



Bureau of Radiation Safety



Environmental Monitoring in the Environs of the Honeywell Metropolis Works Facility Report for Calendar Year 2014

August 2015

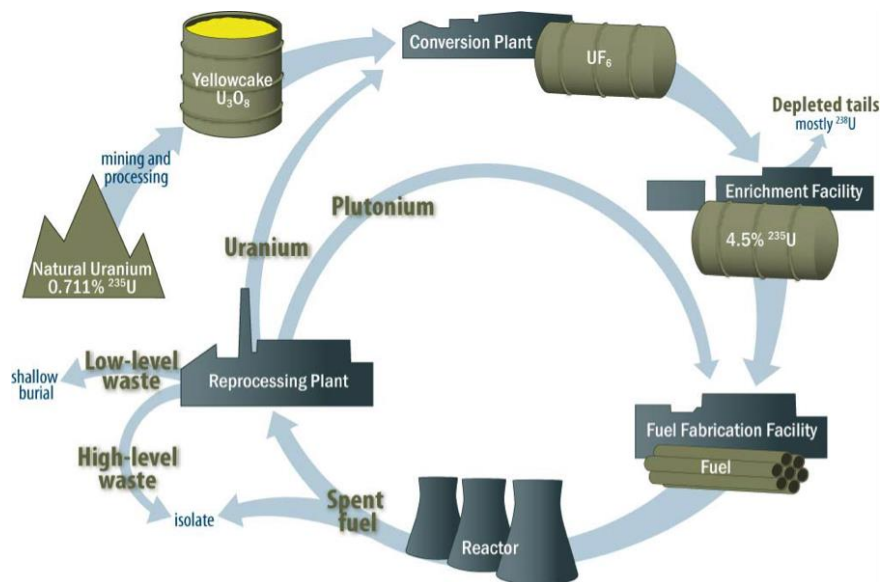
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Introduction

Located on 1,000 acres of land within Massac County and on the peripheries of Metropolis, Illinois, the Honeywell Metropolis Works Facility (HMW) site perimeter is formed by U.S. Highway 45 to the north, the Ohio River to the south, an industrial coal blending plant to the west, and the city of Metropolis to the east. The facility footprint and the land immediately surrounding the facility form a 59 acre restricted area as required by HMW's United States Nuclear Regulatory Commission's (US NRC) Radioactive Materials License, number SUB-526. The 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 . Simplified, this 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.

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 environmental monitoring program. The overall purpose of IEMA's environmental monitoring program is to determine if a public

health or environmental radiological impact is detected in the environs of the HMW facility due to its operation, as well as to determine long term trends in environmental radiation levels.

In 2014, all test results for samples collected as part of IEMA's environmental monitoring program for the Honeywell Metropolis Works facility were consistent with historical data and below regulatory standards and guidelines.

These objectives are achieved through a network of 5 strategically positioned environmental monitoring stations (EMS) within the environs of the HMW. Each EMS is comprised of a continuous low-volume vacuum pump and air filter assembly. An additional network of optically stimulated luminescence (OSL) dosimeters, which passively detects ionizing gamma radiation, is also positioned within the HMW environs and around the facility fence line. Additionally, IEMA collects water, sediment, soil, and vegetation samples from the environs surrounding the HMW. All samples are analyzed at IEMA's Radiochemistry Laboratory in Springfield, Illinois.

Environmental Monitoring Program

During Calendar Year 2014, the IEMA Environmental Monitoring program consisted of sample collection, sample analysis by the IEMA Radiochemistry Laboratory in Springfield, and data review and analysis of the results. The overall purpose of IEMA's environmental monitoring program is to determine if a public health or environmental radiological impact is detected in the environs of the HMW facility due to exposure from its operation, as well as to determine long term trends in environmental radiation levels.

Radiological exposure to the population can occur through direct pathways such as immersion/inhalation or indirectly through the food chain. The inhalation and immersion exposure pathways are monitored through collection of air samples and the use of OSL dosimetry.

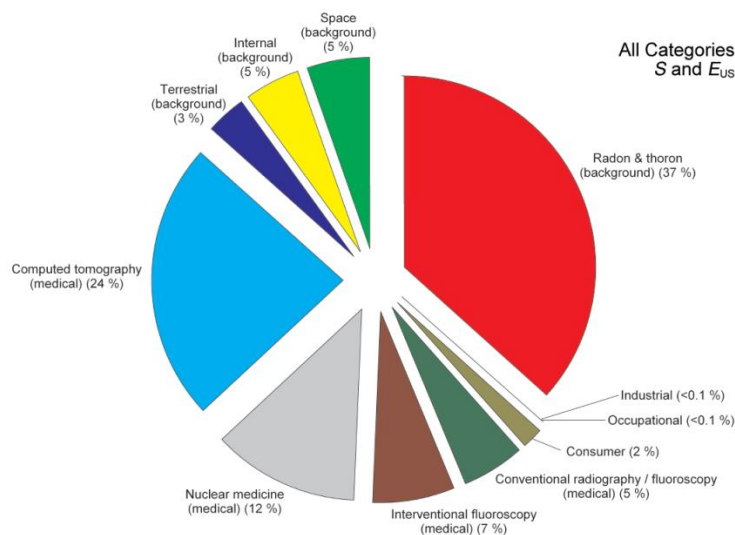
Air particulate samples are collected continuously by low-volume samplers at five different locations throughout Metropolis, and are exchanged and analyzed weekly for airborne radioactivity through gross alpha and beta analysis. Results from each of the five air monitoring stations, are displayed in **Tables 1 – 5** with results in femtocuries per meter cubed (fCi/m³).

OSL dosimeters provide a direct measurement of the total dose produced by all sources of gamma radiation, including naturally occurring radionuclides and cosmic rays. The dosimeters are arrayed around the HMW site and are exchanged and analyzed quarterly. IEMA performs the analyses of the dosimeters at the Springfield Laboratory location.

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. The locations identified by a star (*) preceding the location name are actually on the fence immediately surrounding the plant. The other side of the fence is an area controlled by HMW with restricted access. The results are expected to be higher in these locations because of the proximity to stored radioactive material. The other locations are in and around the city of Metropolis, and are more indicative of potential exposure to members of the public.

Table 12 shows results for OSL dosimeters analyzed during 2013. In addition to the quarterly results, which are expressed as the average millirem per day, we have used those results to calculate the approximate millirem per year that would have been accrued by an individual at that location for an entire year. Those numbers can be compared to the average radiation exposure to an individual of 620 millirem per year from various sources of radiation (according to the 2009 National Council on Radiation Protection’s Report, **Figure 2**). Approximately 8% of that exposure is from Terrestrial and Cosmic radiation (background radiation), and equals approximately 49.6 millirem per year.

Figure 2. Sources of Radiation Exposure to Man



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Determined by IEMA as site specific indirect exposure pathways, water, vegetation, soil, and sediment samples are collected annually and analyzed for radionuclide accumulation in the environment. Sample analysis vary from media to media but focus primarily on uranium-235 and uranium-238, and their decay progeny. Vegetation and soil samples were collected on August 26, 2013, and sediment samples were collected on November 11, 2013. Results for vegetation samples are shown in **Table 6**, results for soil samples are shown in **Table 7**, and results for sediment samples are shown in **Table 8**. Results for water samples are shown in **Tables 9, 10 and 11**. **Table 9** shows Gross Alpha / Beta Screening Results, and **Table 10** shows results when the water was analyzed by gamma spectroscopy, with a focus on uranium-235 and uranium-238 and their decay progeny. **Table 11** shows the results of water samples analyzed for trace quantities of total uranium using Kinetic Phosphorescence Analysis (KPA). **Figure 3** shows all of IEMA’s sample locations.

Background Samples

IEMA has established the environs of Sangchris Lake State Park, a cooling lake for a coal-fired power station, as a Background Sampling Location. To establish “background” radiation levels, water, soil, sediment, vegetation, and fish samples are collected. In addition, there is an array of environmental dosimeters around the power plant, similar to what can be found around the Honeywell Metropolis Works Facility.

Since we routinely take air samples around the Honeywell facility, we have also established a Background Sampling Location for air samples. A continuous air sampling station is location near the IEMA Laboratory in Springfield, and samples are exchanged weekly, similar to the air samplers in the vicinity of Honeywell.

Figure 16 is an overview of all sampling locations in the vicinity of Sangchris Lake State Park. Results for Background Samples can be found in **Appendix C**.

Incident at Honeywell on October 26, 2014

On October 26, 2014, Honeywell Metropolis Works reported an event involving a uranium hexafluoride leak that occurred in the Feeds Material Building (FMB). The leak resulted in a hazardous situation that migrated outside the FMB, but reportedly stayed within the restricted area or inner fence line. IEMA maintains five air Environmental Monitoring Stations in Metropolis, and the air particulate filters are exchanged weekly. At the time of the release, all five air samplers were operational. The air particulate filters were exchanged on October 27, 2014 and analyzed by the IEMA Radiochemistry Laboratory. Appendix D contains a Summary of Analytical Results.

