State of Illinois
Illinois Emergency Management Agency

2015 Radiological Environmental Monitoring Report for Palos Forest Preserve

IEMA

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Introduction

The Illinois Emergency Management Agency (IEMA) is charged with protecting the citizens of Illinois from the potentially harmful effects of radioactive materials. To that end, the IEMA's Division of Nuclear Safety monitors the environment in Illinois for the presence of radionuclides. One of the locations monitored by IEMA is the area around the Site A/Plot M Disposal Sites within Red Gate Woods. Red Gate Woods is a part of the Palos Forest Preserve and is near the village of Palos Park. Appendix A includes maps of the area around the Palos Forest Preserve indicating the locations of IEMA and Argonne National Laboratory sampling points.

History of the Site

In the early 1940s, Enrico Fermi and a team of scientists assembled the world's first atomic "pile" (nuclear reactor), named "CP-1" for "Chicago Pile 1" under an abandoned squash court beneath the Stagg Field football stadium at the University of Chicago, resulting in the first self-sustaining nuclear chain reaction on December 2, 1942. Recognizing the potential radiation exposure to the population of the city of Chicago, the reactor was transferred to Red Gate Woods in 1943, which is part of Palos Forest Preserve, a wooded site located 20 miles southwest of downtown Chicago. There, the reactor was rebuilt, and renamed CP-2.

In 1944, CP-3, the first heavy-water cooled and moderated reactor started operation at the Palos Forest Preserve site. By the mid-1950s, all research programs were transferred to the current site of Argonne National Laboratory, so CP-2 and CP-3 reactors were decommissioned, surveyed, decontaminated, demolished, and components buried at "Site A" in Red Gate Woods. The U.S. Department of Energy performed a limited remediation for Site A in 1996-1997 after high levels of radioactive material (specifically tritium) were found in surface water that drain from the site. In addition to the 19-acre Site A, radioactive material from nuclear research conducted from 1944-1949 is buried in a 150-foot by 140-foot area called "Plot M," also in Red Gate Woods. The material in Plot M is entombed under a 1-foot thick concrete barrier, with side walls extending down 8 feet into the ground, and covered with 2.5 feet of dirt on top.

IEMA Radiological Environmental Monitoring Program

IEMA's radiological environmental monitoring program at Palos Forest Preserve is performed in cooperation with Argonne National Laboratory. Argonne staff collects water samples from six locations within Red Gate Woods (Red Gate Woods Well #5160, Red Gate Wells #11 and #12, Plot M Boreholes #4 and #10, and Site A Borehole #56) during the second quarter of the year, and supplies IEMA with splits of these samples. IEMA collects water samples quarterly from 17 sampling locations. Samples collected by IEMA include surface water samples from nearby canals and from lakes within the park, and ground water from wells located in or near the park. Samples collected from Bullfrog Lake North and South, the Maple Lake Boat Launch, and St. James Church are from ground water wells that are accessible to the public, and could potentially be used as potable water. Although IEMA samples are scheduled to be collected quarterly, samples are not always obtainable due to weather condition, and/or facility closures.

All samples collected and splits obtained are analyzed for man-made and naturally occurring radionuclides. Sample results are then compared to applicable drinking water and groundwater standards. Water Standards are regulated by the USEPA and IEPA, IEMA's purpose for sampling private wells and public water supplies is solely to screen for the presence of radionuclides in drinking water.

In 2015, with the exception of samples collected from Well 5159, results from IEMA's radiological environmental monitoring program at the Palos Forest Preserve site were consistent with historical data and expected contamination levels. A consistent increase in tritium concentration was seen at Well 5159; however the levels observed were well below the USEPA and IEPA Drinking Water Standards for tritium. IEMA will continue to monitor the concentrations at this location. With the exception of samples collected from Plot M Boreholes #4 and #10, results from all samples collected in 2015 were below the national and state standards. Results from water samples collected at Plot M Boreholes #4 and #10 exceeded the USEPA and IEPA Drinking Water Standards for tritium; these results are consistent with historical data and expected contamination levels. Boreholes #4 and #10 are used for testing purposes only, are not accessible to the general public, and are kept capped and locked when not being tested. Sample results from all other locations fell below federal and state safety guidelines.

Laboratory Analysis

This report contains tables of data showing results of analyses of samples taken by both Argonne and IEMA staff. Analysis was performed by the IEMA Radiochemistry Laboratory in Springfield. The laboratory uses standard published radioanalytical procedures and 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).

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 concentrations less than 200 pCi/L could be detected, but with less certainty. Conversely, samples with concentrations higher than 200 pCi/L would be more likely to be detected, approaching 100% as concentrations increase.

Analytical methods are chosen, in part, based on their MDC. As a general rule, methods are chosen such that their MDC is less than 10% of any applicable regulatory limit.

Tritium Results

Tritium (H-3) was measured in water samples using EPA Method 906.0, "Tritium in Drinking Water." Sample analysis was performed using a liquid scintillation analyzer, calibrated for tritium analysis. To provide additional perspective on tritium concentrations at various locations, Appendix B depicts historical tritium results at sampling locations.

The U.S. Environmental Protection Agency's (US EPA) drinking water standard (National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels, 2000) and the

Illinois Environmental Protection Agency's (IEPA) groundwater standard (Groundwater Quality Standards for Class I: Potable Resource Groundwater, 2013) both set the limit for tritium in groundwater at 20,000 pCi/L.

The highest levels of tritium were found in the boreholes at Plot M. Test results from Plot M Boreholes #4 and #10 exceeded the USEPA and IEPA standards referenced above, however, these wells are used for testing purposes only and are capped and kept locked to ensure that the public does not have access to the water. Results from several other sampling locations were above the MDC set for tritium, but did not exceed the USEPA and IEPA standards. A consistent increase in tritium concentrations were seen at Well 5159 in 2015, but remained well below the USEPA and IEPA standards. IEMA will continue to monitor the concentrations at this location. While not all wells are capped and locked like the Plot M boreholes, all wells that have historically seen detectable concentrations of tritium do require the use of a pump handle assembly to retrieve water. The pump handle assemblies are only attached when sampling is being conducted, and immediately removed once complete.

Strontium Results

Radiostrontium was measured in water using EPA 402-R-10-001d, "Rapid Radiochemical Method for Total Radiostrontium (Strontium) in Water for Environmental Restoration Following Homeland Security Events." Gas proportional counting was performed on a low-background gas proportional counter. Strontium results can be found in Table C.2. of Appendix C alongside the gamma spectroscopy results.

The U.S. Environmental Protection Agency's (US EPA) drinking water standard (National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels, 2000), as well as the Illinois Environmental Protection Agency's (IEPA) groundwater standard (Groundwater Quality Standards for Class I: Potable Resource Groundwater, 2013) both set the limit for Strotium-90 in groundwater at 8 pCi/L.

The established MDC for Total Strontium was exceeded at Site A Borehole #56 during the June 10, 2015 sampling. This location is collected by Argonne staff and a split is provided to IEMA once per year. Although the MDC was exceeded, the sample result for Total Strontium remained well below the USEPA and IEPA standards for Strontium-90. Borehole #56 is used for testing purposes only, and is capped and kept locked when not being tested to ensure that there is no public access to the well.

Gamma Spectroscopy Results (Co-60 and Cs-137)

Gamma emitting radionuclides (Cobalt-60 and Cesium-137) are analyzed using a high-purity germanium detector in a process called gamma spectroscopy, which allows the identification of individual radionuclides. Table C.2. of Appendix C contains gamma spectroscopy results.

All gamma spectroscopy results were below established MDCs.

Background Sampling Location

IEMA has established the environs of Sangchris Lake State Park, a cooling lake for a coal-fired power station near Kincaid, IL, as the background sampling location. To establish "background" radiation levels, water samples are collected and analyzed utilizing the same procedures and methodologies used for the Palos Forest Preserve samples.

Results for background samples can be found in Appendix D.

Summary

In 2015, all test results for samples collected as part of IEMA's radiological environmental monitoring program of groundwater within and around the Palos Forest Preserve which are obtainable by the general public, indicate that the level of groundwater contamination is below the limits set by the U.S. Environmental Protection Agency's (US EPA) drinking water standard (National Primary Drinking Water Regulations: Maximum Contaminant Levels and Maximum Residual Disinfectant Levels, 2000) and the Illinois Environmental Protection Agency's (IEPA) groundwater standard (Groundwater Quality Standards for Class I: Potable Resource Groundwater, 2013). With the exception of samples collected from Plot M Boreholes #4 and #10, results from all samples collected in 2015 were below the national and state standards referenced above. Plot M boreholes #4 and #10 contained tritium in excess of the state and national standards. These results are expected, as samples collected from this location have historically produced results in excess of the 20,000 pCi/L standard for tritium. The water sampled from this location is not used for public drinking water, and the boreholes are capped and kept locked when not being tested.

