The results set forth herein are provided by SGS North America Inc.

Technical Report for

Hydro-Environmental Technology, Inc.
8060.00 Indigo-Desoto Parish, LA

SGS Job Number:  LA47396X

Sampling Dates: 09/04/18 - 09/05/18

Report to:

Hydro-Environmental Technology
P.O. BOX 60295
Lafayette, LA 70596
labdata@hetinc.us

ATTN: Stewart L Stover, Jr.

Total number of pages in report: 250

Test results contained within this data package meet the requirements of the National Environmental Laboratory Accreditation Program and/or state specific certification programs as applicable.

Client Service contact: Ralph Frye  337-237-4775

Certifications: LDEQ (2048), LDHH (LA 150012), AR (14-045-04), AZ (AZ 0805), FL (E 87657), IL (200082), KY (#31), NC (487), SC (73004001), NJ (LA 007), TX (T104704186-15-7), WV (257)

This report shall not be reproduced, except in its entirety, without the written approval of SGS.
Test results relate only to samples analyzed.

SGS North America Inc. • 500 Ambassador Caffery • Scott, LA 70583 • tel: 337-237-4775

Please share your ideas about how we can serve you better at: EHS.US.CustomerCare@sgs.com
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## Sample Summary

**Hydro-Environmental Technology, Inc.**

8060.00 Indigo-Desoto Parish, LA

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Subcontract Lab Data

Report of Analysis
SGS NORTH AMERICA INC.

LA47396X

STANDARD LEVEL IV
REPORT OF ANALYSIS

WORK ORDER #18-09016-OR

October 17, 2018

EBERLINE ANALYTICAL/OAK RIDGE LABORATORY
OAK RIDGE, TN
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Date package approved by: 

Laboratory Manager:

Date:

Copy No. 0003
SECTION I

CHAIN OF CUSTODY
& pH CHECK
# Chain of Custody

## Client / Reporting Information
- **Company Name:** SGS North America Inc.
- **Project Name:** 80650.00 Indigo-Desoto Parish, LA

## Project Information
- **Street Address:** 500 Ambassador Caftery Parkway
- **City:** Scott
- **State:** LA
- **Zip:** 70883

## Project Contact
- **Phone #:** 600-334-5227
- **Fax #:** 600-334-5227

## Sample(s) Name(s)
- **Sample(s):** KCLLV

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## Turnaround Time (Business days)
- **4**

## Data Delinier Information
- **Comments / Special Instructions:**
  - Commercial "A" = Results Only
  - Commercial "B" = Results + QC Summary

- **Emergency Rush:** Date 10/1/2018

## Sample Custody must be documented below each time samples change possession, including courier delivery:

### Sample # 1
- **Date & Time:** 10/02/18
- **Received By:**
- **Replenished By:**
- **Held By:**
- **Date Time:**
- **Replenished By:**
- **Held By:**
- **Date Time:**

### Sample # 2
- **Date & Time:**
- **Received By:**
- **Replenished By:**
- **Held By:**
- **Date Time:**
- **Replenished By:**
- **Held By:**
- **Date Time:**

### Sample # 3
- **Date & Time:**
- **Received By:**
- **Replenished By:**
- **Held By:**
- **Date Time:**
- **Replenished By:**
- **Held By:**
- **Date Time:**

### Sample # 4
- **Date & Time:**
- **Received By:**
- **Replenished By:**
- **Held By:**
- **Date Time:**
- **Replenished By:**
- **Held By:**
- **Date Time:**

### Sample # 5
- **Date & Time:**
- **Received By:**
- **Replenished By:**
- **Held By:**
- **Date Time:**
- **Replenished By:**
- **Held By:**
- **Date Time:**
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**Work Order #** 18-09016  
**Lab Deadline** 9/26/2018  
**Analysis** Ra226 - Level 4  
**Sample Matrix** Water
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0009

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Use container #3 for TDS

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SECTION II

SAMPLE ACKNOWLEDGEMENT
2

0013
17 of 250
LA47396X


**Eberline Services  Oak Ridge Laboratory**

**SAMPLE RECEIPT CHECKLIST**

**MP-001-2**

**WORK ORDER #**  18 09016

**SAMPLE MATRIX/MATRICES:**

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<td>If aqueous, properly preserved</td>
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**WERE CHAIN OF CUSTODY SEALS:**

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<tr>
<td>Unbroken on outside of package?</td>
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</tr>
<tr>
<td>Present on samples?</td>
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<tr>
<td>Unbroken on samples?</td>
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<tr>
<td>Was chain of custody present upon sample receipt?</td>
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IF THE RESPONSE TO ANY OF THE ABOVE IS NO, A DISCREPANT SAMPLE RECEIPT REPORT (DSR) HAS BEEN ISSUED.

**REMARKS:**

__________________________

__________________________

__________________________

**SIGNATURE:** __________________________

**DATE:** 9-7-18

Copy No. 0014

Radiochemistry Services
SECTION III
CASE NARRATIVE
CASE NARRATIVE
LA Certificate #05005
Work Order # 18-09016-OR

SAMPLE RECEIPT

This work order contains ten water samples received 09/07/2018. Samples were analyzed for Radium-226/228 and Total Dissolved Solids.

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ANALYTICAL METHODS

Radium-226 was analyzed using EPA Method 903.0 Modified. Radium-228 was analyzed using EPA Method 904.0. Total Dissolved Solids were performed using Standard Methods 2540C.

ANALYTICAL RESULTS

Combined Standard Uncertainty is reported at 1-sigma value.

Minimum Detectable Activity (MDA) values for data represented in this report are sample-specific. MDA measurements are determined based on factors and conditions including instrument settings, aliquot size and matrix type.

RADIUM-226

Samples were prepared by removing representative aliquots followed by mixed acid digestions as appropriate. This was followed by precipitations of Radium/Barium Sulfate. Precipitates were dissolved in alkaline EDTA. Radium was selectively precipitated and then mounted on micro-porous filter media. Samples were counted by alpha spectroscopy using an energy specific region of interest for Radium-226. Inherent self-absorption from elemental Barium was corrected for in the final result. Chemical recovery was calculated by the use of a Barium-133 tracer, which was determined by HPGe gamma spectroscopy.
ANALYTICAL RESULTS CONTINUED
RADIUM-226 CONTINUED

Samples demonstrated acceptable results for all Radium-226 analyses. Chemical recovery was acceptable for all samples. The Radium-226 method blank demonstrated an acceptable result. Results for the Radium-226 duplicate demonstrated a high relative percent difference; however, normalized difference is within acceptable limits for the analytical technique. Results for the Radium-226 laboratory control sample demonstrated an acceptable percent recovery.

RADIUM-228

Following alpha spectroscopy analysis of Radium-226, Barium/Radium Sulfate precipitates were redissolved and allowed for sufficient ingrowth of the Actinium-228 daughter. After ingrowth, Actinium-228 was selectively precipitated. Precipitates were filtered and beta emissions for Actinium-228 were then counted on a gas proportional counter. Chemical recovery was determined by the use of a Barium-133 tracer, the activity of which was determined by HPGe gamma spectroscopy and an elemental Yttrium carrier by gravimetric measurements. The product of these two recoveries was used to calculate chemical yield.

Samples demonstrated acceptable results for all Radium-228 analyses. Chemical recovery was acceptable for all samples. The Radium-228 method blank demonstrated an acceptable result. Results for the Radium-228 duplicate demonstrated a high relative percent difference; however, normalized difference is within acceptable limits for the analytical technique. Results for the Radium-228 laboratory control sample demonstrated an acceptable percent recovery.

TOTAL DISSOLVED SOLIDS (TDS)

A volumetric aliquot of each sample was filtered through a tared 0.45µm filter media into a tared 250ml beaker. Samples were dried on a hot plate and were allowed to cool. The TDS content was determined by reweighing tared beakers.

Samples demonstrated Total Dissolved Solids contents that ranged from 6.0 to 834.0 mg/L.

CERTIFICATION OF ACCURACY

I certify that this data report is in compliance with the terms and conditions of the Purchase Order, both technically and for completeness, for other than the conditions detailed above. Release of the data contained in this hard copy data package has been authorized by the cognizant project manager or his/her designee to be accurate as verified by the following signature.

M.R. McDougall
Laboratory Manager
Date: 10/17/2018

Eberline Analytical wants and encourages your feedback regarding our performance providing radioanalytical services. Please visit http://eberlineanalytical.com/ to provide us with feedback on our services.
SECTION IV

ANALYTICAL RESULTS SUMMARY
# Eberline Analytical
## Final Report of Analysis

### Lab ID | Sample Type | Client ID | Sample Date | Receipt Date | Analysis Date | Batch ID | Analyte | Method | Result | CU | CSU | MDA | Report Units |
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### Notes
- **CU** = Counting Uncertainty
- **CSU** = Combined Standard Uncertainty (1-sigma)
- **MDA** = Minimal Detected Activity
- **LCS** = Laboratory Control Sample
- **MBL** = Blank
- **DUP** = Duplicate
- **TRG** = Normal Sample
- **DO** = Duplicate Original

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**Printed: 10/17/2018 1:00 PM**

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**Eberline Analytical Corporation**
601 Scarborough Road Oak Ridge, TN 37830
865/481-0683 FAX 865/483-4621
# Eberline Analytical

## Final Report of Analysis

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<td></td>
<td></td>
<td>mg/l</td>
</tr>
<tr>
<td>18-09016-08</td>
<td>TRG</td>
<td>GAMBLE RIG SUPPLY WELL</td>
<td>09/04/18 18:45</td>
<td>9/7/2018</td>
<td>9/8/2018</td>
<td>18-09016</td>
<td>TDS</td>
<td>SM2540C</td>
<td>8.26E+02</td>
<td>mg/l</td>
<td></td>
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<td>mg/l</td>
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<tr>
<td>18-09016-09</td>
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<td>FIELD DUPLICATE</td>
<td>09/04/18 18:35</td>
<td>9/7/2018</td>
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<td>18-09016</td>
<td>TDS</td>
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<tr>
<td>18-09016-10</td>
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<td>9/7/2018</td>
<td>9/8/2018</td>
<td>18-09016</td>
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<td>2.22E+02</td>
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<tr>
<td>18-09016-11</td>
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<td>BRYANT POND 7</td>
<td>09/05/18 11:15</td>
<td>9/7/2018</td>
<td>9/8/2018</td>
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<td>mg/l</td>
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<td>9/7/2018</td>
<td>9/8/2018</td>
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<td>TDS</td>
<td>SM2540C</td>
<td>3.01E+02</td>
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<tr>
<td>18-09016-13</td>
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<td>09/04/18 10:40</td>
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<td>6.00E+00</td>
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<td></td>
<td></td>
<td>mg/l</td>
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</tbody>
</table>

**CU**=Counting Uncertainty; **CSU**=Combined Standard Uncertainty (1-sigma); **MDA**=Minimal Detected Activity; **LCS**=Laboratory Control Sample; **MBL**=Blank; **DUP**=Duplicate; **TRG**=Normal Sample; **DO**=Duplicate Original
SECTION V

ANALYTICAL STANDARD
Certificate

Standard Reference Material 4251C
Barium-133 Radioactivity Standard

This Standard Reference Material (SRM) consists of radioactive barium-133 chloride, non-radioactive barium chloride, and hydrochloric acid dissolved in 5 mL of distilled water. The solution is contained in a flame-sealed NIST borosilicate-glass ampoule. The SRM is intended for the calibration of ionization chambers and solid-state gamma-ray spectrometry systems.

