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November 3, 2017

Mr. David Misenhimer, P.E.
Nuclear Material Safety and Safeguards
Division of Decommissioning, Uranium Recovery, and Waste Programs
Materials Decommissioning Branch
U.S. Nuclear Regulatory Commission
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SUBJECT: SCOPING SURVEY PLAN FOR THE EASTERN EMBANKMENT OF INGRAHAM PROPERTY AT 284 NORTH MAIN STREET IN BRISTOL, CONNECTICUT
CONTRACT NO. NRC-HQ-50-17-A-0001; DCN 5307-PL-03-1

Dear Mr. Misenhimer:

Oak Ridge Associated Universities (ORAU) is pleased to provide the attached project-specific plan for the scoping survey of the eastern embankment of Ingraham property at 284 North Main Street in Bristol, Connecticut. This survey plan follows the outline given in the Temporary Instructions 2800/043, Appendix A.

Please feel free to contact me at 865.574.0685 or Erika Bailey at 865.576.6659 if you have any questions.

Sincerely,

David A. King, CHP, PMP
Sr. Health Physicist/Project Manager
ORAU

KME:lw

Attachment

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SCOPING SURVEY PLAN FOR THE EASTERN EMBANKMENT OF INGRAHAM PROPERTY AT 284 NORTH MAIN STREET IN BRISTOL, CONNECTICUT

Prepared by
D. A. King
ORAU

NOVEMBER 2017

FINAL PLAN

Prepared for the
U.S. Nuclear Regulatory Commission

This document was prepared for the U.S. Nuclear Regulatory Commission (NRC) by Oak Ridge Associated Universities under contract number NRC-HQ-50-17-A-0001.

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Property:	Ingraham Clock Company-1 284 North Main Street Bristol, Connecticut 06011
Docket Number:	03038977
Current Property Name(s):	DeLorenzo Towers
Current Property Owner(s):	NCSC-UAW Region 9A Sch Dev Corp
Inspection Dates:	November 14, 2017
Inspector(s):	Orysia Masnyk-Bailey/U.S. Nuclear Regulatory Commission (NRC) supported by Kaitlin Engel and Adam Kirthlink/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, as amended (AEA), to place discrete sources of radium-226 (Ra-226) under NRC regulatory authority as byproduct material. The NRC, in response to this amendment, is actively pursuing properties where discrete sources of Ra-226 were previously used in order to ensure that there are no current health and safety issues associated with these sites. This project involves contacting current site owners of properties suspected of containing discrete sources of Ra-226 to request site access. Initial onsite investigations are performed to determine whether discrete sources of Ra-226 may exist and whether there are potential health and safety concerns.

The 284 North Main Street property sits within the footprint of the former Ingraham Clock Company in Bristol, Connecticut. During a November 2016 site visit, inspectors performed a cursory survey of the undeveloped embankment shown in Figure 1, which lies along the eastern edge of the property. Though access was limited due to steep slopes and thick undergrowth, inspectors identified a slag-like material, pictured in Figure 2, which produced gamma radiation well above ambient background levels (ORAU 2017b). The material was collected and submitted for analysis at an analytical laboratory. Radium-226 was reported at approximately 290 pCi/g—with the noted absence of other possible contaminants. NRC determined that the item is a discrete source of Ra-226, possibly from forging and soldering operations at the former clock company (ORAU 2017b). Due to this finding, NRC determined that a follow-up scoping survey should be performed to more thoroughly investigate the embankment. The objectives of the survey will be to determine if additional discrete sources of Ra-226 are present and, if so, if these sources could result in a dose above regulatory limits.