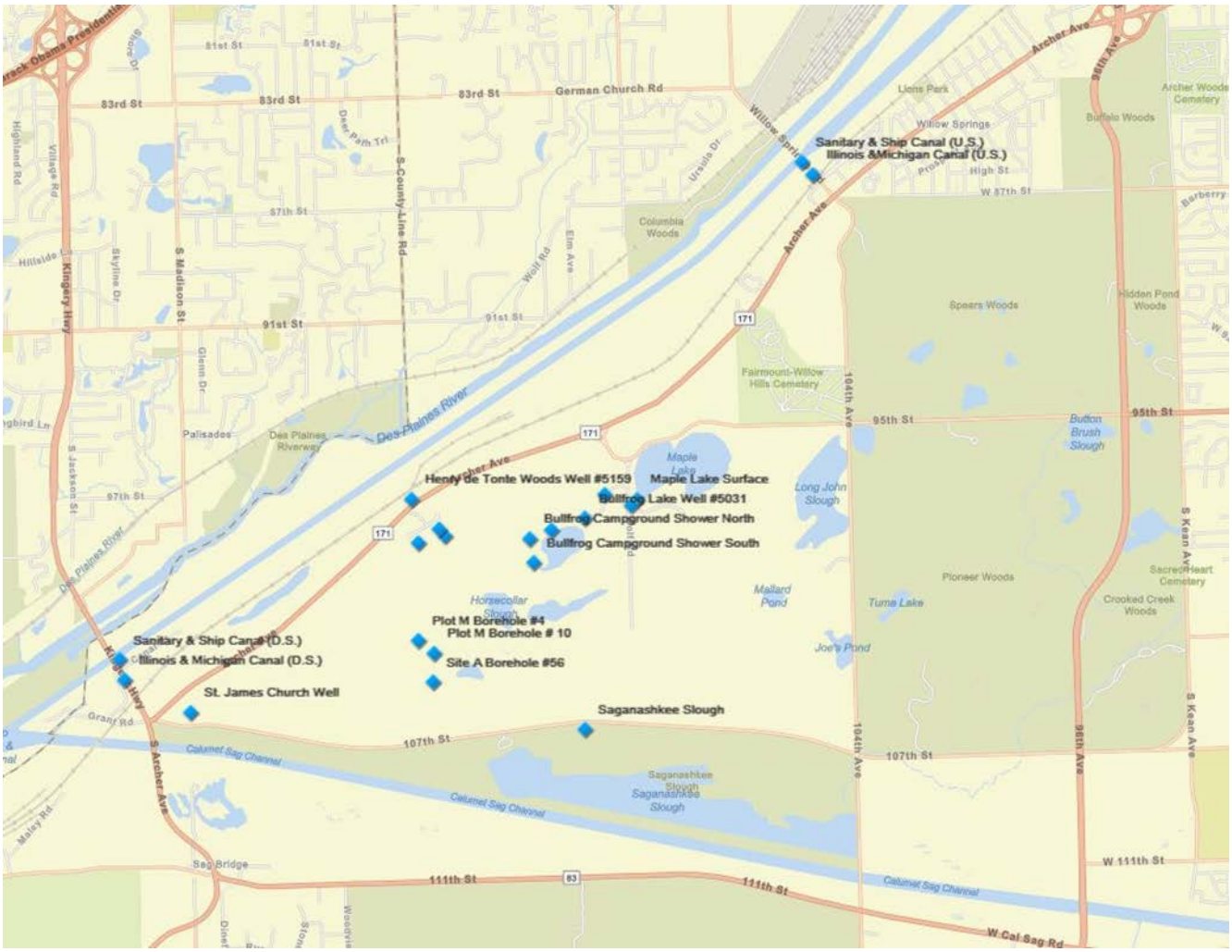
APPENDIX A
Site A / Plot M and Palos Forest Preserve Sampling Locations

Map A.1. Palos Forest Preserve
Sampling Locations

Map Key:

◆ **Water Sampling Location**

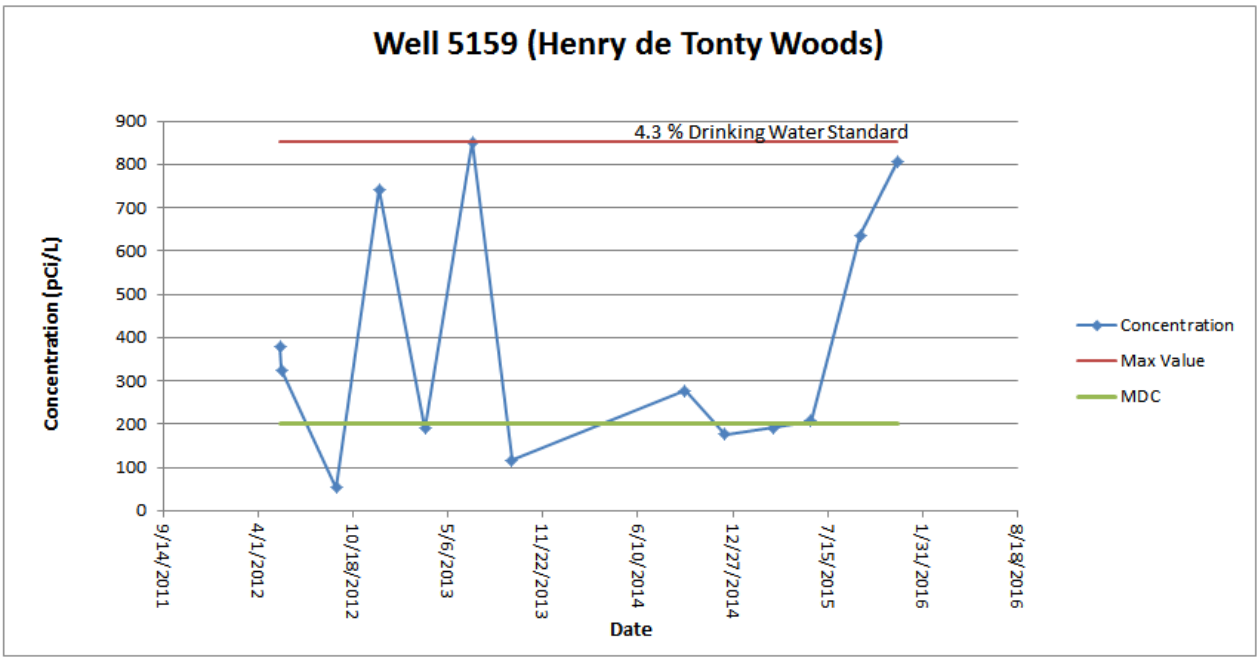
Map A.2. Palos Park Forest Preserve and Peripheral Sampling Locations

