NEXTera ENERGY
POINT BEACH

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10 CFR 72.44
TS 5.6.2

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Point Beach Nuclear Plant, Units 1 and 2
Dockets 50-266, 50-301 and 72-005
Renewed License Nos. DPR-24 and DPR-27

2016 Annual Monitoring Report

In accordance with Point Beach Nuclear Plant (PBNP) Technical Specification 5.6.2, enclosed is the Annual Monitoring Report for PBNP Units 1 and 2, for the period January 1 through December 31, 2016.

The Annual Monitoring Report contains information relating to the effluent impact upon the public, as well as information relating to plant releases, solid waste shipments, results from the radiological environmental monitoring program, the groundwater protection program, and miscellaneous monitoring activities which occurred in 2016. The report also covers the results of radiological monitoring of the PBNP Independent Spent Fuel Storage Installation (ISFSI), as required by 10 CFR 72.44. The contracted laboratory's final Radiological Environmental Monitoring Program results (Appendix 1) is included.

This letter contains no new regulatory commitments and no revisions to existing regulatory commitments.

Very truly yours,

NextEra Energy Point Beach, LLC

Bryan Woyak
Licensing Manager

Enclosure

cc: Administrator, Region III, USNRC
Project Manager, Point Beach Nuclear Plant, USNRC
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ENCLOSURE

ANNUAL MONITORING REPORT 2016

NEXTERA ENERGY POINT BEACH, LLC
POINT BEACH NUCLEAR PLANT

DOCKETS 50-266 (UNIT 1), 50-301 (UNIT 2), 72-005 (ISFSI)
RENEWED LICENSES DPR-24 and DPR-27

January 1, 2016 through December 31, 2016

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SUMMARY

The Annual Monitoring Report for the period from January 1, 2016, through December 31, 2016, is submitted in accordance with Point Beach Nuclear Plant (PBNP) Units 1 and 2, Technical Specification 5.6.2 and filed under Dockets 50-266 and 50-301 for Renewed Facility Operating Licenses DPR-24 and DPR-27, respectively. It also contains results of monitoring in support of the Independent Spent Fuel Storage Installation (ISFSI) Docket 72-005. The report presents the results of effluent and environmental monitoring programs, solid waste shipments, non-radioactive chemical releases, and circulating water system operation.

During 2016, the following Curies (Ci) of radioactive material were released via the liquid and atmospheric pathways:

	Liquid	Atmospheric
Tritium (Ci)	518	64.4
[1]Particulate (Ci)	0.0998	0.0000882
Noble Gas (Ci)	(-)	0.582
C-14[2]	0.0243	11.73

(-)Noble gases in the liquids are added to the atmospheric release totals.
[1]Atmospheric particulate includes radioiodine (I-131 - I-133).
[2]Liquid is measured, atmospheric is calculated.

For the purpose of compliance with the effluent design objectives of Appendix I to 10 CFR 50, doses from effluents are calculated for the hypothetical maximally exposed individual (MEI) for each age group and compared to the Appendix I objectives. Doses less than or equal to the Appendix I values are considered to be evidence that PBNP releases are as low as reasonably achievable (ALARA) and comply with the EPA's limits in 40CFR190. The maximum annual calculated doses in millirem (mrem) or millirad (mrad) are shown below and compared to the corresponding design objectives of 10 CFR 50, Appendix I.

LIQUID RELEASES

Dose Category	Calculated Dose	Appendix I Dose	% Appendix I
Whole body dose	0.00427 mrem	6 mrem	0.071
Organ dose	0.00485 mrem	20 mrem	0.024

ATMOSPHERIC RELEASES

Dose Category	Calculated Dose	Appendix I Dose	% Appendix I
Particulate organ dose	0.0254 mrem	30 mrem	0.085
Noble gas beta air dose	0.0000802 mrad	40 mrad	0.000201
Noble gas gamma ray air dose	0.000213 mrad	20 mrad	0.00107
Noble gas dose to the skin	0.000300 mrem	30 mrem	0.00100
Noble gas dose to the whole body	0.000202 mrem	10 mrem	0.00202

The results show that during 2016, the doses from PBNP effluents were ≤0.09% of the Appendix I design objectives. This is slightly lower than the 2015 results of 0.12%. Therefore, operation of the PBNP radwaste treatment system continues to be ALARA.

A survey of land use with respect to the location of dairy cattle was made pursuant to Section 2.5 of the PBNP Environmental Manual. As in previous years, no dairy cattle were found to be grazing at the site boundary. Therefore, the assumption that cattle graze at the site boundary used in the evaluation of doses from PBNP effluents remains conservative. Of the sixteen compass sectors around PBNP, six are over Lake Michigan. A land use census (LUC) of the remaining ten sectors over land identifies any changes in the closest garden, occupied dwelling, and dairy in each sector. The 2014 LUC results confirmed the assumption that, for the purpose of calculating effluent doses, the maximally exposed person lives at the south boundary remains conservative. There is no change in that assumption for 2016.

The 2016 Radiological Environmental Monitoring Program (REMP) collected 775 individual samples for radiological analyses. Quarterly composites of weekly air particulate filters generated an additional 24 samples and quarterly composites of monthly lake water samples resulted in a further 16 samples. This yielded a total of 815 samples. The ambient radiation measurements in the vicinity of PBNP and the ISFSI were conducted using 144 sets of thermoluminescent dosimeters (TLDs).

Air monitoring from six different sites did not reveal any effect from Point Beach effluents.

Terrestrial monitoring consisting of soil, vegetation, crops, and milk found no influence from PBNP. Similarly, samples from the aquatic environment, consisting of lake and well water, and fish revealed no buildup of PBNP radionuclides released in liquid effluents. (No algae were available in 2016.) Therefore, the data show no plant effect on its environs.

Five new dry storage units were added to the ISFSI in 2016. The total number now comes to 44 dry storage casks: 16 ventilated, vertical storage casks (VSC-24) and 28 NUHOMS®, horizontally stacked storage modules. The subset of the PBNP REMP samples used to evaluate the environmental impact of the PBNP ISFSI showed no environmental impact from its operation.

The environmental monitoring conducted during 2016 confirmed that the effluent control program at PBNP ensured a minimal impact on the environment.

One-hundred-fifty-seven (157) samples were analyzed for H-3 as part of the groundwater protection program (GWPP). These samples came from drinking water wells, monitoring wells, yard drain outfalls, yard manholes, and surface water on site. Included in this number were a sump associated with the subsurface drainage system (SSD) located under the plant foundation, and four groundwater containment integrity monitoring wells located in the facades. The results show no substantial change in H-3 from previous years. Low levels of tritium continue under the plant foundation. No drinking water wells (depth >100 feet) have any detectable H-3. Tritium continues to be confined to the upper soil layer where the flow is toward the lake. Groundwater samples from wells in the vicinity of the remediated, former earthen retention pond continue to show low levels of H-3 whereas none was detectable in the wells monitoring the potential offsite tritium movement. Gamma scans of samples originating within the power block found no plant related gamma emitters.

The results of GWPP monitoring indicate no significant change from previous years.

Part A
EFFLUENT MONITORING

1.0 INTRODUCTION

The PBNP effluent monitoring program is designed to comply with federal regulations for ensuring the safe operation of PBNP with respect to releases of radioactive material to the environment and its subsequent impact on the public. Pursuant to 10 CFR 50.34a, operations should be conducted to keep the levels of radioactive material in effluents to unrestricted areas as low as reasonably achievable (ALARA). In 10 CFR 50, Appendix I, the Nuclear Regulatory Commission (NRC) provides the numerical values for what it considers to be the appropriate ALARA design objectives to which the licensee's calculated effluent doses may be compared. These doses are a small fraction of the dose limits specified by 10 CFR 20.1301 and lower than the Environmental Protection Agency (EPA) limits specified in 40 CFR 190.

10 CFR 20.1302 directs PBNP to make the appropriate surveys of radioactive materials in effluents released to unrestricted and controlled areas. Liquid wastes are monitored by inline radiation monitors as well as by isotopic analyses of samples of the waste stream prior to discharge from PBNP. Airborne releases of radioactive wastes are monitored in a similar manner. The appropriate portions of the radwaste treatment systems are used as required to keep both liquid and atmospheric releases ALARA. Prior to release, results of isotopic analyses are used to adjust the release rate of discrete volumes of liquid and atmospheric wastes (from liquid waste holdup tanks and from gas decay tanks) such that the concentrations of radioactive material in the air and water beyond PBNP are below the PBNP Technical Specification concentration limits for liquid effluents and release rate limits for gaseous effluents.

Solid wastes are shipped offsite for disposal at NRC licensed facilities. The amount of radioactivity in the solid waste is determined prior to shipment in order to determine the proper shipping configuration as regulated by the Department of Transportation and the NRC.

10 CFR 72.210 grants a general license for an Independent Spent Fuel Storage Installation (ISFSI) to all nuclear power reactor sites operating under 10 CFR 50. The annual reporting requirement pursuant to 10 CFR 72.44(d)(3) is no longer applicable. Any release of radioactive materials from the operation of the ISFSI must comply with the limits of Part 20 and Part 50 Appendix I design objectives. The dose criteria for effluents and direct radiation specified by 10 CFR 72.104 states that during normal operations and anticipated occurrences, the annual dose equivalent to any real individual beyond the controlled area must not exceed 25 mrem to the whole body, 75 mrem to the thyroid, and 25 mrem to any other organ. The dose from naturally occurring radon and its decay products are exempt. Because the loading of the storage casks occurs within the primary auxiliary building of PBNP, the doses from effluents due to the loading process will be assessed and quantified as part of the PBNP Radiological Effluent Control Program.

2.0 RADIOACTIVE LIQUID RELEASES

The radioactive liquid release path to the environment is via the circulating water discharge. A liquid waste treatment system in conjunction with administrative controls is used to minimize the impact on the environment and maintain doses to the public ALARA from the liquid releases.

2.1 Doses From Liquid Effluent

Doses from liquid effluent are calculated using the methodology of the Offsite Dose Calculation Manual (ODCM). These calculated doses use parameters such as the amount of radioactive material released, the total volume of liquid, the total volume of dilution water, and usage factors (e.g., water and fish consumption, shoreline and swimming factors). These calculations produce a conservative estimation of the dose. For compliance with 10 CFR 50, Appendix I design objectives, the annual dose is calculated to the hypothetical maximally exposed individual (MEI). The MEI is assumed to reside at the site boundary in the highest χ/Q sector and is maximized with respect to occupancy, food consumption, and other uses of this area. As such, the MEI represents an individual with reasonable deviations from the average for the general population in the vicinity of PBNP. A comparison of the calculated doses to the 10 CFR 50, Appendix I design objectives is presented in Table 2-1. The conservatively calculated dose to the MEI is a very small fraction of the Appendix I design objective.

Table 2-1
Comparison of 2016 Liquid Effluent Calculated Doses to 10 CFR 50 Appendix I Design Objectives

Annual Limit [mrem]	Highest Total Calculated Dose [mrem]	% of Design Objective
6 (whole body)	0.00427	0.0712 %
20 (any organ)	0.00485	0.0243 %

2.2 2016 Circulating Water Radionuclide Release Summary

Radioactive liquid releases via the circulating water discharge are summarized by individual source and total curies released on a monthly basis semi-annual and annual totals (Table 2-2). These releases are composed of processed waste, wastewater effluent, and blowdown from Units 1 and 2. The wastewater effluent consists of liquid from turbine hall sumps, plant well house backwashes, sewage treatment plant effluent, water treatment plant backwashes, the Unit 1 and 2 facade sumps and the subsurface drainage system sump.

2.3 2016 Isotopic Composition of Circulating Water Discharges

The isotopic composition of circulating water discharges during the current reporting period is presented in Table 2-3. The noble gases released in liquids are reported with the airborne releases in Section 3.

The 2016 processed waste volume (Table 2-2) increased about 14% from 2015 (6.94E+05 to 7.92E+05 gallons). There was also an increase in the total isotopic curie distribution of gamma emitters plus hard-to-detects (Co-57/58/60, Cr-51, Fe-59, Fe-55, Ni-63, Tc-99) from 5.16E-02 Ci to 9.98E-02 Ci. The total Sb-122/124/125 increased from 6.56E-04 Ci to 1.30E-02 Ci. These increases are attributable to the months of March – May during which the spring outage occurred. Impacting the antimony increase was the bypassing of Sb specific resin beds. In early 2016 high conductivity attributed to groundwater intrusion was found in the façade sumps which were being processed by ALPS. Based on the high conductivity, some resin beds were bypassed from April to October. The tin isotopes Sn-113/117m decreased from 4.67E-03 to 2.64E-03 Ci. The other months are not much different than 2015. The 2016 C-14 increased to 2.43E-02 Ci from 1.97E-02 Ci in 2015. As in 2013 - 2015, no Sr-89 was detected in liquids during 2016. However, 3 µCi of Sr-90 were detected in processed waste for 2016. The Sr-90 occurred only in the month of April. None was found in 2013 – 2015. Again, this coincides with the spring outage. H-3 decreased from 866 Ci in 2015 to 518 Ci in 2016. Even though H-3 decreased by 40%, it continues to be the major radionuclide released via liquid discharges.

2.4 Beach Drain System Releases Tritium Summary

Beach drain is the term used to describe the point at which the site yard drainage system empties onto the beach of Lake Michigan. Six of these outfalls carry yard and roof drain runoff to the beach. A seventh outfall drains a small portion of the grassy area on top of the bluff overlooking the lake.

The plant foundation has a subsurface drainage system (SSD) around the external base of the foundation. This SSD relieves hydrostatic pressure on the foundation by draining water away from the foundation. The drainage pipes empty out onto the beach. In 2016, the SSD outfalls, designated as S-12 and S-13, were added to the beach drain sampling program. Their quarterly results are presented with the other beach drains.

The quarterly results from the monthly beach drain and SSD samples are presented in Table 2-4. The total monthly flow is calculated assuming that the flow rate at the time of sampling persists for the whole month. In 2016, no tritium was observed at the effluent LLDs. H-3 found in the beach drains is not included in the effluent totals unless it can be shown to be the result of a spill or similar event. Because the source of beach drain H-3 has been determined to be recapture, including beach drain H-3 in the effluent totals would be double counting (NRC RIS 2008-03, Return/re-use of previously discharged radioactive effluents).

The principle source of water for the beach drains is the yard drain system. Yard drain water sources are rain and snow melt containing recaptured H-3. During the winter natural melting is the principle source. (In the past, runoff has been enhanced by the use of snow melting machines where the melt water is emptied into the yard drains. [See Section 14.2 for further discussion.]) Additionally, various roof drains connect to the yard drain system. In addition to precipitation, the roof drains also carry condensate from various building AC

units. A secondary source may be groundwater in leakage. This is evidenced by flow during periods of no precipitation.

Because there are no external storage tanks or piping that carries radioactive liquids, the main source of radioactivity for this system is recapture/washout of airborne H-3 discharges via the yard drain system. Because of these various recapture sources, the beach drains also are sampled as part of the groundwater monitoring program. These results and other groundwater monitoring results are presented in Part D of this Annual Monitoring Report.

Table 2-2
Summary of Circulating Water Discharge
January 1, 2016 through December 31, 2016

	Jan	Feb	Mar	Apr	May	Jun	Total Jan-Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual Total
Total Activity Released (Ci)														
Gamma Scan(+HTDs)[1]	9.81E-04	5.48E-03	1.72E-03	4.06E-02	5.76E-03	3.15E-03	5.77E-02	2.40E-03	2.97E-03	7.40E-04	8.33E-04	1.93E-02	1.59E-02	9.98E-02
Gross Alpha	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Tritium	4.99E+01	3.14E+01	2.76E+01	2.59E+01	3.29E+01	1.87E+00	1.70E+02	2.87E+01	5.65E+01	5.51E+00	5.92E+00	7.88E+01	1.73E+02	5.18E+02
Strontium (89/90/92)	0.00E+00	0.00E+00	0.00E+00	3.04E-06	0.00E+00	0.00E+00	3.04E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.04E-06
Total Vol Released (gal)														
Processed Waste	7.64E+04	6.64E+04	1.33E+05	1.52E+05	4.10E+04	3.32E+04	5.02E+05	7.27E+04	3.85E+04	3.81E+04	3.02E+04	3.93E+04	7.15E+04	7.92E+05
Waste Water Effluent[2]	3.01E+06	2.75E+06	3.05E+06	2.99E+06	2.78E+06	2.49E+06	1.71E+07	2.73E+06	2.60E+06	2.74E+06	3.00E+06	2.77E+06	3.16E+06	3.41E+07
U1 SG Blowdown	2.70E+06	2.62E+06	1.04E+06	4.04E+06	3.59E+06	2.59E+06	1.66E+07	3.17E+06	2.74E+06	2.59E+06	2.70E+06	2.51E+06	2.67E+06	3.30E+07
U2 SG Blowdown	2.66E+06	2.51E+06	2.72E+06	2.56E+06	3.16E+06	2.59E+06	1.62E+07	2.61E+06	2.74E+06	2.53E+06	2.64E+06	2.62E+06	2.75E+06	3.21E+07
Total Gallons	8.45E+06	7.94E+06	6.95E+06	9.74E+06	9.57E+06	7.71E+06	5.04E+07	8.58E+06	8.11E+06	7.90E+06	8.36E+06	7.94E+06	8.65E+06	9.99E+07
Total cc	3.20E+10	3.01E+10	2.63E+10	3.69E+10	3.62E+10	2.92E+10	1.91E+11	3.25E+10	3.07E+10	2.99E+10	3.17E+10	3.01E+10	3.27E+10	3.78E+11
Dilution vol(cc)[3]	7.99E+13	7.40E+13	5.61E+13	1.13E+14	1.20E+14	1.20E+14	5.63E+14	1.26E+14	1.26E+14	1.22E+14	1.25E+14	1.19E+14	1.01E+14	1.28E+15
Avg diluted discharge conc (µCi/cc)														
Gamma Scan (+HTDs)[1]	1.23E-11	5.48E-03	1.72E-03	3.59E-10	4.80E-11	2.63E-11		1.91E-11	2.36E-11	6.08E-12	6.65E-12	1.62E-10	1.57E-10	
Gross Alpha	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Tritium	6.24E-07	4.25E-07	4.93E-07	2.29E-07	2.75E-07	1.56E-08		2.28E-07	4.49E-07	4.53E-08	4.73E-08	6.61E-07	1.71E-06	
Strontium (89/90/92)	0.00E+00	0.00E+00	0.00E+00	2.69E-14	0.00E+00	0.00E+00		0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Max Batch Discharge Conc (µCi/cc)														
Tritium	3.10E-05	1.45E-05	2.04E-05	4.78E-06	2.14E-05	8.52E-07		4.30E-05	2.68E-05	1.94E-06	1.96E-06	3.71E-05	2.84E-05	
Gamma Scan	4.82E-10	4.91E-10	1.68E-09	1.02E-08	2.13E-09	9.63E-10		1.57E-09	3.83E-10	8.25E-11	2.40E-11	2.11E-10	1.05E-10	

1 HTDs include Fe-55, C-14, Ni-63, and Tc-99. Does not include strontium which is totaled separately.
2 The waste water effluent system replaced the Retention Pond which was taken out of service in September 2002.
3 Circulating water discharge from both units.
Note: Dissolved noble gases detected in liquid effluents (e.g., Xe-133, Xe-135, etc.) are added to the atmospheric release summaries

Table 2-3
Isotopic Composition of Circulating Water Discharges (Ci)
January, 2016 through December 31, 2016

Nuclide	Jan	Feb	Mar	Apr	May	Jun	Total Jan-Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total Jan-Dec
H-3	4.99E+01	3.14E+01	2.76E+01	2.59E+01	3.29E+01	1.87E+00	1.70E+02	2.87E+01	5.65E+01	5.51E+00	5.92E+00	7.88E+01	1.73E+02	5.18E+02
C-14	1.99E-05	4.53E-03	6.55E-05	1.78E-04	4.66E-04	0.00E+00	5.26E-03	0.00E+00	1.60E-03	0.00E+00	0.00E+00	3.12E-03	1.43E-02	2.43E-02
Cr-51	0.00E+00	0.00E+00	2.39E-05	6.21E-03	0.00E+00	0.00E+00	6.23E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.23E-03
Mn-54	0.00E+00	0.00E+00	0.00E+00	1.08E-04	0.00E+00	0.00E+00	1.08E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E-04
Fe-55	0.00E+00	0.00E+00	0.00E+00	1.61E-03	0.00E+00	1.89E-04	1.80E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.80E-03
Fe-59	0.00E+00	0.00E+00	0.00E+00	5.37E-04	0.00E+00	0.00E+00	5.37E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.37E-04
Co-57	0.00E+00	0.00E+00	0.00E+00	2.86E-05	0.00E+00	2.46E-06	3.11E-05	0.00E+00	1.31E-06	0.00E+00	0.00E+00	1.60E-06	0.00E+00	3.40E-05
Co-58	9.91E-05	1.17E-04	3.76E-04	1.71E-02	1.53E-03	3.11E-04	1.95E-02	4.32E-04	2.47E-04	1.60E-05	1.88E-05	1.64E-04	6.13E-05	2.05E-02
Co-60	1.74E-04	2.52E-04	3.24E-04	2.16E-03	1.58E-04	5.40E-05	3.12E-03	4.49E-05	4.91E-05	7.82E-06	1.00E-05	6.96E-05	7.39E-05	3.38E-03
Ni-63	4.91E-05	5.03E-05	0.00E+00	7.47E-04	4.66E-04	3.02E-04	1.61E-03	1.60E-04	1.01E-04	3.32E-04	3.65E-04	3.57E-04	5.41E-04	3.47E-03
Zn-65	0.00E+00	0.00E+00	0.00E+00	9.23E-06	0.00E+00	0.00E+00	9.23E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.23E-06
As-76	0.00E+00	0.00E+00	4.90E-06	3.15E-04	0.00E+00	0.00E+00	3.20E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.20E-04
Sr-90	0.00E+00	0.00E+00	0.00E+00	3.04E-06	0.00E+00	0.00E+00	3.04E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.04E-06
Nb-95	1.53E-05	1.15E-05	3.26E-05	1.16E-03	2.12E-05	0.00E+00	1.24E-03	4.72E-06	5.02E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.25E-03
Nb-97	0.00E+00	0.00E+00	0.00E+00	4.93E-04	0.00E+00	0.00E+00	4.93E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.93E-04
Zr-95	0.00E+00	0.00E+00	4.42E-06	7.29E-04	3.81E-06	0.00E+00	7.37E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.37E-04
Tc-99	4.34E-05	1.01E-05	0.00E+00	1.55E-05	5.43E-06	3.52E-06	7.80E-05	4.41E-06	3.35E-06	1.88E-05	0.00E+00	8.03E-06	1.41E-05	1.27E-04
Ag-110m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.40E-06	0.00E+00	7.40E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.40E-06
Sn-113	0.00E+00	0.00E+00	7.52E-06	2.17E-04	4.07E-06	0.00E+00	2.29E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.29E-04
Sn-117m	3.13E-04	3.45E-04	5.33E-04	1.02E-03	8.51E-05	0.00E+00	2.30E-03	3.12E-05	4.08E-05	0.00E+00	0.00E+00	2.06E-05	2.16E-05	2.41E-03
Sb-122	0.00E+00	0.00E+00	0.00E+00	2.84E-04	4.42E-06	0.00E+00	2.88E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.88E-04
Sb-124	0.00E+00	6.05E-07	0.00E+00	1.49E-03	2.88E-04	1.94E-04	1.97E-03	1.87E-04	6.52E-05	4.17E-06	0.00E+00	6.49E-06	0.00E+00	2.24E-03
Sb-125	6.12E-05	1.66E-04	3.37E-04	5.66E-03	1.11E-03	1.29E-03	8.62E-03	8.12E-04	3.54E-04	3.80E-05	1.51E-05	2.22E-04	4.00E-04	1.05E-02
I-131	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.48E-05	0.00E+00	1.48E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.48E-05
I-132	0.00E+00	0.00E+00	7.09E-06	0.00E+00	0.00E+00	0.00E+00	7.09E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.09E-06
Te-132	0.00E+00	0.00E+00	9.20E-06	0.00E+00	0.00E+00	0.00E+00	9.20E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.20E-06
Cs-137	0.00E+00	0.00E+00	0.00E+00	2.04E-04	6.69E-05	2.25E-06	2.73E-04	2.72E-05	2.50E-06	4.14E-06	0.00E+00	0.00E+00	0.00E+00	3.07E-04
Ba-140	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
La-140	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Ce-141	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Note: The dissolved noble gases detected in liquid effluents (e.g., Xe-133, Xe-135, etc.) are added to the atmospheric release summaries. "-" = no analysis

