



State of Illinois  
Illinois Emergency Management Agency

# 2017 Radiological Environmental Monitoring Report of the Honeywell Metropolis Works Facility



# IEEMA

(This Page Intentionally Left Blank)

## Table of Contents

<u>Section Title</u>	<u>Page Number</u>
Introduction.....	4
Site Description.....	4
IEMA Radiological Environmental Monitoring Program .....	5
Sampling and Monitoring Activities.....	5
Air Sampling .....	5
Soil Sampling.....	6
Vegetation Sampling.....	6
Sediment Sampling.....	6
Water Sampling.....	6
Direct Radiation Monitoring.....	6
General Sampling and Monitoring Information.....	6
Laboratory Analysis .....	6
Gross Alpha / Beta Analysis.....	7
Gamma Analysis.....	7
Isotopic Uranium Analysis.....	7
Kinetic Phosphorescence Analyzer (KPA) Analysis.....	7
Optically Stimulated Luminescence Analysis.....	8
Minimum Detectable Concentration (MDC).....	9
Sampling and Monitoring Results .....	9
Air Sample Results .....	9
Soil Sample Results .....	9
Vegetation Sample Results.....	10
Sediment Sample Results .....	10
Water Sample Results.....	10
Direct Radiation Monitoring Results .....	10
Background Reference Areas.....	10
Summary .....	11
Appendix A: Metropolis Monitoring Locations.....	12
Appendix B: Metropolis Sample Results .....	14
Appendix C: Background Location Sample Results .....	23

## Introduction

The Illinois Emergency Management Agency (IEMA) is charged with protecting the citizens of Illinois from the potentially harmful effects of radioactive materials. In support of that mission, IEMA's Division of Nuclear Safety monitors the environment in Illinois for the presence of radionuclides through its radiological environmental monitoring program. This program has three primary functions: 1) collection of diverse samples from carefully chosen locations on a routine basis; 2) analyzing samples for radionuclides; and 3) evaluation of test results on both an annual and historical basis.

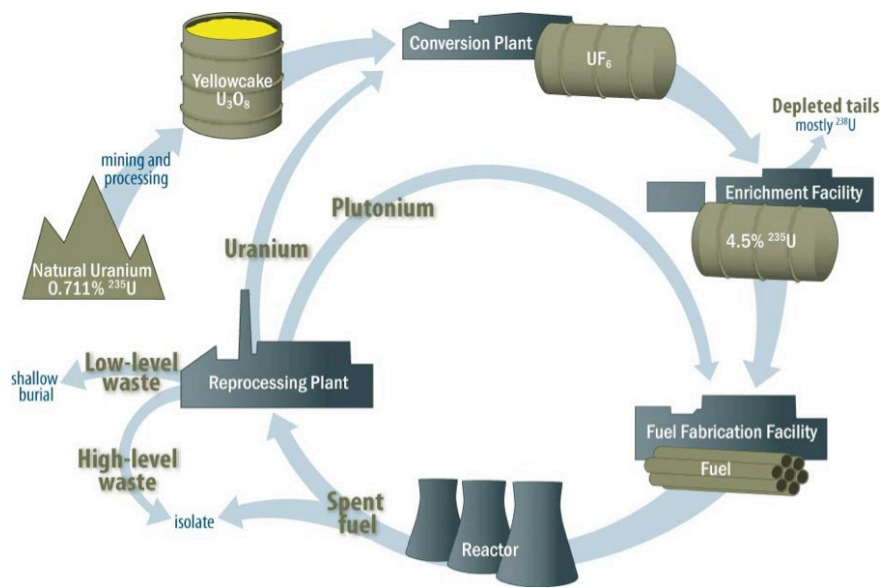
One of the locations monitored by IEMA is the environs of the Honeywell Metropolis Works (HMW) Facility near Metropolis, Illinois. The purpose of this report is to provide updated results of monitoring conducted during calendar year 2017.

## Site Description

Located on approximately 1,100 acres of land within Massac County and on the peripheries of Metropolis, Illinois, the Honeywell Metropolis Works (HMW) facility perimeter is formed by U.S. Highway 45 to the north, the Ohio River to the south, a coal terminal to the west, and the city of Metropolis to the east. The facility footprint and the land immediately surrounding the facility form a 60-acre restricted area as required by HMW's United States Nuclear Regulatory Commission's (US NRC) Radioactive Materials License, number SUB-526. This restricted area is intended for the protection of the public from exposure to radiation and radioactive materials.

Opened in 1958, the HMW, a subsidiary company of Honeywell International Inc., plays a crucial role in the nuclear fuel cycle by converting uranium ore ( $U_3O_8$ ) into uranium hexafluoride ( $UF_6$ ). HMW is unique in that it is the only facility in the United States that produces  $UF_6$ . As depicted in Figure 1, conversion is the second step in the nuclear fuel cycle immediately following mining and processing and preceding enrichment

Figure 1. Nuclear Fuel Cycle



HMW uses a dry conversion process to convert  $U_3O_8$  to  $UF_6$ . The process first strips the  $U_3O_8$  of impurities such as sodium and potassium. The material is then treated with nitrogen to form  $UO_2$  and then hydrofluorinated with hydrofluoric acid to form uranium tetra-fluoride ( $UF_4$ ). The  $UF_4$  is treated with fluorine gas to form  $UF_6$ . After HMW converts  $U_3O_8$  into  $UF_6$ , the  $UF_6$  is then processed, packaged and transported to enrichment plants, both domestic and foreign, where the  $UF_6$  is enriched either by gaseous diffusion or gas centrifugation. The enriched  $UF_6$  is then sent to fuel fabrication facilities and processed into fuel pellets for nuclear power plants.

In 2017, Honeywell announced plans to idle the HMW plant. Preparation for the idle state began late in the year, with plans to have the plant completely idle by March 2018. Honeywell is in the process of, and will continue to pursue a license renewal with the NRC. Full uranium hexafluoride cylinders will continue to be shipped through March 2018, and the plant will continue to receive uranium ore throughout the idle state. Security will be maintained, and emergency response capabilities will be commensurate with the hazards on-site. Honeywell's current plans are for the plant to remain idle until 2020, or until the market conditions improve.

Although the HMW facility is licensed by the US NRC, the Illinois Emergency Management Agency (IEMA) maintains a presence in the surrounding communities through our radiological environmental monitoring program. The overall purpose of IEMA's radiological environmental monitoring program, in relation to the HMW facility, is to determine if a radiological environmental impact is detected in the environs of the facility due to its operation, as well as determine long-term trends in environmental radiation levels.

## IEMA Radiological Environmental Monitoring Program

The IEMA radiological environmental monitoring program consists of sample collection and laboratory analysis, as well as review and analysis of the resulting data. As part of the 2017 HMW radiological environmental monitoring program, samples were collected from various locations around the HMW facility. Sampling included water, vegetation, air, direct radiation, soil, and sediment. Analyses vary from media to media but focus primarily on natural uranium. A general description of sample collection, analysis, and results follows. Sample result tables are located in Appendix B.

