

**La Crosse Boiling Water Reactor**  
**Environmental Radioactivity Survey**  
**2016**



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# La Crosse Boiling Water Reactor Environmental Monitoring Survey 2016

## Executive Summary

[Wisconsin Stat. § 254.41](#) mandates the Wisconsin Department of Health Services (DHS) to conduct environmental radiation monitoring around the nuclear power facilities that affect Wisconsin. This environmental monitoring report is for the La Crosse Boiling Water Reactor (LACBWR) nuclear generating plant for the calendar year (January – December) 2016. It provides descriptions and results of this environmental monitoring program.

The DHS environmental monitoring program consists of the collection of various types of samples from the air, water, and terrestrial exposure pathways, sample analysis, and interpretation of the data. The sampling program includes samples of air particulates ambient gamma radiation, surface water, sediment, soil, and vegetation that are collected from selected locations at planned sampling intervals.

## Program Summary

For 2016, all sample results from the LACBWR environmental monitoring area were less than state and federal standards or guidelines.

The DHS environmental monitoring programs provide an ongoing baseline of radioactivity measurements to assess any health concerns from the operation of nuclear power generating facilities in or near Wisconsin or other radiological incidents that may occur within Wisconsin or worldwide. These monitoring programs show the following:

- Environmental radioactivity levels have been trending downward in the time period since the 1950s-1960s atmospheric nuclear testing and such radiological incidents as the Chernobyl nuclear reactor incident of 1986.
- There were no incidents during 2016, such as the 2011 Japan Fukushima Daiichi incident, that required additional environmental monitoring.
- There were no radioactive incidents related to food consumed in Wisconsin and no health problem related to radioactivity for Wisconsin citizens.

The DHS ongoing environmental monitoring programs will continue to provide assurances to the citizens of Wisconsin that the environment surrounding the LACBWR nuclear power facility and other monitoring areas will continue to be evaluated.

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## Introduction

[Wisconsin Stat. § 254.41](#) mandates the Wisconsin Department of Health Services (DHS) to conduct environmental radiation monitoring around the nuclear power facilities that affect Wisconsin. This environmental monitoring report is for the La Crosse Boiling Water Reactor (LACBWR) for the calendar year (January – December) 2016. It provides descriptions and results of this environmental monitoring program.

## Wisconsin DHS LACBWR Environmental Monitoring Sampling Program

The DHS environmental monitoring program consists of the collection of various types of air particles samples from the air, water and terrestrial exposure pathways. The sampling program includes samples of ambient gamma radiation as measured by thermoluminescent dosimeters (TLD), surface water, fish, soil, and vegetation that are collected from selected locations at planned sampling intervals.

Table 1 is a listing of sampling sites and includes a description, direction, and distance from the monitored power plant. Table 2 provides a listing of the types of samples collected, sites where samples are collected, number of samples collected, number of samples that were missed or had noted problems, and the required analyses. Table 3 provides an explanation of missing samples or non-routine sample analyses. Figure 1 is a map showing the location of each environmental sampling site.

## Program Modifications

On April 30, 1987, Dairyland Power Cooperative permanently shut down the LACBWR facility. Their USNRC (United States Nuclear Regulatory Commission) license was amended to a possess-but-not-operate status on August 4, 1987. On August 7, 1991 the Nuclear Regulatory Commission approved LACBWR's SAFSTOR (deferred decontamination) decommissioning plan. On June 1, 2016 LACBWR transferred their license to LaCrosse Solutions for the purpose of completing decommissioning of LACBWR.

Active decommission of the LACBWR started in the third quarter of 2016. In response to the active decommissioning, air particulate and well water samples were added to the routine environmental monitoring program for LACBWR. Table 2 shows the sample site location and frequency of the sample collection.

## Laboratory Services and Quality Assurance

Analysis of the samples is performed under contract with the Wisconsin State Laboratory of Hygiene (WSLH). WSLH maintains a quality assurance program. Analytical procedures provide for routine replicate analyses to verify methods and instrument operation. Traceable sources are used daily to regularly calibrate instrumentation and conduct performance checks. Instrumentation quality control charts are maintained and available upon written request.

WSLH participates in the Environmental Resource Associates' Proficiency Testing program and has performed satisfactorily over the report period. In addition, WSLH participates in the Multi Analytical Performance Evaluation program (MAPER) for environmental matrix analysis. Proficiency testing results are available from the WSLH.