Table 2-4
Subsoil System Drains - Tritium Summary
January 1, 2016, through December 31, 2016

	S-1	S-3	S-7	S-8	S-9	S-10	S-11	S-12	S-13
1st Qtr									
H-3 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Flow (gal)	1.34E+05	1.79E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.12E+04	0.00E+00	0.00E+00
2nd Qtr									
H-3 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Flow (gal)	1.46E+06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
3rd Qtr									
H-3 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Flow (gal)	9.81E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.08E+04	0.00E+00
4th Qtr									
H-3 (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Flow (gal)	5.58E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

2.6 Land Application of Sewage Sludge and Wastewater

In 1988, pursuant to 10 CFR 20.302(a), Point Beach received NRC approval for the disposal of sewage sludge, which may contain trace amounts of radionuclides, by land application on acreage within the site. Land application of sewage sludge is regulated by the Wisconsin Department of Natural Resources. Point Beach has not land applied sewage sludge for over a decade. Therefore, Point Beach has not renewed its WI DNR permit to dispose of sewage sludge in this manner.

There were no sludge or equalization basin disposals by land application during 2016. All disposals from the PBNP sewage treatment plant (STP) were done at the Manitowoc Sewage Treatment Plant. A total of 123,900 gallons in 18 shipments were made to Manitowoc. All but two sludge and equalization basin discharges were analyzed to environmental LLDs. Those two were analyzed to effluent LLDs. Naturally occurring radionuclides were present in all samples. For the 16 shipments in 2016 the total Ra-226 and K-40 were 74.4 µCi and 64.8 µCi, respectively. Small concentrations of H-3 (151 – 295 pCi/l) were found in nine of the shipments for a total of 44.9 µCi. Based on the daily flow at the Manitowoc plant, the H-3 discharge concentration would be on the order on 0.2 pCi/L or 100,000 times lower than the EPA drinking water limit of 20,000 pCi/L

The H-3 concentrations in the STP are comparable to those found in the ground water in-leakage of the electrical vaults (Z-65 to Z-68). The STP H-3 is attributable to groundwater in-leakage at the STP lift station whose volume is known to increase after a heavy rain or snow melt event.

2.7 Carbon-14

Carbon-14 (C-14) is a naturally occurring radionuclide. Nuclear weapons testing of the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. Small amounts of C-14 also are produced by nuclear reactors, but the amounts produced are less than C-14 produced by weapons testing or that occurs naturally. Based on information from the NRC obtained at industry sponsored workshops, NextEra Point Beach began evaluating C-14 liquid discharges in 2009, prior to the issuance of Regulatory Guide 1.21 [RG 1.21], Rev 2 in June of 2009. Point Beach continues to analyze batch liquid waste discharges for C-14 and reporting the results in the Annual Monitoring Report.

The NRC requested that all nuclear plants report C-14 emissions beginning with the 2010 monitoring reports. Pursuant to NRC guidance in RG 1.21(Rev 2), evaluation of C-14 in liquid wastes is not required because the quantity released via this pathway is much less than that contributed by gaseous emissions. However, as stated above, Point Beach began C-14 analyses and reporting prior to the issuance of RG 1.21 (Rev 2). RG 1.21 states that a radionuclide is a principal effluent component if it contributes greater than 1% of the Appendix I design objective dose compared to the other radionuclides in the effluent type, or, if it is greater than 1% of the activity of all radionuclides in the effluent type. In this case, C-14 is compared to other (non-tritium or noble gases) radionuclides discharged in liquids.

For 2016, the monthly and total C-14 (2.43E-02 Ci) in liquid discharges is documented in Table 2-3. The amount of C-14 released makes up about 25% of the non-tritium radionuclides released in liquids (2.43E-02/9.92E-02).

The liquid C-14 dose contribution is included in the doses calculated for the hypothetically, maximally exposed individual (Table 2-1). Under the parameters and pathways used for the dose calculations, there is no C-14 dose contribution to the infant age group. For the remaining age groups, the C-14 contributes roughly 60% of the bone dose and 2.3 – 4.3% of the dose to the whole body and to other organs specified in RG 1.109.

3.0 RADIOACTIVE AIRBORNE RELEASES

The release paths to the environment contributing to radioactive airborne release totals during this reporting period were the auxiliary building vent stack, the drumming area vent stack, the letdown gas stripper, the Unit 1 containment purge stack, and the Unit 2 containment purge stack. A gaseous radioactive effluent treatment system in conjunction with administrative controls is used to minimize the impact on the environment from the airborne releases and maintain doses to the public ALARA.

3.1 Doses from Airborne Effluent

Doses from airborne effluent are calculated for the maximum exposed individual (MEI) following the methodology contained in the PBNP ODCM. These calculated doses use parameters such as the amount of radioactive material released, the concentration at and beyond the site boundary, the average site weather conditions, and usage factors (e.g., breathing rates, food consumption). In addition to the MEI doses, the energy deposited in the air by noble gas beta particles and gamma rays is calculated and compared to the corresponding Appendix I design objectives. A comparison of the annual Appendix I design objectives for atmospheric effluents to the highest organ dose and the noble gas doses calculated using ODCM methodology is listed in Table 3-1. C-14 is not included in the Appendix I calculations because it is not an Appendix I radionuclide. The C-14 dose calculation has been required since 2010 (see Sections 3.4 through 3.6, below, for a more detailed description) and is treated separately. The comparison between airborne effluent doses with and without C-14 is shown in Table 3-4. The highest Appendix I dose is the child age group for the liver, thyroid, and GI-LLI at 2.54E-02 mrem. Had C-14 been included, the child-bone dose would have been the highest at 2.41E-01 mrem. Even with the inclusion of C-14 the doses demonstrate that releases from PBNP to the atmosphere continue to be ALARA at 0.8% dose objective.

3.2 Radioactive Airborne Release Summary

Radioactivity released in airborne effluents for 2016 is summarized in Table 3-2. The particulate total is slightly higher in 2016 than in 2015 (8.82E-05 Ci vs. 6.89E-05 Ci). H-3 decreased from 80.1 to 64.4 Ci. Noble gases decreased from 8.26E-01 to 5.82E-01Ci.

The noble gas totals include the amount resulting from a leaking GDT valve on November 10-11. Based on measured concentrations and a 1.06 cfm leak rate, this event contributed 2.74E-03 Ci of Xe-133, 2.51E-05 Ci of Xe-133m, and 2.76E-05 Ci of Xe-135. No other noble gases were detected. Event documented in AR02168794 and included in the November monthly effluents.

3.3 Isotopic Airborne Releases

The monthly isotopic airborne releases for 2016, from which the airborne doses were calculated, are presented in Table 3-3. Carbon-14 is not included in Table 3-3 because it was calculated and not measured. C-14 is discussed in the following sections.

As in 2015, in 2016 the outage impact of the isotopic mixture is demonstrated in the comparison of the March particulate releases. During March fifteen different particulates were identified in the airborne effluent whereas in the non-outage months, at most four were found. Most were released via the open hatch on the 66-foot elevation of containment. The convective flow through the open hatch during purge is unfiltered. Although the flow is into the façade, there are two circumferential gaps around the façade. It is assumed that the release into façade is transferred to the outside and therefore is treated as a release to the environment.

3.4 Carbon-14

C-14 is a naturally occurring radionuclide. Nuclear weapons testing of the 1950s and 1960s significantly increased the amount of C-14 in the atmosphere. Small amounts of C-14 also are produced by nuclear reactors as neutrons interact with the dissolved oxygen and nitrogen in the primary coolant. However, the amount produced by nuclear reactors is much less than that produced by weapons testing or that occur naturally.

The NRC has requested that nuclear plants report C-14 emissions. C-14 is a hard-to-detect radionuclide. It is not a gamma emitter and must be chemically separated from the effluent stream before it can be measured. Because nuclear plants currently are not equipped to perform this type of sampling, RG 1.21 allows for calculating C-14 discharges based on fission rates.

The Electric Power Research Institute (EPRI) developed the methodology for calculating C-14 generation and releases for the nuclear industry. The results were published as Technical Report 1021106 (December 2010), "Estimation of Carbon-14 in Nuclear Power Plant Gaseous Effluents." In addition to neutron flux, the percent oxygen and nitrogen in the VCTs is used in the C-14 calculation as both gases contribute to the generation of C-14. Pursuant to NRC guidance (Regulatory Guide 1.21, Rev 2, p. 16, June 2009), most of the C-14 emissions from nuclear plant occur in the gaseous phase.

The Point Beach C-14 generation for 2016 was calculated using the EPRI guidance and the current core parameters resulting from the power uprate. The calculated amounts were 5.87 Ci for Unit 1 and 5.86 Ci for Unit 2 yielding a total of 11.73 Ci which is 0.02 Ci lower than 2015. The 2016 calculated total 11.73 Ci is roughly 500 times higher than the 2.43E-02 Ci of C-14 determined by analyses of composites from liquid waste batch discharges, steam generator blowdown, and other waste streams. The C-14 released in liquids in 2016 is the same as in 2015.

3.5 C-14 Airborne Effluent Dose Calculation

The dose from the airborne C-14 is dependent on its chemical form. The C-14 released to the atmosphere consists of both organic and inorganic species. Both the inorganic and organic C-14 contribute to the inhalation dose. Only the inorganic $^{14}CO_2$ species contributes to the dose from the ingestion of photosynthetically incorporated C-14. The organic forms such as methane, CH_4,

are not photosynthetically active. For PWRs such as PBNP most of the gaseous C-14 occurs as methane, $^{14}CH_4$, not as carbon dioxide, $^{14}CO_2$.

The amount of $^{14}CO_2$ present in the PBNP airborne effluent has not been measured. However, such measurements have been made at a comparable PWR sites similar to the PBNP design. The Ginna nuclear generating station is of similar design to PBNP. It is a Westinghouse 2-loop PWR of the same vintage as PBNP and approximately the same power (prior to the PBNP power uprate). Measurements at Ginna for 18 months in 1980 - 1981 (Kunz, "Measurement of ^{14}C Production and Discharge From the Ginna Nuclear Power Reactor," 1982) found that ten percent of the C-14 was discharged as $^{14}CO_2$. Therefore, 10% of the 11.73 Ci of the calculated C-14 for PBNP will be used in the ingestion dose calculations.

C-14 dose calculations were made using the dose factors and the methodology of Regulatory Guide 1.109. The inhalation dose was calculated using all of the C-14 calculated to be released. All the C-14 is used because whether the C-14 is in the form of $^{14}CO_2$ or one of the organic forms, such as CH_4, both would be inhaled and contribute to a lung dose.

For the other existing pathways, milk, meat, and produce, the dose depends upon the amount incorporated into biomass consumed by cattle and people: forage for cattle and produce for humans. Incorporation only occurs via photosynthesis. Photosynthesis only incorporates $^{14}CO_2$ and hence the use only of the 10% fraction of the total C-14 release for these pathways.

The airborne effluent C-14 dose calculations were made as described above. They were made for the MEI as explained in Section 2.1. This approach utilizes all the pathways that are applicable to a hypothetical person residing at the site boundary. Because C-14 is present as a gas, the pathways are milk, meat, and produce (vegetables, fruit, and grain) and the Regulatory Guide 1.109, Table E-5 usage factors applied to the calculation. As such, the resulting dose will be conservative in that the produce usage factor includes grain and fruit and these pathways do not exist in the vicinity of the point for which the C-14 doses are calculated. Furthermore, because leafy vegetables are included in the produce pathway, they are not used as a separate pathway because that would result in double accounting for leafy vegetable dose contribution.

Carbon-14 is not an Appendix I radionuclide. Therefore, airborne C-14 is not summed with the other airborne radioactive effluents for comparison of airborne effluent dose to the Appendix I dose objectives. However, the C-14 doses are presented and compared to the other radionuclide doses in Table 3-4.

3.6 C-14 Measurements

No C-14 measurements were made of PBNP airborne effluents. In 2010, C-14 was measured in crops grown on fields in the owner controlled area located in the highest χ/Q sector at the site's south boundary. One field is leased for feed corn by a dairy south of the plant. That dairy is part of the REMP. In an adjacent field soybeans are grown by another farmer. These two crops were sampled in this sector and as well as in a background location about 17 miles SW of the

plant. Based on the measurement error, there was no statistical difference between the results obtained on site in the highest χ/Q sector as compared to the background site some 17 miles away (2013 AMR, Table 10-3). These results demonstrated that the dose from C-14 in Point Beach airborne effluents should not measurably increase the C-14 dose compared to that received from naturally occurring C-14 in plants (1 mrem: NCRP Report 93, Ionizing Radiation Exposure of the Population of the United States, 1987, p.12).

Table 3-1
Comparison of 2016 Airborne Effluent Calculated Doses to 10 CFR 50 Appendix I Design Objectives

Category	Annual Appendix I Design Objective	January-December Calculated Dose	Percent of Appendix I Design Objective
Particulate	30 mrem/organ	0.0254 mrem	0.085
Noble gas	40 mrad (beta air)	0.0000802 mrad	0.000201
Noble gas	20 mrad (gamma air)	0.000213 mrad	0.00107
Noble gas	30 mrem (skin)	0.000300 mrem	0.00100
Noble gas	10 mrem (whole body)	0.000202 mrem	0.00202

Table 3-2
Radioactive Airborne Effluent Release Summary
January 1, 2016, through December 31, 2016

							Total							
	Jan	Feb	Mar	Apr	May	Jun	Jan-Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Total NG from Liq (Ci)	4.78E-03	7.87E-03	4.64E-04	1.35E-03	1.67E-04	0.00E+00	1.46E-02	9.42E-05	3.45E-04	0.00E+00	0.00E+00	5.25E-04	1.40E-03	1.70E-02
Total Noble Gas (Ci)[1]	5.42E-02	6.00E-02	5.44E-02	3.43E-02	5.84E-02	4.87E-02	3.10E-01	3.98E-02	4.30E-02	4.40E-02	4.54E-02	5.00E-02	5.00E-02	5.82E-01
Total Radioiodines (Ci)[2]	0.00E+00	0.00E+00	7.45E-05	8.51E-06	0.00E+00	0.00E+00	8.30E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.30E-05
Total Particulate (Ci)[3]	0.00E+00	0.00E+00	5.33E-05	5.14E-09	0.00E+00	0.00E+00	5.33E-05	3.49E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.82E-05
Alpha (Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Strontium(Ci)	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
All other beta + gamma (Ci)	0.00E+00	0.00E+00	5.33E-05	5.14E-09	0.00E+00	0.00E+00	5.33E-05	3.49E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	8.82E-05
Total Tritium (Ci)	4.29E+00	7.00E+00	5.04E+00	5.31E+00	5.09E+00	5.24E+00	3.20E+01	5.01E+00	4.28E+00	4.84E+00	6.58E+00	5.03E+00	6.74E+00	6.44E+01
Max NG H'rly Rel.(Ci/sec)	6.06E-08	5.81E-08	4.25E-08	7.43E-08	7.63E-08	7.44E-08		4.41E-08	6.89E-08	2.10E-07	6.70E-08	6.13E-08	7.00E-08	

[1] Total noble gas (airborne + liquid releases) and activation gas A-41. It does not include the activation gas F-18 because of its short $T_{1/2}$ and because it is not an Appendix I radionuclide.
[2] Airborne radioiodines only include I-131 and I-133. Although for dose calculations iodines are grouped with particulates, for this reporting table they are separated from the particulate group.
[3] Total Particulate is the sum of alpha, strontium, and others. It does not include radioiodines or C-14. C-14 was calculated for the year and no monthly values are available.

TABLE 3-3
Isotopic Composition of Airborne Releases
January 1, 2016 through December 31, 2016

	Jan	Feb	Mar	Apr	May	Jun	Semi-	Jul	Aug	Sep	Oct	Nov	Dec	Total
Nuclide	(Ci)	(Ci)	(Ci)	(Ci)	(Ci)	(Ci)	Annual	(Ci)	(Ci)	(Ci)	(Ci)	(Ci)	(Ci)	(Ci)
H-3	4.29E+00	7.00E+00	5.04E+00	5.31E+00	5.09E+00	5.24E+00	3.20E+01	5.01E+00	4.28E+00	4.84E+00	6.58E+00	5.03E+00	6.74E+00	6.44E+01
Ar-41	4.85E-02	4.29E-02	2.81E-02	2.98E-02	4.55E-02	4.16E-02	2.36E-01	3.85E-02	4.16E-02	3.84E-02	3.89E-02	4.16E-02	4.04E-02	4.76E-01
Kr-85	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-85m	0.00E+00	0.00E+00	2.05E-04	0.00E+00	0.00E+00	0.00E+00	2.05E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.05E-04
Kr-87	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Kr-88	0.00E+00	0.00E+00	1.23E-04	0.00E+00	0.00E+00	0.00E+00	1.23E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.23E-04
Xe-131m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-133	5.64E-03	1.69E-02	1.66E-02	4.38E-03	1.29E-02	7.10E-03	6.35E-02	1.29E-03	1.34E-03	5.62E-03	6.52E-03	8.32E-03	9.64E-03	9.62E-02
Xe-133m	5.12E-05	1.07E-04	3.59E-04	0.00E+00	0.00E+00	0.00E+00	5.17E-04	0.00E+00	0.00E+00	3.30E-05	0.00E+00	2.51E-05	0.00E+00	5.75E-04
Xe-135	5.18E-05	1.05E-04	8.99E-03	8.91E-05	0.00E+00	0.00E+00	9.23E-03	0.00E+00	2.14E-06	0.00E+00	0.00E+00	3.31E-05	0.00E+00	9.27E-03
Xe-135m	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Xe-138	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Cr-51	0.00E+00	0.00E+00	4.93E-06	0.00E+00	0.00E+00	0.00E+00	4.93E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.93E-06
Mn-54	0.00E+00	0.00E+00	3.03E-07	0.00E+00	0.00E+00	0.00E+00	3.03E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.03E-07
Fe-59	0.00E+00	0.00E+00	4.24E-07	0.00E+00	0.00E+00	0.00E+00	4.24E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.24E-07
Co-57	0.00E+00	0.00E+00	1.37E-07	0.00E+00	0.00E+00	0.00E+00	1.37E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.37E-07
Co-58	0.00E+00	0.00E+00	2.96E-05	0.00E+00	0.00E+00	0.00E+00	2.96E-05	3.49E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	6.44E-05
Co-60	0.00E+00	0.00E+00	2.66E-06	0.00E+00	0.00E+00	0.00E+00	2.66E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.66E-06
Zn-65	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Nb-95	0.00E+00	0.00E+00	4.03E-06	3.12E-09	0.00E+00	0.00E+00	4.03E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.03E-06
Zr-95	0.00E+00	0.00E+00	2.32E-06	2.02E-09	0.00E+00	0.00E+00	2.32E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.32E-06
I-131	0.00E+00	0.00E+00	1.09E-06	1.40E-06	0.00E+00	0.00E+00	2.49E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.49E-06
I-132	0.00E+00	0.00E+00	7.34E-05	0.00E+00	0.00E+00	0.00E+00	7.34E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.34E-05
I-133	0.00E+00	0.00E+00	0.00E+00	7.11E-06	0.00E+00	0.00E+00	7.11E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	7.11E-06
Sb-124	0.00E+00	0.00E+00	3.75E-07	0.00E+00	0.00E+00	0.00E+00	3.75E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.75E-07
Sb-125	0.00E+00	0.00E+00	1.99E-07	0.00E+00	0.00E+00	0.00E+00	1.99E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.99E-07
Cs-137	0.00E+00	0.00E+00	9.24E-08	0.00E+00	0.00E+00	0.00E+00	9.24E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	9.24E-08
Fe-55	0.00E+00	0.00E+00	5.02E-06	0.00E+00	0.00E+00	0.00E+00	5.02E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.02E-06
Ni-63	0.00E+00	0.00E+00	3.15E-06	0.00E+00	0.00E+00	0.00E+00	3.15E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.15E-06
Tc-99	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-89	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sr-90	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Sn-113	0.00E+00	0.00E+00	5.02E-07	0.00E+00	0.00E+00	0.00E+00	5.02E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	5.02E-07
Sn-117m	0.00E+00	0.00E+00	3.48E-07	0.00E+00	0.00E+00	0.00E+00	3.48E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	3.48E-07

Note: The Noble Gases listed above include the liquid contribution

Table 3-4
Comparison of Airborne Effluent Doses (Appendix I and C-14)

2016 Appendix I (Airborne Particulate + Tritium) Dose (mrem)

	Bone	Liver	T-WB	Thyroid	Kidney	Lung	GI-LLI	Skin
Adult	1.23E-04	1.51E-02	1.52E-02	1.52E-02	1.51E-02	1.51E-02	1.52E-02	2.12E-04
Teen	1.66E-04	1.74E-02	1.75E-02	1.74E-02	1.73E-02	1.73E-02	1.74E-02	2.12E-04
Child	2.62E-04	2.54E-02	2.55E-02	2.54E-02	2.53E-02	2.53E-02	2.54E-02	2.12E-04
Infant	7.53E-05	1.12E-02	1.13E-02	1.13E-02	1.12E-02	1.12E-02	1.12E-02	2.12E-04
Ann.Limit				3.00E+01				
% Ann Lim				8.48E-02				

2016 Carbon-14 Dose (mrem)

	Bone	Liver	T. Body	Thyroid	Kidney	Lungs	GI-LLI	Skin
Adult	6.65E-02	1.32E-02	1.32E-02	1.32E-02	1.32E-02	1.32E-02	1.32E-02	0.00E+00
Teen	1.04E-01	2.07E-02	2.07E-02	2.07E-02	2.07E-02	2.07E-02	2.07E-02	0.00E+00
Child	2.41E-01	4.80E-02	4.80E-02	4.80E-02	4.80E-02	4.80E-02	4.80E-02	0.00E+00
Infant	1.23E-01	2.60E-02	2.60E-02	2.60E-02	2.60E-02	2.60E-02	2.60E-02	0.00E+00

2016 Total Airborne Non-Noble Gas Dose [Particulate + H-3 + C-14 (mrem)]

Adult	6.66E-02	2.83E-02	2.85E-02	2.84E-02	2.83E-02	2.83E-02	2.84E-02	2.12E-04
Teen	1.04E-01	3.81E-02	3.82E-02	3.81E-02	3.81E-02	3.81E-02	3.81E-02	2.12E-04
Child	2.41E-01	7.34E-02	7.35E-02	7.35E-02	7.34E-02	7.34E-02	7.34E-02	2.12E-04
Infant	1.23E-01	3.72E-02	3.74E-02	3.74E-02	3.72E-02	3.72E-02	3.72E-02	2.12E-04

Ann.Limit	3.00E+01
% Limit	8.04E-01

The percent of limit is calculated using the highest total dose, the Child Age Group.

