Enclosure

OAK RIDGE ASSOCIATED UNIVERSITIES:

SITE STATUS REPORT FOR THE FORMER INGRAHAM CLOCK COMPANY AT 284 NORTH MAIN STREET, BRISTOL, CONNECTICUT

SEPTEMBER 11, 2017

EXECUTIVE SUMMARY

The U.S. Nuclear Regulatory Commission (NRC) requested that the Oak Ridge Associated Universities (ORAU) perform a radiation survey of the property at 284 North Main Street in Bristol, Connecticut. This property covers part of the footprint once occupied by the former Ingraham Clock Company, which used radium paint in the manufacturing of clocks and watches into the late 1950s. The original factory was torn down, and the land has been redeveloped. The objective of this survey was to determine if any discrete sources of radium associated with the former Ingraham Clock Company operations are still present.

ORAU performed the radiation survey on November 17, 2016, and did not identify elevated levels of radiation except for a small piece of slag-like material along the eastern boundary of the property between the retaining wall and the railroad tracks. The material was removed from the site for analysis. Laboratory analysis determined that the slag-like material contains elevated concentrations of radium-226.

Access was limited along the eastern boundary due to steep slopes and heavy undergrowth. No elevated levels of radiation were identified west of the large retaining wall. Because limited surveys were performed along the eastern boundary of the property, ORAU concludes that elevated levels of radium-226 might be present in these un-surveyed locations. It is recommended that the NRC perform a scoping survey of areas east of the retaining wall at the 284 North Main Street property.

SITE STATUS REPORT

Property:	Former Ingraham Clock Company 284 North Main Street Bristol, CT 06010
Docket Number:	03038977
Current Property Name(s):	DeLorenzo Towers
Current Property Owner(s):	NCSC-UAW Region 9A Sch Dev Corp
Inspection Dates:	November 17, 2016
Inspector(s):	Orysia Masnyk Bailey/ U.S. Nuclear Regulatory Commission (NRC), assisted by David King/Oak Ridge Associated Universities (ORAU)

1.0 INTRODUCTION

The Energy Policy Act of 2005 amended section 11e.(3) of the Atomic Energy Act of 1954 to place discrete sources of radium-226 (Ra-226) under NRC regulatory authority as byproduct material. As part of the NRC's program to identify radium sites, the NRC is evaluating properties where the former Ingraham Clock Factory was known to operate. The objectives of the November 17, 2016, initial site visit to the 284 North Main Street, property formerly owned by the Ingraham Clock Company, were to determine if discrete sources of Ra-226 and/or distributed Ra-226 contamination are present, to identify the areas of contamination, to determine if there are any current health and safety concerns, and to determine if a scoping survey is needed.

Data from the November 17, 2016 initial site visit, which included gamma radiation scans and exposure rate measurements, will be used to plan future actions and minimize, as appropriate, the exposure to Ra-226 to current and future site occupants. It is important to note that destructive testing is not generally performed, as described within NRC's procedures, Temporary Instruction 2800/043 "Inspection of Facilities Potentially Contaminated with Discrete Radium-226 Sources" (NRC 2016) (Agencywide Documents Access and Management System [ADAMS] Accession number ML16035A053).

2.0 PROPERTY DESCRIPTION AND CONCEPTUAL MODEL

The site summary included in the Oak Ridge National Laboratory (ORNL) report, *Historical Non-Military Radium Sites Research Effort Addendum* (ORNL 2015) provides known site details about the type, form, history, potential locations, and other information related to discrete sources of Ra-226 used at the site. The information provided in the ORNL report (ORNL 2015) is supplemented by the Agency for Toxic Substances and Disease Registry (ATSDR) report (ATSDR 1999) that addresses radium dial clock companies located in the state of Connecticut. The former Ingraham Clock Company was founded in 1884 and occupied several buildings on North Main Street in Bristol, Connecticut. In 1904, as a result of increased sales due to improvements in manufacturing and machinery, Ingraham replaced the original wooden buildings

with brick buildings. Clocks and watches with luminous radium paint were manufactured in these buildings until production ceased in 1942 due to World War II. Production resumed again in 1946. In 1958, the company moved from North Main Street to Bristol's Redstone Hill Industrial Park at 210 Redstone Hill Road (ORNL 2015).

