



**UNITED STATES  
NUCLEAR REGULATORY COMMISSION**  
WASHINGTON, D.C. 20555-0001

August 13, 2018

All-Star Property Management, LLC  
153 Main Street  
Suite 201  
Ansonia, CT 06401  
ATTN: Jeffrey Smith

**SUBJECT: PROPERTY AT 13 WALLENS STREET—RESULTS AND CONCLUSIONS OF  
U.S. NUCLEAR REGULATORY COMMISSION INITIAL SITE VISIT AND  
SCOPING SURVEY**

Dear Mr. Smith:

I am writing to provide you with the results of the U.S. Nuclear Regulatory Commission's (NRC's) May 1–2, 2018, site visit and June 26–27, 2018, scoping survey at your property at 13 Wallens Street, Winsted, Connecticut, which was formerly occupied by the William L. Gilbert Clock Company. As outlined in our letter to you dated October 6, 2016,<sup>1</sup> the NRC staff conducted these visits to your property to: 1) determine if discrete sources of radium-226 or distributed radium-226 contamination are present, 2) identify the areas of highest contamination (if any radium contamination is identified), 3) determine if there are any current radiological health and safety concerns, and, 4) determine if further action by the NRC is needed. The results of the NRC's initial site visit and scoping survey are summarized below and are discussed in further detail in the enclosed report.

During the initial site visit and scoping survey, the staff conducted radiation surveys in all of the apartments in Building A and more than half of the apartments in Building B/C. The staff surveyed approximately 50 percent of the floor area in occupied apartments and 100 percent of the floor area in unoccupied apartments that were entered. Our ability to survey the occupied apartments was limited because of furniture in the apartments. A detailed list of the apartments that were surveyed can be found in the attached report. Additionally, the staff surveyed approximately 30 percent of the area outside of the apartment buildings. The staff did not survey under the parking lot or building foundations.

During our visits, we identified elevated radiation levels at discrete locations in apartments A-1, A-17, A-19, A-20, A-21, and A-22. In areas where we identified elevated radiation levels, we conducted additional measurements to test for transferable contamination. No transferable contamination was identified. These elevated levels of radiation are indicative of discrete sources of radium. All radium identified in the apartments was evaluated conservatively, assuming a residential-use scenario (i.e., 5,770-hour annual occupancy) as established in the Dose Assessment Technical Basis Document for Potential Exposures to Discrete Sources of Radium-226 and Associated Contamination.<sup>2</sup> As conservatively modeled by the staff, the radium

---

<sup>1</sup> Agencywide Documents Access and Management System (ADAMS) Accession No. ML16277A318.

<sup>2</sup> ADAMS Accession No. ML17072A414.

identified does not exceed the NRC's dose limit of 25 millirem per year for unrestricted use in Title 10 of the *Code of Federal Regulations* (10 CFR), Section 20.1402, *Radiological criteria for unrestricted use*.

No radium contamination was identified in the other apartments surveyed in Building A, or any of the apartments surveyed in Building B/C.

Because radium contamination was identified, as part of any voluntary cleanup effort, you may wish to consult with an NRC or Agreement State licensed service provider to ensure that there is limited potential for radiological contamination to be spread. Please be aware that activities at your site may also be subject to State requirements and standards. However, no further actions on your part are required at this time.

In accordance with 10 CFR 2.390 of the NRC's "Agency Rules of Practice and Procedure," a copy of this letter will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records component of ADAMS. ADAMS is accessible from the NRC Web site at <http://www.nrc.gov/reading-rm/adams.html>.

The staff will contact you in the near future to answer any questions you may have regarding this report, but if you have any immediate questions, please contact Mr. Stephen Koenick, Chief, Materials Decommissioning Branch, Division of Decommissioning, Uranium Recovery and Waste Programs, Office of Nuclear Materials Safety and Safeguards, at (301) 415-6631 or Mr. Jeffrey Whited, Project Manager, at (301) 415-4090.

Sincerely,

**/RA/ AKock for**

John R. Tappert, Director  
Division of Decommissioning, Uranium Recovery  
and Waste Programs  
Office of Nuclear Material Safety  
and Safeguards

Docket No. 03038939

Enclosure:  
Site Status Report

REGISTERED LETTER – RETURN RECEIPT REQUESTED

SUBJECT: PROPERTY AT 13 WALLENS STREET – RESULTS AND CONCLUSIONS OF  
U.S. NUCLEAR REGULATORY COMMISSION INITIAL SITE VISIT AND  
SCOPING SURVEY Dated August 13, 2018

**DISTRIBUTION:**

RidsRgn1MailCenter L.Kauffman, RI

**ADAMS Accession No.: ML18198A423****\*via e-mail**

<b>OFFICE</b>	DUWP	DUWP/LA	DUWP	RI/HP
<b>NAME</b>	JWhited	CHolston	CGrossman*	LKauffman*
<b>DATE</b>	07/19/2018	07/19/2018	07/20/2018	08/02/2018
<b>OFFICE</b>	RI/DNMS	DUWP	OGC*	DUWP
<b>NAME</b>	RPowell*	SKoenick	TCampbell	JTappert (AKock for)
<b>DATE</b>	08/02/2018	08/06/2018	08/06/2018	08/13/2018

**OFFICIAL RECORD COPY**

**Enclosure**

**OAK RIDGE ASSOCIATED UNIVERSITIES:  
SITE STATUS REPORT FOR GILBERT CLOCK SHOP APARTMENTS  
(FORMERLY WILLIAM L. GILBERT CLOCK COMPANY) AT  
13 WALLENS STREET IN WINSTED, CONNECTICUT**

**AUGUST 13, 2018**

## EXECUTIVE SUMMARY

The U.S. Nuclear Regulatory Commission (NRC) requested that Oak Ridge Associated Universities (ORAU) perform a radiation survey of the former William L. Gilbert Clock Company property at 13 Wallens Street in Winsted, Connecticut. Founded in 1866, the Gilbert Manufacturing Company was one of the largest clock-makers in the world and manufactured radium-containing products such as “Night and Day Radium Dial Clocks.” The objectives of this survey were to: (1) determine if discrete sources of radium-226 or distributed radium-226 contamination are present, (2) identify the areas of highest contamination (if any radium contamination is identified), (3) determine if there are any current health and safety concerns, and (4) determine if further action by the NRC is needed.

ORAU performed radiation surveys in accessible portions of Buildings A and B/C during the initial site visit on May 1-2, 2018. Surveys identified discrete sources of radium-226 remaining in Building A; no elevated radiation levels were identified in Building B/C. A detailed dose assessment was performed, and results led to the conclusion that it is unlikely the identified sources would reasonably result in a dose in excess of regulatory requirements. However, because discrete sources of radium were found in two of the apartments sampled, NRC directed ORAU to return to survey the remaining apartments in Buildings A and C. Additional discrete sources of radium-226 were discovered in Building A during the scoping survey on June 26-27, 2018. Subsequent dose assessment results again lead to the conclusion that it is unlikely identified sources would reasonably result in a dose in excess of regulatory requirements. Therefore, it is recommended that the NRC not pursue additional action at the 13 Wallens Street property.

## SITE STATUS REPORT

Property: Former William L. Gilbert Clock Company  
13 Wallens Street  
Winsted, CT 06098

Docket Number: 03038939

Current Property Name(s): Gilbert Clock Shop Apartments

Current Property Owner(s): Gilbert Clock Properties, LLC

Inspection Dates: May 1-2, 2018 (initial site visit)  
June 26-27, 2018 (scoping survey)

Inspector(s): Raymond Powell, Steve Hammann, Katherine Warner, and Anne DeFrancisco/ U.S. Nuclear Regulatory Commission (NRC), supported by Kaitlin Engel, Jason Lee, and Andrew Owens/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. The Gilbert Clock Shop Apartments at 13 Wallens Street in Winsted, Connecticut (CT) were identified as part of the former William L. Gilbert Clock Company property, where clocks were manufactured from 1866 to 1964. During this time, the clock factory employed 500 workers and produced two thousand clocks per day (ORNL 2015). One of Gilbert's products was "Night and Day Radium Dial Clocks" using "LUMA-nous" dials developed by the Gilbert engineering department (Funk and Wagnalls 1920). Because the two remaining original manufacturing buildings were renovated, the extent of Ra-226 contamination, if any, on original structural materials (exterior walls and heavy floor beams) was unknown prior to this 2018 investigation. Surveys were performed as described within NRC's procedure, Temporary Instruction (TI) 2800/043, *Inspection of Facilities Potentially Contaminated with Discrete Radium-226 Sources* (NRC 2018).

During the May 2018 initial site visit, inspectors performed surveys of outdoor areas and 22 percent of the apartments within Buildings A and B/C. Inspectors identified one small area of elevated activity in Apartment A-17 and two small areas of elevated activity in Apartment A-22 that produced gamma radiation above ambient background levels (ORAU 2018). Due to this finding, NRC determined that a follow-up scoping survey should be performed to more thoroughly investigate the property. The scope of the June 2018 scoping survey included the remaining apartments in Buildings A and C that were not surveyed during the May site visit. Additionally, Apartment A-22 was re-surveyed. The objectives of both the initial site visit and scoping surveys were to locate and delineate discrete sources of radium if present and, if so, determine whether these sources could result in a dose above regulatory limits. This site summary report documents findings from the May and June 2018 surveys.

## 2.0 PROPERTY DESCRIPTION AND INITIAL SITE VISIT CONSIDERATIONS

### 2.1 Property Description and History

The William L. Gilbert Clock Company was established in Winsted, Connecticut in July 1871 to take over the Gilbert Manufacturing Company (1866-1871), which was one of the various clock making operations of William L. Gilbert (1806-1890). The historic factory complex was originally located on the north and south sides of Wallens Street and Main Street, on the eastern bank of the Still River. After the original factory was destroyed by fire in 1871, a new factory complex was completed and manufacturing commenced in July 1873 under George B. Owen (1834–1916). In 1897, the Gilbert firm built a four-story building for a case shop, another for storage and shipping by 1900, and a three-story office building in 1902. During this time, the clock company employed 500 workers and produced two thousand clocks per day (ORNL 2015). One of Gilbert's products was "Night and Day Radium Dial Clocks" using "LUMA-nous" dials developed by the Gilbert Engineering Department (Funk and Wagnalls 1920). Despite financial burdens of the recent expansion and the onset of the recession, the company continued until it was sent into receivership in 1932, due to the Great Depression. In July 1934, a new firm, known as the William L. Gilbert Clock Corporation was formed and was allowed to continue making clocks in the 1940s during World War II because it manufactured clocks with molded papier-mâché cases rather than metal. In 1954, the firm began producing adding machines for General Computing Machines Corporation before being subsumed by General Computing Machines Corporation in 1957. In 1955, two hurricanes (Connie and Diane) within a span of one week caused the Still River and the Mad River, which parallels Main Street, to flood. The flooding damaged the buildings that were located south of Wallens Street. In December 1964, the clock making division was sold to Spartus Corporation of Chicago. In 1975, the buildings south of Wallens Street were destroyed by fire. The two large buildings that survive today are the four-story brick buildings (one building directly on the river bank and the other is set up the hill to the east). The buildings were renovated and converted into apartments in 1997 after sitting empty for almost 20 years. Most structural materials are presumed new from the 1997 renovation, except for the existing exterior walls and heavy floor beams (ORNL 2015).

In addition, these surviving buildings are a preservation of Connecticut's history as a center for the manufacture of low-cost clocks that was one of the town's largest employers for many years. The surviving buildings were listed on the National Register of Historic Places in 1984.

Figure 1 shows a current view of the over 8,900-m<sup>2</sup> (2.21-acre) Lot 009 property with the two brick apartment buildings, noting the property boundary outlined in blue. The square footage of the buildings is unknown. Each building contains four floors, and each floor contains seven or eight apartments. Building A is located along Wallens Street, and the long dimension of Building B/C runs along White Street. The first and second floor of Building B/C is associated with Building B, and the third and fourth floors are associated with Building C (thus Building B/C). The buildings contain one- and two-bedroom apartments with different layouts. The property also contains an asphalt parking lot outside of the apartment buildings and a wooded area that runs along the Still River.