4.0 RADIOACTIVE SOLID WASTE SHIPMENTS

4.1 Types, Volumes, and Activity of Shipped Solid Waste

The following types, volumes, and activity of solid waste were shipped from PBNP for offsite disposal or burial during 2016. No Types C or D wastes were shipped. No irradiated fuel was shipped offsite. The volume, activity and type of waste are listed in Table 4-1.

Table 4-1
Quantities and Types of Waste Shipped from PBNP in 2016

A. Spent resins, filter sludge, evaporator bottoms, etc.	15.2 m^3	28.220 Ci
	535.1 ft^3	
B. Dry compressible waste, contaminated equipment, etc	220.2 m^3	0.299 Ci
	7776.0 ft^3	
C. Irradiated components, control rods, etc.	0.00 m^3	N/A Ci
	ft^3	
D. Other	0.0 m^3	N/A Ci
	0 ft^3	

4.2 Solid Waste Disposition

There were seven solid waste shipments from PBNP during 2016. The dates and destinations are shown in Table 4-2.

Table 4-2

2016 PBNP Radioactive Waste Shipments	
Date	**Destination**
01/06/16	Clive, Utah
01/19/16	Wampum, PA
03/02/16	Oak Ridge, TN
03/28/16	Oak Ridge, TN
04/13/16	Oak Ridge, TN
06/07/16	Clive, Utah
06/13/16	Clive, Utah

4.3 Major Nuclide Composition (by Type of Waste)

The major radionuclide content of the 2016 solid waste was determined by gamma isotopic analysis and the application of scaling factors for certain indicator radionuclides based on the measured isotopic content of representative waste stream samples. The estimated isotopic content is presented in Table 4-3. Only those radionuclides with detectable activity are listed.

Table 4-3
2016 Estimated Solid Waste Major Radionuclide Composition

TYPE A			TYPE B		
	Percent	Activity		Percent	Activity
Nuclide	Abundance	(mCi)	Nuclide	Abundance	(mCi)
Total	100.00%	2.82E+04	Total	100.00%	2.99E+02
Co-60	53.80%	1.52E+04	Co-60	44.21%	1.32E+02
Ni-63	13.11%	3.69E+03	Fe-55	27.58%	8.24E+01
Fe-55	10.61%	2.99E+03	Ni-63	6.36%	1.90E+01
Sb-125	5.82%	1.64E+03	Co-58	6.23%	1.86E+01
H-3	3.94%	1.11E+03	Sb-125	3.89%	1.16E+01
Cs-137	2.58%	7.27E+02	Cr-51	2.29%	6.86E+00
Co-58	2.32%	6.53E+02	Mn-54	1.42%	4.25E+00
Mn-54	1.90%	5.36E+02	Nb-95	1.28%	3.82E+00
Nb-95	1.45%	4.08E+02	Zr-95	1.25%	3.73E+00
Zr-95	1.16%	3.26E+02	Zn-65	1.02%	3.04E+00
Sb-124	0.97%	2.73E+02	Fe-59	0.78%	2.33E+00
Zn-65	0.51%	1.43E+02	Sb-124	0.55%	1.63E+00
Ag-110m	0.40%	1.11E+02	Ag-110m	0.42%	1.26E+00
Cr-51	0.36%	1.01E+02	Sn-113	0.38%	1.13E+00
Ce-144	0.28%	8.01E+01	Ni-59	0.36%	1.08E+00
Sn-113	0.23%	6.47E+01	Cs-137	0.35%	1.05E+00
C-14	0.16%	4.55E+01	Co-57	0.33%	9.93E-01
Sn-117m	0.15%	4.31E+01	H-3	0.32%	9.66E-01
Co-57	0.12%	3.47E+01	Nb-94	0.28%	8.33E-01
Ni-59	0.10%	2.83E+01	Ce-144	0.25%	7.38E-01
Pu-241	0.02%	6.61E+00	Tc-99	0.18%	5.53E-01
Sr-90	0.01%	3.70E+00	C-14	0.07%	2.01E-01
Am-241	0.00%	5.07E-01	Sr-90	0.05%	1.52E-01
Pu-238	0.00%	4.13E-01	Sn-117m	0.05%	1.41E-01
Cm-243	0.00%	1.75E-01	Pu-241	0.04%	1.17E-01
Pu-239	0.00%	1.63E-01	Am-241	0.02%	4.78E-02
Cm-242	0.00%	3.00E-02	Pu-239	0.01%	3.30E-02
			Pu-238	0.01%	2.94E-02
			Ru-106	0.01%	2.36E-02
			Cm-243	0.01%	1.92E-02
			Cm-242	0.00%	3.00E-03
			Pu-242	0.00%	6.24E-05
			Sr-89	0.00%	5.13E-07

5.0 NONRADIOACTIVE CHEMICAL RELEASES

5.1 Scheduled Chemical Waste Releases

Scheduled chemical waste releases to the circulating water system from January 1, 2016, to June 30, 2016, included 1.13E+04 gallons of neutralized wastewater. The wastewater contained 5.10E-01 lbs. of suspended solids and 9.91E-02 lbs. of dissolved solids.

Scheduled chemical waste releases to the circulating water system from July 1, 2016, to December 31, 2016, included 2.60+04 gallons of neutralized wastewater. The wastewater contained 1.32E+02 lbs. of suspended solids and an unknown amount of dissolved solids.

Scheduled chemical waste releases are based on the average analytical results obtained from sampling a representative number of neutralizing tanks.

5.2 Miscellaneous Chemical Waste Releases

Miscellaneous chemical waste releases from the wastewater effluent (based on effluent analyses) to the circulating water for January 1, 2016, to June 30, 2016, included 1.68E+07 gallons of clarified effluent. The wastewater contained 2.81E+03 lbs. of suspended solids.

Miscellaneous chemical waste releases from the wastewater effluent (based on effluent analyses) to the circulating water for July 1, 2016, to December 31, 2016, included 1.65E+07 gallons of clarified effluent. The wastewater contained 1.70+03 lbs. of suspended solids.

Miscellaneous chemical waste released directly to the circulating water, based on amount of chemicals used from January 1, 2016, to June 30, 2016, included 5.95E+05 lbs. of sodium bisulfite solution (2.26E+05 lbs. sodium bisulfite), 4.95E+05 lbs. of Sodium Hypochlorite Solution (6.19E+04 lbs. sodium hypochlorite), and 6.48E+03 lbs. Acti-Brom 1338 (2.92E+03 lbs. sodium bromide).

Miscellaneous chemical waste released directly to the circulating water, based on amount of chemicals used from July 1, 2016, to December 31, 2016, included 7.77E+05 lbs. of sodium bisulfite solution (2.95E+05 lbs. sodium bisulfite), 7.78E+05 lbs. Sodium Hypochlorite Solution (9.72E+04 lbs. sodium hypochlorite),and 8.81E+03 lbs. Acti-Brom 1338 (3.96E+03 lbs. sodium bromide).

6.0 CIRCULATING WATER SYSTEM OPERATION

The circulating water system operation during this reporting period for periods of plant operation is described in Table 6-1.

Table 6-1
Circulating Water System Operation for 2016

	UNIT	JAN	FEB	MAR**	APR	MAY	JUN
Average Volume Cooling Water Discharge [million gal/day]*	1	346.7	346.7	135.8	472.1	513.9	537.7
	2	346.7	346.7	354.7	542.8	525.0	542.5
Average Cooling Water Intake Temperature [°F]	1	37.6	37.3	38.3	43.4	48.1	56.8
	2	38.1	37.8	39.7	43.6	48.5	56.4
Average Cooling Water Discharge Temperature [°F]	1	70.3	69.8	64.9	60.1	69.1	73.6
	2	68.8	68.3	68.6	61.0	66.7	76.0
Average Ambient Lake Temperature [°F]		35.5	35.0	37.4	40.7	44.6	52.2

* For days with cooling water discharge flow.
**U1 outage March 11 – April 4

Table 6-1(continued)
Circulating Water System Operation for 2016

	UNIT	JUL	AUG	SEP	OCT	NOV	DEC
Average Volume Cooling* Water Discharge [million gal/day]	1	542.5	542.5	542.5	539.2	539.9	438.7
	2	548.3	548.3	548.3	548.6	526.2	442.5
Average Cooling Water Intake Temperature [°F]	1	56.0	65.2	59.6	54.3	48.4	39.8
	2	56.5	65.8	60.0	54.6	48.9	40.0
Average Cooling Water Discharge Temperature [°F]	1	75.3	84.8	79.2	74.0	67.9	65.8
	2	72.9	82.5	76.9	71.5	67.1	65.1
Average Ambient Lake Temperature [°F]		51.5	60.1	55.3	51.3	45.7	37.2

* For days with cooling water discharge flow.

Part B
Miscellaneous Reporting Requirements

7.0 ADDITIONAL REPORTING REQUIREMENTS

7.1 Revisions to the PBNP Effluent and Environmental Programs

Neither the ODCM, the RECM, nor the Environmental Manual (EM) were revised in 2016.

7.2 Interlaboratory Comparison Program

ATI Environmental, Inc, Midwest Laboratory, the analytical laboratory contracted to perform the radioanalyses of the PBNP environmental samples, participated in the Department of Energy's Mixed Analyte Performance Evaluation Program (MAPEP) as well as in the interlaboratory comparison studies administered by Environmental Resources Associates (ERA) during 2016. The ERA environmental crosscheck program replaces the Environmental Measurements Laboratory (EML) Quality Assessment Program which was discontinued. The results of these comparisons can be found in Appendix A of the attached final report for 2016, January – December 2016 from ATI Environmental Inc.

7.3 Special Circumstances

No special circumstances report regarding operation of the explosive gas monitor for the waste gas holdup system was needed during 2016.

Part C
RADIOLOGICAL ENVIRONMENTAL MONITORING

8.0 INTRODUCTION

The objective of the PBNP Radiological Environmental Monitoring Program (REMP) is to determine whether the operation of PBNP or the ISFSI has radiologically impacted the environment. To accomplish this, the REMP collects and analyzes air, water, milk, soil, vegetation (grasses, weeds, and crops), and fish samples for radionuclides and uses thermoluminescent dosimeters (TLDs) to determine the ambient radiation background. The analyses of the various environmental media provide data on measurable levels of radiation and radioactive materials in the principal pathways of environmental exposure. These measurements also serve as a check of the efficacy of PBNP effluent controls.

The REMP fulfills the requirements of 10 CFR 20.1302, PBNP General Design Criterion (GDC) 17, GDC 64 of Appendix A to 10 CFR 50, and Sections IV.B.2 and IV.B.3 of Appendix I to 10 CFR 50 for the operation of the plant. A subset of the PBNP REMP samples, consisting of air, soil and vegetation also fulfills 10 CFR 72.44(d)(2) for operation of the ISFSI. Additionally, TLDs provide the means to measure changes in the ambient environmental radiation levels at sites near the ISFSI and at the PBNP site boundary to ensure that radiation levels from the ISFSI are maintained within the dose limits of 10 CFR 72.104. Because the ISFSI is within the PBNP site boundary, radiation doses from PBNP and the ISFSI, combined, must be used to assess compliance with 10 CFR 72.122 and 40 CFR 190. Therefore, radiological environmental monitoring for the ISFSI is provided by selected sampling sites, which are part of the PBNP REMP.

For the aquatic environment, the samples include water as well as the biological integrators, such as fish and filamentous algae. Because of their migratory behavior, fish are wide area integrators. In contrast, the filamentous algae periphyton is attached to shoreline rocks and concentrate nuclides from the water flowing by their point of attachment. Grab samples of lake water provide a snapshot of radionuclide concentrations at the time the sample is taken; whereas analysis of fish and filamentous algae yield concentrations integrated over time.

The air-grass-cow-milk exposure pathway unites the terrestrial and atmospheric environments. This pathway is important because of the many dairy farms around PBNP. Therefore, the REMP includes samples of air, general grasses, and milk from the PBNP environs. An annual land use survey is made to determine whether the assumptions on the location of dairy cattle remain conservative with respect to dose calculations for PBNP effluents. The dose calculations assume that the dairy cattle are located at the south site boundary, the highest depositional sector. In addition, soil samples are collected and analyzed in order to monitor the potential for long-term buildup of radionuclides in the vicinity of PBNP.

For the measurement of ambient environmental radiation levels that may be affected by direct radiation from PBNP or by noble gas effluents, the REMP employs a series of TLDs situated around PBNP and the ISFSI.

9.0 PROGRAM DESCRIPTION

9.1 Results Reporting Convention

The vendor used by PBNP to analyze the environmental samples is directed to report analysis results as measured by a detector, which can meet the required lower limit of detection (LLD) as specified in Table 2-2 of the Environmental Manual for each sample. The report provided by the vendor (see Appendix 1) contains values, which can be either negative, positive or zero plus/minus the two sigma counting uncertainty, which provides the 95% confidence level for the measured value.

The LLD is an *a priori* concentration value that specifies the performance capability of the counting system used in the analyses of the REMP samples. The parameters for the *a priori* LLD are chosen such that only a five percent chance exists of falsely concluding a specific radionuclide is present when it is not present at the specified LLD. Based on detector efficiency and average background activity, the time needed to count the sample in order to achieve the desired LLD depends upon the sample size. Hence, the desired LLD may be achieved by adjusting various parameters. When a suite of radionuclides are required to be quantified in an environmental sample such as lake water, the count time used is that required to achieve the LLD for the radionuclide with the longest counting time. Therefore, in fulfilling the requirement for the most difficult to achieve radionuclide LLD, the probability of detecting the other radionuclides is increased because the counting time used is longer than that required to achieve the remaining radionuclide LLDs.

The REMP results in this report are reported as averages of the measurements made throughout the calendar year plus/minus the associated standard deviation. If all net sample concentrations are equal to or less than zero, the result is reported as "Not Detectable" (ND), indicating no detectable level of activity present in the sample. If any of the net sample concentrations indicate a positive result statistically greater than zero, all of the data reported are used to generate the reported statistics. Because of the statistical nature of radioactive decay, when the radionuclide of interest is not present in the sample, negative and positive results centered about zero will be seen. Excluding validly measured concentrations, whether negative or as small positive values below the LLD, artificially inflates the calculated average value. Therefore, all generated data are used to calculate the statistical values (i.e., average, standard deviation) presented in this report. The calculated average may be a negative number.

As mentioned above, radioactive decay is a statistical process which has an inherent uncertainty in the analytical result. No two measurements will yield exactly the same result. However, the results are considered equal if the results fall within a certain range based upon the statistical parameters involved in the process. The REMP analytical results are reported at the 95% confidence limit in which the true result may be two standard deviations above or below the reported result. This means that there is only a 5% chance of concluding that the identified radioactive atom is not there when it really is present in the sample. A false positive is an analytical result which statistically shows that the radionuclide is present in the sample when it really is not there. Typically, if the 95%

confidence interval for a positive does not include zero, the radionuclide is considered to be present. For example, the result is reported as 100 ± 90. One hundred minus 90 yields a positive result and therefore may be considered to be present. However, this may be a false positive. If the radionuclide was not in the plant effluent, this result would fall into that category which 5% of the time it is falsely concluded that the radionuclide is present when in actuality it is not. This usually happens at low concentrations at or near the LLD where fluctuations in the background during the counting process skew the results to produce a positive result.

In interpreting the data, effects due to the plant must be distinguished from those due to other sources. A key interpretive aid in assessment of these effects is the design of the PBNP REMP, which is based upon the indicator-control concept. Most types of samples are collected at both indicator locations and at control locations. A plant effect would be indicated if the radiation level at an indicator location was significantly larger than that at the control location. The difference would have to be greater than could be accounted for by typical fluctuation in radiation levels arising from other sources.

9.2 Sampling Parameters

Samples are collected and analyzed at the frequency indicated in Table 9-1 from the locations described in Table 9-2 and shown in Figures 9-1, 9-2 and 9-3. (The latter two figures show sampling locations not shown in preceding figures due to space limitations. The location of the former retention pond, retired and remediated to NRC unrestricted access criteria, is indicated in Figure 9-3). The list of PBNP REMP sampling sites used to determine environmental impact around the ISFSI is found in Table 9-3. The minimum acceptable sample size is found in Table 9-4. In addition, Table 9-1 indicates the collection and analysis frequency of the ISFSI fence TLDs.

9.3 Deviations from Required Collection Frequency

Deviations from the collection frequency given in Table 9-1 are allowed because of hazardous conditions, automatic sampler malfunction, seasonal unavailability, and other legitimate reasons (Section 2.2.6 of the Environmental Manual). Table 9-5 lists the deviations from the scheduled sampling frequency that occurred during the reporting period.

9.4 Assistance to the State of Wisconsin

The Radiation Protection Unit of the Wisconsin Department of Health and Family Services maintains a radiological environmental monitoring program to confirm the results from the PBNP REMP. As a courtesy to the State of Wisconsin, PBNP personnel also collects certain environmental samples (Table 9-6) for the State from sites that are near PBNP sampling sites, or are co-located.

9.5 Program Modifications

In 2013, the placement of TLDs was reviewed with respect to the potential of trees and structures for interfering with the measurement of ambient radiation from natural background and of direct radiation from the plant and from airborne effluents. Two locations were found to have potential interferences. Two replacement TLD sites (E-16B and E-26B) were added in the 4th quarter of 2013. The new sites are in close proximity to E-16 and E-26 and were used concurrently with the old sites to provide data for comparisons between the old and new locations prior to deleting the old locations. These old sites were discontinued beginning in the second quarter of 2015. Based on the proximity of the new locations to the old locations, there was no need to revise the Environmental Manual maps.