IEMA did not observe measurable increases of radioactivity in the environment as a result of the incident at the Honeywell facility on October 26, 2014.

Laboratory Analysis

Samples were analyzed by the IEMA Radiochemistry Laboratory located in Springfield. The Laboratory participates in semi-annual proficiency testing programs through Environmental Resource Associates, an accredited proficiency testing provider.

The Laboratory uses standard published radioanalytical procedures. Since the radionuclides of interest around the HMW site are uranium and progeny, which emit either alpha or beta particles, all environmental samples are analyzed for total alpha and beta radioactivity. This provides a good method of screening samples for the presence of radioactive material.

Limits of Detection

All analytical methods have limitations: amounts that are just 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 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, due to their MDC. As a general rule, methods are chosen such that their MDC is less than 10% of any applicable regulatory limit. The MDCs for each analytical method are not included in this report.

Analysis of Data

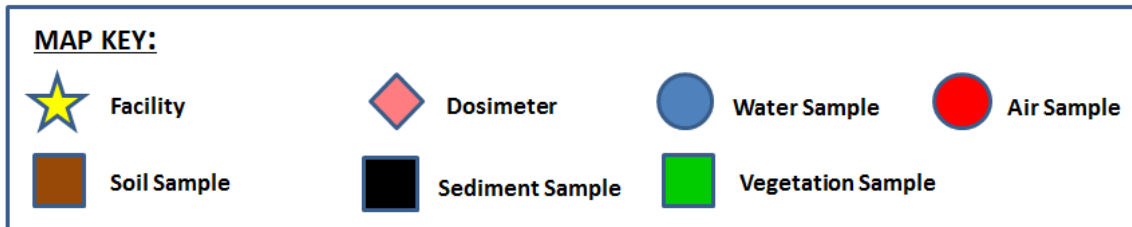
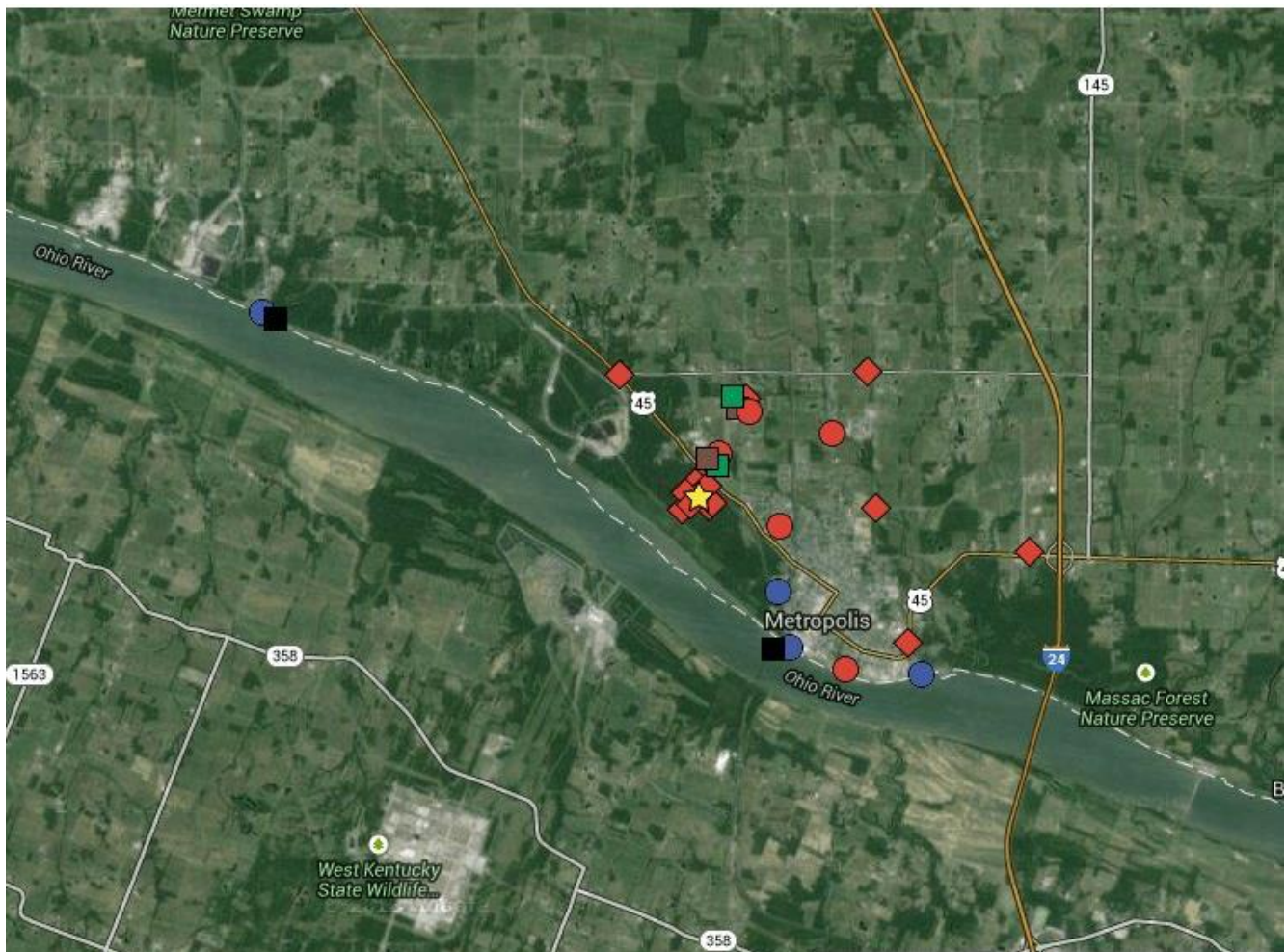
Negative numbers in the tables of this report are the values reported by the IEMA Radiochemistry Laboratory. Each batch of samples is counted with a sample “blank” to determine a “background” for each machine and each type of medium being analyzed. That ‘background’ reading is then subtracted from the analytical results. When the sample has very little radioactivity, subtracting the “background” values may actually result in a negative number.

Understanding a Test Result with a Confidence Interval

What does a tritium result of (519 ± 99.5) pCi/L, with 95% confidence, mean? First, the unit, pCi/L, is used to measure the amount of tritium, in picocuries (pCi), present in one liter (L) of the sample. Thus, the result tells us that the analysis found 519 picocuries of tritium per liter. However, all measurements have some uncertainty associated with them – some range of values which the analysis, if repeated, could reasonably be expected to be the result. In this case, the uncertainty is ± 99.5 pCi/L. If repeated, the analysis could reasonably be expected to return values as low as $519 - 99.5 = 419.5$ pCi/L and as high as $519 + 99.5 = 618.5$ pCi/L. The statement “with 95% confidence” tells us just how certain we can be about that range of values – in this case, we judge that there is a 95% probability that the sample contains between 419.5 and 618.5 picocuries of tritium per liter of water. Tables of data in Appendix B use the term, “Error” instead of “Uncertainty” only for the sake of brevity in the tables.

APPENDIX A

Map A.1. Map of Monitoring Locations around Metropolis



APPENDIX B

**Table B.1. Sample Results for Alpha / Beta Screening of Air Particulate Filters
Nearest Resident
Results are in femtocuries per cubic meter (fCi/m³)**

Location Date	Alpha		Beta		Location Date	Alpha		Beta	
	Result	Error	Result	Error		Result	Error	Result	Error
Residence NNE Boundary					Residence NNE Boundary				
1/13/2014	7.4	+ 0.8	29.5	+ 1.4	7/28/2014	8.2	+ 1.3	34.3	+ 2.7
2/3/2014	6.8	+ 1.4	28.5	+ 2.6	8/4/2014	4.8	+ 1.1	34.3	+ 2.7
2/10/2014	1.9	+ 0.8	25.7	+ 2.0	8/12/2014	7.9	+ 1.2	41.6	+ 2.6
2/18/2014	3.7	+ 0.9	31.7	+ 2.0	8/18/2014	6.9	+ 1.3	28.5	+ 2.9
2/24/2014	6.1	+ 1.2	14.7	+ 1.9	8/25/2014	14.1	+ 1.7	48.4	+ 3.1
3/4/2014	2.1	+ 0.7	22.2	+ 1.7	9/2/2014	11.2	+ 1.4	71.8	+ 3.3
3/10/2014	1.4	+ 0.9	24.4	+ 2.2	9/8/2014	5.2	+ 1.2	30.0	+ 2.9
3/17/2014	11.4	+ 1.5	39.4	+ 2.6	9/15/2014	9.8	+ 1.5	32.8	+ 3.0
3/24/2014	11.2	+ 1.4	28.1	+ 2.1	9/22/2014	6.9	+ 1.2	49.7	+ 3.0
3/31/2014	6.7	+ 1.5	62.8	+ 3.9	9/29/2014	6.2	+ 1.2	39.9	+ 2.8
4/21/2014	4.5	+ 1.0	26.7	+ 2.0	10/6/2014	12.3	+ 1.6	50.5	+ 3.1
4/28/2014	2.8	+ 1.0	22.0	+ 2.5	10/14/2014	6.9	+ 1.1	29.5	+ 2.3
5/12/2014	27.1	+ 2.3	47.9	+ 3.1	10/20/2014	5.7	+ 1.2	24.3	+ 2.6
5/19/2014	1.5	+ 0.8	13.2	+ 2.0	10/27/2014	3.9	+ 1.0	35.0	+ 2.7
5/27/2014	6.3	+ 1.0	28.7	+ 2.0	11/3/2014	5.6	+ 1.1	33.5	+ 2.6
6/2/2014	3.7	+ 1.1	19.6	+ 2.5	11/10/2014	9.6	+ 1.4	42.8	+ 2.9
6/10/2014	4.1	+ 0.9	16.0	+ 1.5	11/17/2014	4.6	+ 1.0	27.9	+ 2.4
6/16/2014	3.5	+ 1.0	20.1	+ 2.1	11/24/2014	9.7	+ 1.4	41.4	+ 2.9
6/23/2014	14.3	+ 1.6	35.7	+ 2.3	12/2/2014	14.7	+ 1.5	44.2	+ 2.7
6/30/2014	5.4	+ 1.2	25.9	+ 2.5	12/8/2014	4.5	+ 1.1	50.5	+ 3.4
7/7/2014	9.9	+ 1.4	27.8	+ 2.1	12/15/2014	4.4	+ 1.0	53.7	+ 3.1
7/14/2014	5.7	+ 1.1	28.9	+ 2.1	12/22/2014	3.0	+ 0.9	34.7	+ 2.7
7/21/2014	3.2	+ 0.9	21.1	+ 1.9	12/29/2014	5.1	+ 1.0	31.0	+ 2.6

