Environmental Radionuclide Concentrations in the Vicinity of the Calvert Cliffs Nuclear Power Plant and Peach Bottom Atomic Power Station 2018-2019

MARYLAND POWER PLANT RESEARCH PROGRAM

Wes Moore - Governor | Aruna Miller - Lieutenant Governor
Josh Kurtz - Secretary

Contact Information:

Toll Free in Maryland 1-877-620-8DNR ext. 8772 or 410-260-8772
Web: dnr.maryland.gov

Maryland Department of Natural Resources
Resource Assessment Service
Power Plant Research Program
580 Taylor Ave.
Annapolis, MD 21401

The facilities of the Maryland Department of Natural Resources are available to all without regard to race, color, religion, sex, sexual orientation, age, national origin or physical or mental disability.

PPRP-R-37
DNR12-020422-302
June 2025

FOREWORD

This report, *Environmental Radionuclide Concentrations in the Vicinity of the Calvert Cliffs Nuclear Power Plant and The Peach Bottom Atomic Power Station: 2018–2019*, contains the results of monitoring and research conducted by the Maryland Department of Natural Resources, Power Plant Assessment Division (PPAD), to evaluate the fate and effects of radionuclides released from the Calvert Cliffs Nuclear Power Plant and the Peach Bottom Atomic Power Station in 2018 and 2019. This is the 24th in a series of radiological assessment reports detailing PPAD's monitoring efforts since 1975. This report was prepared under Contract Number K00B8400006 between PPAD and Versar, Inc.

The authors thank Captains Rick Younger and Gary Culver and first mates Keith Lindemann and Eric Montgomery (Maryland Department of Natural Resources) of the R/V Kerhin (Maryland Resource Assessment Service) for vessel support to collect sediment for radiological analysis. We thank Mr. J. Hixson and staff (Morgan State University, Patuxent Environmental and Aquatic Research Laboratory) for designing equipment and collecting oyster samples. We also thank David Wong, Patrick Donovan, Ryan Corbin, Marc Molé, and Martin Berlett (Versar, Inc.) for collecting samples of sediment and biota. Brent Hood, Estuardo Monterroso, Magdelyn Glaudemans, Amanda Bromilow, Lauren McDonald, Allison Hoy, Allison Foreman, Stephanie Day, István Turcsányi, and Charles Tonkin collected samples of air, water, and milk. Lastly, we would like to thank Exelon Generation Company for providing radionuclide release data for the Calvert Cliffs Nuclear Power Plant and the Peach Bottom Atomic Power Station.

Brent Hood, István Turcsányi, Max Ruehrmund, and Patrick Donovan of the PPAD Radioecology Laboratory assisted with preparing samples, analyzing sediment particle size, and preparing tables and graphics from accumulated radiological data, under the direction of Thomas S. Jones, Laboratory Director and Project Manager. The Radiation Chemistry Laboratory of the Maryland Department of Health (MDH) assisted with analyzing air, water, and milk samples. Allison Brindley contributed to the preparation and technical editing of the report. István Turcsányi, Brent Hood, Marc Molé, and Madison Schwaab assisted with analytical data compilation. Nancy Wilkins supervised the production of this report.

The preferred citation for this report is

PPAD (Power Plant Assessment Division). 2023. Environmental Radionuclide Concentrations in the Vicinity of the Calvert Cliffs Nuclear Power Plant and the Peach Bottom Atomic Power Station: 2018–2019. PPRP-R-37. Final, November 2023. Maryland Department of Natural Resources, Power Plant Assessment Division, Annapolis, MD.

ABSTRACT

The Maryland Power Plant Assessment Division monitors concentrations of radionuclides in samples collected from the vicinity of the Calvert Cliffs Nuclear Power Plant (CCNPP) and the vicinity of Peach Bottom Atomic Power Station (PBAPS) to further understand the effects of the electric generating industry on human and ecological health. The radioactivity in the material derives from power plant operations, historic weapons testing, and natural sources. The purpose of the monitoring program is to estimate the fate and transport of radionuclides released from the two power plants and to apply the results to risk models to estimate potential consequences to the environment and human health. The 2018–2019 report describes monitoring activities and data collected during the 2018 and 2019 calendar years; it is the 24th in a series that documents the results of monitoring studies conducted at CCNPP since 1975 and PBAPS since 1979.