## Detection Limits

Detection limits, required by DHS, are expressed as a lower limit of detection (LLD). The required DHS LLD, as indicated in Table 4 under the heading LLD, is an "a priori" estimate of the capability for detecting an activity concentration by a given measurement system, procedure, and type of sample. Counting statistics of the appropriate instrument background are used to compute the LLD for each specific analysis. Using 4.66 times the standard deviation ( $s_b$ ) of the instrument background, the LLD for each specific analysis is defined at the 95% confidence level.

The LLD for each radioisotope listed in Table 4 has been calculated from the following equation:

$$LLD = \frac{4.66 s_b}{E * V * 2.22 * Y * S * \exp(-dt)}$$

Where:

- LLD is the a priori lower limit of detection as defined above, as picocuries per unit, mass, or volume.
- $s_b$  is the standard deviation of the background counting rate or of the counting rate of blank sample as appropriate, as counts per minute.
- E is the counting efficiency, as counts per disintegration.
- V is the sample size in units of mass or volume.
- 2.22 is the number of disintegrations per minute per picocurie.
- Y is the fractional radiochemical yield, when applicable.
- S is the self-absorption correction factor.
- d is the radioactive decay constant for the particular radionuclide.
- t is the elapsed time, for environmental samples, between sample collection, or end of the sample collection period, and time of counting

Typical values for E, V, Y, and dt have been used to calculate the LLD.

### Reporting of Sample Analysis Results

Results for specific analyses are reported as either a “less than” (<) value or an actual activity value. The reporting of results in Table 4 under the heading “Range” and in Tables 5-12 is an a posteriori calculation based on the actual analysis performed using the actual sample values for E, V, Y, and dt. Typically the reported less than results are lower than the required DHS LLD, indicating that the required DHS LLD has been met.

An actual activity value is accompanied by an uncertainty term for that analysis. The uncertainty term is a plus or minus counting uncertainty term at the 2 sigma (95%) confidence interval and is printed as (+- or ±). Examples and explanations of data reporting are:

Example	Nuclide	Activity reported
1	<sup>137</sup> Cs	< 10 pCi/liter
2	<sup>137</sup> Cs	15 ± 3 pCi/liter

In example 1 we can be 95% confident that the sample activity, if any, is less than the LLD of 10 pCi/liter. In example 2 we can be 95% confident that the actual sample activity is greater than the LLD for that analysis and is between 12 and 18 pCi/liter.

Table 1. DHS LACBWR environmental monitoring sampling sites.

Sample site	Distance and direction (miles)	Location description
LAC-2	0.6 N	Lock & Dam #8
LAC-3	0.1 WSW	Discharge channel
LAC-4	0.7 SSW	Boat launch area
LAC-5	0.6 NNE	Hwy 35 parking lot
LAC-6	0.7 S	Boat launch access road
LAC-7	0.7 SSE	Edgewood Trailer Court
LAC-8	1.15 NNE	Genoa Post Office

Table 1 (continued). DHS LACBWR environmental monitoring sampling sites.

Sample site	Distance and direction (miles)	Location description
LAC-10	0.6 N	South of Lock & Dam #8
LAC-19	0.6 SSW	Island across from the boat launch
LAC-T1	0.6 N	Lock & Dam #8
LAC-T2	0.5 SSE	Edgewood Trailer Court, Hwy 35
LAC-T3	0.2 S	ISFSI outer fence (outside on fence)
LAC-T4	0.2 W	ISFSI outer fence (outside on fence)

Table 2. Sample collection summary and required analyses.

Sample Type	Collection and Frequency	LAC Site locations	Number of Samples Collected	Number of Sample Deviations	Required Analyses
air particulate	C/BW	LAC 2, 7	52	0	GA, GB, GI <sup>w</sup>
TLD	G/Q	LAC T1-T4	16	0	direct exposure
surface water	G/A	LAC 4	1	0	GA <sup>u,v</sup> , GB <sup>u,v</sup> , GI, Sr, H
bottom sediment	G/A	LAC 3,10,19	3	0	GA,GB,GI
vegetation	G/A	LAC 5, 6	2	0	GA, GB, GI
soil	G/A	LAC 5, 6	2	0	GA, GB, GI
well water	G/BA	LAC 7, 8	4	0	GA <sup>u</sup> , GB <sup>u</sup> , H

Collection type: C/ = continuous; G/ = grab

Frequency: /W = weekly; /M = monthly; /Q = quarterly; /A = annually; /BW = bi-weekly; /SA = semi-annually

Required analyses: GA = gross alpha; GB = gross beta; GI = gamma isotopic; Sr = strontium; H = tritium

<sup>u</sup> = Soluble

<sup>v</sup> = Insoluble

<sup>w</sup> = A quarterly composite for each site

Table 3. DHS missing sample or non-routine analysis report for 2016.