**Table 2. Sample Results for Alpha / Beta Screening of Air Particulate Filters
Metropolis Airport**
Results are in femtocuries per cubic meter (fCi/m³)

Location Date	Alpha		Beta		Location Date	Alpha		Beta	
	Result	Error	Result	Error		Result	Error	Result	Error
Metropolis Airport 1 Mi. NNE					Metropolis Airport 1 Mi. NNE				
1/13/2014	2.5	+ 0.5	25.0	+ 1.3	7/7/2014	3.5	+ 0.9	22.9	+ 1.9
1/21/2014	2.4	+ 0.7	20.5	+ 1.8	7/14/2014	3.3	+ 0.9	25.9	+ 2.0
1/27/2014	3.0	+ 1.0	14.2	+ 1.9	7/21/2014	2.6	+ 0.8	24.1	+ 1.9
2/3/2014	1.7	+ 0.9	21.5	+ 2.3	7/28/2014	7.3	+ 1.2	34.0	+ 2.6
2/10/2014	2.0	+ 0.8	31.0	+ 2.1	8/4/2014	6.1	+ 1.2	41.9	+ 3.1
2/18/2014	2.4	+ 3.4	20.8	+ 7.0	8/12/2014	6.5	+ 1.1	42.0	+ 2.6
2/24/2014	2.1	+ 0.8	17.8	+ 1.9	8/18/2014	4.8	+ 1.1	31.9	+ 2.9
3/4/2014	1.9	+ 0.7	29.1	+ 1.9	8/25/2014	7.2	+ 1.2	36.9	+ 2.7
3/10/2014	1.0	+ 0.8	30.6	+ 2.3	9/2/2014	6.6	+ 1.1	44.1	+ 2.7
3/17/2014	3.3	+ 0.9	22.3	+ 2.0	9/8/2014	4.0	+ 1.1	29.4	+ 2.7
3/24/2014	4.8	+ 1.0	21.3	+ 1.9	9/15/2014	3.5	+ 0.9	22.3	+ 2.3
3/31/2014	1.5	+ 0.8	30.7	+ 2.5	9/22/2014	5.8	+ 1.1	46.8	+ 2.9
4/8/2014	1.1	+ 0.7	19.3	+ 2.0	9/29/2014	4.7	+ 1.0	41.1	+ 2.8
4/14/2014	6.5	+ 1.2	22.9	+ 2.2	10/6/2014	3.7	+ 1.0	43.3	+ 2.9
4/21/2014	3.3	+ 0.9	24.0	+ 1.9	10/14/2014	4.7	+ 0.9	28.7	+ 2.2
4/28/2014	1.6	+ 0.8	24.9	+ 2.3	10/20/2014	3.4	+ 1.0	19.3	+ 2.6
5/5/2014	4.0	+ 1.0	24.1	+ 2.3	10/27/2014	2.3	+ 0.8	40.3	+ 2.9
5/12/2014	3.9	+ 1.0	33.9	+ 2.5	11/3/2014	3.7	+ 0.9	28.2	+ 2.4
5/19/2014	1.6	+ 0.7	13.8	+ 1.9	11/10/2014	3.6	+ 0.9	33.7	+ 2.6
5/27/2014	4.3	+ 0.9	29.8	+ 2.0	11/17/2014	2.1	+ 0.7	30.6	+ 2.4
6/2/2014	2.6	+ 1.0	20.7	+ 2.5	11/24/2014	3.0	+ 0.9	39.9	+ 2.7
6/10/2014	1.6	+ 0.6	14.6	+ 1.5	12/2/2014	2.7	+ 0.8	38.0	+ 2.4
6/16/2014	2.5	+ 0.9	16.4	+ 2.0	12/8/2014	2.6	+ 0.9	52.7	+ 3.3
6/23/2014	8.6	+ 1.2	23.6	+ 1.9	12/15/2014	4.1	+ 1.0	54.6	+ 3.1
6/30/2014	2.3	+ 0.9	22.4	+ 2.3	12/22/2014	2.1	+ 0.9	37.2	+ 2.7
					12/29/2014	2.8	+ 0.8	28.2	+ 2.5

**Table 3. Sample Results for Alpha / Beta Screening of Air Particulate Filters
Hospital Roof**
Results are in femtocuries per cubic meter (fCi/m³)

Location	Alpha			Beta		
Date	Result	Error	Result	Error	Result	Error
Massac County Hospital Roof						
1/13/2014	0.7	+ 0.3	9.6	+ 0.9		
1/21/2014	2.3	+ 0.7	21.7	+ 1.8		
1/27/2014	2.6	+ 0.9	15.5	+ 2.0		
2/3/2014	1.0	+ 0.8	22.9	+ 2.2		
2/10/2014	2.4	+ 0.8	28.9	+ 2.1		
2/18/2014	1.1	+ 0.7	31.1	+ 2.1		
2/24/2014	2.3	+ 0.9	16.5	+ 1.9		
3/4/2014	1.9	+ 0.7	30.8	+ 1.9		
3/10/2014	2.1	+ 0.9	35.4	+ 2.5		
3/17/2014	1.5	+ 0.7	9.3	+ 1.6		
3/24/2014	4.7	+ 1.2	20.5	+ 2.2		
3/31/2014	1.3	+ 0.8	27.2	+ 2.5		
4/8/2014	1.5	+ 0.7	20.7	+ 2.1		
4/14/2014	2.5	+ 0.9	14.8	+ 1.9		
4/21/2014	3.5	+ 0.9	27.3	+ 2.0		
4/28/2014	2.0	+ 0.8	25.7	+ 2.3		
5/5/2014	1.2	+ 0.7	18.5	+ 2.1		
5/12/2014	1.9	+ 0.8	28.9	+ 2.5		
5/19/2014	2.4	+ 0.8	14.9	+ 2.0		
5/27/2014	3.5	+ 0.8	23.0	+ 1.8		
6/2/2014	1.9	+ 0.9	20.8	+ 2.5		
6/10/2014	1.1	+ 0.6	14.3	+ 1.5		
6/16/2014	1.6	+ 0.8	19.8	+ 2.1		
6/23/2014	4.7	+ 1.0	20.4	+ 1.9		
6/30/2014	1.4	+ 0.8	22.9	+ 2.3		
Massac County Hospital Roof						
7/7/2014	2.9	+ 0.9	24.5	+ 2.0		
7/14/2014	3.1	+ 0.9	23.9	+ 2.0		
7/21/2014	3.1	+ 0.9	19.2	+ 1.8		
7/28/2014	5.1	+ 1.1	31.8	+ 2.6		
8/4/2014	7.2	+ 1.2	36.3	+ 2.8		
8/12/2014	7.8	+ 1.2	41.8	+ 2.7		
8/18/2014	7.0	+ 1.3	40.4	+ 3.1		
8/25/2014	5.0	+ 1.1	31.5	+ 2.6		
9/2/2014	5.3	+ 1.0	31.6	+ 2.4		
9/8/2014	3.1	+ 1.0	27.3	+ 2.8		
9/15/2014	2.9	+ 0.9	24.0	+ 2.4		
9/22/2014	4.6	+ 1.0	42.6	+ 2.8		
9/29/2014	4.1	+ 1.0	38.9	+ 2.8		
10/6/2014	4.1	+ 1.0	39.5	+ 2.8		
10/14/2014	3.9	+ 0.9	25.2	+ 2.2		
10/20/2014	6.0	+ 1.2	25.9	+ 2.7		
10/27/2014	3.4	+ 0.9	37.7	+ 2.8		
11/3/2014	3.1	+ 0.9	28.0	+ 2.4		
11/10/2014	3.9	+ 1.0	31.7	+ 2.5		
Pump ran for 2 weeks - ice on Hosp. roof						
11/24/2014	2.6	+ 0.5	32.9	+ 1.7		
12/2/2014	2.6	+ 0.7	34.2	+ 2.3		
12/8/2014	1.9	+ 0.9	49.1	+ 3.3		
12/15/2014	8.7	+ 1.3	64.7	+ 3.3		
12/22/2014	2.8	+ 0.9	37.5	+ 2.7		
12/29/2014	1.4	+ 0.7	24.3	+ 2.4		