Scientists used high-resolution gamma spectrometry, liquid scintillation spectrometry, and proportional counting to measure the concentrations of radionuclides (measured as radioactivity per unit weight or volume) in samples of shellfish, finfish, aquatic vegetation, sediment, air, water, and milk. Radionuclides in environmental samples originated from normal operations of CCNPP and PBAPS, historic atmospheric testing of weapons, and natural sources.

Most samples of sediment collected from the vicinity of the two power plants contained measurable concentrations of radionuclides that had also been released during plant operations at CCNPP and PBAPS. The radionuclide ^{137}Cs was found in 86 percent of the samples collected from CCNPP and 100 percent of the samples collected from PBAPS; although both power plants released ^{137}Cs through the aqueous pathways during the 2018–2019 reporting period, the majority of the concentrations of the radionuclide found in the sediments were likely remnants of legacy power plant releases and fallout from historic weapons testing. A principal power plant-related radionuclide was an isotope of cobalt (^{60}Co) detected in sediments from PBAPS (2.6 percent of samples) but not at CCNPP. Radionuclides likely solely attributable to CCNPP and PBAPS represented a very small fraction of the total radioactivity measured in sediments and biota collected from the regions around CCNPP and PBAPS. Naturally occurring radionuclides were responsible for more than 99% of the gamma-emitting radionuclides found in most sediment samples collected during the 2018–2019 reporting period.

The radionuclide ^{137}Cs was the only radionuclide associated with the fallout from weapons testing (i.e., historic atmospheric tests of nuclear weapons) detected in environmental samples collected in 2018 and 2019. A naturally occurring radioactive isotope of potassium (^{40}K) and decay products of uranium and thorium were detected in most samples of biota and all samples of sediment collected during the monitoring period. Background levels of an isotope of beryllium (^{7}Be), alpha radiation, and beta radiation were detected in samples of air and precipitation. Concentrations of naturally occurring radionuclides detected in samples were typically orders of magnitude greater than those of radionuclides released from power plants.

Concentrations of radionuclides detected during the 2018–2019 reporting period would not represent a risk to the ecological health of the Chesapeake Bay or the Susquehanna River or humans that come into contact with the media monitored. The additional increment of radioactivity and radiation dose attributable to the operation of CCNPP and PBAPS is minimal when compared with natural levels of radioactivity and the associated natural radioactive dose. The incremental increase in the dose to humans that could result from the consumption of biota from the vicinity of CCNPP and PBAPS, and which may be attributable to nuclear power production operations, was no more than 0.05% of the dose attributable to natural and other man-made sources, according to model results. All quantities released resulted in estimated doses that were no more than 16% of the regulatory limits set by the United States Nuclear Regulatory Commission.

TABLE OF CONTENTS

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

ACRONYMS, CHEMICAL ABBREVIATIONS, AND UNITS OF MEASUREMENT

ACRONYMS

CCNPP	Calvert Cliffs Nuclear Power Plant
LLD	Lower limit of detection
MDH	Maryland Department of Health
PBAPS	Peach Bottom Atomic Power Station
PPAD	Power Plant Assessment Division
PPRP	Power Plant Research Program
PSEG	Public Service Enterprise Group
USEPA	United States Environmental Protection Agency
USNRC	United States Nuclear Regulatory Commission

ELEMENTS AND RADIONUCLIDES

Ag	silver
^{110m}Ag	silver-110m
Ac	actinium
Be	beryllium
^{7}Be	beryllium-7
Bi	bismuth
C	carbon
^{14}C	carbon-14
Ce	cerium
Co	cobalt
^{58}Co	cobalt-58
^{60}Co	cobalt-60
Cr	chromium
H	hydrogen
Cs	cesium
^{137}Cs	cesium-137
Cu	copper
Fe	iron
Ge	germanium
^{3}H	tritium
I	iodine
^{131}I	iodine-131
K	potassium
^{40}K	potassium-40
La	lanthanum
Li	lithium
Na	sodium
Nb	niobium
P	phosphorus
Pb	lead
Ra	radium
Ru	ruthenium
Sb	antimony
Se	selenium
Sr	strontium
^{89}Sr	strontium-89
^{90}Sr	strontium-90
Th	thorium
Tl	thallium
U	uranium
Xe	xenon
Zn	zinc
^{65}Zn	zinc-65
Zr	zirconium