### 2.2 Initial Site Visit Considerations

Prior to commencing survey activities each day, the general property layout was examined for consistency with historical information and to identify impediments to conducting the survey and health and safety considerations. No health or safety issues were noted. However, it was noted that access was limited in the outdoor area due to steep terrain and heavy branches.

Access was also limited in some apartments due to occupancy (e.g., beds, dressers, couches). A schedule for accessing apartments was developed by the property manager and communicated to the applicable residents. The schedule allotted 60 minutes (initial site visit) or 45 minutes (scoping survey) per apartment to perform and document survey activities. It is also noted that the original flooring has been covered with carpet, with the exception of kitchens, bathrooms, and entryways, where tile or linoleum was used; therefore, direct measurements could not be performed on the original flooring.

### 3.0 SITE OBSERVATIONS AND FINDINGS

#### 3.1 Summary of Activities (Site Visit)

The inspection team conducted the initial site visit survey at the 13 Wallens Street property on May 1-2, 2018. The inspection team included Raymond Powell and Anne DeFrancisco (NRC); and Kaitlin Engel and Andrew Owens (ORAU). Jay Warden (Gilbert Clock Shop Apartments) acted as site escort. The inspection team's intention was to perform general area radiation surveys of the outdoor area of the property as well as inside Buildings A and B/C.



**Figure 1. Current View of 13 Wallens Street (Property Outlined in Blue)**



Radiological surveys performed by the inspection team consisted of gamma radiation scans within the outdoor area and buildings using a Ludlum model 44-10 2-inch by 2-inch (2×2) sodium iodide detector connected to a Ludlum model 2221 ratemeter/scaler, alpha-plus-beta radiation direct measurements using a Ludlum model 44-142 plastic scintillator connected to a Ludlum model 2221 ratemeter/scaler, and radiation exposure rate measurements using a Ludlum model 192 sodium iodide-based  $\mu$ R ratemeter<sup>1</sup>. A hand-held identiFINDER R300-Z was used to confirm, if possible, the presence of Ra-226 when elevated radiation levels were encountered. Table 1 presents the specific instruments used during the initial site visit. Smear samples were also collected at selected locations to quantify the removable surface activity levels.

Table 1. Gilbert Clock Company Survey Instruments for Site Visit			
Radiation Type (units)	Detector Type	Detector Model (Number)	Ratemeter (Number)
Alpha-plus-beta (cpm)	Plastic Scintillator	44-142 (919) Calibrated 04/10/2018	2221 (1139) Calibrated 04/06/2018
		44-142 (920) Calibrated 04/10/2018	2221 (1144) Calibrated 04/06/2018
Gross gamma (cpm)	Sodium Iodide	44-10 (1151) Calibrated 11/03/2017	2221 (1139) Calibrated 04/06/2018
		44-10 (1152) Calibrated 11/03/2017	2221 (1144) Calibrated 04/06/2018
Gross gamma ( $\mu$ R/h)	Exposure Meter	192 (1127) Calibrated 06/02/2017  192 (1128) Calibrated 06/02/2017	N/A
Gamma Spectrum Analyzer (identiFINDER)	Cesium Iodide	R300-Z (CG0343) <sup>a</sup>	N/A

N/A = not applicable

Number = ORAU equipment barcode

cpm = counts per minute

$\mu$ R/h = microRoentgen per hour

<sup>a</sup>A known radium source is used to confirm the identiFINDER will identify Ra-226.

<sup>1</sup>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).

### Summary of Daily Activities—May 1, 2018:

The inspection team arrived at 8:30 a.m. and met with representatives from the NRC and the apartment complex. The inspection team surveyed apartments A-3, A-7, A-8, A-10, A-17, A-22, A-23, and A-25. Surveys were conducted on accessible floor space, with scan coverage ranging from approximately 50 percent (occupied apartments) to 100 percent (vacant apartments). Surveys were also conducted on the four hallways and two stairwells in Building A (100 percent coverage) and the outdoor areas of the site (approximately 30 percent coverage). The team identified three discrete areas exhibiting elevated radiation levels: one small area of elevated activity in apartment A-17 and two small areas of elevated activity in apartment A-22. The team departed the site at approximately 5:00 p.m.

### Summary of Daily Activities—May 2, 2018:

The inspection team arrived at 8:30 a.m. and began surveying Building B/C. Survey activities were conducted in apartments B-32, B-39, B-45, B-48, C-56, C-58, C-64, and C-67. Surveys were conducted on accessible floor space, with scan coverage ranging from approximately 50 percent (occupied apartments) to 100 percent (vacant apartments). Surveys were also conducted on the four hallways, two stairwells, lobby area, and leasing office of Building B/C (100 percent coverage). No areas exhibiting elevated radiation levels were identified. The team departed the site at approximately 2:30 p.m.

### 3.2 Summary of Activities (Scoping Survey)

As directed, the inspection team returned to the site and conducted a scoping survey at the 13 Wallens Street property on June 26-27, 2018. The inspection team included Raymond Powell, Steve Hammann, and Katherine Warner (NRC); and Jason Lee and Andrew Owens (ORAU). Jay Worden, Jeff Smith, and Priscilla O'Malley (Gilbert Clock Shop Apartments) acted as site escorts. The inspection team's objective was to perform general area radiation surveys for the remaining Building A and C apartments not previously surveyed during the initial site visit. Table 2 presents the specific instruments used during the scoping survey. Smear samples were also collected at selected locations to quantify the removable surface activity levels.

<b>Table 2. Gilbert Clock Company Survey Instruments for Scoping Survey</b>			
<b>Radiation Type (units)</b>	<b>Detector Type</b>	<b>Detector Model (Number)</b>	<b>Ratemeter (Number)</b>
Alpha-plus-beta (cpm)	Plastic Scintillator	44-142 (920) Calibrated 04/10/2018	2221 (1141) Calibrated 04/06/2018
Gross gamma (cpm)	Sodium Iodide	44-10 (1151) Calibrated 05/15/2018	2221 (1139) Calibrated 04/06/2018
		44-10 (1152) Calibrated 05/15/2018	2221 (1141) Calibrated 04/06/2018
Gross gamma ( $\mu$ R/h)	Exposure Meter	192 (1127) Calibrated 05/21/2018  192 (1128) Calibrated 05/21/2018	N/A
Gamma Spectrum Analyzer (identiFINDER)	Cesium Iodide	R300-Z (CG0343) <sup>a</sup>	N/A

N/A = not applicable

Number = ORAU equipment barcode

cpm = counts per minute

$\mu$ R/h = microRoentgen per hour

<sup>a</sup>A known radium source is used to confirm the identiFINDER will identify Ra-226.

#### **Summary of Daily Activities—June 26, 2018:**

The inspection team arrived at 8:00 a.m. and met with representatives from the NRC and the apartment complex. The inspection team surveyed all the remaining apartments in Building C (C-53, C-54, C-55, C-57, C-59, C-60, C-61, C-62, C-63, C-65, C-66, C-68, C-69, C-70, C-71, C-72, C-73, C-74), and Building A apartments A-1 and A-22. Surveys were conducted on accessible floor space with scan coverage ranging from approximately 30 percent to 70 percent, depending on furniture and other obstacles in occupied apartments. The team identified a small discrete area exhibiting elevated radiation levels in apartment A-1. The team also investigated an area from the initial site visit in apartment A-22 and found an additional small area of elevated activity. The inspection team departed the site at approximately 4:30 p.m.

#### **Summary of Daily Activities—June 27, 2018:**

The inspection team arrived at 8:00 a.m. Survey activities were conducted in all the remaining apartments in Building A (A-2, A-4, A-5, A-6, A-9, A-11, A-12, A-13, A-14, A-15, A-16, A-18, A-19, A-20, A-21, A-24, A-26, A-27, A-28, and A-29). Surveys were conducted on accessible floor space with scan coverage ranging from approximately 30 percent to 70 percent, depending on furniture and other obstacles in occupied apartments. The team identified six discrete areas exhibiting elevated radiation levels in three apartments: one in apartment A-19, one in

apartment A-20, and four in apartment A-21. The team departed the site at approximately 4:30 p.m.

### 3.3 Summary of Results

Appendix A presents representative photos taken during the survey of vacant apartments, some of the locations that identified exhibited elevated radiation levels, and the outdoor area from both the initial visit and the scoping survey. Appendix B, Figures B-1 through B-8 present the general layout of each survey area, the location of individual radiation measurements (including small areas of elevated activity), and other relevant information for the outdoor areas and only the six apartments where areas of elevated radiation levels were identified. Note that these ORAU-generated facility drawings are not to scale, and the illustrated features are based on the observations of the inspection team at the time of the survey.

Appendix B, Tables B-1 through B-8 present the radiation survey data associated with each respective figure. As applicable, results include the measurement location, smear number, and associated analytical laboratory alpha-plus-beta removable result in disintegrations per minute per 100 cm<sup>2</sup> (dpm/100 cm<sup>2</sup>); gross and net total alpha-plus-beta responses in cpm and dpm/100 cm<sup>2</sup>, respectively; gross 2×2 sodium iodide and exposure rates on contact in cpm and µR/h, respectively; and gross exposure rates in µR/h collected at 1 meter from the surface.

Smears were submitted for gross alpha and gross beta analysis at a radio-analytical laboratory. Static field measurements of total alpha-plus-beta activity in units of cpm were converted to total Ra-226 surface activity in units of dpm/100 cm<sup>2</sup> using the following equation:

$$dpm/100\text{ cm}^2 = \frac{C - B}{\varepsilon_{tot} \times G}$$

Where:

C = measured count rate (cpm)

B = background count rate (cpm)

G = geometry factor (unitless) =  $\frac{\text{Physical Detector Area (cm}^2\text{)}}{100\text{ cm}^2} = 1.0$

$\varepsilon_{tot}$  = total weighted efficiency (unitless) = 0.11

Due to the number of emissions from Ra-226 and its associated progeny, multiple radiation particles are counted during the surface activity measurement. Therefore, a total weighted efficiency for Ra-226 and its associated progeny was calculated by:

$$\varepsilon_{tot} = \sum_n F_n \times \varepsilon_{i,n} \times \varepsilon_{s,n}$$

Where:

$F_n$  = fractional abundance of n<sup>th</sup> emission,

$\varepsilon_{i,n}$  = instrument efficiency for n<sup>th</sup> emission, and

$\varepsilon_{s,n}$  = surface efficiency (0.25 for low-energy beta particles, 0.5 for high-energy beta particles) for n<sup>th</sup> emission.

A total weighted efficiency of 0.11 was estimated at the ORAU facility after conducting a series of radiation measurements using alpha/beta sources and a piece of low-pile carpet. The objective of these measurements was to mimic conditions encountered at the site and, therefore, calculate a realistic efficiency that would not underestimate true radiological conditions. The measurements demonstrated that all alpha radiation and low-energy beta radiation is shielded by carpet, thus the plastic scintillator is estimated to identify only a small percentage of the total alpha/beta radiation emanating from the source surface.

Table 3 summarizes survey results from the May 2018 and June 2018 survey efforts for the 55 apartments, 8 hallways, 4 stairwells, and the outdoor areas surveyed. In general, background gamma radiation levels ranged from 3 to 19  $\mu\text{R/h}$  at 1 meter. Higher background radiation levels are associated with naturally occurring radioactive material (NORM) in the exterior brick walls of the buildings and rock retaining walls on the property. To the extent possible, each room was divided into quadrants and systematic contact 2x2 sodium iodide (in cpm) and 1 meter model 192 exposure rate measurements (in  $\mu\text{R/h}$ ) were collected at the center of each quadrant and at the middle of the room, following the survey design described in ORAU 2018. Surveyors also collected contact gamma and alpha-plus-beta measurements (in cpm) and contact  $\mu\text{R/h}$  data, 1 meter  $\mu\text{R/h}$  data, identiFINDER data, and removable (smear) samples at identified locations exhibiting elevated radioactivity relative to background. Appendix B presents details for the outdoor areas and the six apartments where areas of elevated radiation levels were identified, thus the following discussion presents a general summary for the outdoor and all indoor areas.