Table 4. Sample Results for Alpha / Beta Screening of Air Particulate Filters – North Avenue
Results are in femtocuries per cubic meter (fCi/m³)

Location Date	Alpha		Beta		Location Date	Alpha		Beta	
	Result	Error	Result	Error		Result	Error	Result	Error
North Ave.					North Ave.				
1/13/2014	3.0	+ 0.5	22.9	+ 1.2	7/7/2014	4.4	+ 1.0	24.2	+ 2.0
1/21/2014	4.2	+ 3.0	10.7	+ 5.8	7/14/2014	2.8	+ 0.9	25.6	+ 2.0
1/27/2014	1.6	+ 0.8	17.4	+ 1.9	7/21/2014	2.7	+ 0.8	20.5	+ 1.8
2/3/2014	1.6	+ 0.9	25.1	+ 2.3	7/28/2014	6.8	+ 1.2	34.3	+ 2.7
2/10/2014	1.3	+ 0.7	25.0	+ 2.0	8/4/2014	6.3	+ 1.2	40.7	+ 2.8
2/18/2014	2.4	+ 0.8	36.1	+ 2.1	8/12/2014	6.6	+ 1.1	39.1	+ 2.6
2/24/2014	1.8	+ 0.8	14.2	+ 1.8	8/18/2014	5.3	+ 1.2	37.6	+ 3.0
3/4/2014	2.3	+ 0.7	30.4	+ 1.9	8/25/2014	6.2	+ 1.2	34.5	+ 2.7
3/10/2014	1.1	+ 0.8	25.9	+ 2.2	9/2/2014	6.7	+ 1.1	35.8	+ 2.4
3/17/2014	1.3	+ 0.7	21.9	+ 2.0	9/8/2014	2.9	+ 1.0	25.6	+ 2.6
3/24/2014	3.4	+ 0.9	17.1	+ 1.8	9/15/2014	3.3	+ 0.9	24.7	+ 2.3
3/31/2014	1.9	+ 0.8	28.4	+ 2.4	9/22/2014	3.9	+ 1.0	44.4	+ 2.8
4/8/2014	1.2	+ 0.7	19.2	+ 2.0	9/29/2014	3.9	+ 1.0	45.1	+ 2.9
4/14/2014	3.6	+ 1.0	16.3	+ 1.9	10/6/2014	4.0	+ 1.0	37.4	+ 2.7
4/21/2014	3.3	+ 0.9	23.9	+ 2.0	10/14/2014	4.2	+ 0.9	31.7	+ 2.3
4/28/2014	2.0	+ 0.9	27.0	+ 2.4	10/20/2014	2.7	+ 0.9	26.8	+ 2.7
5/5/2014	1.2	+ 0.8	19.5	+ 2.3	10/27/2014	2.1	+ 0.8	41.6	+ 2.8
5/12/2014	2.0	+ 0.8	28.1	+ 2.4	11/3/2014	3.1	+ 0.9	30.6	+ 2.4
5/19/2014	0.8	+ 0.7	12.9	+ 2.0	11/10/2014	3.4	+ 0.9	34.4	+ 2.6
5/27/2014	4.5	+ 0.9	24.9	+ 1.9	11/17/2014	2.1	+ 0.7	28.3	+ 2.4
6/2/2014	1.5	+ 0.9	22.8	+ 2.5	11/24/2014	2.4	+ 0.8	39.1	+ 2.7
6/10/2014	1.3	+ 0.6	12.4	+ 1.4	12/2/2014	2.8	+ 0.8	35.5	+ 2.4
6/16/2014	0.8	+ 0.8	19.6	+ 2.1	12/8/2014	3.4	+ 1.0	51.0	+ 3.3
6/23/2014	5.5	+ 1.1	22.3	+ 1.9	12/15/2014	4.1	+ 1.0	56.5	+ 3.2
6/30/2014	1.1	+ 0.7	21.0	+ 2.2	12/22/2014	4.3	+ 1.0	34.4	+ 2.7
					12/29/2014	1.9	+ 0.8	30.9	+ 2.6

**Table 5. Sample Results for Alpha / Beta Screening of Air Particulate Filters –
Water Treatment Plant / Dorothy Miller Park
Results are in femtocuries per cubic meter (fCi/m³)**

Location Date	Alpha		Beta		Location Date	Alpha		Beta	
	Result	Error	Result	Error		Result	Error	Result	Error
Dorothy Miller Park					Dorothy Miller Park				
1/13/2014	2.2	+ 0.5	25.4	+ 1.3	7/7/2014	2.2	+ 0.8	20.5	+ 1.8
1/21/2014	1.8	+ 0.7	20.6	+ 1.7	7/14/2014	3.2	+ 0.9	27.9	+ 2.1
1/27/2014	2.1	+ 0.8	16.2	+ 1.9	7/21/2014	3.3	+ 0.9	22.2	+ 1.9
2/3/2014	1.2	+ 0.9	25.5	+ 2.4	7/28/2014	5.7	+ 1.1	34.3	+ 2.7
2/10/2014	2.3	+ 0.8	33.5	+ 2.2	8/4/2014	5.6	+ 1.1	39.4	+ 2.8
2/18/2014	1.7	+ 0.7	34.4	+ 2.1	8/12/2014	7.3	+ 1.2	42.9	+ 2.7
2/24/2014	1.2	+ 0.8	23.6	+ 2.2	8/18/2014	4.5	+ 1.1	34.3	+ 3.0
3/4/2014	1.6	+ 0.6	27.1	+ 1.8	8/25/2014	4.7	+ 1.1	31.1	+ 2.6
3/10/2014	0.8	+ 0.8	34.7	+ 2.4	9/2/2014	5.7	+ 1.0	34.3	+ 2.4
3/17/2014	1.2	+ 0.6	21.6	+ 1.9	9/8/2014	3.4	+ 1.0	31.0	+ 2.8
3/24/2014	3.3	+ 0.9	20.1	+ 1.9	9/15/2014	3.0	+ 0.9	23.8	+ 2.3
3/31/2014	2.0	+ 0.9	32.7	+ 2.6	9/22/2014	4.5	+ 1.0	48.4	+ 2.9
4/8/2014	0.4	+ 0.6	20.6	+ 2.0	9/29/2014	4.5	+ 1.0	39.7	+ 2.8
4/14/2014	2.7	+ 0.9	17.0	+ 2.0	10/6/2014	2.8	+ 0.9	35.4	+ 2.7
4/21/2014	3.7	+ 0.9	27.9	+ 2.1	10/14/2014	3.7	+ 0.9	29.7	+ 2.3
4/28/2014	1.4	+ 0.8	22.8	+ 2.3	10/20/2014	2.6	+ 0.9	21.2	+ 2.5
5/5/2014	0.1	+ 0.6	9.6	+ 1.9	10/27/2014	2.0	+ 0.8	38.4	+ 2.8
5/12/2014	2.5	+ 0.9	30.6	+ 2.5	11/3/2014	2.8	+ 0.8	28.8	+ 2.4
5/19/2014	0.9	+ 0.7	16.2	+ 2.1	11/10/2014	3.2	+ 0.9	34.2	+ 2.6
5/27/2014	2.9	+ 0.7	29.0	+ 1.9	11/17/2014	2.6	+ 0.8	32.1	+ 2.4
6/2/2014	1.0	+ 0.8	19.1	+ 2.4	11/24/2014	2.5	+ 0.8	40.6	+ 2.8
6/10/2014	1.5	+ 0.6	15.5	+ 1.5	12/2/2014	2.6	+ 0.8	38.5	+ 2.5
6/16/2014	3.1	+ 1.0	19.0	+ 2.1	12/8/2014	1.7	+ 0.8	50.0	+ 3.3
6/23/2014	5.3	+ 1.0	22.2	+ 1.9	12/15/2014	4.8	+ 1.1	56.3	+ 3.2
6/30/2014	1.2	+ 0.8	23.2	+ 2.3	12/22/2014	3.7	+ 1.0	39.2	+ 2.8
					12/29/2014	1.2	+ 0.7	28.6	+ 2.5