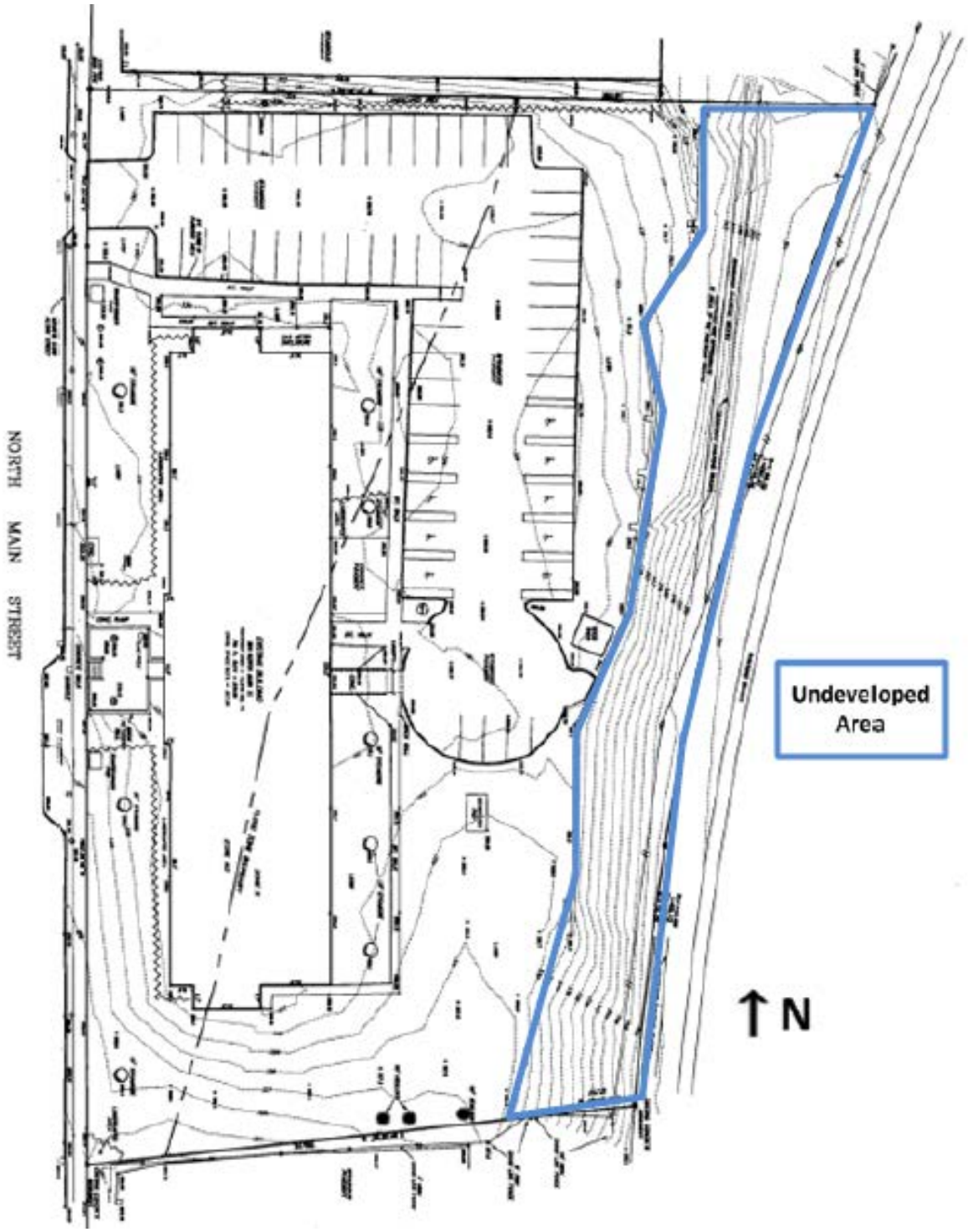

Figure 1. Undeveloped Embankment on the 284 North Main Street Property

Figure 2. Slag-Like Discrete Source of Ra-226

More specifically, data from this scoping survey will be used to plan future actions and to determine if discrete sources of Ra-226 could reasonably result in the following:

- A radiological dose above 100 mrem/yr to a current or plausible future receptor, per 10 Code of Federal Regulations (CFR) Part 20, *Standards for Protection Against Radiation*, Section 20.1301, "Radiological criteria for restricted use," or

- A radiological dose above 25 mrem/yr to a current or plausible future receptor, per 10 CFR Part 20, Section 20.1402, "Radiological criteria for un-restricted use."