**Table 3. Summary of Discrete Areas of Elevated Radiation at the Former Gilbert Clock Company**

Area/Apartment No.	No. Elevated Areas	Gross Gamma (cpm)	Gross Exposure Rate ( $\mu$ R/h)		No. Smears	Surface Activity (dpm/100 cm <sup>2</sup> )		Max Size (m <sup>2</sup> )
			Contact	1 meter		Total Ra-226	Removable	
Outdoor Area - River	0	7,500 to 39,000	NA	8 to 19	0	—	—	—
Outdoor Area - Parking Lot	0	7,000 to 26,000	NA	7 to 17	0	—	—	—
Bldg. A 1st Floor Hallway / S. Stair	0	6,200 to 17,000	NA	5 to 15	0	—	—	—
Bldg. A 2nd Floor Hallway	0	7,700 to 8,900	NA	7 to 8	0	—	—	—
Bldg. A 3rd Floor Hallway	0	6,500 to 8,600	NA	6 to 8	0	—	—	—
Bldg. A 4th Floor Hallway / N. Stair	0	4,800 to 11,200	NA	5 to 9	0	—	—	—
Apt. A-1	1	11,500 to 18,000	18	11 to 15	0	—	—	0.01
Apt. A-2	0	10,200 to 14,000	NA	8 to 15	0	—	—	—
Apt. A-3	0	10,100 to 14,200	NA	9 to 12	0	—	—	—
Apt. A-4	0	10,400 to 13,100	NA	8 to 12	0	—	—	—
Apt. A-5	0	9,500 to 13,000	NA	8 to 12	0	—	—	—
Apt. A-6	0	9,700 to 14,500	NA	8 to 13	0	—	—	—
Apt. A-7	0	9,700 to 15,000	NA	8 to 14	0	—	—	—
Apt. A-8	0	9,200 to 11,800	NA	8 to 11	0	—	—	—
Apt. A-9	0	7,500 to 12,600	NA	6 to 12	0	—	—	—
Apt. A-10	0	7,600 to 17,000	NA	6 to 17	0	—	—	—
Apt. A-11	0	7,200 to 13,000	NA	8 to 14	0	—	—	—
Apt. A-12	0	8,200 to 13,900	NA	8 to 12	0	—	—	—
Apt. A-13	0	7,500 to 15,500	NA	7 to 13	0	—	—	—
Apt. A-14	0	8,000 to 15,000	NA	7 to 13	0	—	—	—
Apt. A-15	0	7,400 to 11,400	NA	7 to 10	0	—	—	—
Apt. A-16	0	6,500 to 12,800	NA	6 to 12	0	—	—	—
Apt. A-17	1	6,800 to 28,500	23	6 to 13	1	2,100	< 1	0.01

**Table 3. Summary of Discrete Areas of Elevated Radiation at the Former Gilbert Clock Company**

Area/Apartment No.	No. Elevated Areas	Gross Gamma (cpm)	Gross Exposure Rate ( $\mu$ R/h)		No. Smears	Surface Activity (dpm/100 cm <sup>2</sup> )		Max Size (m <sup>2</sup> )
			Contact	1 meter		Total Ra-226	Removable	
Apt. A-18	0	7,300 to 13,200	NA	7 to 11	0	—	—	—
Apt. A-19	1	6,700 to 62,000	50	6 to 20	1	16,000	< 1	0.01
Apt. A-20	1	7,100 to 122,000	120	7 to 27	1	36,000	< 1	0.1
Apt. A-21	4	7,200 to 60,000	25 to 60	7 to 18	2	14,000	< 1	0.01
Apt. A-22	3	9,200 to 134,000	38 to 100	7 to 23	2	6,900 to 33,000	< 1 to 1	1
Apt. A-23	0	5,700 to 10,000	NA	5 to 10	0	—	—	—
Apt. A-24	0	5,500 to 9,200	NA	5 to 9	0	—	—	—
Apt. A-25	0	6,200 to 11,400	NA	5 to 11	0	—	—	—
Apt. A-26	0	5,200 to 9,400	NA	5 to 9	0	—	—	—
Apt. A-27	0	5,200 to 15,400	NA	5 to 14	0	—	—	—
Apt. A-28	0	5,300 to 9,400	NA	5 to 9	0	—	—	—
Apt. A-29	0	5,600 to 10,200	NA	5 to 10	0	—	—	—
Bldg. B/C 1st Floor Hallway / Office	0	6,000 to 16,300	NA	4 to 16	0	—	—	—
Bldg. B/C 2nd Floor Hallway	0	4,500 to 11,900	NA	4 to 10	0	—	—	—
Bldg. B/C 3rd Floor Hallway / N. Stair	0	4,600 to 12,200	NA	4 to 12	0	—	—	—
Bldg. B/C 4th Floor Hallway / S. Stair	0	3,900 to 12,800	NA	3 to 11	0	—	—	—
Apt. B-32	0	9,100 to 14,600	NA	8 to 14	0	—	—	—
Apt. B-39	0	8,800 to 13,500	NA	7 to 13	0	—	—	—
Apt. B-45	0	4,900 to 11,400	NA	5 to 11	0	—	—	—
Apt. B-48	0	4,700 to 10,300	NA	5 to 10	0	—	—	—
Apt. C-53	0	4,400 to 12,200	NA	5 to 11	0	—	—	—
Apt. C-54	0	4,000 to 10,200	NA	4 to 10	0	—	—	—
Apt. C-55	0	5,400 to 13,300	NA	5 to 13	0	—	—	—
Apt. C-56	0	5,400 to 13,200	NA	5 to 13	0	—	—	—

**Table 3. Summary of Discrete Areas of Elevated Radiation at the Former Gilbert Clock Company**

Area/Apartment No.	No. Elevated Areas	Gross Gamma (cpm)	Gross Exposure Rate ( $\mu$ R/h)		No. Smears	Surface Activity (dpm/100 cm <sup>2</sup> )		Max Size (m <sup>2</sup> )
			Contact	1 meter		Total Ra-226	Removable	
Apt. C-57	0	3,900 to 10,600	NA	4 to 11	0	—	—	—
Apt. C-58	0	5,000 to 12,700	NA	5 to 12	0	—	—	—
Apt. C-59	0	4,300 to 11,000	NA	4 to 10	0	—	—	—
Apt. C-60	0	5,100 to 13,100	NA	5 to 12	0	—	—	—
Apt. C-61	0	5,400 to 12,500	NA	5 to 12	0	—	—	—
Apt. C-62	0	4,500 to 10,600	NA	4 to 10	0	—	—	—
Apt. C-63	0	5,900 to 16,500	NA	5 to 16	0	—	—	—
Apt. C-64	0	4,500 to 13,000	NA	4 to 14	0	—	—	—
Apt. C-65	0	4,100 to 11,200	NA	4 to 9	0	—	—	—
Apt. C-66	0	5,500 to 14,000	NA	6 to 15	0	—	—	—
Apt. C-67	0	5,200 to 13,400	NA	5 to 14	0	—	—	—
Apt. C-68	0	5,100 to 12,300	NA	5 to 11	0	—	—	—
Apt. C-69	0	4,500 to 11,600	NA	4 to 10	0	—	—	—
Apt. C-70	0	4,300 to 9,600	NA	4 to 9	0	—	—	—
Apt. C-71	0	4,800 to 11,700	NA	4 to 11	0	—	—	—
Apt. C-72	0	5,200 to 12,400	NA	5 to 11	0	—	—	—
Apt. C-73	0	4,100 to 10,200	NA	4 to 10	0	—	—	—
Apt. C-74	0	5,300 to 15,500	NA	5 to 15	0	—	—	—



**Outdoor Areas.** Radiation measurements were collected on the north/east riverbank of the Still River, around Buildings A and B/C, in the parking lots, and at any drains on the property. The outdoor areas exhibited radiation levels consistent with background—no areas exhibiting elevated radiation levels were identified. Radiation levels ranged from 7,000 to 39,000 cpm on contact using the 2×2 sodium iodide detector and 7 to 19 µR/h at 1 meter using the 192 exposure ratemeter. The highest readings were near rock/brick walls and are attributed to NORM in the materials.

**Building A.** Radiation measurements were collected in hallways, stairwells, and all of the apartments in Building A (A-1 through A-29). Radiation levels ranged from 4,800 to 134,000 cpm on contact using the 2×2 sodium iodide detectors and 5 to 27 µR/h at 1 meter using the 192 exposure ratemeter. Areas near exterior (brick) walls and on the lower levels of the building produced higher radiation levels attributed to NORM material. Eleven discrete locations exhibiting elevated radiation levels were identified in Building A. Ten small ( $\leq 0.1 \text{ m}^2$ ) areas of elevated activity were identified (one each in apartments A-1, A-17, A-19, and A-20; two in apartment A-22; and four in apartment A-21) and a larger (approximately  $1 \text{ m}^2$ ) area of elevated activity was identified in apartment A-22. The maximum radiation measurements were recorded at the area in apartment A-20, with a contact exposure of 120 µR/h, noting the exposure rate at 1 meter dropped to 27 µR/h. Direct measurements were collected with a model 44-142 plastic scintillator on all accessible areas of elevated radiation, with a maximum of 36,000 dpm/100 cm<sup>2</sup> in apartment A-20. Smears were also collected, producing a maximum of 1 dpm/100 cm<sup>2</sup> in apartment A-22, noting the apartments have carpet and tile in them, so smears were not collected directly from the original radium-contaminated media (presumably a wood floor). The identiFINDER confirmed the presence of radium on the larger area in apartment A-22 and the small area in apartment A-20, though radiation levels were too low to confirm the presence of Ra-226 at the other nine small areas of elevated activity.

**Building B/C.** Radiation measurements were collected in hallways, stairwells, the office of Building B/C, all of the apartments in Building C (C-53 through C-74), and select apartments in Building B (B-32, B-39, B-45, and B-48). The inspection team determined that no additional surveys were necessary for Building B apartments. This was based on the fact that none of the areas surveyed during the initial site visit in Building B/C exhibited elevated radiation levels. Further, experience has demonstrated that if contamination were present, it would be in upper floors as these had better natural lighting for the dial painting to occur. It is using this rationale that the inspection team decided to survey the remaining Building C apartments. Radiation levels ranged from 3,900 to 16,500 cpm on contact using the 2×2 sodium iodide detectors and 3 to 16 µR/h at 1 meter using the model 192 exposure ratemeter. Areas near exterior walls and on the lower levels of the buildings produced higher radiation levels attributed to NORM material. No discrete locations exhibiting elevated radiation levels were identified in Building B/C.

### 3.4 Summary of Dose Assessment Results

The discussion on the dose assessment results is divided into two subsections: Dose Assessment Method and Dose Assessment Results.

**Dose Assessment Method.** TI 2800/043 presents two Action Levels (ALs) that correlate to 100 mrem/yr for a worker (1-meter measurement of 40 µR/h above background) and a resident (1-meter measurement of 15 µR/h above background). These ALs account for gamma exposure alone and may be used to quickly identify radiation levels that could conservatively produce a dose above the public dose limit in Title 10 of the *Code of Federal Regulations*

(10 CFR) Section 20.1301, *Dose limits for individual members of the public*. The 15-μR/h AL is appropriate for this site because it is configured for residential use. These ALs were established to define a radiation level above which access controls would be recommended. Additional radiological criteria are discussed later in this report.

Dose assessment methods described herein rely upon the *Dose Assessment Technical Basis Document for Potential Exposures to Discrete Sources of Radium-226 and Associated Contamination* (hereafter the Technical Basis Document) to account for site-specific conditions and all potential exposure pathways (ORISE 2017). The Technical Basis Document also presents methods for developing site-specific screening levels and dose estimates, assuming a default conceptual model may not apply at a given site. The average member of the critical group is a residential building occupant, who is conservatively assumed to spend up to 5,770 hours in an apartment in one year; and the potential exposure pathways include external gamma, inhalation, and secondary ingestion. However, contaminated media (floors) identified during the survey are carpeted or otherwise covered with materials that significantly reduce exposure via the inhalation and secondary ingestion pathways. Occupants at some time in the future may engage in activities which uncover the original floors, and be exposed via external gamma, inhalation, and indirect ingestion pathways; therefore, this assessment accounts for all three pathways.