## Sampling and Monitoring Activities

### Air Sampling

Air particulate samples are collected from a network of five strategically positioned environmental monitoring stations (EMS) within the environs of HMW. Each EMS is comprised of a continuous low-volume vacuum pump and air filter assembly. Particulate filter samples are exchanged and analyzed weekly. The fifth EMS (Airport Road) was added in 2017 and began collecting samples in June.

## Soil Sampling

Soil samples are collected from four sampling locations during the second and third quarters of the year and analyzed for radionuclides that may have been transported from the environment and incorporated into the soil.

## Vegetation Sampling

Vegetation samples are collected from four sampling locations during the second and third quarters of the year and analyzed for radionuclides that may have been transported from the environment and incorporated into or on plant tissue.

## Sediment Sampling

Sediment samples are collected from two sampling locations during the second and third quarters of the year and analyzed for radionuclides that may have entered the water stream and settled out of solution or suspension.

## Water Sampling

Water samples are collected and analyzed from four local waterways and one public water supply location on a quarterly basis.

## Direct Radiation Monitoring

Measurements of direct gamma radiation are collected using optically-stimulated luminescent dosimeters (OSLs). A network of nineteen OSL dosimeters is arrayed around the HMW facility; dosimeters are exchanged and analyzed quarterly. OSLs METR-33 was added during the first quarter of 2017, and was placed at the Airport Road EMS location.

## General Sampling and Monitoring Information

Every effort is made to collect all scheduled environmental samples; however, occasionally samples are unobtainable due to weather conditions, water levels, or obstructed access. Appendix A contains maps of all sampling and monitoring locations.

## Laboratory Analysis

Soil, sediment, vegetation, water, and air samples were analyzed by the IEMA Radiochemistry Laboratory located in Springfield, IL. The laboratory participates in semi-annual proficiency testing programs through Environmental Resource Associates, an accredited proficiency testing provider, and the Department of Energy (DOE) Radiological and Environmental Science Laboratory's Mixed Analyte Performance Evaluation Program (MAPEP).

## Gross Alpha/Beta Analysis

Air particulate filters are exchanged and analyzed weekly for airborne radioactivity through gross alpha and beta analysis. Since radionuclides associated with natural uranium emit either alpha or beta particles, analysis of air particulate samples for gross alpha/beta activity provides a good method of screening for the presence of radioactive materials. Results from each of the five air monitoring stations are displayed in Appendix B - Tables B.1 – B.5.

Two “trigger” levels are used to determine if additional analysis is required for air particulate samples. These levels represent approximately 25% and 100% of the total uranium effluent concentration limit of 90 fCi/m<sup>3</sup> established in 10CFR20, Appendix B.

Triggering levels are set at:

- Gross alpha results at or above 25.0 fCi/m<sup>3</sup> are evaluate to determine if Kinetic Phosphorescence Analyzer (KPA) analysis will need to be performed.
- Samples with gross alpha results at or above 90 fCi/m<sup>3</sup> require KPA analysis.

## Gamma Analysis

Soil, vegetation, and sediment samples are analyzed to determine the concentration of individual radionuclides using a high-purity germanium detector in a process called gamma spectroscopy. Gamma spectroscopy results for soil, sediment, and vegetation are reported using Proactinium-234m (Pa-234m) as a surrogate radionuclide for Uranium-238 (a component of natural uranium). Uranium-238 daughter products, Radium-226 and Thorium-230, are also reported. Gamma spectroscopy results for soil, vegetation, and sediment are displayed in Appendix B-Tables B.6, B.8, and B.9.

## Isotopic Uranium Analysis

Beginning with soil samples collected in May 2017, IEMA began using isotopic uranium analysis via alpha spectroscopy to determine specific uranium-234 (U-234), uranium-235 (U-235), and uranium-238 (U-238) concentrations. Although more labor intensive, isotopic uranium analysis provides a more accurate representation of the concentration of uranium present within a sample compared to simply using Pa-234m as a surrogate, and is capable of detecting much smaller concentrations. Beginning in 2018, all soil, vegetation, and sediment samples will be analyzed using this method. Isotopic Uranium results of soil are displayed in Appendix B-Tables B.7.

## Kinetic Phosphorescence Analyzer (KPA) Analysis

Water samples are analyzed for the presence of uranium using Kinetic Phosphorescence Analyzer (KPA) analysis. Air particulate samples with results above the established Gross alpha/beta Triggering Levels may also be analyzed using KPA. KPA results are displayed in Appendix B- Table B.10.

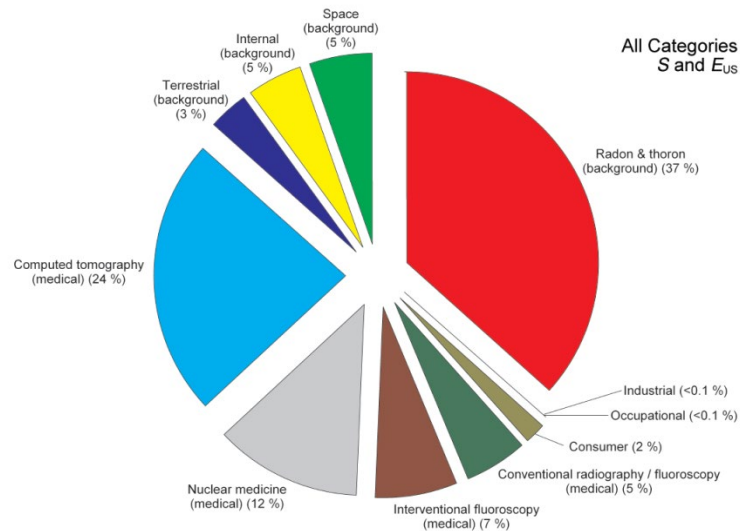
## Optically Stimulated Luminescence Analysis

Optically Stimulated Luminescence (OSL) dosimeters provide a direct measurement of the total dose received from all sources of gamma radiation, including naturally occurring radionuclides and cosmic rays. The dosimeters are used to monitor for small changes in ambient background levels of gamma radiation that could result from releases of radioactive material or exposure to large quantities of stored material on-site.

OSLs are analyzed by IEMA staff using a Landauer In Light System Auto Reader. Results found in Appendix B-Table B.II are expressed as the average milliroentgen (mR) per quarter, and are also calculated to the approximate mR per year that would have been accrued by an individual at that location for an entire year.

The ambient gamma results can be compared to the average annual radiation exposure to an individual of 620 mR/year from various sources (according to the 2009 National Council on Radiation Protection's (NCRP) Report 160). Approximately 8% (49.6 mR/year) of that exposure is from Terrestrial and Cosmic radiation (background radiation), Figure 2.