2.0 PROPERTY DESCRIPTION AND CONCEPTUAL MODEL

The site summary included in the *Historical Non-Military Radium Sites Research Effort Addendum* report (ORNL 2015) provides 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 ORNL 2015 is supplemented by the Agency for Toxic Substances and Disease Registry report (ATSDR 1999), which addresses radium dial clock companies located in the state of Connecticut, and the ORAU Site Summary report that documents findings from the November 2016 initial site visit (ORAU 2017b).

The Ingraham Clock Company was founded in 1884 and occupied several buildings on North Main Street in Bristol, Connecticut. In 1904, Ingraham replaced the original wooden buildings with brick structures. Clocks and watches with luminous radium paint were manufactured in these buildings until production ceased in 1942 due to World War II, though production resumed in 1946. In 1958, the company moved from North Main Street to Bristol's Redstone Hill Industrial

Park. 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 Company was tested for radium. 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 (ORNL 2015).

During NRC's November 2016 initial site visit, an increased response on the detector was made immediately west of the stone wall near the 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 analyzed and contained significantly elevated concentrations of Ra-226 of approximately 290 pCi/g. 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 were present, presumably for metalwork related to clock manufacturing.

3.0 DATA QUALITY OBJECTIVES

The data quality objectives (DQOs) described herein are consistent with NUREG-1575, *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)* (NRC 2000) and provide a formalized method for planning radiation surveys, improving survey efficiency and effectiveness, and ensuring that the type, quality, and quantity of data collected are adequate for the intended decision applications. The seven steps in the DQO process are outlined below:

1. State the problem
2. Identify the decision
3. Identify inputs to the decision
4. Define the study boundaries
5. Develop a decision rule
6. Specify limits on decision errors
7. Optimize the design for obtaining data

3.1 Step 1 – State the Problem

The first step in the DQO process defines the problem that necessitates the study; identifies the planning team; and examines the budget and schedule. The Energy Policy Act of 2005 amended section 11e.(3) of the Atomic Energy Act of 1954, as amended, placing discrete sources of Ra-226 under NRC regulatory authority as byproduct material. The NRC is evaluating former manufacturing facilities and other identified locations where Ra-226 was historically used or stored to determine if residual Ra-226 sources and associated decay products are present and at concentrations above 10 CFR 20.1301 and/or 10 CFR 20.1402

limits. All data collected during the scoping survey will be used for future decision making. Based on this background, the problem statement is as follows:

> A scoping survey is required to determine if additional sources of Ra-226 are present and if the concentrations could contribute to a dose that exceeds the 25 mrem/yr and/or 100 mrem/yr radiological dose limits.

Project Organization and Responsibilities. Table 1 presents the project organization across programs and departments, including key personnel, roles, and contact information. The inspector will coordinate with the NRC's Office of Nuclear Material Safety and Safeguards (NMSS) and the property owner to gain site access. Regional management will coordinate with the property owner for access agreements and scheduling. The inspector will coordinate with the NMSS project manager for site coordination, state coordination, outreach, and internal NRC coordination.

Table 1. Key Personnel Contact Information

Name	Org.	Role	Phone	E-mail
David Misenhimer	NRC, HQ	Project Manager	301-415-6590	David.Misenhimer@nrc.gov
Orysia Masnyk-Bailey	NRC, RI	Inspector	610-337-5323	Orysia.MasnykBailey@nrc.gov
David King	ORAU	Project Manager	865-574-0685	David.King@orau.org

HQ = Headquarters
RI = Region I

Project Budget and Schedule. The project is funded by the NRC under contract NRC-HQ-50-17-A-0001, and the scoping survey is tentatively scheduled for the month of November 2017. Fieldwork is anticipated to last 1 day. A scoping survey report will be issued after the completion of fieldwork. Laboratory analytical data may not be available for the draft report, but results will be submitted to NRC upon receipt and will be included in the final version.

3.2 Step 2 – Identify the Decision

The second step in the DQO process identifies the Principal Study Questions (PSQs) and Alternate Actions (AAs); develops a decision statement; and organizes multiple decisions, as appropriate. This is done by specifying AAs that could result from a "yes" response to the PSQs and combining the PSQs and AAs into a decision statement. Table 2 presents the PSQs and AAs combined into a decision statement.