Radiological Hazard

The SRM ampoule contains barium-133 with a total activity of approximately 2.5 MBq. Barium-133 decays by electron capture and during the decay process X-rays and gamma-rays with energies from 4 to 400 keV are emitted. Most of these photons escape from the SRM ampoule and can represent a radiation hazard. Approximate unshielded dose rates at several distances (as of the reference time) are given in note [a]*. Appropriate shielding and/or distance should be used to minimize personnel exposure. The SRM should be used only by persons qualified to handle radioactive material.

Chemical Hazard

The SRM ampoule contains hydrochloric acid (HCl) with a concentration of 1 mole per liter of water. The solution is corrosive and represents a health hazard if it comes in contact with eyes or skin. If the ampoule is to be opened to transfer the solution, the recommended procedure is given on page 2. The ampoule should be opened only by persons qualified to handle both radioactive material and strong acid solution.

Storage and Handling

The SRM should be stored and used at a temperature between 5 and 65 °C. The solution in an unopened ampoule should remain stable and homogeneous until at least June 2004.

The ampoule (or any subsequent container) should always be clearly marked as containing radioactive material. If the ampoule is transported it should be packed, marked, labeled, and shipped in accordance with the applicable national, international, and carrier regulations. The solution in the ampoule is a dangerous good (hazardous material) both because of the radioactivity and because of the strong acid.

Preparation

This Standard Reference Material was prepared in the Physics Laboratory, Ionizing Radiation Division, Radioactivity Group, J.M.R. Hutchinson, Group Leader. The overall technical direction and physical measurements leading to certification were provided by L.L. Lucas of the Radioactivity Group and D.B. Golas, Nuclear Energy Institute Research Associate.

The support aspects involved in the preparation, certification, and issuance of this SRM were coordinated through the Standard Reference Materials Program by N.M. Trahey.

Gaithersburg, Maryland 20899
October 1994

Thomas B. Gills, Chief
Standard Reference Materials Program

SRM 4251C, page 1 of 6

*Notes and references are on pages 5 and 6.
QUALITY CONTROL PROGRAM
QCP-099

EBERLINE SERVICES - OAK RIDGE LABORATORY
RADIOACTIVE REFERENCE SOLUTIONS
PRIMARY DILUTION RECERTIFICATION
QCP 099-1

SOLUTION REFERENCE # | NIST SRM4251C | SOLUTION # | Ba-6
--- | --- | --- | ---

Principal Radionuclide | Half Life, Years | 1.048E+01 | Half Life, Days | 3.828E+03
--- | --- | --- | --- | ---

Radionuclide | Certified Activity | μCi | Certified Concentration | 1.318E+01 μCi per gram
--- | --- | --- | --- | ---

Ampoule /Solution Gross | Weight, Grams | 9.3081
Empty Ampoule | Weight, Grams | 4.2582
Solution Net | Weight, Grams | 5.0499

Total Activity in Ampoule | 66.5577 μCi

Chemical Composition of Standard Solution

\[ { }^{133}\text{BaCl}_2 \text{ in 1M HCl} \]

Dilution Instructions:

Dilute to a volume of 1000.00 milliliters

Dilution Solvent Used | 1M HCl
--- | ---

Certified Total Activity of 66.5577 μCi Which Equals 1.478E+08 dpm at the date listed above

And after dilution the activity of this solution is 1.478E+05 dpm/ml

Expiration Date: April 26, 2019

Verified & Approved By

Date: 5/5/18

QC Approval

Date: 5/5/18
QUALITY CONTROL PROGRAM
QCP-009

EBERLINE SERVICES - OAK RIDGE LABORATORY
RADIOACTIVE REFERENCE STANDARD SOLUTIONS
SECONDARY DILUTION RECERTIFICATION

QCP-009-1-A
Solution Reference # NIST SRM251C
Solution # Ba-6a

Date 5/5/18

Principal Radionuclide

133Ba

Half Life, Years 1.048E+01

Half Life, Days 3.828E+03

Radionuclide of Interest 133Ba
Parent Solution Conc. 1.48E+05 dpm/ml

Reference Date 9/1/1993 0:00

Chemical Composition of Standard Solution
133BaCl2 in 1M HCl

Dilution Instructions: Dilution Solvent Used 1M HCl

SECONDARY VOLUMETRIC DILUTION

Vol. Parent Solution: 25.0000 ml
Total Activity: 3.8950E+06 dpm
Final Activity Concentration: 3.6950E+03 dpm/ml
Final Volume: 1000.00 ml

This activity concentration is based on the original reference date listed above. All activities are corrected to the date and time of analysis by the laboratory data processing software.

NOTES:

Expiration Date: April 26, 2019

Verified & Approved By

Date: 5/5/18

QC Approval

Date: 5/5/18

0024
CERTIFICATE OF CALIBRATION
ALPHA STANDARD SOLUTION

Radionuclide: Ra-226
Half Life: 1600 ± 7 years
Catalog No.: 7226
Source No.: 453-26
Customer: TMA EBERLINE
P.O.No.: VH1888
Reference Date: February 1, 1994
12:00 PST.

Contained Radioactivity: (Ra-226) 1.001 µCi.

Description of Solution
a. Mass of solution: 5.1864 g (in a 5 ml Flame Sealed Ampoule)
b. Chemical form: Ra(NO3)2 in 1 N HNO3
c. Carrier content: None added
d. Density: 1.0318 g/ml @ 20°C.

Radioimpurities
None detected (other than daughters)

Radioactive Daughters

Radionuclide Concentration
(Ra-226) 0.1929 µCi/g.

Method of Calibration
Weighed aliquots of the solution were assayed using gamma spectrometry:
Energy peak(s) integrated under: 186 keV.
Branching ratio(s) used: 0.0351 gamma rays per decay.

Uncertainty of Measurement
a. Systematic uncertainty in instrument calibration: ±3.4%
b. Random uncertainty in assay: ±3.1%
c. Random uncertainty in weighing(s): ±0.2%
d. Total uncertainty at the 99% confidence level: ±4.6%

NIST Traceability
This calibration is implicitly traceable to the National Institute of Standards and Technology.

Leak Test(s)
See reverse side for Leak Test(s) applied to this source.

Notes
1. Nuclear data were taken from "Table of Radioactive Isotopes", edited by Virginia S. Shirley, 1986.
2. IPL participates in an NIST measurement assurance program to establish and maintain implicit traceability for a number of radionuclides, based on the blind assay (and later NIST certification) of Standard Reference Materials (As in NRC Regulatory Guide 4.15).

QUALITY CONTROL
Feb. 3, 1994

Date Signed

ISOTOPE PRODUCTS LABORATORIES
1800 North Keystone Street
Turbank, California 91504
(818) 843 - 7000
## QUALITY CONTROL PROGRAM

**MP 009**

Rev. 8, 11/01/03
Title: Radioactive Reference Standards Solutions & Records

### EBERLINE SERVICES - OAK RIDGE LABORATORY

**RADIOACTIVE REFERENCE SOLUTIONS**

**PRIMARY DILUTION RECERTIFICATION**

**MP 009**

<table>
<thead>
<tr>
<th>SOLUTION REFERENCE #</th>
<th>CURRENT DATE</th>
<th>SOLUTION #</th>
</tr>
</thead>
<tbody>
<tr>
<td>IPL 453-26</td>
<td>9/17/2018 0:00</td>
<td>Ra-5</td>
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</table>

<table>
<thead>
<tr>
<th>Principal Radionuclide</th>
<th>Half Life, Years</th>
<th>Half Life, Days</th>
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</thead>
<tbody>
<tr>
<td>226Radium</td>
<td>1.600E+03</td>
<td>5.844E+05</td>
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<table>
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<th>Radionuclide</th>
<th>Certified Activity</th>
<th>Certified Concentration</th>
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<tbody>
<tr>
<td>226Ra</td>
<td>1.001E+00 µCi</td>
<td>µCi per gram</td>
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</table>

<table>
<thead>
<tr>
<th>Reference Date</th>
<th>Weight, Grams</th>
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</thead>
<tbody>
<tr>
<td>2/1/1994</td>
<td></td>
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**Ampoule/Solution Gross**

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<thead>
<tr>
<th>Weight, Grams</th>
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</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

**Empty Ampoule**

<table>
<thead>
<tr>
<th>Weight, Grams</th>
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<tbody>
<tr>
<td></td>
</tr>
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</table>

**Solution Net**

<table>
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<tr>
<th>Weight, Grams</th>
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</thead>
<tbody>
<tr>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Total Activity in Ampoule</th>
<th>1.0010 µCi</th>
</tr>
</thead>
</table>

**Chemical Composition of Standard Solution**

<table>
<thead>
<tr>
<th>226Ra(NO3)2 in 1M HNO3</th>
</tr>
</thead>
</table>

**Dilution Instructions:**

<table>
<thead>
<tr>
<th>Dilution Solvent Used</th>
</tr>
</thead>
<tbody>
<tr>
<td>1M HNO3</td>
</tr>
</tbody>
</table>

Dilute to a volume of 1000.00 milliliters

**Certified Total Activity of**

<table>
<thead>
<tr>
<th>1.0010 µCi</th>
</tr>
</thead>
</table>

WhichEquals 2.222E+05 dpm at the date listed above

This activity concentration is based on the original reference data listed above. All activities are corrected to the date and time of analysis by the laboratory data processing software.