Figure 2. Sources of Radiation Exposure to Man



Reprinted with permission of the National Council on Radiation Protection and Measurements.  
(<http://NCRPpublications.org>)



## Minimum Detectable Concentration (MDC)

All analytical methods have limitations: amounts that are too small to be detected. The Minimum Detectable Concentration (MDC) is an “a priori” measure of that limitation – an estimate of the lower limit of detection. It is defined as the smallest quantity that an analytical method has 95% likelihood of detecting. For example, the MDC for IEMA’s method for tritium in water is 200 picocuries per liter (pCi/L). Given a sample with a tritium concentration of 200 pCi/L, our laboratory would detect that tritium approximately 95 times out of 100. Samples with less than 200 pCi/L could be detected, but with less certainty. Conversely, samples with more than 200 pCi/L would be more likely to be detected, approaching 100% as concentrations increase. Analytical methods are chosen, in part, on their MDC. As a general rule, methods are chosen such that their MDC is less than 10% of any applicable regulatory limit.

## Sampling and Monitoring Results

### Air Sampling Results

Air particulate sample results for EMSs located at the Metropolis Airport, Dorothy Miller Park, and on North Avenue were comparable to results obtained from background EMSs located in Marion and Springfield, IL and were consistent with data previously collected by IEMA as part of its HMW radiological environmental monitoring program. Sample results from EMSs located at the nearest residence and the newly installed Airport Road location indicate a slight elevation in gross alpha/beta concentrations. Due to their proximity to the HWM facility, increases in air particulate concentrations are expected at these locations when the plant is operational. All air particulate sample results for 2017 remained below the Trigger Levels established by IEMA.

### Soil Sampling Results

Gamma spectroscopy results for soil samples were comparable to results obtained from the background sampling locations and were consistent with data previously collected by IEMA as part of its HMW radiological environmental monitoring program. Similar to the air particulate sample results, soil samples taken from the nearest residence indicated a slight increase in Pa-234m concentration compared to other sampling locations and to background samples.

As discussed in the Laboratory Analysis section of this report, IEMA began conducting isotopic uranium analysis on soil samples using alpha spectroscopy in 2017. Isotopic uranium results for samples collected from the Metropolis Airport and from the intersection of Gurley and Devers were consistent with results obtained from the background sampling locations. Results from samples taken from the Massac Creek at Country Club Road location were significantly lower than background sample results, and those found at the Nearest Residence location were higher. A comparison of the U-238 concentrations determined through isotopic uranium analysis to the concentration of Pa-234m (U-238 surrogate) found using gamma spectroscopy indicates that the concentrations are relatively consistent, and that smaller concentrations are capable of being detected isotopic uranium analysis via alpha spectroscopy.

## Vegetation Sampling Results

All gamma spectroscopy results for vegetation samples were below established MDCs.

## Sediment Sampling Results

Gamma spectroscopy result concentrations, although above the established MDC for some radionuclides, are comparable to background location sampling data and consistent with data previously collected by IEMA as part of its HMW radiological environmental monitoring program.

Sediments samples were not collected from the background sampling location in 2017; results were compared to data obtained from samples collected at the background sampling location from 2014-2016.

## Water Sampling Results

KPA results for a water sample collected from the Ohio River at Joppa on November 6, 2017 indicated an elevated concentration of uranium. Upon receipt of sample results indicating the elevated uranium concentration, a follow-up sample was collected on January 9, 2018 to determine if concentrations remained elevated. Sample results from the January 9, 2018 sampling indicated that the concentration had returned to the levels typically seen at that location. All other sample results were consistent with data previously collected by IEMA as part of its HMW radiological environmental monitoring program.

## Direct Radiation Monitoring Results

OSL results indicated that the highest annual exposures were found at locations METR-16, 31, 32, and 33. These four OSLs represent IEMA's nearest direct radiation monitoring points to the HMW plant. Due to their proximity to the facility, slightly elevated results can be expected.

The annual exposure recorded at the METR-32 location was over twice that seen at most Metropolis and background reference area monitoring locations. METR-32 is located near an entrance to the plant where shipments of uranium ore are delivered. Therefore, much of the elevated exposure rate can be attributed to its close proximity to uranium ore transportation activities in that area, and not attributable to plant operations.

## Background Reference Areas

For comparison, samples are collected and analyzed from background reference areas located in Springfield, Marion, and/or Kincaid, Illinois. The tables in Appendix C provide the analytical results of samples collected from these background reference areas.

## Summary

In 2017, sampling and monitoring results collected as part of IEMA's HMW radiological environmental monitoring program indicate that radioactivity levels remain consistent with data collected in previous years. As seen in previous years, results from sampling and monitoring locations found near the facility indicate slightly elevated levels of radioactivity in the soil and air when compared to samples collected away from the facility or from background reference areas. Similarly, direct radiation monitoring near the facility shows a slight increase in exposure in those areas when compared to other monitoring locations found away from the plant and background reference areas. In November 2017, a spike in total uranium concentration was seen in the downstream water sample collected from the Ohio River at Joppa. Follow-up sampling performed in January 2018 indicated the level of total uranium concentration had returned to levels historically seen at that sampling location.

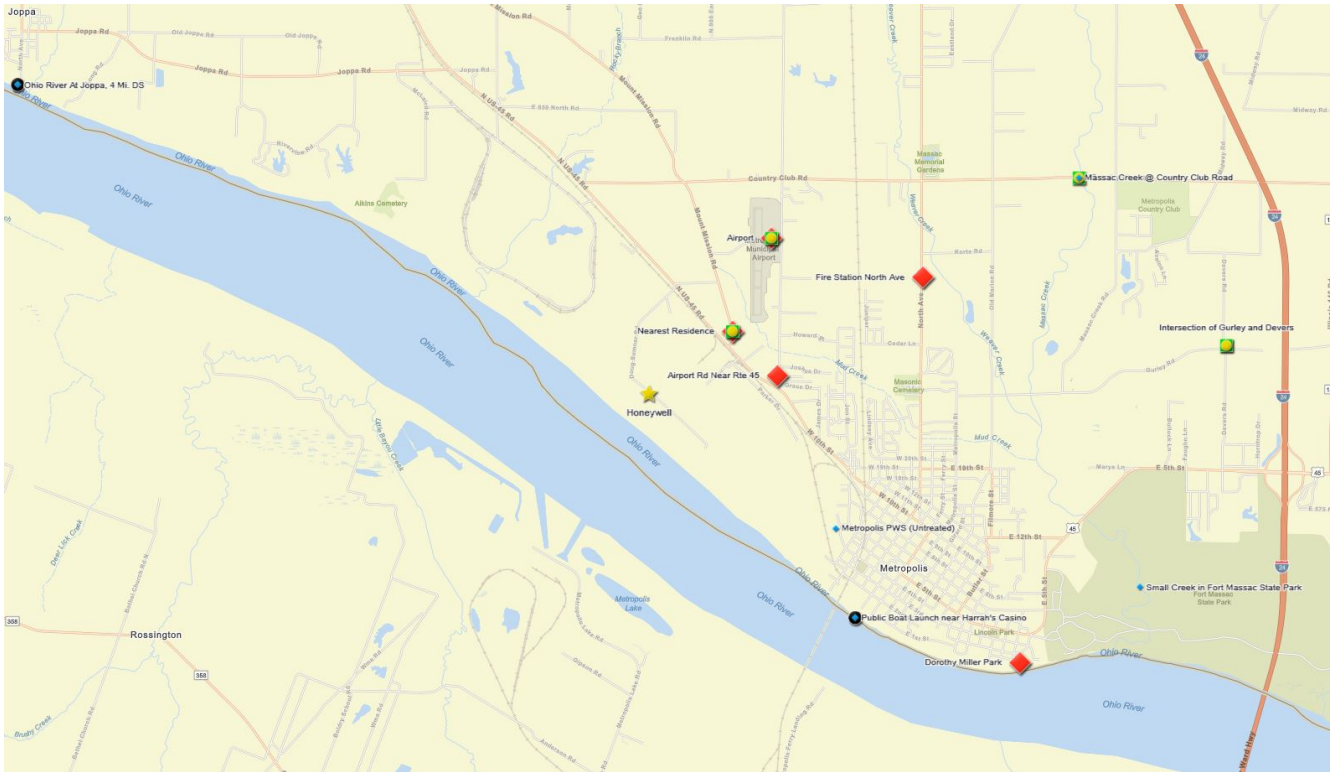
IEMA began using isotopic uranium analysis via alpha spectroscopy to determine specific uranium-234 (U-234), uranium-235 (U-235), and uranium-238 (U-238) concentrations for some soil samples collected in 2017, and plans to expand that practice in 2018 to include all soil, vegetation, and sediment samples collected. Although more labor intensive, isotopic uranium analysis provides a more accurate representation of the concentration of uranium present within a sample compared to using Pa-234m as a surrogate, and is capable of detecting much smaller concentrations.