Table 2. SQs, AAs and Decision Statement	
Principal Study Question	Alternative Actions
PSQ1: Has the scoping survey identified elevated Ra-226 concentrations that could contribute to a dose of greater than 100 mrem/yr?	**No**: The data will be used to determine if concentrations could contribute to a dose of greater than 25 mrem/yr. **Yes**: The data will be used by the NRC to recommend future actions to control and mitigate risk from exposure to discrete sources of Ra-226.
PSQ2: Has the scoping survey identified elevated Ra-226 concentrations that could contribute to a dose of greater than 25 mrem/yr?	**No**: The data will be used to support the conclusion that no additional action is required to protect current or future receptors from exposure to discrete sources of Ra-226. **Yes**: The data will be used by the NRC to recommend future actions to control and mitigate risks from exposure to discrete sources of Ra-226.
Decision Statement	
Discrete sources of Ra-226 are (or are not) present at levels that could contribute to a dose of greater than 25 mrem/yr and/or 100 mrem/yr total dose; therefore, NRC does (or does not) recommend additional action at the property to control and mitigate risks from exposure to discrete sources of Ra-226.	

3.3 Step 3 – Identify Inputs to the Decision

The third step in the DQO process identifies both the information needed and the sources for this information; determines the basis for action levels; and identifies sampling and analytical methods that will meet data requirements. For this effort, information inputs include the following:

- Energy Policy Act of 2005 amended section 11e.(3) of the Atomic Energy Act of 1954, as amended
- 10 CFR Part 20, Standards for Protection Against Radiation, Sections 20.1301 and 20.1402
- *Site Status Report for Former Ingraham Clock Company Property at 284 North Main Street in Bristol, Connecticut* (ORAU 2017b)
- Site access agreements and associated limitations, if any
- Site summary documentation (ORNL 2015; ATSDR 1999)
- NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (NRC 1998), for estimating detector-specific minimum detectable concentrations (MDCs)

- Applicable field instrumentation and survey procedures, method procedures, data/sample management procedures, and survey results

- Applicable analytical laboratory procedures, method procedures, data/sample management procedures, and analytical results

3.4 Step 4 – Define the Study Boundaries

The fourth step in the DQO process defines target populations and spatial boundaries; determines the timeframe for collecting data and making decisions; addresses practical constraints; and determines the smallest subpopulations, area, volume, and time for which separate decisions must be made.

The scoping survey will be performed within the undeveloped area of the embankment shown in Figure 1, which lies along the eastern edge of the property. Boundary conditions include physical and practical factors that may limit the scoping survey. More specifically:

- Physical boundary: The eastern portion of the property contains dense underbrush and tree cover, including evergreens.

    - Undergrowth may limit physical access to some areas;

    - Evergreens and other trees will limit, if not preclude, use of global positioning system equipment; and

    - The embankment has a steep incline potentially limiting safe access to some portions of the area.

- Temporal boundary: Inspectors will have limited time (one workday) to survey and sample the embankment.

- Practical boundary: Access agreements and weather conditions could limit the area surveyed or further restrict the time window.

3.5 Step 5 – Develop a Decision Rule

The fifth step in the DQO process specifies the appropriate parameter of interest (e.g., mean, median); confirms action levels (ALs) are above detection limits; and develops an "if…then…" decision rule statement. This is a judgmental investigation designed to identify discrete sources of Ra-226 that could produce a dose above regulatory limits.

Field and analytical laboratory detection limits are addressed under Sections 3.6 and 6 of this plan. This is a judgmental investigation designed to define the magnitude and extent of Ra-226 contamination and identify any discrete sources of Ra-226, if present. Thus, the scoping survey design does not fit a traditional DQO model that requires mean, median, etc., for parameters of interest. That is, the identification of a single discrete source of Ra-226 may result in future NRC actions. Additionally, access will likely be limited based on physical boundary conditions (as described under Step 4), so the objective is to cover as much area as possible, in the time allowed, to support future decisions.