**And after dilution the activity of this solution is**

<table>
<thead>
<tr>
<th>2.222E+03 dpm/ml</th>
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</thead>
</table>

**Expiration Date:** September 10, 2019

**Verified & Approved By**

<table>
<thead>
<tr>
<th>Date: 9/17/2018</th>
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**QC Approval**

<table>
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<tr>
<th>Date: 9/18/18</th>
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</table>
## QUALITY CONTROL PROGRAM

**MP 009**

**Rev:** 8, 11/01/03  
**Title:** Radioactive Reference Standards Solutions & Records

### EBERLINE SERVICES - OAK RIDGE LABORATORY

#### RADIOACTIVE REFERENCE STANDARD SOLUTIONS

**SECONDARY DILUTION RECERTIFICATION**

<table>
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<td>Ra-5b</td>
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**Principle Radionuclide**

<table>
<thead>
<tr>
<th>226Radium</th>
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</thead>
</table>

**Half Life, Years**

| 1.600E+03 |

**Half Life, Days**

| 5.844E+05 |

**Radionuclide of Interest**

| 226Radium |

**Parent Solution Conc.**

| 2.22E+03 dpm/ml |

**Reference Date**

| 2/1/1994 0:00 |

### Chemical Composition of Standard Solution

**226Ra(NO₃)₂ in 1M HNO₃**

### Dilution Instructions:

**Dilution Solvent Used**

| 1M HNO₃ |

#### SECONDARY VOLUMETRIC DILUTION

**Vol. Parent Solution:**

| 20.0000 ml |

**Total Activity:**

| 4.4440E+04 dpm |

**Final Activity Concentration:**

| 4.4440E+01 dpm/ml |

**Final Volume:**

| 1000.00 ml |

**NOTES:**

This activity concentration is based on the original reference date listed above. All activities are corrected to the date and time of analysis by the laboratory data processing software.

**Expiration Date:**

| 10-Sep-19 |

**Verified & Approved By**

| [Signature]

**Date:**

| 9/17/2018 0:00 |

**QC Approval**

| [Signature]  
**Date:**

| 9/18/18 |
CERTIFICATE OF CALIBRATION
Standard Radionuclide Source

72325-207
Ra-228 5 mL Liquid in Flame Sealed Vial

This standard radionuclide source was prepared gravimetrically from a calibrated master solution. The master solution was calibrated using a germanium gamma spectrometer system.

Radionuclide purity and calibration were checked using a germanium gamma spectrometer system. The nuclear decay rate and assay date for this source are given below.

ANALYTICS maintains traceability to the National Institute of Standards and Technology through Measurements Assurance Programs as described in USNRC Reg. Guide 4.15, Revision 1.

ISOTOPE: Ra-228
ACTIVITY (dps): 4.022 E3
HALF-LIFE: 5.75 years
CALIBRATION DATE: February 10, 2006 12:00 EST
RELATIVE EXPANDED UNCERTAINTY (k=2): 4.0%

Impurities: γ-impurities <0.1%
5.10721 grams 0.1M HCl solution with 50 μg/g Ba carrier.
P O NUMBER 00003181, Item 1

SOURCE PREPARED BY: M. Taskaeva, Radiochemist

QA APPROVED: M. M. 2/13/06
# QUALITY CONTROL PROGRAM

**EBERLINE SERVICES - OAK RIDGE LABORATORY**

**RADIOACTIVE REFERENCE SOLUTIONS**

**INITIAL DILUTION**

**MP 009**

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<tr>
<th>Principal Radionuclide</th>
<th>Half Life, Years</th>
<th>Half Life, Days</th>
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</thead>
<tbody>
<tr>
<td>$^{238}$Ra</td>
<td>5.750E+00</td>
<td>2.100E+03</td>
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<table>
<thead>
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<th>Radionuclide</th>
<th>Certified Activity</th>
<th>Certified Concentration</th>
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</thead>
<tbody>
<tr>
<td>$^{238}$Ra</td>
<td>1.087E-01 µCi</td>
<td>µCi per gram</td>
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</table>

<table>
<thead>
<tr>
<th>Ampoule /Solution Gross</th>
<th>Weight, Grams</th>
<th>Empty Ampoule</th>
<th>Weight, Grams</th>
<th>Solution Net</th>
<th>Weight, Grams</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.9858</td>
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<td>5.0883</td>
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<table>
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<tr>
<th>Total Activity in Ampoule</th>
<th>µCi</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>0.1087</td>
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**Chemical Composition of Standard Solution**

$^{238}$Ra(NO$_3$)$_2$ in 0.5 M HCl

**Dilution Instructions:**

Dilute to a volume of **991.00 Kg**

**Dilution Solvent Used:**

0.5 M HCl

**Certified Total Activity of**

0.1087 µCi

**Which Equals**

2.413E+05 dpm at the date listed above

**And after dilution the activity of this solution is**

2.435E+02 dpm/ml

**Expiration Date:** February 12, 2019

**Recertified By**

*Signature*

**Date:** 2/12/18

**Date:** 2/13/18

**QC Approval**

*Signature*

**Date:** 2/13/18
SECTION VI
QUALITY CONTROL SAMPLE RESULTS SUMMARY
<table>
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<tr>
<th>Analyte</th>
<th>LCS Measured</th>
<th>CSU Measured</th>
<th>LCS Expected</th>
<th>Uncert. Expected</th>
<th>Known</th>
<th>Known Error</th>
<th>Result</th>
<th>CSU</th>
<th>Standard ID</th>
<th>Standard ACT (dpm)</th>
<th>Standard Error</th>
<th>Standard Added (g)</th>
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<tbody>
<tr>
<td>RA-226</td>
<td>98.76%</td>
<td>25.18%</td>
<td>100.00%</td>
<td>4.60%</td>
<td>1.01E+01</td>
<td>4.65E-01</td>
<td>9.99E+00</td>
<td>2.52E+00</td>
<td>Ra-5b</td>
<td>4.40E+01</td>
<td>4.60E+00</td>
<td>5.11E-01</td>
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### Matrix Spike

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Normalized Difference</th>
<th>MS Actual % Rec</th>
<th>Expected MS Result</th>
<th>Expected MS Uncert</th>
<th>Actual MS Result</th>
<th>Actual MS CSU</th>
<th>Sample Result</th>
<th>Sample CSU</th>
<th>Sample Aliquot</th>
<th>Standard ID</th>
<th>Standard ACT (dpm)</th>
<th>Standard Error %</th>
<th>Standard Added (g)</th>
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### Duplicate Results

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<tr>
<th>Analyte</th>
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<th>RPD</th>
<th>Original Result</th>
<th>Original CSU</th>
<th>Duplicate Result</th>
<th>Duplicate CSU</th>
<th>LCS Relative Bias</th>
<th>LCS % R</th>
<th>MS % R</th>
<th>MS ND</th>
<th>Rep RPD</th>
<th>Rep ND</th>
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<tbody>
<tr>
<td>RA-226</td>
<td>1.55</td>
<td>314.19</td>
<td>1.20E-01</td>
<td>1.73E-01</td>
<td>-2.66E-02</td>
<td>6.60E-02</td>
<td>0.99</td>
<td>OK</td>
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<td></td>
</tr>
</tbody>
</table>
Eberline Analytical
Analysis Control Chart

WO  | Analysis | Run | Activity Units | Aliquot Units | Client Name
--- | --- | --- | --- | --- | ---
18-09016 | Ra226 | 1 | pCi | 1 | SGS North America Inc.

LCS % Recovery

Replicate Sample RPD

Normalized Difference

No Matrix Spike

Version 2
### Laboratory Control Sample

<table>
<thead>
<tr>
<th>Analyte</th>
<th>LCS Measured</th>
<th>CSU Measured</th>
<th>LCS Expected</th>
<th>Uncert. Expected</th>
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<th>Known Error</th>
<th>Result</th>
<th>CSU</th>
<th>Standard ID</th>
<th>Standard ACT (dpm)</th>
<th>Standard Error</th>
<th>Standard Added (g)</th>
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</thead>
<tbody>
<tr>
<td>RA-228</td>
<td>113.37%</td>
<td>23.94%</td>
<td>100.00%</td>
<td>5.10%</td>
<td>9.01E+00</td>
<td>4.60E-01</td>
<td>1.02E+01</td>
<td>2.45E+00</td>
<td>Ra-12</td>
<td>5.33E+01</td>
<td>5.10E+00</td>
<td>3.75E-01</td>
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### Matrix Spike

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Normalized Difference</th>
<th>MS Actual % Rec</th>
<th>Expected MS Result</th>
<th>Expected MS Uncert</th>
<th>Actual MS Result</th>
<th>Actual MS CSU</th>
<th>Sample Result</th>
<th>Sample CSU</th>
<th>Sample Aliquot</th>
<th>Standard ID</th>
<th>Standard ACT (dpm)</th>
<th>Standard Error %</th>
<th>Standard Added (g)</th>
</tr>
</thead>
</table>

<table>
<thead>
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<th>Analyte</th>
<th>Normalized Difference</th>
<th>RPD</th>
<th>Original Result</th>
<th>Original CSU</th>
<th>Duplicate Result</th>
<th>Duplicate CSU</th>
<th>LCS Relative Bias</th>
<th>LCS % R</th>
<th>MS % R</th>
<th>MS ND</th>
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<th>Rep ND</th>
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<tbody>
<tr>
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<td>123.45</td>
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<td>2.68E-01</td>
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SECTION VII

LABORATORY TECHNICIAN'S NOTES
RA-226 NOTES
<table>
<thead>
<tr>
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<th>Date</th>
<th>Dept</th>
<th>User</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>09/13/18 12:36</td>
<td>PREP</td>
<td>JHARVEY</td>
<td>ALIQUOTED AND ADDED SPIKES AND TRACERS- PHD SAMPLES- PRECIPITATED WITH BA AND PB CARRIERS AND AMMONIUM SULFATE- DECANTED SAMPLES AND CENTRIFUGED- SUBMITTED RADIUM PRECIP TO SEPARATIONS</td>
</tr>
</tbody>
</table>