Because measured values are preferable to modeled values, measured exposure rate in μR/h are used to estimate dose received via the external gamma pathway (assuming 1 μR/h ~ 1 μrem/h). The Technical Basis Document presents dose-to-source ratios (DSRs) for the inhalation ( $1.61 \times 10^{-8}$  mrem/hr per dpm/100 cm<sup>2</sup>) and secondary ingestion ( $4.30 \times 10^{-8}$  mrem/hr per dpm/100 cm<sup>2</sup>) pathways, for a total DSR of  $5.91 \times 10^{-8}$  mrem/hr per dpm/100 cm<sup>2</sup> (see ORISE 2017, Table 4.3). These DSRs are selected for a small area of elevated activity on the order of 0.1 m<sup>2</sup>, given only small areas of elevated activity were encountered during the surveys. The dose estimate method, therefore, consists of the following calculations, which include multiplying the occupancy time by the measured exposure rate (for the external dose), and by multiplying the occupancy time by the measured surface activity and total DSR (for the internal dose):

$$\text{External Dose} \left( \frac{\text{mrem}}{\text{yr}} \right) = \text{Time} \left( \frac{\text{h}}{\text{yr}} \right) \times \frac{\text{Measured Exposure Rate} \left( \frac{\mu\text{R}}{\text{hr}} \sim \frac{\mu\text{rem}}{\text{hr}} \right)}{1000 \mu\text{rem/mrem}},$$

$$\text{Internal Dose} \left( \frac{\text{mrem}}{\text{yr}} \right) = \text{Time} \left( \frac{\text{h}}{\text{yr}} \right) \times \text{Surface Activity} \left( \frac{\text{dpm}}{100 \text{ cm}^2} \right) \times 5.91 \times 10^{-8} \left( \frac{\text{mrem/h}}{\text{dpm}/100 \text{ cm}^2} \right),$$

and finally,

$$\text{Total Dose} = \text{External Dose} + \text{Internal Dose}.$$

Note that even when doses are averaged over a reasonably conservative area, such as a room, the DSRs for small areas are still used given the sum of the contaminated area is a very small percentage of the total. For example, apartment A-22 contains three areas of elevated activity, with a total estimated contaminated area of 1 m<sup>2</sup>, compared to a total apartment area of approximately 65 m<sup>2</sup>. Therefore, an upper estimate of the contaminated area represents approximately 1 percent of total living space.

Because only small areas of elevated activity were identified, the dose assessment was performed assuming two occupancy duration scenarios. The first scenario assumes an

individual would spend the entire 5,770-h/yr occupancy period in the room or area containing the area of elevated activity identified in a survey unit (“maximum room” scenario). This scenario is very conservative given an individual is highly unlikely to spend all modeled time in only the bedroom, or the kitchen, or the hallway section, etc., of a given survey unit. The second scenario assumes an individual would spend the 5,770-h/yr occupancy period averaged over the entire survey unit (e.g., the whole apartment). This scenario is still conservative but more closely aligns with the conceptual model described in the Technical Basis Document (ORISE 2017). Therefore, the first scenario is intended to generate an upper bound of the dose within a given survey unit, and the second scenario is intended to generate a still conservative but more realistic representation of conditions expected to be encountered within a survey unit.

The source term for each scenario is a net value (excludes background) and is also conservatively estimated. The source term in the first (“maximum room”) scenario is defined by the highest measured radioactivity within the survey unit. The source term in the second scenario is the average of all measured radioactivity in the survey unit. This value is conservative because results for a given small area of elevated activity are weighted equally with background measurements, though the area containing elevated activity is a very small fraction of the total surface area in any survey unit. Background is likewise estimated by averaging all measurements in the room or area, though excluding locations with elevated activity. Because the highest levels of radiation were identified in apartments A-20 and A-22, dose calculations are conservatively performed using source terms for these two apartments. The apartment A-20 source term is presented in Table B-6, and the apartment A-22 source term is presented in Table B-8.

In summary, the dose assessment method described herein uses multiple conservative assumptions. For example, worst-case doses assume the receptor spends 100 percent of the occupancy period in a single room. Additionally, an “average” survey unit source term is conservatively biased by combining data from measurements of small areas of elevated activity, though they represent a very small percentage of the total surface area, with larger areas of background measurements in an unweighted manner. As a result of this layered conservatism, dose estimates presented in the following discussion should overestimate the true value.

**Dose Assessment Results.** Appendix B presents dose assessment results for all survey units. Table B-9 lists dose estimates for the external gamma pathways only and represents potential doses to current occupants of apartments A-20 and A-22—recalling that floor covering significantly reduces exposure via inhalation and secondary ingestion pathways. Table B-10 lists dose estimates for internal pathways only, representing potential doses via inhalation and secondary ingestion, assuming floor coverings are removed at some time in the future. These values must be added to the corresponding values in Table B-9 to estimate the total dose to the hypothetical future occupant, who may be exposed through all potential exposure pathways. Table B-11 summarizes dose estimated for both the current occupant (external gamma only) and the hypothetical future occupant (all pathways). As presented in Table B-11, the maximum estimated dose, assuming an individual spends the entire 5,770-hr/yr occupancy period in a single room/area, is 14 mrem/yr (apartment A-20 living room). The highest estimated dose from across an entire apartment is 5.6 mrem/yr (two rooms in apartment A-22).

As noted earlier, two dose limits are considered in this assessment. The first dose limit is the 100-mrem/yr public dose limit in 10 CFR 20.1301. An estimated dose above 100 mrem/yr to the average member of the critical group would require immediate action, such as access controls to limit current occupant exposures to discreet sources of Ra-226. The second dose limit is the 25-mrem/yr unrestricted use limit in 10 CFR 20.1402, *Radiological criteria for unrestricted use*.

An estimated dose above 25 mrem/yr to the average member of the critical group would not require immediate action, though additional characterization and remediation may be required prior to unrestricted release. In any case, no action is required if the estimated dose is less than 25 mrem/yr.

These results demonstrate that current and potential future occupants are unlikely to receive a dose above the 25-mrem/yr unrestricted use limit in 10 CFR 20.1402. Therefore, although discrete sources of Ra-226 were identified within several apartments, none are present at concentrations that would reasonably produce a dose above regulatory limits.

#### 4.0 OBSERVATIONS AND RECOMMENDATIONS

Based on the data collected during the May 2018, and June 2018, surveys, the former Gilbert Clock Company property located at 13 Wallens Street contains discrete sources of Ra-226. However, the identified sources are not at concentrations or configured in a manner that would reasonably result in a dose in excess of regulatory requirements. This conclusion is based on the following observations:

- Elevated direct gamma and/or surface radiation due to discrete sources of Ra-226 were identified in six Building A apartments (A-1, A-17, A-19, A-20, A-21, and A-22).
- Identified Ra-226 contamination is limited to 11 small areas of elevated activity (approximately 1 m<sup>2</sup> total).
- Dose estimates show that a residential building occupant would receive an estimated dose less than the 25-mrem/yr unrestricted use limit in 10 CFR 20.1402, conservatively assuming an occupancy of 5,770hr/yr averaged over a single room.

Based on these observations, it is recommended that the NRC not pursue additional actions at the former Gilbert Clock Company facility. NRC should, however, communicate to the owner the location and magnitude of identified Ra-226 contamination, even though isolated areas of elevated activity are unlikely to exceed NRC's dose standards for unrestricted use.

## 5.0 REFERENCES

Funk and Wagnalls 1920. *The Literary Digest Volume LXIV*, Funk & Wagnalls Company, New York, digitized by Google, pp. 383, 944, and 1463 of 1909, January—March.

NRC 2018. *Inspection of Facilities Potentially Contaminated with Discrete Radium-226 Sources*, Temporary Instruction 2800/043, Revision 2, U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards, Washington, D.C., May. (ADAMS Accession No. ML17297B921).

ORAU 2018. *Project-Specific Plan for the Survey of the Former William L. Gilbert Clock Company Property at 13 Wallens Street in Winsted, Connecticut*, DCN 5307-PL-05-1, Oak Ridge Associated Universities, Oak Ridge, Tennessee, February 22.

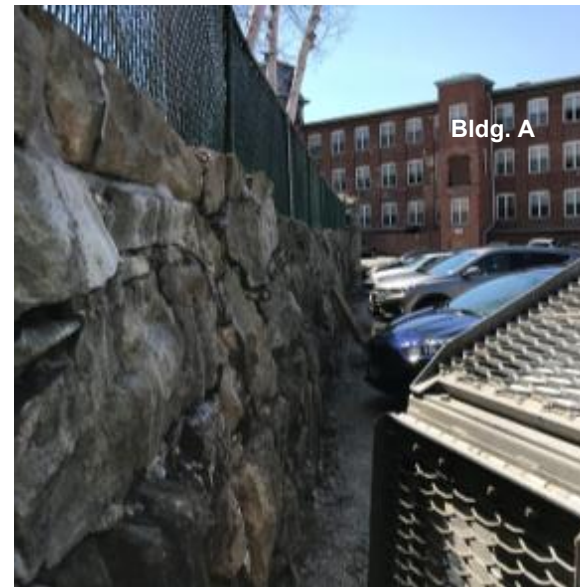
ORNL 2015. *Historical Non-Military Radium Sites Research Effort Addendum*, “William L. Gilbert Clock Company: Site Summary,” pp. 161-165, Oak Ridge National Laboratory, Oak Ridge, Tennessee, November 24. (ADAMS Accession No. ML16291A488).

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).