UNITS OF MEASUREMENT

Bq	becquerel	L	liter
Ci	curie	m	meter
cm	centimeters	m^3	cubic meter
fCi	femtocurie (10^{-15} Ci)	m^3/s	cubic meter per second
ft^3/s	cubic feet per second	mCi	millicurie (10^{-3} Ci)
GWe-yr	gigawatt electrical-year	mm	millimeter
GWh	gigawatt hour	mrem	millirem
keV	kiloelectronvolt	pCi	picocurie (10^{-12} Ci)
kg	kilogram (10^3 grams)	TBq	terabecquerel (27.027 Ci)
km	kilometer	yr	year

RADIOLOGICAL DEFINITIONS AND REPORT TERMS

Absorbed dose. The amount of radiation absorbed by a material. The unit of absorbed dose is the radiation absorbed dose (rad).

Activity. The quantification of the rate of decay of radioactive material.

Becquerel (Bq). One of three units that define the quantity of radioactivity in a sample. One becquerel is defined as one disintegration per second.

Chain. A radionuclide (parent) and all of the atomic transformations that it undergoes (daughters; decay products) as it decays.

Curie (Ci). One of three units that define the quantity of radioactivity in a sample. One curie is defined as 3.7×10^{10} disintegrations per second.

Decay. The spontaneous transformation of one radionuclide into a different radioactive or non-radioactive nuclide, or into a different energy state of the same nuclide.

Dose commitment. The absorbed dose that an organ or tissue would accumulate during a specified period of time as a result of intake (e.g., by ingestion or inhalation) of one or more radionuclides.

Effective dose. A measure of the damage to a tissue or quality factor as a result of exposure to radiation. The unit for effective dose is the roentgen equivalent man (rem).

Environmentally significant. Radionuclides that are known to be assimilated (bioaccumulated) by biological organisms do not decay rapidly to stable forms and are discharged in detectable amounts.

Half-life. The time required for a radioactive substance to lose half of its activity by decay.

Ionizing radiation. Any electromagnetic or particulate radiation capable of producing ions (electrically charged atoms or atomic particles), directly or indirectly in its passage through matter.

Maximally exposed individual. A hypothetical individual who remains in an uncontrolled area and would receive the greatest possible dose when all potential routes of exposure from a facility's operations are considered.

Photopeak. A full-energy peak in the spectrum resulting from the unimpeded interaction of source photons on the detector as they release all of their energy.

Rad. A measurement unit for the amount of radiation energy deposited in a medium from the radiation source as it passes through the medium (see absorbed dose).

Radionuclide. An unstable nuclide capable of spontaneous transformation into other nuclides by changing its nuclear configuration or energy level. This transformation is accompanied by the emission of photons or particles.

Rem. A measurement unit for the effective dose (see effective dose).

Stable. Not radioactive or not easily decomposed or otherwise modified chemically.

1.0 INTRODUCTION

The Maryland Power Plant Assessment Division (PPAD) sponsors research on the effects of the electric generating industry on human and ecological health. To contribute to these efforts to understand complex interactions, PPAD monitors radionuclide concentrations in environmental samples that have the potential for affecting human and ecological resources in Maryland. The Power Plant Assessment Division has conducted research and monitoring to assess the effects of radioactive material released from Calvert Cliffs Nuclear Power Plant (CCNPP) since 1975 and Peach Bottom Atomic Power Station (PBAPS) since 1979 on Maryland's environmental resources and to estimate potential exposure risks to humans, specifically via ingestion of foods and drinking water obtained from the regions of the two power plants that may contain traces of radionuclides.