9/13/18
<table>
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<tr>
<th>#</th>
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<th>User</th>
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<tbody>
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<td>1</td>
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<td>JHARVEY</td>
<td>ALIQUOTED AND ADDED SPIKES AND TRACERS TO PHD SAMPLES. PRECIPITATED WITH BA AND PB CARRIERS AND AMMONIUM Sulfate. DECANTED SAMPLES AND CENTRIFUGED. SUBMITTED RADIUM PRECIP TO SEPARATIONS.</td>
</tr>
<tr>
<td>2</td>
<td>09/18/18</td>
<td>CHEM</td>
<td>JBAILEY</td>
<td>ADDED EDTA TO SAMPLES AND LET SIT. ADDED AMMONIUM Sulfate AND ACETIC ACID TO SAMPLES. FILTERED ONTO TARED FILTER PAPERS, LET DRY UNDER HEAT LAMP, REWEIGHED, AND SUBMITTED TO COUNT.</td>
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</table>
**Reagents Used in an Analysis**

<table>
<thead>
<tr>
<th>Reagent ID</th>
<th>Reagent Name</th>
<th>Reagent Concentration</th>
<th>Analyst ID</th>
<th>Date Recorded</th>
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<td>9/13/2018</td>
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<tr>
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<td>9/13/2018</td>
</tr>
<tr>
<td>019792D06</td>
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</tr>
<tr>
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</tr>
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<tr>
<td>#</td>
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<td>Dept</td>
<td>User</td>
<td>Notes</td>
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JH
9/13/18
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<th>User</th>
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<tr>
<td>2</td>
<td>09/19/18</td>
<td>CHEM</td>
<td>JBAILEY</td>
<td>ADDED FILTER PAPERS FROM COUNT ROOM TO LABELED C-TUBES. FILLED WITH EDTA SOLUTION AND LET SIT OVERNIGHT. REMOVED FILTER FROM EDTA-ADDED 2MLS YTTRIUM 90MGML CARRIER ADDED 18N NAOH TO SAMPLES AND RECORDED T1. HOT BATHED FOR 15 MIN, CENTRIFUGED AND DISCARDED SUPERNANT. ADDED 1N HNO3, DI WATER, AND 10N NAOH. HOT BATHED FOR 15 MIN, CENTRIFUGED AND DISCARDED SUPERNANT. ADDED 1N HNO3, DI WATER, AND AMMONIUM OXALATE. FILTERED ONTO TARED FILTER PAPERS. LET DRY UNDER HEAT LAMP, REWEIGHED AND SUBMITTED TO COUNT.</td>
</tr>
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### Reagents Used in an Analysis

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<th>Reagent ID</th>
<th>Reagent Name</th>
<th>Reagent Concentration</th>
<th>Analyst ID</th>
<th>Date Recorded</th>
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<td>9/13/2018</td>
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<tr>
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<td>Barium Carrier</td>
<td>1 mg/ml</td>
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<tr>
<td>019767D01</td>
<td>Lead Carrier</td>
<td>166 mg/ml</td>
<td>JHARVEY</td>
<td>9/13/2018</td>
</tr>
<tr>
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<td>Nitric Acid</td>
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Run: 1
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<td>Daily Bkgd Lab</td>
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<td>B</td>
<td>KB</td>
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<tr>
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<tr>
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<td>User</td>
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<tr>
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<td>09/06/18</td>
<td>PREP</td>
<td>MIGHTOWER</td>
<td>Filtered sample into tared beaker, dried, re-weighed</td>
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Mh 9/6/18
SECTION VIII

ANALYTICAL DATA (RADİUM-226)
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<th>Sample Aliquot</th>
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<tr>
<td>03</td>
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<td>04</td>
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* SAF1 is used for Gross Alpha and all other radionuclides. SAF2 is used for Gross Beta only.  
^ Indicates estimated SAF value.  
** Actual mass exceeded the calibration curve range. Results should be qualified as appropriate.
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<th>Radiometric Tracer (pCi)</th>
<th>Radiometric % Rec</th>
<th>Grav Carrier Added (ml)</th>
<th>Grav Filter Tare (g)</th>
<th>Grav Filter Final (g)</th>
<th>Grav Filter Net (g)</th>
<th>Grav % Rec</th>
<th>Mean % Rec</th>
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* SAF1 is used for Gross Alpha and all other radionuclides. SAF2 is used for Gross Beta only.  
^ Indicates estimated SAF value.  
** Actual mass exceeded the calibration curve range. Results should be qualified as appropriate.
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* SAF1 is used for Gross Alpha and all other radionuclides. SAF2 is used for Gross Beta only.  ^ Indicates estimated SAF value.
** Actual mass exceeded the calibration curve range. Results should be qualified as appropriate.
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# Spike and Tracer Worksheet

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Version 2.0 06/99
# Aliquot Worksheet

**Work Order**: 18-09016  
**Run**: 1  
**Analysis Code**: Ra226  
**Rpt Units**: liters  
**Lab Deadline**: 9/26/2018  
**Technician**: JHARVEY

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**Comments**

**Technician**: [Signature]  
**Date**: 9/13/2018
## Gravimetric Worksheet

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Technician: [Signature]  Date: 9/18/2018
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Spectrum File: \OR-ALPHA\Canberra\ApexAlpha\Root\Data\00002225
Batch Identification: 1809016A-RA
Sample Identification: 01
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_039
Chamber Serial Number: 06027396A
Detector Serial Number: 83109
Env. Background: System Bkgd 225250
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 3.000E+000
Generic Div. Factor: 1.000E+000
Sample Date/Time: 9/18/2018 10:02:31 AM
Acquisition Date/Time: 9/18/2018 11:59:07 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1765 +/- 0.0031 on 2/16/2018 9:34:28 AM
Effective Efficiency: 0.1765 +/- 0.0031

Control Certificate Name: Ra226 Ra-5b
Chem. Recov. of Control: RA-226 0.329187 +/- 0.025005
Peak Match Tolerance: 0.350 MeV

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9/9/18
### Spectral Data Report

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Sample Description: BLANK
Spectrum File: \OR-ALPHA\Canberra\ApexAlpha\Root\Data\00002225
Batch Identification: 1809016A-RA
Sample Identification: 02
Sample Geometry: Shelf 2
Procedure Description: Ra
Detector Name: Alpha_040
Chamber Serial Number: 06027396B
Detector Serial Number: 91135
Env. Background: System bkgd 225251
Reagent Blank: <not performed>
Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 3.000E+000 Generic Div. Factor: 1.000E+000
Sample Date/Time: 9/18/2018 10:02:31 AM
Acquisition Date/Time: 9/18/2018 11:59:09 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes
Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1757 +/- 0.0031 on 2/16/2018 9:34:27 AM
Effective Efficiency: 0.1757 +/- 0.0031
Peak Match Tolerance: 0.350 MeV

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AG
9/19/18
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0067
Channel Data Report  9/18/2018  3:16:00 PM  Page 2

Sample Title: 02

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Sample Identification: 03  
Sample Geometry: Shelf 2  
Procedure Description: Ra  
Detector Name: Alpha_041  
Chamber Serial Number: 05026930A  
Detector Serial Number: 91087  
Env. Background: System Bkgd 225252  
Reagent Blank: <not performed>  
Sample Size: 1.000E+000 +/- 0.000E+000 liter  
Generic Mult. Factor: 2.230E+000  
Generic Div. Factor: 1.000E+000  
Sample Date/Time: 9/4/2018 10:02:31 AM  
Acquisition Date/Time: 9/18/2018 11:59:10 AM  
Acquisition Live Time: 170.0 minutes  
Acquisition Real Time: 170.0 minutes  
Chem. Recovery Factor: 1.0000 +/- 0.0000  
Counting Efficiency: 0.1885 +/- 0.0033 on 2/16/2018 9:34:24 AM  
Effective Efficiency: 0.1885 +/- 0.0033  
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Sample Title: 03
Sample Description: HANSON RELIEF WELL
Spectrum File: \OR-ALPHA\Canberra\ApexAlpha\Root\Data\00002225
Batch Identification: 1809016A-RA
Sample Identification: 04
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_042
Chamber Serial Number: 05026930B
Detector Serial Number: 84185
Env. Background: System Bkgd 225253
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 3.000E+000
Generic Div. Factor: 1.000E+000
Sample Date/Time: 9/4/2018 10:02:31 AM
Acquisition Date/Time: 9/18/2018 11:59:12 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes
Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1722 +/- 0.0030 on 2/16/2018 9:34:23 AM
Effective Efficiency: 0.1722 +/- 0.0030
Peak Match Tolerance: 0.350 MeV

----- PEAK AREA REPORT -----

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----- NUCLIDE ANALYSIS RESULTS -----

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AG 9/19/8
### Channel Data Report

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Sample Description: BILLINGSLEY RELIEF WELL
Spectrum File: \OR-ALPHA\Canberra\ApexAlpha\Root\Data\00002225
Batch Identification: 1809016A-RA
Sample Identification: 05
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_043
Chamber Serial Number: 04026481A
Detector Serial Number: 91068
Env. Background: System Bkgd 225254
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 2.370E+000  Generic Div. Factor: 1.000E+000
Sample Date/Time: 9/4/2018  10:02:31 AM
Acquisition Date/Time: 9/10/2018  11:59:14 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1903 +/- 0.0033 on 2/16/2018  9:34:21 AM
Effective Efficiency: 0.1903 +/- 0.0033

Peak Match Tolerance: 0.350 MeV

--- PEAK AREA REPORT ---

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--- NUCLIDE ANALYSIS RESULTS ---

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Ag 9/19/18

0080
Channel Data Report

Sample Title: 05
Elapsed Live time: 10200
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Spectrum File:  \OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00002225
Batch Identification:  1809016A-RA
Sample Identification:  06
Sample Geometry:  Shelf 2
Procedure Description:  Ra

Detector Name:  Alpha_044
Chamber Serial Number:  04026481B
Detector Serial Number:  84168
Env. Background:  System Bkgd 225255
Reagent Blank:  <not performed>