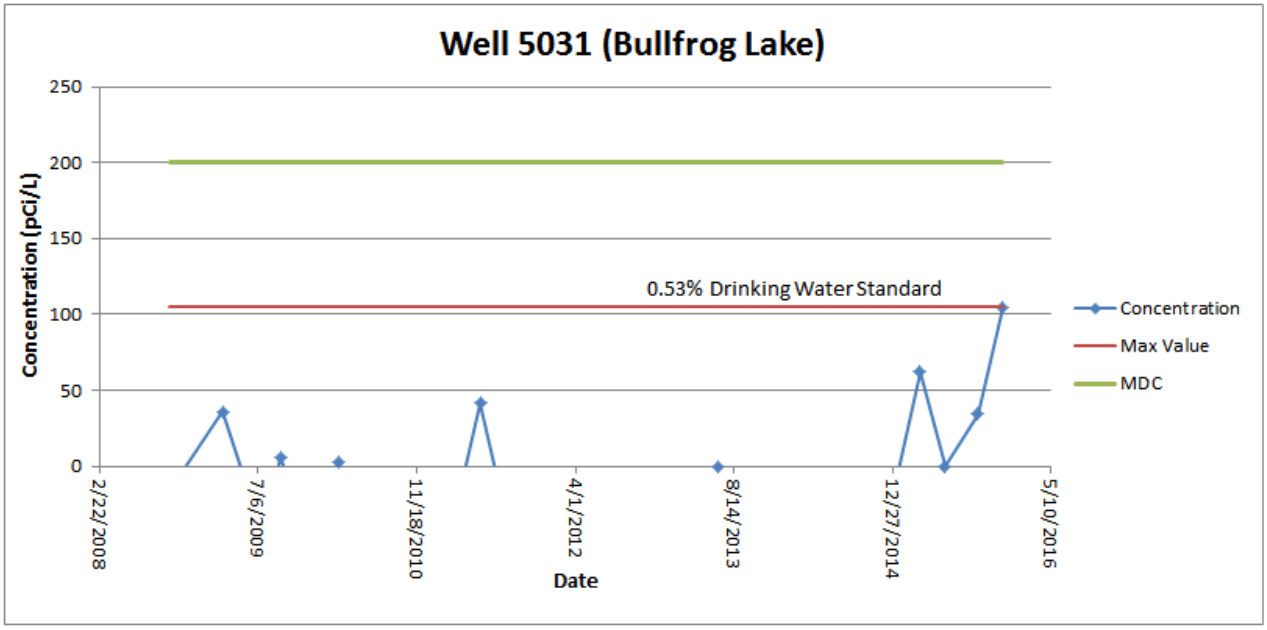


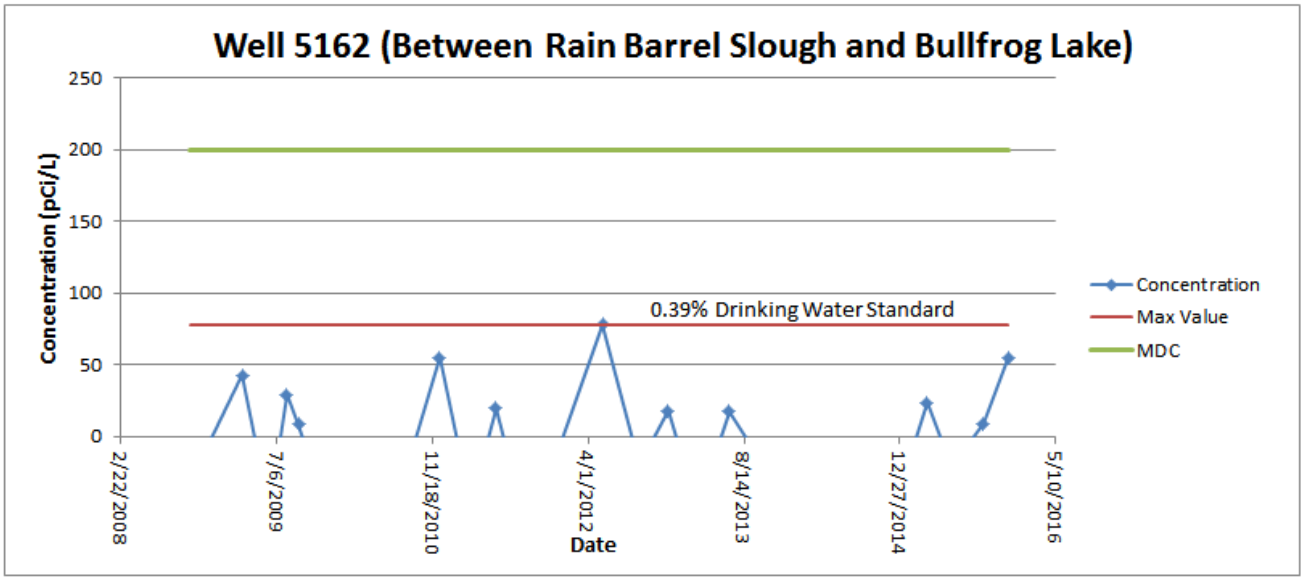
Map Key:

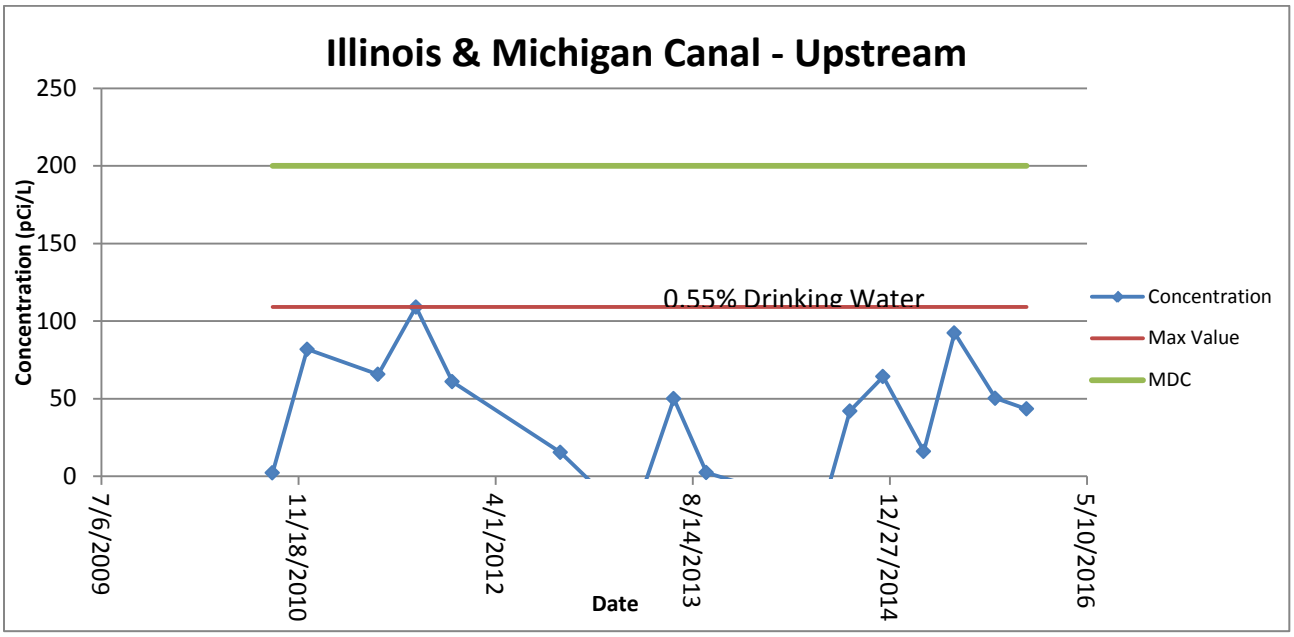
◆ **Water Sampling Location**

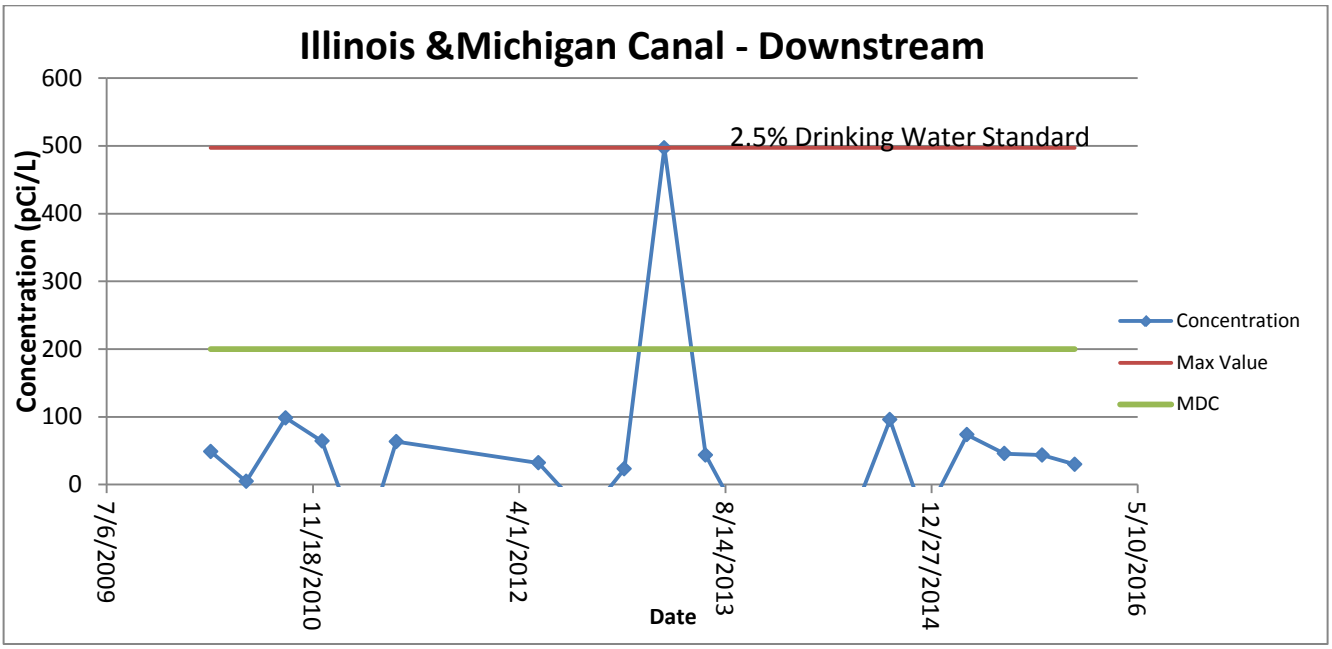
APPENDIX B
Graphical Representations of Tritium (H-3) Water Sample Results through 2015

