-03	9.1e-03	1.9e-02	PCI	11/22/2013 11:00 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG 1300090

PREPARATION BATCH SUMMARY

Preparation batch #: 0010525X
Analysis method: NAREL TH-EICHROM
Preparation procedure: N/A

NAREL Sample #	Client Sample ID	Analysis #	QC Type	Yield	± 2 σ Uncertainty	Analyst
B3.11217E	RO1	00677696D		59.18 %	2.15 %	SPK
B3.11218F	SO2	00677702H		95.62 %	3.06 %	SPK
B3.11218F	SO2	00679393Z	DUP	88.45 %	2.88 %	SPK
B3.11219G	SO3	00677708P		60.25 %	2.17 %	SPK
B3.11220Z	SO4	00677714M		76.84 %	2.58 %	SPK
B3.11221A	SO5	00677720K		72.68 %	2.47 %	SPK
B3.11222B	SO6	00677726R		56.54 %	2.08 %	SPK
B3.11223C	SO7	00677732P		81.47 %	2.70 %	SPK
B3.11224D	SO8	00677738W		82.84 %	2.74 %	SPK
B3.11225E	DO9	00677744U		81.59 %	2.74 %	SPK
LCS-00679285W *		00679285W	LCS	96.90 %	3.13 %	SPK
RBK-00679284V *		00679284V	RBK	93.19 %	3.00 %	SPK

* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

QC RESULTS FOR BATCH 0010525X

NAREL Sample #	Analysis #	QC Type	Analyte	%R	RPD	Z	Evaluation
B3.11218F	00679393Z	DUP	TH227		-200.0	-0.22	PASS
B3.11218F	00679393Z	DUP	TH228		5.8	0.08	PASS
B3.11218F	00679393Z	DUP	TH230		-200.0	0.61	PASS
B3.11218F	00679393Z	DUP	TH232		84.9	0.93	PASS
LCS-00679285W	00679285W	LCS	TH230	99.1		-0.20	PASS
RBK-00679284V	00679284V	RBK	TH227				PASS
RBK-00679284V	00679284V	RBK	TH228				PASS
RBK-00679284V	00679284V	RBK	TH230				PASS
RBK-00679284V	00679284V	RBK	TH232				PASS

U.S.ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY
540 S. MORRIS AVE., MONTGOMERY, AL 36115
RA226 ANALYSES

REPORT OF SAMPLE DELIVERY GROUP #1300090

Project:	Region 5 - BASF Corp, Cleveland, OH
Analysis method:	Radium-226 in Water: Rapid Method for High-Activity Samples
Report ID:	1300090-RA226
Report type:	Original
Date reported:	12/16/2013
Total pages in report:	21

SAMPLES

NAREL Sample #	Client Sample ID	Location	Matrix	Date Collected	Date Received
B3.11217E	RO1	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11218F	SO2	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11219G	SO3	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11220Z	SO4	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11221A	SO5	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11222B	SO6	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11223C	SO7	OH:CLEVELAND	WATER	10/29/2013	10/30/2013
B3.11224D	SO8	OH:CLEVELAND	WATER	10/29/2013	10/30/2013
B3.11225E	DO9	OH:CLEVELAND	WATER	10/29/2013	10/30/2013

EXCEPTIONS

1. **Packaging and shipping** – No problems were observed.
2. **Documentation** – The dates and times of collection were recorded on the chain of custody and the removable sample tags but were not recorded on the sample containers.
3. **Sample preparation** – Samples were not preserved in the field. NAREL preserved the samples with nitric acid to a pH of 2.
4. **Analysis** – No problems were encountered.
5. **Holding times** – No holding times were specified.

QUALITY CONTROL

1. **QC samples** – All QC analysis results met NAREL acceptance criteria.
2. **Yields** – All chemical yields were within acceptance limits.
3. **Instruments** – Response and background checks for all instruments used in these analyses met NAREL acceptance criteria.

ACCREDITATION

All analyses included in this data package are accredited by the Oregon Environmental Laboratory Accreditation Program (ORELAP) to the TNI standard.

CERTIFICATION

I certify that this data report complies with the terms and conditions of the Quality Assurance Project Plan, except as noted above. Release of the data contained in this report has been authorized by the Director of the Center for Environmental Radioanalytical Laboratory Science and the NAREL Quality Assurance Manager, or their designees, as verified by the following signatures.

for Mary F. Wisdom — 12/19/13 Date
Quality Assurance Manager, NAREL

Cynthia White — 12-23-13 Date
Director, Center for Environmental Radioanalytical Laboratory Science

GENERAL INFORMATION

SAMPLE TYPES

BLD	Blind sample
FBK	Field blank
SAM	Normal sample

ANALYSIS QC TYPES

ANA	Normal analysis
DUP	Laboratory duplicate
LCS	Laboratory control sample, or blank spike
MS	Matrix spike
MSD	Matrix spike duplicate (not currently analyzed)
RBK	Method blank
STD	External standard (used for ^{228}Ra yield determination)

QUALITY INDICATORS

RPD	Relative Percent Difference
%R	Percent Recovery
Z	Number of standard deviations by which a QC measurement differs from the expected value

RADIOCHEMICAL DATA

Radiochemical analyses usually require the subtraction of an instrument background measurement result from a gross sample measurement result. Both values are positive, but when the sample activity is low, random variations in the two measurements can cause the gross value to be less than the background, resulting in a measured activity less than zero. Although negative activities have no physical significance, they do have statistical importance, as for example in the evaluation of trends or the comparison of two groups of samples.

To the extent practical, it is the policy of NAREL to report results as generated, whether positive, negative, or zero, together with the "2-sigma" measurement uncertainty and a sample-specific estimate of the minimum detectable concentration (MDC). The measurement result, uncertainty, and MDC are always expressed in the same unit of measurement.

EVALUATION OF QC ANALYSES

A method blank result is considered unacceptable if it is more than 3 standard deviations below zero or more than 3 standard deviations above a predetermined upper control limit. For some analyses NAREL has set the upper control limit at zero. For others the control limit is a small positive number.

NAREL evaluates the results of duplicate and spike analyses using "Z scores." A Z score is the number of standard deviations by which the QC result differs from its ideal value. Generally the score is considered acceptable if its absolute value is not greater than 3.

The Z score for a spiked sample is computed by dividing the difference between the measured value and the target value by the combined standard uncertainty of the difference. The Z score for a duplicate analysis is computed by dividing the difference between the two measured values by the combined standard uncertainty of the difference.

NAREL reports the "relative percent difference," or RPD, between duplicate results and the "percent recovery," or %R, for spiked analyses, but does not use these values for evaluation of most analyses. An exception is the use of %R in the evaluation of gross alpha matrix spike results. A gross alpha matrix spike result is considered acceptable if either $|Z| \leq 3$ or $60 \leq \%R \leq 110$.

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

ANALYSIS SUMMARY

Analysis method: NAREL RA226-EICHROM
Title: Radium-226 in Water: Rapid Method for High-Activity Samples

NAREL Sample #	Client Sample ID	QC Type	Date Completed	Preparation Batch #	Assay Batch #
B3.11217E	RO1		12/11/2013	0010575H	0017632P
B3.11218F	SO2		12/11/2013	0010575H	0017632P
B3.11219G	SO3		12/11/2013	0010575H	0017632P
B3.11220Z	SO4		12/11/2013	0010575H	0017632P
B3.11220Z	SO4	DUP	12/11/2013	0010575H	0017632P
B3.11221A	SO5		12/11/2013	0010575H	0017632P
B3.11222B	SO6		12/12/2013	0010576J	0017640P
B3.11223C	SO7		12/12/2013	0010576J	0017640P
B3.11223C	SO7	DUP	12/12/2013	0010576J	0017640P
B3.11224D	SO8		12/12/2013	0010576J	0017640P
B3.11225E	DO9		12/12/2013	0010576J	0017640P
LCS-00680233Z *		LCS	12/11/2013	0010575H	0017632P
RBK-00680232Y *		RBK	12/11/2013	0010575H	0017632P
LCS-00680236C *		LCS	12/12/2013	0010576J	0017640P
RBK-00680235B *		RBK	12/12/2013	0010576J	0017640P

* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11217E	Amount analyzed:	2.000e-01 L
Client sample ID:	RO1	Preparation batch #:	0010575H
Matrix:	WATER	Assay batch #:	0017632P
Collected:	2013-10-25 08:10 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL RA226-EICHROM
Dry/wet weight:	N/A	Analyst:	PH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/10/2013 16:23	1000.0	AS124	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra226	5.33e-02	6.7e-02	9.0e-02	PCI/L	12/09/2013 13:41 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11218F	Amount analyzed:	2.000e-01 L
Client sample ID:	SO2	Preparation batch #:	0010575H
Matrix:	WATER	Assay batch #:	0017632P
Collected:	2013-10-25 09:26 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL RA226-EICHROM
Dry/wet weight:	N/A	Analyst:	PH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/10/2013 16:23	1000.0	AS125	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra226	4.14e-01	1.9e-01	1.2e-01	PCI/L	12/09/2013 13:45 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11219G	Amount analyzed:	2.000e-01 L
Client sample ID:	SO3	Preparation batch #:	0010575H
Matrix:	WATER	Assay batch #:	0017632P
Collected:	2013-10-25 10:00 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL RA226-EICHROM
Dry/wet weight:	N/A	Analyst:	PH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/10/2013 16:23	1000.0	AS127	CEB

ANALYTICAL RESULTS

Analyte	Activity	±2 σ Uncertainty	MDC	Unit	Reference Date
Ra226	1.01e-01	8.4e-02	9.5e-02	PCI/L	12/09/2013 13:56 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
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SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11220Z	Amount analyzed:	2.000e-01 L
Client sample ID:	SO4	Preparation batch #:	0010575H
Matrix:	WATER	Assay batch #:	0017632P
Collected:	2013-10-25 10:28 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL RA226-EICHROM
Dry/wet weight:	N/A	Analyst:	PH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/10/2013 16:23	1000.0	AS129	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra226	1.34e-01	8.7e-02	8.2e-02	PCI/L	12/09/2013 13:54 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11220Z	Amount analyzed:	2.000e-01 L
Client sample ID:	SO4	Preparation batch #:	0010575H
Matrix:	WATER	Assay batch #:	0017632P
Collected:	2013-10-25 10:28 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL RA226-EICHROM
Dry/wet weight:	N/A	Analyst:	PH
Ash/dry weight:	N/A	QC type:	DUP
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/10/2013 16:23	1000.0	AS130	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra226	6.10e-02	6.5e-02	8.1e-02	PCI/L	12/09/2013 13:51 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
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SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11221A	Amount analyzed:	2.000e-01 L
Client sample ID:	SO5	Preparation batch #:	0010575H
Matrix:	WATER	Assay batch #:	0017632P
Collected:	2013-10-25 10:55 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL RA226-EICHROM
Dry/wet weight:	N/A	Analyst:	PH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/10/2013 16:23	1000.0	AS131	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra226	1.37e-01	9.4e-02	9.2e-02	PCI/L	12/09/2013 14:02 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11222B	Amount analyzed:	2.000e-01 L
Client sample ID:	SO6	Preparation batch #:	0010576J
Matrix:	WATER	Assay batch #:	0017640P
Collected:	2013-10-25 11:20 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL RA226-EICHROM
Dry/wet weight:	N/A	Analyst:	PH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/11/2013 16:29	1000.0	AS65	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra226	7.96e-02	1.2e-01	2.0e-01	PCI/L	12/10/2013 12:49 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11223C	Amount analyzed:	2.000e-01 L
Client sample ID:	SO7	Preparation batch #:	0010576J
Matrix:	WATER	Assay batch #:	0017640P
Collected:	2013-10-29 09:50 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL RA226-EICHROM
Dry/wet weight:	N/A	Analyst:	PH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/11/2013 16:29	1000.0	AS66	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra226	1.53e-01	1.0e-01	1.0e-01	PCI/L	12/10/2013 12:38 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11223C	Amount analyzed:	2.000e-01 L
Client sample ID:	SO7	Preparation batch #:	0010576J
Matrix:	WATER	Assay batch #:	0017640P
Collected:	2013-10-29 09:50 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL RA226-EICHROM
Dry/wet weight:	N/A	Analyst:	PH
Ash/dry weight:	N/A	QC type:	DUP
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/11/2013 16:30	1000.0	AS67	CEB

ANALYTICAL RESULTS

Analyte	Activity	±2 σ Uncertainty	MDC	Unit	Reference Date
Ra226	3.34e-02	6.0e-02	9.9e-02	PCI/L	12/10/2013 12:42 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11224D	Amount analyzed:	2.000e-01 L
Client sample ID:	SO8	Preparation batch #:	0010576J
Matrix:	WATER	Assay batch #:	0017640P
Collected:	2013-10-29 10:20 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL RA226-EICHROM
Dry/wet weight:	N/A	Analyst:	PH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/11/2013 16:30	1000.0	AS68	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra226	1.51e-01	1.1e-01	1.1e-01	PCI/L	12/10/2013 12:36 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11225E	Amount analyzed:	2.000e-01 L
Client sample ID:	DO9	Preparation batch #:	0010576J
Matrix:	WATER	Assay batch #:	0017640P
Collected:	2013-10-29 10:20 EDT	Prep procedure:	N/A
Sample type:	SAM	Analysis method:	NAREL RA226-EICHROM
Dry/wet weight:	N/A	Analyst:	PH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/11/2013 16:30	1000.0	AS69	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra226	7.70e-02	8.5e-02	1.2e-01	PCI/L	12/10/2013 12:32 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
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SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	LCS-00680233Z	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0010575H
Matrix:	N/A	Assay batch #:	0017632P
Collected:	N/A	Prep procedure:	N/A
Sample type:	N/A	Analysis method:	NAREL RA226-EICHROM
Dry/wet weight:	N/A	Analyst:	PH
Ash/dry weight:	N/A	QC type:	LCS
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/10/2013 16:23	1000.0	AS133	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra226	3.31e+00	3.1e-01	1.7e-02	PCI	12/09/2013 13:45 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	RBK-00680232Y	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0010575H
Matrix:	N/A	Assay batch #:	0017632P
Collected:	N/A	Prep procedure:	N/A
Sample type:	N/A	Analysis method:	NAREL RA226-EICHROM
Dry/wet weight:	N/A	Analyst:	PH
Ash/dry weight:	N/A	QC type:	RBK
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/10/2013 16:23	1000.0	AS134	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra226	9.17e-03	1.3e-02	1.9e-02	PCI	12/09/2013 13:44 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	LCS-00680236C	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0010576J
Matrix:	N/A	Assay batch #:	0017640P
Collected:	N/A	Prep procedure:	N/A
Sample type:	N/A	Analysis method:	NAREL RA226-EICHROM
Dry/wet weight:	N/A	Analyst:	PH
Ash/dry weight:	N/A	QC type:	LCS
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/11/2013 16:30	1000.0	AS71	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra226	3.21e+00	3.3e-01	3.0e-02	PCI	12/10/2013 12:27 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	RBK-00680235B	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0010576J
Matrix:	N/A	Assay batch #:	0017640P
Collected:	N/A	Prep procedure:	N/A
Sample type:	N/A	Analysis method:	NAREL RA226-EICHROM
Dry/wet weight:	N/A	Analyst:	PH
Ash/dry weight:	N/A	QC type:	RBK
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/11/2013 16:30	1000.0	AS72	CEB

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra226	-5.98e-03	8.0e-03	2.7e-02	PCI	12/10/2013 12:27 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG 1300090

PREPARATION BATCH SUMMARY

Preparation batch #: 0010575H
Analysis method: NAREL RA226-EICHROM
Preparation procedure: N/A

NAREL Sample #	Client Sample ID	Analysis #	QC Type	Yield	± 2 σ Uncertainty	Analyst
B3.11217E	RO1	00677697E		99.01 %	8.50 %	PH
B3.11218F	SO2	00677703J		70.77 %	6.82 %	PH
B3.11219G	SO3	00677709Q		102.49 %	8.65 %	PH
B3.11220Z	SO4	00677715N		91.06 %	7.13 %	PH
B3.11220Z	SO4	00680231X	DUP	84.18 %	6.82 %	PH
B3.11221A	SO5	00677721L		83.99 %	6.86 %	PH
LCS-00680233Z *		00680233Z	LCS	88.23 %	7.01 %	PH
RBK-00680232Y *		00680232Y	RBK	81.72 %	6.73 %	PH

* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

QC RESULTS FOR BATCH 0010575H

NAREL Sample #	Analysis #	QC Type	Analyte	%R	RPD	Z	Evaluation
B3.11220Z	00680231X	DUP	RA226		74.8	-1.34	PASS
LCS-00680233Z	00680233Z	LCS	RA226	98.2		-0.37	PASS
RBK-00680232Y	00680232Y	RBK	RA226		-		PASS

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG 1300090

PREPARATION BATCH SUMMARY

Preparation batch #: 0010576J
Analysis method: NAREL RA226-EICHROM
Preparation procedure: N/A

NAREL Sample #	Client Sample ID	Analysis #	QC Type	Yield	± 2 σ Uncertainty	Analyst
B3.11222B	SO6	00677727T		91.31 %	7.62 %	PH
B3.11223C	SO7	00677733Q		90.83 %	7.70 %	PH
B3.11223C	SO7	00680234A	DUP	89.53 %	7.51 %	PH
B3.11224D	SO8	00677739X		84.79 %	7.25 %	PH
B3.11225E	DO9	00677745V		90.39 %	7.60 %	PH
LCS-00680236C *		00680236C	LCS	86.48 %	7.35 %	PH
RBK-00680235B *		00680235B	RBK	87.43 %	7.43 %	PH

* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

QC RESULTS FOR BATCH 0010576J

NAREL Sample #	Analysis #	QC Type	Analyte	%R	RPD	Z	Evaluation
B3.11223C	00680234A	DUP	RA226		128.1	-1.98	PASS
LCS-00680236C	00680236C	LCS	RA226	95.2		-0.93	PASS
RBK-00680235B	00680235B	RBK	RA226				PASS

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RADIATION AND INDOOR AIR
National Air and Radiation Environmental Laboratory
540 South Morris Avenue, Montgomery, AL 36115-2601
(334) 270-3400

December 24, 2013

RECEIVED
JAN 02 2014
WATER ENFORCEMENT & COMPLIANCE
ASSURANCE BRANCH, EPA, REGION 5

MEMORANDUM

SUBJECT: Radiochemical Results for BASF Cleveland Samples

FROM: Cynthia White, Director
Center for Environmental Radioanalytical Laboratory Science

TO: Noel Vargas, Environmental Engineer
Region 5

Attached is a data package for radium-228 analysis of samples collected from BASF in Cleveland, Ohio. The samples constitute NAREL batch number 1300090.

Specific information concerning all aspects of the radiological analysis of the samples is contained in the batch case narratives of the data packages. If you have any questions concerning the analytical results, please contact me at (334)270-7052.

Due to a reorganization within the Office of Radiation and Indoor Air, the National Air and Radiation Environmental Laboratory is now called the National Analytical Radiation Environmental Laboratory. (Acronym remains the same, NAREL.)

Attachments

U.S.ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY
540 S. MORRIS AVE., MONTGOMERY, AL 36115
RA228 ANALYSES

REPORT OF SAMPLE DELIVERY GROUP #1300090

Project:	Region 5 - BASF Corp, Cleveland, OH
Analysis method:	Radium-228 in Environmental Matrices
Report ID:	1300090-RA228
Report type:	Original
Date reported:	12/18/2013
Total pages in report:	29

SAMPLES

NAREL Sample #	Client Sample ID	Location	Matrix	Date Collected	Date Received
B3.11217E	RO1	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11218F	SO2	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11219G	SO3	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11220Z	SO4	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11221A	SO5	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11222B	SO6	OH:CLEVELAND	WATER	10/25/2013	10/30/2013
B3.11223C	SO7	OH:CLEVELAND	WATER	10/29/2013	10/30/2013
B3.11224D	SO8	OH:CLEVELAND	WATER	10/29/2013	10/30/2013
B3.11225E	DO9	OH:CLEVELAND	WATER	10/29/2013	10/30/2013

EXCEPTIONS

1. **Packaging and shipping** – No problems were observed.
2. **Documentation** – The dates and times of collection were recorded on the chain of custody and the removable sample tags but were not recorded on the sample containers.
3. **Sample preparation** – Samples were not preserved in the field. NAREL preserved the samples with nitric acid to a pH of 2.
4. **Analysis** – Sample B3.11222 leaked during analysis and had to be reanalyzed. The result of the reanalysis is reported in this data package.
5. **Holding times** – No holding times were specified.

QUALITY CONTROL

1. **QC samples** – All QC analysis results met NAREL acceptance criteria.
2. **Yields** – All chemical yields were within acceptance limits.
3. **Instruments** – Response and background checks for all instruments used in these analyses met NAREL acceptance criteria.