During the 1960s, the abandoned buildings at the North Main Street location were torn down as part of a redevelopment project. Extensive testing took place at the site prior to 1980. The exact dates of testing, the types of tests performed, and the results are not known. Therefore, it is unknown if soil at the North Main Street location of the former Ingraham Clock Company was tested for radium (ORNL 2015). Test wells were drilled and still exist. Redevelopment activities included the removal of soil from the site for use as cover material at a Bristol landfill, a river running through the site was piped underground, and backfill was brought onto the site. As part of the redevelopment, residential and commercial properties were constructed in the 1980s and early 1990s at the North Main Street locations, including: (1) 430 North Main Street in the early 1980s; (2) 284 North Main Street in 1987; (3) 400 North Main Street in 1989-90; and (4) 420 North Main Street in 1990-91 (ORNL 2015). This report documents the initial site visit to the portion of the former Ingraham property that is currently associated with 284 North Main Street, the land area surrounding DeLorenzo Towers.

A March 1921 street map of Bristol shows that 284 North Main Street lies on the southern portion of the former Ingraham Clock Company footprint (Sanborn Map Company 1921). The map of the former clock company is based on "Office Plans" and indicates that forges and soldering iron furnaces would be present, presumably for metalwork related to clock manufacturing.

3.0 SITE OBSERVATIONS AND FINDINGS

3.1 Summary of Activities

The inspection team conducted radiological surveys at the 284 North Main Street property on November 17, 2016. A pre-inspection meeting was held with Pat Kohnte and Judy Reilly (DeLorenzo Towers), Pete Hollenbeck (Radiological Consultant with Radiation Safety and Control Services), Gary McCahill (Connecticut Department of Energy and Environmental Protection [CT DEEP]), David King (ORAU), and Orysia Masnyk Bailey (NRC). Participants discussed the inspection team's intention to perform general area surveys of the 284 North Main Street parking lot and adjacent land areas.

Radiological surveys consisted of gamma radiation scans using a Ludlum model 44-10 2-inch by 2-inch sodium iodide (2×2 NaI) detector connected to a Ludlum model 2221 ratemeter/scaler and exposure rate measurements using a Ludlum model 192 NaI-based µR ratemeter[1]. The 2×2 NaI detector gamma radiation measurements were collected near the ground surface, and the exposure rate readings were collected at approximately 1 meter (3 feet) above the ground surface. As a rule-of-thumb, the 2×2 sodium iodide detector can respond to gamma-emitting radionuclides located in the top 6 to 12 inches of soil. A SAM-940 spectrum analyzer was also available in case elevated gamma radiation levels were identified. Table 1 presents the specific instruments used during the site visit.

[1]Roentgen is a unit of exposure (energy absorbed in air), whereas a rem is a unit of dose delivered to a person (resulting from the radiation energy absorbed in that person). While Roentgen and rem are related, these are different units. Because they are similar for gamma ray energies from Ra-226, NRC makes the simplifying assumption in this case that these units are equivalent (1 Roentgen = 1 rem).

Table 1. Former Ingraham Clock Company Survey Instruments			
Radiation Type (units)	**Detector Type**	**Detector (Number)**	**Ratemeter (Number)**
Gross gamma (cpm)	Sodium Iodide	44-10 (908) Calibrated 11/01/2016	2221 (590) Calibrated 08/08/2016
Gross gamma (μR/h)	Gamma Exposure Ratemeter	192 (1127) Calibrated 06/03/2016	N/A
Gamma Spectrum Analyzer (SAM-940)	Lanthanum Bromide	940 (40272) Daily check source response	N/A

N/A = not applicable; ratemeter is not required.
cpm = counts per minute
μR/h = micro roentgen per hour