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

Location	Ac-228		Be-7		Bi-212		Bi-214		Cs-137		K-40		Pa-234m		Pb-210		Pb-212	
Date	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Intersection of Gurley and Devers (@ Road Ends Sign)																		
5/13/2014	1.0	± 0.0	0.0	± 0.1	0.9	± 0.1	1.0	± 0.0	0.0	± 0.0	11.3	± 0.5	1.5	± 0.7	2.7	± 1.3	1.0	± 0.0
8/12/2014	1.0	± 0.0	0.0	± 0.0	1.0	± 0.1	1.0	± 0.0	0.1	± 0.0	11.6	± 0.6	0.6	± 0.6	1.9	± 0.1	1.0	± 0.0
Massac Creek @ Country Club Road																		
5/13/2014	0.3	± 0.0	0.0	± 0.0	0.3	± 0.0	0.3	± 0.0	0.0	± 0.0	1.1	± 0.1	0.0	± 0.3	0.4	± 0.2	0.3	± 0.0
8/12/2014	1.0	± 0.1	-0.1	± 0.2	0.8	± 0.3	0.9	± 0.1	0.0	± 0.0	13.2	± 0.9	2.1	± 2.0	1.5	± 0.6	1.0	± 0.1
Metropolis Airport 1 Mi. NNE																		
5/12/2014	1.1	± 0.0	0.1	± 0.1	1.0	± 0.1	1.1	± 0.0	0.2	± 0.0	10.9	± 0.5	1.6	± 0.6	2.4	± 0.2	1.1	± 0.0
8/12/2014	1.0	± 0.0	0.0	± 0.1	0.9	± 0.1	0.9	± 0.0	0.3	± 0.0	10.3	± 0.5	1.5	± 0.7	1.3	± 0.1	1.0	± 0.0
Residence NNE Boundary																		
5/13/2014	1.1	± 0.0	0.0	± 0.1	1.1	± 0.1	1.2	± 0.0	0.2	± 0.0	12.7	± 0.6	2.8	± 0.9	1.5	± 0.1	1.1	± 0.0
8/12/2014	0.9	± 0.0	0.0	± 0.1	1.0	± 0.1	1.0	± 0.0	0.4	± 0.0	11.8	± 0.5	3.4	± 0.8	1.5	± 0.1	1.0	± 0.0

Location	Pb-214		Ra-226		Th-230		Th-231		Th-234		Tl-208		U-234		U-235	
Date	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Intersection of Gurley and Devers (@ Road Ends Sign)																
5/13/2014	1.1	± 0.0	1.1	± 0.5	0.1	± 2.2	-5.0	± 1.1	1.0	± 0.4	0.9	± 0.0	1.3	± 17.7	0.1	± 0.0
8/12/2014	1.1	± 0.0	1.5	± 0.5	0.8	± 0.8	-0.8	± 0.4	1.2	± 0.3	0.9	± 0.0	8.4	± 3.2	0.0	± 0.0
Massac Creek @ Country Club Road																
5/13/2014	0.3	± 0.0	0.6	± 0.1	-0.1	± 1.0	-1.5	± 0.5	0.3	± 0.1	0.3	± 0.0	3.3	± 3.7	0.0	± 0.0
8/12/2014	1.0	± 0.1	1.9	± 0.4	3.5	± 5.4	-1.8	± 3.2	1.3	± 0.7	0.9	± 0.1	7.3	± 19.3	0.1	± 0.0
Metropolis Airport 1 Mi. NNE																
5/12/2014	1.2	± 0.0	0.8	± 0.5	2.4	± 1.1	-0.3	± 0.4	1.6	± 0.4	1.0	± 0.0	7.4	± 3.7	0.1	± 0.0
8/12/2014	1.0	± 0.0	0.8	± 0.5	-1.1	± 1.0	-0.7	± 0.4	1.4	± 0.3	0.9	± 0.0	8.8	± 2.6	0.1	± 0.0
Residence NNE Boundary																
5/13/2014	1.4	± 0.0	1.3	± 0.5	0.2	± 1.1	-3.1	± 0.7	2.4	± 0.5	1.0	± 0.0	10.4	± 3.4	0.1	± 0.0
8/12/2014	1.1	± 0.0	0.8	± 0.5	1.0	± 1.0	0.0	± 0.0	3.0	± 0.7	0.8	± 0.0	7.7	± 3.2	0.2	± 0.0

Table 7. Gamma Spectroscopy Sample Results for Vegetation Samples
Results are in picocuries per kilogram (pCi/kg)

Location	Ac-228		Be-7		Bi-212		Bi-214		Cs-137		K-40		Pa-234m		Pb-210		Pb-212	
Date	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Intersection of Gurley and Devers (@ Road Ends Sign)																		
5/13/2014	0.1	± 0.1	2.4	± 0.4	0.2	± 0.2	0.0	± 0.0	0.0	± 0.0	12.1	± 0.8	0.9	± 2.4	0.3	± 0.1	0.0	± 0.0
8/12/2014	0.1	± 0.1	4.2	± 0.4	0.3	± 0.3	0.1	± 0.1	0.0	± 0.0	18.5	± 1.3	-0.7	± 3.8	0.9	± 0.2	0.0	± 0.0
Massac Creek @ Country Club Road																		
5/13/2014	0.1	± 0.2	2.9	± 1.1	0.6	± 0.9	0.1	± 0.1	0.0	± 0.1	22.0	± 1.9	-7.3	± 8.6	-0.1	± 0.7	0.0	± 0.1
8/12/2014	0.4	± 0.2	3.0	± 0.6	0.4	± 0.6	0.2	± 0.1	0.0	± 0.0	15.2	± 1.5	5.2	± 6.1	0.1	± 0.5	0.0	± 0.1
Metropolis Airport 1 Mi. NNE																		
5/12/2014	0.0	± 0.0	1.4	± 0.2	0.1	± 0.2	0.1	± 0.0	0.0	± 0.0	15.7	± 0.9	0.3	± 1.8	0.1	± 0.1	0.0	± 0.0
8/12/2014	0.1	± 0.1	1.7	± 0.4	0.1	± 0.4	0.0	± 0.1	0.0	± 0.0	10.2	± 1.0	4.2	± 4.0	0.4	± 0.1	0.0	± 0.0
Residence NNE Boundary																		
5/13/2014	0.1	± 0.2	5.8	± 0.8	0.0	± 0.5	0.1	± 0.1	0.0	± 0.0	37.0	± 2.3	3.8	± 5.9	1.1	± 0.4	0.0	± 0.1
8/12/2014	0.0	± 0.3	2.8	± 1.1	-0.1	± 1.2	0.3	± 0.2	0.0	± 0.1	15.7	± 2.0	-2.3	± 10.0	0.7	± 0.8	0.0	± 0.1

Location	Pb-214		Ra-226		Th-230		Th-231		Th-234		Tl-208		U-234		U-235	
Date	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Intersection of Gurley and Devers (@ Road Ends Sign)																
5/13/2014	0.1	± 0.0	0.0	± 0.3	0.2	± 1.2	1.1	± 1.2	0.1	± 0.1	0.0	± 0.0	4.3	± 3.9	0.0	± 0.0
8/12/2014	0.1	± 0.0	1.0	± 0.4	-1.9	± 1.8	0.8	± 1.7	0.2	± 0.2	0.1	± 0.1	4.2	± 6.1	0.0	± 0.0
Massac Creek @ Country Club Road																
5/13/2014	-0.1	± 0.1	0.2	± 1.1	-1.8	± 6.0	-2.8	± 4.8	-0.5	± 0.8	0.0	± 0.2	23.9	± 20.2	0.0	± 0.1
8/12/2014	0.1	± 0.1	0.3	± 0.8	-1.4	± 3.3	0.3	± 3.5	-0.1	± 0.6	0.3	± 0.1	15.7	± 11.2	0.0	± 0.0
Metropolis Airport 1 Mi. NNE																
5/12/2014	0.0	± 0.0	0.0	± 0.2	0.3	± 0.9	-0.1	± 0.8	0.1	± 0.1	0.0	± 0.0	3.9	± 2.9	0.0	± 0.0
8/12/2014	0.1	± 0.1	0.6	± 0.3	0.1	± 1.6	-0.7	± 1.3	0.1	± 0.2	0.1	± 0.1	5.5	± 3.7	0.0	± 0.0
Residence NNE Boundary																
5/13/2014	0.1	± 0.1	1.1	± 0.7	0.6	± 2.9	-1.0	± 2.7	1.2	± 0.5	0.1	± 0.1	15.1	± 9.5	0.1	± 0.0
8/12/2014	0.2	± 0.2	1.3	± 1.1	-3.8	± 7.8	2.1	± 6.5	1.4	± 0.9	0.1	± 0.2	27.0	± 25.5	0.1	± 0.1

Table 8. Gamma Spectroscopy Sample Results for Sediment Samples

Results are in picocuries per gram (pCi/g)