ACCREDITATION

All analyses included in this data package are accredited by the Oregon Environmental Laboratory Accreditation Program (ORELAP) to the TNI standard.

CERTIFICATION

I certify that this data report complies with the terms and conditions of the Quality Assurance Project Plan, except as noted above. Release of the data contained in this report has been authorized by the Director of the Center for Environmental Radioanalytical Laboratory Science and the NAREL Quality Assurance Manager, or their designees, as verified by the following signatures.

for Mary F. Wisdom — 12/24/13
Quality Assurance Manager, NAREL — Date

Cynthia White — 12-24-13
Director, Center for Environmental Radioanalytical Laboratory Science — Date

GENERAL INFORMATION

SAMPLE TYPES

BLD	Blind sample
FBK	Field blank
SAM	Normal sample

ANALYSIS QC TYPES

ANA	Normal analysis
DUP	Laboratory duplicate
LCS	Laboratory control sample, or blank spike
MS	Matrix spike
MSD	Matrix spike duplicate (not currently analyzed)
RBK	Method blank
STD	External standard (used for ^{228}Ra yield determination)

QUALITY INDICATORS

RPD	Relative Percent Difference
%R	Percent Recovery
Z	Number of standard deviations by which a QC measurement differs from the expected value

RADIOCHEMICAL DATA

Radiochemical analyses usually require the subtraction of an instrument background measurement result from a gross sample measurement result. Both values are positive, but when the sample activity is low, random variations in the two measurements can cause the gross value to be less than the background, resulting in a measured activity less than zero. Although negative activities have no physical significance, they do have statistical importance, as for example in the evaluation of trends or the comparison of two groups of samples.

To the extent practical, it is the policy of NAREL to report results as generated, whether positive, negative, or zero, together with the "2-sigma" measurement uncertainty and a sample-specific estimate of the minimum detectable concentration (MDC). The measurement result, uncertainty, and MDC are always expressed in the same unit of measurement.

EVALUATION OF QC ANALYSES

A method blank result is considered unacceptable if it is more than 3 standard deviations below zero or more than 3 standard deviations above a predetermined upper control limit. For some analyses NAREL has set the upper control limit at zero. For others the control limit is a small positive number.

NAREL evaluates the results of duplicate and spike analyses using "*Z* scores." A *Z* score is the number of standard deviations by which the QC result differs from its ideal value. Generally the score is considered acceptable if its absolute value is not greater than 3.

The *Z* score for a spiked sample is computed by dividing the difference between the measured value and the target value by the combined standard uncertainty of the difference. The *Z* score for a duplicate analysis is computed by dividing the difference between the two measured values by the combined standard uncertainty of the difference.

NAREL reports the "relative percent difference," or RPD, between duplicate results and the "percent recovery," or %R, for spiked analyses, but does not use these values for evaluation of most analyses. An exception is the use of %R in the evaluation of gross alpha matrix spike results. A gross alpha matrix spike result is considered acceptable if either $|Z| \leq 3$ or $60 \leq \%R \leq 110$.

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

ANALYSIS SUMMARY

Analysis method: NAREL RA-05
Title: Radium-228 in Environmental Matrices

NAREL Sample #	Client Sample ID	QC Type	Date Completed	Preparation Batch #	Assay Batch #
B3.11217E	RO1		12/06/2013	0010574G	0017617Q
B3.11218F	SO2		12/06/2013	0010574G	0017617Q
B3.11219G	SO3		12/06/2013	0010574G	0017617Q
B3.11220Z	SO4		12/06/2013	0010574G	0017617Q
B3.11221A	SO5		12/06/2013	0010574G	0017617Q
B3.11222B	SO6		12/12/2013	0010588N	0017643T
B3.11223C	SO7		12/06/2013	0010574G	0017617Q
B3.11223C	SO7	MS	12/06/2013	0010574G	0017617Q
B3.11224D	SO8		12/06/2013	0010574G	0017617Q
B3.11224D	SO8	DUP	12/06/2013	0010574G	0017617Q
B3.11225E	DO9		12/06/2013	0010574G	0017617Q
B3.12056K *			12/12/2013	0010588N	0017643T
B3.12056K *		MS	12/12/2013	0010588N	0017643T
B3.12061G *			12/16/2013	0010588N	0017644U
B3.12061G *		DUP	12/16/2013	0010588N	0017644U
LCS-00680171C *		LCS	12/06/2013	0010574G	0017617Q
RBK-00680170B *		RBK	12/06/2013	0010574G	0017617Q
STD-00680172D *		STD	12/06/2013	0010574G	0017617Q
LCS-00680549T *		LCS	12/16/2013	0010588N	0017644U
RBK-00680550K *		RBK	12/12/2013	0010588N	0017643T
STD-00680553N *		STD	12/12/2013	0010588N	0017643T
STD-00680554P *		STD	12/16/2013	0010588N	0017644U

* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11217E	Amount analyzed:	8.000e-01 L
Client sample ID:	RO1	Preparation batch #:	0010574G
Matrix:	WATER	Assay batch #:	0017617Q
Collected:	2013-10-25 08:10 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/06/2013 11:03	100.0	QA1A	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	-1.43e-01	5.3e-01	9.6e-01	PCI/L	12/04/2013 10:05 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11218F	Amount analyzed:	8.000e-01 L
Client sample ID:	SO2	Preparation batch #:	0010574G
Matrix:	WATER	Assay batch #:	0017617Q
Collected:	2013-10-25 09:26 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/06/2013 11:03	100.0	QA1B	JEA

ANALYTICAL RESULTS

Analyte	Activity	±2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	7.45e-01	6.0e-01	9.5e-01	PCI/L	12/04/2013 10:05 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11219G	Amount analyzed:	8.000e-01 L
Client sample ID:	SO3	Preparation batch #:	0010574G
Matrix:	WATER	Assay batch #:	0017617Q
Collected:	2013-10-25 10:00 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/06/2013 11:03	100.0	QA1C	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	1.82e-02	5.6e-01	9.8e-01	PCI/L	12/04/2013 10:05 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11220Z	Amount analyzed:	8.000e-01 L
Client sample ID:	SO4	Preparation batch #:	0010574G
Matrix:	WATER	Assay batch #:	0017617Q
Collected:	2013-10-25 10:28 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/06/2013 11:03	100.0	QA2A	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	3.18e-01	5.3e-01	8.8e-01	PCI/L	12/04/2013 10:05 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11221A	Amount analyzed:	8.000e-01 L
Client sample ID:	SO5	Preparation batch #:	0010574G
Matrix:	WATER	Assay batch #:	0017617Q
Collected:	2013-10-25 10:55 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/06/2013 11:03	100.0	QA2B	JEA

ANALYTICAL RESULTS

Analyte	Activity	±2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	-1.96e-01	4.9e-01	9.0e-01	PCI/L	12/04/2013 10:05 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11222B	Amount analyzed:	8.000e-01 L
Client sample ID:	SO6	Preparation batch #:	0010588N
Matrix:	WATER	Assay batch #:	0017643T
Collected:	2013-10-25 11:20 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/12/2013 10:59	100.0	QA1A	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	7.50e-01	6.5e-01	1.0e+00	PCI/L	12/10/2013 10:20 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11223C	Amount analyzed:	8.000e-01 L
Client sample ID:	SO7	Preparation batch #:	0010574G
Matrix:	WATER	Assay batch #:	0017617Q
Collected:	2013-10-29 09:50 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/06/2013 11:03	100.0	QA2C	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	2.31e-01	5.0e-01	8.5e-01	PCI/L	12/04/2013 10:05 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11223C	Amount analyzed:	8.000e-01 L
Client sample ID:	SO7	Preparation batch #:	0010574G
Matrix:	WATER	Assay batch #:	0017617Q
Collected:	2013-10-29 09:50 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	MS
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/06/2013 11:03	100.0	QA2D	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	1.73e+01	1.7e+00	8.6e-01	PCI/L	12/04/2013 10:05 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11224D	Amount analyzed:	8.000e-01 L
Client sample ID:	SO8	Preparation batch #:	0010574G
Matrix:	WATER	Assay batch #:	0017617Q
Collected:	2013-10-29 10:20 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/06/2013 11:03	100.0	QBIA	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	5.38e-01	5.9e-01	9.6e-01	PCI/L	12/04/2013 10:05 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11224D	Amount analyzed:	8.000e-01 L
Client sample ID:	SO8	Preparation batch #:	0010574G
Matrix:	WATER	Assay batch #:	0017617Q
Collected:	2013-10-29 10:20 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	DUP
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/06/2013 11:03	100.0	QB1B	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	1.69e-01	5.6e-01	9.6e-01	PCI/L	12/04/2013 10:05 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.11225E	Amount analyzed:	8.000e-01 L
Client sample ID:	DO9	Preparation batch #:	0010574G
Matrix:	WATER	Assay batch #:	0017617Q
Collected:	2013-10-29 10:20 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/06/2013 11:03	100.0	QB1C	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	4.67e-01	5.9e-01	9.6e-01	PCI/L	12/04/2013 10:05 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.12056K	Amount analyzed:	1.000e+00 L
Client sample ID:	N/A	Preparation batch #:	0010588N
Matrix:	WATER	Assay batch #:	0017643T
Collected:	2013-11-13 08:30 MST	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

This sample is not in SDG #1300090

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/12/2013 10:59	100.0	QB1A	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	3.12e-01	4.9e-01	8.1e-01	PCI/L	12/10/2013 10:20 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.12056K	Amount analyzed:	5.000e-01 L
Client sample ID:	N/A	Preparation batch #:	0010588N
Matrix:	WATER	Assay batch #:	0017643T
Collected:	2013-11-13 08:30 MST	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	MS
Sample description:	N/A		
Comment:	N/A		

This sample is not in SDG #1300090

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/12/2013 10:59	100.0	QB1C	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	2.80e+01	2.8e+00	1.6e+00	PCI/L	12/10/2013 10:20 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.12061G	Amount analyzed:	1.000e+00 L
Client sample ID:	N/A	Preparation batch #:	0010588N
Matrix:	WATER	Assay batch #:	0017644U
Collected:	2013-11-13 12:40 MST	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

This sample is not in SDG #1300090

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/16/2013 10:34	100.0	QB1D	RCL

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	3.46e-01	4.6e-01	7.6e-01	PCI/L	12/10/2013 10:20 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	B3.12061G	Amount analyzed:	5.000e-01 L
Client sample ID:	N/A	Preparation batch #:	0010588N
Matrix:	WATER	Assay batch #:	0017644U
Collected:	2013-11-13 12:40 MST	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	DUP
Sample description:	N/A		
Comment:	N/A		

This sample is not in SDG #1300090

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/16/2013 10:34	100.0	QB2A	RCL

ANALYTICAL RESULTS

Analyte	Activity	+ 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	8.66e-02	8.0e-01	1.4e+00	PCI/L	12/10/2013 10:20 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	LCS-00680171C	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0010574G
Matrix:	N/A	Assay batch #:	0017617Q
Collected:	N/A	Prep procedure:	NAREL RA-03
Sample type:	N/A	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	LCS
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/06/2013 11:03	100.0	QB1D	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	1.19e+01	1.3e+00	8.0e-01	PCI	12/04/2013 10:05 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	RBK-00680170B	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0010574G
Matrix:	N/A	Assay batch #:	0017617Q
Collected:	N/A	Prep procedure:	NAREL RA-03
Sample type:	N/A	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	RBK
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/06/2013 11:04	100.0	QB2B	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	-2.07e-01	4.1e-01	7.6e-01	PCI	12/04/2013 10:05 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	STD-00680172D	Amount analyzed:	1.000e+00 ML
Client sample ID:	N/A	Preparation batch #:	0010574G
Matrix:	N/A	Assay batch #:	0017617Q
Collected:	N/A	Prep procedure:	NAREL RA-03
Sample type:	N/A	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	STD
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/06/2013 11:04	100.0	QB2D	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	8.46e+01	3.8e+00		%	12/04/2013 10:05 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	LCS-00680549T	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0010588N
Matrix:	N/A	Assay batch #:	0017644U
Collected:	N/A	Prep procedure:	NAREL RA-03
Sample type:	N/A	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	LCS
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/16/2013 10:42	100.0	GQ2A	RCL

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	1.38e+01	1.3e+00	7.7e-01	PCI	12/10/2013 10:20 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	RBK-00680550K	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0010588N
Matrix:	N/A	Assay batch #:	0017643T
Collected:	N/A	Prep procedure:	NAREL RA-03
Sample type:	N/A	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	RBK
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/12/2013 10:59	100.0	QB2B	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	2.02e-01	4.8e-01	8.2e-01	PCI	12/10/2013 10:20 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	STD-00680553N	Amount analyzed:	1.000e+00 ML
Client sample ID:	N/A	Preparation batch #:	0010588N
Matrix:	N/A	Assay batch #:	0017643T
Collected:	N/A	Prep procedure:	NAREL RA-03
Sample type:	N/A	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	STD
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/12/2013 10:59	100.0	QB2D	JEA

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	7.68e+01	3.5e+00		%	12/10/2013 10:20 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG #1300090

SAMPLE ANALYSIS REPORT

Lab sample #:	STD-00680554P	Amount analyzed:	1.000e+00 ML
Client sample ID:	N/A	Preparation batch #:	0010588N
Matrix:	N/A	Assay batch #:	0017644U
Collected:	N/A	Prep procedure:	NAREL RA-03
Sample type:	N/A	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	STD
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
12/16/2013 10:42	100.0	GQ2B	RCL

ANALYTICAL RESULTS

Analyte	Activity	± 2 σ Uncertainty	MDC	Unit	Reference Date
Ra228	8.23e+01	3.6e+00		%	12/10/2013 10:20 CST

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG 1300090

PREPARATION BATCH SUMMARY

Preparation batch #: 0010574G
Analysis method: NAREL RA-05
Preparation procedure: NAREL RA-03

NAREL Sample #	Client Sample ID	Analysis #	QC Type	Yield	± 2 σ Uncertainty	Analyst
B3.11217E	RO1	00677694B		N/A		VH
B3.11218F	SO2	00677700F		N/A		VH
B3.11219G	SO3	00677706M		N/A		VH
B3.11220Z	SO4	00677712K		N/A		VH
B3.11221A	SO5	00677718R		N/A		VH
B3.11223C	SO7	00677730M		N/A		VH
B3.11223C	SO7	00680168H	MS	N/A		VH
B3.11224D	SO8	00677736U		N/A		VH
B3.11224D	SO8	00680169J	DUP	N/A		VH
B3.11225E	DO9	00677742R		N/A		VH
LCS-00680171C *		00680171C	LCS	N/A		VH
RBK-00680170B *		00680170B	RBK	N/A		VH
STD-00680172D *		00680172D	STD	N/A		VH

* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

QC RESULTS FOR BATCH 0010574G

NAREL Sample #	Analysis #	QC Type	Analyte	%R	RPD	Z	Evaluation
B3.11224D	00680169J	DUP	RA228		104.6	-0.90	PASS
LCS-00680171C	00680171C	LCS	RA228	87.0		-1.86	PASS
B3.11223C	00680168H	MS	RA228	99.5		-0.06	PASS
RBK-00680170B	00680170B	RBK	RA228				PASS

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG 1300090

PREPARATION BATCH SUMMARY

Preparation batch #: 0010588N
Analysis method: NAREL RA-05
Preparation procedure: NAREL RA-03

NAREL Sample #	Client Sample ID	Analysis #	QC Type	Yield	± 2 σ Uncertainty	Analyst
B3.11222B	SO6	00677724P		N/A		VH
B3.12056K *		00679423M		N/A		VH
B3.12056K *		00680551L	MS	N/A		VH
B3.12061G *		00679443R		N/A		VH
B3.12061G *		00680552M	DUP	N/A		VH
LCS-00680549T *		00680549T	LCS	N/A		VH
RBK-00680550K *		00680550K	RBK	N/A		VH
STD-00680553N *		00680553N	STD	N/A		VH
STD-00680554P *		00680554P	STD	N/A		VH

* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

QC RESULTS FOR BATCH 0010588N

NAREL Sample #	Analysis #	QC Type	Analyte	%R	RPD	Z	Evaluation
B3.12061G	00680552M	DUP	RA228		120.0	-0.56	PASS
LCS-00680549T	00680549T	LCS	RA228	101.4		0.18	PASS
B3.12056K	00680551L	MS	RA228	101.4		0.17	PASS
RBK-00680550K	00680550K	RBK	RA228				PASS

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY

SDG 1300090

ASSAY BATCH SUMMARY

EXTERNAL STANDARD

Assay Batch	Analysis #	Analyte	Standard Concentration	Reference Date	Yield	± 2 σ Uncertainty
0017617Q	00680172D	RA228	9.45e+01 PCI/ML	07/19/2013	84.59 %	3.77 %
0017643T	00680553N	RA228	9.45e+01 PCI/ML	07/19/2013	76.77 %	3.47 %
0017644U	00680554P	RA228	9.45e+01 PCI/ML	07/19/2013	82.26 %	3.63 %

SAMPLES ANALYZED

NAREL Sample #	QC Type	Aliquot Size	Completion Date	Assay Batch
B3.11217E		8.00e-01 L	12/06/2013	0017617Q
B3.11218F		8.00e-01 L	12/06/2013	0017617Q
B3.11219G		8.00e-01 L	12/06/2013	0017617Q
B3.11220Z		8.00e-01 L	12/06/2013	0017617Q
B3.11221A		8.00e-01 L	12/06/2013	0017617Q
B3.11222B		8.00e-01 L	12/12/2013	0017643T
B3.11223C		8.00e-01 L	12/06/2013	0017617Q
B3.11223C	MS	8.00e-01 L	12/06/2013	0017617Q
B3.11224D		8.00e-01 L	12/06/2013	0017617Q
B3.11224D	DUP	8.00e-01 L	12/06/2013	0017617Q
B3.11225E		8.00e-01 L	12/06/2013	0017617Q
B3.12056K *		1.00e+00 L	12/12/2013	0017643T
B3.12056K *	MS	5.00e-01 L	12/12/2013	0017643T
B3.12061G *		1.00e+00 L	12/16/2013	0017644U
B3.12061G *	DUP	5.00e-01 L	12/16/2013	0017644U
LCS-00680171C *	LCS	1.00e+00 SAMP	12/06/2013	0017617Q
RBK-00680170B *	RBK	1.00e+00 SAMP	12/06/2013	0017617Q
STD-00680172D *	STD	1.00e+00 ML	12/06/2013	0017617Q
LCS-00680549T *	LCS	1.00e+00 SAMP	12/16/2013	0017644U
RBK-00680550K *	RBK	1.00e+00 SAMP	12/12/2013	0017643T
STD-00680553N *	STD	1.00e+00 ML	12/12/2013	0017643T
STD-00680554P *	STD	1.00e+00 ML	12/16/2013	0017644U

Samples marked with an asterisk (*) are not in SDG #1300090 but were analyzed with it for QC purposes

USEPA NAREL MONTGOMERY, AL

Trace Metals Analysis by 7500Ce CRC ICP-MS
- COVER PAGE -
INORGANIC ANALYSIS DATA PACKAGE

Client: BASF CLEVELAND

SDG No.: 1300090 Method Type: ICP-MS SOW No.: SW846-6020A

Contract: WATER Lab Code: US EPA/NAREL Case No.: RO1, SO SAS No.: XXXXX

Lab Sample ID	Client Sample ID	QC Description
B3.11217E	RO1	
B3.11218F	SO2	
B3.11219G	SO3	
B3.11220Z	SO4	
B3.11220Z-D	SO4	Sample Duplicate
B3.11220Z-S	SO4	Matrix Spike
B3.11220Z-SD	SO4	Matrix Spike Duplicate
B3.11221A	SO5	
B3.11222B	SO6	
B3.11223C	SO7	
B3.11224D	SO8	
B3.11225E	DO9	

Were ICP interelement corrections applied?	Yes/No	Yes	
Were ICP background corrections applied?	Yes/No	No	
If yes - were raw data generated before applications of background corrections?	Yes/No	No	

Comments: BASF Cleveland, OH

I certify that this data package is in compliance with the terms and conditions of the contract, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hardcopy data package and in the computer-readable data submitted on diskette has been authorized by the Laboratory Manager or the Manager's designee, as verified by the following signature.