In general, the 2×2 sodium iodide detector background responses ranged from approximately 6,000 to 7,000 cpm over asphalt and 8,000 to 10,000 cpm over grassy areas except near brick buildings and stone walls, where responses peaked around 12,000 to 14,000 cpm. Likewise, the gamma exposure ratemeter background responses ranged from approximately 5 to 6 μR/h over asphalt and 5 to 8 μR/h over grassy areas except near brick buildings, where responses peaked around 10 μR/h. An increased response of 46,000 cpm and 35 μR/h (contact) measurement was made immediately west of the stone wall near railroad tracks and was determined to be associated with a small piece of slag-like material buried 3 to 4 inches underground. The material was removed and sent to the ORAU Radiological and Environmental Analytical Laboratory for analysis. Radiation levels returned to ambient levels after the material was removed. Analytical results for the slag-like material and photos are presented in Appendix A. The strip of land between a large retaining wall and small brick wall was difficult to access because of steep slopes and heavy undergrowth. Appropriate industrial safety equipment was not available during the site visit. As a result, surveys within this area were limited to the boundaries shown in Figures 1 and 2.

3.2 Summary of Results

Figure 1 presents a summary of results from the November 17, 2016, DeLorenzo Towers site visit. Inspectors identified no anomalous gamma radiation measurements aside from the slag-like material found at Location A (see Figure 1). Surveys covered approximately 25 percent of the site land area west of the large retaining wall; much of the outdoor area is covered by concrete, asphalt, cars, etc. Land area east of a large retaining wall, on the east side of DeLorenzo Towers, is steep, with several areas of heavy undergrowth, and was difficult to access at the time of the initial site visit. Surveys within this area were limited to the boundaries shown in Figures 1 and 2, specifically to the base of the retaining wall/incline on the west and the low stone wall on the east. The slag-like material was identified well east of this large retaining wall, against the low stone wall, pictured in Appendix A.

The analytical laboratory reported a Ra-226 concentration on the order of 290 pCi/g in the slag-like material (see Appendix A). This item was removed, though it is unknown whether additional Ra-226-contaminated materials are present in the difficult-to-access area along the eastern property boundary. The specific source of the slag-like material is unknown, though innocuous concentrations of other naturally occurring radionuclides strongly suggest that elevated Ra-226

concentrations are associated with former Ingraham Clock Company operation. The 1921 map also suggests the slag-like material containing elevated Ra-226 concentration could represent a waste product of forge and soldering iron furnace operations (e.g., items containing Ra-226 paint were recycled).

3.3 Summary of Dose Assessment Results

Because no radiation levels were detected above background and no discrete sources of radium were encountered after removing the slag-like material from Location A, a dose calculation attributed to discrete sources of Ra-226 was not necessary. However, if other slag-like materials are present at similar concentrations, it is plausible that doses could exceed regulatory limits, assuming another contaminated item is found and placed in a habitable area. For example, the *Dose Assessment Technical Basis Document for Potential Exposures to Discrete Sources of Radium-226 and Associated Contamination* (ORAU 2017) presents a 42 pCi/g not-to-exceed concentration for soil or soil-like material—the 290 pCi/g material removed from the site is well in excess of this threshold.

4.0 RECOMMENDATIONS

Based on the areas that were assessed during the initial site visit, there is no indication that surface soil in occupied portions of the DeLorenzo Towers property, 284 North Main Street, occupying a portion of the former Ingraham Clock Company, contains discrete sources of Ra-226. This conclusion is based on the following observations:

- Gamma radiation levels were consistent with background except as associated with the slag-like material (which was removed from the site) along the eastern boundary—the eastern portion of the site is steep with sections of heavy undergrowth, and is currently unoccupied.

- The absence of gamma radiation anomalies in occupied area indicates that there are no sources of Ra-226 present in surface soil, though elevated radiation was noted from the slag-like materials, presumably associated with waste from forging and soldering operations at the former clock company.

- The only evidence that discrete sources of Ra-226 are present following the 1960s facility demolition and the property's subsequent redevelopment is associated with the slag-like material removed from along the eastern property boundary.

- Risk of potential contamination on occupied portions of the site is low and, if present, would most likely be found at a significant depth in the subsurface soil.