Sample type	Date	Site	Explanation
air particulate	1 <sup>st</sup> Qtr	LAC-2	Active decommissioning had not started during this quarter
air particulate	2 <sup>nd</sup> Qtr	LAC-2	Active decommissioning had not started during this quarter
air particulate	1 <sup>st</sup> Qtr	LAC-7	Active decommissioning had not started during this quarter
air particulate	2 <sup>nd</sup> Qtr	LAC-7	Active decommissioning had not started during this quarter
air particulate	9/15/16	LAC-2	data collection error in the field
air particulate	9/28/16	LAC-2	the original data sheet was not returned
air particulate	11/23/16	LAC-2	there was a problem with mechanical/electrical issue
air particulate	10/26/16	LAC-7	there was a problem with mechanical/electrical issue
air particulate	11/09/16	LAC-7	the original data sheet was not returned
air particulate	12/07/16	LAC-7	the original data sheet was not returned



Figure 1. Wisconsin DHS environmental monitoring sampling sites for the LACBWR monitoring program.

## Results and Discussion for the LACBWR Environmental Monitoring Program

### Air Particulate

Table 4 provides a summary of reported activities by DHS for air particulate samples. Tables 5–12 provide results from the individual sample analyses. Air sample collection started in July of 2016 in response to active decommissioning.

The gross beta activities listed in Table 5 contain several samples that had gross beta activity above the LLD. The gross beta values were comparable to the gross beta activity at the other nuclear plant across the state.

The gamma isotopic analysis of the quarterly air particulate filter composites detected only trace amounts of Beryllium-7 ( $^7\text{Be}$ ). All other radioisotopes were below their respective LLD. Beryllium-7 ( $^7\text{Be}$ ) was detected in all composites, and is a naturally occurring radioisotope that is constantly produced through nuclear reactions between cosmic rays and nuclei in the atmosphere.

### Ambient Gamma Radiation - Thermoluminescent Dosimeters (TLDs)

Table 4 provides a summary of reported activities by DHS for ambient gamma radiation. Table 7 provides results from the individual sample analyses.

Ambient gamma radiation (TLD) data for 2016 from the DHS network was comparable for all sites. Significant differences in exposure were not noticed at different distances from the LACBWR facility. The average quarterly exposure from the four sites located within Wisconsin was  $19.5 \pm 1.0$  milliroentgens. The average quarterly exposure for 2016 was at background levels and was comparable to other areas within Wisconsin. Influence by the LACBWR facility is not evident from air ambient gamma radiation analysis.

### Surface Water

Table 4 provides a summary of reported activities by DHS for surface water samples. Table 11 provides results from the individual sample analysis.

The gamma isotopic analysis detected activities below background levels. The surface water samples uniformly showed activities below state or federal standards. Influence by the LACBWR facility is not evident from surface water sample analysis.

### Vegetation

Table 4 provides a summary of reported activities by DHS for vegetation samples. Table 9 provides results from the individual sample.

The gamma isotopic analysis detected gross beta concentration above the LLD, and beryllium-7 ( $^7\text{Be}$ ) concentration above the LLD at both sites. Also, naturally occurring potassium-40 ( $^{40}\text{K}$ ) and beryllium-7 was above the LLD at both sites. Influence by the LACBWR facility is not evident from vegetation sample analysis. All samples with values above the LLD were below state or federal standards. All other gamma emitting isotopes measured below detection levels.

### Soil

Table 4 provides a summary of reported activities by DHS for soil samples. Table 10 provides results from the individual sample analyses.