**APPENDIX A**  
**PHOTOS FROM THE FORMER GILBERT CLOCK COMPANY SURVEY**



**Figure A-1. Bldg. A / Lower Level Parking Lot**



**Figure A-2. Rock Wall**



**Figure A-3. Inaccessible Hill South of Bldg. B/C**



**Figure A-4. Upper Level Parking Lot**





**Figure A-5. Retaining Wall**



**Figure A-6. Outdoor Area Near Still River**



**Figure A-7. Outdoor Area Near Still River**



**Figure A-8. Outdoor Area Near Still River**





**Figure A-9. Outdoor Area Near Still River**



**Figure A-10. Outdoor Area Near Still River**



**Figure A-11. Outdoor Area Near Still River**



**Figure A-12. West Side of Bldg. A**



**Figure A-13. Apartment Kitchen**



**Figure A-14. Apartment Living Room**



**Figure A-15. Apartment Bathroom**



**Figure A-16. Apartment Bedroom**





**Figure A-17. Apartment Ceiling**



**Figure A-18. Apartment Ceiling**



**Figure A-19. Bldg. A 1<sup>st</sup> Floor Hallway with Rock Wall**



**Figure A-20. Apartment Hallway**



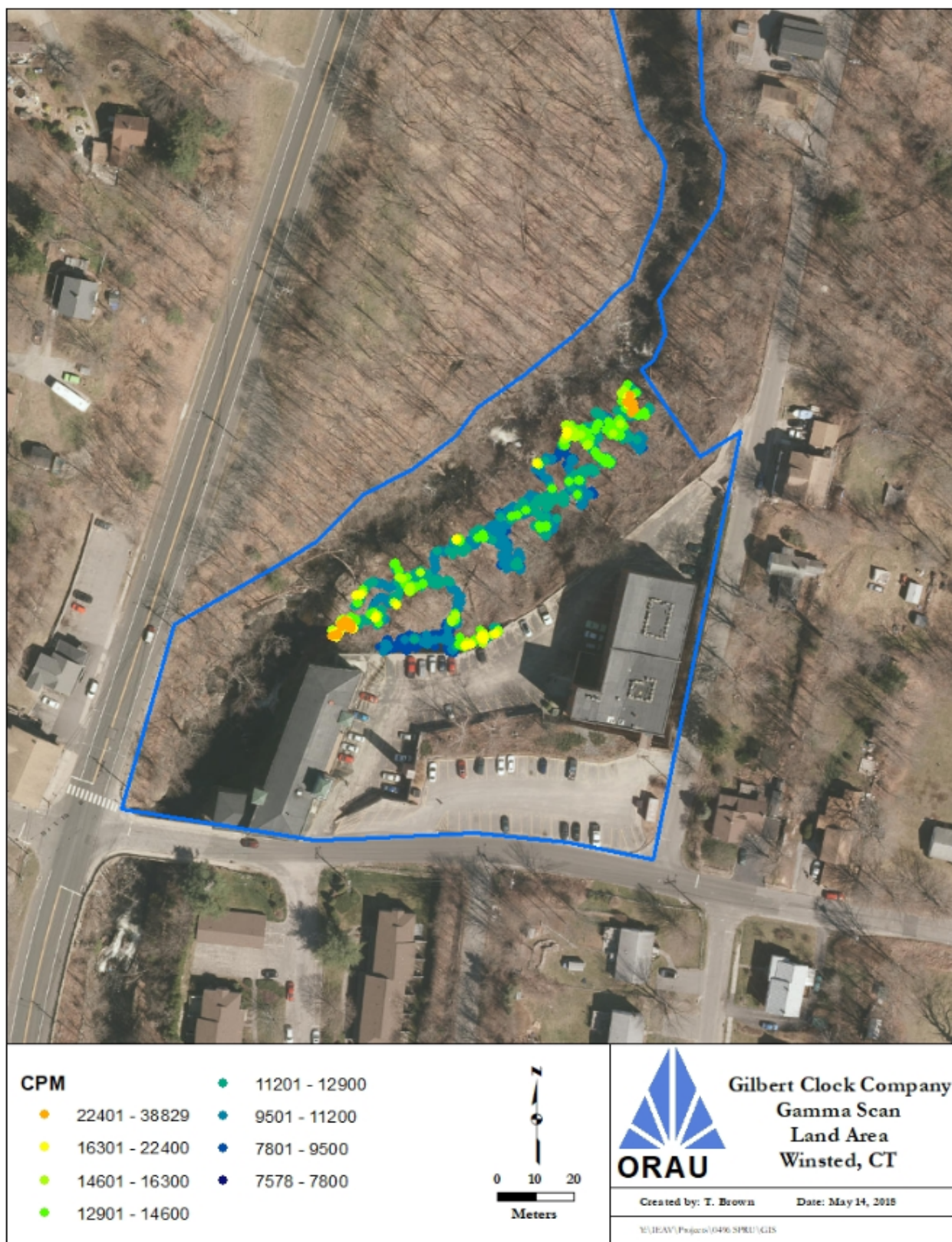
**Figure A-21. Apartment A-22**



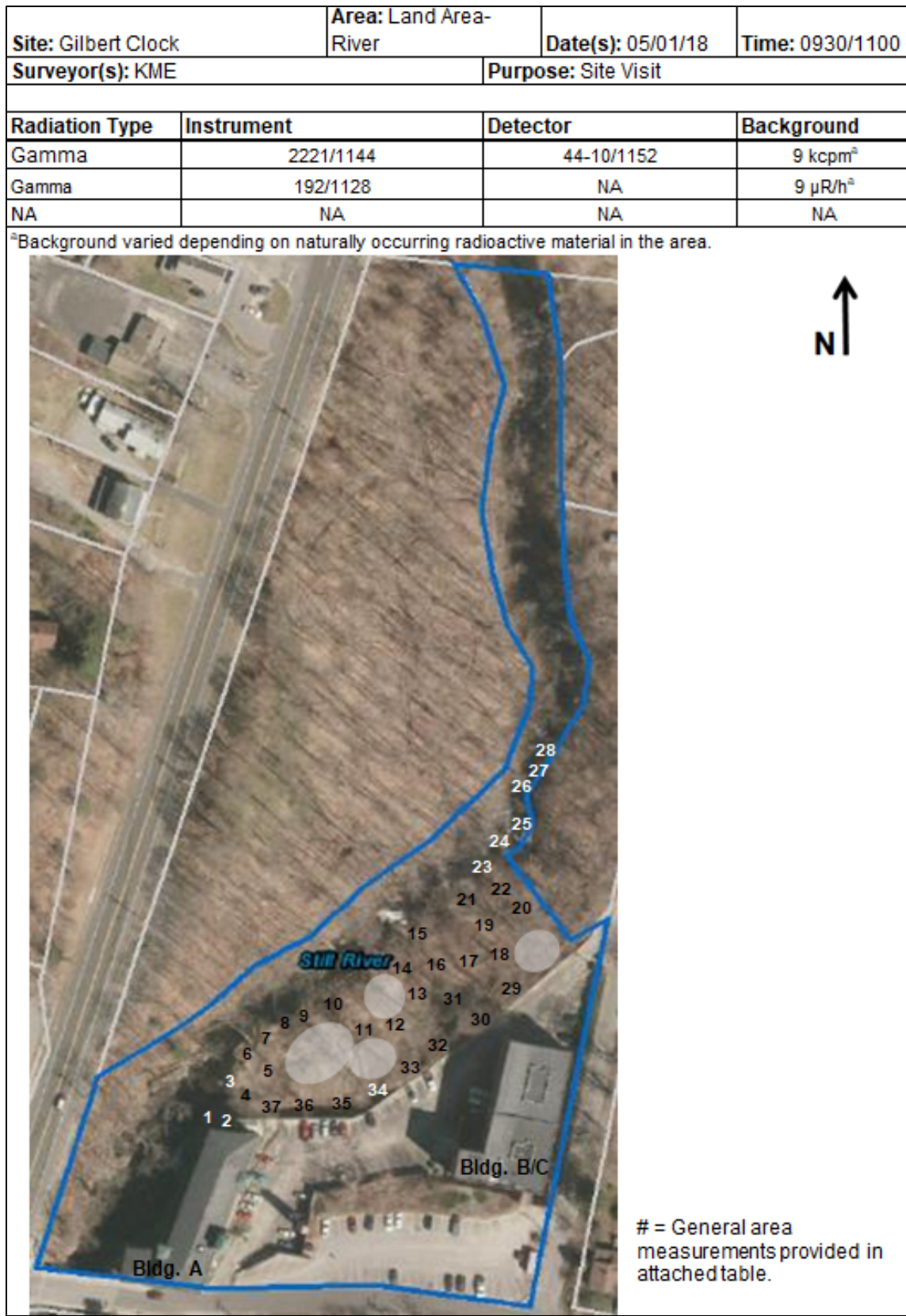
**Figure A-22. Apartment A-22**

**APPENDIX B**  
**SURVEY MAPS AND DATA FROM THE FORMER GILBERT CLOCK COMPANY SURVEY**





**Figure B-1a. Gamma Walkover Survey of Outdoor Area near River**



**Figure B-1b. Exposure Survey of Outdoor Area near River**

**Table B-1. Gilbert Clock Apts.—Outdoor Area near River**

Location No.	Gamma	Comments
	$\mu\text{R/h}$ at 1 meter	
1	19	Rocks
2	12	
3	15	
4	10	
5	8	
6	11	
7	11	
8	11	
9	10	
10	10	
11	9	
12	9	
13	11	Rocks
14	10	
15	15	Rocks
16	10	
17	10	
18	9	
19	15	
20	12	Rocks
21	12	
22	10	
23	11	Rocks
24	9	
25	10	
26	15	Rocks
27	12	
28	12	
29	9	
30	11	
31	9	
32	9	
33	10	
34	9	Rocks
35	8	
36	8	
37	8	





**Figure B-2a. Gamma Walkover Survey of the Parking Lot**



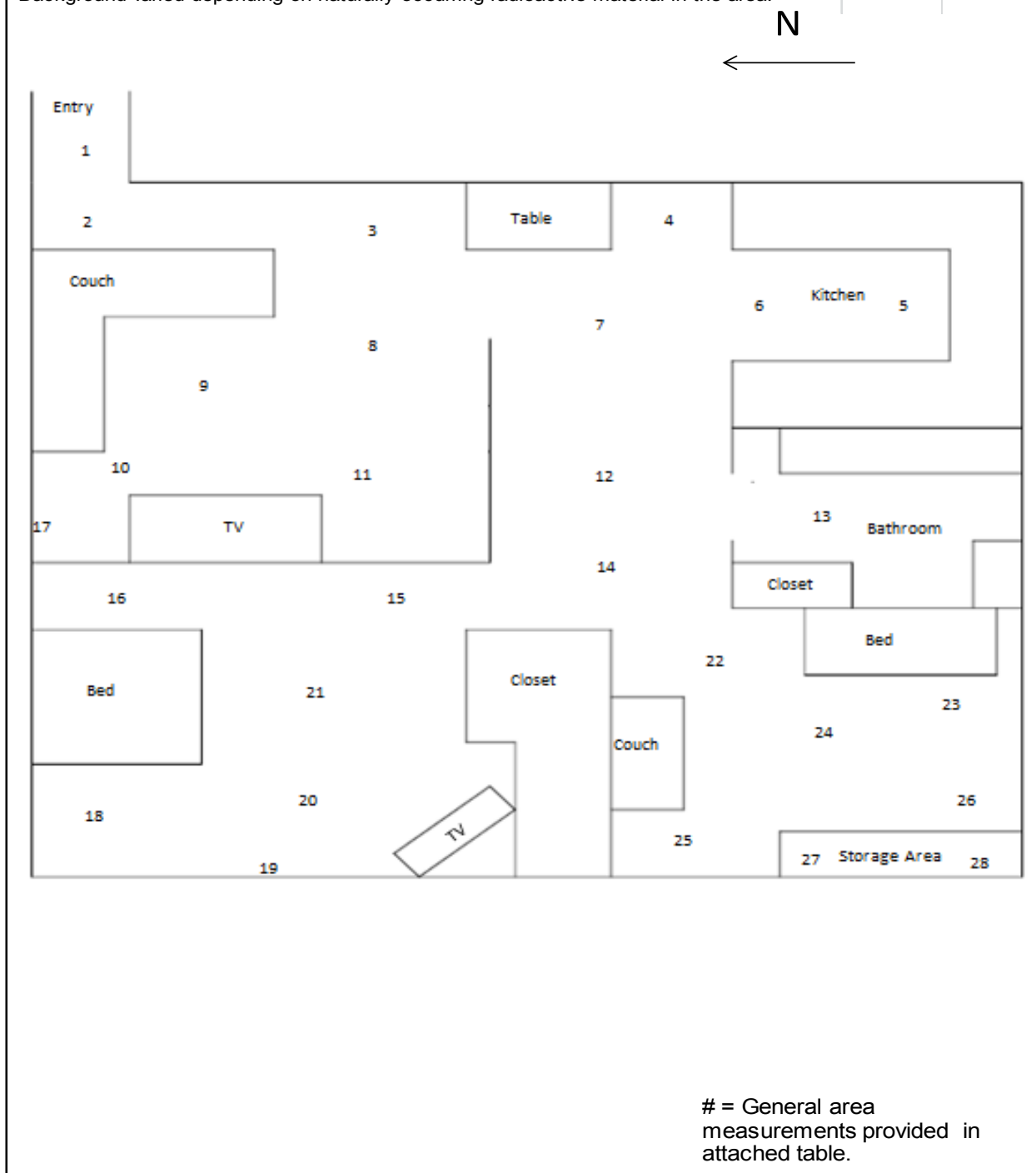
**Figure B-2b. Exposure Survey of the Parking Lot**

Table B-2. Gilbert Clock Apts.—Outdoor Area Parking Lot		
Location No.	Gamma	Comments
	$\mu\text{R/h}$ at 1 meter	
1	11	
2	10	North Entrance to Bldg.
3	9	
4	10	
5	12.5	
6	8	
7	9.5	AC Units Enclosure
8	10	
9	11	South Entrance to Bldg.
10	10.5	
11	10	
12	10	
13	11	
14	10	
15	8	Drain
16	10	
17	11	
18	10	
19	11	Rock Wall
20	10	
21	8	
22	10	
23	9	
24	9	
25	9	
26	10	
27	10	
28	10	
29	10	
30	13	
31	12	
32	13	
33	14	
34	14	
35	11	
36	13	
37	15	
38	15	

Table B-2. Gilbert Clock Apts.—Outdoor Area Parking Lot		
Location No.	Gamma	Comments
	$\mu\text{R/h}$ at 1 meter	
39	12	Rock Wall
40	14	Rock Wall
41	12	Rock Wall
42	9	
43	8	Northern Street Entrance
44	9	
45	10	
46	10	
47	10	
48	9	
49	10	
50	7.5	
51	7	
52	11	
53	14	
54	14	Chimney
55	10	Chimney
56	15	Chimney
57	10	
58	15	Rock Wall
59	17	Rock Wall
60	15	Rock Wall
61	10	
62	10	Lobby Entrance
63	13	
64	12	
65	12	
66	12.5	
67	12.5	

<b>Site:</b> Gilbert Clock		<b>Area:</b> Apt. A-1		<b>Date(s):</b> 06/26/18		<b>Time:</b> 1530/1600	
<b>Surveyor(s):</b> JDL				<b>Purpose:</b> Scoping			
<b>Radiation Type</b>	<b>Instrument</b>		<b>Detector</b>		<b>Background</b>		
Gamma	2221/1141		44-10/1152		11 - 16 kcpm <sup>a</sup>		
Gamma	192/1128		NA		11 - 15 µR/h <sup>a</sup>		

<sup>a</sup>Background varied depending on naturally occurring radioactive material in the area.