Location	Ac-228		Be-7		Bi-212		Bi-214		Cs-137		K-40		Pa-234m		Pb-210		Pb-212	
Date	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Ohio River At Joppa, 4 Mi. DS																		
5/12/2014	0.9	+ 0.1	1.2	+ 0.4	1.1	+ 0.3	0.9	+ 0.1	0.0	+ 0.0	10.5	+ 0.8	2.2	+ 2.4	1.0	+ 0.3	0.8	+ 0.1
11/17/2014	0.3	+ 0.0	0.0	+ 0.0	0.3	+ 0.1	0.4	+ 0.0	0.0	+ 0.0	4.3	+ 0.2	0.3	+ 0.4	0.4	+ 0.1	0.3	+ 0.0
Public Boat Launch near Harrah's Casino																		
5/12/2014	1.0	+ 0.0	0.0	+ 0.1	1.0	+ 0.1	1.0	+ 0.0	0.0	+ 0.0	13.1	+ 0.6	1.4	+ 0.7	1.5	+ 0.1	1.0	+ 0.0
11/17/2014	0.7	+ 0.0	0.0	+ 0.0	0.7	+ 0.1	0.7	+ 0.0	0.0	+ 0.0	8.7	+ 0.4	0.8	+ 0.5	0.9	+ 0.2	0.7	+ 0.0

Location	Pb-214		Ra-226		Th-230		Th-231		Th-234		Tl-208		U-234		U-235	
Date	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Ohio River At Joppa, 4 Mi. DS																
5/12/2014	0.9	+ 0.1	1.5	+ 0.4	-1.2	+ 2.7	-3.5	+ 2.4	1.3	+ 0.5	0.7	+ 0.1	3.0	+ 8.6	0.1	+ 0.0
11/17/2014	0.4	+ 0.0	0.4	+ 0.3	0.7	+ 0.5	-0.6	+ 0.3	0.5	+ 0.1	0.3	+ 0.0	2.6	+ 1.4	0.0	+ 0.0
Public Boat Launch near Harrah's Casino																
5/12/2014	1.1	+ 0.0	0.8	+ 0.5	0.5	+ 1.0	-0.1	+ 0.3	1.1	+ 0.3	0.9	+ 0.0	6.7	+ 3.4	0.1	+ 0.0
11/17/2014	0.8	+ 0.0	0.6	+ 0.5	0.0	+ 1.6	-1.1	+ 0.6	0.8	+ 0.3	0.6	+ 0.0	7.0	+ 5.7	0.0	+ 0.0

**Table 9. Sample Results for Gross Alpha / Beta Screening of Water Samples
Results are in picocuries per liter (pCi/L)**

Location	Alpha			Beta		
	Date	Result	Error	Result	Error	Error
Massac Creek @ Country Club Road						
5/13/2014	0.3	+ 1.4		-2.3	+ 2.3	
8/12/2014	0.1	+ 1.4		5.5	+ 2.6	
11/17/2014	0.9	+ 1.4		3.7	+ 2.4	
Metropolis PWS						
3/10/2014	3.5	+ 1.5		0.7	+ 2.5	
5/12/2014	3.0	+ 1.5		2.4	+ 2.5	
8/12/2014	1.7	+ 1.4		2.7	+ 2.6	
11/17/2014	2.3	+ 1.5		3.3	+ 2.4	
Ohio River 2 Mi. UpS						
3/10/2014	0.7	+ 1.4		2.3	+ 2.5	
5/12/2014	0.8	+ 1.4		0.9	+ 2.4	
8/12/2014	-0.3	+ 1.4		3.0	+ 2.6	
11/17/2014	-1.2	+ 1.3		5.0	+ 2.5	
Ohio River At Joppa, 4 Mi. DnS						
3/10/2014	0.3	+ 1.3		0.5	+ 2.5	
5/12/2014	0.3	+ 1.4		-1.3	+ 2.4	
8/12/2014	-0.4	+ 1.4		4.7	+ 2.6	
11/17/2014	1.8	+ 1.4		6.5	+ 2.5	
Public Boat Launch near Harrah's Casino						
3/10/2014	0.1	+ 1.3		2.6	+ 2.5	
5/12/2014	0.0	+ 1.4		2.7	+ 2.5	
Small Creek in Fort Massac State Park						
5/13/2014	2.2	+ 1.6		15.3	+ 2.7	
8/12/2014	-0.7	+ 1.3		6.2	+ 2.6	

Table 10. Gamma Spectroscopy Sample Results for Water Samples

Results are in picocuries per liter (pCi/L)