Analysis of the soil samples showed no unusual activities. In table 4, the gamma isotopic analysis detected only gross beta above the LLD. The naturally occurring radioisotope potassium-40 ( $^{40}\text{K}$ ) was detected above the LLD in all samples. Naturally occurring radioisotopes from the uranium-238 ( $^{238}\text{U}$ ) and thorium-232 ( $^{232}\text{Th}$ ) decay

series are commonly detected but have not been quantified or reported. Influence by the LACBWR facility is not evident from soil sample analysis.

## Bottom Sediments

Table 4 provides a summary of reported activities by DHS for bottom sediment samples. Table 8 provides results from the individual sample analyses.

The naturally occurring radioisotope potassium-40 ( $^{40}\text{K}$ ) was detected in all samples. Two location had gross beta counts above the LLD. The gamma isotopic analysis of the bottom sediment samples taken at all three sites detected small activities for cesium-137 ( $^{137}\text{Cs}$ ). The reported activities for cesium-137 ( $^{137}\text{Cs}$ ) can be attributed to past effluent discharges from the LACBWR facility and have also been detected in previous years. Naturally occurring radioisotopes from the uranium-238 ( $^{238}\text{U}$ ) and thorium-232 ( $^{232}\text{Th}$ ) decay series are commonly detected but have not been quantified or reported. Influence by the LACBWR facility is not evident from analysis of bottom sediment sample. The only influence by LACBWR is attributed to past effluent near the effluent discharge. All other sediment samples show no influence by LACBWR facility.

## Well Water

Table 4 provides a summary of reported activities in the well water samples. Table 12 provides results from individual sample analyses.

The well water samples showed no unusual gross alpha, gross beta, or tritium ( $^3\text{H}$ ) activities, and all activities were below the LLD. The measured activities were all below state and federal standards. Influence by LACBWR is not evident from well water sample analysis.

## Dose to an Average Individual

Federal regulations 10 C.F.R. § 20, 10 C.F.R. § 50 Appendix I and 40 C.F.R. § 190 restrict the annual exposure of the population from all parts of the nuclear fuel cycle, including nuclear power plants. Doses resulting from gaseous and liquid effluent releases from the LACBWR facility are less than the limits as stated in these federal regulations.

DHS limits for permissible levels of radiation exposure from external sources in unrestricted areas are defined in Wis. Admin. Code § DHS 157.23. Doses resulting from gaseous and liquid effluent releases from the LACBWR facility are less than the limits as stated in Wis. Admin. Code § DHS 157.23.

## References

Off-Site Dose Calculation Manual Guidance: Standard Radiological Effluent Controls for Pressurized Water Reactors, NUREG-1301, Generic Letter 89-01, Supplement No. 1, April 1991.

Wisconsin Admin. Code § DHS 157.23

U.S. Environmental Protection Agency (EPA), Limiting Values of Radionuclide Intake and Air Concentration and Dose Conversion Factors for Inhalation, Submersion, and Ingestion, Federal Guidance Report No. 11, EPA-520/1-88-020 (Office of Radiation Programs Washington, DC), September 1988.

U.S. Environmental Protection Agency, Environmental Radiation Requirements for Normal Operations of Activities in the Uranium Fuel Cycle, EPA 520/4-76-016, 40 CFR Part 190, November 1976.

U.S. Nuclear Regulatory Commission, Title 10, Part 20.

U.S. Nuclear Regulatory Commission, Title 10, Part 50, Appendix I.

## Sample Activity Summary

Table 4. Sample activity summary for the DHS LACBWR environmental monitoring program.