**Figure B-3. Survey Map of Apt. A-1**

Table B-3. Gilbert Clock Co.—Apt. A-1

Location No.	Removable		Alpha-plus-Beta <sup>a</sup>		Gamma <sup>b</sup>			Comments
	Smear No.	Alpha-plus-Beta	Gross	Total	Contact		1 m	
		dpm/100 cm <sup>2</sup>	cpm	dpm/100 cm <sup>2</sup>	cpm	μR/hr	μR/hr	
1	—	—	—	—	11,500	—	12	
2	—	—	—	—	13,500	—	12	
3	—	—	—	—	14,000	—	12	
4	—	—	—	—	12,700	—	12	
5	—	—	—	—	12,200	—	11	
6	—	—	—	—	12,300	—	11	
7	—	—	—	—	12,100	—	11	
8	—	—	—	—	13,300	—	12	
9	—	—	—	—	12,800	—	12	
10	—	—	—	—	13,200	—	12	
11	—	—	—	—	12,200	—	12	
12	—	—	—	—	11,500	—	11	
13	—	—	—	—	12,800	—	11	
14	—	—	—	—	12,800	—	11	
15	—	—	—	—	13,100	—	11	
16	—	—	—	—	14,200	—	13	
17	—	—	—	—	15,100	—	13	
18	—	—	—	—	14,600	—	15	
19	—	—	—	—	12,800	—	12	
20	—	—	—	—	15,500	—	13	
21	—	—	—	—	14,000	—	13	
22	—	—	—	—	11,500	—	11	
23	—	—	—	—	13,200	—	12	
24	—	—	—	—	14,500	—	14	
25	—	—	—	—	15,200	—	13	
26	—	—	—	—	16,000	—	N/A	

**Table B-3. Gilbert Clock Co.—Apt. A-1**

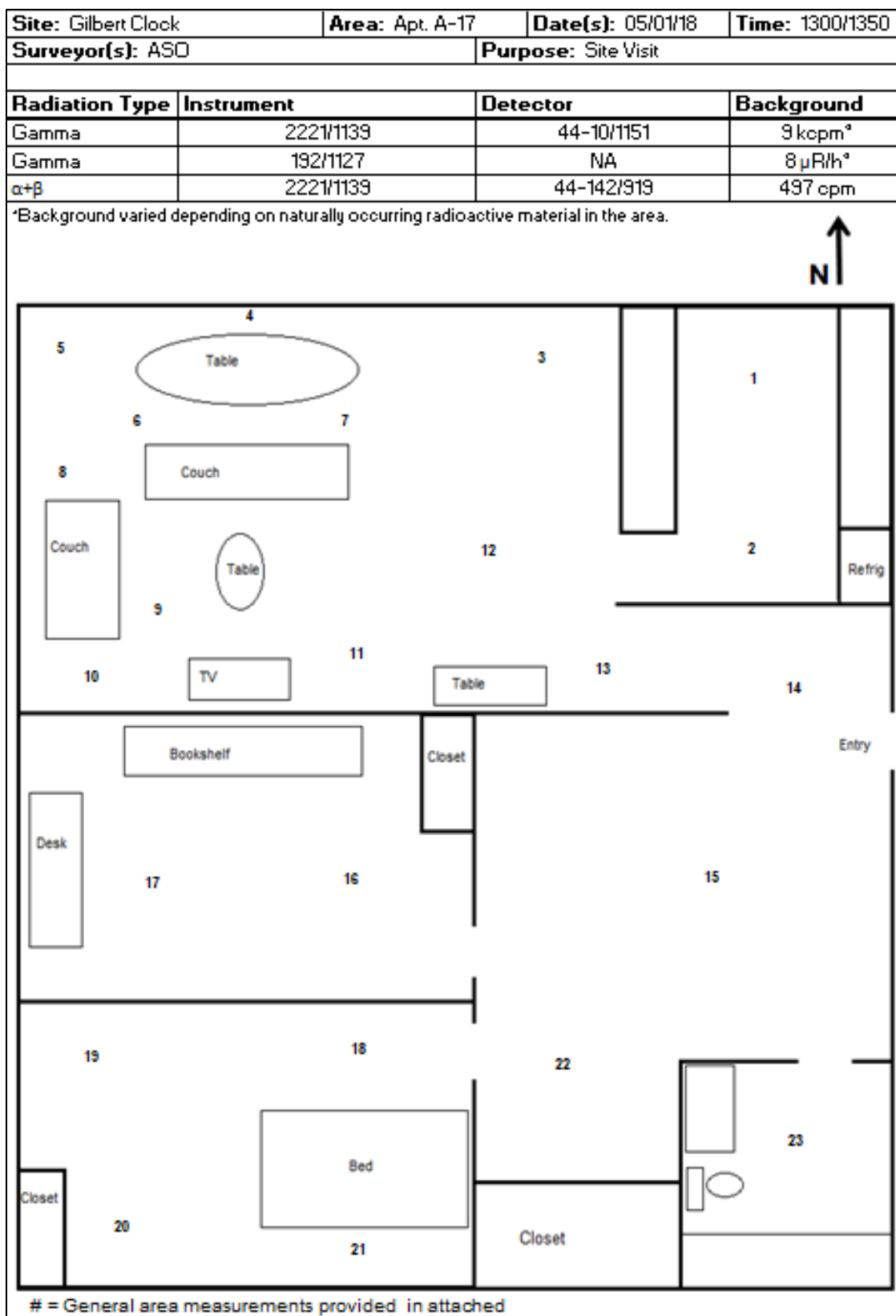
Location No.	Removable		Alpha-plus-Beta <sup>a</sup>		Gamma <sup>b</sup>			Comments
	Smear No.	Alpha-plus-Beta	Gross	Total	Contact		1 m	
		dpm/100 cm <sup>2</sup>	cpm	dpm/100 cm <sup>2</sup>	cpm	μR/hr	μR/hr	
27	—	—	—	—	12,400	—	11	
28	—	—	—	—	18,000	18	15	Wall, < 0.01 m <sup>2</sup>
Rm Background	—	—	—	0	16,560	—	12	Living Room
Rm Average	—	—	—	0	14,400	—	13	Living Room, locations 22-28
Apt Background	—	—	—	0	13,296	—	12	Apartment
Apt Average	—	—	—	0	13,464	—	12	Apartment

a) Ludlum 44-142 plastic scintillator with Ludlum 2221 ratemeter

b) Ludlum 44-10 NaI with Ludlum 2221 ratemeter; Ludlum 192 NaI

— indicates measurement not collected at this location





**Figure B-4. Survey Map of Apt. A-17**



**Table B-4. Gilbert Clock Co.—Apt. A-17**

Location No.	Removable		Alpha-plus-Beta <sup>a</sup>		Gamma <sup>b</sup>			Comments
	Smear No.	Alpha-plus-Beta	Gross	Total	Contact		1 m	
		dpm/100 cm <sup>2</sup>	cpm	dpm/100 cm <sup>2</sup>	cpm	μR/hr	μR/hr	
1	—	—	—	—	9,300	—	8	
2	—	—	—	—	7,600	—	6	
3	—	—	—	—	14,200	—	12	
4	—	—	—	—	25,000	—	13	
5	—	—	—	—	25,000	—	12	
6	—	—	—	—	14,400	—	10	
7	—	—	—	—	15,500	—	9.5	
8	—	—	—	—	10,400	—	11	
9	R0123	< 1	723	2,100	28,500	23	10	Living Room, < 0.01 cm <sup>2</sup>
10	—	—	—	—	24,000	—	10	
11	—	—	—	—	10,400	—	9	
12	—	—	—	—	11,500	—	10	
13	—	—	—	—	10,000	—	6	
14	—	—	—	—	9,100	—	6	
15	—	—	—	—	8,200	—	7	
16	—	—	—	—	8,400	—	6	
17	—	—	—	—	9,200	—	8	
18	—	—	—	—	8,300	—	6	
19	—	—	—	—	10,000	—	10	
20	—	—	—	—	10,400	—	10	
21	—	—	—	—	7,400	—	8	
22	—	—	—	—	7,200	—	6	
23	—	—	—	—	6,800	—	6	

**Table B-4. Gilbert Clock Co.—Apt. A-17**

Location No.	Removable		Alpha-plus-Beta <sup>a</sup>		Gamma <sup>b</sup>			Comments
	Smear No.	Alpha-plus-Beta	Gross	Total	Contact		1 m	
		dpm/100 cm <sup>2</sup>	cpm	dpm/100 cm <sup>2</sup>	cpm	μR/hr	μR/hr	
Rm Background	—	—	—	0	16,711	—	11	Living Room
Rm Average	—	—	—	210	17,890	—	11	Living Room, locations 3-12
Apt Background	—	—	—	0	11,923	—	8.6	Apartment
Apt Average	—	—	—	91	12,643	—	8.7	Apartment

a) Ludlum 44-142 plastic scintillator with Ludlum 2221 ratemeter

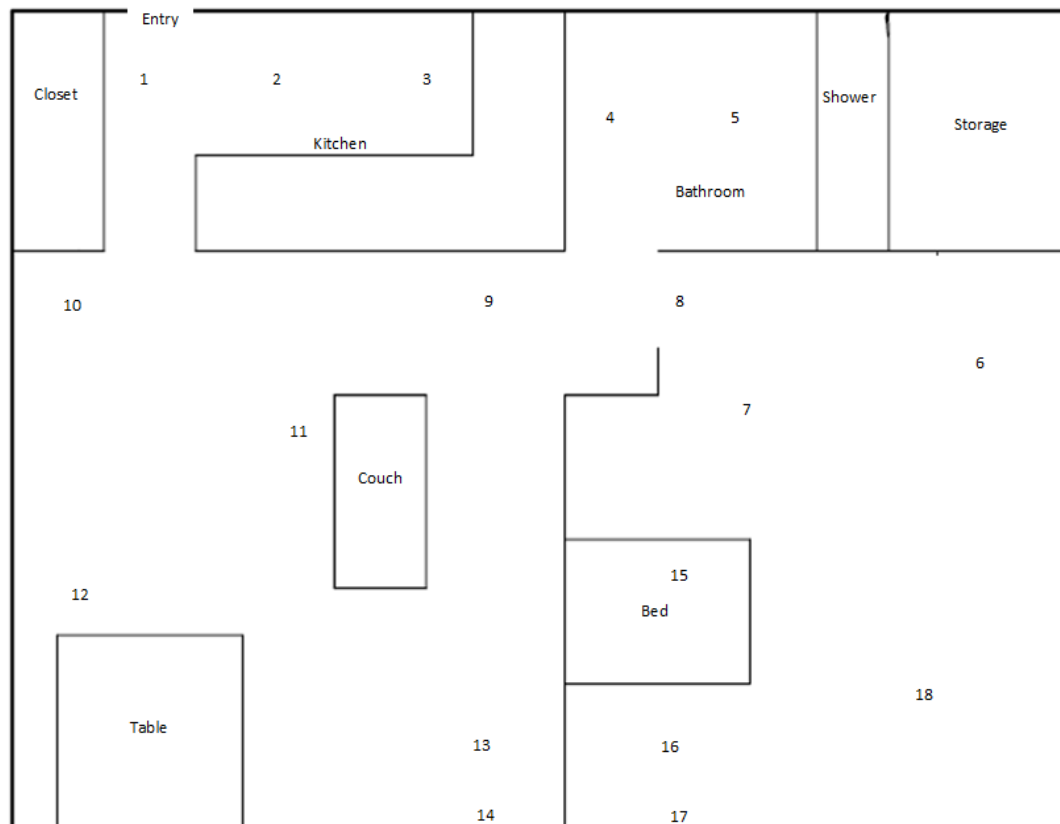
b) Ludlum 44-10 NaI with Ludlum 2221 ratemeter; Ludlum 192 NaI

— indicates measurement not collected at this location

<b>Site:</b> Gilbert Clock	<b>Area:</b> Apt. A-19	<b>Date(s):</b> 06/27/18	<b>Time:</b> 0940/1015
<b>Surveyor(s):</b> JDL		<b>Purpose:</b> Scoping	

<b>Radiation Type</b>	<b>Instrument</b>	<b>Detector</b>	<b>Background</b>
Gamma	2221/1141	44-10/1152	6 - 13 kcpm <sup>a</sup>
Gamma	192/1128	NA	6 - 12 $\mu$ R/h <sup>a</sup>
Beta	2221/1141	44-142/920	322 cpm

<sup>a</sup>Background varied depending on naturally occurring radioactive material in the area.