Table 9-1
PBNP REMP Sample Analysis and Frequency

Sample Type	Sample Codes	Analyses	Frequency
Environmental Radiation Exposure	E-01, -02, -03, -04, -05 -06, -07, -08, -09, -12 -14, -15, -16, -16B, -17, -18, 20, -22, -23, -24, -25, -26, -26B, -27, -28 -29, -30, 31, -32, -38, -39,-41, -42,-43, -TC -	TLD	Quarterly
Vegetation	E-01, -02, -03, -04, -06, -08, -09, -20,	Gross Beta Gamma Isotopic Analysis	3x/yr as available
Algae	E-05, -12	Gross Beta Gamma Isotopic Analysis	3x/yr as available
Fish	E-13	Gross Beta Gamma Isotopic Analysis (Analysis of edible portions only)	3x/yr as available
Well Water	E-10	Gross Beta, H-3 Sr-89, 90, I-131 Gamma Isotopic Analysis	Quarterly
Lake Water	E-01, -05, -06, -33	Gross Beta, Sr-89/90, H-3 I-131 Gamma Isotopic Analysis	Monthly / Quarterly composite of monthly collections Monthly Monthly
Milk	E-11, -40, -21	Sr-89, 90 I-131 Gamma Isotopic Analysis	Monthly
Air Filters	E-01, -02, -03, -04, -08, -20	Gross Beta I-131 Gamma Isotopic Analysis	Weekly (particulate) Weekly (charcoal) Quarterly (on composite particulate filters)
Soil	E-01, -02, -03, -04, -06, -08, -09, -20,	Gross Beta Gamma Isotopic Analysis	2x/yr
Shoreline Sediment	E-01, -05, -06, -12, -33,	Gross Beta Gamma Isotopic Analysis	2x/yr
ISFSI Ambient Radiation Exposure	North, East, South, West Fence Sections	TLD	Quarterly

Table 9-2
PBNP REMP Sampling Locations

Location Code	Location Description
E-01	Primary Meteorological Tower South of the Plant
E-02	Site Boundary Control Center - East Side of Building
E-03	Tapawingo Road, about 0.4 Miles West of Lakeshore Road
E-04	North Boundary
E-05	Two Creeks Park
E-06	Point Beach State Park - Coast Guard Station; TLD located South of the Lighthouse on Telephone pole
E-07	WPSC Substation on County V, about 0.5 Miles West of Hwy 42
E-08	G.J. Francar Property at Southeast Corner of the Intersection of Cty. B and Zander Road
E-09	Nature Conservancy
E-10	PBNP Site Well
E-11	Dairy Farm about 3.75 Miles West of Site
E-12	Discharge Flume/Pier
E-13	Pumphouse
E-14	South Boundary, about 0.2 miles East of Site Boundary Control Center
E-15	Southwest Corner of Site
E-16, 16B	WSW, Hwy 42, a residence about 0.25 miles North of Nuclear Road
E-17	North of Mishicot, Cty. B and Assman Road, Northeast Corner of Intersection
E-18	Northwest of Two Creeks at Zander and Tannery Roads
E-20	Reference Location, 17 miles Southwest, at Silver Lake College
E-21	Local Dairy Farm just South of Site on Lakeshore and Irish Roads
E-22	West Side of Hwy 42, about 0.25 miles North of Johanek Road
E-23	Greenfield Lane, about 4.5 Miles South of Site, 0.5 Miles East of Hwy 42
E-24	North Side of County Rt. V, near intersection of Saxonburg Road
E-25	South Side of County Rt. BB, about 0.5 miles West of Norman Road
E-26, -26B	804 Tapawingo Road, about 0.4 miles East of Cty. B, North Side of Road
E-27	Intersection of Saxonburg and Nuclear Roads, Southwest Corner, about 4 Miles WSW
E-28	TLD site on western most pole between the 2nd and 3rd parking lots.
E-29	Area of North Meteorological Tower.
E-30	NE corner at Intersection of Tapawingo and Lakeshore Roads.
E-31	On utility pole North side of Tapawingo Road closest to the gate at the West property line.
E-32	On a tree located at the junction of property lines, as indicated by trees and shrubs, about 500 feet east of the west gate on Tapawingo Road and about 1200 feet south of Tapawingo Road. The location is almost under the power lines between the blue and gray transmission towers.
E-33	Lake Michigan shoreline accessed from the SE corner of KNPP parking lot. Sample South of creek.
E-38	Tree located at the West end of the area previously containing the Retention Pond.
E-39	Tree located at the East end of the area previously containing the Retention Pond.
E-40	Local Dairy Farm, W side of Hwy 42, about 1.8 miles north of the Nuclear Rd intersection
E-41	NW corner of Woodside and Nuclear Rds (Kewaunee County)
E-42	NW corner of Church and Division, East of Mishicot
E-43	West side of Tannery Rd south of Elmwood (7th pole south of Elmwood)
E-TC	Transportation Control; Reserved for TLDs

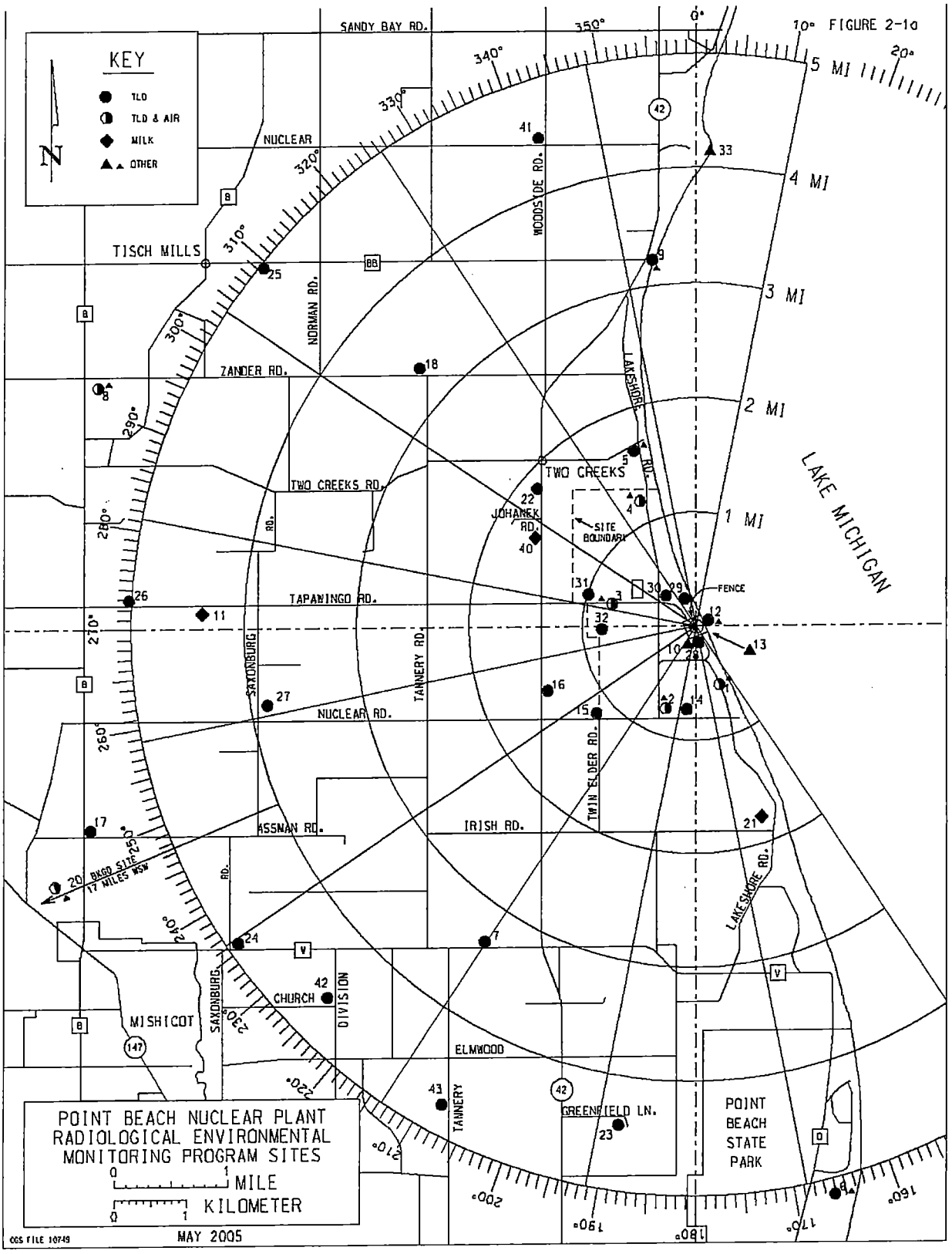


Figure 9-1
PBNP REMP Sampling Sites

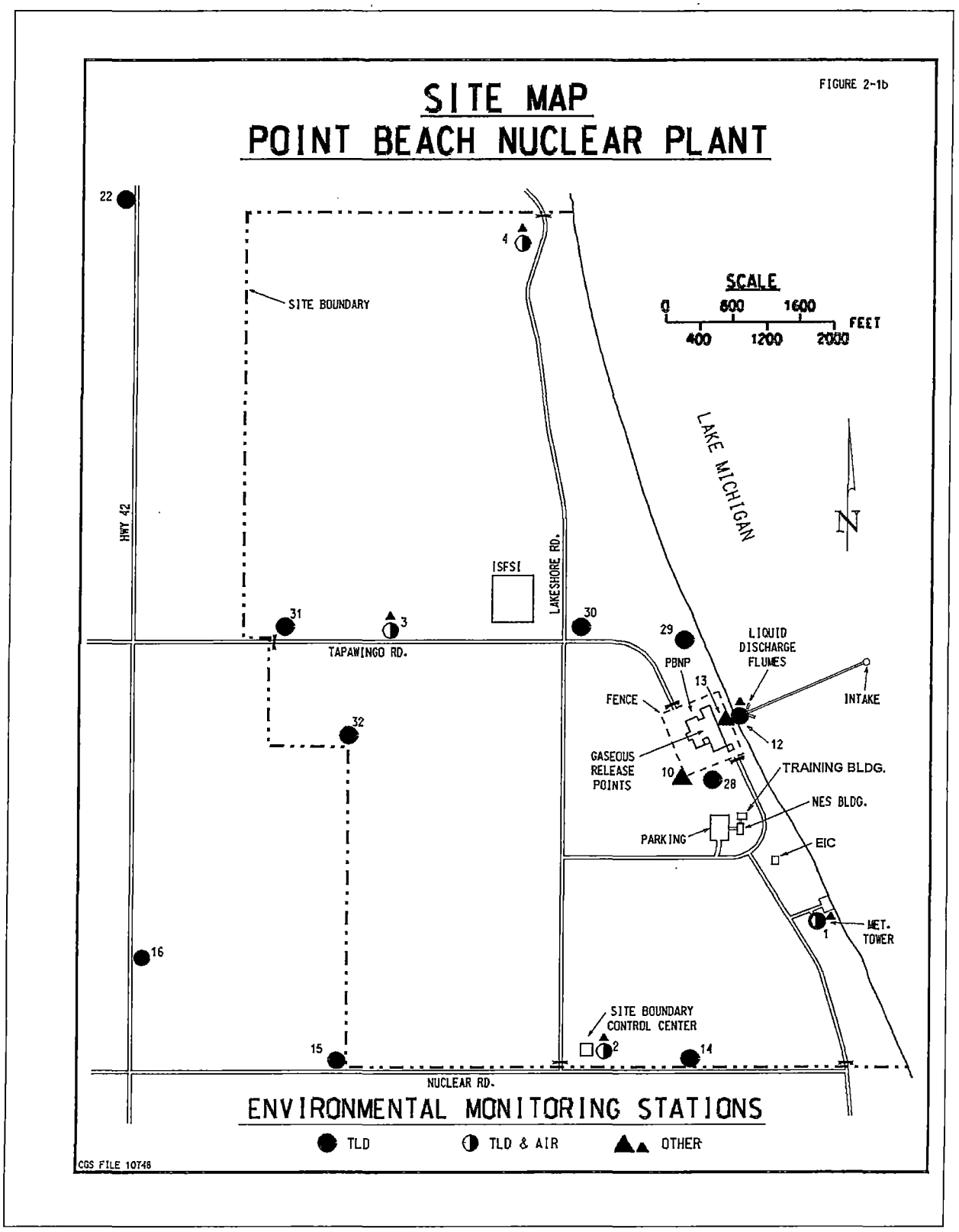


Figure 9-2
Map of REMP Sampling Sites Located Around PBNP

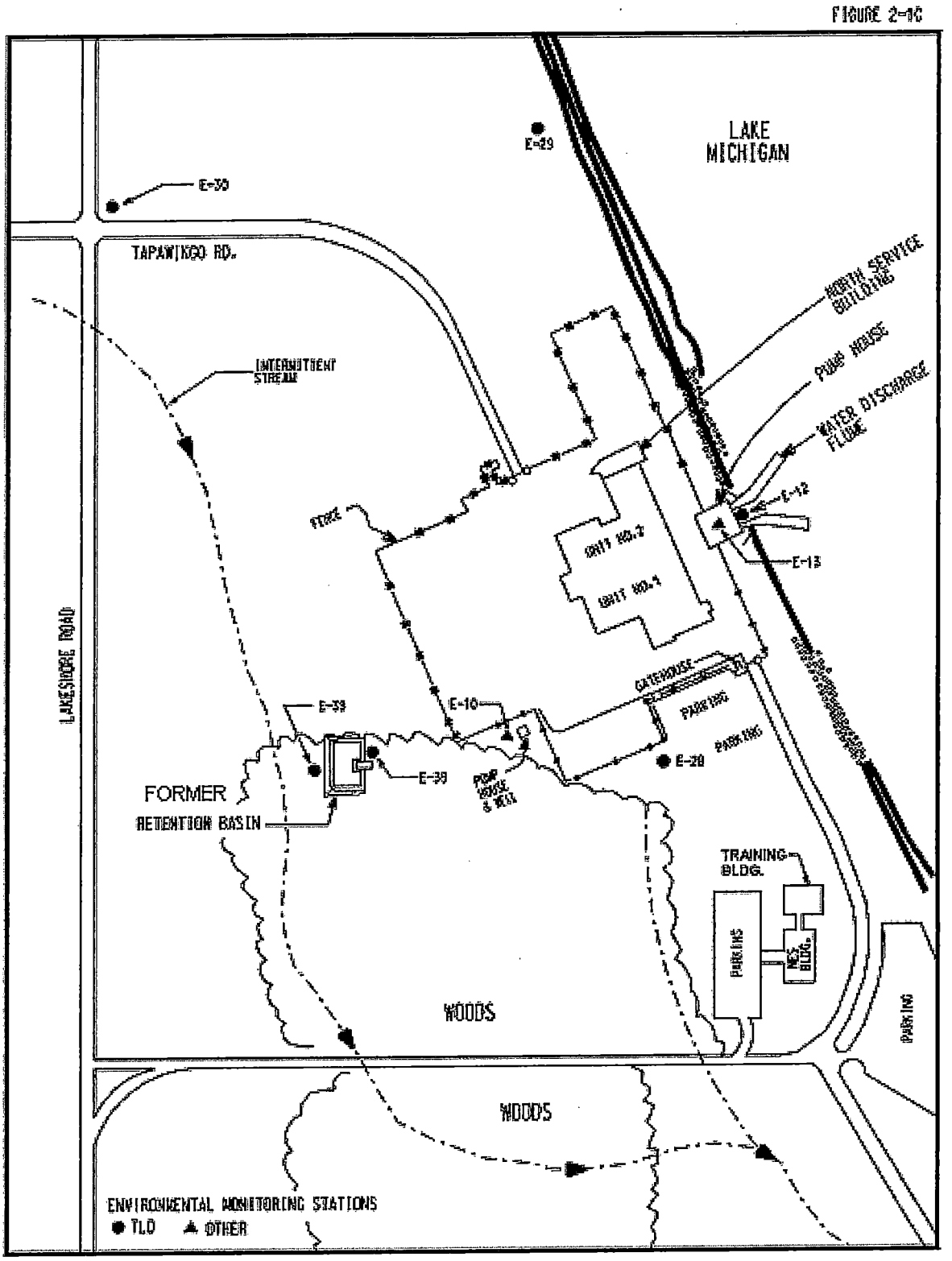


Figure 9-3
Enhanced Map Showing REMP Sampling Sites Closest to PBNP

Table 9-3
ISFSI Sampling Sites

Ambient Radiation Monitoring (TLD)	Soil, Vegetation and Airborne Monitoring
E-03	E-02
E-28	E-03
E-29	E-04
E-30	
E-31	
E-32	

Table 9-4
Minimum Acceptable Sample Size

Sample Type	**Size**
Vegetation	100-1000 grams
Lake Water	8 liters
Air Filters	250 m3 (volume of air)
Well Water	8 liters
Milk	8 liters
Algae	100-1000 grams
Fish (edible portions)	1000 grams
Soil	500-1000 grams
Shoreline Sediment	500-1000 grams

Table 9-5
Deviations from Scheduled Sampling and Frequency During 2016

Sample Type	Location	Collection Date	Reason for not conducting REMP as required	Plans for Preventing Recurrence
LW	E-05	1/13/2016	Icy conditions at the shore prevented	Nautral occurrence
LW	E-06	1/13/2016	Icy conditions at the shore prevented	Nautral occurrence
LW	E-33	1/13/2016	Icy conditions at the shore prevented	Nautral occurrence
LW	E-33	2/11/2016	Icy conditions at the shore prevented	Nautral occurrence
LW	E-01	12/31/2016	Icy conditions at the shore prevented	Nautral occurrence
LW	E-05	12/31/2016	Icy conditions at the shore prevented	Nautral occurrence
LW	E-06	12/31/2016	Icy conditions at the shore prevented	Nautral occurrence
LW	E-33	12/31/2016	Icy conditions at the shore prevented	Nautral occurrence
AP/AI	E-02	2/4/2016	GFI failure	check circuitry
AP/AI	E-01	3/30/2016	Pump failed	new pump
AP/AI	E-01	6/22/2016	Loss of power	unknown cause
AP/AI	E-04	6/22/2016	Loss of power	unknown cause
AP/AI	E-01	7/6/2016	Electrical issue with pump	checked - unknown cause
AP/AI	E-01	7/27/2016	Electrical issue with pump	checked - unknown cause
WW	GW-17	9/28/2016	no water available	Nautral occurrence
Algae	E-05, E-12	6/8/2016	No algae found growing in area	Natural occurrence
Algae	E-05, E-12	8/10/2016	No algae found growing in area	Natural occurrence
Algae	E-05, E-12	10/5/2016	No algae found growing in area	Natural occurrence

Table 9-6
Sample Collections for State of Wisconsin

Sample Type	Location	Frequency
Lake Water	E-01	Monthly
Air Filters	E-07 E-08	Weekly
Fish	E-13	Quarterly, As Available
Precipitation	E-04 E-08	Twice a month, As Available
Milk	E-11 E-21	Monthly
Well Water	E-10	Twice per year

9.6 Analytical Parameters

The types of analyses and their frequencies are given in Table 9-1. The LLDs for the various analyses are found in the Section 10 (Table 10-1) with the summary of the REMP results. All environmental LLDs listed in Table 2-2 of the Environmental Manual (also in Table 10-1) were achieved during 2016.

9.7 Description of Analytical Parameters in Table 9-1

9.7.1 Gamma isotopic analysis

Gamma isotopic analysis consists of a computerized scan of the gamma ray spectrum from 80 keV to 2048 keV. Specifically included in the scan are Mn-54, Fe-59, Co-58, Co-60, Zr-95, Nb-95, Ru-103, Ru-106, I-131, Ba-La-140, Cs-134, Cs-137, Ce-141, and Ce-144. However, other detected nuclear power plant produced radionuclides also are noted. The above radionuclides detected by gamma isotopic analysis are decay corrected to the time of collection. Frequently detected, but not normally reported in the Annual Monitoring Report, are the naturally occurring radionuclides Ra-226, Bi-214, Pb-212, Tl-208, Ac-228, Be-7, and K-40.

9.7.2 Gross Beta Analysis

Gross beta analysis is a non-specific analysis that consists of measuring the total beta activity of the sample. No individual radionuclides are identifiable by this method. Gross beta analysis is a quick method of screening samples for the presence of elevated activity that may require additional, immediate analyses.

9.7.3 Water Samples

Water samples include both Lake Michigan and well water. The Lake Michigan samples are collected along the shoreline at two locations north and two locations south of PBNP. The well water is sampled from the on-site PBNP well. Gross beta measurements are made on the solids remaining after evaporation of the unfiltered sample to dryness. Gamma isotopic analyses are performed using 1-liter liquid samples. Strontium is determined by chemical separation and beta counting.

9.7.4 Air Samples

Particulate air filters are allowed to decay at least 72 hours before gross beta measurements are made in order for naturally occurring radionuclides to become a negligible part of the total activity. Gross beta measurements serve as a quick check for any unexpected activity that may require immediate investigation. Quarterly composites of the particulate air filters are analyzed for long-lived radionuclides such as Cs-134 and Cs-137. Charcoal cartridges for radioiodine are counted as soon as possible so the I-131 will undergo only minimal decay prior to analyses. The weekly charcoal cartridges are screened for I-131 by

counting them all at the same time to achieve a lower LLD. If a positive result is obtained, each cartridge is counted individually.

In order to ensure that the air sampling pumps are operating satisfactorily, a gross leak check is performed weekly. The pumps are changed out annually for calibration and maintenance beyond what can be accomplished in the field.

9.7.5 Vegetation

Vegetation samples consist predominantly of green, growing plant material (grasses and weeds most likely to be eaten by cattle if they were present at the sampling site). Care is taken not to include dirt associated with roots by cutting the vegetation off above the soil line.

No special vegetation samples were obtained for C-14 analyses in 2016.

9.7.6 Environmental Radiation Exposure

The 2016 environmental radiation exposure measurements were made using TLD cards. The TLD card is a small passive detector, which integrates radiation exposure. Each TLD consists of a Teflon sheet coated with a crystalline, phosphorus material (calcium sulfate containing dysprosium) which absorbs the gamma ray energy deposited in them. Each TLD is read in four distinct areas to yield four exposure values which are averaged. Prior to the third quarter of 2001, exposure data was obtained using three lithium fluoride (LiF) TLD chips sealed in black plastic. The difference in material types can impact the amount of exposure measured. An evaluation of the response difference between the two types of TLD in 2001 demonstrated that the TLD cards produced a 14% higher response than the LiF chips (2011 AMR, Table 9-7, p. 36).

The reported field exposure is the arithmetic average of the measured exposure values at each location minus the exposure transportation control TLD (exposure received while the field TLD is in storage and transit). The gamma rays may originate from PBNP produced radionuclides or from naturally occurring radionuclides. The TLDs remain at the monitoring site for roughly three months prior to analyses and the results are reported as mrem per seven days. Because the TLDs are constantly bombarded by naturally occurring gamma radiation, even during shipment to and from PBNP, the amount of exposure during transportation is measured using transportation controls with each shipment of TLDs to and from the laboratory. The doses recorded on the transportation controls are subtracted from the monitoring TLDs in order to obtain the net *in situ* dose.

9.7.7 ISFSI Ambient Radiation Exposure

The ISFSI fence TLDs are part of the 10CFR72.44 monitoring and are not considered part of the REMP. However, their results can be used indirectly to determine whether the operation of the ISFSI is having an impact on the ambient environmental radiation beyond the site boundary. Impacts are determined by comparison of fence TLD results to the results of the monitoring at PBNP site boundary and other selected locations. These results are used as part of the 40CFR190 compliance demonstration.