Given the above information, the decision rule can be stated as:

> If discrete sources of Ra-226 are found to contribute to a radiation dose above a dose limit, then the NRC may recommend actions to control access to the area; else the data may be used to support a no-further-action decision.

3.6 Step 6 – Specify Limits on Decision Errors

The sixth step in the DQO process specifies the decision maker's limits on decision errors, which are then used to establish performance goals for the survey. The nature of this project and the boundary conditions typical for scoping surveys do not support robust decision errors that may be developed for a statistical (rather than judgmental) survey design. Statistical-based methods are routinely applied to characterization or final status efforts and not scoping, which are typically smaller scale and rely on judgmental (rather that statistical) data. However, controls related to instrument sensitivity will be in place such that data will be of sufficient quality for future use.

A Ludlum Model 44-10 2×2 sodium iodide detector coupled to a Ludlum Model 2221 ratemeter-scaler will be used to locate discrete sources of Ra-226. The Ra-226 will be identified based on an increase in audible output from the ratemeter and marked using pin flags. The surveyor will document the location (photographs and field maps) and estimate the area of the contamination in square-meter units (m^2). Judgmental volumetric samples to assess the contamination will be collected and submitted to the laboratory for analysis, as requested by NRC.

Using the default methods described in NUREG-1507, *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions* (NRC 1998), the scan MDC for Ra-226 is estimated at 2.8 pCi/g, as presented in Table 3. A background concentration of approximately 1 pCi/g is expected, based on previous survey data. Larger detectors (e.g., a 3×3) or detector collimators could be used to increase the signal or decrease background, but the slope and undergrowth make these options impractical. The Dose Assessment Technical Basis Document presents ALs for small areas of elevated activity that could produce a dose of 25 mrem/yr (ORISE 2017). The concentration-based AL for a 1-m^2 small area of elevated activity is 4.2 pCi/g, and the concentration-based AL for a 0.1-m^2 small area of elevated activity is 42 pCi/g. Therefore, though the 2×2 sodium iodide may not be sufficient for detecting Ra-226 concentrations just above background, the detector is sufficient for locating contractions at ALs associated with small areas of elevated activity (i.e., ≤ 1 m^2).

Table 3. Example Minimum Detectable Concentrations

Radiation Type	Detector Type	Typical Bkg (cpm)	Detector Model (Number)	Ratemeter (Number)	Scan MDC
Gamma	Sodium Iodide	10,000	44-10	2221	2.8 pCi/g[a,b]

[a] Assumes equilibrium with progeny
[b] Default scan MDC from NUREG-1507 for soil or soil-like (bulk) materials

3.7 Step 7 – Optimize the Design for Obtaining Data.

The seventh step in the DQO process is used to review DQO outputs; develop data collection design alternatives; formulate mathematical expressions for each design; select the sample size to satisfy DQOs; decide on the most resource-effective design of agreed alternatives; and document requisite details. The overall approach is to collect sufficient data for NRC to make a decision given the boundary conditions identified in Section 3.4.

The scoping survey team will survey the eastern portion of the property using the 2×2 sodium iodide detector to identify any additional sources of Ra-226 that may be present. Discrete sources of Ra-226 will be identified based on an increase in audible output from the ratemeter. The goal is for 100 percent survey coverage; however, this may be precluded by dense vegetation and the steep incline of the embankment.

Two ORAU personnel will be present during the survey. One person will perform the survey using the 2×2 sodium iodide detector and exposure ratemeter, and the other person will record the data. Areas with elevated levels of radiation will be delineated, clearly marked in field maps, and located (e.g., by recording distances to known landmarks). Judgmental locations will be selected and sampled based on survey results, and as otherwise directed by NRC.