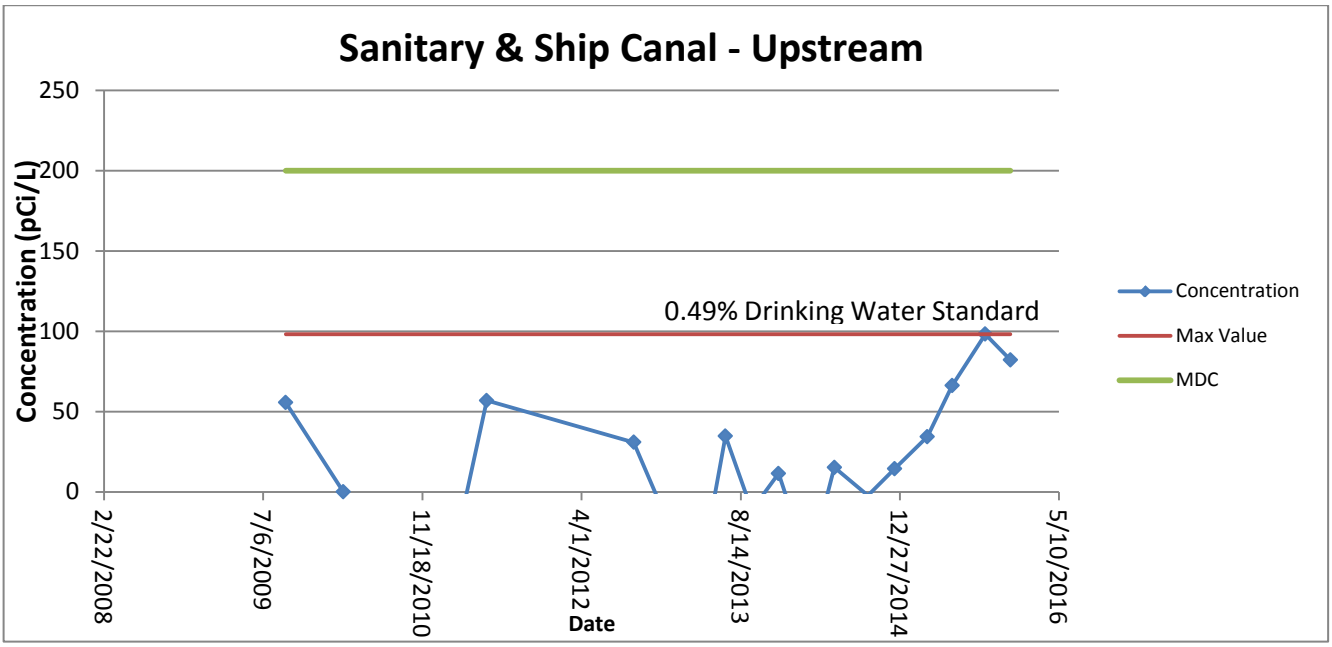


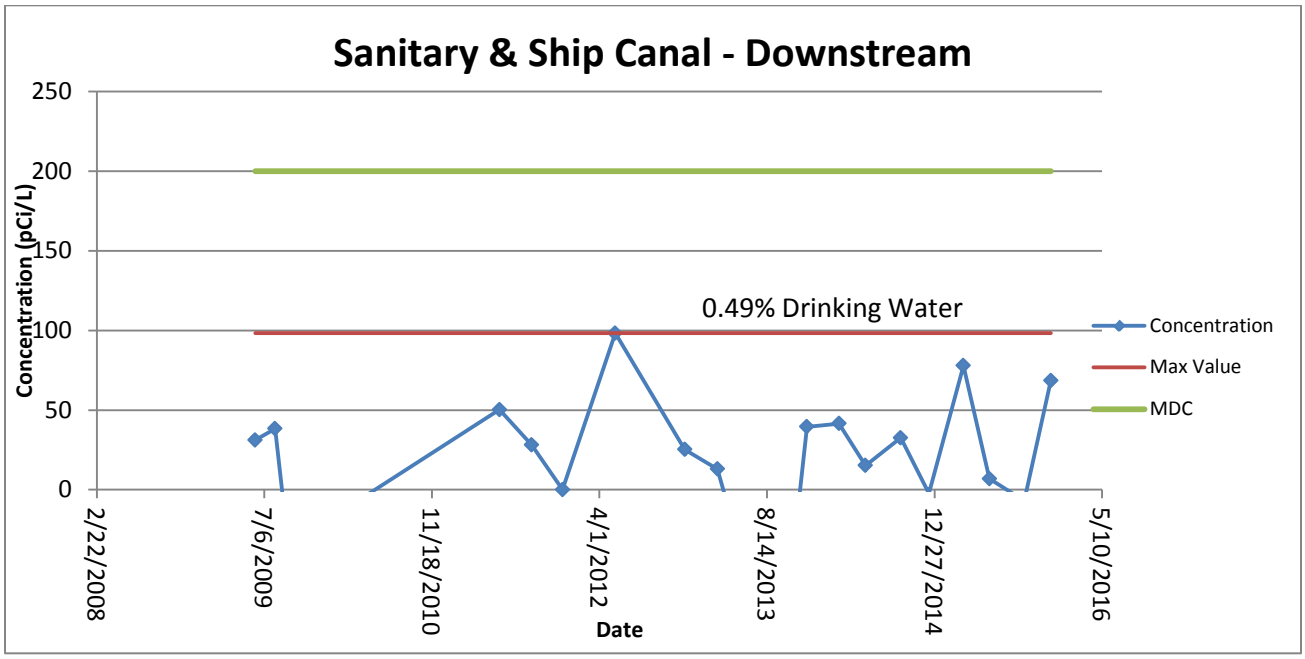


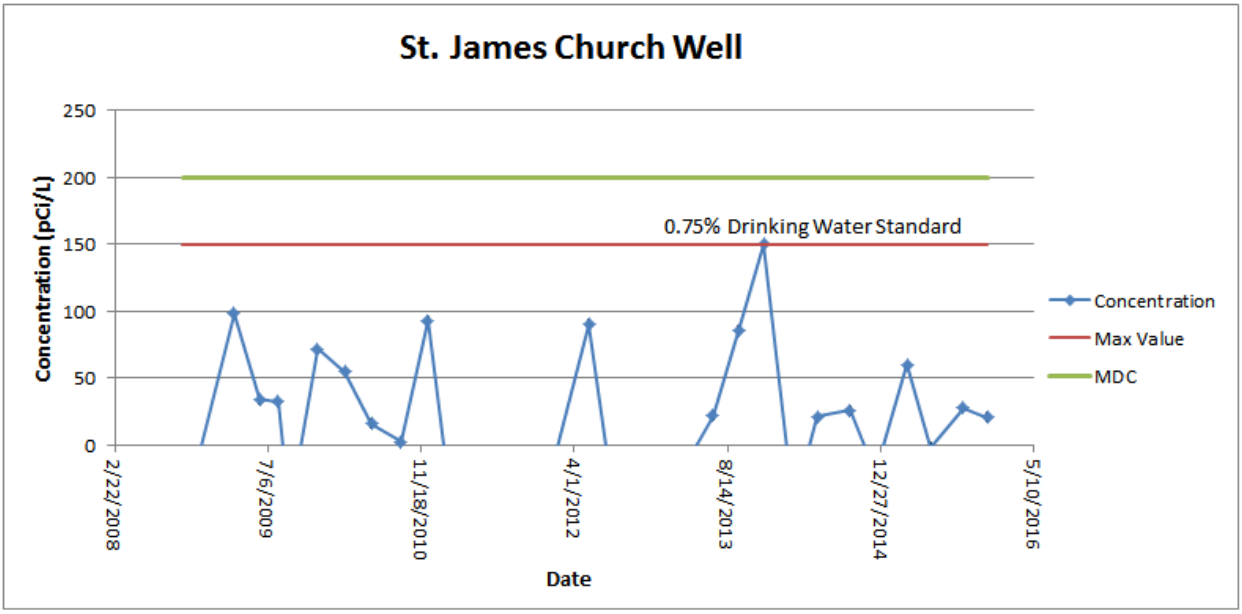

Well 5162 (Between Rain Barrel Slough and Bullfrog Lake)
Concentration (pCi/L)
250
200
150
100
50
0
0.39% Drinking Water Standard
2/22/2008
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
Date
Concentration
Max Value
MDC