Also in 2017, Honeywell announced plans to idle the HMW plant. Preparation for the idle state began late in the year, with plans to have the plant completely idle by March 2018. HMW plans to continue receiving, testing, and storing uranium ore throughout the idle period.

## APPENDIX A

### Maps of Monitoring and Sampling Locations around Metropolis

#### Map A.1. Sampling Locations



#### Map Key:

- |               |              |
|---------------|--------------|
| ◆ OSL*        | ● Soil       |
| ◆ Water       | ● Sediment   |
| ◆ Air Sampler | ■ Vegetation |
| ★ Honeywell   |              |

\*OSL = Optically-Stimulated Luminescence Dosimeter

Sample icons are stacked to indicate multiple types of samples collected at the same location

## Map A.2. Optically Stimulated Luminescence (OSL) Monitoring Locations



### Map Key:

- |               |              |
|---------------|--------------|
| ◆ OSL*        | ● Soil       |
| ◆ Water       | ● Sediment   |
| ◆ Air Sampler | ■ Vegetation |
| ★ Honeywell   |              |

\*OSL = Optically-Stimulated Luminescence Dosimeter

Sample icons are stacked to indicate multiple types of samples collected at the same location

## APPENDIX B

### Sample Analysis Results for Samples Collected from the Environs of the HMW Facility

Table B.1 Sample Results for Alpha / Beta Screening of Air Particulate Filters  
Nearest Residence

Results are in femtocuries per cubic meter (fCi/m<sup>3</sup>)

Location Date	Alpha		Beta	
	Result	MDC	Result	MDC
<b>Nearest Residence</b>				
1/3/2017	3.76	1.43	26.25	4.25
1/9/2017	4.19	1.43	37.88	4.25
1/17/2017	17.57	1.43	51.43	4.25
1/24/2017	6.14	2.86	44.39	8.5
1/31/2017	4.94	1.43	28.98	4.25
2/6/2017	2.81	1.43	25.08	4.25
2/14/2017	7.77	1.43	37.6	4.25
2/21/2017				
2/28/2017	9.12	1.43	35.91	4.25
3/7/2017	10.49	1.43	33.03	4.25
3/13/2017	9.11	1.43	31.71	4.25
3/20/2017	4.95	1.43	28.4	4.25
3/28/2017	4.97	1.43	29.42	4.25
4/3/2017	4.2	1.43	25.15	4.25
4/11/2017	16.34	1.43	38.06	4.25
4/17/2017	12.63	1.43	58.6	4.25
4/24/2017	15.5	1.43	32.54	4.25
5/1/2017	4.55	1.43	28.98	4.25
5/9/2017	1.86	1.43	17.87	4.25
5/15/2017	13.62	1.43	39.15	4.25
5/22/2017	16.48	1.43	38.39	4.25
5/30/2017	8.14	1.43	28.76	4.25
6/6/2017	4.66	1.43	30.98	4.25
6/13/2017	9.67	1.43	26.6	4.25
6/19/2017	9.01	1.43	30.52	4.25
6/26/2017	3.23	1.43	24.35	4.25

Location Date	Alpha		Beta	
	Result	MDC	Result	MDC
<b>Nearest Residence</b>				
7/10/2017	6.78	1.43	29.78	4.25
7/18/2017	6.93	1.43	37.68	4.25
7/24/2017	9.39	1.43	43.39	4.25
7/31/2017	4.97	1.43	32.37	4.25
8/7/2017	8.93	1.43	38.75	4.25
8/14/2017				
8/22/2017	13.78	1.43	44.95	4.25
8/29/2017	4.25	1.43	31.98	4.25
9/5/2017	9.69	1.43	55.4	4.25
9/12/2017	4.46	1.43	32.17	4.25
9/18/2017	6.37	1.43	43.73	4.25
9/26/2017	6.33	1.43	51.48	4.25
10/3/2017	1.86	1.43	37	4.25
10/10/2017	4.58	1.43	27.38	4.25
10/16/2017	1.93	1.43	27.8	4.25
10/23/2017	4.21	1.43	30.5	4.25
10/30/2017	3.47	1.43	18.12	4.25
11/14/2017	3.81	1.43	31.51	4.25
11/21/2017	7.18	1.43	40.12	4.25
11/27/2017	5.86	1.43	36.98	4.25
12/5/2017	6.82	1.43	44.18	4.25
12/11/2017				
12/20/2017	7.34	1.43	33.33	4.25

No sample submitted on 2/21/2017 and 12/11/2017 due to an air pump malfunctions.  
No sample submitted on 8/14/2017 due to a missing sample.