Location	Ac-228		Be-7		Bi-212		Bi-214		Cs-137		K-40		Pa-234m		Pb-210		Pb-212	
Date	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Massac Creek @ Country Club Road																		
5/13/2014	4.2 ± 7.1		10.0 ± 216		10.0 ± 235		7.3 ± 4.7		1.4 ± 1.8		-8.0 ± 35.3		30.0 ± 235.2		63.0 ± 43.1		2.3 ± 3.1	
8/12/2014	0.8 ± 6.1		-1.9 ± 18.7		13.0 ± 24.5		-0.7 ± 4.1		-0.3 ± 1.7		1.2 ± 20.4		49.0 ± 203.8		0.1 ± 55.5		-1.1 ± 2.5	
1/17/2014	4.2 ± 6.3		10.1 ± 17.8		-2.0 ± 25.5		1.4 ± 3.5		-1.1 ± 1.6		41.0 ± 19.6		46.0 ± 188.2		36.0 ± 54.9		1.0 ± 2.4	
Metropolis PWS																		
3/10/2014	8.1 ± 9.0		-20.0 ± 216		8.0 ± 314		12.4 ± 4.7		-0.4 ± 2.2		16.0 ± 25.5		330.0 ± 274.4		5.0 ± 25.5		1.7 ± 2.7	
5/12/2014	9.5 ± 9.8		12.0 ± 27.4		19.0 ± 27.4		1.3 ± 5.1		0.9 ± 2.2		-23.0 ± 25.5		130.0 ± 274.4		-14.0 ± 29.4		-3.2 ± 3.9	
8/12/2014	7.0 ± 6.6		-8.1 ± 20.0		-18.2 ± 28.6		7.7 ± 3.9		1.0 ± 2.0		22.5 ± 22.0		83.8 ± 209.7		12.9 ± 44.3		-1.3 ± 2.7	
1/17/2014	-1.8 ± 3.3		4.0 ± 21.6		-14.0 ± 29.4		0.0 ± 5.3		-0.1 ± 2.2		-31.0 ± 33.3		110.0 ± 274.4		-13.0 ± 27.4		-1.7 ± 3.9	
Ohio River 2 Mi. UpS																		
3/10/2014	3.8 ± 10.4		-9.0 ± 29.4		11.0 ± 33.3		9.6 ± 5.3		0.7 ± 2.4		9.0 ± 37.2		60.0 ± 313.6		-230.0 ± 1528.8		-3.6 ± 3.9	
5/12/2014	5.1 ± 6.5		5.0 ± 23.5		11.0 ± 23.5		5.8 ± 3.7		-0.6 ± 1.8		6.0 ± 35.3		210.0 ± 235.2		72.0 ± 43.1		4.1 ± 2.7	
8/12/2014	7.2 ± 7.8		4.6 ± 22.0		15.9 ± 29.0		2.0 ± 6.1		0.8 ± 1.9		12.9 ± 32.5		290.0 ± 262.6		620.0 ± 280.3		2.8 ± 4.1	
1/17/2014	8.9 ± 7.1		14.4 ± 17.2		0.0 ± 25.5		5.7 ± 3.7		0.3 ± 1.8		-1.0 ± 29.4		230.0 ± 196.0		18.0 ± 43.1		-0.1 ± 3.5	
Ohio River At Joppa, 4 Mi. DnS																		
3/10/2014	2.9 ± 9.8		5.0 ± 216		2.0 ± 27.4		7.7 ± 3.9		0.9 ± 2.0		67.0 ± 25.5		90.0 ± 274.4		4.0 ± 29.4		-2.3 ± 3.9	
5/12/2014	5.9 ± 6.4		-14.9 ± 23.3		-12.5 ± 24.7		4.6 ± 3.6		1.2 ± 1.8		21.3 ± 34.5		76.0 ± 227.4		73.5 ± 43.7		0.2 ± 3.1	
8/12/2014	4.2 ± 8.6		-12.7 ± 20.2		-16.1 ± 33.9		3.7 ± 4.4		0.4 ± 2.1		21.4 ± 30.6		166.1 ± 258.7		20.3 ± 24.9		0.4 ± 2.7	
1/17/2014	16.6 ± 8.8		-1.0 ± 19.6		21.0 ± 25.5		7.8 ± 4.3		-0.9 ± 2.0		40.0 ± 25.5		360.0 ± 274.4		25.0 ± 25.5		-0.3 ± 3.7	
Public Boat Launch near Harrah's Casino																		
3/10/2014	14.5 ± 8.2		16.7 ± 19.2		28.0 ± 31.4		1.1 ± 5.7		0.9 ± 1.9		-1.0 ± 35.3		210.0 ± 274.4		510.0 ± 254.8		5.4 ± 2.7	
5/12/2014	9.9 ± 7.6		15.0 ± 23.5		28.0 ± 25.5		9.4 ± 3.7		0.3 ± 1.7		50.0 ± 33.3		200.0 ± 235.2		-21.0 ± 37.2		-1.1 ± 3.9	
Small Creek in Fort Massac State Park																		
5/13/2014	10.4 ± 7.8		-5.0 ± 23.5		26.0 ± 23.5		5.1 ± 5.1		0.0 ± 1.8		35.0 ± 35.3		220.0 ± 235.2		-12.0 ± 37.2		-1.3 ± 4.3	
8/12/2014	6.2 ± 6.3		1.7 ± 15.6		16.3 ± 23.5		5.6 ± 3.6		-0.5 ± 1.8		7.8 ± 34.9		217.0 ± 215.6		31.3 ± 41.7		0.9 ± 3.4	
Location																		
Date	Pb-214		Ra-226		Th-230		Th-231		Th-234		Tl-208		U-234		U-235			
	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error	Result	Error
Massac Creek @ Country Club Road																		
5/13/2014	2.3 ± 4.7		-29.0 ± 35.3		250.0 ± 313.6		-210.0 ± 235.2		46.0 ± 33.3		0.6 ± 6.5		2830.0 ± 1254.4		-1.8 ± 2.2			
8/12/2014	7.2 ± 3.9		61.4 ± 30.8		345.0 ± 454.7		168.0 ± 266.6		-5.6 ± 60.2		0.8 ± 4.7		5490.0 ± 1815.0		2.4 ± 1.9			
1/17/2014	2.8 ± 3.7		68.0 ± 31.4		-80.0 ± 450.8		-30.0 ± 274.4		0.0 ± 58.8		3.4 ± 4.3		4610.0 ± 1744.4		3.8 ± 1.9			
Metropolis PWS																		
3/10/2014	1.5 ± 4.9		30.0 ± 23.5		80.0 ± 274.4		-163.0 ± 188.2		27.0 ± 29.4		3.8 ± 5.9		1270.0 ± 803.6		2.6 ± 1.5			
5/12/2014	-0.1 ± 4.3		-30.0 ± 39.2		-100.0 ± 196.0		-80.0 ± 196.0		-21.0 ± 33.3		5.3 ± 7.1		710.0 ± 627.2		-1.9 ± 2.5			
8/12/2014	4.0 ± 4.1		21.6 ± 31.9		-17.9 ± 346.9		19.6 ± 274.4		-24.6 ± 36.1		0.5 ± 5.1		1770.0 ± 1360.2		0.8 ± 2.0			
1/17/2014	6.6 ± 3.5		30.0 ± 43.1		-140.0 ± 196.0		-150.0 ± 196.0		-1.0 ± 31.4		2.2 ± 7.4		590.0 ± 627.2		1.9 ± 2.7			
Ohio River 2 Mi. UpS																		
3/10/2014	5.0 ± 5.5		21.0 ± 56.8		-400.0 ± 1391.6		-80.0 ± 450.8		210.0 ± 215.6		-2.8 ± 9.6		-9000.0 ± 21560.0		1.3 ± 3.5			
5/12/2014	3.0 ± 3.3		-16.0 ± 41.2		80.0 ± 294.0		200.0 ± 215.6		53.0 ± 33.3		1.2 ± 6.1		3460.0 ± 1234.8		-1.0 ± 2.5			
8/12/2014	2.9 ± 5.5		-25.3 ± 49.2		539.0 ± 686.0		201.0 ± 274.4		-56.6 ± 106.2		2.4 ± 5.6		6580.0 ± 4468.8		-1.6 ± 3.1			
1/17/2014	3.4 ± 3.3		30.0 ± 41.2		40.0 ± 294.0		30.0 ± 215.6		-9.0 ± 41.2		1.8 ± 6.7		3330.0 ± 1274.0		1.9 ± 2.5			
Ohio River At Joppa, 4 Mi. DnS																		
3/10/2014	-0.3 ± 4.9		-24.0 ± 41.2		150.0 ± 215.6		-110.0 ± 196.0		2.0 ± 33.3		-1.9 ± 6.5		740.0 ± 686.0		-1.5 ± 2.5			
5/12/2014	1.5 ± 3.2		22.6 ± 40.4		-139.0 ± 299.9		21.9 ± 219.5		-14.0 ± 40.8		4.5 ± 5.3		2590.0 ± 1230.9		1.4 ± 2.5			
8/12/2014	4.6 ± 3.6		34.4 ± 24.5		-108.0 ± 282.2		81.5 ± 191.5		0.1 ± 28.6		-1.5 ± 5.3		1320.0 ± 791.8		1.4 ± 1.5			
1/17/2014	7.7 ± 3.5		-5.0 ± 43.1		-30.0 ± 192.1		110.0 ± 194.0		23.0 ± 33.3		4.7 ± 7.6		590.0 ± 627.2		-0.3 ± 2.7			
Public Boat Launch near Harrah's Casino																		
3/10/2014	0.9 ± 5.7		2.0 ± 47.0		90.0 ± 725.2		-270.0 ± 294.0		-153.0 ± 103.9		1.2 ± 5.7		6000.0 ± 4508.0		0.1 ± 2.9			
5/12/2014	-0.8 ± 4.9		25.0 ± 43.1		10.0 ± 274.4		60.0 ± 215.6		5.0 ± 37.2		1.4 ± 6.5		1600.0 ± 842.8		1.6 ± 2.7			
Small Creek in Fort Massac State Park																		
5/13/2014	5.8 ± 4.1		-2.0 ± 45.1		-230.0 ± 274.4		-90.0 ± 215.6		52.0 ± 37.2		5.2 ± 6.9		980.0 ± 842.8		-0.1 ± 2.9			
8/12/2014	1.7 ± 3.1		-25.9 ± 38.6		165.0 ± 305.8		16.7 ± 217.6		26.2 ± 31.8		6.5 ± 5.2		2800.0 ± 1246.6		-1.6 ± 2.4			

Table 11. KPA (Total Uranium) Sample Results for Water Samples
Results are in picocuries per liter (pCi/L)

Location	Date	Result	Error
Ohio River 2 Mi. UpS	3/10/2014	0.3	± 0.0
Ohio River 2 Mi. UpS	5/12/2014	0.4	± 0.0
Ohio River 2 Mi. UpS	8/12/2014	0.3	± 0.0
Ohio River 2 Mi. UpS	11/17/2014	0.4	± 0.0
Ohio River At Joppa, 4 Mi. DnS	3/10/2014	0.1	± 0.1
Ohio River At Joppa, 4 Mi. DnS	5/12/2014	0.3	± 0.0
Ohio River At Joppa, 4 Mi. DnS	8/12/2014	0.6	± 0.0
Ohio River At Joppa, 4 Mi. DnS	11/17/2014	1.0	± 0.1
Metropolis PWS	3/10/2014	0.4	± 0.0
Metropolis PWS	5/12/2014	0.4	± 0.0
Metropolis PWS	8/12/2014	0.4	± 0.0
Metropolis PWS	11/17/2014	0.3	± 0.0
Public Boat Launch near Harrah's Casino	3/10/2014	0.4	± 0.0
Public Boat Launch near Harrah's Casino	5/12/2014	0.2	± 0.0
Massac Creek @ Country Club Road	5/13/2014	0.0	± 0.0
Massac Creek @ Country Club Road	8/12/2014	0.0	± 0.0
Massac Creek @ Country Club Road	11/17/2014	0.0	± 0.0
Small Creek in Fort Massac State Park	5/13/2014	0.3	± 0.0
Small Creek in Fort Massac State Park	8/12/2014	0.1	± 0.0

Table 12. Summary of Ambient Gamma Results

Location	Quarter 1 mRem/day	Quarter 1 mrem/day	Quarter 1 mrem/day	Quarter 1 mrem/day	Annual Dose mRem/year
METR-01	0.08	0.09	0.11	0.10	35.22
METR-02	0.05	0.07	0.09	0.09	28.11
METR-03	0.09	0.12	0.10	0.12	39.79
METR-04	0.09	0.09	0.12		35.53
METR-05	0.09	0.09	0.11	0.12	36.59
METR-06	0.08	0.10	0.12	0.10	36.87
METR-07 *	0.14	0.15	0.18	0.19	59.86
METR-08 *	0.15	0.14			52.38
METR-09 *	0.12	0.15	0.15	0.15	51.83
METR-10 *	0.79	0.86	0.90	0.89	313.63
METR-11 *	0.15	0.15	0.17	0.17	57.49
METR-12 *	0.56	0.83	0.95	1.03	306.51
METR-13 *	2.22	2.29	2.09	2.06	789.59
METR-14 *	0.30	0.33	0.32	0.29	113.70
METR-15	0.07				27.01
METR-16	0.12	0.14	0.13	0.14	47.09
METR-17 *	0.81	0.77	0.73	0.72	277.13
METR-18 *	2.46	2.44	2.64	2.59	924.18
METR-19 *	2.44	2.57	2.54	1.69	843.15
METR-20	0.08	0.10	0.09	0.10	33.67
METR-21	0.11	0.13	0.13	0.14	46.36
METR-22	0.09	0.11	0.11	0.12	38.69

* Starred locations are within a restricted access area immediately surrounding the facility, thus inaccessible to the public. Site labeled METR-15 was a test site for one quarter.

The 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.