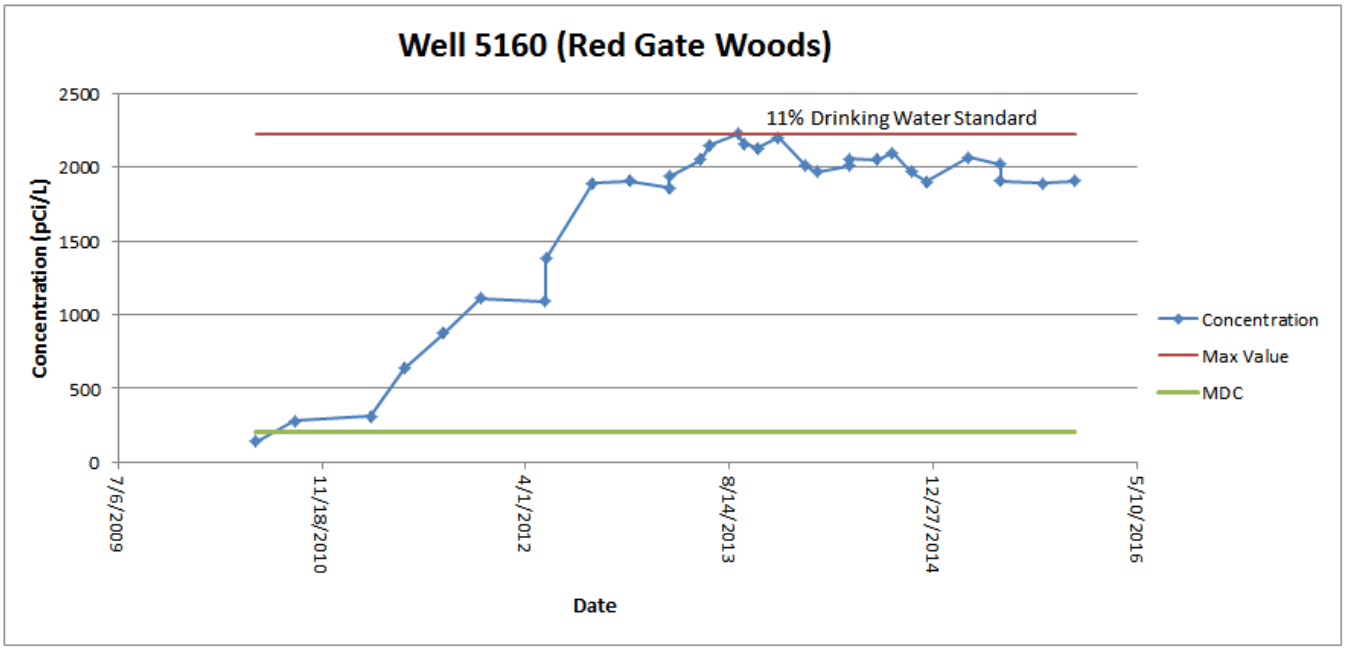

Illinois & Michigan Canal - Upstream
Concentration (pCi/L)
250
200
150
100
50
0
0.55% Drinking Water
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
Date
Concentration
Max Value
MDC

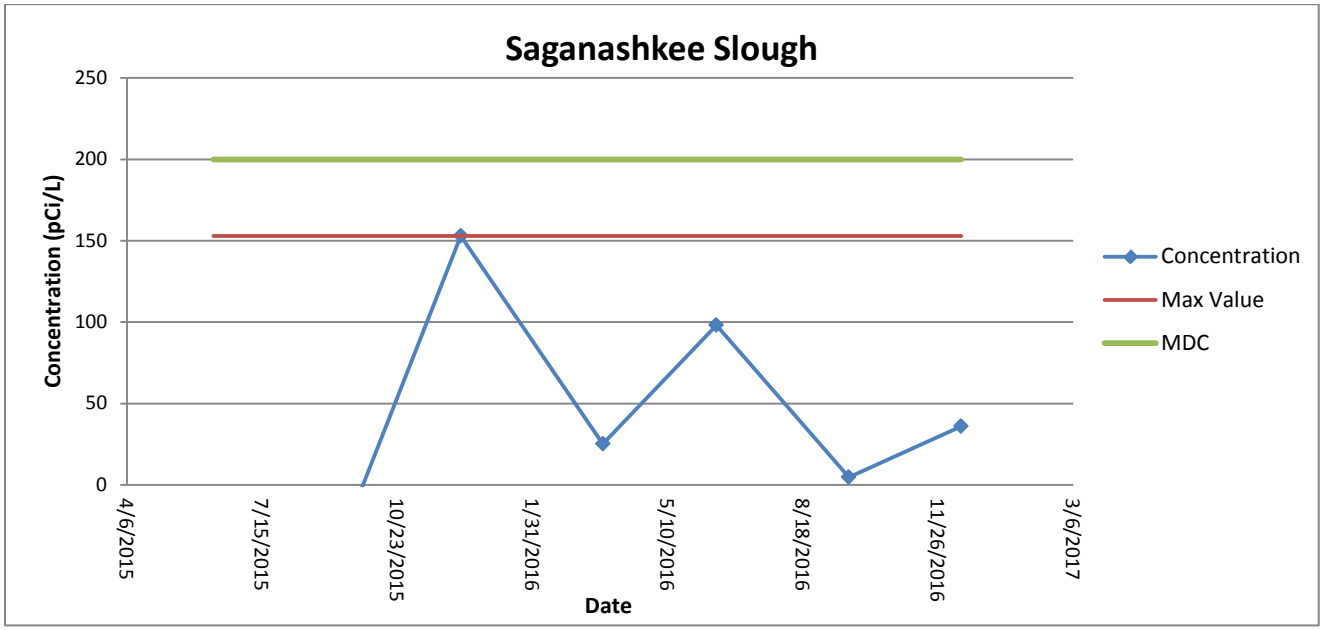

Illinois &Michigan Canal - Downstream
Concentration (pCi/L)
600
500
400
300
200
100
0
2.5% Drinking Water Standard
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
Date
Concentration
Max Value
MDC

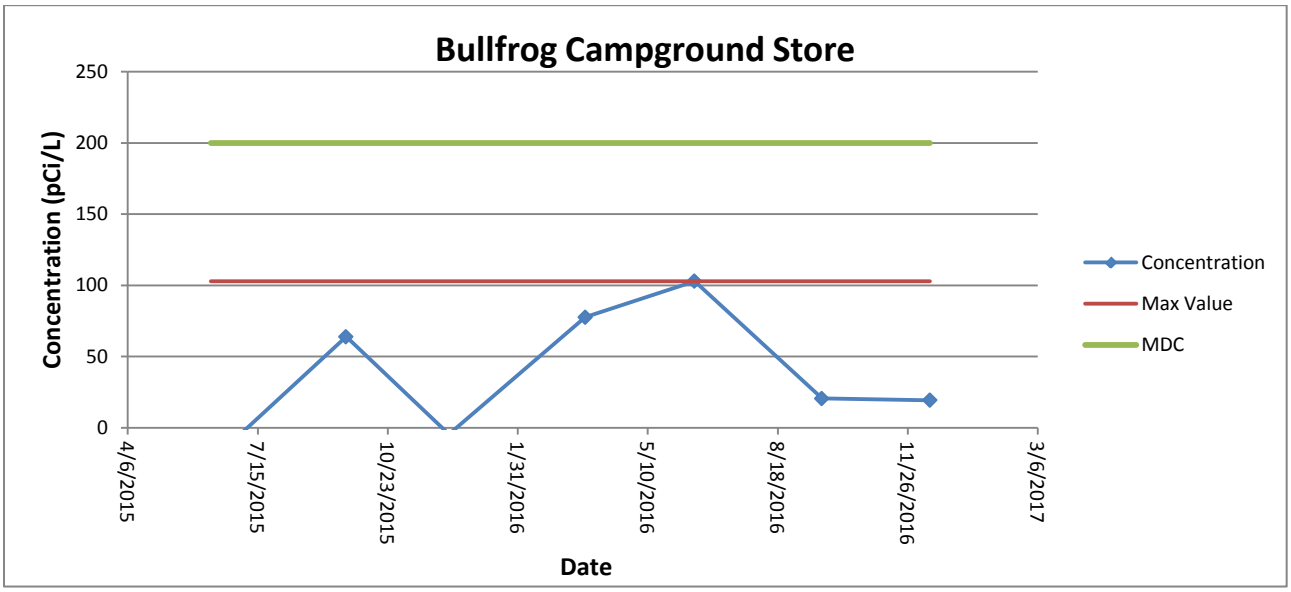

Sanitary & Ship Canal - Upstream
Concentration (pCi/L)
250
200
150
100
50
0
0.49% Drinking Water Standard
2/22/2008
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
Date
Concentration
Max Value
MDC