**Table B.2 Sample Results for Alpha / Beta Screening of Air Particulate Filters  
Metropolis Airport**  
Results are in femtocuries per cubic meter (fCi/m<sup>3</sup>)

Location Date	Alpha		Beta	
	Result	MDC	Result	MDC
<b>Airport 1 Mi. NNE</b>				
1/3/2017	2.35	1.43	23.92	4.25
1/9/2017	3.17	1.43	41.17	4.25
1/17/2017	3.3	1.43	25.46	4.25
1/24/2017				
1/31/2017	2.91	1.43	27.81	4.25
2/6/2017	2.54	1.43	29.58	4.25
2/14/2017	2.02	1.43	30.08	4.25
2/21/2017	3.78	1.43	25.8	4.25
2/28/2017	3.16	1.43	21.98	4.25
3/7/2017	2.09	1.43	19.7	4.25
3/13/2017	4.12	1.43	27.96	4.25
3/20/2017	3.98	1.43	25.73	4.25
3/28/2017	3.15	1.43	24.81	4.25
4/3/2017	2.44	1.43	16.21	4.25
4/11/2017	4.11	1.43	22.06	4.25
4/17/2017	3.45	1.43	32.35	4.25
4/24/2017	3.04	1.43	14.97	4.25
5/1/2017	2.12	1.43	18.99	4.25
5/9/2017	<MDC	1.43	19.11	4.25
5/15/2017	3.99	1.43	33.28	4.25
5/22/2017	4.59	1.43	23.42	4.25
5/30/2017	3.71	1.43	20.25	4.25
6/6/2017	3.26	1.43	31.42	4.25
6/13/2017	4.32	1.43	22.96	4.25
6/19/2017	4.83	1.43	29.78	4.25
6/26/2017	2.6	1.43	19.77	4.25

Location Date	Alpha		Beta	
	Result	MDC	Result	MDC
<b>Airport 1 Mi. NNE</b>				
7/10/2017	4.06	1.43	24.52	4.25
7/18/2017	5.35	1.43	30.63	4.25
7/24/2017	6.24	1.43	36.45	4.25
7/31/2017	4.97	1.43	28.86	4.25
8/7/2017	4.93	1.43	32.36	4.25
8/14/2017	5.21	1.43	43.82	4.25
8/22/2017	7.09	1.43	34.87	4.25
8/29/2017	3.67	1.43	29.88	4.25
9/5/2017	7.18	1.43	48.23	4.25
9/12/2017	3.87	1.43	32.68	4.25
9/18/2017	4.72	1.43	43.9	4.25
9/26/2017	4.56	1.43	43.54	4.25
10/3/2017	2.29	1.43	35.6	4.25
10/10/2017	2.08	1.43	25.19	4.25
10/16/2017	2.12	1.43	27.08	4.25
10/23/2017	2.25	1.43	27.48	4.25
10/30/2017	2.7	1.43	17.92	4.25
11/14/2017	3.03	1.43	30	4.25
11/21/2017	6.03	1.43	50.1	4.25
11/27/2017	5.53	1.43	36.86	4.25
12/5/2017	3.92	1.43	38.2	4.25
12/11/2017	5.87	1.43	26.43	4.25
12/20/2017	5.07	1.43	27.84	4.25

No sample submitted on 1/24/2017 due to an air pump malfunction.

Table B.3 Sample Results for Alpha / Beta Screening of Air Particulate Filters  
 North Avenue  
 Results are in femtocuries per cubic meter (fCi/m<sup>3</sup>)

Location Date	Alpha		Beta	
	Result	MDC	Result	MDC
<b>Fire Station North Ave</b>				
1/3/2017	1.52	1.43	22.2	4.25
1/9/2017	3.91	1.43	44.32	4.25
1/17/2017	3.82	1.43	35.52	4.25
1/24/2017	4.36	1.43	35.22	4.25
1/31/2017	3.84	1.43	30.55	4.25
2/6/2017	2.34	1.43	25.7	4.25
2/14/2017	3.27	2.86	28.19	8.5
2/21/2017	3.72	1.43	24.75	4.25
2/28/2017	3.02	1.43	22.68	4.25
3/7/2017	2.66	1.43	26.5	4.25
3/13/2017	4.76	1.43	27.98	4.25
3/20/2017	3.01	1.43	25.78	4.25
3/28/2017	3.59	1.43	25.75	4.25
4/3/2017	1.62	1.43	19.57	4.25
4/11/2017	2.39	1.43	26.66	4.25
4/17/2017	1.86	1.43	29.73	4.25
4/24/2017	1.43	1.43	15.21	4.25
5/1/2017	<MDC	1.43	21.2	4.25
5/9/2017	1.6	1.43	16.08	4.25
5/15/2017	3.09	1.43	33.8	4.25
5/22/2017	3.94	1.43	20.93	4.25
5/30/2017	3.87	1.43	20.69	4.25
6/6/2017	4.33	1.43	31.26	4.25
6/13/2017	2.85	1.43	19.24	4.25
6/19/2017	3.87	1.43	28.36	4.25
6/26/2017	2.58	1.43	21.23	4.25

Location Date	Alpha		Beta	
	Result	MDC	Result	MDC
<b>Fire Station North Ave</b>				
7/10/2017	3.02	1.43	24.42	4.25
7/18/2017	3.63	1.43	29.87	4.25
7/24/2017	5.14	1.43	36.69	4.25
7/31/2017	4.23	1.43	33.05	4.25
8/7/2017	4.57	1.43	34.94	4.25
8/14/2017	5.62	1.43	45.21	4.25
8/22/2017	4.81	1.43	36.33	4.25
8/29/2017	3.22	1.43	29.85	4.25
9/5/2017	5.13	1.43	48.13	4.25
9/12/2017	3.29	1.43	29.31	4.25
9/18/2017	3.26	1.43	41.36	4.25
9/26/2017	4.12	1.43	49.87	4.25
10/3/2017	2.18	1.43	37.92	4.25
10/10/2017	2.56	1.43	25.22	4.25
10/16/2017	2.43	1.43	28.11	4.25
10/23/2017	1.86	1.43	29.99	4.25
10/30/2017	2.35	1.43	17.53	4.25
11/14/2017	3.51	1.43	33.32	4.25
11/21/2017	7.01	1.43	52.79	4.25
11/27/2017	5.91	1.43	37.92	4.25
12/5/2017	5.94	1.43	42.65	4.25
12/11/2017	5.5	1.43	29.18	4.25
12/20/2017	4.4	1.43	28.68	4.25



Table B.4 Sample Results for Alpha / Beta Screening of Air Particulate Filters  
 Dorothy Miller Park  
 Results are in femtocuries per cubic meter (fCi/m<sup>3</sup>)

Location Date	Alpha		Beta	
	Result	MDC	Result	MDC
<b>Dorothy Miller Park</b>				
1/3/2017	1.62	1.43	21.98	4.25
1/9/2017	3.79	1.43	46.45	4.25
1/17/2017	2.84	1.43	28.96	4.25
1/24/2017	3.87	1.43	35.43	4.25
1/31/2017	2.24	1.43	27.77	4.25
2/6/2017	2.49	1.43	28.01	4.25
2/14/2017	3.43	1.43	30.97	4.25
2/21/2017	4.07	1.43	26.61	4.25
2/28/2017	3.34	1.43	24.69	4.25
3/7/2017	2.95	1.43	24.31	4.25
3/13/2017	3.11	1.43	27.21	4.25
3/20/2017	3.13	1.43	23.11	4.25
3/28/2017	2.07	1.43	23.41	4.25
4/3/2017	1.53	1.43	15.38	4.25
4/11/2017	1.99	1.43	26.78	4.25
4/17/2017	1.73	1.43	25.99	4.25
4/24/2017	1.54	1.43	15.19	4.25
5/1/2017	<MDC	1.43	17.33	4.25
5/9/2017	<MDC	1.43	19.54	4.25
5/15/2017	<MDC	1.43	26.18	4.25
5/22/2017	3.72	1.43	22.41	4.25
5/30/2017	4	1.43	19.32	4.25
6/6/2017	4.09	1.43	28.14	4.25
6/13/2017	2.22	1.43	18.26	4.25
6/19/2017	1.86	1.43	13.16	4.25
6/26/2017	5.16	1.43	20.29	4.25