A detailed logbook will be maintained, which will provide a comprehensive description of field activities. ORAU, at a minimum, will clearly document the following:

- Dates, times, and individuals performing the scoping survey
- Instrumentation type and identification numbers
- Site and environmental conditions and instrument background measurement data
- Soil sample identification numbers and proposed analyses
- Detailed maps or drawings documenting measurement and sample location information
- Detailed description of the location, physical characteristics, and radiation levels associated with confirmed discrete sources, if identified
- Relevant discussions or interactions with non-project personnel/stakeholders
- Details regarding any deviation from the plan

Surveyors will perform continuous scans of all accessible areas while recording the detector response on a map every 2 to 4 meters. The location of inaccessible areas will be documented on the field map. The end product will be photos and maps documenting the results of the survey. Figure 3 presents an example of the data map that will be generated showing the expected coverage density of survey data (represented by black dots).

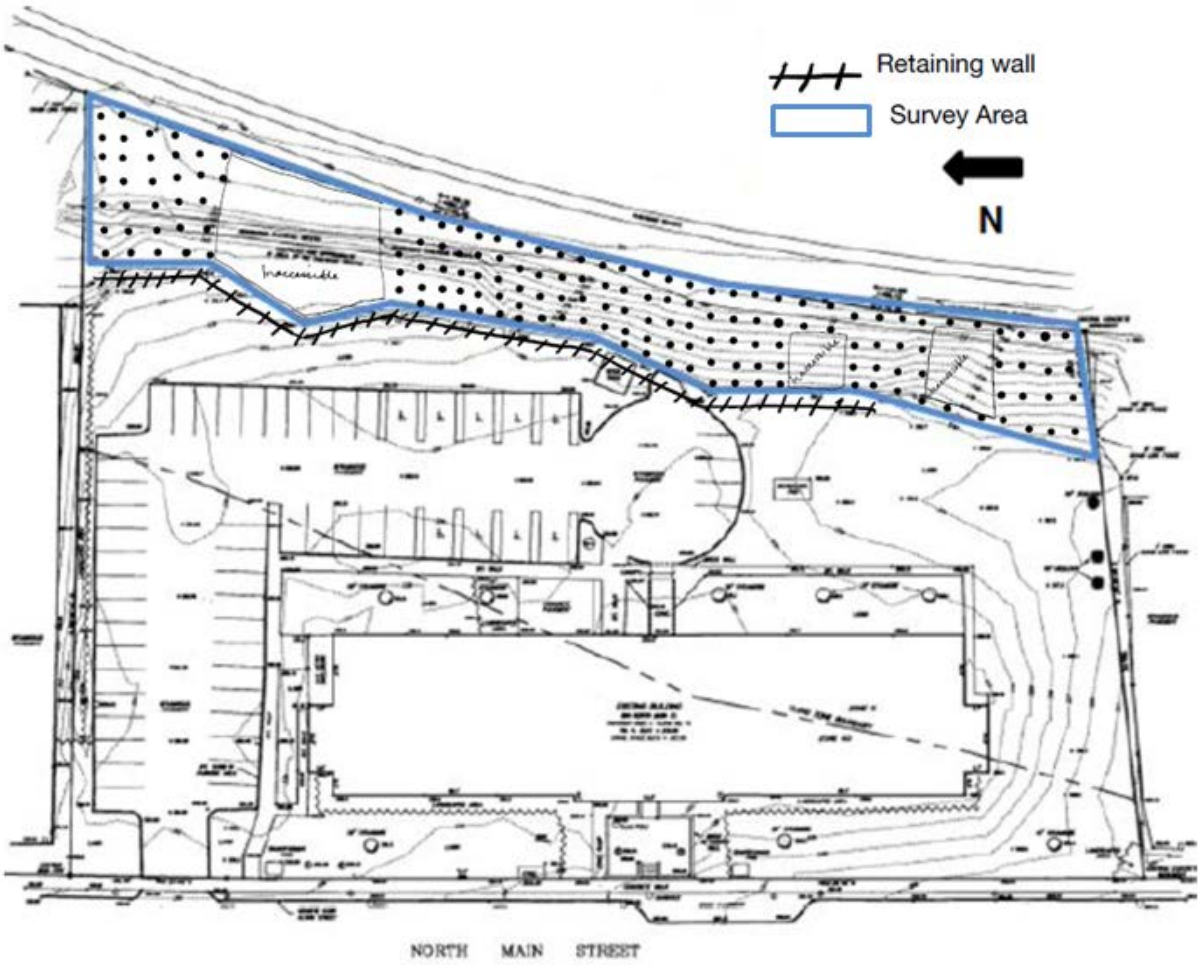

Figure 3. Example of Data Map from Scoping Survey

4.0 HEALTH AND SAFETY

Because the maximum level of contamination, if any, is unknown, inspectors will need to be flexible and prepared to upgrade personal protective equipment (PPE) if needed. Initial PPE will be minimal but will be adjusted as necessary.