Signature: Rattana Maholan Name: RATTANA MAHOLAN

Date: 01/14/14 Title: PHYSICAL SCIENTIST

Trace Metals Analysis by 7500Ce CRC ICP-MS

INORGANIC ANALYSIS DATA PACKAGE

Client: BASF CLEVELAND **SDG No.:** 1300090 **Method Type:** SW846-6020A

Sample ID: B3.11217E **Customer Sample ID:** RO1

Matrix: WATER **Date Received:** 10/30/2013 **Level:** LOW **Analyst:** RM

% Solids: **Sample Wt/Vol:** 45.00 **Final Vol:** 50.00

Prep Batch ID: 1300090 **Prep Date:** 12/23/2013 **Instrument:** AG 7500Ce ICPMS

Analyte	CAS No.	Concentration	Units	C	Qual	M	RDL	DL	Dil	Analytical Date	Analytical Time
Aluminum	7429-90-5	2.16e+01	ug/L		>RDL	MS	1.23e+01	4.65e-01	1	1/8/2014	15:57
Antimony	7440-36-0	2.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	15:57
Arsenic	7440-38-2	5.00e-02	ug/L	B	>RDL	MS	1.23e+00	1.80e-02	1	1/8/2014	15:57
Barium	7440-39-3	1.70e-01	ug/L	B	>RDL	MS	1.23e+00	3.60e-02	1	1/8/2014	15:57
Beryllium	7440-41-7	1.00e-02	ug/L	B	>RDL	MS	1.23e+00	6.20e-03	1	1/7/2014	16:16
Cadmium	7440-43-9	2.00e-02	ug/L	B	>RDL	MS	1.23e+00	0.00000	1	1/8/2014	15:57
Calcium	7440-70-2	4.37e+01	ug/L	B	>RDL	MS	1.23e+02	7.41e+00	1	1/8/2014	15:57
Chromium	7440-47-3	7.00e-02	ug/L	B	>RDL	MS	1.23e+00	4.72e-02	1	1/8/2014	15:57
Cobalt	7440-48-4	2.00e-02	ug/L	B	>RDL	MS	1.23e+00	8.80e-03	1	1/8/2014	15:57
Copper	7440-50-8	1.20e-01	ug/L	B	>RDL	MS	1.23e+00	3.01e-02	1	1/8/2014	15:57
Iron	7439-89-6	1.12e+01	ug/L	U		MS	1.23e+02	1.12e+01	1	1/8/2014	15:57
Lead	7439-92-1	7.00e-02	ug/L	B	>RDL	MS	1.23e+00	3.66e-02	1	1/8/2014	15:57
Magnesium	7439-95-4	5.62e+00	ug/L	B	>RDL	MS	1.23e+02	4.91e-01	1	1/8/2014	15:57
Manganese	7439-96-5	1.09e-01	ug/L	U		MS	1.23e+00	1.09e-01	1	1/8/2014	15:57
Molybdenum	7439-98-7	6.10e-01	ug/L	B	>RDL	MS	1.23e+00	3.26e-02	1	1/8/2014	15:57
Nickel	7440-02-0	1.10e-01	ug/L	B	>RDL	MS	1.23e+00	3.19e-02	1	1/8/2014	15:57
Potassium	7440-09-7	3.10e+00	ug/L	U		MS	1.23e+02	3.10e+00	1	1/8/2014	15:57
Selenium	7782-49-2	6.00e-02	ug/L	B	>RDL	MS	1.23e+00	1.23e-02	1	1/8/2014	15:57
Silver	7440-22-4	2.33e-02	ug/L	U		MS	1.23e+00	2.33e-02	1	1/8/2014	15:57
Sodium	7440-23-5	4.45e+00	ug/L	B	>RDL	MS	1.23e+02	3.65e+00	1	1/8/2014	15:57
Thallium	7440-28-0	2.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	15:57
Vanadium	7440-62-2	3.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	15:57
Zinc	7440-66-6	3.50e-01	ug/L	B	>RDL	MS	1.23e+00	1.27e-01	1	1/8/2014	15:57
Uranium	7440-61-1	1.00e-02	ug/L	B	>RDL	MS	1.23e+00	0.00000	1	1/8/2014	15:57

Color Before: Colorless **Clarity Before:** Clear **Texture:** N/A

Color After: Colorless **Clarity After:** Clear **Artifacts:** None

Comments:

Checked by: _____ **Date:** _____

USEPA NAREL MONTGOMERY, AL

Trace Metals Analysis by 7500Ce CRC ICP-MS

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: BASF CLEVELAND SDG No.: 1300090 Method Type: SW846-6020A

Sample ID: B3.11218F Customer Sample ID: S02

Matrix: WATER Date Received: 10/30/2013 Level: LOW Analyst: RM

% Solids: Sample Wt/Vol: 45.00 Final Vol: 50.00

Prep Batch ID: 1300090 Prep Date: 12/23/2013 Instrument: AG 7500Ce ICPMS

Analyte	CAS No.	Concentration	Units	C	Qual	M	RDL	DL	Dil	Analytical Date	Analytical Time
Aluminum	7429-90-5	1.47e+01	ug/L		>RDL	MS	1.23e+01	4.65e-01	1	1/8/2014	16:45
Antimony	7440-36-0	3.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	16:45
Arsenic	7440-38-2	2.74e+00	ug/L		>RDL	MS	1.23e+00	1.80e-02	1	1/8/2014	16:45
Barium	7440-39-3	3.44e+01	ug/L		>RDL	MS	1.23e+00	3.60e-02	1	1/8/2014	16:45
Beryllium	7440-41-7	3.00e-02	ug/L	B	>RDL	MS	1.23e+00	6.20e-03	1	1/7/2014	16:21
Cadmium	7440-43-9	1.40e-01	ug/L	B	>RDL	MS	1.23e+00	0.00000	1	1/8/2014	16:45
Calcium	7440-70-2	1.87e+05	ug/L		>RDL	MS	3.08e+03	1.85e+02	28	1/8/2014	16:13
Chromium	7440-47-3	1.30e-01	ug/L	B	>RDL	MS	1.23e+00	4.72e-02	1	1/8/2014	16:45
Cobalt	7440-48-4	1.09e+03	ug/L		>RDL	MS	6.17e+00	4.39e-02	6	1/8/2014	16:18
Copper	7440-50-8	5.20e-01	ug/L	B	>RDL	MS	1.23e+00	3.01e-02	1	1/8/2014	16:45
Iron	7439-89-6	2.58e+03	ug/L		>RDL	MS	1.23e+02	1.12e+01	1	1/8/2014	16:45
Lead	7439-92-1	6.00e-02	ug/L	B	>RDL	MS	1.23e+00	3.66e-02	1	1/8/2014	16:45
Magnesium	7439-95-4	3.46e+04	ug/L		>RDL	MS	6.17e+02	2.46e+00	6	1/8/2014	16:18
Magnesium	7439-95-4	3.39e+04	ug/L		>RDL	MS	1.23e+02	4.91e-01	1	1/8/2014	16:45
Manganese	7439-96-5	4.92e+03	ug/L		>RDL	MS	3.08e+01	2.72e+00	28	1/8/2014	16:13
Molybdenum	7439-98-7	1.21e+00	ug/L	B	>RDL	MS	1.23e+00	3.26e-02	1	1/8/2014	16:45
Nickel	7440-02-0	4.09e+04	ug/L		>RDL	MS	2.47e+02	6.37e+00	222	1/8/2014	16:02
Selenium	7782-49-2	1.71e+00	ug/L		>RDL	MS	1.23e+00	1.23e-02	1	1/8/2014	16:45
Silver	7440-22-4	6.00e-02	ug/L	B	>RDL	MS	1.23e+00	2.33e-02	1	1/8/2014	16:45
Sodium	7440-23-5	2.62e+05	ug/L		>RDL	MS	3.08e+03	9.12e+01	28	1/8/2014	16:13
Thallium	7440-28-0	4.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	16:45
Vanadium	7440-62-2	4.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	16:45
Zinc	7440-66-6	2.62e+01	ug/L		>RDL	MS	1.23e+00	1.27e-01	1	1/8/2014	16:45
Uranium	7440-61-1	2.99e+00	ug/L		>RDL	MS	1.23e+00	0.00000	1	1/8/2014	16:45

Color Before: Colorless Clarity Before: Clear Texture: N/A

Color After: Colorless Clarity After: Clear Artifacts: None

Comments:

Checked by: _____ Date: _____

USEPA NAREL MONTGOMERY, AL

Trace Metals Analysis by 7500Ce CRC ICP-MS

INORGANIC ANALYSIS DATA PACKAGE

Client: BASF CLEVELAND SDG No.: 1300090 Method Type: SW846-6020A

Sample ID: B3.11219G Customer Sample ID: SO3

Matrix: WATER Date Received: 10/30/2013 Level: LOW Analyst: RM

% Solids: Sample Wt/Vol: 45.00 Final Vol: 50.00

Prep Batch ID: 1300090 Prep Date: 12/23/2013 Instrument: AG 7500Ce ICPMS

Analyte	CAS No.	Concentration	Units	C	Qual	M	RDL	DL	Dil	Analytical Date	Analytical Time
Aluminum	7429-90-5	9.80e+00	ug/L	B	>RDL	MS	1.23e+01	4.65e-01	1	1/8/2014	17:01
Antimony	7440-36-0	6.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	17:01
Arsenic	7440-38-2	1.00e+00	ug/L	B	>RDL	MS	1.23e+00	1.80e-02	1	1/8/2014	17:01
Barium	7440-39-3	2.81e+00	ug/L		>RDL	MS	1.23e+00	3.60e-02	1	1/8/2014	17:01
Beryllium	7440-41-7	3.00e-02	ug/L	B	>RDL	MS	1.23e+00	6.20e-03	1	1/7/2014	16:26
Cadmium	7440-43-9	3.00e-02	ug/L	B	>RDL	MS	1.23e+00	0.00000	1	1/8/2014	17:01
Calcium	7440-70-2	4.61e+03	ug/L		>RDL	MS	1.23e+02	7.41e+00	1	1/8/2014	17:01
Chromium	7440-47-3	1.00e-01	ug/L	B	>RDL	MS	1.23e+00	4.72e-02	1	1/8/2014	17:01
Cobalt	7440-48-4	3.91e+00	ug/L		>RDL	MS	1.23e+00	8.80e-03	1	1/8/2014	17:01
Copper	7440-50-8	2.70e-01	ug/L	B	>RDL	MS	1.23e+00	3.01e-02	1	1/8/2014	17:01
Iron	7439-89-6	9.19e+02	ug/L		>RDL	MS	1.23e+02	1.12e+01	1	1/8/2014	17:01
Lead	7439-92-1	1.90e-01	ug/L	B	>RDL	MS	1.23e+00	3.66e-02	1	1/8/2014	17:01
Magnesium	7439-95-4	1.13e+04	ug/L		>RDL	MS	1.23e+02	4.91e-01	1	1/8/2014	17:01
Manganese	7439-96-5	1.73e+02	ug/L		>RDL	MS	1.23e+00	1.09e-01	1	1/8/2014	17:01
Molybdenum	7439-98-7	2.46e+00	ug/L		>RDL	MS	1.23e+00	3.26e-02	1	1/8/2014	17:01
Nickel	7440-02-0	5.94e+02	ug/L		>RDL	MS	6.17e+00	1.59e-01	6	1/8/2014	16:56
Potassium	7440-09-7	4.17e+03	ug/L		>RDL	MS	1.23e+02	3.10e+00	1	1/8/2014	17:01
Selenium	7782-49-2	1.50e-01	ug/L	B	>RDL	MS	1.23e+00	1.23e-02	1	1/8/2014	17:01
Silver	7440-22-4	2.33e-02	ug/L	U		MS	1.23e+00	2.33e-02	1	1/8/2014	17:01
Sodium	7440-23-5	5.16e+05	ug/L		>RDL	MS	6.17e+03	1.82e+02	56	1/8/2014	16:50
Thallium	7440-28-0	1.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	17:01
Vanadium	7440-62-2	6.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	17:01
Zinc	7440-66-6	1.80e+00	ug/L		>RDL	MS	1.23e+00	1.27e-01	1	1/8/2014	17:01
Uranium	7440-61-1	2.00e-02	ug/L	B	>RDL	MS	1.23e+00	0.00000	1	1/8/2014	17:01

Color Before: Colorless Clarity Before: Clear Texture: N/A

Color After: Colorless Clarity After: Clear Artifacts: None

Comments:

Checked by: _____ Date: _____

USEPA NAREL MONTGOMERY, AL

Trace Metals Analysis by 7500Ce CRC ICP-MS

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: BASF CLEVELAND SDG No.: 1300090 Method Type: SW846-6020A

Sample ID: B3.11220Z Customer Sample ID: SO4

Matrix: WATER Date Received: 10/30/2013 Level: LOW Analyst: RM

% Solids: Sample Wt/Vol: 45.00 Final Vol: 50.00

Prep Batch ID: 1300090 Prep Date: 12/23/2013 Instrument: AG 7500Ce ICPMS

Analyte	CAS No.	Concentration	Units	C	Qual	M	RDL	DL	Dil	Analytical Date	Analytical Time
Aluminum	7429-90-5	5.60e+02	ug/L		>RDL	MS	1.23e+02	4.65e+00	11	1/8/2014	17:06
Antimony	7440-36-0	1.37e+01	ug/L		>RDL	MS	1.23e+00	5.70e-03	1	1/7/2014	16:32
Arsenic	7440-38-2	5.58e+00	ug/L		>RDL	MS	1.23e+00	1.80e-02	1	1/7/2014	16:32
Barium	7440-39-3	5.53e+01	ug/L		>RDL	MS	1.23e+00	3.60e-02	1	1/7/2014	16:32
Beryllium	7440-41-7	1.30e-01	ug/L	B	>RDL	MS	1.23e+00	6.20e-03	1	1/7/2014	16:32
Cadmium	7440-43-9	1.62e+01	ug/L		>RDL	MS	1.23e+00	0.00000	1	1/7/2014	16:32
Calcium	7440-70-2	9.18e+04	ug/L		>RDL	MS	1.23e+03	7.41e+01	11	1/8/2014	17:06
Chromium	7440-47-3	2.20e+01	ug/L		>RDL	MS	1.23e+00	4.72e-02	1	1/7/2014	16:32
Cobalt	7440-48-4	2.70e+01	ug/L		>RDL	MS	1.23e+00	8.80e-03	1	1/7/2014	16:32
Copper	7440-50-8	2.23e+01	ug/L		>RDL	MS	1.23e+00	3.01e-02	1	1/7/2014	16:32
Iron	7439-89-6	1.61e+02	ug/L		>RDL	MS	1.23e+02	1.12e+01	1	1/7/2014	16:32
Lead	7439-92-1	4.91e+01	ug/L		>RDL	MS	1.23e+00	3.66e-02	1	1/7/2014	16:32
Magnesium	7439-95-4	1.37e+04	ug/L		>RDL	MS	6.17e+02	2.46e+00	6	1/8/2014	17:28
Manganese	7439-96-5	3.09e+01	ug/L		>RDL	MS	1.23e+00	1.09e-01	1	1/7/2014	16:32
Molybdenum	7439-98-7	1.04e+01	ug/L		>RDL	MS	1.23e+00	3.26e-02	1	1/7/2014	16:32
Nickel	7440-02-0	4.96e+02	ug/L		>RDL	MS	1.23e+01	3.19e-01	11	1/8/2014	17:06
Potassium	7440-09-7	1.73e+04	ug/L		>RDL	MS	6.17e+02	1.55e+01	6	1/8/2014	17:28
Selenium	7782-49-2	9.05e+00	ug/L		>RDL	MS	6.17e+00	6.16e-02	6	1/8/2014	17:28
Silver	7440-22-4	2.33e-02	ug/L	U		MS	1.23e+00	2.33e-02	1	1/7/2014	16:32
Sodium	7440-23-5	2.06e+04	ug/L		>RDL	MS	6.17e+02	1.82e+01	6	1/8/2014	17:28
Thallium	7440-28-0	7.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/7/2014	16:32
Vanadium	7440-62-2	1.43e+00	ug/L		>RDL	MS	1.23e+00	5.70e-03	1	1/7/2014	16:32
Zinc	7440-66-6	5.95e+01	ug/L		>RDL	MS	1.23e+00	1.27e-01	1	1/7/2014	16:32
Uranium	7440-61-1	1.04e+02	ug/L		>RDL	MS	1.23e+00	0.00000	1	1/7/2014	16:32

Color Before: Colorless Clarity Before: Clear Texture: N/A

Color After: Colorless Clarity After: Clear Artifacts: None

Comments:

Checked by: _____ Date: _____

Trace Metals Analysis by 7500Ce CRC ICP-MS

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: BASF CLEVELAND SDG No.: 1300090 Method Type: SW846-6020A

Sample ID: B3.11221A Customer Sample ID: S05

Matrix: WATER Date Received: 10/30/2013 Level: LOW Analyst: RM

% Solids: Sample Wt/Vol: 45.00 Final Vol: 50.00

Prep Batch ID: 1300090 Prep Date: 12/23/2013 Instrument: AG 7500Ce ICPMS

Analyte	CAS No.	Concentration	Units	C	Qual	M	RDL	DL	Dil.	Analytical Date	Analytical Time
Aluminum	7429-90-5	5.10e+02	ug/L		>RDL	MS	6.17e+01	2.33e+00	6	1/8/2014	18:10
Antimony	7440-36-0	1.30e+01	ug/L		>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	18:15
Arsenic	7440-38-2	4.96e+00	ug/L		>RDL	MS	1.23e+00	1.80e-02	1	1/8/2014	18:15
Barium	7440-39-3	5.40e+01	ug/L		>RDL	MS	1.23e+00	3.60e-02	1	1/8/2014	18:15
Beryllium	7440-41-7	1.10e-01	ug/L	B	>RDL	MS	1.23e+00	6.20e-03	1	1/7/2014	17:24
Cadmium	7440-43-9	1.75e+01	ug/L		>RDL	MS	1.23e+00	0.00000	1	1/8/2014	18:15
Calcium	7440-70-2	8.51e+04	ug/L		>RDL	MS	6.17e+02	3.71e+01	6	1/8/2014	18:10
Chromium	7440-47-3	1.90e+01	ug/L		>RDL	MS	1.23e+00	4.72e-02	1	1/8/2014	18:15
Cobalt	7440-48-4	2.87e+01	ug/L		>RDL	MS	1.23e+00	8.80e-03	1	1/8/2014	18:15
Copper	7440-50-8	2.40e+01	ug/L		>RDL	MS	1.23e+00	3.01e-02	1	1/8/2014	18:15
Iron	7439-89-6	2.04e+02	ug/L		>RDL	MS	1.23e+02	1.12e+01	1	1/8/2014	18:15
Lead	7439-92-1	4.32e+01	ug/L		>RDL	MS	1.23e+00	3.66e-02	1	1/8/2014	18:15
Magnesium	7439-95-4	1.31e+04	ug/L		>RDL	MS	1.23e+02	4.91e-01	1	1/8/2014	18:15
Manganese	7439-96-5	2.85e+01	ug/L		>RDL	MS	1.23e+00	1.09e-01	1	1/8/2014	18:15
Molybdenum	7439-98-7	1.16e+01	ug/L		>RDL	MS	1.23e+00	3.26e-02	1	1/8/2014	18:15
Nickel	7440-02-0	4.57e+02	ug/L		>RDL	MS	6.17e+00	1.59e-01	6	1/8/2014	18:10
Potassium	7440-09-7	1.65e+04	ug/L		>RDL	MS	1.23e+02	3.10e+00	1	1/8/2014	18:15
Selenium	7782-49-2	8.96e+00	ug/L		>RDL	MS	1.23e+00	1.23e-02	1	1/8/2014	18:15
Silver	7440-22-4	6.65e+00	ug/L		>RDL	MS	1.23e+00	2.33e-02	1	1/8/2014	18:15
Sodium	7440-23-5	2.07e+04	ug/L		>RDL	MS	1.23e+02	3.65e+00	1	1/8/2014	18:15
Thallium	7440-28-0	9.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	18:15
Vanadium	7440-62-2	1.48e+00	ug/L		>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	18:15
Zinc	7440-66-6	8.64e+01	ug/L		>RDL	MS	1.23e+00	1.27e-01	1	1/8/2014	18:15
Uranium	7440-61-1	9.39e+01	ug/L		>RDL	MS	1.23e+00	0.00000	1	1/8/2014	18:15

Color Before: Colorless Clarity Before: Clear Texture: N/A

Color After: Colorless Clarity After: Clear Artifacts: None

Comments:

Checked by: _____ Date: _____

USEPA NAREL MONTGOMERY, AL

Trace Metals Analysis by 7500Ce CRC ICP-MS

INORGANIC ANALYSIS DATA PACKAGE

Client: BASF CLEVELAND SDG No.: 1300090 Method Type: SW846-6020A

Sample ID: B3.11222B Customer Sample ID: SO6

Matrix: WATER Date Received: 10/30/2013 Level: LOW Analyst: RM

% Solids: Sample Wt/Vol: 45.00 Final Vol: 50.00

Prep Batch ID: 1300090 Prep Date: 12/23/2013 Instrument: AG 7500Ce ICPMS

Analyte	CAS No.	Concentration	Units	C	Qual	M	RDL	DL	Dil	Analytical Date	Analytical Time
Aluminum	7429-90-5	1.13e+03	ug/L		>RDL	MS	1.23e+02	4.65e+00	11	1/8/2014	18:21
Antimony	7440-36-0	6.00e-01	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	18:26
Arsenic	7440-38-2	1.68e+00	ug/L		>RDL	MS	1.23e+00	1.80e-02	1	1/8/2014	18:26
Barium	7440-39-3	3.95e+01	ug/L		>RDL	MS	1.23e+00	3.60e-02	1	1/8/2014	18:26
Beryllium	7440-41-7	4.00e-02	ug/L	B	>RDL	MS	1.23e+00	6.20e-03	1	1/7/2014	17:29
Cadmium	7440-43-9	2.50e-01	ug/L	B	>RDL	MS	1.23e+00	0.00000	1	1/8/2014	18:26
Calcium	7440-70-2	6.31e+04	ug/L		>RDL	MS	1.23e+03	7.41e+01	11	1/8/2014	18:21
Chromium	7440-47-3	2.87e+00	ug/L		>RDL	MS	1.23e+00	4.72e-02	1	1/8/2014	18:26
Cobalt	7440-48-4	7.70e-01	ug/L	B	>RDL	MS	1.23e+00	8.80e-03	1	1/8/2014	18:26
Copper	7440-50-8	4.82e+00	ug/L		>RDL	MS	1.23e+00	3.01e-02	1	1/8/2014	18:26
Iron	7439-89-6	1.19e+03	ug/L		>RDL	MS	1.23e+02	1.12e+01	1	1/8/2014	18:26
Lead	7439-92-1	3.51e+00	ug/L		>RDL	MS	1.23e+00	3.66e-02	1	1/8/2014	18:26
Magnesium	7439-95-4	1.33e+04	ug/L		>RDL	MS	1.23e+02	4.91e-01	1	1/8/2014	18:26
Manganese	7439-96-5	6.08e+01	ug/L		>RDL	MS	1.23e+00	1.09e-01	1	1/8/2014	18:26
Molybdenum	7439-98-7	9.14e+00	ug/L		>RDL	MS	1.23e+00	3.26e-02	1	1/8/2014	18:26
Nickel	7440-02-0	6.74e+00	ug/L		>RDL	MS	1.23e+00	3.19e-02	1	1/8/2014	18:26
Potassium	7440-09-7	6.65e+03	ug/L		>RDL	MS	1.23e+02	3.10e+00	1	1/8/2014	18:26
Selenium	7782-49-2	4.90e-01	ug/L	B	>RDL	MS	1.23e+00	1.23e-02	1	1/8/2014	18:26
Silver	7440-22-4	2.33e-02	ug/L	U		MS	1.23e+00	2.33e-02	1	1/8/2014	18:26
Sodium	7440-23-5	1.15e+05	ug/L		>RDL	MS	1.23e+03	3.65e+01	11	1/8/2014	18:21
Thallium	7440-28-0	4.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	18:26
Vanadium	7440-62-2	2.98e+00	ug/L		>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	18:26
Zinc	7440-66-6	2.08e+01	ug/L		>RDL	MS	1.23e+00	1.27e-01	1	1/8/2014	18:26
Uranium	7440-61-1	1.06e+00	ug/L	B	>RDL	MS	1.23e+00	0.00000	1	1/8/2014	18:26

Color Before: Colorless Clarity Before: Clear Texture: N/A

Color After: Colorless Clarity After: Clear Artifacts: None

Comments:

Checked by: _____ Date: _____

USEPA NAREL MONTGOMERY, AL

Trace Metals Analysis by 7500Ce CRC ICP-MS

INORGANIC ANALYSIS DATA PACKAGE

Client: BASF CLEVELAND SDG No.: 1300090 Method Type: SW846-6020A

Sample ID: B3.11223C Customer Sample ID: S07

Matrix: WATER Date Received: 10/30/2013 Level: LOW Analyst: RM

% Solids: Sample Wt/Vol: 45.00 Final Vol: 50.00

Prep Batch ID: 1300090 Prep Date: 12/23/2013 Instrument: AG 7500Ce ICPMS

Analyte	CAS No.	Concentration	Units	C	Qual	M	RDL	DL	Dil	Analytical Date	Analytical Time
Aluminum	7429-90-5	3.06e+02	ug/L		>RDL	MS	6.17e+01	2.33e+00	6	1/8/2014	18:32
Antimony	7440-36-0	1.10e+01	ug/L		>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	18:37
Arsenic	7440-38-2	3.07e+00	ug/L		>RDL	MS	1.23e+00	1.80e-02	1	1/8/2014	18:37
Barium	7440-39-3	4.63e+01	ug/L		>RDL	MS	1.23e+00	3.60e-02	1	1/8/2014	18:37
Beryllium	7440-41-7	1.00e-01	ug/L	B	>RDL	MS	1.23e+00	6.20e-03	1	1/7/2014	17:35
Cadmium	7440-43-9	2.12e+01	ug/L		>RDL	MS	1.23e+00	0.00000	1	1/8/2014	18:37
Calcium	7440-70-2	8.17e+04	ug/L		>RDL	MS	6.17e+02	3.71e+01	6	1/8/2014	18:32
Chromium	7440-47-3	1.79e+01	ug/L		>RDL	MS	1.23e+00	4.72e-02	1	1/8/2014	18:37
Cobalt	7440-48-4	2.69e+01	ug/L		>RDL	MS	1.23e+00	8.80e-03	1	1/8/2014	18:37
Copper	7440-50-8	2.53e+01	ug/L		>RDL	MS	1.23e+00	3.01e-02	1	1/8/2014	18:37
Iron	7439-89-6	1.94e+02	ug/L		>RDL	MS	1.23e+02	1.12e+01	1	1/8/2014	18:37
Lead	7439-92-1	4.31e+01	ug/L		>RDL	MS	1.23e+00	3.66e-02	1	1/8/2014	18:37
Magnesium	7439-95-4	1.34e+04	ug/L		>RDL	MS	1.23e+02	4.91e-01	1	1/8/2014	18:37
Manganese	7439-96-5	3.08e+01	ug/L		>RDL	MS	1.23e+00	1.09e-01	1	1/8/2014	18:37
Molybdenum	7439-98-7	1.24e+01	ug/L		>RDL	MS	1.23e+00	3.26e-02	1	1/8/2014	18:37
Nickel	7440-02-0	4.01e+02	ug/L		>RDL	MS	6.17e+00	1.59e-01	6	1/8/2014	18:32
Potassium	7440-09-7	1.56e+04	ug/L		>RDL	MS	1.23e+02	3.10e+00	1	1/8/2014	18:37
Selenium	7782-49-2	6.76e+00	ug/L		>RDL	MS	1.23e+00	1.23e-02	1	1/8/2014	18:37
Silver	7440-22-4	2.33e-02	ug/L	U		MS	1.23e+00	2.33e-02	1	1/8/2014	18:37
Sodium	7440-23-5	2.36e+04	ug/L		>RDL	MS	6.17e+02	1.82e+01	6	1/8/2014	18:32
Thallium	7440-28-0	7.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	18:37
Vanadium	7440-62-2	1.02e+00	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	18:37
Zinc	7440-66-6	6.60e+01	ug/L		>RDL	MS	1.23e+00	1.27e-01	1	1/8/2014	18:37
Uranium	7440-61-1	1.15e+02	ug/L		>RDL	MS	1.23e+00	0.00000	1	1/8/2014	18:37

Color Before: Colorless Clarity Before: Clear Texture: N/A

Color After: Colorless Clarity After: Clear Artifacts: None

Comments:

Checked by: _____ Date: _____

USEPA NAREL MONTGOMERY, AL

Trace Metals Analysis by 7500Ce CRC ICP-MS

INORGANIC ANALYSIS DATA PACKAGE

Client: BASF CLEVELAND SDG No.: 1300090 Method Type: SW846-6020A

Sample ID: B3.11224D Customer Sample ID: S08

Matrix: WATER Date Received: 10/30/2013 Level: LOW Analyst: RM

% Solids: Sample Wt/Vol: 45.00 Final Vol: 50.00

Prep Batch ID: 1300090 Prep Date: 12/23/2013 Instrument: AG 7500Ce ICPMS

Analyte	CAS No.	Concentration	Units	C	Qual	M	RDL	DL	Dil	Analytical Date	Analytical Time
Aluminum	7429-90-5	3.31e+02	ug/L		>RDL	MS	6.17e+01	2.33e+00	6	1/8/2014	18:42
Antimony	7440-36-0	1.10e+01	ug/L		>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	18:48
Arsenic	7440-38-2	3.26e+00	ug/L		>RDL	MS	1.23e+00	1.80e-02	1	1/8/2014	18:48
Barium	7440-39-3	4.74e+01	ug/L		>RDL	MS	1.23e+00	3.60e-02	1	1/8/2014	18:48
Beryllium	7440-41-7	8.00e-02	ug/L	B	>RDL	MS	1.20e+00	1.00e-02	1	1/7/2014	17:40
Cadmium	7440-43-9	1.99e+01	ug/L		>RDL	MS	1.23e+00	0.00000	1	1/8/2014	18:48
Calcium	7440-70-2	8.23e+04	ug/L		>RDL	MS	6.17e+02	3.71e+01	6	1/8/2014	18:42
Chromium	7440-47-3	1.71e+01	ug/L		>RDL	MS	1.23e+00	4.72e-02	1	1/8/2014	18:48
Cobalt	7440-48-4	2.86e+01	ug/L		>RDL	MS	1.23e+00	8.80e-03	1	1/8/2014	18:48
Copper	7440-50-8	2.19e+01	ug/L		>RDL	MS	1.23e+00	3.01e-02	1	1/8/2014	18:48
Iron	7439-89-6	2.52e+02	ug/L		>RDL	MS	1.23e+02	1.12e+01	1	1/8/2014	18:48
Lead	7439-92-1	4.01e+01	ug/L		>RDL	MS	1.23e+00	3.66e-02	1	1/8/2014	18:48
Magnesium	7439-95-4	1.35e+04	ug/L		>RDL	MS	1.23e+02	4.91e-01	1	1/8/2014	18:48
Manganese	7439-96-5	4.98e+01	ug/L		>RDL	MS	1.23e+00	1.09e-01	1	1/8/2014	18:48
Molybdenum	7439-98-7	1.21e+01	ug/L		>RDL	MS	1.23e+00	3.26e-02	1	1/8/2014	18:48
Nickel	7440-02-0	4.01e+02	ug/L		>RDL	MS	6.17e+00	1.59e-01	6	1/8/2014	18:42
Potassium	7440-09-7	1.57e+04	ug/L		>RDL	MS	1.23e+02	3.10e+00	1	1/8/2014	18:48
Selenium	7782-49-2	6.91e+00	ug/L		>RDL	MS	1.23e+00	1.23e-02	1	1/8/2014	18:48
Silver	7440-22-4	2.33e-02	ug/L	U		MS	1.23e+00	2.33e-02	1	1/8/2014	18:48
Sodium	7440-23-5	2.37e+04	ug/L		>RDL	MS	6.17e+02	1.82e+01	6	1/8/2014	18:42
Thallium	7440-28-0	8.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	18:48
Vanadium	7440-62-2	1.09e+00	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	18:48
Zinc	7440-66-6	6.67e+01	ug/L		>RDL	MS	1.23e+00	1.27e-01	1	1/8/2014	18:48
Uranium	7440-61-1	1.18e+02	ug/L		>RDL	MS	1.23e+00	0.00000	1	1/8/2014	18:48

Color Before: Colorless Clarity Before: Clear Texture: N/A

Color After: Colorless Clarity After: Clear Artifacts: None

Comments:

Checked by: _____ Date: _____

USEPA NAREL MONTGOMERY, AL

Trace Metals Analysis by 7500Ce CRC ICP-MS

INORGANIC ANALYSIS DATA PACKAGE

Client: BASF CLEVELAND SDG No.: 1300090 Method Type: SW846-6020A

Sample ID: B3.11225E Customer Sample ID: DO9

Matrix: WATER Date Received: 10/30/2013 Level: LOW Analyst: RM

% Solids: Sample Wt/Vol: 45.00 Final Vol: 50.00

Prep Batch ID: 1300090 Prep Date: 12/23/2013 Instrument: AG 7500Ce ICPMS

Analyte	CAS No.	Concentration	Units	C	Qual	M	RDL	DL	Dil	Analytical Date	Analytical Time
Aluminum	7429-90-5	3.35e+02	ug/L		>RDL	MS	6.17e+01	2.33e+00	6	1/8/2014	19:14
Antimony	7440-36-0	1.10e+01	ug/L		>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	19:25
Arsenic	7440-38-2	3.16e+00	ug/L		>RDL	MS	1.23e+00	1.80e-02	1	1/8/2014	19:25
Barium	7440-39-3	4.71e+01	ug/L		>RDL	MS	1.23e+00	3.60e-02	1	1/8/2014	19:25
Beryllium	7440-41-7	8.00e-02	ug/L	B	>RDL	MS	1.23e+00	6.20e-03	1	1/7/2014	17:51
Cadmium	7440-43-9	1.96e+01	ug/L		>RDL	MS	1.23e+00	0.00000	1	1/8/2014	19:25
Calcium	7440-70-2	8.47e+04	ug/L		>RDL	MS	6.17e+02	3.71e+01	6	1/8/2014	19:14
Chromium	7440-47-3	1.70e+01	ug/L		>RDL	MS	1.23e+00	4.72e-02	1	1/8/2014	19:25
Cobalt	7440-48-4	2.85e+01	ug/L		>RDL	MS	1.23e+00	8.80e-03	1	1/8/2014	19:25
Copper	7440-50-8	2.16e+01	ug/L		>RDL	MS	1.23e+00	3.01e-02	1	1/8/2014	19:25
Iron	7439-89-6	2.49e+02	ug/L		>RDL	MS	1.23e+02	1.12e+01	1	1/8/2014	19:25
Lead	7439-92-1	3.90e+01	ug/L		>RDL	MS	1.23e+00	3.66e-02	1	1/8/2014	19:25
Magnesium	7439-95-4	1.34e+04	ug/L		>RDL	MS	1.23e+02	4.91e-01	1	1/8/2014	19:25
Manganese	7439-96-5	4.86e+01	ug/L		>RDL	MS	1.23e+00	1.09e-01	1	1/8/2014	19:25
Molybdenum	7439-98-7	1.23e+01	ug/L		>RDL	MS	1.23e+00	3.26e-02	1	1/8/2014	19:25
Nickel	7440-02-0	4.13e+02	ug/L		>RDL	MS	6.17e+00	1.59e-01	6	1/8/2014	19:14
Potassium	7440-09-7	1.55e+04	ug/L		>RDL	MS	1.23e+02	3.10e+00	1	1/8/2014	19:25
Selenium	7782-49-2	7.06e+00	ug/L		>RDL	MS	1.23e+00	1.23e-02	1	1/8/2014	19:25
Silver	7440-22-4	4.00e-01	ug/L	B	>RDL	MS	1.23e+00	2.33e-02	1	1/8/2014	19:25
Sodium	7440-23-5	2.46e+04	ug/L		>RDL	MS	6.17e+02	1.82e+01	6	1/8/2014	19:14
Thallium	7440-28-0	8.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	19:25
Vanadium	7440-62-2	1.10e+00	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	19:25
Zinc	7440-66-6	6.64e+01	ug/L		>RDL	MS	1.23e+00	1.27e-01	1	1/8/2014	19:25
Uranium	7440-61-1	1.18e+02	ug/L		>RDL	MS	1.23e+00	0.00000	1	1/8/2014	19:25

Color Before: Colorless Clarity Before: Clear Texture: N/A

Color After: Colorless Clarity After: Clear Artifacts: None

Comments:

Checked by: _____ Date: _____

USEPA NAREL MONTGOMERY, AL

Trace Metals Analysis by 7500Ce CRC ICP-MS

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PREPARATION BLANK SUMMARY

Client: BASF CLEVELAND SDG No.: 1300090

Contract: WATER Lab Code: US EPA/NAREL Case No.: RO1, SO2-SO8, DO9 SAS No.: XXXXX

Sample ID	Analyte	Result (ug/L)	Conc Qual	Q	Acceptance Limit	IDL	RDL	M	Analysis Date	Analysis Time	Run
RBLK1300090			WATER								
	Aluminum	3.15e+00	B		+/-1.23e+01	4.65e-01	1.23e+01	MS	1/8/2014	15:46	14A08o00.B
	Antimony	1.00e-02	B		+/-1.23e+00	6.00e-03	1.23e+00	MS	1/7/2014	16:05	14A07o00.B
	Arsenic	2.00e-02	B		+/-1.23e+00	1.80e-02	1.23e+00	MS	1/7/2014	16:05	14A07o00.B
	Barium	3.00e-01	B		+/-1.23e+00	3.60e-02	1.23e+00	MS	1/7/2014	16:05	14A07o00.B
	Beryllium	1.00e-02	B		+/-1.23e+00	6.00e-03	1.23e+00	MS	1/7/2014	16:05	14A07o00.B
	Cadmium	0.000	B		+/-1.23e+00	0.000	1.23e+00	MS	1/7/2014	16:05	14A07o00.B
	Calcium	7.41e+00	U		+/-1.23e+02	7.41e+00	1.23e+02	MS	1/8/2014	15:46	14A08o00.B
	Chromium	5.00e-02	B		+/-1.23e+00	4.70e-02	1.23e+00	MS	1/7/2014	16:05	14A07o00.B
	Cobalt	1.00e-02	B		+/-1.23e+00	9.00e-03	1.23e+00	MS	1/7/2014	16:05	14A07o00.B
	Copper	4.00e-02	B		+/-1.23e+00	3.00e-02	1.23e+00	MS	1/7/2014	16:05	14A07o00.B
	Iron	1.12e+01	U		+/-1.23e+02	1.12e+01	1.23e+02	MS	1/7/2014	16:05	14A07o00.B
	Lead	3.70e-02	U		+/-1.23e+00	3.70e-02	1.23e+00	MS	1/7/2014	16:05	14A07o00.B
	Magnesium	1.60e+00	B		+/-1.23e+02	4.91e-01	1.23e+02	MS	1/8/2014	15:46	14A08o00.B
	Manganese	1.09e-01	U		+/-1.23e+00	1.09e-01	1.23e+00	MS	1/7/2014	16:05	14A07o00.B
	Molybdenum	1.00e-01	B		+/-1.23e+00	3.30e-02	1.23e+00	MS	1/7/2014	16:05	14A07o00.B
	Nickel	6.70e-02	B		+/-1.23e+00	3.20e-02	1.23e+00	MS	1/8/2014	15:46	14A08o00.B
	Potassium	3.10e+00	U		+/-1.23e+02	3.10e+00	1.23e+02	MS	1/8/2014	15:46	14A08o00.B
	Selenium	3.76e-01	B		+/-1.23e+00	1.20e-02	1.23e+00	MS	1/8/2014	15:46	14A08o00.B
	Silver	2.30e-02	U		+/-1.23e+00	2.30e-02	1.23e+00	MS	1/7/2014	16:05	14A07o00.B
	Sodium	3.65e+00	U		+/-1.23e+02	3.65e+00	1.23e+02	MS	1/8/2014	15:46	14A08o00.B
	Thallium	1.00e-02	B		+/-1.23e+00	6.00e-03	1.23e+00	MS	1/7/2014	16:05	14A07o00.B
	Vanadium	3.00e-02	B		+/-1.23e+00	6.00e-03	1.23e+00	MS	1/7/2014	16:05	14A07o00.B
	Zinc	2.80e-01	B		+/-1.23e+00	1.27e-01	1.23e+00	MS	1/7/2014	16:05	14A07o00.B
	Uranium	0.000	B		+/-1.23e+00	0.000	1.23e+00	MS	1/7/2014	16:05	14A07o00.B

Trace Metals Analysis by 7500Ce CRC ICP-MS

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MATRIX SPIKE SUMMARY

Client: BASF CLEVELAND Level: LOW SDG No.: 1300090

Contract: WATER Lab Code: US EPA/NAREL Case No.: RO1, SO2-SO8, DO9 SAS No.: XXXXX

Matrix: WATER Sample ID: B3.11220Z Client ID: SO4

Percent Solids for Sample: 0.00 Spiked ID: B3.11220Z-S Percent Solids for Spike Sample: 0.00