Location Date	Alpha		Beta	
	Result	MDC	Result	MDC
<b>Dorothy Miller Park</b>				
7/10/2017	2.92	1.43	21.07	4.25
7/18/2017	3.85	1.43	25.35	4.25
7/24/2017	4.88	1.43	33.07	4.25
7/31/2017	3.43	1.43	25.02	4.25
8/7/2017	2.71	1.43	32.07	4.25
8/14/2017	5.54	1.43	43.08	4.25
8/22/2017	3.7	1.43	32.41	4.25
8/29/2017	3.62	1.43	30.74	4.25
9/5/2017	6.49	1.43	49.15	4.25
9/12/2017	3.97	1.43	33.01	4.25
9/18/2017	3.83	1.43	39.96	4.25
9/26/2017	4.62	1.43	50.36	4.25
10/3/2017	3.14	1.43	37.8	4.25
10/10/2017	2.46	1.43	22	4.25
10/16/2017	1.82	1.43	29.09	4.25
10/23/2017	2.93	1.43	29	4.25
10/30/2017	2.84	1.43	19.03	4.25
11/14/2017	4.28	1.43	36.33	4.25
11/21/2017	8	1.43	52.63	4.25
11/27/2017	3.86	1.43	35.88	4.25
12/5/2017	5.29	1.43	46.53	4.25
12/11/2017	5.19	1.43	30.1	4.25
12/20/2017	4.17	1.43	31.42	4.25

Table B.5 Sample Results for Alpha / Beta Screening of Air Particulate Filters  
 Airport Road  
 Results are in femtocuries per cubic meter (fCi/m<sup>3</sup>)

Location Date	Alpha		Beta	
	Result	MDC	Result	MDC
<b>Airport Road</b>				
6/6/2017	3.98	1.43	38.47	4.25
6/13/2017	3.19	1.43	22.17	4.25
6/19/2017	4.72	1.43	20.54	4.25
6/26/2017	14.18	1.43	32.58	4.25
7/10/2017	4.16	1.43	23.21	4.25
7/18/2017	4.08	1.43	29.17	4.25
7/24/2017	6.28	1.43	37.61	4.25
7/31/2017	4.3	1.43	32.7	4.25
8/7/2017	4.1	1.43	36.05	4.25
8/14/2017	5.96	1.43	42.54	4.25
8/22/2017	7.59	1.43	36.44	4.25
8/29/2017	3.53	1.43	32.8	4.25
9/5/2017	7.21	1.43	49.91	4.25
9/12/2017	2.88	1.43	31.28	4.25
9/18/2017	4.91	1.43	40.08	4.25
9/26/2017	5.04	1.43	47.56	4.25
10/3/2017	2.59	1.43	34.29	4.25
10/10/2017	1.86	1.43	21.88	4.25
10/16/2017	<MDC	1.43	27.19	4.25
10/23/2017	1.78	1.43	29.73	4.25
10/30/2017	3.74	1.43	18.61	4.25
11/14/2017	3.52	1.43	32.81	4.25
11/21/2017	7.07	1.43	48.25	4.25
11/27/2017	5.2	1.43	38.92	4.25
12/5/2017	4.47	1.43	41.17	4.25
12/11/2017	5.52	1.43	29.94	4.25
12/20/2017	4.89	1.43	31.5	4.25

The Airport Road Environmental Monitoring Station was newly installed in 2017.

Table B.6 Gamma Spectroscopy Sample Results for Soil Samples  
Results in picocuries per gram (pCi/g)

Location Date	Pa-234m		Ra-226		Th-230	
	Result	MDC	Result	MDC	Result	MDC
<b>Airport 1 Mi. NNE</b>						
5/9/2017	1.7	1.5	1.3	0.3	<MDC	7.3
8/29/2017	<MDC	1.5	1.3	0.3	<MDC	7.3
<b>Intersection of Gurley and Devers</b>						
5/9/2017	<MDC	1.5	<MDC	0.3	<MDC	7.3
8/29/2017	<MDC	1.5	1.1	0.3	<MDC	7.3
<b>Massac Creek at Country Club Road</b>						
5/9/2017	<MDC	1.5	0.7	0.3	<MDC	7.3
8/29/2017	<MDC	1.5	0.3	0.3	<MDC	7.3
<b>Nearest Residence</b>						
5/9/2017	2.4	1.5	1.6	0.3	<MDC	7.3
8/29/2017	2.4	1.5	1.4	0.3	<MDC	7.3

Table B.7 Isotopic Uranium Sample Results for Soil Samples  
Results in picocuries per gram (pCi/g)

Location Date	U-234		U-235		U-238	
	Result	MDC	Result	MDC	Result	MDC
<b>Airport 1 Mi. NNE</b>						
5/9/2017	1.41	0.02	0.06	0.02	1.54	0.01
8/29/2017	1.39	0.02	0.08	0.02	1.47	0.01
<b>Intersection of Gurley and Devers</b>						
5/9/2017	1.18	0.02	0.05	0.02	1.05	0.01
8/29/2017	1.05	0.02	0.04	0.02	1.06	0.01
<b>Massac Creek at Country Club Road</b>						
5/9/2017	0.33	0.02	0.02	0.02	0.41	0.01
8/29/2017	0.46	0.02	0.02	0.02	0.56	0.01
<b>Nearest Residence</b>						
5/9/2017	2.18	0.02	0.13	0.02	2.09	0.01
8/29/2017	2.03	0.02	0.11	0.02	2.14	0.01

Table B.8 Gamma Spectroscopy Sample Results for Vegetation Samples  
Results in picocuries per gram (pCi/g)

Location Date	Pa-234m		Ra-226		Th-230	
	Result	MDC	Result	MDC	Result	MDC
<b>Airport 1 Mi. NNE</b>						
5/9/2017	<MDC	11.7	<MDC	2.4	<MDC	37.0
8/29/2017	<MDC	11.7	<MDC	2.4	<MDC	37.0
<b>Intersection of Gurley and Devers</b>						
5/9/2017	<MDC	11.7	<MDC	2.4	<MDC	37.0
8/29/2017	<MDC	11.7	<MDC	2.4	<MDC	37.0
<b>Massac Creek at Country Club Road</b>						
5/9/2017	<MDC	11.7	<MDC	2.4	<MDC	37.0
8/29/2017	<MDC	11.7	<MDC	2.4	<MDC	37.0
<b>Nearest Residence</b>						
5/9/2017	<MDC	11.7	<MDC	2.4	<MDC	37.0
8/29/2017	<MDC	11.7	<MDC	2.4	<MDC	37.0