10.0 RESULTS

10.1 Summary of 2016 REMP Results

Radiological environmental monitoring conducted at PBNP from January 1, 2016, through December 31, 2016, consisted of analysis of air filters, milk, lake water, well water, soil, fish, shoreline sediments, algae, and vegetation as well as TLDs. The results are summarized, averages and high values, in Table 10-1 which contain the following information:

Sample:	Type of the sample medium
Description:	Type of measurement
N:	Number of samples analyzed
LLD:	*a priori* lower limit of detection
Average:	Average value ± the standard deviation of N samples
High:	Highest measured value ± it's associated 2 sigma counting error
Units:	Units of measurement

For certain analyses, an LLD, which is lower than that required by REMP, is used because the lower value derives from the counting time required to obtain the LLDs for radionuclides that are more difficult to detect. For these analyses, both LLDs are listed with the tech spec required REMP LLD given in parentheses. The results are discussed in the narrative portion of this report (Section 11). Blank values have not been subtracted from the results presented in Table 10-1. A listing of all the individual results obtained from the contracted analytical laboratory and the laboratory's radioanalytical quality assurance results and Interlaboratory Crosscheck Program results are presented in the Appendix.

In Table 10-1 no results are reported as less than LLD (<LLD). All results are reported to Point Beach by the contracted radioanalytical laboratory "as measured" whether positive or negative (see Section 9-1). Based on these results, a radionuclide is considered detected if it meets the criterion that the measured value minus its 2σ counting error is greater than zero ($x-2\sigma > 0$). An "ND" entry in Table 10-1 means that for this radionuclide the criterion was not satisfied for any of the measurements. If one analysis fulfilled the criterion, then all of the reported results, both positive and negative, were used in calculating the average shown in Table 10-1.

The method of determining averages based on "as measured" results follows the recommendations made in NUREG-0475 (1978), "Radiological Environmental Monitoring by NRC Licensees for Routine Operations of Nuclear Facilities Task Force Report," and in Health Physics Society Committee Report HPSR-1 (1980) "Upgrading Environmental Radiation Data" released as document EPA 520/1-80-012 and in more recent documents such as ANSI N42.23-1996, "Instrument Quality Assurance for Radioassay Laboratories;" ANSI N13.30-1996, "Performance Criteria for Radiobioassay;" DE91-013607, "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance" and NUREG-1576, "Multi-Agency Radiological Laboratory Analytical Protocols Manual."

In addition to the required radionuclides for each medium analyzed, Table 10-1 also has an additional radionuclide listed known to originate with nuclear power plants. This radionuclide is either Co-60, Ru-103, or any other radionuclide which has the lowest LLD based on the analytical parameters needed to meet the LLDs required for radionuclides specified for the medium being analyzed. The radionuclide is identified by parentheses.

During the analyses for those radionuclides specifically required to be identified, naturally occurring radionuclides such as Ra-226, Be-7 and K-40 are detected in many samples. Their concentrations are presented in Table 10-1 for a comparison to those radionuclides for which specific analyses are required by the regulations. There are no regulatory required LLDs for naturally occurring radionuclides.

Finally, Point Beach reports the results for soil analyses. There is no regulatory requirement for soil analyses in standard RETS (NUREG-0472 and NUREG-1301). Point Beach includes soil analyses in the REMP to be able to compare current results to the historical record.

The crop sampling initiated in 2015 continued in 2016 and is incorporated into the REMP via HPIP 3.58.1. Approximately 60% of the 1260 acres (FSAR 2.1) comprising the NextERA Point Beach site is licensed to farmers who use the land to grow various crops. These crops consist of corn, hay, alfalfa, and soy beans and appear to be for cattle feed. Ten samples were obtained from the nine separate plots and gamma scanned for radionuclides representative of Point Beach effluents and for naturally occurring radionuclides. Results are reported in Table 10-2.

Table 10-3 contains the ISFSI fence TLD results.

Table 10-1
Summary of Radiological Environmental Monitoring Results for 2016

Sample	Description	N	LLD (a)	Average ± 1 Std. Deviation (b)	High ± 2 sigma	Units
TLD	Environmental Radiation	124	1 mrem	1.19 ± 0.21	1.68 ± 0.1	mR/7days
	Control (E-20)	4	1 mrem	1.29 ± 0.14	1.47 ± 0.12	mR/7days
Air	Gross Beta	253	0.01	0.023 ± 0.007	0.045 ± 0.005	pCi/m3
	Control (E-20) Gross beta	52	0.01	0.024 ± 0.007	0.047 ± 0.004	pCi/m3
	I-131	253	0.030 (0.07)	ND	-	pCi/m3
	Control (E-20) I-131	52	0.030 (0.07)	ND	-	pCi/m3
	Cs-134	20	0.01(0.05)	ND	-	pCi/m3
	Control (E-20) Cs-134	4	0.01(0.05)	ND	-	pCi/m3
	Cs-137	20	0.01(0.06)	ND	-	pCi/m3
	Control (E-20) Cs-137	4	0.01(0.06)	ND	-	pCi/m3
	Other γ emitters (Co-60)	20	0.1	ND	-	pCi/m3
	Control (E-20) Other (Co-60)	4	0.1	ND	-	pCi/m3
	Natural Be-7	20	-	0.070 ± 0.014	0.099 ± 0.017	pCi/m3
	Control (E-20) Natural Be-7	4	-	0.072 ± 0.018	0.096 ± 0.019	pCi/m3
Milk	Sr-89	36	5	ND	-	pCi/L
	Sr-90	36	1	0.6 ± 0.3	1.2 ± 0.5	pCi/L
	I-131	36	0.5	ND	-	pCi/L
	Cs-134	36	5 (15)	ND		pCi/L
	Cs-137	36	5 (18)	0.4 ± 1.0	2.2 ± 1.8	pCi/L
	Ba-La-140	36	5 (15)	-0.5 ± 1.6	3.0 ± 1.2	pCi/L
	Other gamma emitters(Co-60)	36	15	0.2 ± 1.3	3.3 ± 2.2	pCi/L
	Natural K-40	36	-	1370 ± 60	1469 ± 94	pCi/L
Well Water	Gross beta	4	4	3.4 ± 0.7	4.1 ± 1.7	pCi/L
	H-3	4	200 (3000)	ND	-	pCi/L
	Sr-89	4	5(10)	ND	-	pCi/L
	Sr-90	4	1 (2)	ND	-	pCi/L
	I-131	4	0.5 (2)	ND	-	pCi/L
	Mn-54	4	10 (15)	ND	-	pCi/L
	Fe-59	4	30	-0.1 ± 2.9	4.2 ± 3.5	pCi/L
	Co-58	4	10(15)	ND	-	pCi/L
	Co-60	4	10(15)	ND	-	pCi/L
	Zn-65	4	30	ND	-	pCi/L
	Zr-Nb-95	4	15	ND	-	pCi/L
	Cs-134	4	10(15)	0.8 ± 1.6	3.1 ± 1.8	pCi/L
	Cs-137	4	10(18)	ND	-	pCi/L
	Ba-La-140	4	15	ND	-	pCi/L
	Other gamma emitters(Ru-103)	4	30	ND	-	pCi/L
Algae	Gross beta	0	0.25	NS		pCi/g
	Co-58	0	0.25	NS		pCi/g
	Co-60	0	0.25	NS		pCi/g
	Cs-134	0	0.25	NS		pCi/g
	Cs-137	0	0.25	NS		pCi/g
	Natural Be-7	0	-	NS		pCi/g
	Natural K-40	0	-	NS		pCi/g
	NS = no sample					

Table 10-1 (continued)
Summary of Radiological Environmental Monitoring Results for 2016

Sample	Description	N	LLD (a)	Average ± 1 Std. Deviation (b)	High ± 2 sigma	Units
Lake Water	Gross beta	40	4	1.7 ± 0.7	3.2 ± 1.6	pCi/L
	I-131	40	0.5 (2)	ND	-	pCi/L
	Mn-54	40	10 (15)	0.0 ± 0.7	1.6 ± 1.3	pCi/L
	Fe-59	40	30	0.0 ± 1.9	4.1 ± 3.0	pCi/L
	Co-58	40	10(15)	0.1 ± 1.0	2.5 ± 1.7	pCi/L
	Co-60	40	10(15)	0.1 ± 1.0	2.7 ± 1.3	pCi/L
	Zn-65	40	30	ND	-	pCi/L
	Zr-Nb-95	40	15	-0.1 ± 1.0	3.2 ± 1.7	pCi/L
	Cs-134	40	10 (15)	-0.1 ± 0.8	3.5 ± 3.4	pCi/L
	Cs-137	40	10 (18)	0.1 ± 1.1	0.7 ± 0.6	pCi/L
	Ba-La-140	40	15	-1.0 ± 4.0	7.0 ± 1.4	pCi/L
	Other gamma (Ru-103)	40	30	ND	-	pCi/L
	Sr-89	16	5(10)	ND	-	pCi/L
	Sr-90	16	1 (2)	0.24 ± 0.16	0.51 ± 0.43	pCi/L
	H-3	16	200 (3000)	109 ± 69	286 ± 87	pCi/L
Fish	Gross beta	25	0.5	3.66 ± 0.49	4.89 ± 0.10	pCi/g
	Mn-54	25	0.13	0.002 ± 0.005	0.012 ± 0.011	pCi/g
	Fe-59	25	0.26	-0.003 ± 0.020	0.058 ± 0.020	pCi/g
	Co-58	25	0.13	0.001 ± 0.009	0.011 ± 0.009	pCi/g
	Co-60	25	0.13	0.001 ± 0.007	0.017 ± 0.012	pCi/g
	Zn-65	25	0.26	ND	-	pCi/g
	Cs-134	25	0.13	ND	-	pCi/g
	Cs-137	25	0.15	0.017 ± 0.015	0.077 ± 0.031	pCi/g
	Other gamma (Ru-103)	25	0.5	0.003 ± 0.008	0.028 ± 0.011	pCi/g
	Natural K-40	25	-	3.09 ± 0.34	3.66 ± 0.40	pCi/g
Shoreline Sediment	Gross beta	10	2	8.98 ± 1.62	11.60 ± 1.29	pCi/g
	Cs-134	10	0.18	-0.010 ± 0.030	0.009 ± 0.007	pCi/g
	Cs-137	10	0.15	0.010 ± 0.010	0.023 ± 0.012	pCi/g
	Natural Be-7	10	-	ND	-	pCi/g
	Natural K-40	10	-	5.81 ± 1.22	7.47 ± 0.42	pCi/g
	Natural Ra-226	10	-	0.53 ± 0.43	1.74 ± 0.38	pCi/g
Soil	Gross beta	16	2	25.37 ± 6.70	36.87 ± 1.40	pCi/g
	Cs-134	16	0.15	ND		pCi/g
	Cs-137	16	0.15	0.15 ± 0.10	0.37 ± 0.03	pCi/g
	Natural Be-7	16	-	0.088 ± 0.160	0.520 ± 0.290	pCi/g
	Natural K-40	16	-	15.23 ± 4.25	21.94 ± 0.84	pCi/g
	Natural Ra-226	16	-	1.09 ± 0.59	2.83 ± 0.34	pCi/g
Vegetation	Gross beta	24	0.25	5.92 ± 1.55	8.92 ± 0.18	pCi/g
	I-131	24	0.06	-0.001 ± 0.007	0.009 ± 0.008	pCi/g
	Cs-134	24	0.06	ND	-	pCi/g
	Cs-137	24	0.08	0.001 ± 0.005	0.017 ± 0.009	pCi/g
	Other gamma emitters (Co-60)	24	0.25	ND	-	pCi/g
	Natural Be-7	24	-	2.08 ± 1.62	5.58 ± 0.38	pCi/g
	Natural K-40	24	-	5.00 ± 1.00	6.58 ± 0.52	pCi/g

(a) When two LLD values are listed, the required LLD per the PBNP REMP is enclosed in the parentheses. Whenever possible, PBNP uses the lower value to obtain greater sensitivity.

(b) "ND" indicates that the sample result is Not Detectable, i.e., sample concentrations were statistically equal to zero or <MDA.

Table 10-2
Feed Crops Grown on Point Beach Land

	Number	Average pCi/g	±	1σ	Max pCi/g	±	2σ
Gross Beta	10	3.25	±	0.98	5.65	±	0.18
Be-7	10	0.25	±	0.51	1.27	±	0.15
K-40	10	2.66	±	1.55	6.02	±	0.41
Co-60	10	0.002	±	0.003	0.010	±	0.007
I-131	10	-0.001	±	0.010	0.015	±	0.003
Cs-134	10	ND			-		
Cs-137	10	0.002	±	0.003	0.008	±	0.006

ND = Not detected

Table 10-3
Average ISFSI Fence TLD Results for 2016

Fence Location	Average	±	Standard Deviation	Units
North	2.30	±	0.24	mR/7 days
East	3.34	±	0.31	mR/7 days
South	1.33	±	0.18	mR/7 days
West	4.35	±	0.16	mR/7 days

11.0 DISCUSSION

11.1 TLD Cards

The ambient radiation was measured in the general area of the site boundary, at an outer ring four – five miles from the plant, at special interest areas, and at one control location, roughly 17 miles southwest of the plant. The average indicator TLD is 1.19 ± 0.21 mR/7-days compared to 1.29 ± 0.14 mR/7-days at the background location. These two values are not significantly different from each other. Neither are the indicator TLD values significantly different from those observed from 2001 through 2015 for the same type of TLD (tabulated below in Table 11-1). Prior to third quarter of 2001 TLD LiF chips were used versus the current TLD cards, see Section 9.7.6 for additional information. The response difference between the two types of TLDs is evident in Table 11-1. Prior to 2001 all of the annual averages are <1 mrem/7-days. Beginning in 2001, all are >1 mrem/7-days.

Table 11-1
Average Indicator TLD Results from 1993 – 2016

Year	Average mR/7-days	±	St. Dev*
1993	0.82	±	0.15
1994	0.90	±	0.12
1995	0.87	±	0.13
1996	0.85	±	0.12
1997	0.87	±	0.11
1998	0.79	±	0.13
1999	0.79	±	0.21
2000	0.91	±	0.15
2001	1.06	±	0.19
2002	1.17	±	0.21
2003	1.10	±	0.20
2004	1.10	±	0.22
2005	1.04	±	0.21
2006	1.14	±	0.21
2007	1.08	±	0.20
2008	1.05	±	0.17
2009	1.08	±	0.17
2010	1.11	±	0.15
2011	1.14	±	0.25
2012	1.17	±	0.17
2013	1.14	±	0.20
2014	1.07	±	0.19
2015	1.18	±	0.20
2016	1.19	±	0.21

*St. Dev = Standard Deviation

Five new casks of fuel were added to the ISFSI during 2016. The west fence TLDs continue to record higher exposures followed by the east, north, and south fence locations (Table 11-2). This sequence has been observed for the last five years.

There is no significant change in the exposure on the TLD monitoring locations around the ISFSI (Table 11-3). The results at E-03 and E-31 (W of the ISFSI) and E-32 (SW of the ISFSI) are similar to previous years (1.36, 1.28, and 1.50, respectively) and continue to be higher than E-30 (1.06) on the east side and closest to the ISFSI. E-03, about equidistant between the ISFSI and the site boundary location E-31, continues to be slightly higher than the site boundary location but the difference is not statistically different. (See Figs. 9-1 and 9-2 for locations).

Table 11-2
Average ISFSI Fence TLD Results (mR/7 days)

	TLD FENCE LOCATION			
	North	East	South	West
1995	1.29	1.28	1.10	1.26
1996	2.12	1.39	1.10	1.68
1997	2.05	1.28	1.00	1.66
1998	2.08	1.37	1.02	1.86
1999	2.57	1.84	1.11	3.26
2000	2.72	2.28	1.25	5.05
2001	2.78	2.54	1.36	6.08
2002	2.79	2.74	1.42	6.46
2003	2.70	2.60	1.50	6.88
2004	2.61	2.12	1.41	6.50
2005	2.54	2.05	1.44	5.63
2006	2.73	2.35	1.38	5.80
2007	2.72	2.73	1.34	5.47
2008	2.64	2.37	1.36	5.36
2009	2.36	2.35	1.20	4.63
2010	2.64	3.02	1.41	5.05
2011	2.44	2.62	1.31	4.75
2012	2.59	3.27	1.40	4.92
2013	2.62	3.66	1.15	4.28
2014	2.45	3.35	1.14	4.24
2015	2.31	3.24	1.17	4.36
2016	2.30	3.34	1.33	4.35

Although the mR/7-day results for the three TLD locations nearest the site boundary (E-03 1.35 ± 0.26; E-31, 1.28 ± 0.22; E-32, 1.50 ± 0.37) are higher than at the background site E-20 (1.20 ± 0.29), they are comparable at the 95% confidence

level, indicating a small, but not significant, increase in ambient gamma radiation at the site boundary due to the operation of the ISFSI.

Further data supporting this conclusion is the comparison of the TLD results at selected locations around the ISFSI before and after the storage of spent fuel at the ISFSI (Figure 11-1). As stated in Section 9.7.6, the TLD values increased by about 14% in the second half of 2001 when the TLD monitoring devices were changed from LiF chips in the first half of the 2001 to calcium sulfate impregnated TLD cards. After that initial change, the measured radiation exposure, as measured by the TLD cards, has remained fairly constant with a slight increase with the addition of stored fuel at the ISFSI. Each year the variations in the TLD results appear to move in concert with each other and with the background site, E-20, which is 17 miles south west of the ISFSI.

Comparing the ISFSI TLD results to results from surrounding REMP indicator and background TLDs reveals minimal impact of the ISFSI on the surrounding radiation levels (Figure 11-2). As previously discussed, the small increase is more related to the switch from the LiF chips to the calcium sulfate impregnated Teflon TLD cards as evidenced by the synchronicity with E-20, the background site.

LiF TLD chips were replaced with calcium sulfate impregnated Teflon TLD cards in the third quarter of 2001 resulting in a higher measured background values.

Figure 11-1 ISFSI AREA TLD RESULTS

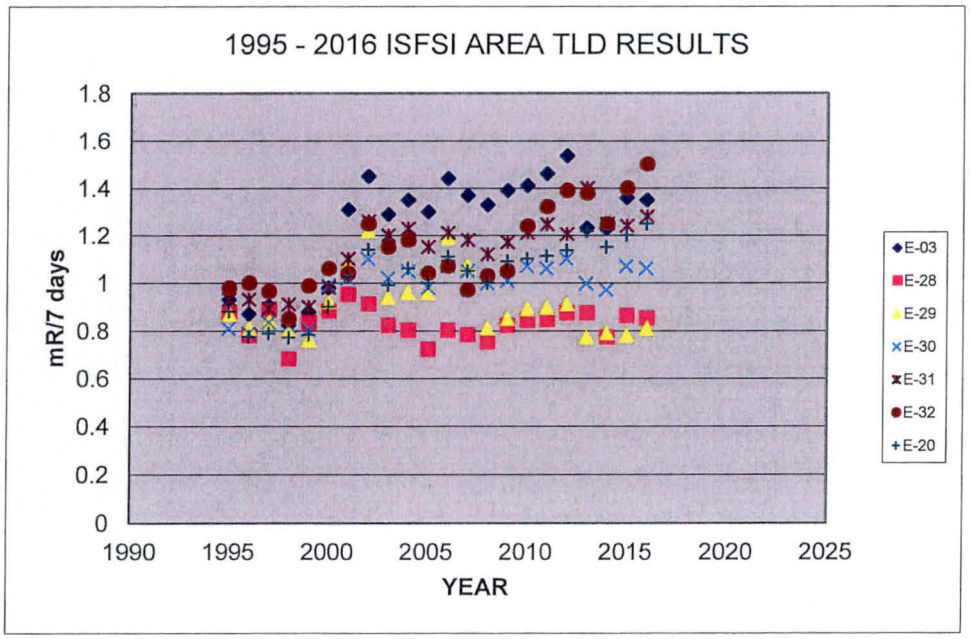
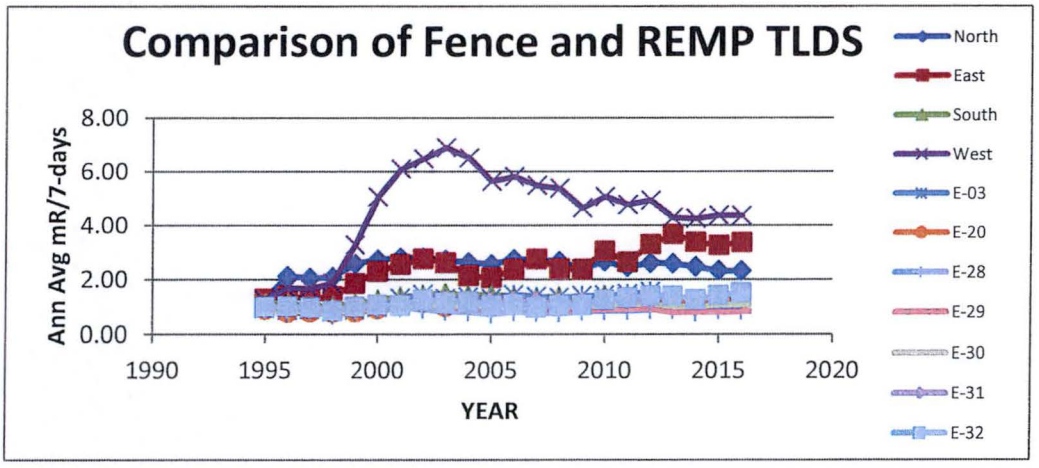


Table 11-3
Average TLD Results Surrounding the ISFSI (mR/7 days)

	Sampling Site						
	E-03	E-28	E-29	E-30	E-31**	E-32**	E-20***
Pre-Operation*	0.93	0.87	0.87	0.81	0.93	0.98	0.88
1996	0.87	0.78	0.81	0.79	0.93	1.00	0.78
1997	0.91	0.89	0.84	0.84	0.89	0.97	0.79
1998	0.82	0.68	0.80	0.82	0.91	0.85	0.77
1999	0.88	0.83	0.76	0.80	0.90	0.99	0.78
2000	0.98	0.88	0.92	0.99	0.98	1.06	0.90
2001	1.31	0.95	1.07	1.02	1.10	1.04	1.03
2002	1.45	0.91	1.22	1.10	1.26	1.25	1.14
2003	1.29	0.82	0.94	1.02	1.20	1.15	0.99
2004	1.35	0.80	0.96	1.05	1.23	1.18	1.06
2005	1.30	0.72	0.96	0.98	1.15	1.04	1.00
2006	1.44	0.80	1.19	1.07	1.21	1.07	1.11
2007	1.37	0.78	1.07	1.05	1.18	0.97	1.05
2008	1.33	0.75	0.81	1.00	1.12	1.03	1.00
2009	1.39	0.82	0.85	1.01	1.17	1.05	1.09
2010	1.41	0.84	0.89	1.07	1.21	1.24	1.10
2011	1.46	0.85	0.90	1.06	1.25	1.32	1.12
2012	1.54	0.87	0.91	1.10	1.21	1.39	1.14
2013	1.23	0.87	0.77	1.00	1.40	1.38	1.22
2014	1.23	0.77	0.79	0.97	1.25	1.25	1.15
2015	1.36	0.86	0.78	1.07	1.24	1.40	1.20
2016	1.35	0.85	0.81	1.06	1.28	1.50	1.25

*Pre-Operational data are the averages of the years 1992 through 3rd quarter of 1995.
**Sites E-31 and E-32 are located at the Site Boundary to the West and South-West of the ISFSI.
***E-20 is located approximately 17 miles WSW of the ISFSI.