Sample type (units)	LLD	Number of samples <sup>a</sup>	Analysis	Range
Air particulate (pCi/m <sup>3</sup> )	0.005	20 / 15	gross beta	0.002 - 0.34
			<b>gamma isotopic</b>	
	0.020	4 / 4	Be-7	0.004 - 0.045
	0.002	4 / 0	Mn-54	< 0.0003
	0.002	4 / 0	Co-58	< 0.0003
	0.005	4 / 0	Fe-59	< 0.0006
	0.002	4 / 0	Co-60	< 0.0003
	0.005	4 / 0	Zn-65	< 0.0005
	0.002	4 / 0	Nb-95	< 0.0004
	0.005	4 / 0	Zr-95	< 0.0006
	0.002	4 / 0	Ru-103	< 0.0004
	0.015	4 / 0	Ru-106	< 0.0024
	0.020	4 / 0	I-131	< 0.0015
	0.002	4 / 0	Cs-134	< 0.0002
	0.002	4 / 0	Cs-137	< 0.0003
	0.030	4 / 0	Ba-140	< 0.0029
0.020	4 / 0	La-140	< 0.0009	
0.002	4 / 0	Ce-141	< 0.0005	
0.005	4 / 0	Ce-144	< 0.0013	
Direct Exposure (TLD) (mR/Std Qtr)	1.0 <sup>b</sup>	16 / 16	direct exposure	16.5 – 22.6
Surface Water (pCi/liter)	3.0	2 / 0	gross alpha (sol)	0.7 - 1.3
	3.0	2 / 0	gross beta (sol)	1.2 - 2.1
	3.0	2 / 0	gross alpha (insol)	< 0.5 - 1
	3.0	2 / 0	gross beta (insol)	< 0.8 - 1
	300	2 / 0	H-3	< 181
	2.0	2 / 0	Sr-89	< 1
	1.0	2 / 0	Sr-90	< 0.5
			<b>gamma isotopic</b>	
	10	2 / 0	Mn-54	< 2
	15	2 / 0	Co-58	< 3 - 2
	30	2 / 0	Fe-59	< 4
	15	2 / 0	Co-60	< 2
	30	2 / 0	Zn-65	< 6
	15	2 / 0	Nb-95	< 3
	30	2 / 0	Zr-95	< 5
	15	2 / 0	I-131	< 6
	15	2 / 0	Cs-134	< 3
	15	2 / 0	Cs-137	< 3
	60	2 / 0	Ba-140	< 10
15	2 / 0	La-140	< 3	
Well water (pCi/liter)	5.0	4 / 0	gross alpha	< 1.3 – 1.7
	3.0	4 / 0	gross beta	< 3.0 – 2.0
	300	4 / 0	H-3	< 210

Table 4 (continued). Sample activity summary for the DHS LACBWR environmental monitoring program.

Sample type (units)	LLD	Number of samples <sup>a</sup>	Analysis	Range	
Soil (pCi/kg dry)	13000	2 / 0	gross alpha	9180 - 10600	
	6000	2 / 2	gross beta	11000 - 22800	
	<b>gamma isotopic</b>				
	800	2 / 0	Cs-134	< 19	
	60	2 / 0	Cs-137	< 25	
	90	2 / 0	Co-58	< 22	
	600	2 / 0	Co-60	< 26	
	90	2 / 0	Fe-59	< 72	
	300	2 / 0	Mn-54	< 20	
	100	2 / 0	Nb-95	< 37	
	250	2 / 2	K-40	10500 - 24400	
	80	2 / 0	Zn-95	< 50	
	80	2 / 0	Zr-95	< 46	
	Vegetation (pCi/kg wet)	5000	2 / 0	gross alpha	< 1060
4000		2 / 1	gross beta	3980 - 5110	
<b>gamma isotopic</b>					
600		2 / 2	Be-7	1110 - 1550	
2000		2 / 2	K-40	4840 - 6100	
90		2 / 0	Mn-54	< 29	
100		2 / 0	Co-58	< 27	
200		2 / 0	Fe-59	< 65	
100		2 / 0	Co-60	< 30	
250		2 / 0	Zn-65	< 58	
100		2 / 0	Nb-95	< 35	
200		2 / 0	Zr-95	< 50	
80		2 / 0	I-131	< 80	
80		2 / 0	Cs-134	< 28	
90		2 / 0	Cs-137	< 26	
350		2 / 0	Ba-140	< 178	
100		2 / 0	La-140	< 67	
Bottom Sediment (pCi/kg dry)	13000	3 / 0	gross alpha	< 3820 - 10200	
	6000	3 / 2	gross beta	3780 - 12600	
	<b>gamma isotopic</b>				
	800	3 / 3	K-40	6190 - 15100	
	60	3 / 0	Mn-54	< 10	
	90	3 / 0	Co-58	< 22	
	600	3 / 0	Fe-59	< 109	
	90	3 / 0	Co-60	< 8	
	300	3 / 0	Zn-65	< 23	
	100	3 / 0	Nb-95	< 93	
	250	3 / 0	Zr-95	< 47	
	80	3 / 0	Cs-134	< 7	
	80	3 / 1	Cs-137	10 - 235	

a - Number of analysis / number of analyses detected above the Wisconsin DHS LLD.

b - 1.0 mR / TLD.