Table B.9 Gamma Spectroscopy Sample Results for Sediment Samples  
Results in picocuries per gram (pCi/g)

Location Date	Pa-234m		Ra-226		Th-230	
	Result	MDC	Result	MDC	Result	MDC
<b>Ohio River at Joppa, 4 Mi. DnS</b>						
8/29/2017	1.1	0.9	1.0	0.2	<MDC	2.9
<b>Public Boat Launch near Harrah's Casino</b>						
8/29/2017	<MDC	0.9	0.6	0.2	<MDC	2.9

Table B.10 KPA (Total Uranium) Sample Results for Water Samples  
Results in picocuries per liter (pCi/L)

Location Date	Uranium	
	Result	MDC
<b>Massac Creek at Country Club Road</b>		
2/21/2017	0.2	0.1
5/9/2017	<MDC	0.1
8/29/2017	<MDC	0.1
<b>Ohio River at Joppa, 4 Mi. DnS</b>		
2/21/2017	0.7	0.1
5/9/2017	0.2	0.1
8/29/2017	0.4	0.1
11/6/2017	2.9	0.1
<b>Public Boat Launch near Harrah's Casino</b>		
2/21/2017	0.5	0.1
5/9/2017	0.3	0.1
8/29/2017	0.3	0.1
11/6/2017	0.3	0.1
<b>PWS (Untreated)</b>		
2/21/2017	0.5	0.1
5/9/2017	0.4	0.1
8/29/2017	0.4	0.1
11/6/2017	0.4	0.1
<b>Creek in Fort Massac State Park</b>		
11/6/2017	0.1	0.1

Table B.II Summary of Ambient Gamma Results

Location	Quarter 1 mR/quarter	Quarter 2 mR/quarter	Quarter 3 mR/quarter	Quarter 4 mR/quarter	Annual Exposure mR/year
METR-01	8.30	7.39	6.94		30.17
METR-02	7.85	6.39	9.13	7.48	30.84
METR-03	9.13	7.57	8.58	6.75	32.03
METR-04	7.67	8.12	9.67	8.40	33.85
METR-05	8.49	8.94	9.76	8.58	35.77
METR-06	9.58	6.66	10.04	10.31	36.59
METR-16	10.68	10.59	12.59	10.59	44.44
METR-20	6.94	7.76	8.76	7.12	30.57
METR-21	9.31	8.30	11.32	9.95	38.87
METR-22	10.68	9.40	9.22	8.85	38.14
METR-25	6.39	4.56			21.90
METR-26	9.49	10.13	11.22	8.03	38.87
METR-27	7.76	7.21	7.39	6.21	28.56
METR-28	8.30	7.48	8.40	6.30	30.48
METR-29	9.03	7.48	10.13	9.13	35.77
METR-30	9.03	8.85	9.95	8.58	36.41
METR-31	12.41	14.60			54.02
METR-32	18.71	18.62	22.81	20.99	81.12
METR-33	12.05	9.95	11.41	12.32	45.72

Blanks in the table indicate that the dosimeter was missing at the end of the quarter.  
 The Annual Dose column is based on averages of all available data.  
 Quarters estimated to be 91.25 days in length.

**APPENDIX C**  
**Sample Analysis Results for Samples Collected from Established Background Locations**

Table C.1 Sample Results for Alpha / Beta Screening of Air Samples  
 Springfield Background Location  
 Results are in femtocuries per cubic meter (fCi/m<sup>3</sup>)

Location Date	Alpha		Beta	
	Result	MDC	Result	MDC
<b>Knotts Street Air Sampler</b>				
1/3/2017	4.08	1.41	30.9	3.76
1/10/2017	2.77	1.41	38.55	3.76
1/17/2017	3.38	1.41	36.49	3.76
1/30/2017	2.2	1.41	29.55	3.76
2/6/2017	<MDC	1.41	17.1	3.76
2/14/2017	<MDC	1.41	25.71	3.76
2/21/2017	3.91	1.41	28.71	3.76
2/27/2017	3.41	1.41	31.25	3.76
3/6/2017	3.1	1.41	25.73	3.76
3/13/2017	1.79	1.41	18.85	3.76
3/20/2017	2.63	1.41	14.1	3.76
3/27/2017	2.78	1.41	24.75	3.76
4/3/2017	<MDC	1.41	17.08	3.76
4/10/2017	1.76	1.41	28.23	3.76
4/17/2017	<MDC	1.41	24.05	3.76
4/24/2017	<MDC	1.41	19.61	3.76
5/1/2017	<MDC	1.41	15.72	3.76
5/8/2017	<MDC	1.41	21.7	3.76
5/15/2017	<MDC	1.41	28.85	3.76
5/22/2017	1.88	1.41	18	3.76
5/30/2017	2.61	1.41	21.56	3.76
6/6/2017	2.51	1.41	29.91	3.76
6/12/2017	2.61	1.41	25.62	3.76
6/19/2017	1.77	1.41	16.3	3.76
6/26/2017	2.25	1.41	14.76	3.76

Location Date	Alpha		Beta	
	Result	MDC	Result	MDC
<b>Knotts Street Air Sampler</b>				
7/5/2017	3.65	1.41	27.34	3.76
7/10/2017	3.18	1.41	26.5	3.76
7/17/2017	3.84	1.41	24.21	3.76
7/24/2017	4.59	1.41	30.24	3.76
7/31/2017	2.95	1.41	21.04	3.76
8/7/2017	2.47	1.41	28.88	3.76
8/14/2017	1.86	1.41	26.73	3.76
8/21/2017	4.45	1.41	38.58	3.76
8/28/2017	2.54	1.41	24.44	3.76
9/11/2017	1.98	1.41	24.04	3.76
9/18/2017	2.38	1.41	37.2	3.76
9/25/2017	2.9	1.41	38.54	3.76
10/2/2017	2.14	1.41	32.21	3.76
10/10/2017	<MDC	1.41	24.42	3.76
10/17/2017	1.56	1.41	26.08	3.76
10/24/2017	2.27	1.41	31.14	3.76
10/31/2017	3.12	1.41	15.46	3.76
11/7/2017	4.86	1.41	40.86	3.76
11/13/2017	4.34	1.41	34.76	3.76
11/27/2017	2.81	1.41	37.74	3.76
12/4/2017	4.9	1.41	31.94	3.76
12/11/2017	4.15	1.41	29.92	3.76
12/19/2017	3.9	1.41	28.34	3.76
12/27/2017	5.53	1.41	35.84	3.76

Table C.2 Sample Results for Alpha / Beta Screening of Air Samples  
 Marion Background Location  
 Results are in femtocuries per cubic meter (fCi/m<sup>3</sup>)