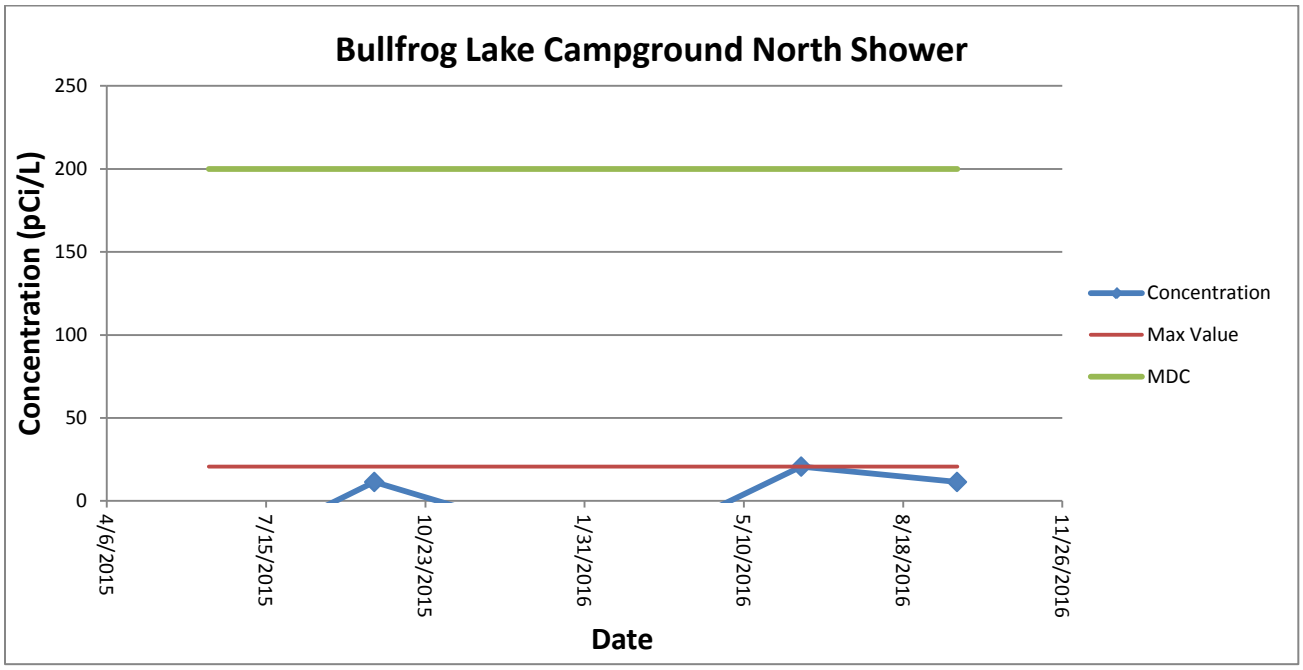

Sanitary & Ship Canal - Downstream
250
200
150
100
50
0
Concentration (pCi/L)
0.49% Drinking Water
Concentration
Max Value
MDC
2/22/2008
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
Date

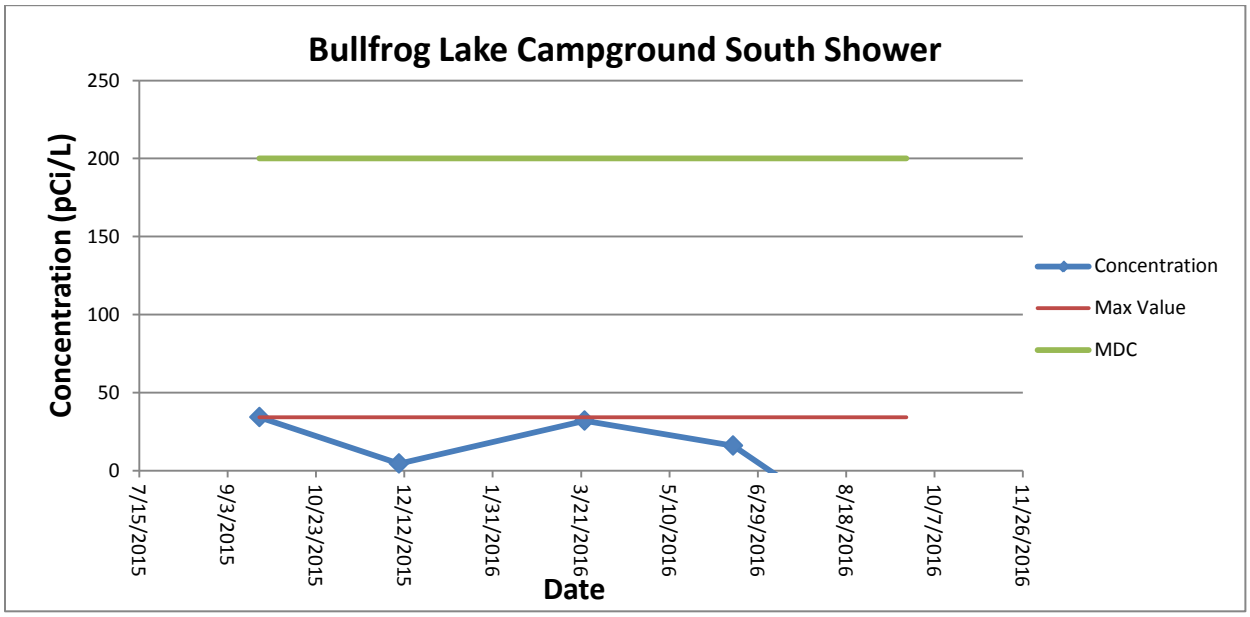

St. James Church Well
250
200
150
100
50
0
Concentration (pCi/L)
0.75% Drinking Water Standard
Concentration
Max Value
MDC
2/22/2008
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
Date

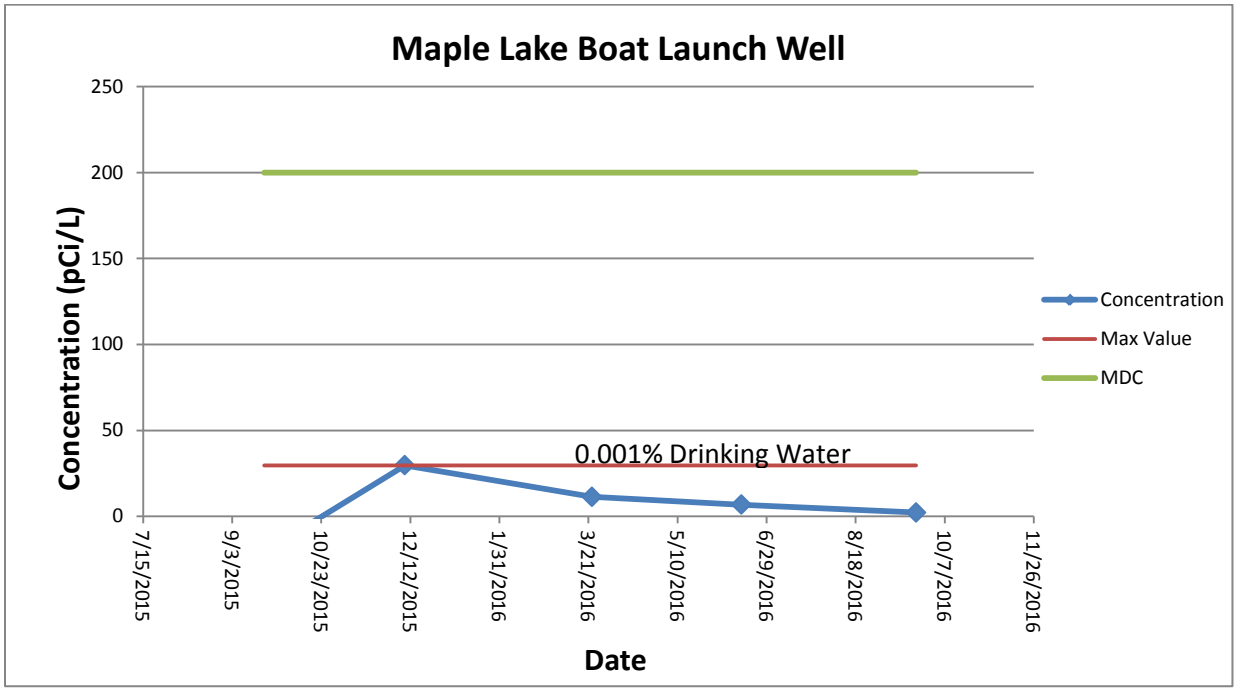

Well 5160 (Red Gate Woods)
11% Drinking Water Standard
Concentration (pCi/L)
2500
2000
1500
1000
500
0
7/6/2009
11/18/2010
4/1/2012
8/14/2013
12/27/2014
5/10/2016
Date
Concentration
Max Value
MDC