Table 5. DHS air particulate gross beta analysis results from the LACBWR environmental monitoring program.

Measurements in units of pCi/m <sup>3</sup>			Measurements in units of pCi/m <sup>3</sup>		
<b>LAC-2 (2100 series); Lock &amp; Dam #8</b>			<b>LAC-7 (12000 series); Edgewood Trailer Court</b>		
Collection date	Volume m <sup>3</sup>	Air particulate	Collection date	Volume m <sup>3</sup>	Air particulate
08/18/16	928	0.021 ± 0.001	09/01/16	1097	0.002 ± 0.001
09/01/16	995	0.018 ± 0.001	09/14/16	9144	0.002 ± 0.000
09/15/16	*c	*c	09/14/16	914	0.002 ± 0.000
09/28/16	*b	0.016 ± 0.001	09/28/16	962	0.018 ± 0.001
3rd Qtr			3rd Qtr		
mean +- s.d.		0.018 ± 0.003	mean +- s.d.		0.006 ± 0.008
10/12/16	1033	0.017 ± 0.001	10/12/16	1016	0.340 ± 0.020
10/26/16	1004	0.002 ± 0.000	10/26/16	9 *a	0.031 ± 0.064
11/09/16	1004	0.030 ± 0.001	11/09/16	*b	0.028 ± 0.001
11/23/16	859 *a	0.030 ± 0.001	11/23/16	1029	0.027 ± 0.001
12/07/16	1022	0.025 ± 0.001	12/07/16	*b	0.025 ± 0.001
12/21/16	1063	0.026 ± 0.001	12/21/16	1048	0.027 ± 0.001
4th Qtr			4th Qtr		
mean +- s.d.		0.022 ± 0.011	mean +- s.d.		0.08 ± 0.128

\*a = There was a mechanical problem with the air collection unit

\*b = The original data sheet was not returned.

\*c = Data entry error

Table 6. DHS gamma isotopic analysis results from the quarterly composites of air particulate filters collected from the LACBWR environmental monitoring program.

Measurements in units of pCi/m <sup>3</sup>			Measurements in units of pCi/m <sup>3</sup>		
<b>Site: LAC-2</b>	3 <sup>rd</sup> quarter	4th quarter	<b>Site: LAC-7</b>	3 <sup>rd</sup> quarter	4th quarter
Be-7	0.045 +- 0.0044	0.045 +- 0.0044	Be-7	0.044 +- 0.0042	0.041 +- 0.0042
Mn-54	< 0.0003	< 0.0003	Mn-54	< 0.0002	< 0.0002
Co-58	< 0.0003	< 0.0003	Co-58	< 0.0003	< 0.0003
Fe-59	< 0.0006	< 0.0006	Fe-59	< 0.0006	< 0.0006
Co-60	< 0.0003	< 0.0003	Co-60	< 0.0001	< 0.0001
Zn-65	< 0.0005	< 0.0005	Zn-65	< 0.0004	< 0.0004
Nb-95	< 0.0004	< 0.0004	Nb-95	< 0.0003	< 0.0003
Zr-95	< 0.0006	< 0.0006	Zr-95	< 0.0003	< 0.0003
Ru-103	< 0.0004	< 0.0003	Ru-103	< 0.0003	< 0.0003
Ru-106	< 0.0024	< 0.0024	Ru-106	< 0.0020	< 0.0020
I-131	< 0.0015	< 0.0015	I-131	< 0.0013	< 0.0013
Cs-134	< 0.0002	< 0.0002	Cs-134	< 0.0002	< 0.0002
Cs-137	< 0.0003	< 0.0003	Cs-137	< 0.0002	< 0.0002
Ba-140	< 0.0029	< 0.0029	Ba-140	< 0.0022	< 0.0022
La-140	< 0.0008	< 0.0008	La-140	< 0.0009	< 0.0009
Ce-141	< 0.0005	< 0.0005	Ce-141	< 0.0004	< 0.0004
Ce-144	< 0.0013	< 0.0013	Ce-144	< 0.0009	< 0.0009

Table 7. DHS TLD network for the LACBWR environmental monitoring program.