Location Date	Alpha		Beta		Location Date	Alpha		Beta	
	Result	MDC	Result	MDC		Result	MDC	Result	MDC
<b>Marion Office</b>					<b>Marion Office</b>				
1/3/2017	1.4	1.2	24.28	3.4	6/26/2017	3.42	1.2	21.14	3.4
1/9/2017	3.43	1.2	35.17	3.4	7/10/2017	3.34	1.2	26.06	3.4
1/17/2017	3.52	1.2	31.13	3.4	7/18/2017	4.16	1.2	29	3.4
1/24/2017	2.95	1.2	33.67	3.4	7/24/2017	4.98	1.2	39.77	3.4
1/31/2017	2.12	1.2	27.03	3.4	7/31/2017	4.33	1.2	33.04	3.4
2/6/2017	1.22	1.2	28.51	3.4	8/7/2017	3.46	1.2	29.2	3.4
2/14/2017	2	1.2	28.43	3.4	8/14/2017	5.56	1.2	37.87	3.4
2/21/2017	<MDC	1.2	8.8	3.4	8/22/2017	3.78	1.2	31.75	3.4
2/28/2017	3.99	2.4	42.13	6.8	8/29/2017	3.45	1.2	32.1	3.4
3/7/2017	2.92	1.2	26.35	3.4	9/5/2017	5.76	1.2	50.77	3.4
3/13/2017	2.44	1.2	25.63	3.4	9/12/2017	3.15	1.2	30.5	3.4
3/20/2017	2.38	1.2	25.13	3.4	9/18/2017	4.93	1.2	42.67	3.4
3/28/2017	2.19	1.2	23.47	3.4	9/26/2017	3.71	1.2	45.49	3.4
4/3/2017	<MDC	1.2	13.75	3.4	10/3/2017	1.61	1.2	32.34	3.4
4/11/2017	1.59	1.2	20.64	3.4	10/10/2017	2.64	1.2	22.59	3.4
4/17/2017	1.26	1.2	25.23	3.4	10/16/2017	2.05	1.2	28.41	3.4
4/24/2017	<MDC	1.2	16.85	3.4	10/23/2017	2.51	1.2	28.79	3.4
5/1/2017	<MDC	1.2	15.87	3.4	10/30/2017	2.71	1.2	16.79	3.4
5/9/2017					11/14/2017	3.31	1.2	31.81	3.4
5/15/2017	1.3	1.2	29	3.4	11/21/2017	6.98	1.2	49.96	3.4
5/22/2017	3.44	1.2	19.8	3.4	11/27/2017	5.12	1.2	40.25	3.4
5/30/2017	3.39	1.2	20.42	3.4	12/5/2017	4.25	1.2	42.39	3.4
6/6/2017	2.97	1.2	28.2	3.4	12/11/2017	6.25	1.2	25.5	3.4
6/13/2017	2.82	1.2	20.37	3.4	12/20/2017	4.88	1.2	29.54	3.4
6/19/2017	1.84	1.2	20.96	3.4					

No sample submitted on 5/9/2017 due to an air pump malfunction



Table C.3 Gamma Spectroscopy Soil Samples  
 Kincaid, IL Background Locations  
 Results are in picocuries per gram (pCi/g)

Location Date	Pa-234m		Ra-226		Th-230	
	Result	MDC	Result	MDC	Result	MDC
<b>East Boat Ramp</b>						
4/19/2017	1.7	1.4	1.3	0.3	<MDC	7.4
7/18/2017	<MDC	1.4	1.3	0.3	<MDC	7.4
<b>Strawkaws Boat Ramp</b>						
4/19/2017	1.7	1.4	1.0	0.3	<MDC	7.4
7/18/2017	<MDC	1.4	1.6	0.3	<MDC	7.4
<b>West Boat Ramp</b>						
4/19/2017	2.1	1.4	0.7	0.3	<MDC	7.4
7/18/2017	<MDC	1.4	1.9	0.3	<MDC	7.4

Table C.4 Isotopic Uranium Soil Samples  
 Kincaid, IL Background Locations  
 Results are in picocuries per gram (pCi/g)

Location Date	U-234		U-235		U-238	
	Result	MDC	Result	MDC	Result	MDC
<b>East Boat Ramp</b>						
4/19/2017	1.06	0.02	0.04	0.02	1.06	0.01
7/18/2017	0.90	0.02	0.06	0.02	0.91	0.01
<b>Strawkaws Boat Ramp</b>						
4/19/2017	1.12	0.02	0.04	0.02	1.14	0.01
7/18/2017	0.89	0.02	0.05	0.02	1.08	0.01
<b>West Boat Ramp</b>						
4/19/2017	1.07	0.02	0.07	0.02	1.13	0.01
7/18/2017	0.90	0.02	0.06	0.02	0.95	0.01

Table C.5 Gamma Spectroscopy Vegetation Samples  
 Kincaid, IL Background Locations  
 Results are in picocuries per gram (pCi/g)

Location Date	Pa-234m		Ra-226		Th-230	
	Result	MDC	Result	MDC	Result	MDC
<b>East Boat Ramp</b>						
4/19/2017	<MDC	16.0	<MDC	2.7	<MDC	42.0
7/18/2017	<MDC	16.0	<MDC	2.7	<MDC	42.0
<b>Strawkaws Boat Ramp</b>						
4/19/2017	<MDC	16.0	<MDC	2.7	<MDC	42.0
7/18/2017	<MDC	16.0	<MDC	2.7	<MDC	42.0
<b>West Boat Ramp</b>						
4/19/2017	<MDC	16.0	<MDC	2.7	<MDC	42.0
7/18/2017	<MDC	16.0	<MDC	2.7	<MDC	42.0

Table C.6 Gamma Spectroscopy Sample Results for Sediment Samples  
 Kincaid, IL Background Locations  
 Results are in picocuries per gram (pCi/g)

No sediment collected in 2017

Table C.7 Summary of Ambient Gamma Results  
Kincaid, IL Background Locations

Location	Quarter 1 mR/quarter	Quarter 2 mR/quarter	Quarter 3 mR/quarter	Quarter 4 mR/quarter	Annual Exposure mR/year
KC-01	9.22	10.59	10.13	11.32	41.25
KC-02	7.67	10.86	11.68	10.49	40.70
KC-03	9.40		9.49	8.58	36.62
KC-04	8.58	9.95	10.13	8.40	37.05
KC-05	9.40	9.03	9.03	8.76	36.23
KC-06	7.76		10.22	9.31	36.38
KC-07	7.94	8.03	10.59	10.31	36.87
KC-08	7.21	8.67	8.94	8.21	33.03
KC-09	8.76	8.67	10.49	11.32	39.24
KC-10	8.49		10.04	10.13	38.20
KC-11		10.49	12.41	9.49	43.19
KC-12	9.95	8.49	9.76	11.41	39.60
KC-13	8.67	9.86	9.03	11.32	38.87
KC-14	9.58	10.13	12.05	10.59	42.34
KC-15	9.22	9.95	10.95	8.94	39.06

Blanks in the table indicate that the dosimeter was missing at the end of the quarter.  
The Annual Dose column is based on averages of all available data.  
Quarters estimated to be 91.25 days in length.

---

**Illinois Emergency Management Agency**  
1035 Outer Park Drive  
Springfield, IL 62704

[www.iema.illinois.gov](http://www.iema.illinois.gov)

---