# = General area measurements provided in attached table.

**Figure B-5. Survey Map of Apt. A-19**

**Table B-5. Gilbert Clock Co.—Apt. A-19**

Location No.	Removable		Alpha-plus-Beta <sup>a</sup>		Gamma <sup>b</sup>			Comments
	Smear No.	Alpha-plus-Beta	Gross	Total	Contact		1 m	
		dpm/100 cm <sup>2</sup>	cpm	dpm/100 cm <sup>2</sup>	cpm	μR/hr	μR/hr	
1	—	—	—	—	6,700	—	6	
2	—	—	—	—	7,000	—	7	
3	—	—	—	—	7,000	—	6	
4	—	—	—	—	8,600	—	9	
5	—	—	—	—	11,000	—	10	
6	—	—	—	—	10,500	—	10	
7	—	—	—	—	11,800	—	11	
8	—	—	—	—	11,800	—	10	
9	—	—	—	—	11,200	—	10	
10	—	—	—	—	10,300	—	10	
11	—	—	—	—	12,500	—	11	
12	—	—	—	—	13,000	—	12	
13	—	—	—	—	12,300	—	11	
14	—	—	—	—	10,800	—	10	
15	—	—	—	—	12,500	—	11	
16	—	—	—	—	12,300	—	12	
17	—	—	—	—	11,600	—	11	
18	R0127	< 1	2,100	16,000	62,000	50	20	Bedroom, < 0.01 m <sup>2</sup>
Rm Background	—	—	—	0	11,750	—	11	Bedroom
Rm Average	—	—	—	2,286	18,929	—	12	Bedroom, locations 6-8 & 15-18
Apt Background	—	—	—	0	10,641	—	10	Apartment
Apt Average	—	—	—	889	13,494	—	10	Apartment

a) Ludlum 44-142 plastic scintillator with Ludlum 2221 ratemeter

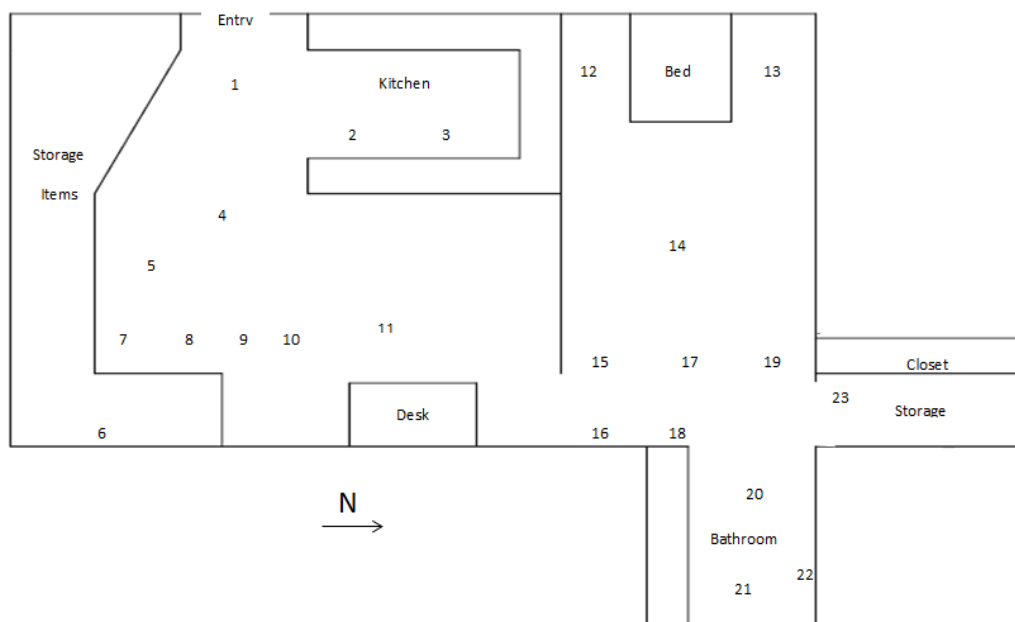
b) Ludlum 44-10 NaI with Ludlum 2221 ratemeter; Ludlum 192 NaI

— indicates measurement not collected at this location

<b>Site:</b> Gilbert Clock	<b>Area:</b> Apt. A-20	<b>Date(s):</b> 06/27/18	<b>Time:</b> 0850/0940
<b>Surveyor(s):</b> JDL		<b>Purpose:</b> Scoping	

<b>Radiation Type</b>	<b>Instrument</b>	<b>Detector</b>	<b>Background</b>
Gamma	2221/1141	44-10/1152	7 - 15 kcpm <sup>a</sup>
Gamma	192/1128	NA	7 - 14 $\mu$ R/h <sup>a</sup>
Beta	2221/1141	44-142/920	350 cpm

<sup>a</sup>Background varied depending on naturally occurring radioactive material in the area.



# = General area measurements provided in attached table.

**Figure B-6. Survey Map of Apt. A-20**

**Table B-6. Gilbert Clock Co.—Apt. A-20**

Location No.	Removable		Alpha-plus-Beta <sup>a</sup>		Gamma <sup>b</sup>			Comments
	Smear No.	Alpha-plus-Beta	Gross	Total	Contact		1 m	
		dpm/100 cm <sup>2</sup>	cpm	dpm/100 cm <sup>2</sup>	cpm	μR/hr	μR/hr	
1	—	—	—	—	7,700	—	7	
2	—	—	—	—	7,400	—	7	
3	—	—	—	—	7,800	—	8	
4	—	—	—	—	7,100	—	7	
5	—	—	—	—	9,100	—	8	
6	—	—	—	—	10,800	—	10	
7	—	—	—	—	12,800	—	12	
8	—	—	—	—	9,500	—	10	
9	—	—	—	—	9,700	—	10	
10	—	—	—	—	10,500	—	11	
11	R0126	< 1	4,270	36,000	122,000	120	27	Living Room, ~0.1 m <sup>2</sup>
12	—	—	—	—	8,000	—	8	
13	—	—	—	—	7,800	—	8	
14	—	—	—	—	9,400	—	9	
15	—	—	—	—	11,900	—	12	
16	—	—	—	—	10,200	—	10	
17	—	—	—	—	9,800	—	10	
18	—	—	—	—	10,900	—	10	
19	—	—	—	—	10,100	—	9	
20	—	—	—	—	13,200	—	12	
21	—	—	—	—	13,600	—	12	
22	—	—	—	—	14,400	—	14	
23	—	—	—	—	9,200	—	10	



**Table B-6. Gilbert Clock Co.—Apt. A-20**

Location No.	Removable		Alpha-plus-Beta <sup>a</sup>		Gamma <sup>b</sup>			Comments
	Smear No.	Alpha-plus-Beta	Gross	Total	Contact		1 m	
		dpm/100 cm <sup>2</sup>	cpm	dpm/100 cm <sup>2</sup>	cpm	μR/hr	μR/hr	
Rm Background	—	—	—	0	9,929	—	10	Living Room
Rm Average	—	—	—	4,500	23,938	—	12	Living Room, locations 4-11
Apt Background	—	—	—	0	10,041	—	10	Apartment
Apt Average	—	—	—	1,565	14,909	—	10	Apartment

a) Ludlum 44-142 plastic scintillator with Ludlum 2221 ratemeter

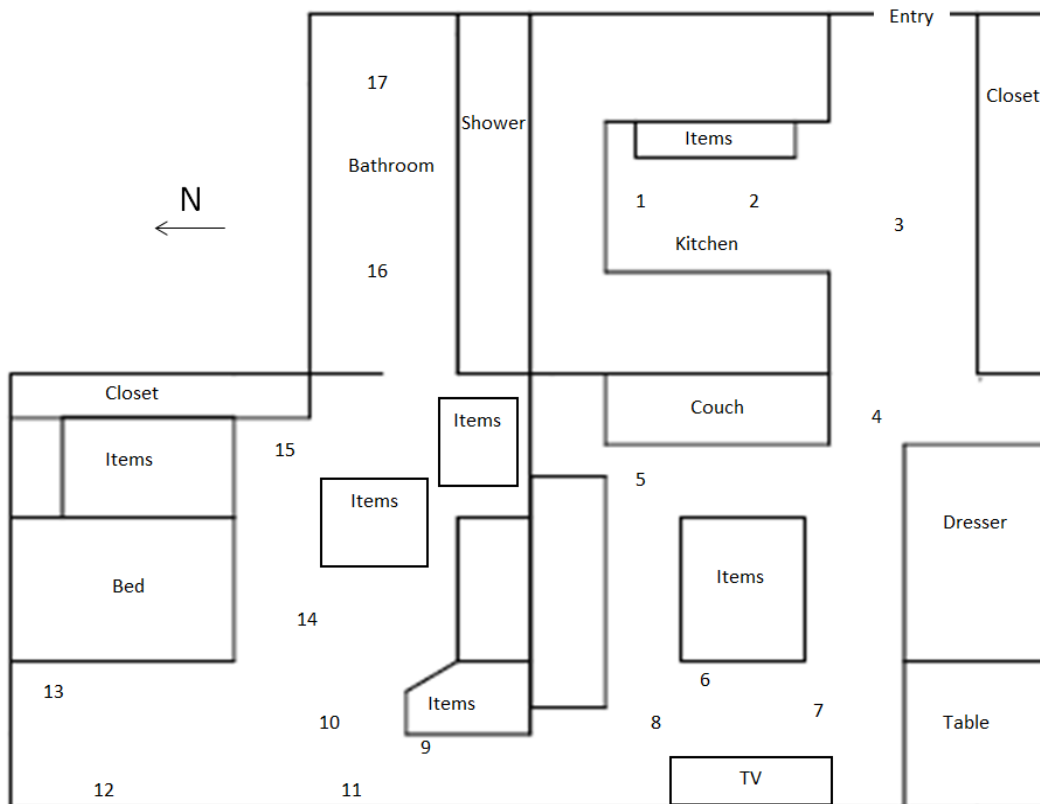
b) Ludlum 44-10 NaI with Ludlum 2221 ratemeter; Ludlum 192 NaI

— indicates measurement not collected at this location

<b>Site:</b> Gilbert Clock	<b>Area:</b> Apt. A-21	<b>Date(s):</b> 06/27/18	<b>Time:</b> 1040/1115
<b>Surveyor(s):</b> JDL		<b>Purpose:</b> Scoping	

Radiation Type	Instrument	Detector	Background
Gamma	2221/1141	44-10/1152	7 - 17 kcpm <sup>a</sup>
Gamma	192/1128	NA	7 - 14 $\mu$ R/h <sup>a</sup>
Beta	2221/1141	44-142/920	400 cpm

<sup>a</sup>Background varied depending on naturally occurring radioactive material in the area.