- Appropriate PPE for this scoping survey consists of sturdy work shoes. Consult the *Health and Safety and Waste Management Work Instructions for Scoping Surveys at Sites Potentially Contaminated by Discrete Sources of Radium* (ORAU 2017a).

- If an exposure rate is encountered greater than 2 mrem/hr at 1 meter, or if the area is suspected of containing airborne contamination, then:

    - Coordinate/plan with regional management should significant contamination be encountered—NRC will notify the property owners, as appropriate.

    - Consider how best to delineate and control the area, and, if appropriate, clearly post the area to limit public access during and after sampling activities.

- Inspectors may be required to upgrade the level of PPE while sampling.

- Any waste (e.g., PPE and sampling equipment) will be managed according to the waste management plan (see Section 5.0).

Note that state officials from the Department of Energy and Environmental Protection may request to accompany the inspectors during the scoping survey. It should be clearly communicated that these individuals are responsible for their own health and safety.

A 3-meter-high retaining wall bounds part of the western edge of the embankment. For safety reasons, surveys may not approach within 1 meter of the top edge of the wall.

5.0 WASTE MANAGEMENT

Scoping survey activities have the potential for generating waste containing non-trivial levels of Ra-226 activity. Types of waste include PPE, sampling equipment (e.g., trowels, scrapers), and the sampled media (e.g., soil). Inspectors will implement a waste management plan prepared for these activities, in accordance with the *Health and Safety and Waste Management Work Instructions for Scoping Surveys at Sites Potentially Contaminated by Discrete Sources of Radium* (ORAU 2017a), to assure that potentially contaminated materials generated during the scoping survey are safely removed and ultimately dispositioned at an appropriate facility.

6.0 ANALYTICAL REQUIREMENTS

Table 4 presents example parameters used to plan the collection and analysis of medium-specific radium samples. Samples will be given a unique sample identification number and will be shipped under chain-of-custody to a subcontracted laboratory for analysis.

Volumetric samples will be analyzed either by gamma spectroscopy or, if approved by NRC, alpha spectroscopy; and the results reported in pCi/g.

Table 4. Example Sample and Analytical Parameters

Analyte	Matrix	Container	Preserv.	Hold Time	Method
Ra-226	Solids	Plastic Bag	None	180 d	Gamma or alpha spec.

7.0 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,* prepared by the Connecticut Department of Public Health under Cooperative Agreement with The Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services. January 29. (Agencywide Documents Access and Management System [ADAMS] Accession No. ML17038A052).

NRC 1998. *Minimum Detectable Concentrations with Typical Radiation Survey Instruments for Various Contaminants and Field Conditions*, NUREG-1507, U.S. Nuclear Regulatory Commission, Washington, D.C., January.

NRC 2000. *Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)*, NUREG-1575, Rev. 1, U.S. Nuclear Regulatory Commission, Washington, D.C., August.

ORAU 2017a. *Health and Safety and Waste Management Work Instructions for Scoping Surveys at Sites Potentially Contaminated by Discrete Sources of Radium*, DCN 5307-PL-02-1, Oak Ridge Associated Universities, Oak Ridge, Tennessee, August.

ORAU 2017b. *Site Status Report for Former Ingraham Clock Company Property at 284 North Main Street in Bristol, Connecticut.* DCN 5307-SR-20-1, Oak Ridge Associated Universities, September 11. (ADAMS Accession No. ML17034A506).

ORISE 2017. *Dose Assessment Technical Basis Document for Potential Exposures to Discrete Sources of Radium-226 and Associated Contamination*, DCN 5289-TR-01-2, Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee, May 30. (ADAMS Accession No. ML17152A204).

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