Analyte	Units	Acceptance Limit %R	Spiked Result	C	Sample Result	C	Spike Added	% Recovery	Qual	M
Antimony	ug/L	75 - 125	1.17e+02		1.37e+01		1.11e+02	93.0		MS
Antimony	ug/L	75 - 125	1.15e+02		1.37e+01		1.11e+02	91.0		MS
Arsenic	ug/L	75 - 125	1.07e+02		5.58e+00		1.11e+02	91.6		MS
Arsenic	ug/L	75 - 125	1.07e+02		5.58e+00		1.11e+02	91.0		MS
Barium	ug/L	75 - 125	1.59e+02		5.53e+01		1.11e+02	93.5		MS
Barium	ug/L	75 - 125	1.56e+02		5.53e+01		1.11e+02	90.4		MS
Beryllium	ug/L	75 - 125	9.98e+01		1.30e-01	B	1.11e+02	89.7		MS
Beryllium	ug/L	75 - 125	9.87e+01		1.30e-01	B	1.11e+02	88.7		MS
Cadmium	ug/L	75 - 125	1.15e+02		1.62e+01		1.11e+02	88.5		MS
Cadmium	ug/L	75 - 125	1.14e+02		1.62e+01		1.11e+02	88.0		MS
Chromium	ug/L	75 - 125	1.33e+02		2.20e+01		1.11e+02	100.1		MS
Chromium	ug/L	75 - 125	1.36e+02		2.20e+01		1.11e+02	102.7		MS
Cobalt	ug/L	75 - 125	1.33e+02		2.70e+01		1.11e+02	95.7		MS
Cobalt	ug/L	75 - 125	1.33e+02		2.70e+01		1.11e+02	95.5		MS
Copper	ug/L	75 - 125	1.25e+02		2.23e+01		1.11e+02	92.6		MS
Copper	ug/L	75 - 125	1.25e+02		2.23e+01		1.11e+02	92.2		MS
Iron	ug/L	75 - 125	1.08e+04		1.61e+02		1.11e+04	95.9		MS
Iron	ug/L	75 - 125	1.13e+04		1.61e+02		1.11e+04	99.9		MS
Lead	ug/L	75 - 125	1.55e+02		4.91e+01		1.11e+02	94.8		MS
Lead	ug/L	75 - 125	1.54e+02		4.91e+01		1.11e+02	93.9		MS
Manganese	ug/L	75 - 125	1.44e+02		3.09e+01		1.11e+02	101.7		MS
Manganese	ug/L	75 - 125	1.44e+02		3.09e+01		1.11e+02	101.5		MS
Molybdenum	ug/L	75 - 125	1.17e+02		1.04e+01		1.11e+02	96.2		MS
Molybdenum	ug/L	75 - 125	1.15e+02		1.04e+01		1.11e+02	94.6		MS
Silver	ug/L	75 - 125	1.01e+02		2.33e-02	U	1.11e+02	90.5		MS
Silver	ug/L	75 - 125	1.00e+02		2.33e-02	U	1.11e+02	90.1		MS
Thallium	ug/L	75 - 125	1.08e+02		7.00e-02	B	1.11e+02	96.9		MS
Thallium	ug/L	75 - 125	1.06e+02		7.00e-02	B	1.11e+02	95.6		MS
Vanadium	ug/L	75 - 125	1.13e+02		1.43e+00		1.11e+02	100.7		MS
Vanadium	ug/L	75 - 125	1.12e+02		1.43e+00		1.11e+02	99.8		MS
Zinc	ug/L	75 - 125	1.58e+02		5.95e+01		1.11e+02	88.6		MS
Zinc	ug/L	75 - 125	1.55e+02		5.95e+01		1.11e+02	86.0		MS
Uranium	ug/L	75 - 125	2.06e+02		1.04e+02		1.11e+02	91.7		MS
Uranium	ug/L	75 - 125	2.04e+02		1.04e+02		1.11e+02	89.6		MS

USEPA NAREL MONTGOMERY, AL

Trace Metals Analysis by 7500Ce CRC ICP-MS
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POST DIGEST SPIKE SUMMARY

Client: BASF CLEVELAND SDG No.: 1300090

Contract: WATER Lab Code: US EPA/NAREL Case No.: ROI. S02-S08. D09 SAS No.: XXXXX

Matrix: WATER Level: LOW Client ID: S04

Sample ID: B3.11220Z Spiked ID: B3.11220Z-A

Analyte	Units	Acceptance Limit %R	Spiked Result	C	Sample Result	C	Spike Added	% Recovery	Qual	M
Aluminum	ug/L	80 - 120	1.67e+03		5.60e+02		1.23e+03	89.8		MS
Aluminum	ug/L	80 - 120	1.63e+03		5.60e+02		1.23e+03	86.3		MS
Antimony	ug/L	80 - 120	1.24e+02		1.37e+01		1.11e+02	98.9		MS
Antimony	ug/L	80 - 120	1.24e+02		1.37e+01		1.11e+02	99.0		MS
Arsenic	ug/L	80 - 120	1.11e+02		5.58e+00		1.11e+02	95.3		MS
Arsenic	ug/L	80 - 120	1.12e+02		5.58e+00		1.11e+02	95.6		MS
Barium	ug/L	80 - 120	1.64e+02		5.53e+01		1.11e+02	98.0		MS
Barium	ug/L	80 - 120	1.64e+02		5.53e+01		1.11e+02	97.4		MS
Beryllium	ug/L	80 - 120	1.08e+02		1.30e-01	B	1.11e+02	96.9		MS
Beryllium	ug/L	80 - 120	1.07e+02		1.30e-01	B	1.11e+02	96.3		MS
Cadmium	ug/L	80 - 120	1.24e+02		1.62e+01		1.11e+02	97.2		MS
Cadmium	ug/L	80 - 120	1.23e+02		1.62e+01		1.11e+02	96.4		MS
Calcium	ug/L	80 - 120	1.99e+05		9.18e+04		1.23e+05	86.7		MS
Calcium	ug/L	80 - 120	1.98e+05		9.18e+04		1.23e+05	86.4		MS
Chromium	ug/L	80 - 120	1.35e+02		2.20e+01		1.11e+02	102.1		MS
Chromium	ug/L	80 - 120	1.36e+02		2.20e+01		1.11e+02	102.5		MS
Cobalt	ug/L	80 - 120	1.35e+02		2.70e+01		1.11e+02	97.0		MS
Cobalt	ug/L	80 - 120	1.35e+02		2.70e+01		1.11e+02	96.9		MS
Copper	ug/L	80 - 120	1.28e+02		2.23e+01		1.11e+02	94.7		MS
Copper	ug/L	80 - 120	1.28e+02		2.23e+01		1.11e+02	95.0		MS
Iron	ug/L	80 - 120	1.17e+04		1.61e+02		1.11e+04	104.2		MS
Iron	ug/L	80 - 120	1.18e+04		1.61e+02		1.11e+04	104.6		MS
Lead	ug/L	80 - 120	1.60e+02		4.91e+01		1.11e+02	99.7		MS
Lead	ug/L	80 - 120	1.60e+02		4.91e+01		1.11e+02	100.0		MS
Magnesium	ug/L	80 - 120	7.03e+04		1.37e+04		6.17e+04	91.7		MS
Magnesium	ug/L	80 - 120	6.95e+04		1.37e+04		6.17e+04	90.5		MS
Manganese	ug/L	80 - 120	1.45e+02		3.09e+01		1.11e+02	102.6		MS
Manganese	ug/L	80 - 120	1.46e+02		3.09e+01		1.11e+02	103.2		MS
Molybdenum	ug/L	80 - 120	1.20e+02		1.04e+01		1.11e+02	98.5		MS
Molybdenum	ug/L	80 - 120	1.20e+02		1.04e+01		1.11e+02	98.8		MS
Nickel	ug/L	80 - 120	1.57e+03		4.96e+02		1.23e+03	87.2		MS
Nickel	ug/L	80 - 120	1.55e+03		4.96e+02		1.23e+03	85.7		MS
Potassium	ug/L	80 - 120	7.55e+04		1.73e+04		6.17e+04	94.4		MS
Potassium	ug/L	80 - 120	7.41e+04		1.73e+04		6.17e+04	92.1		MS
Selenium	ug/L	80 - 120	5.78e+02		9.05e+00		6.17e+02	92.2		MS

Trace Metals Analysis by 7500Ce CRC ICP-MS

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POST DIGEST SPIKE SUMMARY

Client: BASF CLEVELAND SDG No.: 1300090

Contract: WATER Lab Code: US EPA/NAREL Case No.: ROI. SO2-SO8. DO9 SAS No.: XXXXX

Matrix: WATER Level: LOW Client ID: SO4

Sample ID: B3.11220Z Spiked ID: B3.11220Z-A

Analyte	Units	Acceptance Limit %R	Spiked Result	C	Sample Result	C	Spike Added	% Recovery	Qual	M
Selenium	ug/L	80 - 120	5.68e+02		9.05e+00		6.17e+02	90.7		MS
Silver	ug/L	80 - 120	1.11e+02		2.00e-02	U	1.11e+02	99.9		MS
Silver	ug/L	80 - 120	1.10e+02		2.00e-02	U	1.11e+02	98.9		MS
Sodium	ug/L	80 - 120	7.73e+04		2.06e+04		6.17e+04	91.9		MS
Sodium	ug/L	80 - 120	7.69e+04		2.06e+04		6.17e+04	91.3		MS
Thallium	ug/L	80 - 120	1.16e+02		7.00e-02	B	1.11e+02	104.3		MS
Thallium	ug/L	80 - 120	1.15e+02		7.00e-02	B	1.11e+02	103.3		MS
Vanadium	ug/L	80 - 120	1.17e+02		1.43e+00		1.11e+02	104.0		MS
Vanadium	ug/L	80 - 120	1.17e+02		1.43e+00		1.11e+02	104.4		MS
Zinc	ug/L	80 - 120	1.57e+02		5.95e+01		1.11e+02	88.1		MS
Zinc	ug/L	80 - 120	1.58e+02		5.95e+01		1.11e+02	88.2		MS
Uranium	ug/L	80 - 120	2.10e+02		1.04e+02		1.11e+02	94.8		MS
Uranium	ug/L	80 - 120	2.10e+02		1.04e+02		1.11e+02	94.8		MS

Trace Metals Analysis by 7500Ce CRC ICP-MS

DUPLICATE SAMPLE SUMMARY

Client: BASF CLEVELAND Level: LOW SDG No.: I300090

Contract: WATER Lab Code: US EPA/NAREL Case No.: RO1, SO2-SO8, DO9 SAS No.: XXXXX

Matrix: WATER Sample ID: B3.11220Z Client ID: SO4

Percent Solids for Sample: 0.00 Duplicate ID: B3.11220Z-D Percent Solids for Duplicate: 0.00

Analyte	Units	Acceptance Limit	Sample Result	C	Duplicate Result	C	RPD	Qual	M
Aluminum	ug/L	0 - 20	5.60e+02		5.84e+02		4.18		MS
Antimony	ug/L	0 - 20	1.37e+01		1.52e+01		10.13		MS
Antimony	ug/L	0 - 20	1.17e+02		1.15e+02		1.92		MS
Arsenic	ug/L	0 - 20	5.58e+00		6.38e+00		13.42		MS
Arsenic	ug/L	0 - 20	1.07e+02		1.07e+02		0.62		MS
Barium	ug/L	0 - 20	5.53e+01		6.10e+01		9.83		MS
Barium	ug/L	0 - 20	1.59e+02		1.56e+02		2.18		MS
Beryllium	ug/L	0 - 20	1.30e-01	B	1.33e-01	B	2.43		MS
Beryllium	ug/L	0 - 20	9.98e+01		9.87e+01		1.12		MS
Cadmium	ug/L	0 - 20	1.62e+01		1.87e+01		14.35		MS
Cadmium	ug/L	0 - 20	1.15e+02		1.14e+02		0.48		MS
Calcium	ug/L	0 - 20	9.18e+04		9.82e+04		6.75		MS
Chromium	ug/L	0 - 20	2.20e+01		2.46e+01		11.19		MS
Chromium	ug/L	0 - 20	1.33e+02		1.36e+02		2.15		MS
Cobalt	ug/L	0 - 20	2.70e+01		3.01e+01		10.94		MS
Cobalt	ug/L	0 - 20	1.33e+02		1.33e+02		0.17		MS
Copper	ug/L	0 - 20	2.23e+01		2.48e+01		10.65		MS
Copper	ug/L	0 - 20	1.25e+02		1.25e+02		0.36		MS
Iron	ug/L	0 - 20	1.61e+02		1.83e+02		12.60		MS
Iron	ug/L	0 - 20	1.08e+04		1.13e+04		4.11		MS
Lead	ug/L	0 - 20	4.91e+01		5.46e+01		10.55		MS
Lead	ug/L	0 - 20	1.55e+02		1.54e+02		0.65		MS
Magnesium	ug/L	0 - 20	1.37e+04		1.49e+04		8.55		MS
Manganese	ug/L	0 - 20	3.09e+01		3.44e+01		10.88		MS
Manganese	ug/L	0 - 20	1.44e+02		1.44e+02		0.16		MS
Molybdenum	ug/L	0 - 20	1.04e+01		1.02e+02		163.00	*	MS
Molybdenum	ug/L	0 - 20	1.17e+02		1.15e+02		1.53		MS
Nickel	ug/L	0 - 20	4.96e+02		5.25e+02		5.71		MS
Potassium	ug/L	0 - 20	1.73e+04		1.90e+04		9.17		MS
Selenium	ug/L	0 - 20	9.05e+00		1.04e+01		13.68		MS
Silver	ug/L	0 - 20	2.33e-02	U	4.44e-02	B	200.0		MS
Silver	ug/L	0 - 20	1.01e+02		1.00e+02		0.48		MS
Sodium	ug/L	0 - 20	2.06e+04		2.25e+04		9.18		MS
Thallium	ug/L	0 - 20	7.00e-02	B	7.77e-02	B	10.43		MS
Thallium	ug/L	0 - 20	1.08e+02		1.06e+02		1.40		MS
Vanadium	ug/L	0 - 20	1.43e+00		1.60e+00		11.12		MS

Trace Metals Analysis by 7500Ce CRC ICP-MS

DUPLICATE SAMPLE SUMMARY

Client: BASF CLEVELAND Level: LOW SDG No.: 1300090

Contract: WATER Lab Code: US EPA/NAREL Case No.: RO1, SO2-SO8, DO9 SAS No.: XXXXX

Matrix: WATER Sample ID: B3.11220Z-S Client ID: SO4

Percent Solids for Sample: 0.00 Duplicate ID: B3.11220Z-SD Percent Solids for Duplicate: 0.00

Analyte	Units	Acceptance Limit	Sample Result	C	Duplicate Result	C	RPD	Qual	M
Vanadium	ug/L	0 - 20	1.13e+02		1.12e+02		0.89		MS
Zinc	ug/L	0 - 20	5.95e+01		6.73e+01		12.35		MS
Zinc	ug/L	0 - 20	1.58e+02		1.55e+02		1.84		MS
Uranium	ug/L	0 - 20	1.04e+02		1.18e+02		12.55		MS
Uranium	ug/L	0 - 20	2.06e+02		2.04e+02		1.14		MS

LABORATORY CONTROL SAMPLE

Client: BASF CLEVELAND SDG ID: 1300090

Initial Wt/Vol: 45.00 Final Vol: 50.0 Prep Batch ID: 1300090 Prep Date: 12/23/201

Analytical Dil: 1 % Solids: 0.0 Instrument: AG 7500Ce ICPMS Prep Analyst: RM

Analyte	Units	True Value	Result	C	% Recovery	Qual	Acceptance Limits	Analytical Date	Analytical Time	Prep Batch
Sample ID:	LCSI300090									
Aluminum	ug/L	1.00e+02	1.21e+02		120.50		80.0 - 120.0	1/8/2014	15:52	1300090
Antimony	ug/L	1.00e+02	9.85e+01		98.45		80.0 - 120.0	1/7/2014	16:10	1300090
Arsenic	ug/L	1.00e+02	9.73e+01		97.29		80.0 - 120.0	1/7/2014	16:10	1300090
Barium	ug/L	1.00e+02	1.03e+02		102.61		80.0 - 120.0	1/7/2014	16:10	1300090
Beryllium	ug/L	1.00e+02	9.71e+01		97.14		80.0 - 120.0	1/7/2014	16:10	1300090
Cadmium	ug/L	1.00e+02	9.96e+01		99.62		80.0 - 120.0	1/7/2014	16:10	1300090
Calcium	ug/L	1.00e+04	9.36e+03		93.56		80.0 - 120.0	1/8/2014	15:52	1300090
Chromium	ug/L	1.00e+02	1.07e+02		106.85		80.0 - 120.0	1/7/2014	16:10	1300090
Cobalt	ug/L	1.00e+02	1.06e+02		106.46		80.0 - 120.0	1/7/2014	16:10	1300090
Copper	ug/L	1.00e+02	1.06e+02		106.37		80.0 - 120.0	1/7/2014	16:10	1300090
Iron	ug/L	1.00e+04	1.06e+04		106.24		80.0 - 120.0	1/7/2014	16:10	1300090
Lead	ug/L	1.00e+02	1.04e+02		103.66		80.0 - 120.0	1/7/2014	16:10	1300090
Magnesium	ug/L	1.00e+04	9.43e+03		94.27		80.0 - 120.0	1/8/2014	15:52	1300090
Manganese	ug/L	1.00e+02	1.06e+02		106.06		80.0 - 120.0	1/7/2014	16:10	1300090
Molybdenum	ug/L	1.00e+02	1.06e+02		106.30		80.0 - 120.0	1/7/2014	16:10	1300090
Nickel	ug/L	1.00e+02	9.68e+01		96.77		80.0 - 120.0	1/8/2014	15:52	1300090
Potassium	ug/L	1.00e+04	9.38e+03		93.80		80.0 - 120.0	1/8/2014	15:52	1300090
Selenium	ug/L	1.00e+02	8.90e+01		88.96		80.0 - 120.0	1/8/2014	15:52	1300090
Silver	ug/L	1.00e+02	1.05e+02		104.86		80.0 - 120.0	1/7/2014	16:10	1300090
Sodium	ug/L	1.00e+04	9.41e+03		94.08		80.0 - 120.0	1/8/2014	15:52	1300090
Thallium	ug/L	1.00e+02	1.04e+02		104.12		80.0 - 120.0	1/7/2014	16:10	1300090
Vanadium	ug/L	1.00e+02	1.05e+02		105.05		80.0 - 120.0	1/7/2014	16:10	1300090
Zinc	ug/L	1.00e+02	9.89e+01		98.87		80.0 - 120.0	1/7/2014	16:10	1300090
Uranium	ug/L	1.00e+02	1.05e+02		104.58		80.0 - 120.0	1/7/2014	16:10	1300090

Trace Metals Analysis by 7500Ce CRC ICP-MS

SERIAL DILUTION SAMPLE SUMMARY

Client: BASF CLEVELAND SDG No.: 1300090

Contract: WATER Lab Code: US EPA/NAREL Case No.: RO1, SO2-SO8, DO9 SAS No.: XXXXX

Matrix: WATER Level: LOW Client ID: DO9

Sample ID: B3.11225E Serial Dilution ID: B3.11225E-L

Analyte	Initial Result ug/L	C	Serial Result ug/L	C	% Difference	Qual	Acceptance Limits	M
Aluminum	3.35e+02		3.49e+02		104.1		110.00 %	MS
Antimony	1.10e+01		1.15e+01		104.0		110.00 %	MS
Arsenic	3.16e+00		3.33e+00	B	105.4		110.00 %	MS
Barium	4.71e+01		4.79e+01		101.7		110.00 %	MS
Beryllium	8.00e-02	B	1.00e-01	B	125.0		110.00 %	MS
Cadmium	1.96e+01		2.07e+01		105.2		110.00 %	MS
Calcium	8.47e+04		8.39e+04		99.0		110.00 %	MS
Chromium	1.70e+01		1.73e+01		101.6		110.00 %	MS
Cobalt	2.85e+01		2.95e+01		103.5		110.00 %	MS
Copper	2.16e+01		2.33e+01		108.0		110.00 %	MS
Iron	2.49e+02		2.68e+02	B	107.6		110.00 %	MS
Lead	3.90e+01		3.84e+01		98.5		110.00 %	MS
Magnesium	1.34e+04		1.45e+04		108.6		110.00 %	MS
Manganese	4.86e+01		4.92e+01		101.2		110.00 %	MS
Molybdenum	1.23e+01		1.23e+01		99.9		110.00 %	MS
Nickel	4.13e+02		4.11e+02		99.4		110.00 %	MS
Potassium	1.55e+04		1.68e+04		108.1		110.00 %	MS
Selenium	7.06e+00		6.67e+00		94.5		110.00 %	MS
Silver	2.00e-02	B	2.00e-02	U	100.0		110.00 %	MS
Sodium	2.46e+04		2.47e+04		100.4		110.00 %	MS
Thallium	8.00e-02	B	1.30e-01	B	162.5		110.00 %	MS
Vanadium	1.10e+00	B	1.17e+00	B	106.4		110.00 %	MS
Zinc	6.64e+01		7.57e+01		113.9		110.00 %	MS
Uranium	1.18e+02		1.09e+02		91.9		110.00 %	MS