Figure 11-2 Comparison of ISFSI Fence TLDs to Selected REMP TLDs



11.2 Milk

Naturally occurring potassium-40 (1370 ± 60 pCi/l) continues to be the most prevalent radionuclide measured in milk at concentrations roughly 2000 times

higher than the only potential plant related radionuclide, Sr-90 (1.2 ± 0.5 pCi/l), detected in milk. The annual average Sr-90 concentrations in milk continue to be similar to previous years. There were several (4 of 36) positive Ba-La-140 results based on the criterion stated in Section 10.1. However, PBNP did not discharge any Ba-La-140 during the years 2013 - 2016. Given the short half-life of Ba-La-140 (12.8 days), it is unlikely that these results represent a carry- over from previous years. Because the highest Ba-La-140 concentration is very near the detection limit, the positive values are considered to be false positives attributable to the statistical nature of radioactive decay.

Some low positive Cs-137 (4 of 36) results were obtained. Cs-137 was discharged from PBNP only in March 2016. The Cs-137 values also are near the detection limit and therefore may be false positive. Another possibility is residual Cs-137 recycling through the environment from the 1960's atmospheric weapons tests and events such as Chernobyl and Fukushima. No Cs-134 was discharged and no positive Cs-134 results were obtained.

Several (3 of 36) positive Co-60 values were obtained. The only airborne Co-60 release occurred in March 2016 via the Unit 1 via convective flow (unfiltered) through the 66' elevation containment hatch. All three of the small positive results occurred in months when the cattle would not be on pasture. Also, all three Co-60 results are less than the minimum detectable level for the analysis. Therefore it is concluded that these Co-60 results are false positives.

Approximately 2.5 µCi of airborneI-131 were discharged during the time of the U1 refueling outage. No I-131 was detected in any of the milk samples.

The 2016 average Sr-90 concentrations have not changed much over the last few years (Figure 11-3). Over the past twenty years, the average has decreased from 1.2 ± 0.5 pCi/L in 1997 to 0.6 ± 0.3 pCi/L in 2016. The graph of the annual averages displays a logarithmic decrease over time.

The annual averages are from the monthly Sr-90 measurements from three different dairies (Figure 9-1). The only dairy that has been in the monitoring program over the entire 1997 – 2016 timespan under consideration is located at site E-21. It is located south of the plant. The other two, E-40 and E-11, are replacements for dairies which had dropped out of the program at various times during this time interval. The replacements were chosen to maintain, to the extent possible, the former sampling sites west and north of Point Beach.

The decrease by one-half from 1997 to 2016 indicates a Sr-90 removal half-life of about 20 years which is lower than its radiological half-life of 28.6 years. However, given the standard deviation of the annual averages, the actual decrease probably is not much different from the radiological half-life.

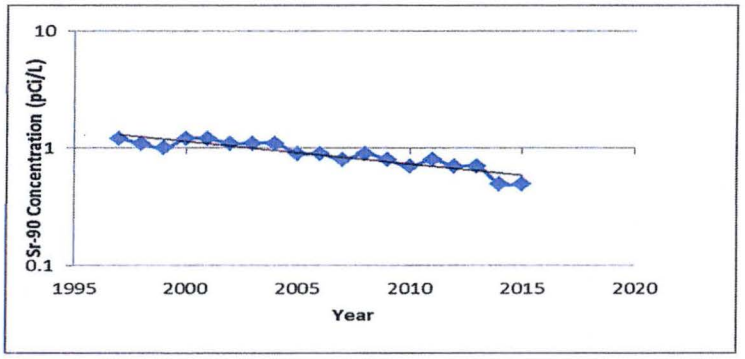
Point Beach discharged no airborne Sr-90 in 2016. Since 1998, PBNP has discharged airborne Sr-90 only in 3 years: 1998, 2.4E-08 Ci; 2004, 3.2E-08 Ci; and 2011, 1.6 E-08 Ci. It is interesting to note that nine of highest Sr-90 results occur at E-11 located about 4.4 miles west of PBNP (Fig. 9-1). If the observed Sr-90 activity were from Point Beach the highest Sr-90 concentrations would occur at E-21, the dairy south of the site boundary in the highest X/Q and D/Q meteorological sector.

This dairy grows feed corn on site and in a field across the road from the site boundary in the highest D/Q sectors. Feed crops are the dominant source of food for dairy cattle. No cattle have been seen grazing for many years.

The major Sr-90 input to the environment is from fallout from atmospheric weapons testing during the early 1960s with minor inputs during the 50's, 70's and later contributions from the Chernobyl accident in the late 1980s and from Fukushima in 2011. The Sr-90 in milk persists due to its 28.6 year half-life and to cycling in the biosphere. With little or no atmospheric input to the environment, the mode of entry into cattle feed must be root uptake by forage crops and transfer into the milk. Over the time period of this graph (1997 – 2016), these low discharges do not appear to impact the decreasing concentrations as they continue to decrease over time.

It is concluded that the milk data for 2016 show no radiological effects of the plant operation.

Figure 11-3
Sr-90 Concentration in Milk (1997 – 2016)



11.3 Air

The average annual gross beta concentrations (plus/minus the 2σ uncertainty) in weekly airborne particulates at the indicator and control locations were 0.023 ± 0.014 pCi/m^3 and 0.024 ± 0.015 pCi/m^3, respectively, and are similar to levels observed from 1993 through 2016 (Figure 11-4).

The 2016 weekly gross beta concentrations reveal higher winter values and lower summer values (Figure 11-5). This is a repeat of the patterns seen in 2006 - 2015. As in 2015, there is a slight peak in August followed by a slight decrease and then peaking in late November and December. The cause for this variation is not known. However, the control and indicators are moving in concert. Therefore, a plant effect can be ruled out.

Figure 11-4 Annual Average Air Gross β (1993 – 2016)

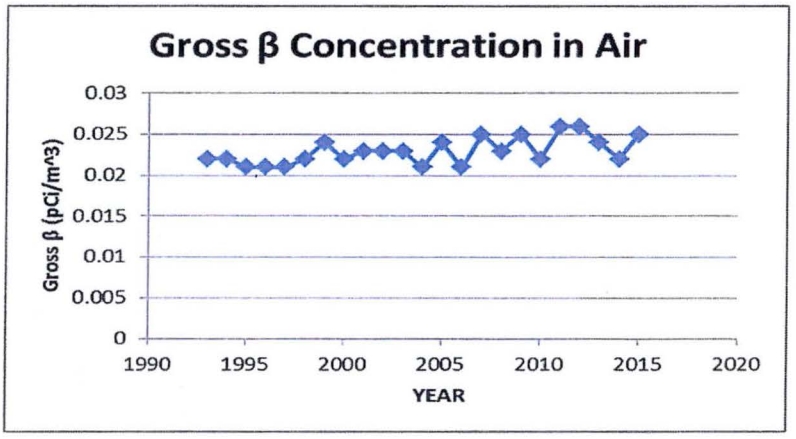
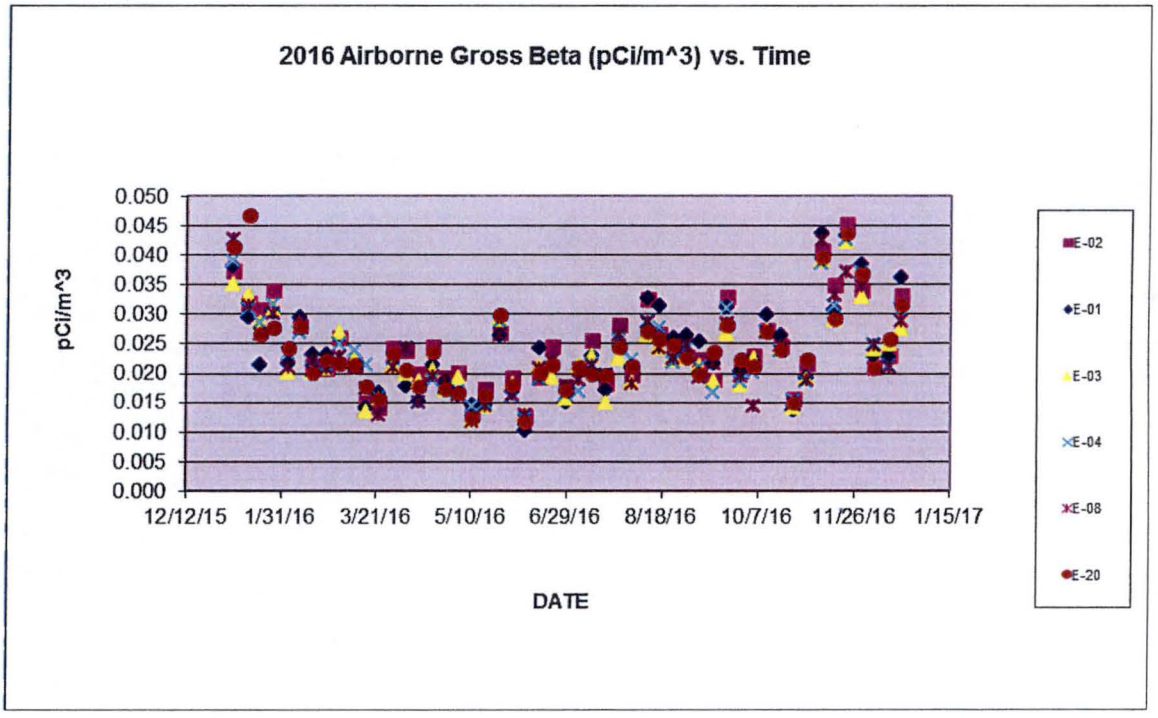


Figure 11-5 2016 Airborne Gross Beta



No I-131 was detected during 2016. In 2005, the new method of evaluating airborne I-131 was instituted. Instead of counting each charcoal cartridge separately, all six cartridges for the week are counted as one sample in a predetermined geometry to screen the samples for I-131. If any airborne radioiodine is detected, each sample cartridge is counted individually. With no detectable I-131, the reported analytical result is the minimum detectable activity (MDA) conservatively calculated using the smallest of the six sample volumes. The reported MDAs ranged from 0.005 to 0.0.016 pCi/m^3. Because the analysis LLD is based on counting only one cartridge, the use of six cartridges or roughly six times

the sample volume with the same count time as would be needed to achieve the desired LLD for only one sample, the actual LLD is about six times lower than the programmatic value given in Table 10-1. Similarly, the actual MDA is about one-sixth of that reported, in the range of 0.001 to 0.003 pCi/m^3.

At each sampling location, the particulate filters are composited quarterly and analyzed for Cs-134, Cs-137 and any other (Co-60) detectable gamma emitters. As summarized in Table 10-1, no gamma emitters were detected. By contrast, naturally occurring Beryllium-7 was found in all of the quarterly composites at concentrations ranging from 4.96E-02 to 9.94E-02 pCi/m^3. Be-7 ($T_{1/2}$ = 53.3 days) is produced in the atmosphere by the interaction of cosmic rays with oxygen and nitrogen nuclei. Its half-life is long enough to allow for it to be detected in the quarterly composited filters.

In summary, the 2016 air gamma data from quarterly composites do not indicate an environmental impact from the operation of PBNP.

11.4 Lake Water

For the REMP-specified gamma emitting radionuclides listed in Table 10-1, reported concentrations continue to occur as small, negative and positive values scattered around zero, indicating no radiological impact from the operation of PBNP. Lake Michigan water samples are collected north (E-33 and E-05) and south (E-01 and E-06) of PBNP (see Figure 9-1).

There were 26 slightly positive indications of gamma emitters during 2016, 18 south of the plant and 8 to the north. Although the major off-shore current is from north to south, these locations may be upstream or downstream of the plant discharge depending upon wind stress which can reverse currents. A comparison of when the positive results were obtained to when discharges occurred suggests that the small, positive results are false positives. For example, positive results were obtained for Cs-134 and Ba-La-140 which were not in the 2016 effluents. Similarly, positive results were obtained for Mn-54 (Jan, May), Fe-59 (Mar), and Zr/Nb-95 (Jun) in months when these radionuclides were not discharged. Finally, the measured concentrations are in the range of 1 – 4 pCi/l which converts to 1 – 4E-09 µCi/cc or 10 – 100 times greater than the typical discharge concentrations of E-14 to E-11 µCi/cc. Based on the further dilution which occurs in the lake after discharge, it is highly unlikely that observed positive results are real. Therefore, based on these comparisons, it is concluded that the 26 positive results are false positives and not indications of PBNP effluents in Lake Michigan during 2016.

A false positive is concluding an isotope is present when it isn't. False positives occur most often at the detection limit when the random fluctuations of the background result in lower than normal background activity. The result is a higher net count and hence falsely concluding an isotope is present when it isn't because the value is statistically above zero.

In conclusion, based on the results of the gamma scans of Lake Michigan water, there is no measureable impact on the lake from PBNP discharges.

Aliquots of the monthly samples are composited quarterly and analyzed for Sr-89/90 and for tritium. Small amounts of Sr-90 were detected in five of the quarterly composites. They occurred north and south of the plant. All the results were below their statistically calculated minimum detectable concentrations (MDCs). The only month in 2016 during which PBNP discharged Sr-90 was March. There was no Sr-90 discharged in 2012 – 2015. Sr-90 has a 28.6 year half-life and, like Cs-137, is a remnant of atmospheric weapons testing in the '50s and '60s. Therefore, positive Sr-90 concentrations could be indicative of fallout being recycled in Lake Michigan. Or, because the concentrations are below their MDCs, they could be false positives. In either case it is unlikely to be the result of PBNP effluent.

Tritium, in addition to being produced by water-cooled reactors such as PBNP, also is a naturally occurring radionuclide. It also was produced by atmospheric weapons testing. However, due to its mobility, any H-3 now found in Lake Michigan at the concentrations typically found in monitoring programs cannot be from that time period. It is the result of power plant discharges. Point Beach discharges on the order of 700 - 800 Ci of tritium per year.

Ten of the sixteen quarterly composites had positive H-3 indications. Only two of the ten had concentrations above their MDCs. Four occurrences were north and six were south of the PBNP discharge. The highest, 286 ± 87 pCi/l, was from a fourth quarter composite sample from site E-01 located about 0.5 miles south of the Point Beach discharge. All results are lower than the EPA drinking water standard of 20,000 pCi/l. The positive results may indicate a slight impact of PBNP effluents.

11.5 Algae

Filamentous algae attached to rocks along the Lake Michigan shoreline are known to concentrate radionuclides from the water. Samples are obtained at Two Creeks Park and at the PBNP discharge (locations 5 and 12 in Figure 9-1). In order to allow the algae time to grow, typically no samples are collected until June and then again August and October. This is done to ensure that there is enough new growth to provide a sample.

In 2016 no algae samples were obtained. There either were no algae present or it was located in an inaccessible location. On each of the three scheduled sampling times when no algae was available, attempts were made to collect the sample on subsequent weeks. Again, none was available.

Algae sampling is not called for in either NUREG-0472 or 1301 the standard RETS documents. However, PBNP has continued to collect algae as a good practice to provide continuity between the current REMP and the pre-operational REMP.

11.6 Fish

Twenty-five fish were analyzed in 2016 with 15 fish having detectable Cs-137. Concentrations ranged from 0.011 ± 0.010 to 0.077 ± 0.031 pCi/g. Seven of the 15 positive Cs-137 results are greater than the MDC. The Cs-137 is attributable to the recycling of this radionuclide in Lake Michigan. The majority of Cs-137 entered

Lake Michigan as fallout from atmospheric weapons testing in the '50s and '60s with lesser amounts from events at Chernobyl and Fukushima.

Positive results were found also for Mn-54, Fe-59, Co-58, Co-60, and Ru-103. Of these, only Fe-59 at 0.058 ± 0.020 pCi/g is above its MDC of 0.056 pCi/g. This result is for a month when no Fe-59 was released. Therefore, it is concluded that these results are false positives.

The highest radionuclide concentration in fish is naturally occurring K-40 with an average concentration of 3.66E+00 pCi/g.

Based on these results, it is concluded that there is no impact of PBNP discharges on Lake Michigan fish.

11.7 Well Water

Two plant related radionuclides were detected in main plant well water (E-10) during 2016, Fe-59 and Cs-134. Both are below their MDCs and there was no Cs-134 in PBNP effluents. Therefore, it is concluded that there is no evidence of PBNP effluents getting into the aquifer supplying drinking water to PBNP.

11.8 Soil

Cs-137 is present in the soils throughout North America and the world resulting from the atmospheric nuclear weapons testing in the 1950s, 1960s, and 1970s and from the 1986 Chernobyl accident, and more recently, from the Fukushima event. Soil is an integrating sample media, in that it is a better indicator of long term buildup of Cs-137 as opposed to current deposition for local sources. In addition to erosion and radioactive decay, human activities can modify the soil Cs-137 concentrations.

In 2016, Cs-137 was detected in all 16 soil samples. Concentrations ranged from 0.077 ± 0.031 to 0.37 ± 0.03. As in 2014 and 2015, the highest values occurred in May and in October and both were at E-06, Point Beach State Park. This high is comparable to the 2015 Cs-137 concentrations found at E-06, 0.315 ± 0.036 pCi/g in May and 0.28 ± 0.033 in October. This Cs-137 is attributable to fallout from atmospheric weapons testing in the 50s and 60 as well as the Chernobyl and Fukushima events and subsequently being bound to the soil. Excluding the E-06 Cs-137 results, there is no significant difference between the results at the background location E-20, 0.11 ± 0.02 to 0.22 ± 0.03, and the remaining soil sampling locations, 0.035 ± 0.041 to 0.16 ± 0.02. Based on the rather uniform distribution of Cs-137 in soils at various locations, no plant based effect is indicated.

By comparison to naturally occurring radionuclides, Cs-137 continues to be present in soil samples at well below the levels of naturally occurring Be-7, K-40, and Ra-226 (see Table 10-1).

11.9 Shoreline Sediment

Shoreline sediment consists of sand and other sediments washed up on the Lake Michigan shore. As in soil samples, the only non-naturally occurring radionuclide found in these samples is Cs-137. Six of the ten samples have Cs-137

concentrations statistically different from zero. Three results are >MDC. The one positive Cs-134 is below its MDC. Since no Cs-134 was released in 2016, this result is a false positive.

Shoreline sediment Cs-137 concentrations continue to be about one-tenth of that found in soils (Table 10-1). This is expected because Cs-137 in the geological media is bound to fine particles, such as clay, as opposed to the sand found on the beach. Lake Michigan sediments are a known reservoir of fallout Cs-137. Wave action suspends lake sediments depositing them on the beach. The fine particles deposited on the beach eventually are winnowed from the beach leaving the heavier sand; hence the lower Cs-137 concentrations in beach samples. In contrast to Cs-137, K-40, which is actually part of the minerals making up the clay and sand, is at a concentration about several hundred times higher than the Cs-137 that is attached to particle surfaces. Therefore, it is not surprising that Cs-137 is present at concentrations 1% or less of the naturally occurring concentrations of K-40.

The absence of any PBNP effluent nuclides, such as Co-58/60, other than Cs-137 indicates that the most likely source of the observed Cs-137 is the cycling of radionuclide in the Lake Michigan environment and not current PBNP discharges. As with soil, the naturally occurring radionuclides such as K-40, and Ra-226 are found in the shoreline sediment samples. Therefore, the shoreline sediment data indicate no radiological effects from current plant operation.

11.10 Vegetation

The REMP collects two general types of vegetation within the site. The first consists of general vegetation, non-cultivated plants which would be consumed by grazing cattle. The second consists of crops grown on site acreage licensed to farmers, about half the site's 1400 acres, for growing feed crops for cattle. Ten samples of cultivated crops (corn, hay, alfalfa, and soybeans) grown on this acreage were obtained for analyses.

The naturally occurring radionuclides Be-7 and K-40 were found in all of the general vegetation samples. The source of Be-7 is atmospheric deposition. It is continuously formed in the atmosphere by cosmic ray spallation of oxygen, carbon, and nitrogen atoms. (Spallation is a process whereby a cosmic ray breaks up the target atom's nucleus producing a radionuclide of lower mass.) Be-7 concentrations ranged from 0.44 ± 0.18 to 5.58 ± 0.38 pCi/g. The average concentrations increased from May (0.79 ± 0.74 pCi/g) to July (1.44 ± 0.45) to October (3.94 ± 1.27). This is consistent with the known temporal variability in Be-7 concentrations in air near the earth's surface and the gradual build-up of fallout on the vegetation over time. In contrast, K-40 is a primordial radionuclide which is incorporated into vegetation from the soil during the growing process. By not being dependent upon seasonal atmospheric variations and plant surface to capture deposition, the K-40 concentrations from root uptake are more uniform with averages of 4.48, 5.31, and 5.15 in May, July, and October, respectively.