Sample Size:  1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor:  2.400E+000  Generic Div. Factor:  1.000E+000
Sample Date/Time:  9/4/2018  10:02:31 AM
Acquisition Date/Time:  9/18/2018  11:59:16 AM
Acquisition Live Time:  170.0 minutes
Acquisition Real Time:  170.0 minutes

Chem. Recovery Factor:  1.0000 +/- 0.0000
Counting Efficiency:  0.1840 +/- 0.0032 on 2/16/2018  9:34:19 AM
Effective Efficiency:  0.1840 +/- 0.0032

Peak Match Tolerance:  0.350 MeV

----- PEAK AREA REPORT -----

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AG 9/19/18
Sample Title: 06

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Sample Description: DRNISON RIG SUPPLY WELL
Spectrum File: \OR-ALPHA\Canberra\ApexAlpha\Root\Data\00002225
Batch Identification: 1809016A-RA
Sample Identification: 07
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_045
Chamber Serial Number: 04026482A
Detector Serial Number: 91131
Env. Background: System Bkgd 225256
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 2.470E+000  Generic Div. Factor: 1.000E+000
Sample Date/Time: 9/4/2018 10:02:31 AM
Acquisition Date/Time: 9/18/2018 11:59:18 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1735 +/- 0.0031 on 2/16/2018 9:34:18 AM
Effective Efficiency: 0.1735 +/- 0.0031

Peak Match Tolerance: 0.350 MeV

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Channel Data Report 9/18/2018 3:16:57 PM Page 3
Sample Description: GAMBLE RIG SUPPLY WELL
Spectrum File: \OR-ALPHA\Canberra\ApexAlpha\Root\Data\00002225
Batch Identification: 1809016A-RA
Sample Identification: 08
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha 046
Chamber Serial Number: 04026482B
Detector Serial Number: 58762
Env. Background: System Bkgd 225257
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Multi. Factor: 2.470E+000
Generic Div. Factor: 1.000E+000
Sample Date/Time: 9/4/2018 10:02:31 AM
Acquisition Date/Time: 9/10/2018 11:59:19 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1783 +/- 0.0031 on 2/16/2018 9:34:16 AM
Effective Efficiency: 0.1783 +/- 0.0031

Peak Match Tolerance: 0.350 MeV

--- PEAK ARENA REPORT ---

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0097
Channel Data Report  

9/18/2018  3:17:03 PM  

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### Channel Data Report

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Sample Description: FIELD DUPLICATE
Spectrum File: \OR-ALPHA\Canberra\ApexAlpha\Root\Data\00002225
Batch Identification: 1809016A-RA
Sample Identification: 09
Sample Geometry: Shelf 2
Procedure Description: Ra
Detector Name: Alpha_047
Chamber Serial Number: 10006125A
Detector Serial Number: 91086
Env. Background: System Bkgd 225258
Reagent Blank: <not performed>
Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 2.470E+000  Generic Div. Factor: 1.000E+000
Sample Date/Time: 9/4/2018 10:02:31 AM
Acquisition Date/Time: 9/18/2018 11:59:21 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes
Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1744 +/- 0.0030 on 6/6/2018 2:37:41 PM
Effective Efficiency: 0.1744 +/- 0.0030
Peak Match Tolerance: 0.350 MeV

----- PEAK AREA REPORT -----

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----- NUCLIDE ANALYSIS RESULTS -----

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0100
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Spectrum File: \OR-ALPHA\Canberra\ApexAlpha\Root\Data\00002225
Batch Identification: 1809016A-RA
Sample Identification: 10
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_048
Chamber Serial Number: 10006125B
Detector Serial Number: 83111
Env. Background: System Bkgd 225259
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 2.580E+000  Generic Div. Factor: 1.000E+000
Sample Date/Time: 9/5/2018 10:02:31 AM
Acquisition Date/Time: 9/18/2018 11:59:23 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1760 +/- 0.0030 on 6/6/2018 2:37:42 PM
Effective Efficiency: 0.1760 +/- 0.0030

Peak Match Tolerance: 0.350 MeV

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**NUCLEIDE ANALYSIS RESULTS**

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**9/18/2018  3:17:19 PM  Page 3**

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Spectrum File: \OR-ALPHA\Canberra\ApexAlpha\Root\Data\00002225
Batch Identification: 1809016A-RA
Sample Identification: 11
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_049
Chamber Serial Number: 10006121A
Detector Serial Number: 49
Env. Background: System Bkgd 225260
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 2.870E+000
Generic Div. Factor: 1.000E+000
Sample Date/Time: 9/5/2018 10:02:31 AM
Acquisition Date/Time: 9/18/2018 11:59:25 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1565 +/- 0.0028 on 2/16/2018 12:37:01 PM
Effective Efficiency: 0.1565 +/- 0.0028

Peak Match Tolerance: 0.350 MeV

---------- PEAK AREA REPORT ----------

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### Spectral Data Report

#### Sample Title: 11

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**Elapsed Real Time:** 10200

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0112
### Channel Data Report

**Sample Title:** 11

| Channel | 377 | 385 | 393 | 401 | 409 | 417 | 425 | 433 | 441 | 449 | 457 | 465 | 473 | 481 | 489 | 497 | 505 | 513 | 521 | 529 | 537 | 545 | 553 | 561 | 569 | 577 | 585 | 593 | 601 | 609 | 617 | 625 | 633 | 641 | 649 | 657 | 665 | 673 | 681 | 689 | 697 | 705 | 713 | 721 | 729 | 737 | 745 | 753 | 761 | 769 | 777 | 785 | 793 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
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**Date:** 9/18/2018  3:17:27 PM

**Page:** 2

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0113
Channel Data Report  
9/18/2018  3:17:27 PM  Page 3

Sample Title:  11

| Channel | 809 | 817 | 825 | 833 | 841 | 849 | 857 | 865 | 873 | 881 | 889 | 897 | 905 | 913 | 921 | 929 | 937 | 945 | 953 | 961 | 969 | 977 | 985 | 993 | 1001 | 1009 | 1017 |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
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0114
Sample Description: BRYANT POND 12
Spectrum File: \OR-ALPHA1\Canberra\ApexAlpha\Root\Data\00002225
Batch Identification: 1809016A-RA
Sample Identification: 12
Sample Geometry: Shelf 2
Procedure Description: Ra
Detector Name: Alpha_050
Chamber Serial Number: 10006121B
Detector Serial Number: 50
Env. Background: System Bkgd 225261
Reagent Blank: <not performed>
Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Mult. Factor: 2.820E+000 Generic Div. Factor: 1.000E+000
Sample Date/Time: 9/5/2018 10:02:31 AM
Acquisition Date/Time: 9/16/2018 11:59:27 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes
Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1369 +/- 0.0025 on 2/16/2018 12:37:00 PM
Effective Efficiency: 0.1369 +/- 0.0025
Peak Match Tolerance: 0.350 MeV

---------- PEAK AREA REPORT ----------

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---------- NUCLIDE ANALYSIS RESULTS ----------

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0115
Sample Title: 12

Elapsed Live time: 10200
Elapsed Real Time: 10200

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0117
Channel Data Report  9/18/2018  3:17:35 PM  Page 2

Sample Title:  12

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Sample Description: EQUIPMENT BLANK
Spectrum File: \\OR-ALPHA\Canberra\ApexAlpha\Root\Data\00002225
Batch Identification: 1809016A-RA
Sample Identification: 13
Sample Geometry: Shelf 2
Procedure Description: Ra

Detector Name: Alpha_051
Chamber Serial Number: 10006123A
Detector Serial Number: 51
Env. Background: System Bkgd 225274
Reagent Blank: <not performed>

Sample Size: 1.000E+000 +/- 0.000E+000 liter
Generic Multi. Factor: 2.340E+000  Generic Div. Factor: 1.000E+000
Sample Date/Time: 9/4/2018 10:02:31 AM
Acquisition Date/Time: 9/18/2018 11:59:20 AM
Acquisition Live Time: 170.0 minutes
Acquisition Real Time: 170.0 minutes

Chem. Recovery Factor: 1.0000 +/- 0.0000
Counting Efficiency: 0.1452 +/- 0.0026 on 2/16/2018 12:36:58 PM
Effective Efficiency: 0.1452 +/- 0.0026

Peak Match Tolerance: 0.350 MeV

--- PEAK AREA REPORT ---

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--- NUCLIDE ANALYSIS RESULTS ---

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APPROVED BY: __KP__

APPROVAL DATE: 9/18/18
Library Listing Report

6/12/12  12:16:17 PM

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****  LIBRARY LISTING REPORT ****
***************************************************************************************************************************************************************

Nuclide Library Title:  Radium

Nuclide Library Description:  Ra-226, Po-218, Rn-222

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* = key line

TOTALS:  3  Nuclides  3  Energy Lines
SECTION IX

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* SAF1 is used for Gross Alpha and all other radionuclides. SAF2 is used for Gross Beta only.  
** Indicates estimated SAF value.  
** Actual mass exceeded the calibration curve range. Results should be qualified as appropriate.
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** Actual mass exceeded the calibration curve range. Results should be qualified as appropriate.