However, because only a limited portion of the area east of the retaining wall could be accessed during the site visit and the slag-like material containing elevated concentrations of Ra-226 was found in that area, it is recommended that a scoping survey be performed in areas along the eastern edge of the site boundary. Furthermore, the laboratory results suggest that elevated Ra-226 concentrations are associated with the former Ingraham Clock Company, likely the forge and soldering iron furnace.

SITE: Ingraham	AREA: 284 North Main St.	DATE: 11/17/16	TIME: 9:30 – 11:00
SURVEYOR(S): David King		PURPOSE: Site Visit	

TYPE	INSTRUMENT	DETECTOR	BACKGROUND
Gamma	2221 #590 - Calibrated 8/8/2016	44-10 #908 - Calibrated 11/1/2016	*
Gamma	192 #1127 - Calibrated 6/3/2016	N/A	*

*Background readings varied depending on proximity to brick buildings and other natural media (e.g., landscaping).

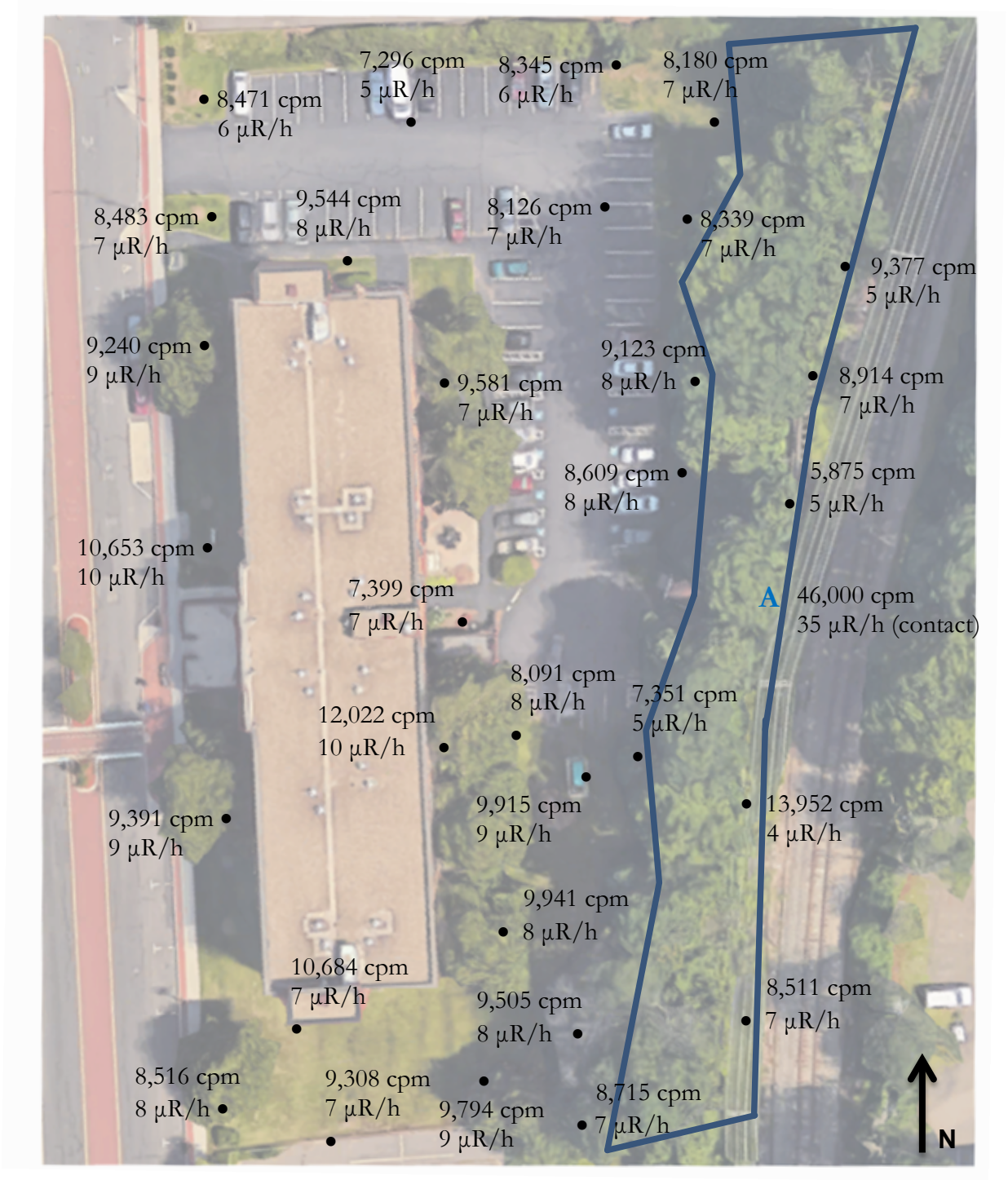

Figure 1. Survey Results for 284 North Main Street Property

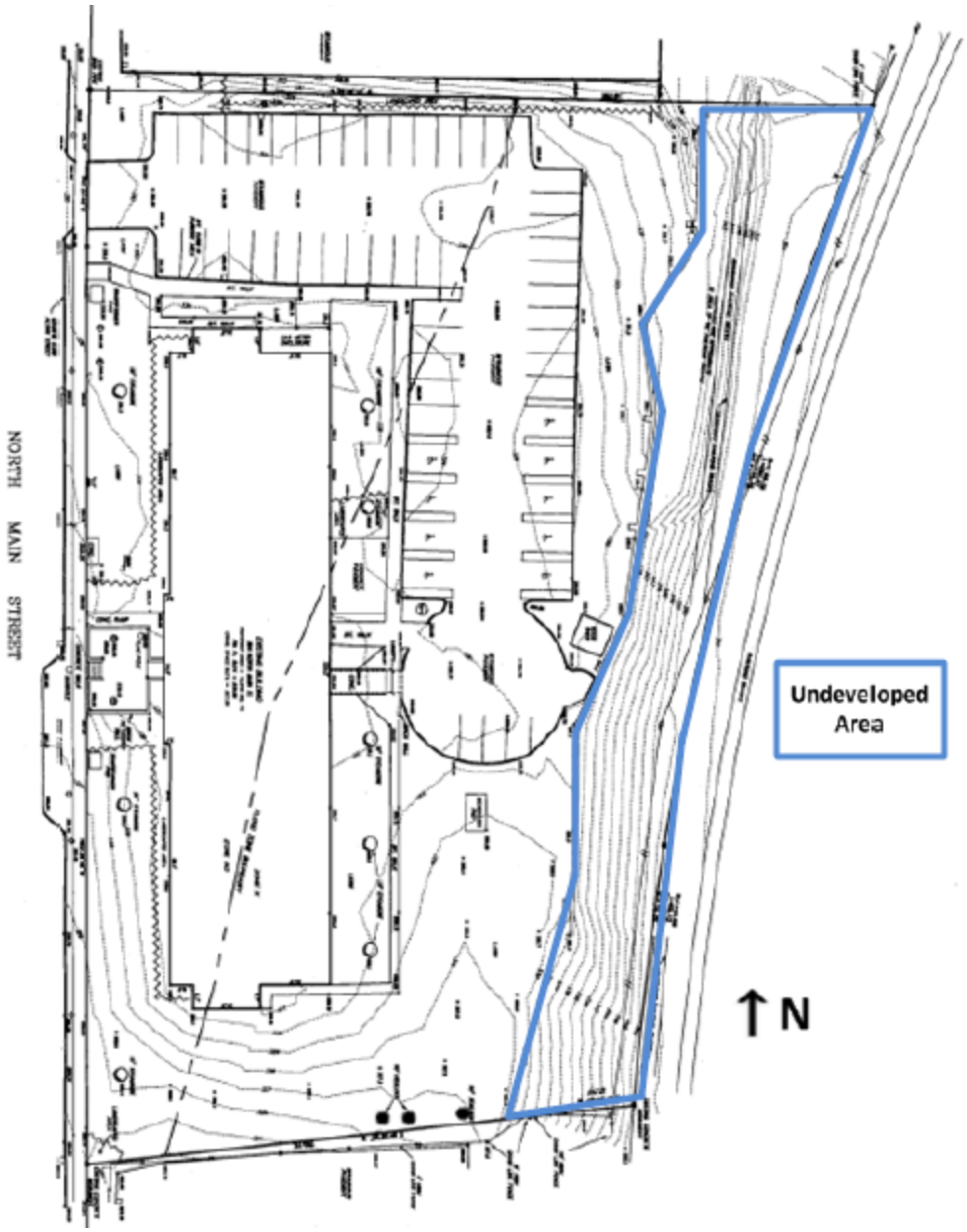

Figure 2. Contour Map of the 284 North Main Street Property

5.0 REFERENCES