	1st quarter	2nd quarter	3rd quarter	4th quarter
Date Placed:	01/05/16	04/13/16	07/07/16	10/06/16
Date Removed:	04/13/16	07/07/16	10/06/16	01/18/17
Days in the Field:	99	85	91	104
Individual quarterly date is reported as: mR / Standard Quarter + 2 sigma counting error.				
LAC-T1	16.5 +- 1.7	17.4 +- 0.7	18.4 +- 1.7	17.7 +- 0.8
LAC-T2	18.5 +- 1.0	20.6 +- 1.3	20.7 +- 0.5	20.9 +- 1.3
LAC-T3	18.0 +- 0.8	22.1 +- 0.6	20.7 +- 0.7	22.6 +- 0.9
LAC-T4	17.8 +- 0.7	19.2 +- 1.0	20.5 +- 0.9	19.6 +- 1.0
Quarterly average +- s.d.	17.7 +- 0.9	19.8 +- 2.0	20.1 +- 1.1	20.2 +- 2.1
ND = No Data, TLD lost in the field				

Table 8. DHS analysis results for bottom sediment samples collected for the LACBWR environmental monitoring program.

Measurements in units of pCi/kilogram (dry)

Collection date:	04/27/16	04/27/16	04/27/16
Site:	LAC-10 upstream	LAC-3 Discharge	LAC-19 downstream
gross alph	< 3820	< 3450	10200 < 3620
gross beta	6920 +- 957	3780 +- 853	12600 +- 1390
<b>gamma isotopic</b>			
K-40	7470 +- 1220	6190 +- 1070	15100 +- 2440
Mn-54	< 8	< 7	< 10
Co-58	< 22	< 19	< 20
Fe-59	< 109	< 104	< 108
Co-60	< 7	< 8	< 8
Zn-65	< 23	< 19	< 21
Nb-95	< 90	< 93	< 87
Zr-95	< 47	< 41	< 45
Cs-134	< 7	< 6	< 6
Cs-137	10 +- 3	235 +- 16	28 +- 4

Table 9. DHS analysis results for vegetation collected for the LACBWR environmental monitoring program.

<b>Vegetation - Measurements in units of pCi/kilogram (wet)</b>		
Collection date:	06/07/16	06/07/16
Site:	LAC-5	LAC-6
gross alph	< 1060	< 1020
gross beta	3980 +- 474	5110 +- 377
<b>gamma isotopic</b>		
Be-7	1110 +- 184	1550 +- 208
K-40	6100 +- 1100	4840 +- 880
Mn-54	< 29	< 21
Co-58	< 27	< 25
Fe-59	< 65	< 48
Co-60	< 30	< 27
Zn-65	< 58	< 55
Nb-95	< 35	< 30
Zr-95	< 50	< 42
I-131	< 80	< 78
Cs-134	< 28	< 22
Cs-137	< 25	< 26
Ba-140	< 176	< 178
La-140	< 67	< 57

Table 10. DHS analysis results for soil samples collected for the LACBWR environmental monitoring program.

<b>Soil - Measurements in units of pCi/kilogram (dry)</b>		
Collection date:	06/07/16	06/07/16
Site:	LAC-5	LAC-6
gross alph	9180 +- 3460	10600 +- 3570
gross beta	22800 +- 1410	11000 +- 1340
<b>gamma isotopic</b>		
Cs-134	< 19	< 19
Cs-137	< 24.6	< 21
Co-58	< 22	< 21
Co-60	< 26	< 21
Fe-59	< 72	< 57
Mn-54	< 19	< 20
Nb-95	< 37	< 35
K-40	24400 +- 3980	10500 +- 1740
Zn-95	< 50	< 44
Zr-95	< 46	< 38

Naturally occurring radioisotopes such as radium-226 ( $^{226}\text{Ra}$ ), bismuth-214 ( $^{214}\text{Bi}$ ), lead-214 ( $^{214}\text{Pb}$ ), actinium-228 ( $^{228}\text{Ac}$ ), bismuth-212 ( $^{212}\text{Bi}$ ), lead-212 ( $^{212}\text{Pb}$ ) from the naturally occurring uranium-238 ( $^{238}\text{U}$ ), and thorium-232 ( $^{232}\text{Th}$ ) decay series are commonly detected but have not been quantified or reported.

Radioisotopes other than those reported were not detected.