^ Indicates estimated SAF value.
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* SAF1 is used for Gross Alpha and all other radionuclides. SAF2 is used for Gross Beta only.  
* Indicates estimated SAF value.  
** Actual mass exceeded the calibration curve range. Results should be qualified as appropriate.
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# Aliquot Worksheet

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- **Work Order**: 18-09016
- **Run**: 1
- **Analysis Code**: Ra228
- **Rpt Units**: liters
- **Lab Deadline**: 9/26/2018
- **Technician**: JHARVEY

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**Technician:**

**Date:** 9/13/18
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SECTION X

BARIUM-133 ANALYTICAL TRACER DATA
# GAMMA SPECTRUM ANALYSIS

Sample Identification: 1809016-01  
Sample Description: SPIKE  
Sample Type: RA RECOVERY  
Sample Size: 1.000E+00 units  
Facility: Countroom  
Sample Taken On: 9/18/2018 9:54:50AM  
Acquisition Started: 9/18/2018 10:32:22AM  
Procedure: BAFIL  
Operator: Administrator  
Detector Name: GE2  
Geometry: BAFIL  
Live Time: 900.0 seconds  
Real Time: 900.3 seconds  
Dead Time: 0.03 %  
Peak Locate Threshold: 2.50  
Peak Locate Range (in channels): 1 - 4096  
Peak Area Range (in channels): 28 - 4096  
Identification Energy Tolerance: 1.000 FWHM  
Energy Calibration Used Done On: 2/17/2018  
Efficiency Calibration Used Done On: 2/24/2018  
Efficiency Calibration Description:  
Sample Number: 71934

---

# PEAK ANALYSIS REPORT

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Peak Analysis From Channel: 1  
Peak Analysis To Channel: 4096

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M = First peak in a multiplet region  
 m = Other peak in a multiplet region  
 F = Fitted singlet  
 Errors quoted at 2.000sigma

### BACKGROUND SUBTRACT REPORT

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M = First peak in a multiplet region  
m = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.000sigma

## NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : \OR-GAMMA\\ApexRoot\Countroot\Library\WSRC.NLB

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0147
### Analysis Report for 1809016-01

**SPIKE**

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* = Energy line found in the spectrum.
- = Manually added nuclide.
@ = Energy line not used for Weighted Mean Activity

Energy Tolerance: 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

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### INTERFERENCE CORRECTED REPORT

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? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 2.000sigma
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M = First peak in a multiplet region  
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Analysis Report for 1809016-01

SPIKE

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
@ = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction

0151
GAMMA SPECTRUM ANALYSIS

Sample Identification : 1809016-02
Sample Description : BLANK
Sample Type : RA RECOVERY
Sample Size : 1.000E+00 units
Facility : Countroom
Sample Taken On : 9/18/2018 9:55:09AM
Acquisition Started : 9/18/2018 10:32:31AM
Procedure : BAFIL
Operator : Administrator
Detector Name : GE3
Geometry : BAFIL
Live Time : 900.0 seconds
Real Time : 902.0 seconds
Dead Time : 0.22 %

Peak Locate Threshold : 2.50
Peak Locate Range (in channels) : 1 - 4096
Peak Area Range (in channels) : 9 - 4096
Identification Energy Tolerance : 1.000FWHM

Energy Calibration Used Done On : 7/21/2018
Efficiency Calibration Used Done On : 7/21/2018
Efficiency Calibration Description :

Sample Number : 71935

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 9/18/2018 10:47:42AM
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Peak Analysis To Channel : 4096

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M = First peak in a multiplet region
m = Other peak in a multiplet region
P = Fitted singlet
Errors quoted at 2.000sigma

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**BACKGROUND SUBTRACT REPORT**

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0154
### Analysis Report for 1809016-02

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M = First peak in a multiplet region  

m = Other peak in a multiplet region  

F = Fitted singlet  

Errors quoted at 2.000 sigma  

---

**NUCLIDE IDENTIFICATION REPORT**

Nuclide Library Used: \1OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

**IDENTIFIED NUCLIDES**

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SGS
## Analysis Report for 1809016-02

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* = Energy line found in the spectrum.
- = Manually added nuclide.
@ = Energy line not used for Weighted Mean Activity

Energy Tolerance: 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

---

**INTERFERENCE CORRECTED REPORT**

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? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 2.000sigma
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M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

### NUCLIDE MDA REPORT

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+= Nuclide identified during the nuclide identification
*= Energy line found in the spectrum
<> MDA value not calculated
@ = Half-life too short to be able to perform the decay correction

0158
# GAMMA SPECTRUM ANALYSIS

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# PEAK ANALYSIS REPORT

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M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

### BACKGROUND SUBTRACT REPORT

Peak Analysis Performed on: 9/18/2018 11:02:58AM

Env. Background File: \OR-GAMMA1\ApexRoot\Countroom\Data\0000070288.CNF

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M = First peak in a multiplet region  
M = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.000sigma

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### NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used: \OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

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* = Energy line found in the spectrum.
- = Manually added nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance: 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

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? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity
Errors quoted at 2.000sigma
UNIDENTIFIED PEAKS

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Peak Locate To Channel: 4096

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M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2,000sigma

NUCLIDE MDA REPORT

Nuclide Library Used: \OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

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+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
GAMMA SPECTRUM ANALYSIS

Sample Identification : 1809016-04
Sample Description  : HANSON RELIEF WELL
Sample Type        : RA RECOVERY
Sample Size        : 1.000E+00 units
Facility           : Countroom
Sample Taken On    : 9/18/2018  9:55:56AM
Acquisition Started: 9/18/2018  10:48:03AM
Procedure          : BAFIL
Operator           : Administrator
Detector Name      : GE3
Geometry           : BAFIL
Live Time          : 900.0 seconds
Real Time          : 901.9 seconds
Dead Time          : 0.21 %
Peak Locate Threshold : 2.50
Peak Locate Range (in channels) : 1 - 4096
Peak Area Range (in channels) : 10 - 4096
Identification Energy Tolerance : 1.000FWHM
Energy Calibration Used Done On : 7/21/2018
Efficiency Calibration Used Done On : 7/21/2018
Efficiency Calibration Description : 
Sample Number      : 71938

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 9/18/2018  11:03:14AM
Peak Analysis From Channel : 1
Peak Analysis To Channel   : 4096

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### Analysis Report for 1809016-04

#### HANSON RELIEF WELL

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M = First peak in a multiplet region  
M = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.000sigma

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### BACKGROUND SUBTRACT REPORT

Peak Analysis Performed on : 9/18/2018 11:03:18AM  
Env. Background File : \OR-GAMMA1\ApexRoot\Countroom\Data0000070289.CNF

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0168
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M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

## NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used:  \%OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

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0169
Analysis Report for 1809016-04
HANSON RELIEF WELL

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* = Energy line found in the spectrum.
- = Manually added nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance: 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

INTERFERENCE CORRECTED REPORT

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? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 2.000sigma
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M = First peak in a multiplet region  
m = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2,000sigma

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+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
0172
### GAMMA SPECTRUM ANALYSIS

**Sample Identification**: 1809016-05  
**Sample Description**: BILLINGSLEY RELIEF WELL  
**Sample Type**: RA RECOVERY  
**Sample Size**: 1.000E+00 units  
**Facility**: Countroom  
**Sample Taken On**: 9/18/2018 9:56:16AM  
**Acquisition Started**: 9/18/2018 11:03:15AM  
**Procedure**: BAFIL  
**Operator**: Administrator  
**Detector Name**: GE2  
**Geometry**: BAFIL  
**Live Time**: 900.0 seconds  
**Real Time**: 900.3 seconds  
**Dead Time**: 0.03 %  
**Peak Locate Threshold**: 2.50  
**Peak Locate Range (in channels)**: 1 - 4096  
**Peak Area Range (in channels)**: 28 - 4096  
**Identification Energy Tolerance**: 1.000FWHM  
**Energy Calibration Used Done On**: 2/17/2018  
**Efficiency Calibration Used Done On**: 2/24/2018  
**Efficiency Calibration Description**:  
**Sample Number**: 71939

### PEAK ANALYSIS REPORT

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**Peak Analysis From Channel**: 1  
**Peak Analysis To Channel**: 4096

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M = First peak in a multiplet region  
M = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.000sigma

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**BACKGROUND SUBTRACT REPORT**

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M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

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NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used: \OR-GAMMA\ApexRoot\Countroom\Library\WSRC.NLB

IDENTIFIED NUCLIDES

0176
Analysis Report for 1809016-05
BILLINGSLEY RELIEF WELL

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* = Energy line found in the spectrum.
- = Manually added nuclide.
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Energy Tolerance = 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

INTERFERENCE CORRECTED REPORT

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? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
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Errors quoted at 2.000sigma
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M = Other peak in a multiplet region  
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## Analysis Report for 1809016-05

**BILLINGSLEY RELIEF WELL**

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0180
Live Time: 900.000 sec
Real Time: 900.000 sec
Start: 1: 1.1016(keV)
Stop: 4096: 4095.2(keV)
Acq. Start: Tue Sep 18 11:03:13 2018
GAMMA SPECTRUM ANALYSIS

Sample Identification: 1809016-06
Sample Description: DAVID MASON RELIEF WELL
Sample Type: RA RECOVERY
Sample Size: 1.000E+00 units
Facility: Countroom
Sample Taken On: 9/18/2018 9:56:31AM
Acquisition Started: 9/18/2018 11:03:26AM
Procedure: BAFIL
Operator: Administrator
Detector Name: GE3
Geometry: BAFIL
Live Time: 900.0 seconds
Real Time: 902.1 seconds
Dead Time: 0.23 %
Peak Locate Threshold: 2.50
Peak Locate Range (in channels): 1 - 4096
Peak Area Range (in channels): 9 - 4096
Identification Energy Tolerance: 1.000FWHM
Energy Calibration Used Done On: 7/21/2018
Efficiency Calibration Used Done On: 7/21/2018
Efficiency Calibration Description:
Sample Number: 71940

PEAK ANALYSIS REPORT

Peak Analysis Performed on: 9/18/2018 11:18:34AM
Peak Analysis From Channel: 1
Peak Analysis To Channel: 4096

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## DAVID MASON RELIEF WELL

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M = First peak in a multiplet region  
m = Other peak in a multiplet region  
P = Fitted singlet  
Errors quoted at 2.000sigma

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## BACKGROUND SUBTRACT REPORT

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0183
### DAVID MASON RELIEF WELL

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M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2,000sigma

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### NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used: \1\OR-GAMMA\ApexRoot\Countroom\Library\WSRC.NLB

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0184
Analysis Report for 1809016-06

DAVID MASON RELIEF WELL

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* = Energy line found in the spectrum.
- = Manually added nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance: 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

INTERFERENCE CORRECTED REPORT

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? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity
Errors quoted at 2.000sigma
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M = First peak in a multiplet region  

m = Other peak in a multiplet region  

F = Fitted singlet  

Errors quoted at 2.00sigma

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### NUCLIDE MDA REPORT

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0186
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+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
Analysis Report for 1809016-07
DENNISON RIG SUPPLY WELL