Cs-137 can be present in vegetation via both pathways. Fresh Cs-137 fallout is associated, like Be-7, with deposition on the plant surface. Old fallout from the '50s and '60s is now being incorporated into growing plants in the same manner as

potassium because it is in the same chemical family as potassium. This fallout Cs-137 has been found in firewood ash at many locations in the United States that are far from any nuclear plants (S. Farber, "Cesium-137 in Wood Ash, Results of a Nationwide Survey," 5th Ann. Nat. Biofuels Conf., 10/21/1992).

In 2016 only two of the twenty-four vegetation samples had a positive indication for Cs-137 and only E-06 (0.017 ± 0.009) was above the MDC of 0.016 pCi/g. Typically, only the vegetation collected at monitoring site E-06, in the Point Beach State Park south of PBNP, has detectable levels of Cs-137. Both the positive 2016 results were from E-06. This occurrence is attributed to the above described mechanism. In the last two years, the only airborne Cs-137 discharged by PBNP occurred in October 2015 and March 2016. Therefore, it is unlikely that the positive Cs-137 values resulted from PBNP releases.

The only other radionuclide having positive indication was I-131. I-131 releases occurred only in March (1 μCi) and the last week in April (1.4 μCi) of 2016. Based on its 8-day half-life, the I-131 would have decreased by 4 half-lives by the time of the May 26th sample or to 1/16th of its original value. Factoring in the dispersion coefficients, it is unlikely that it would be detected in any vegetation. Additionally, both I-131 results were below the calculated MDC. Therefore the I-131 results are considered to be false positives.

Based on the 2016 general vegetation sampling results, it is concluded that there is little or no effect from PBNP effluents.

Similar results and conclusions are reached from the analytical results for the crops grown on site acreage. In 2015 naturally occurring Be-7 and K-40 was found in all crops. In 2016, while the same was true for K-40, Be7 was found only in five of the crop samples with only three of the five being >MDC. Neither of the Cs-137 and Co-60 results were >MDC. Based on these results from crops grown on site, there is no impact from PBNP airborne effluents.

11.12 Land Use Census

In accordance with the requirements of Section 2.5 of the Environmental Manual, a visual verification of animals grazing in the vicinity of the PBNP site boundary was completed in 2016. No significant change in the use of pasturelands or grazing herds was noted. Therefore, the existing milk-sampling program continues to be acceptable. The nearest dairy (E-21) lies in the SSE sector and it is one of the Point Beach REMP milk sampling sites. This dairy leases land in the S and SSE sectors at the PBNP site boundary for growing feed corn. Also, the highest χ/Q (1.09E-06) and D/Q (6.23E-09) values occur in these sectors. As demonstrated from the analyses of feed crops, there is no measureable plant impact on the crops grown on site by this dairy. Therefore, dose calculations to the maximum exposed hypothetical individual, assumed to reside at the site boundary in the S sector, continues to be conservative for the purpose of calculating doses via the grass-cow-milk and the other ingestion pathways.

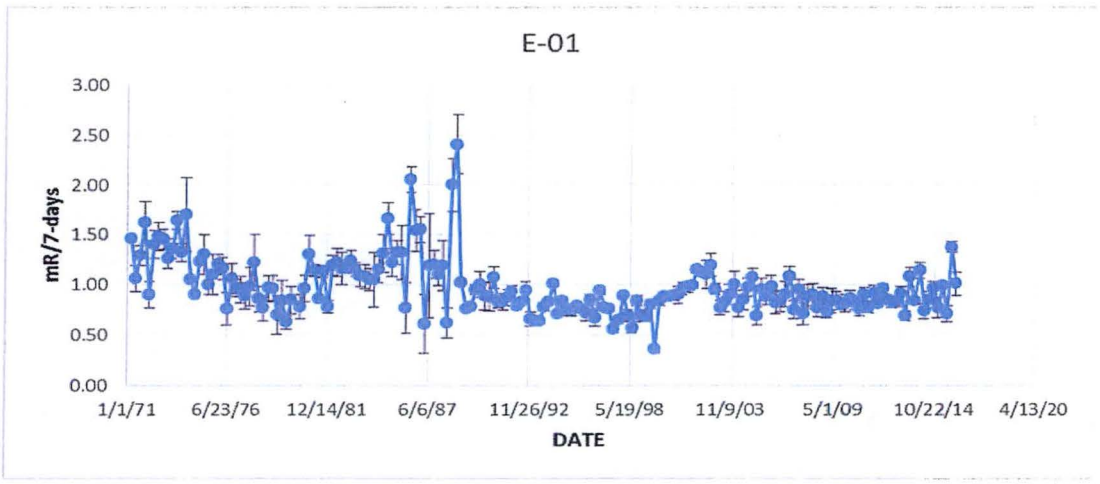
11.13 Long Term TLD Trending

To put the 2016 REMP TLD results in perspective, it is instructive to look at long term trends. The following examines the TLD results from 1971 to 2016. The ANSI standard (ANSI/HPS N13.37-2014 "Environmental Dosimetry) states that the data from early vintage dosimetry systems (c. 1970 – 1990) should not be considered comparable to current dosimetry systems in establishing a baseline for environmental TLD results. These problems are evident from the review of our early data as discussed below.

The pre-operational data, 1968 – 1970, are not included. The pre-operational ambient radiation monitoring sites were E-01 (the met tower area) through E-04 (the north boundary). They were monitored using TLDs and ionization chambers. E-04 was used as a background location until E-08 (see Figure 9-1) was added for the operational REMP in 1971. Prior to 1975, a control TLD stored in a lead pig was used for a comparison to those placed in the field. In the pre-operational data, the control TLD could be equal to or higher than the field results and both the field and control TLD results appear erratic compared to the ion-chamber results. Also, the reported TLD results do not have transportation exposures from New Mexico to Wisconsin subtracted. Therefore, only the TLD results beginning in 1971, with the transportation caveat, are used in this analysis of long-term trends.

The trend at E-01(Figure 11-6) shows slowly decreasing tread from 1971 to 1979. This is may be an artifact. The cause is not known. As previously mentioned, no transportation controls were used until the 4th quarter of 1975 so no transport dose corrections were made prior to that quarter. There is a small increase in 1980 when the current contracted REMP lab began. A slowly decreasing exposure rate occurs from 1980 – 1992 except for the 1984 - 1988 time segments. The erratic results from 1984 – 1988 were traced to a faulty connection in the TLD reader.

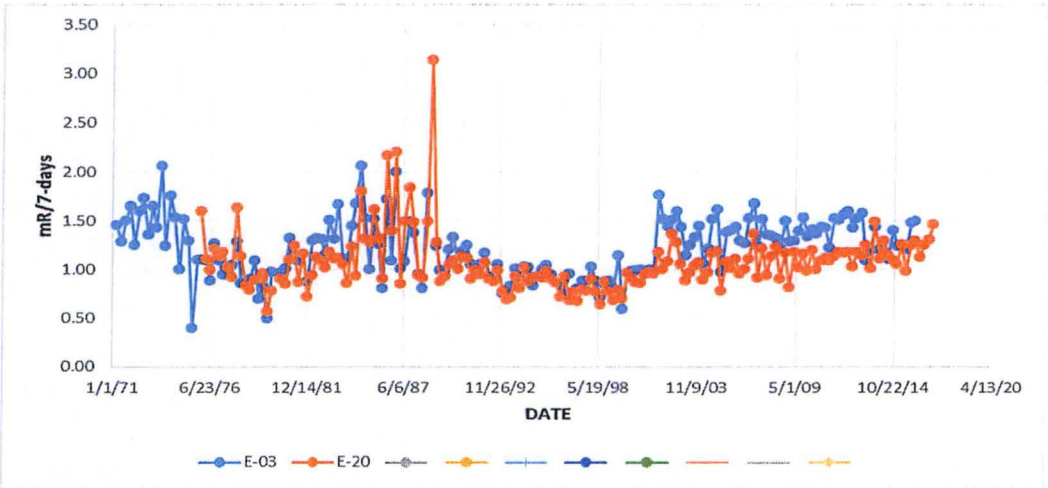
Figure 11-6 E-01 Results 1971 – 2016



The TLD package from 1980 to 2001 consisted of three LiF chips sealed in a black plastic bag. The magnitude of the error bars indicates the degree of variability of the 1984 - 1988 results from the three chips due to a fault in the TLD reader. The results appear much the same for the E-03 and E-20 results (Figure 11-7). Note

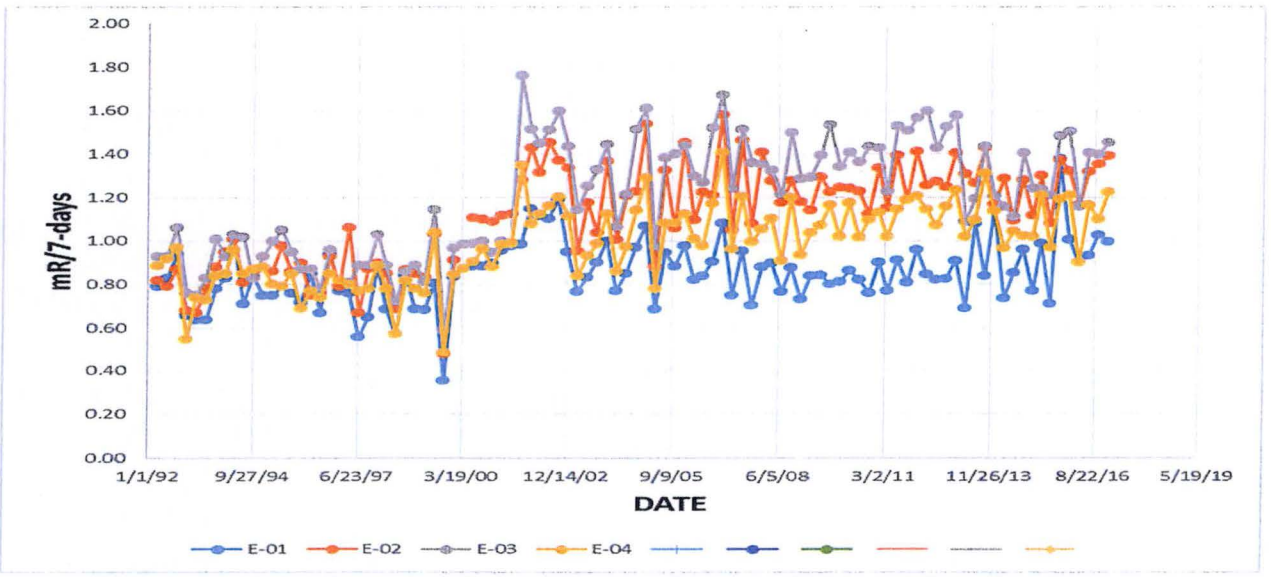
that E-20 did not begin until 1976. Again, there is an increase in both the E-20 (the background site) and E-03 (the location nearest the ISFSI) which coincides with the switch from the LiF chips to the Teflon TLD cards. Given that the first twelve casks were loaded December 1995 to September 2000 in which there were no increases in the TLD results, the increase in 2001 indicates that this change is the result of the different response of the new TLDs and not of any effluents or shine from the plant.

Figure 11-7 Comparison of E-03 and E-20 Results 1971 – 2016



Narrowing the time window for the TLD results from 1992 to the present allows for a comparison among the for original four TLD locations since the introduction of the ISFSI (Figure 11-8) without the interference by the faulty TLD reader in the mid-1980s. Sites E-01 and E-02 are about 1 mile south of the ISFSI. E-03 is 1200 feet west and E-04 is 4300 feet north.

Figure 11-8 Comparison of E-01, E-02, E-03 and E-04 (1992 –2016)



The comparison shows a definite difference between E-01 and the other three locations. E-01, although approximately the same distance from the ISFSI as E-02

and further away than either E-03 or E-04, is lower than the other three sites. Therefore, distance is not the determining factor in the difference among the measured exposures. There are two factors which could cause the observed difference. The first difference is that E-02, E-3, and E-04 are surrounded by plowed fields whereas the area around E-01 is uncultivated. Second, E-01 is within 100 feet of the lake. Therefore, about 50% of the area contributing natural radiation to the location is a combination of sandy soil, beach sand, and lake water. As seen from the REMP soil and beach analyses, the soil at E-01 has lower average Ra-226 content (0.90 pCi/g) than the soil at E-02, -03, -04 (1.30 pCi/g). Similar results are obtained for K-40, 11.6 pCi/g at E-01 vs. 16.0 pCi/g (E-02, -03, -04). Furthermore, the beach sands at E-01 have lower Ra-226 (0.31 pCi/g) and K-40 (5.75 pCi/g) concentrations than the soil at E-01.

The impact of the ISFSI on the ambient radiation levels at its nearest site boundary, the west boundary is shown in Figure 11-9. The ISFSI impact on ambient exposure levels was addressed briefly in Section 11.1 (see Figure 11-2).

Figure 11-9 E-03, E-31, and Background Site E-20 Results 1992 to 2016

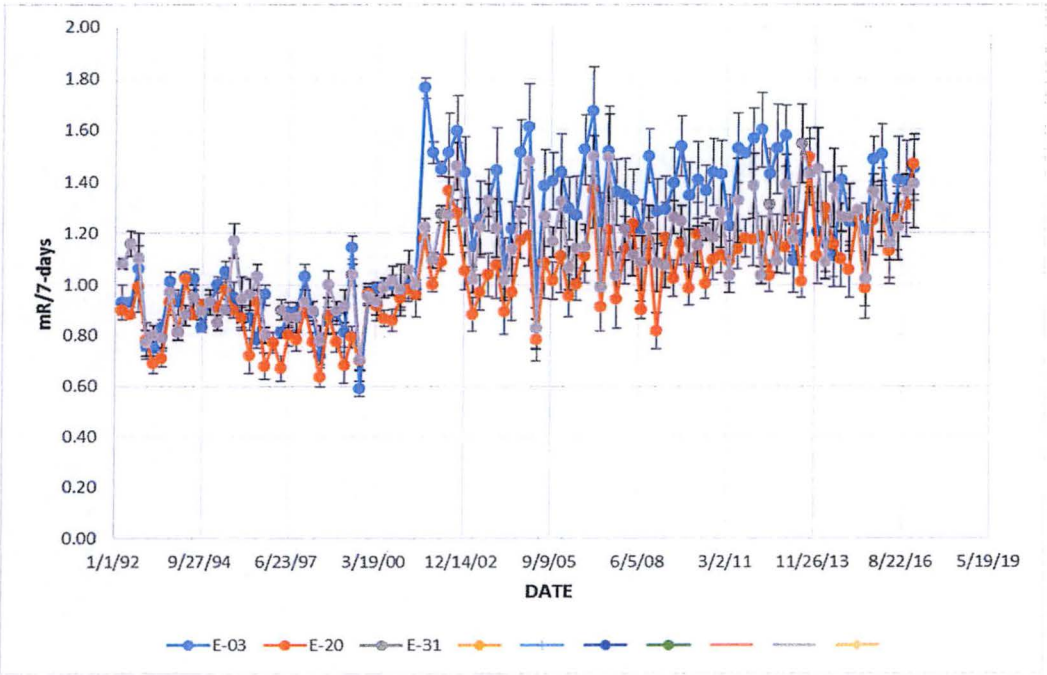


Figure 11-2 shows that beginning with the use of the Teflon TLD cards in the fourth quarter of 2000, the measured exposure levels at E-03 are 2 – 5 mR/7-days lower than the exposures at the west fence of the ISFSI. Figure 11-9 shows that although their individual 95% confidence levels overlap indicating no statistical difference, the quarterly exposures at E-03 (about 1200 feet from the ISFSI) are consistently higher than the exposure at E-31 (at the site boundary about 1400 feet west of E-03). Therefore, the lower values at E-31 compared to E-03 appear to be a real difference as the distance from the ISFSI increases at the west boundary. Because land usage and location are similar at E-03 and E-31, the cause of the previously identified response differences between E-03 and E-01 are not applicable. Therefore, the lower results at the site boundary location E-31 show that the

exposures from the ISFSI are dropping off and approaching the lower readings found at the background site E-20.

12.0 REMP CONCLUSION

Based on the analytical results from the 815 environmental samples (775 individual samples with an additional 24 quarterly air particulate composites and 16 quarterly lake water composites) together with 144 sets of TLDs that comprised the PBNP REMP for 2016, PBNP effluents had no discernable effect on the surrounding environs. The calculated effluent doses are below the 10 CFR 50, Appendix I dose objectives demonstrate that PBNP continues to have good controls on effluent releases. The control of effluents from PBNP continues to be acceptable pursuant to the ALARA criteria of 10 CFR 50.34a. Additionally, when the TLD results are factored in to the overall exposure, the resulting doses are lower than the ISFSI (10 CFR 72.104) and EPA (40 CFR 190) limits of 25 mrem whole body, 75 mrem thyroid, and 25 mrem any other organ.

From the long-term analysis of TLD results, there is no evidence of elevated ambient radiation levels from the operation of Point Beach and the ISFSI except for the slightly higher exposures measured at the site boundary (E-31) compared to the background reference site (E-20) [see Figure 11-9].

Part D
GROUNDWATER MONITORING

13.0 PROGRAM DESCRIPTION

PBNP monitors groundwater for tritium as part of the Groundwater Protection Program (GWPP). During 2016 the sampling program consisted of beach drains, intermittent stream and bog locations, drinking water wells, façade wells, yard electrical manholes, ground water monitoring wells, and the subsurface drainage (SSD) system sump located in the U-2 façade.

In the late 1970s, the beach drains entering Lake Michigan were found to contain tritium. The beach drains are the discharge points for yard drainage system, which carries storm water runoff, and are known to be infiltrated by groundwater as observed by discharges even when no rain has occurred. In the 1980s, the source of H-3 for this pathway was postulated to be spent fuel pool leakage into the groundwater under the plant. Based on this observation, modifications were made to the pool, and the tritium concentrations decreased below the effluent LLDs. Beach drain effluents continue to be monitored and are accounted for in the monthly effluent quantification process. Because the beach drains are susceptible to groundwater in-leakage from other sources such as the area around the former retention pond which is known to contain H-3, the beach drains are monitored as part of the groundwater monitoring program. In addition to H-3, groundwater beach drain samples also are gamma scanned for the same suite of radionuclides as lake water using the lake water LLDs.

Three intermittent stream locations and the Energy Information Center (EIC) well were added to the groundwater monitoring program in the late 1990s when it was discovered that tritium diffusion from the then operable, earthen retention pond was observable in the intermittent streams which transverse the site in a NW to SE direction. A fourth stream location closer to the plant was added in 2008. These streams pass on the east and west sides of the former retention pond and empty into Lake Michigan about half a mile south of the plant near the meteorological tower. The intermittent stream samples track H-3 in the surface groundwater.

The groundwater monitoring program also includes two bogs / ponds on site. One is located about 400 feet SSE of the former retention pond; the other, about 1500 feet N.

In addition to the main plant well, four other drinking water wells also are monitored. The Site Boundary Control Center well, located at the plant entrance, the Warehouse 6 well, on the north side of the plant, and the EIC well, located south of the plant. In 2012, a new building (Warehouse 7) was constructed for radwaste. The well for this building was added to the GWPP. These wells do not draw water from the top 20 - 30 feet of soil which is known to contain H-3. These wells monitor the deeper (200 - 600 feet), drinking water aquifer from which the main plant well draws its water. The two soil layers are separated by a gray, very dense till layer of low permeability identified by hydrological studies.

Manholes in the plant yard and for the subsurface drainage (SSD) system under the plant are available for obtaining ground water samples. The plant yard manholes for accessing

electrical conduits are susceptible to ground water in-leakage. Therefore, a number of these were sampled. The SSD system was designed to lessen hydrostatic pressure on the foundation by controlling the flow of water under the plant and around the perimeter of the foundation walls. The SSD system flows to a sump in the Unit 2 facade. The sump was sampled twelve times during 2016.

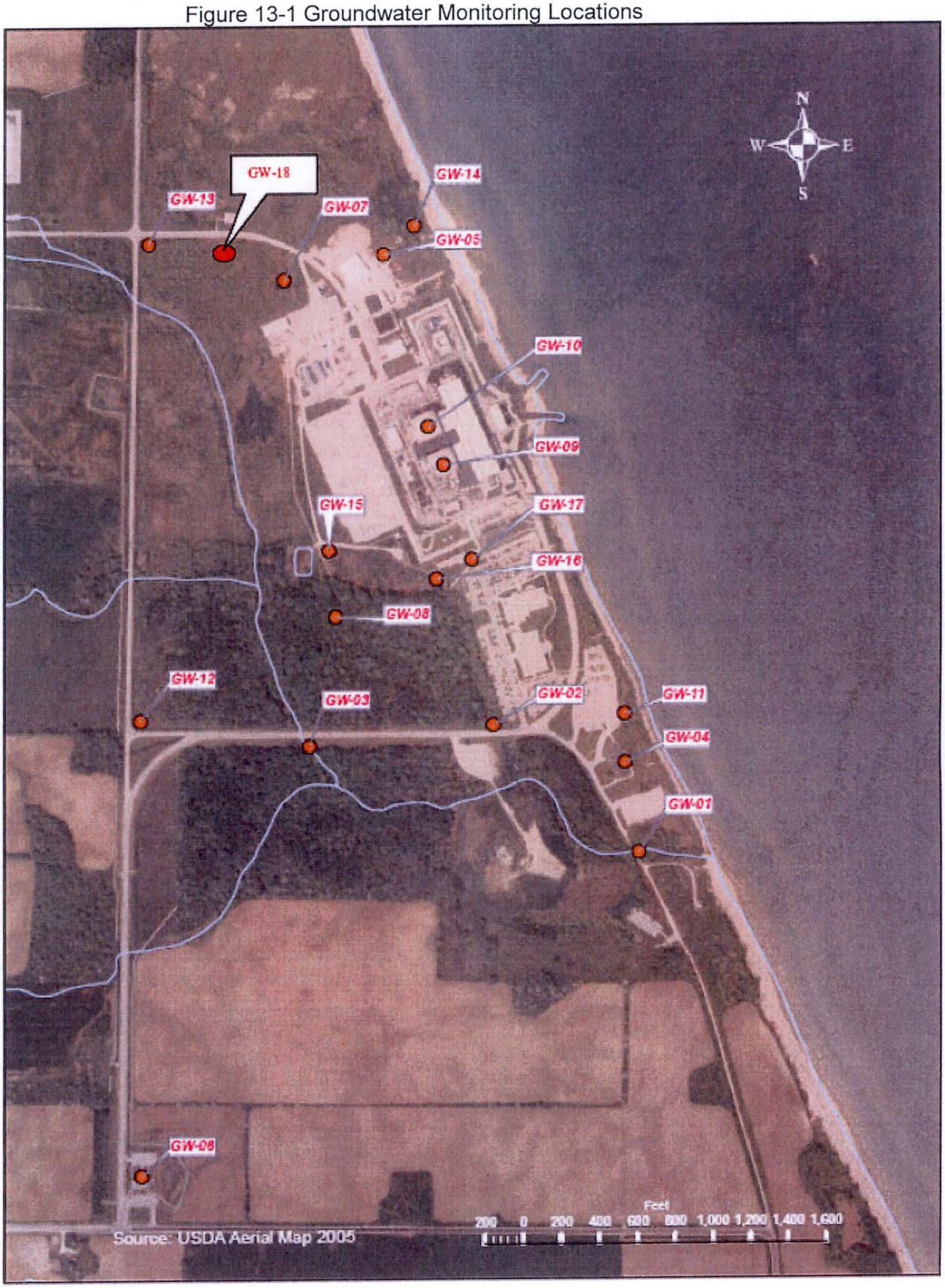
Due to flooding concerns, man-holes and clean-outs for the SSD were sealed in 2014. Therefore, only the SSD sump now is used for sampling.