Trace Metals Analysis by 7500Ce CRC ICP-MS

SAMPLE PREPARATION SUMMARY

Client: BASF CLEVELAND SDG No.: 1300090

Contract: WATER Lab Code: US EPA/NAREL Method: MS SAS No.: XXXXX

Case No.: RO1, SO2-SO8, DO9

Sample ID	Client ID	Sample Type	Matrix	Prep Date	Initial Sample Size(mL)	Final Sample Volume (mL)	Percent Solids
Batch Number:	1300090						
RBLK1300090	Method Blank	MB	WATER	12/23/13	45.0	50	
LCS1300090	Lab Control Sample	LCS	WATER	12/23/13	45.0	50	
B3.11217B	RO1	SAM	WATER	12/23/13	45.0	50	
B3.11218F	SO2	SAM	WATER	12/23/13	45.0	50	
B3.11219G	SO3	SAM	WATER	12/23/13	45.0	50	
B3.11220Z	SO4	SAM	WATER	12/23/13	45.0	50	
B3.11220Z-D	SO4	DUP	WATER	12/23/13	45.0	50	
B3.11220Z-S	SO4	MS	WATER	12/23/13	45.0	50	
B3.11220Z-SD	SO4	MSD	WATER	12/23/13	45.0	50	
B3.11221A	SO5	SAM	WATER	12/23/13	45.0	50	
B3.11222B	SO6	SAM	WATER	12/23/13	45.0	50	
B3.11223C	SO7	SAM	WATER	12/23/13	45.0	50	
B3.11224D	SO8	SAM	WATER	12/23/13	45.0	50	
B3.11225E	DO9	SAM	WATER	12/23/13	45.0	50	

Trace Metals Analysis by 7500Ce CRC ICP-MS
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ANALYSIS RUN LOG

Client: BASF CLEVELAND Contract: WATER

Lab Code: US EPA/NAREL Case No.: RO1, SO2 SAS No.: XXXXX SDG No.: 1300090

Instrument ID Number: AG 7500Ce ICPMS Method: MS Run Number: 14A07o00.B

Start Date: 1/7/2014 End Date: 1/7/2014

EPA Sample No.	D/F	Time	% R	Analytes																							
				AL	SB	AS	BA	BE	CD	CA	CR	CO	CU	FE	PB	MG	MN	HG	NI	K	SE	AG	NA	TL	V	ZN	CN	
RBLK1300090	1.11	1605			X	X	X	X	X		X	X	X	X	X		X					X		X	X	X		*
LCS1300090	1.11	1610			X	X	X	X	X		X	X	X	X	X		X					X		X	X	X		*
B3.11217E	1.11	1616						X																				
B3.11218F	1.11	1621						X																				
B3.11219G	1.11	1626						X																				
B3.11220Z	1.11	1632			X	X	X	X	X		X	X	X	X	X		X					X		X	X	X		*
B3.11220Z-A	1.11	1637			X	X	X	X	X		X	X	X	X	X		X					X		X	X	X		*
B3.11220Z-A	1.11	1703			X	X	X	X	X		X	X	X	X	X		X					X		X	X	X		*
B3.11220Z-D	1.11	1709			X	X	X	X	X		X	X	X	X	X		X					X		X	X	X		*
B3.11220Z-S	1.11	1714			X	X	X	X	X		X	X	X	X	X		X					X		X	X	X		*
B3.11220Z-SD	1.11	1719			X	X	X	X	X		X	X	X	X	X		X					X		X	X	X		*
B3.11221A	1.11	1724						X																				
B3.11222B	1.11	1729						X																				
B3.11223C	1.11	1735						X																				
B3.11224D	1.11	1740						X																				
B3.11225E	1.11	1751						X																				
B3.11225E-L	5.55	1817						X																				

Trace Metals Analysis by 7500Ce CRC ICP-MS

ANALYSIS RUN LOG

Client: BASF CLEVELAND Contract: WATER

Lab Code: US EPA/NAREL Case No.: R01, S02 SAS No.: XXXXX SDG No.: 1300090

Instrument ID Number: AG 7500Ce ICPMS Method: MS Run Number: 14A07o00.B

Start Date: 1/7/2014 End Date: 1/7/2014

EPA Sample No.	D/F	Time	% R	Analytes																							
				B	AU	LI	MO	OS	PD	P	PT	SI	S	SN	SR	TI	U	W	IN								
RBLK1300090	1.11	16:05					X										X										
LCS1300090	1.11	16:10					X										X										
B3.11217E	1.11	16:16																									
B3.11218F	1.11	16:21																									
B3.11219G	1.11	16:26																									
B3.11220Z	1.11	16:32					X										X										
B3.11220Z-A	1.11	16:37					X										X										
B3.11220Z-A	1.11	17:03					X										X										
B3.11220Z-D	1.11	17:09					X										X										
B3.11220Z-S	1.11	17:14					X										X										
B3.11220Z-SD	1.11	17:19					X										X										
B3.11221A	1.11	17:24																									
B3.11222B	1.11	17:29																									
B3.11223C	1.11	17:35																									
B3.11224D	1.11	17:40																									
B3.11225E	1.11	17:51																									
B3.11225E-L	5.55	18:17																									

Trace Metals Analysis by 7500Ce CRC ICP-MS
14
ANALYSIS RUN LOG

Client: BASF CLEVELAND Contract: WATER

Lab Code: US EPA/NAREL Case No.: RO1, SO2 SAS No.: XXXXX SDG No.: 1300090

Instrument ID Number: AG 7500Ce ICPMS Method: MS Run Number: 14A08o00.B

Start Date: 1/8/2014 End Date: 1/8/2014

EPA Sample No.	D/F	Time	% R	Analytes																								
				AL	SB	AS	BA	BE	CD	CA	CR	CO	CU	FE	PB	MG	MN	HG	NI	K	SE	AG	NA	TL	V	ZN	CN	
RBLK1300090	1.11	1546		X						X						X			X	X	X		X					
LCS1300090	1.11	1552		X						X						X			X	X	X		X					
B3.11217E	1.11	1557		X	X	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		*
B3.11218F	222.00	1602																	X									
B3.11218F	27.75	1613								X							X						X					
B3.11218F	5.55	1618										X				X												
B3.11218F	1.11	1645		X	X	X	X		X		X		X	X	X	X					X	X		X	X	X		*
B3.11219G	55.50	1650																					X					
B3.11219G	5.55	1656																	X									
B3.11219G	1.11	1701		X	X	X	X		X	X	X	X	X	X	X	X	X			X	X	X		X	X	X		*
B3.11220Z	11.10	1706		X						X									X									
B3.11220Z-A	11.10	1712		X						X									X									
B3.11220Z-A	11.10	1717		X						X									X									
B3.11220Z-D	1.11	1722		X						X									X									
B3.11220Z	5.55	1728														X				X	X		X					
B3.11220Z-A	5.55	1733														X				X	X		X					
B3.11220Z-A	5.55	1759														X				X	X		X					
B3.11220Z-D	1.11	1805														X				X	X		X					
B3.11221A	5.55	1810		X						X									X									
B3.11221A	1.11	1815			X	X	X		X		X	X	X	X	X	X	X			X	X	X	X	X	X	X		*
B3.11222B	11.10	1821		X						X													X					
B3.11222B	1.11	1826			X	X	X		X		X	X	X	X	X	X	X		X	X	X	X		X	X	X		*
B3.11223C	5.55	1832		X						X									X				X					
B3.11223C	1.11	1837			X	X	X		X		X	X	X	X	X	X	X			X	X	X		X	X	X		*
B3.11224D	5.55	1842		X						X									X				X					
B3.11224D	1.11	1848			X	X	X		X		X	X	X	X	X	X	X			X	X	X		X	X	X		*
B3.11225E	5.55	1914		X						X									X				X					
B3.11225E-L	27.75	1920		X						X									X				X					
B3.11225E	1.11	1925			X	X	X	X	X		X	X	X	X	X	X	X			X	X	X		X	X	X		*
B3.11225E-L	5.55	1930			X	X	X	X	X		X	X	X	X	X	X	X			X	X	X		X	X	X		*

Trace Metals Analysis by 7500Ce CRC ICP-MS

ANALYSIS RUN LOG

Client: BASF CLEVELAND Contract: WATER

Lab Code: US EPA/NAREL Case No.: R01, S02 SAS No.: XXXXX SDG No.: 1300090

Instrument ID Number: AG 7500Ce ICPMS Method: MS Run Number: 14A08o00.B

Start Date: 1/8/2014 End Date: 1/8/2014

EPA Sample No.	D/F	Time	% R	Analytes																							
				B	AU	LI	MO	OS	PD	P	PT	SI	S	SN	SR	TI	U	W	IN								
RBLK1300090	1.11	15:46																									
LCS1300090	1.11	15:52																									
B3.11217E	1.11	15:57					X										X										
B3.11218F	222.00	16:02																									
B3.11218F	27.75	16:13																									
B3.11218F	5.55	16:18																									
B3.11218F	1.11	16:45					X										X										
B3.11219G	55.50	16:50																									
B3.11219G	5.55	16:56																									
B3.11219G	1.11	17:01					X										X										
B3.11220Z	11.10	17:06																									
B3.11220Z-A	11.10	17:12																									
B3.11220Z-A	11.10	17:17																									
B3.11220Z-D	1.11	17:22																									
B3.11220Z	5.55	17:28																									
B3.11220Z-A	5.55	17:33																									
B3.11220Z-A	5.55	17:59																									
B3.11220Z-D	1.11	18:05																									
B3.11221A	5.55	18:10																									
B3.11221A	1.11	18:15					X										X										
B3.11222B	11.10	18:21																									
B3.11222B	1.11	18:26					X										X										
B3.11223C	5.55	18:32																									
B3.11223C	1.11	18:37					X										X										
B3.11224D	5.55	18:42																									
B3.11224D	1.11	18:48					X										X										
B3.11225E	5.55	19:14																									
B3.11225E-L	27.75	19:20																									
B3.11225E	1.11	19:25					X										X										
B3.11225E-L	5.55	19:30					X										X										

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF RADIATION AND INDOOR AIR
National Air and Radiation Environmental Laboratory
540 South Morris Avenue, Montgomery, AL 36115-2601
(334) 270-3400

January 21, 2014

MEMORANDUM

SUBJECT: Radiochemical Results for BASF Cleveland Samples

FROM: Cynthia White, Director
Center for Environmental Radioanalytical Laboratory Science

TO: Noel Vargas, Environmental Engineer
Region 5

Attached is a data package for trace metals analysis of samples collected from BASF in Cleveland, Ohio. The samples constitute NAREL batch number 1300090.

Specific information concerning all aspects of the radiological analysis of the samples is contained in the batch case narratives of the data packages. If you have any questions concerning the analytical results, please contact me at (334)270-7052.

Due to a reorganization within the Office of Radiation and Indoor Air, the National Air and Radiation Environmental Laboratory is now called the National Analytical Radiation Environmental Laboratory. (Acronym remains the same, NAREL.)

Attachments

RECEIVED
JAN 28 2014
WATER ENFORCEMENT & COMPLIANCE ASSURANCE BRANCH, EPA, REGION 5

Case Narrative

III. QUALITY CONTROL

A. Blanks: All blank values were within QC limits.

B. Laboratory Control Samples:

Laboratory Control Sample recovery for Aluminum falls outside QC limits.

C. Laboratory Duplicate:

Laboratory Duplicate for Molybdenum is high.

D. Laboratory Matrix Spiked:

Laboratory Matrix Spikes were within acceptable ranges. Some target analyte concentrations were greater than calibration ranges, further dilution and Post Digestion Spikes were performed. All Post Digestion Spike sample recoveries were within QC limits.

IV. Release of the data contained in this package has been authorized by the Director of Center for Environmental Radiological Laboratory Science (CERLS), the NAREL Quality Assurance Manager (QAM), and Mixed Waste Analytical Program (MWAP) or their designees, as verified by the following signatures.

Cindy White 1-21-14
Cindy White Date
Director, CERLS

Mary Wisdom 1-15-14
Mary F. Wisdom Date
Quality Assurance Manager, NAREL

C Eric Boswell 1/14/14
C Eric Boswell Date
Team Leader, MWAP

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL ANALYTICAL RADIATION ENVIRONMENTAL LABORATORY
INORGANIC ANALYSES

REPORT OF SAMPLE DELIVERY GROUP SDG1300090

Project Name: BASF CLEVELAND

NAREL SDG #: 1300090

I. RECEIPT

A. Sample Information

NAREL Sample #	Client Sample ID	Type	Matrix	Date Collected	Date Received
B3.11217E	RO1	SAM	WATER	10/25/2013	10/30/2013
B3.11218F	SO2	SAM	WATER	10/25/2013	10/30/2013
B3.11219G	SO3	SAM	WATER	10/25/2013	10/30/2013
B3.11220Z	SO4	SAM	WATER	10/25/2013	10/30/2013
B3.11221A	SO5	SAM	WATER	10/25/2013	10/30/2013
B3.11222B	SO6	SAM	WATER	10/25/2013	10/30/2013
B3.11223C	SO7	SAM	WATER	10/29/2013	10/30/2013
B3.11224D	SO8	SAM	WATER	10/29/2013	10/30/2013
B3.11225E	DO9	SAM	WATER	10/29/2013	10/30/2013

B. Documentation Exceptions: See Table 1 for a list of reporting qualifier definitions.

II. ANALYSIS

A. Holding Times: All analyses were performed within holding time.

B. Preparation Exceptions: No exceptions were encountered.

C. Analytical Exceptions: No exceptions were encountered.

Table 1

Definitions of Reporting Qualifiers

Concentration (C) Qualifiers:

B - The reported value is less than the Reporting Limit but greater than or equal to the Instrument Detection Limit (IDL).

U - Indicates compound was analyzed for but not detected.

Quality Control (Q) Qualifiers:

E - The reported value is estimated because of the presence of interferences.

M - Duplicate injection precision requirements not met.

N - Spiked sample recovery not within control limits.

S - The reported value was determined by the Method of Standard Additions (MSA).

* - Duplicate analysis not within control limits.

+ - QC Limit does not apply.

Method (M) Qualifiers:

AV-FIMS - Automated Cold Vapor Flow Injection Mercury System

ICP-MS - Inductively Coupled Plasma Mass Spectrometer

USEPA NAREL MONTGOMERY, AL

Trace Metals Analysis by 7500Ce CRC ICP-MS

- 1 -

INORGANIC ANALYSIS DATA PACKAGE

Client: BASF CLEVELAND SDG No.: 1300090 Method Type: SW846-6020A

Sample ID: B3.11218F Customer Sample ID: SO2

Matrix: WATER Date Received: 10/30/2013 Level: LOW Analyst: RM

% Solids: Sample Wt/Vol: 45.00 Final Vol: 50.00

Prep Batch ID: 1300090 Prep Date: 12/23/2013 Instrument: AG 7500Ce ICPMS

Analyte	CAS No.	Concentration	Units	C	Qual	M	RDL	DL	Dil	Analytical Date	Analytical Time
Aluminum	7429-90-5	1.47e+01	ug/L		>RDL	MS	1.23e+01	4.65e-01	1	1/8/2014	16:45
Antimony	7440-36-0	3.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	16:45
Arsenic	7440-38-2	2.74e+00	ug/L		>RDL	MS	1.23e+00	1.80e-02	1	1/8/2014	16:45
Barium	7440-39-3	3.44e+01	ug/L		>RDL	MS	1.23e+00	3.60e-02	1	1/8/2014	16:45
Beryllium	7440-41-7	3.00e-02	ug/L	B	>RDL	MS	1.23e+00	6.20e-03	1	1/7/2014	16:21
Cadmium	7440-43-9	1.40e-01	ug/L	B	>RDL	MS	1.23e+00	0.00000	1	1/8/2014	16:45
Calcium	7440-70-2	1.87e+05	ug/L		>RDL	MS	3.08e+03	1.85e+02	28	1/8/2014	16:13
Chromium	7440-47-3	1.30e-01	ug/L	B	>RDL	MS	1.23e+00	4.72e-02	1	1/8/2014	16:45
Cobalt	7440-48-4	1.09e+03	ug/L		>RDL	MS	6.17e+00	4.39e-02	6	1/8/2014	16:18
Copper	7440-50-8	5.20e-01	ug/L	B	>RDL	MS	1.23e+00	3.01e-02	1	1/8/2014	16:45
Iron	7439-89-6	2.58e+03	ug/L		>RDL	MS	1.23e+02	1.12e+01	1	1/8/2014	16:45
Lead	7439-92-1	6.00e-02	ug/L	B	>RDL	MS	1.23e+00	3.66e-02	1	1/8/2014	16:45
Magnesium	7439-95-4	3.46e+04	ug/L		>RDL	MS	6.17e+02	2.46e+00	6	1/8/2014	16:18
Manganese	7439-96-5	4.92e+03	ug/L		>RDL	MS	3.08e+01	2.72e+00	28	1/8/2014	16:13
Molybdenum	7439-98-7	1.21e+00	ug/L	B	>RDL	MS	1.23e+00	3.26e-02	1	1/8/2014	16:45
Nickel	7440-02-0	4.09e+04	ug/L		>RDL	MS	2.47e+02	6.37e+00	222	1/8/2014	16:02
Potassium	7440-09-7	1.07e+04	ug/L		>RDL	MS	1.23e+02	3.10e+00	1	1/8/2014	16:45
Selenium	7782-49-2	1.71e+00	ug/L		>RDL	MS	1.23e+00	1.23e-02	1	1/8/2014	16:45
Silver	7440-22-4	6.00e-02	ug/L	B	>RDL	MS	1.23e+00	2.33e-02	1	1/8/2014	16:45
Sodium	7440-23-5	2.62e+05	ug/L		>RDL	MS	3.08e+03	9.12e+01	28	1/8/2014	16:13
Thallium	7440-28-0	4.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	16:45
Vanadium	7440-62-2	4.00e-02	ug/L	B	>RDL	MS	1.23e+00	5.70e-03	1	1/8/2014	16:45
Zinc	7440-66-6	2.62e+01	ug/L		>RDL	MS	1.23e+00	1.27e-01	1	1/8/2014	16:45
Uranium	7440-61-1	2.99e+00	ug/L		>RDL	MS	1.23e+00	0.00000	1	1/8/2014	16:45

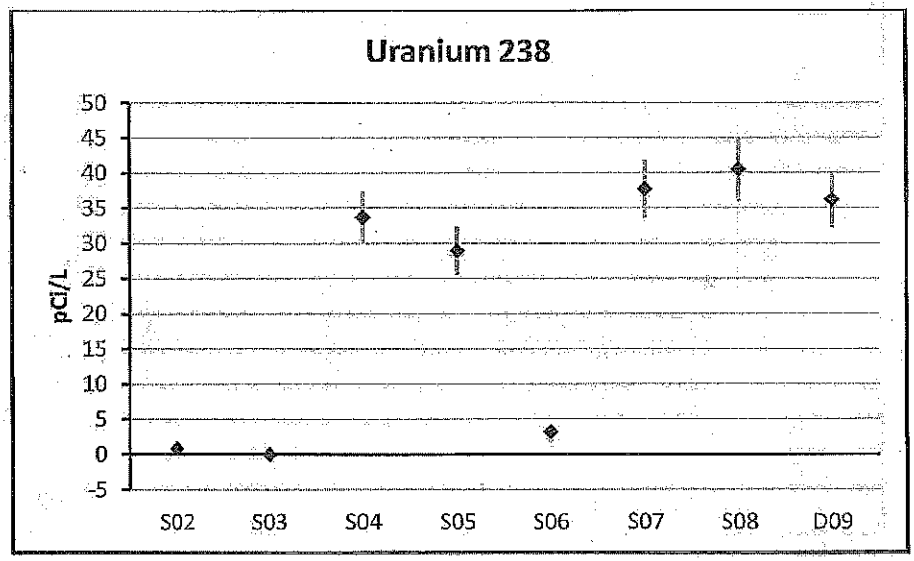
Color Before: Colorless Clarity Before: Clear Texture: N/A

Color After: Colorless Clarity After: Clear Artifacts: None

Comments:

Checked by: [signature] Date: 2/3/14

APPENDIX D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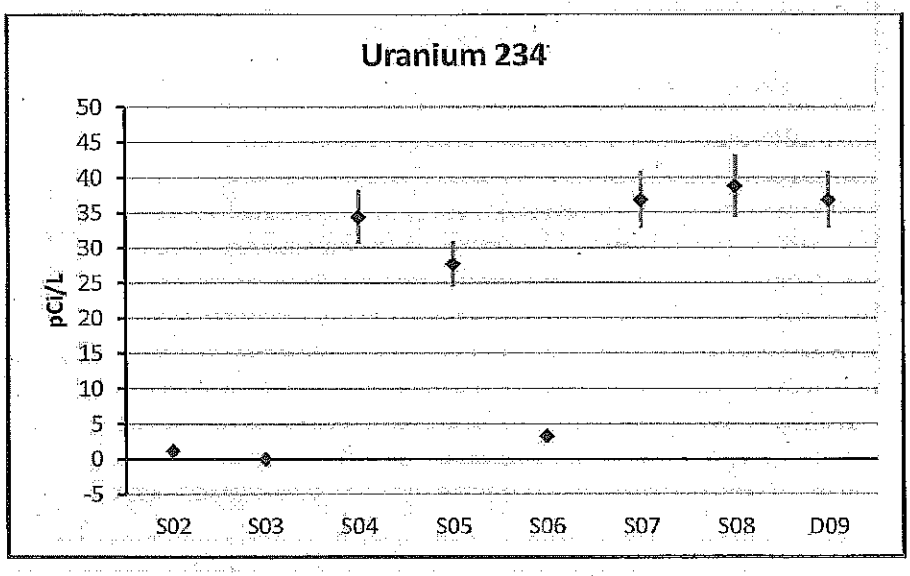
S07
S08
D09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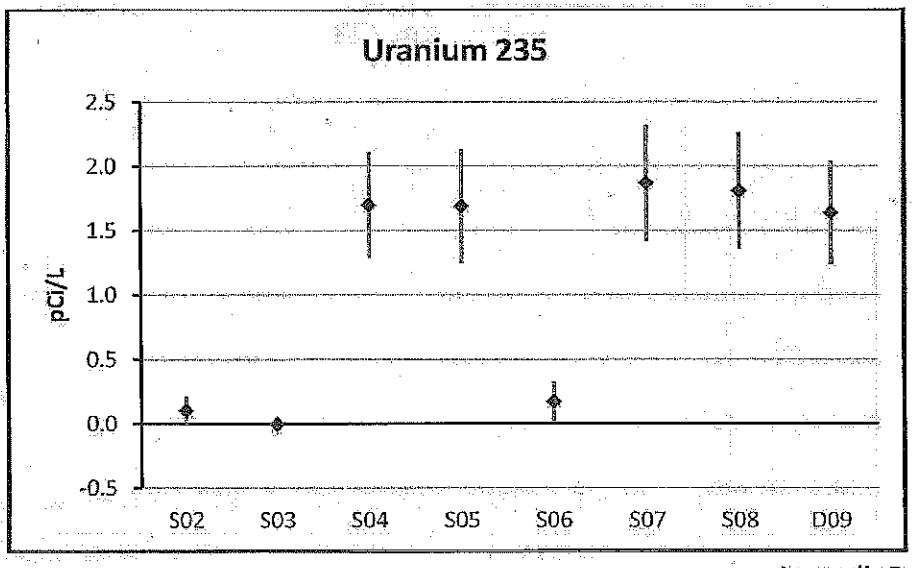
S06
S07
S08
D09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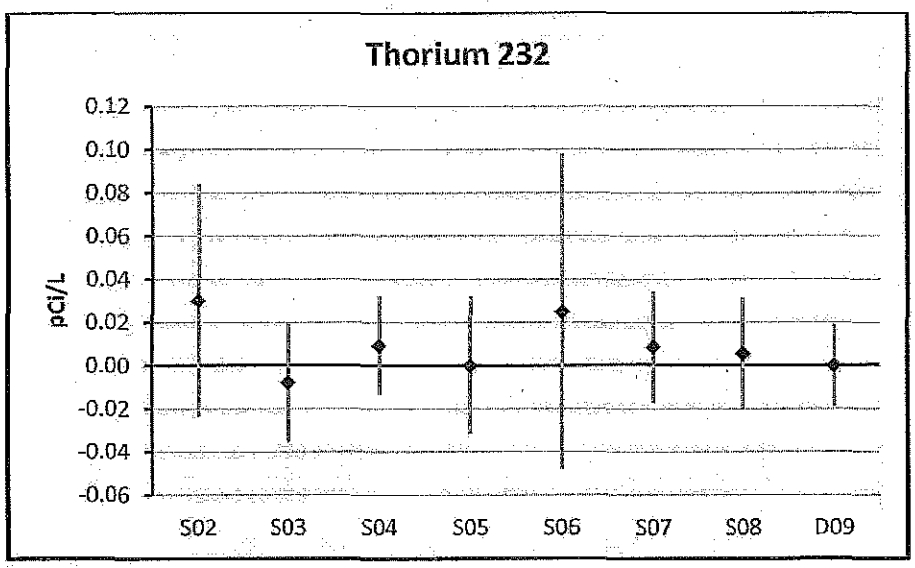
S07
S08
D09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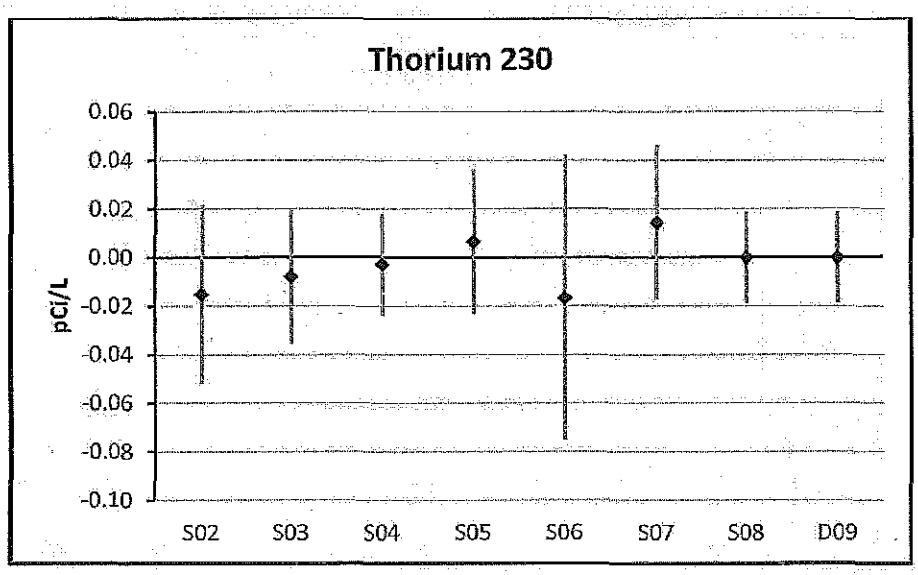
S04
S05
S06
S07
S08
D09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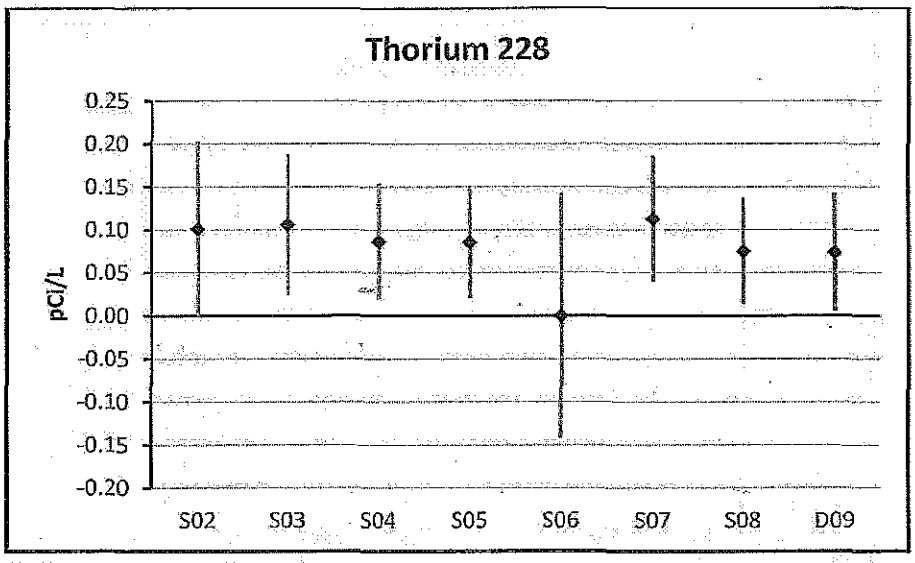
S07
S08
D09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pCi/L
S02
S03
S04
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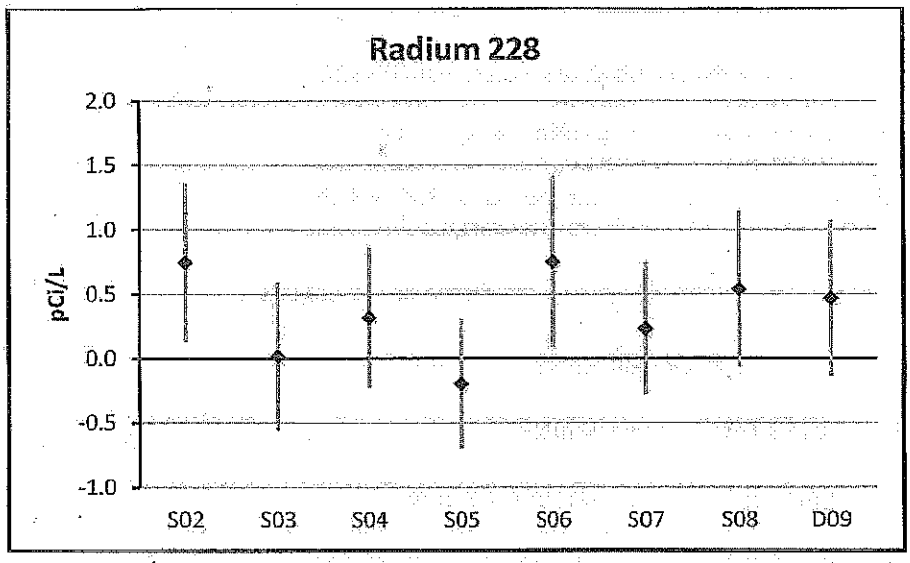
S06
S07
S08
D09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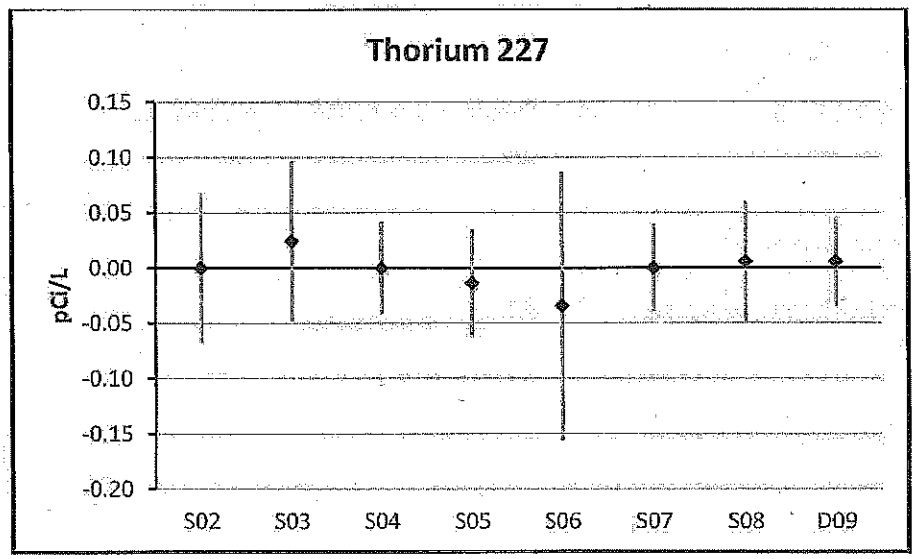
D09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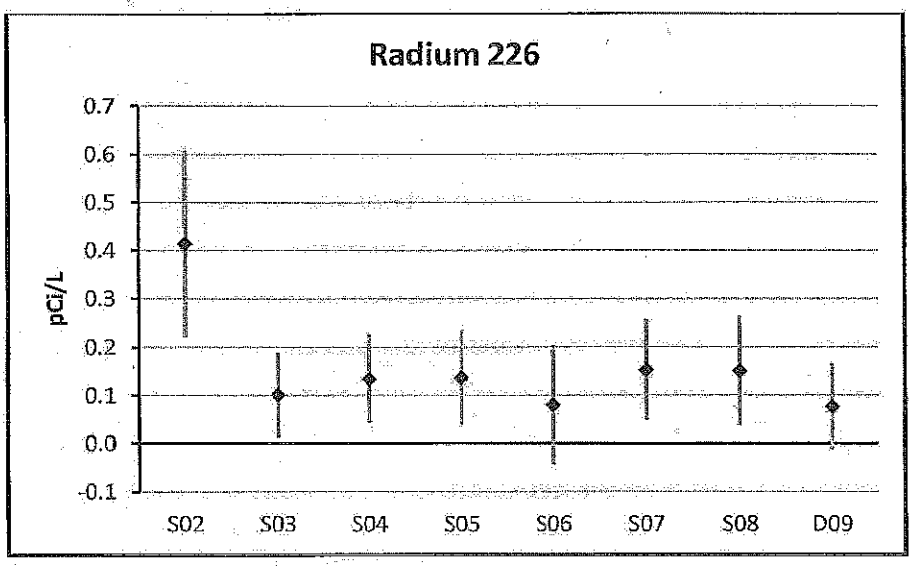
pCi/L
S02
S03
S04
S05
S06
S07
S08
D09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0.3
0.2
0.1
0.0
-0.1
pCi/L
S02
S03
S04
S05
S06
S07
S08
D09

Notes applicable to the plots of radionuclides in Appendix D.

◆ – The black diamonds are the reported activity results.

| – The vertical red lines are the uncertainty associated with the reported results (±2 standard deviations).

S02 – BASF Pump and Treat Influent Sample

S03 – BASF Pump and Treat Effluent Sample

S04 and S07 – Outfall 007 Monitoring Station Samples

S05 and S08 – Outfall 007 Discharge to Cuyahoga River Samples

S06 – Cuyahoga River at Outfall 007 Sample

D09 – Duplicate of Sample S08 (Outfall 007 Discharge to Cuyahoga River Sample)

S02 – S06 were collected 10/25/2013

S07, S08 and D09 were collected 10/29/2013

APPENDIX E

ENFORCEMENT CONFIDENTIAL

DRAFT Document Date: 7/15/2013
Updated: 10/22/2013

U.S. EPA, REGION 5
CLEVELAND OFFICE
QUALITY ASSURANCE PROJECT PLAN/SAMPLING PLAN
FOR ENVIRONMENTAL COMPLIANCE ASSESSMENT

PREPARED BY: Mark E. Moloney — 10-24-13
Mark Moloney, Sampling Team Leader — Date
OECA - Cleveland Office, U.S. EPA, Region 5

APPROVED BY: Mark Conti — 10-24-13
Mark Conti, OECA, Cleveland Office QA Manager — Date
OECA, U.S. EPA, Region 5

APPROVED BY: _____ — 10-24-13
Brooke Furio, OECA, Cleveland Office Section Chief — Date
OECA, U.S. EPA, Region 5

APPROVED BY: _____ — _____
Noel Vargas, Project Leader, — Date
WECAB, U.S. EPA, Region 5

APPROVED BY: _____ — _____
Kenneth Gunter, QA/QC Sampling Manager — Date
WECAB, U.S. EPA, Region 5

APPROVED BY: _____ — _____
Dean Maraldo, Chief — Date
WECAB, U.S. EPA, Region 5

APPROVED BY: _____ — _____
Cindy White, Analytical Services Coordinator — Date
NAREL, Montgomery, AL

ENFORCEMENT CONFIDENTIAL

DRAFT Document Date: 7/15/2013
Updated: 10/22/2013

U.S. EPA, REGION 5
CLEVELAND OFFICE
QUALITY ASSURANCE PROJECT PLAN/SAMPLING PLAN
FOR ENVIRONMENTAL COMPLIANCE ASSESSMENT

PREPARED BY: _____ _____
Mark Moloney, Sampling Team Leader — Date
OECA - Cleveland Office, U.S. EPA, Region 5

APPROVED BY: _____ _____
Mark Conti, OECA, Cleveland Office QA Manager — Date
OECA, U.S. EPA, Region 5

APPROVED BY: _____ _____
Brooke Furio, OECA, Cleveland Office Section Chief — Date
OECA, U.S. EPA, Region 5

APPROVED BY: Noel Vargas 10/22/13
Noel Vargas, Project Leader, — Date
WECAB, U.S. EPA, Region 5

APPROVED BY: K. Gunter 10/23/13
Kenneth Gunter, QA/QC Sampling Manager — Date
WECAB, U.S. EPA, Region 5

APPROVED BY: _____ 10/23/13
Dean Maraldo, Chief — Date
WECAB, U.S. EPA, Region 5

APPROVED BY: _____ _____
Cindy White, Analytical Services Coordinator — Date
NAREL, Montgomery, AL

ENFORCEMENT CONFIDENTIAL

DRAFT Document Date: 7/15/2013
Updated: 10/22/2013

U.S. EPA, REGION 5
CLEVELAND OFFICE
QUALITY ASSURANCE PROJECT PLAN/SAMPLING PLAN
FOR ENVIRONMENTAL COMPLIANCE ASSESSMENT

PREPARED BY: _____ _____
Mark Moloney, Sampling Team Leader — Date
OECA - Cleveland Office, U.S. EPA, Region 5

APPROVED BY: _____ _____
Mark Conti, OECA, Cleveland Office QA Manager — Date
OECA, U.S. EPA, Region 5

APPROVED BY: _____ _____
Brooke Furio, OECA, Cleveland Office Section Chief — Date
OECA, U.S. EPA, Region 5

APPROVED BY: _____ _____
Noel Vargas, Project Leader, — Date
WECAB, U.S. EPA, Region 5

APPROVED BY: _____ _____
Kenneth Gunter, QA/QC Sampling Manager — Date
WECAB, U.S. EPA, Region 5

APPROVED BY: _____ _____
Dean Maraldo, Chief — Date
WECAB, U.S. EPA, Region 5

APPROVED BY: Cindy White 10-25-13
Cindy White, Analytical Services Coordinator — Date
NAREL, Montgomery, AL

Site Name & Location: BASF Cleveland
1000 Harvard Avenue
Cleveland, Ohio

Sampling Dates: October 24, 2013 and October 29, 2013
(back-up dates: October 25 and October 30 or 31)

Introduction

In 2011, the U.S. Army Corps of Engineers (USACE) provided U.S. EPA Region 5 with unconfirmed evidence that BASF Corporation, 1000 Harvard Avenue, Cleveland, Ohio ("BASF" or "the Site") was discharging uranium-contaminated water from Outfall 007 into the Cuyahoga River, and at a point just four miles upstream from Lake Erie, in violation of section 301 of the Clean Water Act, 33 U.S.C. § 1311.

Representatives of U.S. EPA Region 5 will attempt to confirm the USACE's evidence by inspecting the site and sampling groundwater/wastewater at internal locations and discharges to the Cuyahoga River.

Site Description

The BASF site is located approximately 3.5 miles southwest of downtown Cleveland, Ohio. It is situated along the western bank of the Cuyahoga River, just north of its confluence with Big Creek. Harvard Avenue splits the property into a north and south section. The BASF property consists of approximately 24.46 acres and is comprised of four parcels (2, 3, 4 and 5) (Figure 1). Parcel 2 is approximately 4.37 acres in size and is currently a vacant lot. Parcel 3 is approximately 18.94 acres in size and includes seven remaining buildings. The current buildings within Parcel 3 include a warehouse (Building W-1), former foundry (Building F-1), former boiler house (Building B-1), groundwater recovery and treatment system building, garage, former hydrogen fluoride plant wastewater treatment system (Building H-10), and former scale house. Parcel 4 is approximately 0.87 acres in size and Parcel 5 is approximately 0.28 acres in size: both are currently vacant lots. The BASF site also includes a structure referred to as Building G-1 and the property occupied by Building G-1, which is owned by BGD Company, an affiliate of Chevron USA, Inc. This building is located in the north-central portion of Parcel 3 and shown on Figure 1 as the area marked with hatch marks.

The BASF site is the subject of response action by the USACE under the federal government's Formerly Utilized Sites Remedial Action Program (FUSRAP) and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Numerous other buildings that were once located at the Site for manufacturing have been demolished with oversight by the Nuclear Regulatory Commission (NRC), although most of the floor slabs remain. The locations of former and existing buildings are shown on Figure 1.