# = General area measurements provided in attached table.

**Figure B-7. Survey Map of Apt. A-21**

**Table B-7. Gilbert Clock Co.—Apt. A-21**

Location No.	Removable		Alpha-plus-Beta <sup>a</sup>		Gamma <sup>b</sup>			Comments
	Smear No.	Alpha-plus-Beta	Gross	Total	Contact		1 m	
		dpm/100 cm <sup>2</sup>	cpm	dpm/100 cm <sup>2</sup>	cpm	μR/hr	μR/hr	
1	—	—	—	—	7,200	—	7.0	
2	—	—	—	—	7,500	—	7.0	
3	—	—	—	—	8,800	—	7.0	
4	—	—	—	—	11,000	—	10	
5	—	—	—	—	14,400	—	12	
6	—	—	—	—	29,000	25	14	Could not directly access
7	—	—	—	—	14,000	—	13	
8	—	—	—	—	16,500	—	14	
9	—	—	—	—	30,000	28	15	Could not directly access
10	—	—	—	—	13,000	—	13	
11	—	—	—	—	12,400	—	12	
12	R0128	< 1	1,924	14,000	60,000	39	15	0.01 m <sup>2</sup>
13	R0129	< 1	1,921	14,000	40,000	60	18	0.01 m <sup>2</sup>
14	—	—	—	—	15,000	—	14	
15	—	—	—	—	12,500	—	12	
16	—	—	—	—	9,800	—	9.0	
17	—	—	—	—	8,800	—	7.0	
Rm Background	—	—	—	0	13,225	—	13	Bedroom
Rm Average	—	—	—	4,000	26,129	—	14	Bedroom, locations 9-15
Apt Background	—	—	—	0	18,819	—	11	Apartment
Apt Average	—	—	—	1,647	18,229	—	12	Apartment

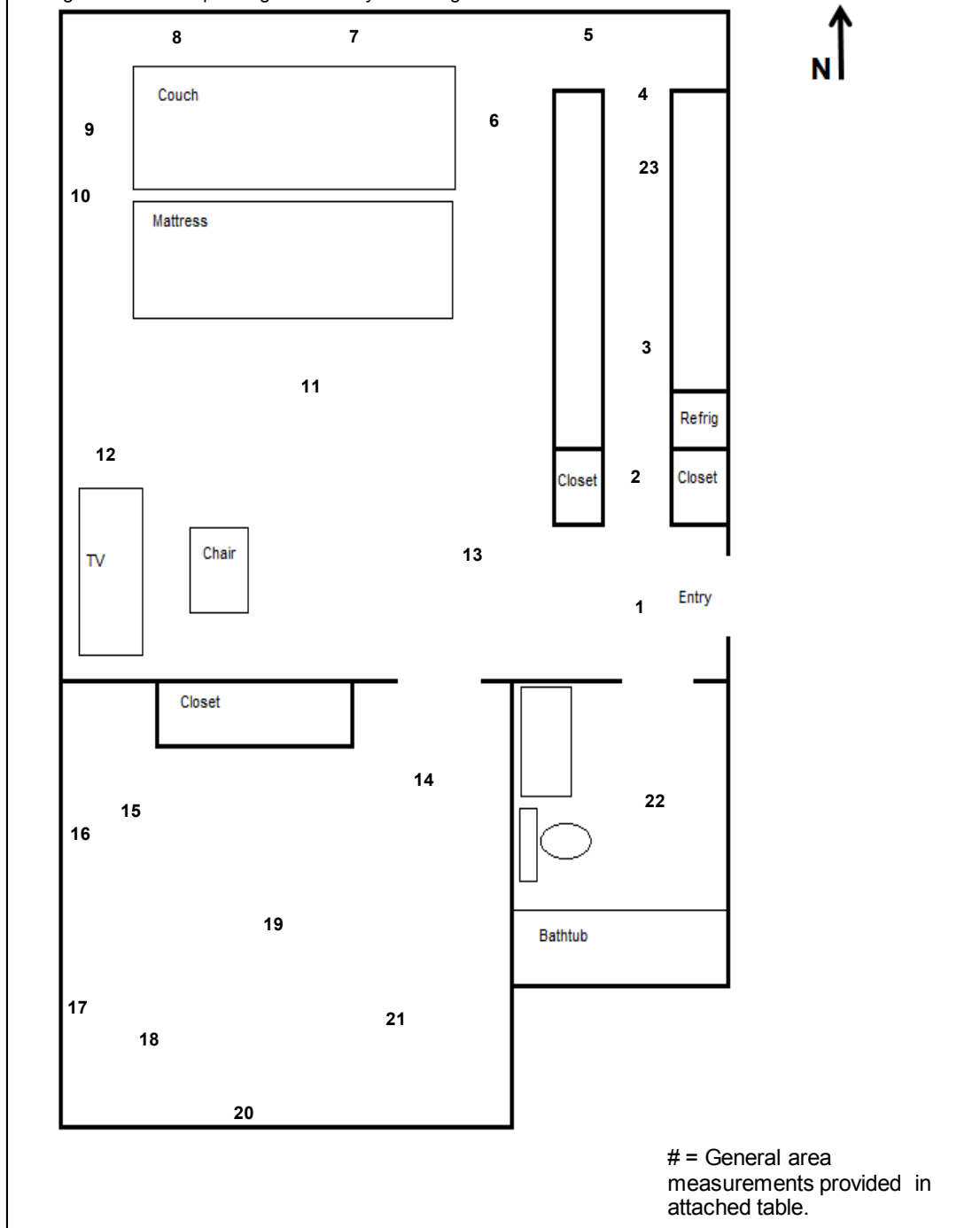
a) Ludlum 44-142 plastic scintillator with Ludlum 2221 ratemeter

b) Ludlum 44-10 NaI with Ludlum 2221 ratemeter; Ludlum 192 NaI

— indicates measurement not collected at this location

<b>Site:</b> Gilbert Clock		<b>Area:</b> Apt. A-22	<b>Date(s):</b> 05/01/18	<b>Time:</b> 1400/1500
<b>Surveyor(s):</b> ASO			<b>Purpose:</b> Site Visit (Reinvestigated on Scoping Survey)	
<b>Radiation Type</b>	<b>Instrument</b>	<b>Detector</b>		<b>Background</b>
Gamma	2221/1139	44-10/1151		9 - 19 kcpm <sup>a</sup>
Gamma	192/1127	NA		7 - 15 $\mu$ R/h <sup>a</sup>

<sup>a</sup>Background varied depending on naturally occurring radioactive material in the area.



**Figure B-8. Survey Map of Apt. A-22**

Table B-8. Gilbert Clock Co.—Apt. A-22

Location No.	Removable		Alpha-plus-Beta <sup>a</sup>		Gamma <sup>b</sup>			Comments
	Smear No.	Alpha-plus-Beta dpm/100 cm <sup>2</sup>	Gross cpm	Total dpm/100 cm <sup>2</sup>	Contact		1 m	
					cpm	μR/hr	μR/hr	
1	—	—	—	—	9,300	—	7	
2	—	—	—	—	9,500	—	8	
3	R0125	< 1	1,410	6,900	74,000	55	13	Kitchen, < 100 cm <sup>2</sup>
4	—	—	—	—	13,200	—	11	
5	—	—	—	—	11,400	—	10	
6	—	—	—	—	11,500	—	11	
7	—	—	—	—	10,000	—	10	
8	—	—	—	—	11,300	—	10	
9	—	—	—	—	12,000	—	10	
10	—	—	—	—	10,500	—	10	
11	—	—	—	—	12,000	—	10	
12	—	—	—	—	9,500	—	10	
13	—	—	—	—	10,000	—	9	
14	—	—	—	—	10,500	—	10	
15	—	—	—	—	13,000	—	15	
16	—	—	—	—	11,900	—	10	
17	—	—	—	—	12,300	—	11	
18	—	—	—	—	13,900	—	7.0	
19	—	—	—	—	18,500	—	12	
20	—	—	—	—	17,300	—	13	
21	R0124	1	4,324	33,000	134,000	100	23	Bedroom, ~1 m <sup>2</sup>
22	—	—	—	—	9,200	—	7	
23	—	—	—	—	43,000	38	14	Kitchen, < 100 cm <sup>2</sup>
Rm Background	—	—	—	0	10,850	—	9	Kitchen
Rm Average	—	—	—	1,380	26,733	—	11	Kitchen, locations 1-5 & 23
Rm Background	—	—	—	0	12,217	—	11	Bedroom

**Table B-8. Gilbert Clock Co.—Apt. A-22**

Location No.	Removable		Alpha-plus-Beta <sup>a</sup>		Gamma <sup>b</sup>			Comments
	Smear No.	Alpha-plus-Beta	Gross	Total	Contact		1 m	
		dpm/100 cm <sup>2</sup>	cpm	dpm/100 cm <sup>2</sup>	cpm	μR/hr	μR/hr	
Rm Average	—	—	—	4,125	28,925	—	13	Bedroom, locations 14-21
Apt Background			—	0	11,840	—	10	Apartment
Apt Average	—	—	—	1,735	21,209	—	11	Apartment

a) Ludlum 44-142 plastic scintillator with Ludlum 2221 ratemeter

b) Ludlum 44-10 NaI with Ludlum 2221 ratemeter; Ludlum 192 NaI

— indicates measurement not collected at this location



**Table B-9. Estimated Dose from the External Pathway Only**

Area/Apartment No.	Measured $\mu\text{R/hr}$ at 1 m				Gamma-only Dose  (mrem/yr)		Locations used in max room calculations <sup>a</sup>
	Survey Unit Avg		Max Room Avg				
	All Data	Bkg	All Data	Bkg	Survey Unit	Max Room	
Apt. A-20 Living Room	10	9.7	12	10	4.3	12	Calculated from 8 living room measurements
Apt. A-22 Kitchen	11	10	11	9.0	5.0	8.7	Calculated from 6 kitchen measurements
Apt. A-22 Bedroom	11	10	13	11	5.0	8.6	Calculated from 8 bedroom measurements

Survey Unit Avg = the average value considering all data collected in the survey unit (apartment or common area)

Max Room Avg = the average value for the room or area with the highest measured radioactivity

All Data= results from across the entire apartment or room, as applicable

Bkg = all results excluding results from hot spots

<sup>a</sup>See survey maps for gross measurement data by location.

**Table B-10. Estimated Dose from the Internal Pathways Only**

Area/Apartment No.	Measured dpm/100 cm <sup>2</sup>				Internal Dose		Locations used in max room calculations <sup>a</sup>
	Survey Unit Avg		Max Room Avg		(mrem/yr)		
	All Data	Bkg	All Data	Bkg	Survey Unit	Max Room	
Apt. A-20 Living Room	1,565	0	4,500	0	0.5	1.5	Locations 4-11; living room
Apt. A-22 Kitchen	1,735	0	1,380	0	0.6	0.5	Locations 1-5, 23; kitchen
Apt. A-22 Bedroom	1,735	0	4,125	0	0.6	1.4	Locations 14-21; bedroom

Survey Unit Avg = the average value considering all data collected in the survey unit (apartment or common area)

Max Room Avg = the average value for the room or area with the highest measured radioactivity

All Data= results from across the entire apartment or room, as applicable

Bkg = all results excluding results from hot spots

<sup>a</sup>See survey maps for gross measurement data by location.

<b>Table B-11. Total Estimated Dose for Current or Future Occupants</b>				
<b>Area/Apartment No.</b>	<b>Current Dose<sup>a</sup></b>		<b>Future Dose<sup>b</sup></b>	
	<b>(mrem/yr)</b>		<b>(mrem/yr)</b>	
	<b>Survey Unit</b>	<b>Max Room</b>	<b>Survey Unit</b>	<b>Max Room</b>
Apt. A-20 Living Room	4.3	12	4.9	14
Apt. A-22 Kitchen	5.0	8.7	5.6	9.1
Apt. A-22 Bedroom	5.0	8.6	5.6	10

<sup>a</sup>Current dose is due to the external pathway only (values from Table B-9)

<sup>b</sup>Future dose is comprised of all pathways and is a summation of the values from Tables B-9 and B-10; rounded to two digits or to the nearest 0.1 mrem/yr.