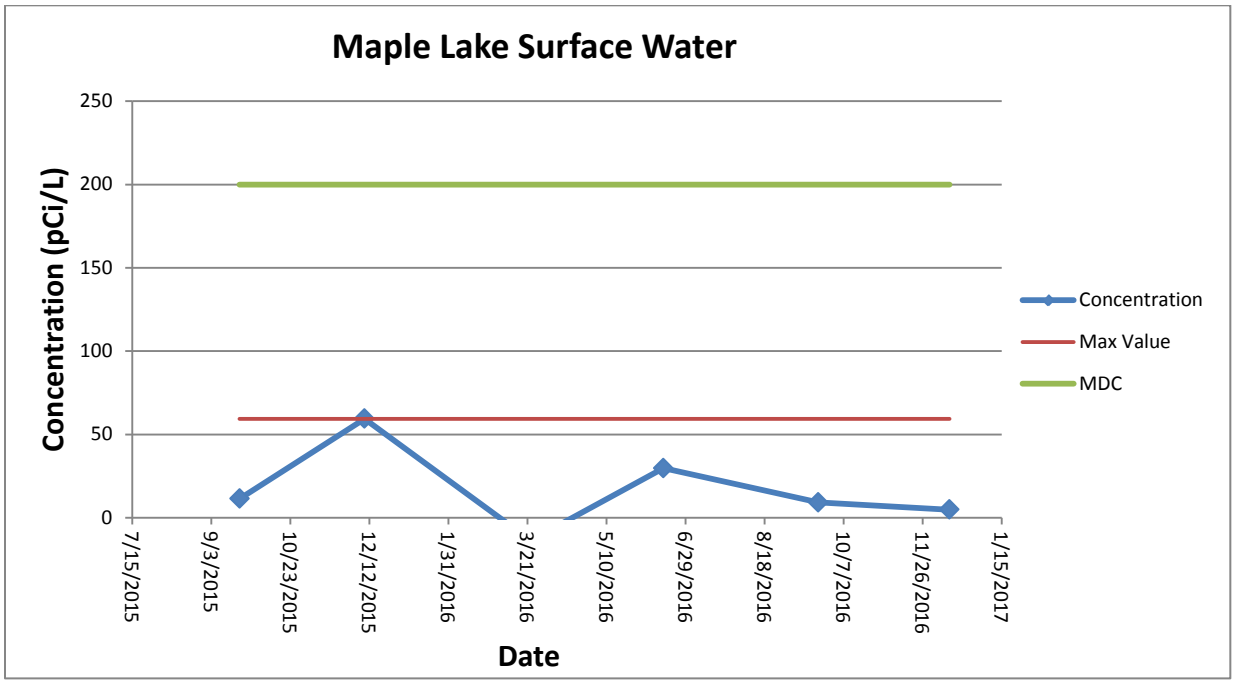

Saganashkee Slough
Concentration (pCi/L)
250
200
150
100
50
0
4/6/2015
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016
3/6/2017
Date
Concentration
Max Value
MDC

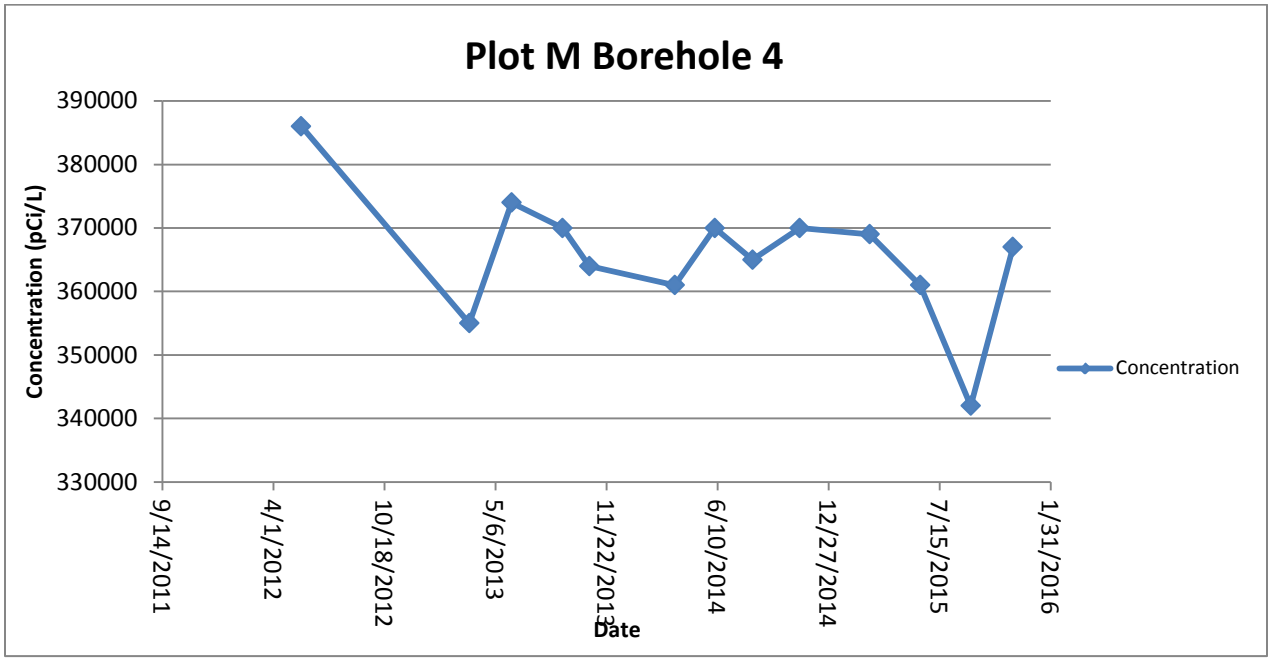

Bullfrog Campground Store
Concentration (pCi/L)
250
200
150
100
50
0
4/6/2015
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016
3/6/2017
Date
Concentration
Max Value
MDC


Bullfrog Lake Campground North Shower
Concentration (pCi/L)
250
200
150
100
50
0
4/6/2015
7/15/2015
10/23/2015
1/31/2016
5/10/2016
8/18/2016
11/26/2016
Date
Concentration
Max Value
MDC

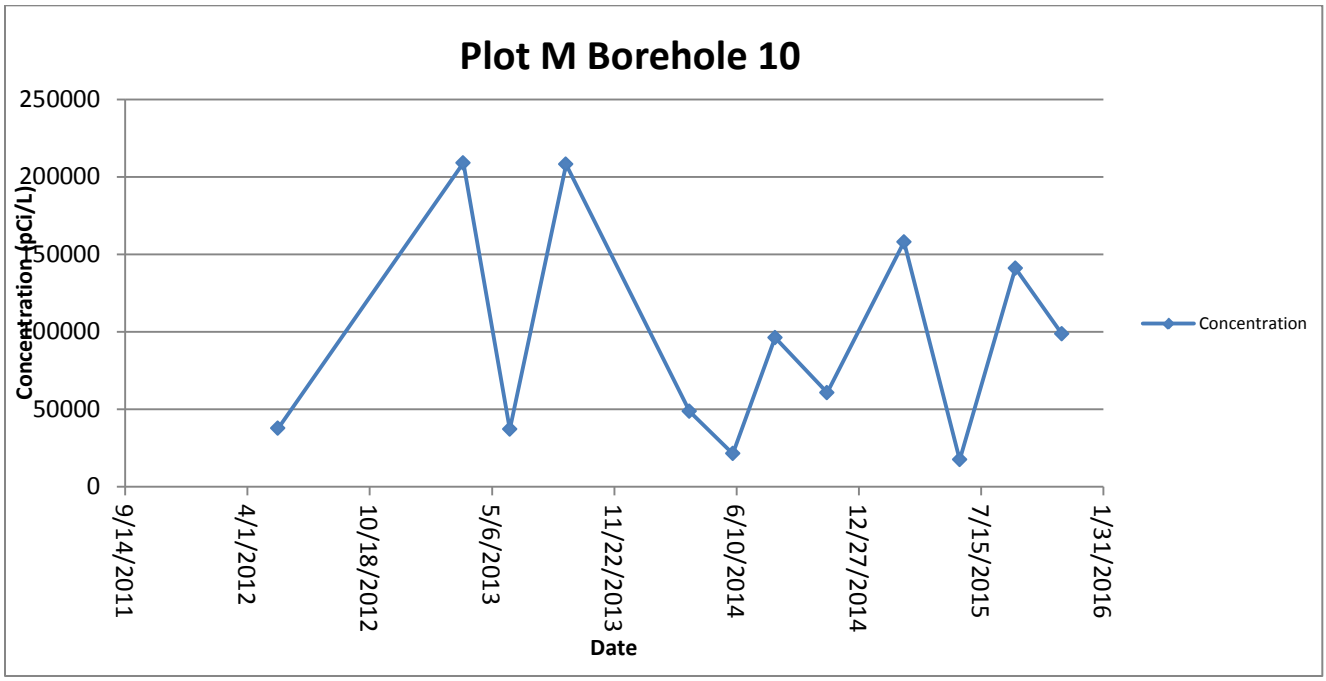

Bullfrog Lake Campground South Shower
Concentration (pCi/L)
250
200
150
100
50
0
7/15/2015
9/3/2015
10/23/2015
12/12/2015
1/31/2016
3/21/2016
5/10/2016
6/29/2016
8/18/2016
10/7/2016
11/26/2016
Date
Concentration
Max Value
MDC


Maple Lake Boat Launch Well
Concentration (pCi/L)
250
200
150
100
50
0
0.001% Drinking Water
7/15/2015
9/3/2015
10/23/2015
12/12/2015
1/31/2016
3/21/2016
5/10/2016
6/29/2016
8/18/2016
10/7/2016
11/26/2016
Date
Concentration
Max Value
MDC





*MDC is 200 pCi/L, not visible at this scale.



*MDC is 200 pCi/L, not visible at this scale.