APPENDIX C
Background Data for Comparison

**Table C-1. Sample Results for Alpha/Beta Screening of Water from the
 Background Reference Area**
Results are in picocuries per liter (pCi/L)

Location Date	Alpha		Beta	
	Result	Error	Result	Error
Kincaid East Boat Dock				
1/30/2014	2.7 ±	1.8	6.7 ±	2.7
7/23/2014	-0.2 ±	1.3	6.1 ±	2.7
10/29/2014	1.0 ±	1.5	5.3 ±	2.6
Kincaid Strawkaws Boat Ramp				
1/30/2014	1.8 ±	1.7	5.9 ±	2.7
7/23/2014	0.1 ±	1.4	6.1 ±	2.7
10/29/2014	-0.1 ±	1.5	4.8 ±	2.6
Kincaid West Boat Ramp				
10/29/2014	0.5 ±	1.5	2.0 ±	2.5

**Table C-2. Alpha / Beta Screening Results for Air Samples in the
Springfield Area
Results are in picocuries per liter (pCi/L)**

Location Date	Alpha		Beta		Location Date	Alpha		Beta	
	Result	Error	Result	Error		Result	Error	Result	Error
Springfield Background - Knotts St.					Springfield Background - Knotts St.				
1/6/2014	3.1	± 1.0	35.4	± 2.6	7/7/2014	0.9	± 0.8	22.0	± 2.3
1/13/2014	2.1	± 0.9	26.3	± 2.4	7/14/2014	1.5	± 0.7	19.4	± 1.8
1/21/2014	2.2	± 0.8	28.1	± 2.1	7/21/2014	2.0	± 0.7	20.7	± 1.8
1/27/2014	1.4	± 0.8	14.9	± 1.9	7/28/2014	4.5	± 3.1	44.6	± 7.3
2/3/2014	1.2	± 0.8	23.0	± 2.3	8/4/2014	4.1	± 1.0	31.2	± 2.6
2/10/2014	0.8	± 0.7	27.1	± 2.0	8/11/2014	5.6	± 1.1	45.6	± 3.0
2/18/2014	1.6	± 0.7	38.1	± 2.2	8/18/2014	4.3	± 1.0	30.4	± 2.6
2/24/2014	2.1	± 0.9	16.5	± 1.9	8/26/2014	4.8	± 1.0	37.0	± 2.5
3/3/2014	1.5	± 0.7	32.2	± 2.2	9/2/2014	2.8	± 0.8	24.7	± 2.2
3/10/2014	0.7	± 0.7	22.1	± 2.0	9/8/2014	2.5	± 0.9	22.8	± 2.6
3/17/2014	1.0	± 0.6	17.0	± 1.7	9/15/2014	2.3	± 0.8	19.7	± 2.3
3/24/2014	3.5	± 0.9	17.0	± 1.7	9/22/2014	3.8	± 1.0	42.6	± 2.9
3/31/2014	1.6	± 0.8	26.1	± 2.5	9/29/2014	3.0	± 0.9	41.5	± 2.8
4/7/2014	0.5	± 0.6	19.4	± 2.1	10/6/2014	3.5	± 0.9	27.6	± 2.5
4/14/2014	3.6	± 0.9	17.5	± 1.8	10/14/2014	2.1	± 0.7	21.6	± 2.1
4/21/2014	4.0	± 1.0	33.0	± 2.6	10/20/2014	1.4	± 0.7	11.3	± 1.7
4/28/2014	0.7	± 0.7	21.3	± 2.2	10/27/2014	2.5	± 0.8	33.1	± 2.6
5/5/2014	0.4	± 0.6	8.1	± 1.8	11/3/2014	2.0	± 0.8	20.9	± 2.3
5/12/2014	0.7	± 0.7	22.8	± 2.3	11/10/2014	1.2	± 0.7	24.1	± 2.4
5/19/2014	1.1	± 0.7	14.2	± 2.0	11/17/2014	1.2	± 0.7	26.8	± 2.5
5/27/2014	1.8	± 0.7	20.5	± 2.1	11/24/2014	1.7	± 0.4	29.2	± 1.4
6/2/2014	0.6	± 0.8	24.2	± 2.7	12/1/2014	1.4	± 0.7	41.9	± 2.8
6/9/2014	1.3	± 0.7	21.9	± 1.9	12/8/2014	2.1	± 0.9	46.0	± 3.0
6/16/2014	0.8	± 0.7	14.7	± 1.7	12/15/2014	3.5	± 1.0	48.4	± 3.1
6/23/2014	3.8	± 0.9	19.3	± 1.8	12/22/2014	2.4	± 0.8	34.9	± 2.6
6/30/2014	4.3	± 1.0	20.4	± 2.3	12/29/2014	1.4	± 0.8	26.0	± 2.5

Table C-3. Summary of Ambient Gamma Results for Background Reference Area

Location	Quarter 1 mrem/day	Quarter 1 mrem/day	Quarter 1 mrem/day	Quarter 1 mrem/day	Annual Dose mrem/year
KC-01	0.09	0.10	0.11	0.12	38.51
KC-02	0.12	0.11	0.12		42.46
KC-03		0.09			31.76
KC-04	0.10	0.11	0.11	0.13	41.25
KC-05	0.12	0.11	0.12	0.14	44.07
KC-06	0.08	0.09	0.10	0.11	33.76
KC-07	0.09	0.11	0.11	0.11	38.33
KC-08	0.11	0.11	0.11	0.11	39.51
KC-09	0.10	0.09	0.11	0.12	39.06
KC-10	0.11	0.11	0.12		40.15
KC-11	0.12	0.13	0.12	0.14	46.36
KC-12	0.11	0.10	0.11	0.14	41.25
KC-13	0.11	0.10	0.12		38.81
KC-14	0.10	0.12	0.11	0.12	41.25
KC-15	0.11	0.09	0.12	0.14	41.79

Blanks in the table indicate that dosimeters were missing at the end of the quarter.
Annual Dose column based on averages of all available data.

APPENDIX D

Summary of Analytical Results for October 26, 2014 Event

Summary of Analytical Results
Environmental Monitoring for Radionuclides in the
Environs of Honeywell Metropolis Works

November 5, 2014

Preface

The Illinois Emergency Management Agency Bureau of Radiation Safety (IEMA) routinely monitors for radioactivity in the environment surrounding Honeywell Metropolis Works (Honeywell).

IEMA maintains five Environmental Monitoring Stations in Metropolis and typically exchanges air particulate filters (APFs) on a weekly basis as a component of its routine environmental monitoring program. IEMA was collecting week-long air samples in the form of APFs at the time of the incident at Honeywell on October 26, 2014.

APFs were exchanged at all five monitoring locations on October 27, 2014. The samples cover the period from October 20, 2014 through October 27, 2014. These samples were collected per normal operations. The only difference from normal operations was that these samples were prioritized when submitted to our Radiochemistry Laboratory due to the Honeywell incident on October 26, 2014.

Results

APFs were analyzed for gross alpha and gross beta activity using a Gas Proportional Counter. Test results, in femtocuries per cubic meter (fCi/m³), are displayed in the table below.

**IEMA Gross Alpha and Gross Beta Results for Air Particulate Filters
Collected from October 20, 2014 through October 27, 2014**

Location	Nuclide	Result	Uncertainty*	Nuclide	Result	Uncertainty*
Airport	Alpha	2.3	0.8	Beta	40.3	2.9
Nearest Resident	Alpha	3.9	1.0	Beta	35.0	2.7
North Ave.	Alpha	2.1	0.8	Beta	41.6	2.8
Massac County Hospital	Alpha	3.4	0.9	Beta	37.7	2.8
Dorothy Miller Park	Alpha	2.0	0.8	Beta	38.4	2.8

* expanded counting uncertainty (k=1.96)

For comparison, average gross alpha and beta results for weekly samples collected at the same locations from the period beginning July 2013 through August 2014 are presented below.

**IEMA Average Gross Alpha and Gross Beta Results for Air Particulate Filters
Collected from July 2013 through August 2014**

Location	Nuclide	Average	Minimum	Maximum
Airport	Alpha	3.1	0.1	8.6
Nearest Resident	Alpha	5.7	1.2	27.1
North Ave.	Alpha	2.5	0.8	6.8
Massac County Hospital	Alpha	2.6	0.7	7.8
Dorothy Miller Park	Alpha	2.6	0.1	7.3

Location	Nuclide	Average	Minimum	Maximum
Airport	Beta	27.3	4.4	44.4
Nearest Resident	Beta	31.1	13.2	62.8
North Ave.	Beta	26.5	10.7	42.5
Massac County Hospital	Beta	26.1	9.3	47.0
Dorothy Miller Park	Beta	26.6	9.6	42.9

Note: An Environmental Monitoring Station was moved from the water treatment plant to Dorothy Miller Park in November 2013. Therefore, results for Dorothy Miller Park cover the period from November 2013 through August 2014.

Conclusion

Results for the samples collected from October 20, 2014 through October 27, 2014 were within the range of the results collected from July 2013 through August 2014. IEMA did not observe measurable increases of radioactivity in the environment as a result of the incident at the Honeywell facility on October 26, 2014.