ATSDR 1999. *Public Health Implications of Radiation Contamination at Former Clock Factories Located in Bristol (Hartford County), New Haven, (New Haven County), Thomaston (Litchfield County), and Waterbury (New Haven County), Connecticut*. U.S. Department of Health and Human Services. January 29. (Agencywide Documents Access and Management System [ADAMS] Accession No. ML17038A052).

NRC 2016. *Inspection of Facilities Potentially Contaminated with Discrete Radium-226 Sources*, Temporary Instruction 2800/043, U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Washington, D.C., October. (ADAMS Accession No. ML16035A053).

ORNL 2015. *Historical Non-Military Radium Sites Research Effort Addendum*. Oak Ridge National Laboratory, Oak Ridge, Tennessee, November 24. (ADAMS Accession No. ML16291A488).

ORAU 2017. *Dose Assessment Technical Basis Document for Potential Exposures to Discrete Sources of Radium-226 and Associated Contamination*. Oak Ridge Associated Universities, Oak Ridge, Tennessee, May 30. (ADAMS Accession No. ML17072A414).

Sanborn Map Company 1921. “Mar. 1921 Bristol Conn.” Stack 766, B77, Sheets 12 and 13.

APPENDIX A
PHOTOS AND SAMPLE RESULTS FROM LOCATION A

Figure A.1. Slag-like material removed from location A

Figure A.2. Small Stone Wall East of the DeLorenzo Towers Property