APPENDIX C
Site A / Plot M and Palos Forest Preserve Sample Results

Table C.1. Tritium (H-3) Results for Water Samples
Results are in picocuries per liter (pCi/L)

Location	H3	
Date	Result	MDC
Bullfrog Campground North		
6/9/2015	<MDC	200
9/21/2015	<MDC	200
12/9/2015	<MDC	200
Bullfrog Campground South		
9/21/2015	<MDC	200
12/9/2015	<MDC	200
Bullfrog Lake		
6/9/2015	<MDC	200
9/21/2015	<MDC	200
12/9/2015	<MDC	200
Illinois & Michigan Canal (D.S.)		
3/23/2015	<MDC	200
6/22/2015	<MDC	200
9/21/2015	<MDC	200
12/9/2015	<MDC	200
Illinois &Michigan Canal (U.S.)		
3/23/2015	<MDC	200
6/9/2015	<MDC	200
9/21/2015	<MDC	200
12/9/2015	<MDC	200
Maple Lake Boat Launch Well		
9/21/2015	<MDC	200
12/9/2015	<MDC	200
Maple Lake Surface		
9/21/2015	<MDC	200
12/9/2015	<MDC	200

Location	H3	
Date	Result	MDC
Plot M Borehole #10		
3/11/2015	158000	200
6/10/2015	17400	200
9/9/2015	141000	200
11/24/2015	98700	200
Plot M Borehole #4		
3/11/2015	369000	200
6/10/2015	361000	200
9/9/2015	342000	200
11/24/2015	367000	200
Red Gate Dolomite Well #11		
6/10/2015	871	200
Red Gate Dolomite Well #12		
6/10/2015	588	200
Saganashkee Slough		
6/9/2015	<MDC	200
9/21/2015	<MDC	200
12/9/2015	<MDC	200
Sanitary & Ship Canal (D.S.)		
3/23/2015	<MDC	200
6/9/2015	<MDC	200
9/21/2015	<MDC	200
12/9/2015	<MDC	200
Sanitary & Ship Canal (U.S.)		
3/23/2015	<MDC	200
6/9/2015	<MDC	200
9/21/2015	<MDC	200
12/9/2015	<MDC	200

Location	H3	
Date	Result	MDC
Site A Borehole #56		
6/10/2015	1390	200
St. James Church Well		
3/23/2015	<MDC	200
6/9/2015	<MDC	200
9/21/2015	<MDC	200
12/9/2015	<MDC	200
Well #5031		
3/23/2015	<MDC	200
6/9/2015	<MDC	200
9/21/2015	<MDC	200
12/9/2015	<MDC	200
Well #5159 Opposite Red Gate Woods		
3/23/2015	<MDC	200
6/9/2015	208	200
9/21/2015	637	200
12/9/2015	806	200
Well #5160 Red Gate Woods		
3/23/2015	2070	200
6/9/2015	2020	200
6/10/2015	1910	200
9/21/2015	1890	200
12/9/2015	1910	200
Well #5162		
3/23/2015	<MDC	200
6/9/2015	<MDC	200
9/21/2015	<MDC	200
12/9/2015	<MDC	200

Table C.2. Gamma and Strontium Results for Palos Water Samples
Results are in picocuries per liter (pCi/L)

Location	Co-60		Cs-137		Strontium	
Date	Result	MDC	Result	MDC	Result	MDC
Bullfrog Campground North						
6/9/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
9/21/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
12/9/2015	<MDC	4.4	<MDC	3.9		
Bullfrog Campground South						
9/21/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
12/9/2015	<MDC	4.4	<MDC	3.9		
Bullfrog Lake						
6/9/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
9/21/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
12/9/2015	<MDC	4.4	<MDC	3.9		
Illinois & Michigan Canal (D.S.)						
3/23/2015	<MDC	4.4	<MDC	3.9		
6/9/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
9/21/2015	<MDC	4.4	<MDC	3.9		
12/9/2015	<MDC	4.4	<MDC	3.9		
Illinois &Michigan Canal (U.S.)						
3/23/2015	<MDC	4.4	<MDC	3.9		
6/9/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
9/21/2015	<MDC	4.4	<MDC	3.9		
12/9/2015	<MDC	4.4	<MDC	3.9		
Maple Lake Boat Launch Well						
9/21/2015	<MDC	4.4	<MDC	3.9		
12/9/2015	<MDC	4.4	<MDC	3.9		
Maple Lake Surface						
9/21/2015	<MDC	4.4	<MDC	3.9		
12/9/2015	<MDC	4.4	<MDC	3.9		

Table C.2. (cont.) Gamma and Strontium Results for Palos Water Samples
Results are in picocuries per liter (pCi/L)

Location	Co-60		Cs-137		Strontium	
Date	Result	MDC	Result	MDC	Result	MDC
Site A Borehole #56						
6/10/2015	<MDC	4.4	<MDC	3.9	1.8	1.3
St. James Church Well						
3/23/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
6/9/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
9/21/2015	<MDC	4.4	<MDC	3.9		
12/9/2015	<MDC	4.4	<MDC	3.9		
Well #5031						
3/23/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
6/9/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
9/21/2015	<MDC	4.4	<MDC	3.9		
12/9/2015	<MDC	4.4	<MDC	3.9		
Well #5159 Opposite Red Gate Woods						
3/23/2015	<MDC	4.4	<MDC	3.9		
6/9/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
9/21/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
12/9/2015	<MDC	4.4	<MDC	3.9		
Well #5160 Red Gate Woods						
3/23/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
6/9/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
6/10/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
9/21/2015	<MDC	4.4	<MDC	3.9		
12/9/2015	<MDC	4.4	<MDC	3.9		
Well #5162						
3/23/2015	<MDC	4.4	<MDC	3.9		
6/9/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
9/21/2015	<MDC	4.4	<MDC	3.9		
12/9/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3

Table C.2. (cont.) Gamma and Strontium Results for Palos Water Samples
Results are in picocuries per liter (pCi/L)

Location	Co-60		Cs-137		Strontium	
Date	Result	MDC	Result	MDC	Result	MDC
Plot M Borehole #10						
3/11/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
6/10/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
9/9/2015	<MDC	4.4	<MDC	3.9		
11/24/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
Plot M Borehole #4						
3/11/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
6/10/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
9/9/2015	<MDC	4.4	<MDC	3.9		
11/24/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
Red Gate Dolomite Well #11						
6/10/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
Red Gate Dolomite Well #12						
6/10/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
Saganashkee Slough						
6/9/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
9/21/2015	<MDC	4.4	<MDC	3.9		
12/9/2015	<MDC	4.4	<MDC	3.9		
Sanitary & Ship Canal (D.S.)						
3/23/2015	<MDC	4.4	<MDC	3.9		
6/9/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
9/21/2015	<MDC	4.4	<MDC	3.9		
12/9/2015	<MDC	4.4	<MDC	3.9		
Sanitary & Ship Canal (U.S.)						
3/23/2015	<MDC	4.4	<MDC	3.9		
6/9/2015	<MDC	4.4	<MDC	3.9	<MDC	1.3
9/21/2015	<MDC	4.4	<MDC	3.9		
12/9/2015	<MDC	4.4	<MDC	3.9		

APPENDIX D
Background Location Sample Results

Table D.1. Tritium (H-3) Results for Water Samples from Background Location
Results are in picocuries per liter (pCi/L)

Location	H3	
Date	Result	MDC
Kincaid East Boat Dock		
1/21/2015	<MDC	200
4/7/2015	<MDC	200
7/22/2015	<MDC	200
10/21/2015	<MDC	200
Kincaid Strawkaws Boat Ramp		
1/21/2015	<MDC	200
4/7/2015	<MDC	200
7/22/2015	<MDC	200
10/21/2015	<MDC	200
Kincaid West Boat Ramp		
1/21/2015	<MDC	200
4/7/2015	<MDC	200
7/22/2015	<MDC	200
10/21/2015	<MDC	200

Table D.2. Gamma Results for Water Samples from Background Location
Results are in picocuries per liter (pCi/L)

Location Date	Co-60 Result	Co-60 MDC	Cs-137 Result	Cs-137 MDC
Kincaid East Boat Dock				
1/21/2015	<MDC	3.9	<MDC	3.9
4/7/2015	<MDC	3.9	<MDC	3.9
7/22/2015	<MDC	3.9	<MDC	3.9
10/21/2015	<MDC	3.9	<MDC	3.9
Kincaid Strawkaws Boat Ramp				
1/21/2015	<MDC	3.9	<MDC	3.9
4/7/2015	<MDC	3.9	<MDC	3.9
7/22/2015	<MDC	3.9	<MDC	3.9
10/21/2015	<MDC	3.9	<MDC	3.9
Kincaid West Boat Ramp				
1/21/2015	<MDC	3.9	<MDC	3.9
4/7/2015	<MDC	3.9	<MDC	3.9
7/22/2015	<MDC	3.9	<MDC	3.9
10/21/2015	<MDC	3.9	<MDC	3.9

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