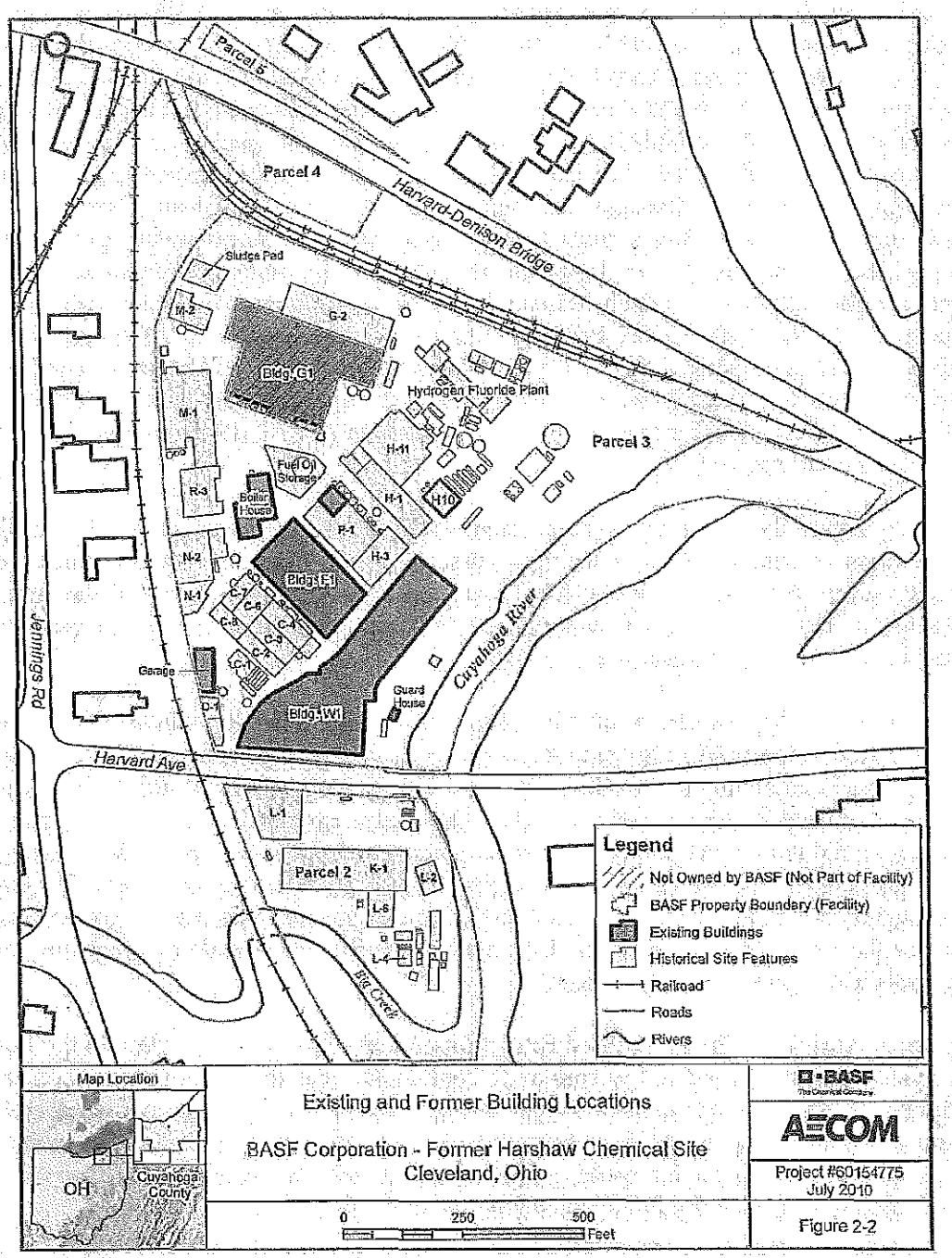

Figure 1 – Former Harshaw Chemical Site Diagram (drawing obtained from AECOM 6/17/2010 Report – *Draft Description of Current Conditions*)

In 1901, the Harshaw Chemical Company (Harshaw) became the original owner and operator of a 40-acre site. Harshaw conducted chemical manufacturing and processing of catalysts, inorganic fluorides, and metal finishing compounds. During the 1930s and 1940s, the U.S. government contracted with Harshaw to complete uranium research and enrichment at Building G-1 of the Site, in support of the government's Manhattan Project. Building G-1, the underlying

soil, and groundwater became, and remain, heavily contaminated with uranium and other radioactive contaminants. In 1977, the Gulf Oil Corporation ("Gulf") purchased Harshaw and Gulf became parent company to subsidiary Harshaw. In 1983, Gulf and the Kaiser Aluminum and Chemical Corporation ("Kaiser") entered into a partnership, and Harshaw remained the owner of the Site and the Gulf/Kaiser Partnership became the operator of the Site. Shortly thereafter, Chevron purchased Gulf and Chevron assumed Gulf's position in the Gulf/Kaiser Partnership. Historically, Harshaw was the permittee of several Clean Water Act NPDES permits for the Site, including permits for process wastewater, storm water, groundwater, and approximately eight outfalls. In 1988, the Engelhard Corporation purchased the entire Site, except for Building G-1, which remained owned and operated by the Chevron/Kaiser Partnership. In the early 1990s, BASF purchased the Site, except for Building G-1, which remained owned and operated by the Chevron/Kaiser Partnership. BASF never conducted any operations at the Site, except for a pump and treat system to remediate nickel contamination on the Site, pursuant to an Order from the State of Ohio. On April 1, 1998, the remaining NPDES permits for the Site expired.

In the early 2000s, the U.S. Congress delegated to the USACE the remediation of the radioactive contamination at Building G-1 of the Site pursuant to the Formerly Utilized Sites Remedial Action Program (FUSRAP). The USACE was funded for the investigation of the site through the Record of Decision. USACE had planned to begin remediation in 5 to 15 years, but this remained subject to tight budgetary constraints.

On March 30, 2010, Region 5 of EPA issued to BASF a RCRA 3008(h) Administrative Corrective Action Order (the Order) to remediate hazardous waste and hazardous constituents in all contaminated environmental media at the Site. The Order excluded Building G-1 of the Site, since it was owned by Chevron/Kaiser. The Order also excluded Building G-1 since RCRA contaminants did not include radioactive contaminants, and since the U.S. Congress delegated to USACE the radioactive remediation of the Site. There was also no evidence the radioactive contamination of Building G-1, or its underlying soil or groundwater, had migrated from those origins at the time. (BASF provided EPA with its RCRA RFI workplan pursuant to EPA's Order, and EPA is completing its review.)

On or about April 2010, BASF notified EPA it found radioactive contamination in the Pump and Treat System that it was ordered to employ to contain and remediate groundwater contaminated with nickel on the Site, pursuant to a State of Ohio Order. It is not known whether BASF's attempts to adjust its Pump and Treat System to reduce radioactive contamination in the system were successful. One objective of this sampling plan will be to determine whether the effluent from the treatment system is contaminated with radionuclides.

In 2011, the Land and Chemicals Division (Christine McConaghy) discovered a pipe (Outfall 007) on the Site discharging water into the Cuyahoga River. BASF and USACE stated they were unaware of the discharge. In May of 2011, USACE sampled the water from the pipe (Outfall 007) and found the discharge contained 141.65 pCi/L total/148.73 pCi/L dissolved uranium. In May of 2012, USACE sampled the water from Outfall 007 and found the discharge contained 43.18 pCi/L total uranium. In April of 2012, USACE sampled water in the storm sewer from Building G-1 to the Cuyahoga River and found high levels of uranium in the storm

sewer water near Building G-1 (2079 μg/L total/1855 μg/L dissolved), a decreased level of uranium in the storm sewer water at Outfall 007 (77.4 μg/L total/75.3 μg/L dissolved), and a further decreased level in the Cuyahoga River (41 μg/L total/18 μg/L dissolved).[1] Figure 2 is a site plan for the Outfall 007 drainage and process sewer system located at the BASF site.

Recently, USACE stated to EPA it had sampled the water from the pipe (Outfall 007) annually since at least 2008. However, USACE has not shared with EPA many details of the sampling events such as its quality assurance plan: notwithstanding repeated requests, and notwithstanding USACE's oral agreements to do so. Therefore, to date, EPA has no separate and independent information to confirm USACE's findings or to provide factual or legal conclusions with necessary confidence.

Project/Sampling Objectives

The objective is to confirm whether metals and/or radionuclides are being discharged into the Cuyahoga River from BASF property and whether the same pollutants are present in the Cuyahoga River. Sampling results will also be used to learn whether radionuclides are being drawn into BASF's recovery wells and subsequently being discharged from the nickel treatment system into the Northeast Ohio Regional Sewer District sewage system.

To satisfy these objectives, groundwater, wastewater, and ambient river water will be sampled at several locations as described below. The potential sampling locations are marked in Figure 3. Actual sampling locations will be recorded using a GPS device.

- Groundwater withdrawn by BASF's recovery wells that enters the water treatment system (i.e., pump and treat system influent) for total metals and radionuclides,
- Groundwater treated by BASF's nickel pump and treat system for total metals and radionuclides,
- Groundwater/wastewater in the sewer pipe on BASF's property at a location upgradient of the same pipe that discharges via Outfall 007, for total metals and radionuclides. Two potential locations are considered: BASF's former NPDES sampling station for Outfall 007 and a manhole over a sewer between the former NPDES sampling station and Outfall 007.
- Wastewater discharged from Outfall 007 for total metals and radionuclides, and
- River water in the immediate proximity of Outfall 007 for total metals and radionuclides.

Table 1 summarizes the sampling design. Samples will be collected as grab samples, and to the extent possible, they will be collected directly into the sample containers. Depending on the information gathered during the on-site evaluation, EPA personnel may need to modify the sampling locations and or approach in an effort to collect representative samples. Samples will be shipped to the National Air and Radiation Environmental Laboratory (NAREL) in Montgomery, Alabama for analysis.

In additional to collecting samples for laboratory analysis as shown in Table 1, the field team

[1] μg/L can be converted to pCi/L by multiplying by 0.67

will take measurements for pH, conductivity, and temperature at each sampling location. If BASF or USACE request to split samples, EPA will collect the split samples for them.

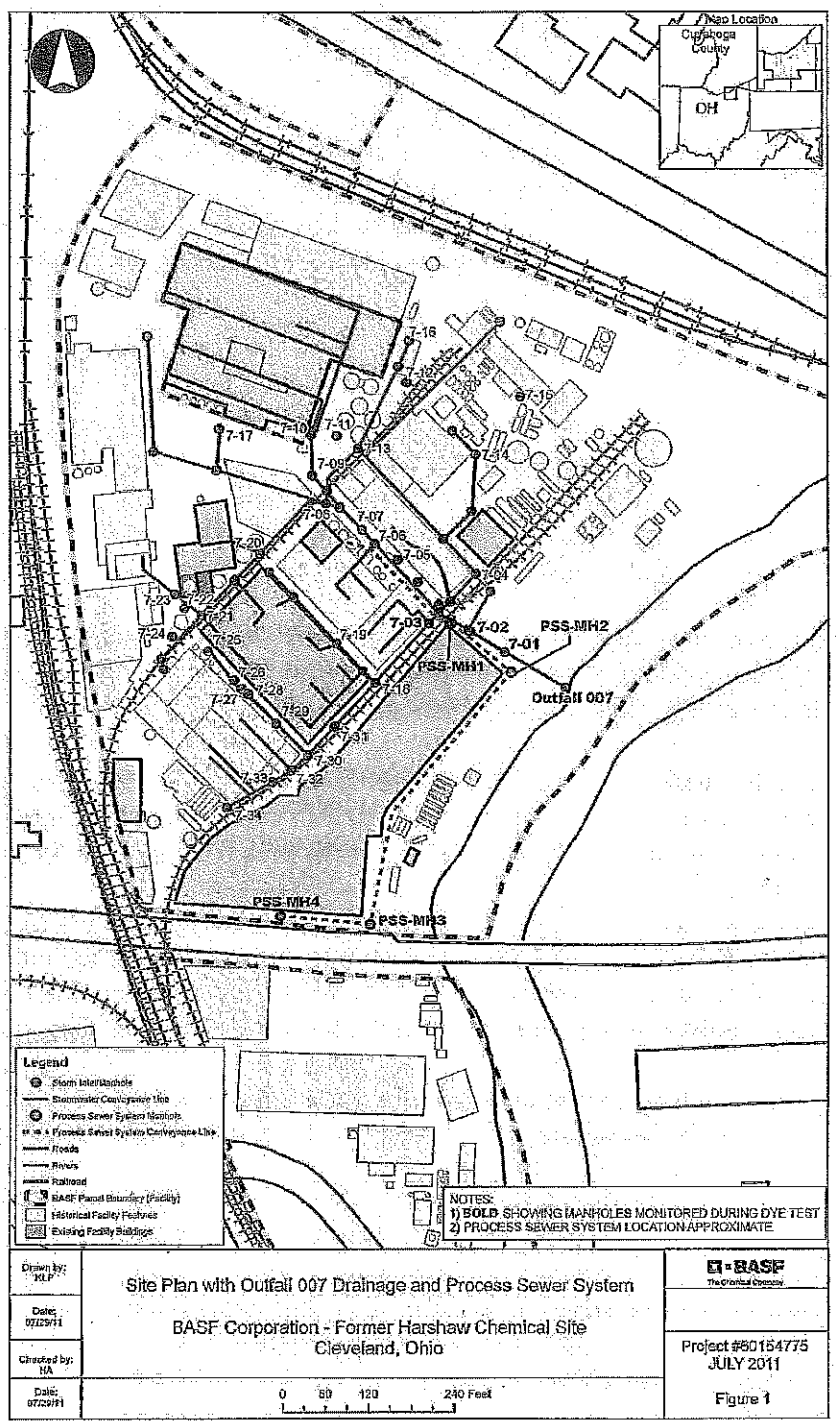

Figure 2 - Outfall 007 Drainage and Process Sewer System (drawing obtained from AECOM 10/20/11 memo)

Table 1. Proposed Sampling Design

Date[1]	Location[2]	Parameters	Analytical Method[3]	Container & Volume[4]	Preservation[5]
Week 1	A: BASF nickel pump and treat system inlet	Total Metals	NAREL SOP	HDPE 500 mL	None
		Ra-226	NAREL Ra226-Eichrom	HDPE 4 L	
		Ra-228	NAREL Ra-05		
		Uranium-234, 235, and 238	NAREL U-Eichrom		
		Thorium-230 and 232	NAREL Th-Eichrom		
Week 1	B: BASF nickel pump and treat system outlet	Total Metals	NAREL SOP	HDPE 500 mL	None
		Ra-226	NAREL Ra226-Eichrom	HDPE 4 L	
		Ra-228	NAREL Ra-05		
		Uranium-234, 235, and 238	NAREL U-Eichrom		
		Thorium-230 and 232	NAREL Th-Eichrom		
Week 1 & 2	C: BASF's former NPDES monitoring station for Outfall 007	Total Metals	NAREL SOP	HDPE 500 mL	None
		Ra-226	NAREL Ra226-Eichrom	HDPE 4 L	
		Ra-228	NAREL Ra-05		
		Uranium-234, 235, and 238	NAREL U-Eichrom		
		Thorium-230 and 232	NAREL Th-Eichrom		
Week 1 & 2	D: Outfall 007	Total Metals	NAREL SOP	HDPE 500 mL	None
		Ra-226	NAREL Ra226-Eichrom	HDPE 4 L	
		Ra-228	NAREL Ra-05		
		Uranium-234, 235, and 238	NAREL U-Eichrom		
		Thorium-230 and 232	NAREL Th-Eichrom		
Week 1	Cuyahoga River adjacent to Outfall 007	Total Metals	NAREL SOP	HDPE 500 mL	None
		Ra-226	NAREL Ra226-Eichrom	HDPE 4 L	
		Ra-228	NAREL Ra-05		
		Uranium-234, 235, and 238	NAREL U-Eichrom		
		Thorium-230 and 232	NAREL Th-Eichrom		

Date[1]	Location[2]	Parameters	Analytical Method[3]	Container & Volume[4]	Preservation[5]
Week 1 or 2	Field QC samples (trip blank & duplicate)	Total Metals	NAREL SOP	HDPE 500 mL	None
		Ra-226	NAREL Ra226-Eichrom	HDPE 4 L	
		Ra-228	NAREL Ra-05		
		Uranium-234, 234, and 238	NAREL U-Eichrom		
		Thorium-230 and 232	NAREL Th-Eichrom		

[1]Week 1 is October 23, 2013, with October 24 as a back-up date. Week 2 is October 29, 2013, with October 30 and 31 as back-up dates.
[2]See Figure 3 for map locations.
[3]The NAREL SOP for total recoverable metals is based on EPA SW-846 Method 6020A, Revision 1 (Inductively Coupled Plasma - Mass Spectrometry). The digestion procedure to solubilize analytes in suspended material is based on SW-846 Method 3015A, Revision 1.
[4]One extra container of sample is required for laboratory QC analyses for metals and radionuclides for the project.
[5]Field preservation is not required. NAREL will acidify samples prior to analysis.

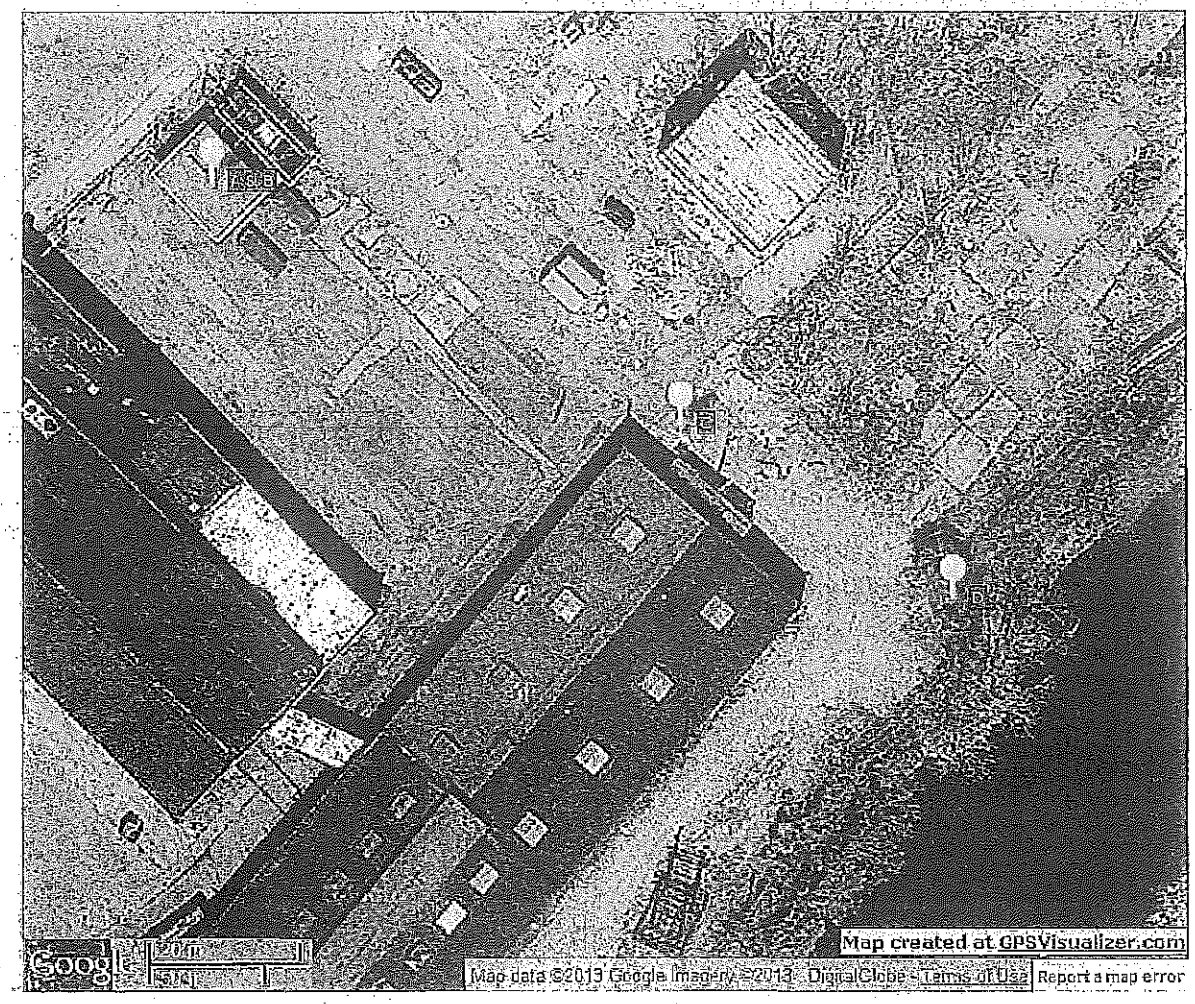

Figure 3 – Map of Proposed Sampling Locations

Sample Packaging and Transport

Samples will be shipped in coolers. Individual sample containers will be packaged to prevent spillage by placing them in leak-tight plastic bags, and then filling cooler voids with packing media. A chain of custody form will be placed inside a leak-tight bag and put in one of the sample coolers. Sample coolers will be taped shut, and custody seals will be placed at opposite corners of the coolers. Alternatively, the samples may be placed in a single plastic garbage bag inside a cooler with a custody seal taped on the closure. Samples will be shipped by UPS for next day delivery. Cindy White, Analytical Services Coordinator for NAREL, must be notified when the samples are shipped.

Sampling Plan Modification

This sampling plan is subject to modification depending upon conditions encountered in the field and other circumstances.

Contact Information during this Sampling Project

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Mark Conti
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NAREL Personnel

Cindy White	334-270-7052 (office) white.cindy@epa.gov

Attachments

NAREL Analytical Request Form