Summary Results By Sample

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Report Date: December 01, 2016

Client Sample ID:	5298S0001	Receipt Date:	11/21/2016
Lab Sample ID:	11310M0001	Collection Date:	11/17/2016
Project Name:	NRC Radium Sites	COC # :	1611-003
Project # :	201211310	SDG # :	201211310-2

Analyte:	Result	TPU (2s)	MDC	Units	Qualifier Flag	Batch #	SOP (Rev. #)
Bi-212	1.8	2.5	5.2	pCi/g	U	GS0393	CP1 (21)
Bi-214	252	19	1	pCi/g		GS0393	CP1 (21)
K-40	9.5	1.9	3.9	pCi/g		GS0393	CP1 (21)
Pa-234	15	27	54	pCi/g	U	GS0393	CP1 (21)
Ra-226	292	17	5	pCi/g		GS0393	CP1 (21)
Ra-226 by Pb-214	290	15	1	pCi/g		GS0393	CP1 (21)
Th-228 by Pb-212	-14.20	0.94	1.07	pCi/g	U	GS0393	CP1 (21)
Th-230	14	21	50	pCi/g	U	GS0393	CP1 (21)
Th-232 by Ac-228	2.30	0.60	1.29	pCi/g		GS0393	CP1 (21)
U-235	0.46	0.99	2.29	pCi/g	U	GS0393	CP1 (21)
U-238 by Th-234	0.2	2.7	6.7	pCi/g	U	GS0393	CP1 (21)

Electronically Validated By:
William Smith- 12/1/2016 07:45

Electronically Approved By:

Wade Ivey 12/1/2016 10:47

Qualifier Flags:
U = Analyte not detected (< MDC)

TPU = Total Propagated Uncertainty
MDC = Minimum Detectable Concentration

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