GAMMA SPECTRUM ANALYSIS

Sample Identification : 1809016-07
Sample Description : DENNISON RIG SUPPLY WELL
Sample Type : RA RECOVERY
Sample Size : 1.000E+00 units
Facility : Countroom
Sample Taken On : 9/18/2018 9:56:47AM
Acquisition Started : 9/18/2018 11:03:33AM
Procedure : BAFIL
Operator : Administrator
Detector Name : GE4
Geometry : BAFIL
Live Time : 900.0 seconds
Real Time : 900.5 seconds
Dead Time : 0.06 %
Peak Locate Threshold : 2.50
Peak Locate Range (in channels) : 1 - 4096
Peak Area Range (in channels) : 9 - 4096
Identification Energy Tolerance : 1.000FWHM
Energy Calibration Used Done On : 2/24/2018
Efficiency Calibration Used Done On : 11/9/2014
Efficiency Calibration Description : 
Sample Number : 71941

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 9/18/2018 11:18:47AM
Peak Analysis From Channel : 1
Peak Analysis To Channel : 4096

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## DENNISON RIG SUPPLY WELL

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M = First peak in a multiplet region  
m = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.000sigma

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## BACKGROUND SUBTRACT REPORT

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Env. Background File: \\OR-GAMMA1\ApexRoot\Countroom\Data\0000071072.CNF

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M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

### NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used: `\OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB`

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0191
**INTERFERENCE CORRECTED REPORT**

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? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 2,000 sigma
## UNIDENTIFIED PEAKS

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Peak Locate To Channel: 4096

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M = First peak in a multiplet region  
m = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.000sigma

## NUCLIDE MDA REPORT

Nuclide Library Used: \OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB
### DENNISON RIG SUPPLY WELL

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+  = Nuclide identified during the nuclide identification
*  = Energy line found in the spectrum
>  = MDA value not calculated
@  = Half-life too short to be able to perform the decay correction
GAMMA SPECTRUM ANALYSIS

Sample Identification: 1809016-08
Sample Description: GAMBLE RIG SUPPLY WELL
Sample Type: RA RECOVERY
Sample Size: 1.000E+00 units
Facility: Countroom
Sample Taken On: 9/18/2018 9:57:04AM
Acquisition Started: 9/18/2018 11:20:56AM
Procedure: BAFIL
Operator: Administrator
Detector Name: GE2
Geometry: BAFIL
Live Time: 900.0 seconds
Real Time: 900.3 seconds
Dead Time: 0.03%
Peak Locate Threshold: 2.50
Peak Locate Range (in channels): 1 - 4096
Peak Area Range (in channels): 28 - 4096
Identification Energy Tolerance: 1.000FWHM
Energy Calibration Used Done On: 2/17/2018
Efficiency Calibration Used Done On: 2/24/2018
Efficiency Calibration Description:
Sample Number: 71943

PEAK ANALYSIS REPORT

Peak Analysis Performed on: 9/18/2018 11:36:00AM
Peak Analysis From Channel: 1
Peak Analysis To Channel: 4096

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M = First peak in a multiplet region  
M = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.00sigma

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**BACKGROUND SUBTRACT REPORT**

Peak Analysis Performed on: 9/18/2018 11:36:00AM  
Env. Background File: \OR-GAMMA1\ApxRoot\Countroom\Data\0000070288.CNF

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M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

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NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : \OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

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* = Energy line found in the spectrum.  
- = Manually added nuclide.  
@ = Energy line not used for Weighted Mean Activity  
Energy Tolerance: 2.000FWHM  
Nuclide confidence index threshold = 0.30  
Errors quoted at 2.000sigma

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### INTERFERENCE CORRECTED REPORT

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? = nuclide is part of an undetermined solution  
X = nuclide rejected by the interference analysis  
@ = nuclide contains energy lines not used in Weighted Mean Activity  
Errors quoted at 2.000sigma
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M = First peak in a multiplet region  
M = Other peak in a multiplet region  
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Errors quoted at 2.000sigma
## NUCLIDE MDA REPORT

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Analysis Report for 1809016-08

GAMBLE RIG SUPPLY WELL

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction

0202
GAMMA SPECTRUM ANALYSIS

Sample Identification : 1809016-09
Sample Description : FIELD DUPLICATE
Sample Type : RA RECOVERY
Sample Size : 1.000E+00 units
Facility : Countroom
Sample Taken On : 9/18/2018  9:57:16AM
Acquisition Started : 9/18/2018  11:21:05AM
Procedure : BAFIL
Operator : Administrator
Detector Name : GE3
Geometry : BAFIL
Live Time : 900.0 seconds
Real Time : 902.0 seconds
Dead Time : 0.22 %
Peak Locate Threshold : 2.50
Peak Locate Range (in channels) : 1 - 4096
Peak Area Range (in channels) : 9 - 4096
Identification Energy Tolerance : 1.000FWHM
Energy Calibration Used Done On : 7/21/2018
Efficiency Calibration Used Done On : 7/21/2018
Efficiency Calibration Description :
Sample Number : 71944

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 9/18/2018  11:36:15AM
Peak Analysis From Channel : 1
Peak Analysis To Channel : 4096

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M = First peak in a multiplet region  
m = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.000sigma

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## BACKGROUND SUBTRACT REPORT

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0205
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M = First peak in a multiplet region  
m = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.000sigma

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### NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used: \OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

---

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### Analysis Report for 1809016-09

**FIELD DUPLICATE**

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* = Energy line found in the spectrum.
- = Manually added nuclide.
@ = Energy line not used for Weighted Mean Activity

Energy Tolerance: 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

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### INTERFERENCE CORRECTED REPORT

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? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity
Errors quoted at 2.000sigma
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Peak Locate From Channel: 1  
Peak Locate To Channel: 4096

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M = First peak in a multiplet region  
m = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.000sigma
## NUCLIDE MDA REPORT

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0209
Analysis Report for 1809016-09

FIELD DUPLICATE

+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction

0210
Analysis Report for 1809016-10
BRYANT POND 2

GAMMA SPECTRUM ANALYSIS

Sample Identification : 1809016-10
Sample Description : BRYANT POND 2
Sample Type : RA RECOVERY
Sample Size : 1.000E+00 units
Facility : Countroom
Sample Taken On : 9/18/2018 9:57:30AM
Acquisition Started : 9/18/2018 11:21:12AM
Procedure : BAFIL
Operator : Administrator
Detector Name : GE4
Geometry : BAFIL
Live Time : 900.0 seconds
Real Time : 900.5 seconds
Dead Time : 0.05 %
Peak Locate Threshold : 2.50
Peak Locate Range (in channels) : 1 - 4096
Peak Area Range (in channels) : 9 - 4096
Identification Energy Tolerance : 1.000FWHM
Energy Calibration Used Done On : 2/24/2018
Efficiency Calibration Used Done On : 11/9/2014
Efficiency Calibration Description :
Sample Number : 71945

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Peak Analysis To Channel : 4096

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0212
Analysis Report for 1809016-10

BRYANT POND 2

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M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.00sigma

BACKGROUND SUBTRACT REPORT

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Env. Background File: \OR-GAMMA1\ApexRoot\Countroom\Data\0000071072.CNF

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## Analysis Report for 1809016-10

### BRYANT POND 2

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M = First peak in a multiplet region  
m = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.000sigma

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### NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : \OR-GAMMA\ApexRoot\Countroom\Library\WSRC.NLB

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0214
**INTERFERENCE CORRECTED REPORT**

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? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 2.000sigma
## UNIDENTIFIED PEAKS

Peak Locate Performed on: 9/18/2018 11:36:28AM  
Peak Locate From Channel: 1  
Peak Locate To Channel: 4096

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M = First peak in a multiplet region  
m = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.000sigma

## NUCLIDE MDA REPORT

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+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
**GAMMA SPECTRUM ANALYSIS**

Sample Identification : 1809016-11  
Sample Description : BRYANT POND 7  
Sample Type : RA RECOVERY  
Sample Size : 1.000E+00 units  
Facility : Countroom  
Sample Taken On : 9/18/2018  
Acquisition Started : 9/18/2018  
Procedure : BAFIL  
Operator : Administrator  
Detector Name : GE2  
Geometry : BAFIL  
Live Time : 900.0 seconds  
Real Time : 900.3 seconds  
Dead Time : 0.03 %  
Peak Locate Threshold : 2.50  
Peak Locate Range (in channels) : 1 - 4096  
Peak Area Range (in channels) : 28 - 4096  
Identification Energy Tolerance : 1.000FWHM  
Energy Calibration Used Done On : 2/17/2018  
Efficiency Calibration Used Done On : 2/24/2018  
Efficiency Calibration Description :  
Sample Number : 71948  

**PEAK ANALYSIS REPORT**

Peak Analysis Performed on : 9/18/2018 11:52:23AM  
Peak Analysis From Channel : 1  
Peak Analysis To Channel : 4096  

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<th>Net Area Uncertainty</th>
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### Analysis Report for 1809016-11

**BRYANT POND 7**

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M = First peak in a multiplet region  
m = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.000sigma

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**BACKGROUND SUBTRACT REPORT**

Peak Analysis Performed on: 9/18/2018 11:52:23AM  
Env. Background File: \OR-GAMMA1\ApexRoot\Countroom\Data0000070288.CNF

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M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

 NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used: \OR-GAMMA1\ApexRoot\Countroom\Library\WSRC.NLB

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0221
Analysis Report for 1809016-11
BRYANT POND 7

* = Energy line found in the spectrum.
- = Manually added nuclide.
@ = Energy line not used for Weighted Mean Activity
Energy Tolerance : 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

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? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 2.000sigma
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M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.00sigma

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# NUCLIDE MDA REPORT

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+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction

0224
GAMMA SPECTRUM ANALYSIS

Sample Identification : 1809016-12
Sample Description : BRYANT POND 12
Sample Type : RA RECOVERY
Sample Size : 1.000E+00 units
Facility : Countroom
Sample Taken On : 9/18/2018 9:57:55AM
Acquisition Started : 9/18/2018 11:37:28AM
Procedure : BAFIL
Operator : Administrator
Detector Name : GE3
Geometry : BAFIL
Live Time : 900.0 seconds
Real Time : 902.0 seconds
Dead Time : 0.22 %
Peak Locate Threshold : 2.50
Peak Locate Range (in channels) : 1 - 4096
Peak Area Range (in channels) : 10 - 4096
Identification Energy Tolerance : 1.000FWHM
Energy Calibration Used Done On : 7/21/2018
Efficiency Calibration Used Done On : 7/21/2018
Efficiency Calibration Description :
Sample Number : 71949