Table 11. DHS analysis results for surface water supplies collected for the LACBWR environmental monitoring program.

Measurements in units of pCi/liter			
Collection date:	06/07/16	10/06/16	
Site:	LAC-4	LAC-4	
gross alpha-sol	1.3 ± 0.4	0.7 ± 0.4	
gross beta-sol	1.2 ± 0.3	2.1 ± 0.6	
gross alpha-insol	< 0.5	0.5 ± 0.2	
gross beta-insol	< 0.8	1.1 ± 0.6	
H-3	< 146	< 181	
Sr-89	< 0.6	< 1.0	
Sr-90	< 0.5	< 0.4	
gamma isotopic			
Mn-54	< 1.8	< 2.3	
Co-58	2 ± 1.2	< 3.1	
Fe-59	< 3.0	< 4.1	
Co-60	< 1.7	< 1.4	
Zn-65	< 1.8	< 6.1	
Nb-95	< 2.8	< 3.1	
Zr-95	< 4.9	< 4.4	
I-131	< 5.7	< 5.7	
Cs-134	< 2.3	< 2.9	
Cs-137	< 2.7	< 2.0	
Ba-140	< 8.5	< 10.3	
La-140	< 3.1	< 2.3	

Radioisotopes other than those reported were not detected.

Table 12. DHS analysis results for well water samples collected for the LACBWR environmental monitoring program.

Measurements in units of pCi/liter				
Collection date:	06/07/16	06/07/16	10/06/16	10/06/16
	LAC-7	LAC-8	LAC-7	LAC-8
gross alph	< 1.3	1.54 +- 1.2	< 1.2	1.74 +- 1.1
gross beta	1.5 +- 1.0	2.03 +- 1.0	< 3.0	< 3.0
H-3	< 210	< 210	< 208	< 208

## Appendices

### Appendix A – Radionuclide concentration levels needing review by state radiological coordinator (SRC)

If radioactivity concentrations exceed SRC review levels for a given radionuclide, the SRC will be consulted for review and assessment.

Medium	Radionuclide	SRC Review Level
Airborne Particulates or Gas (pCi/m <sup>3</sup> )	Gross Beta	1
	I-131 (Charcoal)	0.1
	Cs-134	1
	Cs-137	1
Water (pCi/l)	Gross Alpha	10
	Gross Beta	30
	H-3	10,000
	Mn-54	100
	Fe-59	40
	Co-58	100
	Co-60	30
	Zr-Nb-95	40
	Cs-134	10
	Cs-137	20
	Ba-La-140	100
	Sr-89	8
	Sr-90	8
	Zn-65	30
Vegetation (pCi/kg wet)	Gross Beta	30,000
	I-131	100
	Cs-134	200
	Cs-137	200
	Sr-89	1,000
	Sr-90	1,000
Soil, Bottom Sediment (pCi/kg)	Gross Beta	5,000
	Cs-134	5,000
	Cs-137	5,000
	Sr-89	5,000
	Sr-90	5,000

Radionuclides will be monitored by the DHS, Radiation Protection Sections, Environmental Monitoring program and concentrations above the listed levels will be reported to the SRC for further review and assessment.

## Appendix B – Sample Point Locations

Sample Point	Location Description	Longitude or X	Latitude or Y
LAC-2	Lock & Dam #8	-91.226110	43.553209
LAC-3	Discharge sample location (bottom sediment)	-91.23323	43.55931
LAC-4	Boat launch area	-91.23463	43.55166
LAC-5	Hwy 35 parking lot	-91.22888	43.56850
LAC-6	Boat launch access road	-91.23167	43.55063
LAC-7	Edgewood Trailer Court	-91.226110	43.553209
LAC-7	Edgewood Trailer Court (Well water)	-91.226729	43.553008
LAC-8	Genoa Post Office	-91.225503	43.574875
LAC-10	Upstream sample location (bottom sediment)	-91.22970	43.56723
LAC-19	Downstream sample location (bottom sediment)	-91.23772	43.55147
LAC-T1	Lock & Dam #8	-91.22931	43.56986
LAC-T2	Trailer court, Hwy 35	-91.22807	43.55387
LAC-T3	ISFSI outer fence (outside on fence)	-91.23207	43.55073
LAC-T4	ISFSI outer fence (outside on fence)	-91.23343	43.55192