In the 1990s, two wells were sunk in each unit's façade to monitor the groundwater levels and look for evidence of concrete integrity as part of the ISI IWE Containment Inspection Program. These wells are stand pipes which are sampled periodically for chemical analyses. Façade well sampling has been part of the GWPP since 2007. These wells are sampled quarterly.

Rising lake levels has washed away the access to beach drain S-3 south of the U2 discharge. No samples have been available since the second quarter of 2016.

The groundwater sampling sites (other than the beach drains, SSDs and manholes) are shown in Figure 13.1.

Figure 13-1 Groundwater Monitoring Locations



14.0 RESULTS AND DISCUSSION

14.1 Streams and Bogs

The results from the surface groundwater monitoring associated with the former retention pond are presented in Table 14-1. For the most part, the creek results are barely above the detection level and less than the MDC. The highest averages are for the East Creek and STP which are in the groundwater flow path from the retention pond area to Lake Michigan. The West Creek is west of the former retention pond, an upstream location with respect to the groundwater flow. The H-3 concentration at GW-08, close to the former retention pond, is about one-tenth of the H-3 concentrations it had prior to the remediation of the retention pond.

Table 14-1 Intermittent Streams and Bogs
H-3 Concentration (pCi/l)

Month	GW-01(E-01)	GW-02	GW-03	GW-17	BOGS		MDC
	Creek Confluence	E. Creek	W. Creek	STP	GW-07	GW-08	
Jan	NS ±	NS ±	NS ±	NS ±			
Feb	27 ± 79	186 ± 87	ND ±	171 ± 86			155
Mar	71 ± 76	190 ± 82	ND ±	243 ± 85			145
Apr	83 ± 82	227 ± 89	ND ±	236 ± 89			147
May	71 ± 79	194 ± 85	ND ±	236 ± 87	120 ± 81	212 ± 85	151
Jun	148 ± 80	111 ± 78	ND ±	129 ± 79			150
Jul	165 ± 81	164 ± 81	ND ±	118 ± 79			145
Aug	105 ± 80	114 ± 81	ND ±	152 ± 83			155
Sep	115 ± 82	689 ± 106	ND ±	NS ±			157
Oct	215 ± 104	52 ± 98	ND ±	199 ± 103			182
Nov	6 ± 90	116 ± 94	ND ±	109 ± 94			180
Dec	59 ± 79	NS ±	NS ±	207 ± 87			153
Average	97 ± 61	204 ± 178	±	180 ± 51			

A blank indicates no sample was scheduled. Streams are sampled monthly; bogs, annually.
NS = no sample due to dry or frozen. Streams are sampled monthly; bogs, annually.
Values are presented as the measured value and the 95% confidence level counting error.
ND = measured value minus 2σ is less than zero and <MDC. The LLD = 200 pCi/l.
STP is the north end of the E. Creek at the SE corner of the sewage treatment plant.

The analyses of these surface water samples show low concentrations of H-3. Although small positive H-3 concentrations occur in samples from the confluence of the two creeks (GW-01) all but two of these concentrations are above their associated MDCs. The West Creek (GW-03) samples had no detectable H-3. In contrast, there are more positive results from GW-02 (south end of the East Creek) and GW-17 (located at the north end of the East Creek). GW-17 is east of the former retention pond area in the groundwater flow path to Lake Michigan. Except for the September sample result, the East Creek concentrations are generally lower than the 300 - 350 pCi/l found before the retention pond was remediated in 2002. Reanalysis of the September sample yielded a result of 591 ± 130 pCi/L. The reason for this higher concentration in September is not known. It should be noted that the East Creek, in addition to being in the path of the west to east groundwater flow from the old retention pond, also is fed by yard runoff from the west side of the yard which may account for the higher values.

The bog (GW-08) SE of the former retention pond is higher than the bog at GW-07 north of the former retention pond. The low H-3 value at GW-07 indicates that the impact of groundwater flow from the retention pond area is not to the north. These results are in conformance with the west to east groundwater flow described in the Site Conceptual Model and the FSAR. The GW-08 bog result is down from the 3000 pCi/l seen before the pond was remediated.

14.2 Beach Drains

The 2016 results for the beach drains are presented in Table 14-2. [The drain data from left to right in the table are in the order of the drains from north to south.] S-1 collects yard drainage from the north part of the site yard; S-3, from the south. Drains S-8 and S-9 carry water from the lake side yard drains whereas drains S-7 and S-10 are from the turbine building roof. S-11 is not connected to any yard drain system and mainly carries groundwater flow and runoff from a small lawn area south of the plant. No samples have been available from S-3 and S-11 since March due to high lake levels washing out the access to these positions.

Table 14-2
2016 Beach Drain Tritium
Average H-3 Concentration (pCi/l)

Month	S-1	S-7	S-8	S-9	S-10	S-3	S-11	MDC
Jan	NF ±	NF ±	NF ±	NF ±	NF ±	NF ±	NF ±	
Feb	NF ±	NF ±	NF ±	NF ±	NF ±	NF ±	NF ±	
Mar	181 ± 84	NF ±	NF ±	NF ±	NF ±	244 ± 87	140 ± 82	150
Apr	629 ± 102	NF ±	NF ±	NF ±	NF ±	NS ±	NS ±	152
May	187 ± 84	NF ±	NF ±	NF ±	NF ±	NS ±	NS ±	157
Jun	267 ± 88	NF ±	NF ±	NF ±	NF ±	NS ±	NS ±	147
Jul	228 ± 89	NF ±	NF ±	NF ±	NF ±	NS ±	NS ±	146
Aug	168 ± 80	NF ±	NF ±	NF ±	NF ±	NS ±	NS ±	149
Sep	176 ± 90	NF ±	NF ±	NF ±	NF ±	NS ±	NS ±	151
Oct	260 ± 85	NF ±	NF ±	NF ±	NF ±	NS ±	NS ±	177
Nov	211 ± 93	NF ±	NF ±	NF ±	NF ±	NS ±	NS ±	158
Dec	241 ± 86	NF ±	NF ±	NF ±	NF ±	NS ±	NS ±	155
Avg =	255 ± 136					244 ± 87	140 ± 82	

ND = not detected and ≤MDC
NF = no sample due to no flow
NS = no sample due to no path to sample location

Only one beach drain site (S-1) had enough available data to make reasonable comparisons in 2016. However, the high H-3 concentration (629 pCi/L, April) is consistent with the spring high (355 pCi/L, March) of 2015. Also to be noted is that the S-1 beach drain H-3 concentration value (obtained on April 21) is similar to the H-3 concentration from electrical vault Z-068 (496 ± 95 pCi/L, April 29, Table 14-3). The yard drain for S-1 is in the vicinity of Z-068. Groundwater leakage into the yard drain lines and the electrical vaults is known to occur. As shown in previous reports, these high values are attributable to precipitation scavenging by rain and snow followed by melting.

Gamma scans were performed on the beach drain samples at the LLD used for lake water. A few indications of small, positive concentration values below their

calculated MDCs were found for both Zr-Nb-95 (S-1, May) and Ba-La-140(S-1, Nov.) as well as for naturally occurring Be-7(S-2, Nov. and Dec.). No Ba-La-140 was released via liquid or airborne effluents in 2016. Also, the measured value is below the MDC. Therefore, the identification of Ba-La-140 is concluded to be a false positive. By contrast, μCi amounts of Zr-Nb-95 were in the airborne effluents in March and April. Although the Zr-Nb-95 was below its MDC, it is possible that recapture could have contributed to the observed values. Therefore, it is concluded that H-3 is the only PBNP radionuclide positively found in the beach drains.

14.3 Electrical Vaults and Other Manholes

Manholes for access to below ground electrical facilities are susceptible to groundwater in-leakage. The manholes east side of the plant, between the Turbine building and Lake Michigan have low H-3 concentrations (Table 14-3). These manholes, Z-066A and Z-067A through Z-066D AND Z-067D, run in parallel in the NE section of the yard beginning just north of the Unit 2 truck bay and run from the Unit 2 truck bay north to the EDG building. Z-068 is located just west of the EDG building and north of Z-66/67D. Each of the two A, B, C, and D vaults is side by side. Based on being side-by-side, it is expected that the each pair of manholes 66A/67A, etc. would have similar H-3 concentrations. This is appears to hold for all the paired vaults. The similarity of the April Z-068 H-3 value to the S-1 beach drain was noted in the previous section.

Table 14-3
2016 East Yard Area Manhole Tritium (pCi/l)

MH	4/28-29/2016	10/28/2016
Z-066A	234 ± 86	227 ± 94
Z-067A	226 ± 83	246 ± 95
Z-066B	218 ± 82	102 ± 89
Z-067B	230 ± 83	180 ± 92
Z-066C	222 ± 82	166 ± 92
Z-067C	192 ± 81	126 ± 90
Z-066D	167 ± 80	207 ± 93
Z-067D	190 ± 81	224 ± 94
Z-068	496 ± 95	187 ± 93
MDC	146	177
ND = not detected		

14.4 Façade Wells and Subsurface Drainage System

There are two methods of sampling the groundwater under the plant foundation. The first is a set of four shallow wells, two in each façade. The other is a subsurface drainage system (SSD). The façade wells were installed to monitor for groundwater conditions which may be detrimental to the integrity of the concrete and rebar of each unit's foundation. The SSD was designed to relieve hydrostatic pressure on each unit's foundation as well as the Auxiliary and Turbine buildings.

The façade wells are not located symmetrically in the two units. The Unit 1 façade wells are east of the containment in the SE (1Z-361A) and NE (1Z-361B) corners of the façade. However, in Unit 2, there is one well in the NW corner (2Z-361A) and

the other rotated approximately 180° in the SW corner (2Z-361B). In each the well cap is level with the floor.

The 2016 façade well results are shown in Table 14-4. The Unit 1 wells continue to have higher H-3 concentrations than the U2 wells with 1Z-361A, in the SE corner of the Unit 1 façade, having the highest H-3 concentrations. The highest results are in line with the 2013, 2014, and 2015 highs of 324, 375, and 346 pCi/l, respectively. By contrast, the 2007 and 2008 high concentrations were 1169 - 1331 pCi/l. Based on these façade well results, the conclusion is that H-3 is unevenly distributed in the soil beneath and that the H-3 concentrations are decreasing.

Table 14-4
2016 Facade Well Water Tritium (pCi/l)

Month	UNIT 1		UNIT 2		MDC
	1Z-361A	1Z-361B	2Z-361A	2Z-361B	
January	242 ± 82	146 ± 78	NS ±	ND ±	140
April	295 ± 90	153 ± 83	ND ±	ND ±	152
May	190 ± 85	45 ± 78	ND ±	NS	152
July	138 ± 80	138 ± 80	ND ±	ND ±	150
October	211 ± 87	75 ± 79	ND ±	ND ±	156

To relieve hydrostatic pressure on the foundation, Point Beach has an external and an internal subsurface drainage system (SSD) to drain groundwater away from the foundation.

The internal SSD consist of perforated piping which drains groundwater by gravity to a sump located in the Unit 2 façade. The part of the SSD under the Turbine Building is at a higher elevation than the part under the facades. The SSD sump results are presented in Table 14-5. The 2016 concentrations are more variable than those measured in 2015 as evidenced by an average and standard deviation of 918 ± 447 pCi/l compared to 590 ± 128 in 2015. Also, while the highest 2015 concentration was 721 pCi/L, four concentrations >1000 occurred in 2016.

Table 14-5
2016 Unit 2 Facade SSD Sump H-3 (pCi/l)

Date	pCi/l	2σ	MDC
01/31/16	199 ±	102	150
02/29/16	510 ±	102	149
03/31/16	507 ±	99	150
4/30/216	572 ±	102	152
05/31/16	1018 ±	133	157
06/30/16	1230 ±	125	147
07/31/16	1333 ±	128	146
08/31/16	929 ±	116	149
09/30/16	615 ±	104	151
10/31/16	966 ±	119	177
11/13/16	1616 ±	140	158
12/31/16	1523 ±	136	155
Average	918 ±	447	

Why the façade wells have lower H-3 concentrations than the SSD sump is not known. The difference does illustrate that during 2016 the groundwater H-3 was not uniformly distributed under the foundation.

The external SSD system runs along the external foundation walls for the Unit 1 and Unit 2 facades, the Auxiliary Building, the North Service Building, and the Turbine Hall. It is not connected to the internal SSD system. During 2014, work to mitigate the possibility of external flooding events uncovered the N (S-12) and S (S-13) external SSD outfalls. Both the north and south halves of the external SSD system drain toward the beach. No samples from the external SSD S-13 were obtained in 2016 because there was not flow. One sample was obtained from S-12 with a H-3 concentration of 236 ± 93m pCi/L. This is comparable to the concentrations found in various manholes (Table 14-3) on the east side of the plant.

In addition to H-3 analysis, the façade wells and internal SSD samples were gamma scanned. As in lake water samples, small positive values below their calculated, minimum detectable concentrations were found. The isotopes in the SSD and façade wells were Be-7, Mn-54, Fe-59, Co-58/60, Zr-Nb-95, Cs-137, and Ba-La-140. Only the Co-60 in the October façade well sample was above its MDC (3.1 ± 1.4, MDC = 2.4). There are no known inputs to the soil beneath the plant. Therefore, because all but one of the values were less than or equal to the MDC, it is concluded that these results, including the Co-60, are false positives.

14.5 Potable Water and Monitoring Wells

Outside of the protected area, ten wells, in addition to the main plant well (Section 11.7), are used for monitoring H-3 in groundwater: the four potable water wells, GW-04 (Energy Information Center or EIC), GW-05 (Warehouse 6), GW-18 (Warehouse 7), GW-06 (Site Boundary Control Center), and six H-3 groundwater monitoring wells, GW-11 through GW-16 (Figure 13-1). The potable water wells monitor the deep, drinking water aquifer whereas the monitoring wells penetrate less than 30 feet to monitor the top soil layer. The potable water aquifer is separated from the shallow, surface water aquifer by a thick, impermeable clay layer. The potable water wells had no detectable H-3 (Table 14-6).

The monitoring well results are similar to that obtained in 2015. The two monitoring wells showing consistent, detectable H-3 (GW-15, GW-16) are in the flow path from the retention pond area to the lake (Table 14-7). In contrast to previous years (Table 14-8), the highest H-3 concentration occurs at GW-14 located on the bluff above Lake Michigan and north of the plant and not GW-15, nearest the former unlined retention pond. This the only GW-14 H-3 value above the MDC whereas two of the four GW-15 values are above the MDC. Also, at GW-15, two of the duplicate samples had non-detectable results. At these low concentrations, these differences may not be significant based on the statistical uncertainty of the analyses. Finally, the results from GW-16 (further downstream from the retention pond area) are generally higher than the GW-15 results. This was not observed previously (Table 14-8).

Table 14-6
2016 Potable Well Water Tritium Concentration (pCi/l)

Month	EIC WELL GW-04	EIC MDC	Warehouse 6 Well GW-05	SBCC Well GW-06	WH 7 GW-18	GW-05, 06, 18 MDC
Jan	ND	148	ND	ND	ND	141
Feb	ND	155				
Mar	ND	145				
Apr	ND	147	ND	ND	ND	148
May	ND	151				
Jun	ND	150				
Jul	ND	145	ND	ND	ND	147
Aug	ND	155				
Sep	ND	148				
Oct	ND	182	ND	ND	ND	151
Nov	ND	180				
Dec	ND	153				

ND= not detected

In summary, the results from monitoring wells GW-15 and GW-16 as well as results from the nearby surface water sample locations (GW-03, the east creek; GW-08, the bog to the SE of the former pond; and GW-17, the surface water on the SE corner of the STP) show that the area around and in the groundwater flow from the former retention pond remain impacted by the H-3 that diffused from the pond into the soil while it was in use.

Table 14-7 2016 Quarterly Monitoring Well Tritium (pCi/l)

Q	MW-01 GW-11	MW-02 GW-12	MW-06 GW-13	MW-05 GW-14	MW-04 GW-15	MW-03 GW-16	MDC
1	122 ± 76	ND ±	100 ± 75	81 ± 74	213 ± 81	201 ± 80	140
2	93 ± 79	ND ±	ND ±	103 ± 79	*143 ± 86	220 ± 85	149
3	160 ± 81	ND ±	ND ±	236 ± 85	125 ± 79	181 ± 82	145
4	ND ±	ND ±	ND ±	ND ±	*171 ± 87	ND ±	156

ND= not statistically different from zero and <MDC. NS = no sample available

*Duplicate samples taken. The other results were ND.

Table 14-8 2013 Quarterly Monitoring Well Tritium (pCi/l)

Q	MW-01 GW-11	MW-02 GW-12	MW-06 GW-13	MW-05 GW-14	MW-04 GW-15	MW-03 GW-16	MDC
1	115 ± 77	ND ±	ND ±	ND ±	278 ± 84	NS ±	143
2	128 ± 83	90 ± 81	84 ± 81	151 ± 84	277 ± 89	232 ± 87	146
3	ND ±	ND ±	106 ± 85	ND ±	252 ± 92	210 ± 90	152
4	87 ± 78	ND ±	ND ±	81 ± 78	255 ± 87	169 ± 83	149

ND= not statistically different from zero. NS = no sample available

14.6 AC Condensate Samples

The results from the airborne H-3 recapture study presented in the 2011 AMR demonstrated that the H-3 via precipitation was higher close to the plant than away from the plant. Additionally, it was shown that the condensate from AC units located on building roofs and within the plant contained high concentrations of H-3. Similar results for AC condensate were demonstrated in 2012, 2013, 2014, and 2016. No AC condensate samples were collected in 2015. A comparison of the results is shown in Table 14-9.

Table 14-9
Comparison of 2012, 2013, 2014 and 2016 AC Condensate

Location	2012 H-3 (pCi/l)	2σ	2013 H-3 (pCi/l)	2σ	2014 H-3 (pCi/l)	2σ	2016 H-3 (pCi/l)	2σ
NSB (4th floor)	557 ±	102	478 ±	102	328 ±	101	NS	
Turbine Bldg 66'	998 ±	118	757 ±	112	527 ±	108	6096 ±	240
S Service Bldg Roof	5822 ±	231	2606 ±	166	2690 ±	166	2911 ±	174
South Gate Roof	473 ±	99	217 ±	91	173 ±	95	171 ±	85
Turbine Bldg 8'	602 ±	104	1055 ±	123	874 ±	119	NS	
Training Bldg Roof	185 ±	86	203 ±	90	ND ±		ND	

NS = no sample ND = not detected, measured value - $2\sigma \leq 0$

These results show that the H-3 concentrations continue to be higher in the immediate vicinity of Units 1 and 2 (S. Service Building and Turbine Building) than at the Training Building, which is some 800 feet south. The higher concentrations occurring within the area of the yard drains feeding beach drains support the conclusion that precipitation scavenging and roof drains continue to be a source for the H-3 found in the beach drains.

15.0 GROUNDWATER SUMMARY

Groundwater monitoring indicates that low levels of tritium continue to occur in the upper soil layer but not in the deep, drinking water aquifer. These results also indicate that the low levels of tritium are restricted to a small, well defined area close to the plant. Results from precipitation analyses (2011 AMR) show that airborne H-3 concentrations are higher close to the plant as compared to results at the site boundaries. The observed tritium concentrations in the yard manholes can be explained by the higher H-3 in precipitation close to the plant. In addition to tritium captured by precipitation, the beach drains also receive the H-3 captured in the AC condensate because the condensate drainage is connected to the yard drain system.

Tritium continues in the soil below the plant foundation as evidenced by results from the subsurface drainage system and from the façade wells.

Except for the monitoring wells downstream from the former retention pond, the monitoring well tritium concentrations are not different from zero. These results conform to the known

west-to-east groundwater flow at the site. Therefore, the impact on beach drain tritium results from the flow of tritiated groundwater from the vicinity of the former retention pond toward the lake as cannot be discounted.

In conclusion, the groundwater H-3 concentrations observed at Point Beach are below the EPA drinking water standards prior to emptying into Lake Michigan where they will undergo further dilution. All analyses to date indicate that the drinking water contains no tritium. None of the H-3 in the upper soil layer is migrating off-site toward the surrounding population. This is based on the known west-to-east groundwater flow toward Lake Michigan and the negative results from the four wells (GW-11 through GW-14, Figure 13-1). Additionally, because no H-3 is detected in either of the four on-site drinking water wells close to the power block or from the drinking water well at the site boundary, none of the H-3 observed in the upper soil layer has penetrated into the drinking water aquifer to impact either on-site or off-site personnel.