PEAK ANALYSIS REPORT

Peak Analysis Performed on : 9/18/2018 11:52:38AM
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Peak Analysis To Channel : 4096

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M = First peak in a multiplet region  
m = Other peak in a multiplet region  
P = Fitted singlet  
Errors quoted at 2,000sigma

### BACKGROUND SUBTRACT REPORT

Peak Analysis Performed on: 9/18/2018 11:52:38AM

Env. Background File: \OR-GAMMA1\ApexRoot\Countroom\Data\0000070289.CNF

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0227
### Analysis Report for 1809016-12

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M = First peak in a multiplet region  
\( m \) = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.00\( \sigma \) sigma

### NUCLIDE IDENTIFICATION REPORT

Nuclide Library Used : \1OR-GAMMA\1ApexRoot\Countroom\Library\WSRC.NLB

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0228
Analysis Report for 1809016-12
BRYANT POND 12

* = Energy line found in the spectrum.
- = Manually added nuclide.
@ = Energy line not used for Weighted Mean Activity

Energy Tolerance: 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

**INTERFERENCE CORRECTED REPORT**

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<tr>
<th>Nuclide Name</th>
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? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 2.000sigma
UNIDENTIFIED PEAKS

Peak Locate Performed on: 9/18/2018 11:52:38AM
Peak Locate From Channel: 1
Peak Locate To Channel: 4906

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M = First peak in a multiplet region
m = Other peak in a multiplet region
F = Fitted singlet
Errors quoted at 2.000sigma

NUCLIDE MDA REPORT

Nuclide Library Used: \OR-GAMMA\ApexRoot\Countroom\Library\WSRC.NLB

0230
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<th>Yield(%)</th>
<th>Line MDA (pCi/units)</th>
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+ = Nuclide identified during the nuclide identification
* = Energy line found in the spectrum
> = MDA value not calculated
@ = Half-life too short to be able to perform the decay correction
GAMMA SPECTRUM ANALYSIS

Sample Identification: 1809016-13
Sample Description: EQUIPMENT BLANK
Sample Type: RA RECOVERY
Sample Size: 1.000E+00 units
Facility: Countroom
Sample Taken On: 9/18/2018 9:58:10AM
Acquisition Started: 9/18/2018 11:37:34AM
Procedure: BAFIL
Operator: Administrator
Detector Name: GE4
Geometry: BAFIL
Live Time: 900.0 seconds
Real Time: 920.0 seconds
Dead Time: 2.17 %
Peak Locate Threshold: 2.50
Peak Locate Range (in channels): 1 - 4096
Peak Area Range (in channels): 9 - 4096
Identification Energy Tolerance: 1.000FWHM
Energy Calibration Used Done On: 2/24/2018
Efficiency Calibration Used Done On: 11/9/2014
Efficiency Calibration Description: 
Sample Number: 71950

PEAK ANALYSIS REPORT

Peak Analysis Performed on: 9/18/2018 11:52:56AM
Peak Analysis From Channel: 1
Peak Analysis To Channel: 4096

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<th>Net Peak Area</th>
<th>Net Area Uncertainty</th>
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M = First peak in a multiplet region  
m = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.00sigma

### BACKGROUND SUBTRACT REPORT

Peak Analysis Performed on: 9/18/2018 11:52:56AM  
Env. Background File: \OR-GAMMA1\ApexRoot\Countroom\Data\0000071072.CNF

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M = First peak in a multiplet region  
m = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.000sigma

**NUCLEIDE IDENTIFICATION REPORT**

Nuclide Library Used: \OR-GAMMA\ApexRoot\Countroom\Library\WSRC.NLB

**IDENTIFIED NUCLIDES**

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* = Energy line found in the spectrum.
- = Manually added nuclide.
@ = Energy line not used for Weighted Mean Activity

Energy Tolerance: 2.000FWHM
Nuclide confidence index threshold = 0.30
Errors quoted at 2.000sigma

INTERFERENCE CORRECTED REPORT

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? = nuclide is part of an undetermined solution
X = nuclide rejected by the interference analysis
@ = nuclide contains energy lines not used in Weighted Mean Activity

Errors quoted at 2.000sigma
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M = First peak in a multiplet region  
m = Other peak in a multiplet region  
F = Fitted singlet  
Errors quoted at 2.000sigma

### NUCLIDE MDA REPORT

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+ = Nuclide identified during the nuclide identification  
* = Energy line found in the spectrum  
> = MDA value not calculated  
@ = Half-life too short to be able to perform the decay correction
SECTION XI

ANALYTICAL DATA (TOTAL DISSOLVED SOLIDS)
# TDS / TSS Worksheet

<table>
<thead>
<tr>
<th>Work Order</th>
<th>Run</th>
<th>Analysis Code</th>
<th>Technician</th>
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<td>18-09016</td>
<td>1</td>
<td>TDS</td>
<td>MHIGHTOWER</td>
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</table>

<table>
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<th>SGS North America Inc.</th>
<th>Aliquot ml</th>
<th>Filter Tare (g)</th>
<th>Filter Final (g)</th>
<th>Filter Net (g)</th>
<th>TDS/TSS (mg/L)</th>
<th>Maximum Aliq (mL)</th>
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<tbody>
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Technician: [Signature]  
Date: 9/8/18
## Aliquot Worksheet

**Work Order:** 18-09016 | **Run:** 1 | **Analysis Code:** TDS | **Rpt Units:** liters | **Lab Deadline:** 9/26/2018 | **Technician:** MHIGHTOWER

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<th>SGS North America Inc.</th>
<th>Sample</th>
<th>Muffle Data</th>
<th>Dilution Data</th>
<th>Aliquot Data</th>
<th>MS Aliquot Data</th>
<th>H-3 Solids Only</th>
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<td>Post/Pre</td>
<td>No of Dil</td>
<td>Dil Factor</td>
<td>Ratio</td>
<td>Aliquot</td>
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<td>RCS</td>
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<td>TRG</td>
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**Comments**

**Technician:** [Signature] | **Date:** 9/8/2018
Misc. Forms

Custody Documents and Other Forms

Includes the following where applicable:

- Chain of Custody
# SAMPLE CHAIN-OF-CUSTODY RECORD

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<th>Sample I.D.</th>
<th>Type</th>
<th>Date/Time Sampled</th>
<th>Containers</th>
<th>Analysis Requested/Method</th>
<th>Comments</th>
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<tbody>
<tr>
<td>1</td>
<td>AQ</td>
<td>9/4/2018 10:45</td>
<td>(2) Liter Plastic HNO₃ (1) 250mL, Plastic</td>
<td>Radium 226, Radium 228, TDS</td>
<td>4°C</td>
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<td>Radium 226, Radium 228, TDS</td>
<td>4°C</td>
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<td>AQ</td>
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<td>Radium 226, Radium 228, TDS</td>
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<td>AQ</td>
<td>9/4/2018 16:45</td>
<td>(2) Liter Plastic HNO₃ (1) 250mL, Plastic</td>
<td>Radium 226, Radium 228, TDS</td>
<td>4°C</td>
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<tr>
<td>5</td>
<td>AQ</td>
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Received: 4/6/34 M.319

Reinforced By: [Signature]
Date/Time: 9/6/18 10:00

Reinforced By: [Signature]
Date/Time: 9/6/18 12:00

Analysis Due: Verbal

Reinforced By: [Signature]
Date/Time: 9/6/18 12:20

Written: 9/6/18 12:20

Hydro-Environmental Technology, Inc.

Laboratory: Eberline
Collected By: KCL/VI/EM/MJ

Project Name: Indigo
Project Number: 8060.00
Project Location: DeSoto Parish, Louisiana
Date: 9/4/2018
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<th>Date/Time Sampled</th>
<th>Containers</th>
<th>Analysis Requested/Method</th>
<th>Comments</th>
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<td>(2) Liter Plastic HNO3</td>
<td>Radium 226, Radium 228, TDS</td>
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Reinquished By: [Signature]
Date/Time: 9-6-18

Received By: [Signature]
Date/Time: 9-6-18
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<th>Y or N</th>
<th>Sample Integrity - Condition</th>
<th>Y or N</th>
<th>Sample Integrity - Instructions</th>
<th>Y or N</th>
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<td>1. Sample labels present on bottles:</td>
<td>☑</td>
<td>1. Sample recvd within HT:</td>
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<td>1. Analysis requested is clear:</td>
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<td>2. Container labeling complete:</td>
<td>☑</td>
<td>2. Bottles received for unspecified tests</td>
<td>☑</td>
<td>2. Bottles received for unspecified tests</td>
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<td>3. COC Present:</td>
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<td>3. Sufficient volume recvd for analysis:</td>
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<td>5. Filtering instructions clear:</td>
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<td>4. No. Coolers:</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quality Control_Preservation</th>
<th>Y or N</th>
<th>Sample Integrity - Documentation</th>
<th>Y or N</th>
<th>Sample Integrity - Condition</th>
<th>Y or N</th>
<th>Sample Integrity - Instructions</th>
<th>Y or N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Trip Blank present / cooler:</td>
<td>☑</td>
<td>1. Sample labels present on bottles:</td>
<td>☑</td>
<td>1. Sample recvd within HT:</td>
<td>☑</td>
<td>1. Analysis requested is clear:</td>
<td>☑</td>
</tr>
<tr>
<td>2. Trip Blank listed on COC:</td>
<td>☑</td>
<td>2. Container labeling complete:</td>
<td>☑</td>
<td>2. Bottles received for unspecified tests</td>
<td>☑</td>
<td>2. Bottles received for unspecified tests</td>
<td>☑</td>
</tr>
<tr>
<td>3. Samples preserved properly:</td>
<td>☑</td>
<td>3. Sample container label / COC agree:</td>
<td>☑</td>
<td>3. All containers accounted for:</td>
<td>☑</td>
<td>3. Sufficient volume recvd for analysis:</td>
<td>☑</td>
</tr>
<tr>
<td>4. VOCs headspace free:</td>
<td>☑</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Cooler Temps (Initial/Adjusted): #1: (4.6/4.6); #2: (3.4/3.4); DV439

Comments: ☑

La47396X: Chain of Custody

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