The two facilities, CCNPP and PBAPS, generate minimal gaseous and liquid radioactive wastes that are discharged into the atmosphere and adjacent surface waters, respectively. Calvert Cliffs Nuclear Power Plant is located in southeastern Calvert County, Maryland, on the western shore of the Chesapeake Bay. Peach Bottom Atomic Power Station is located in southeastern York County, Pennsylvania, on the western shore of the lower Susquehanna River. Both power plants draw cooling water from the adjacent bodies of water; the cooling water absorbs radioactivity as it passes through the plants' nuclear reactor chambers. The power plants return the irradiated cooling water to the same bodies of water in the form of aqueous discharge, as a function of normal plant operations; the facilities release a by-product of the cooling process to the air as water vapor through the cooling towers. The aqueous discharges to the Chesapeake Bay and the Susquehanna River may contain radionuclides that can become associated with sediments and accumulated by biota. Ultimately, these radionuclides may contribute to a radiation dose to humans by being transported through the food chain. The atmospheric discharges disperse through the ambient air as a plume from each facility. As the plume interacts with the surrounding air and precipitation, some of the particles from the plume settle on exposed surfaces in the region around the power plants (e.g., soil and plants). These particles can then be assimilated into the groundwater or consumed by herbivores.

The 2018–2019 Radionuclide Monitoring Report provides summaries of the results of monitoring programs conducted in the vicinities of CCNPP and PBAPS, and nearby areas of the Chesapeake Bay and the lower Susquehanna River, respectively, in the 2018 and 2019 calendar years by the Maryland Department of Natural Resources, PPAD. The report provides the following qualitative and quantitative information, which is relevant to the 2018–2019 period or the duration of the monitoring program through 2019, as applicable:

- quantities of environmentally significant radionuclides discharged from the nuclear power plants to the atmosphere, Chesapeake Bay, and Susquehanna River;
- descriptions of procedures for collecting, preparing, and analyzing environmental samples;

- concentrations of radionuclides measured in samples of aquatic vegetation, shellfish, finfish, and sediment collected from the lower Susquehanna River and the Chesapeake Bay in 2018 and 2019;
- concentrations of radionuclides measured in samples of air, precipitation, water, and milk collected from the vicinities of CCNPP and PBAPS; and
- an assessment of the potential risks to the environment and human health that were associated with exposure to radionuclides from the discharges from CCNPP and PBAPS as detected in samples from the Susquehanna River, Chesapeake Bay, and other target areas near CCNPP and PBAPS.

1.1 MONITORING OBJECTIVES

The radionuclide monitoring aspect of the overall program is designed to provide information concerning the fate and transport of radionuclides released by the power plants CCNPP and PBAPS to the Chesapeake Bay and the Susquehanna River and to estimate the concentrations of radionuclides absorbed by sediments and representative biota from individual trophic levels of the ecosystems of the Chesapeake Bay and the Susquehanna River in the vicinities of the two power plants. This monitoring tracks the aqueous pathway from each power plant to its receiving waterway. To monitor the aqueous pathway in the receiving waterbody, PPAD collects sediment samples from locations in a pre-determined sampling grid spatially relevant to the discharge points and representative biota from several trophic levels (producers and primary and secondary consumers) in the vicinities of the two power plants.

The two target power plants, CCNPP and PBAPS, release radionuclides to the atmospheric pathway through airborne effluent from the cooling towers. To monitor the behavior of radionuclides in the atmospheric environment, PPAD continuously monitors levels of gaseous and particulate radionuclides in the air and indirectly monitors transport and uptake of airborne radioactivity by periodically collecting samples of precipitation and processed milk. Additionally, PPAD periodically collects drinking water from the vicinity of CCNPP to monitor infiltration of radionuclides into groundwater.

1.1.1 Sediment

Sediment sampling and corresponding analysis determine the areal extent of deposition of radionuclides discharged from the respective power plants' cooling-water outfalls. Such deposition serves as a confirmatory indicator of the power plants' radionuclide discharge reports. Quantifying radionuclide deposition in the sediment layer provides a measure of long-term radionuclide storage compared to naturally occurring radionuclides and an estimate of their potential availability to the food web and potential dose to humans.

1.1.2 Tray Oysters

The Power Plant Assessment Division mounts trays of oysters (*Crassostrea virginica*) in the Chesapeake Bay near the discharge port of CCNPP to expose the oysters to the effluent for a variety of predefined exposure periods. The program monitors the amounts of radionuclides present in the oysters collected from the trays at different times to assess the effects of repeated uptake and elimination (if not bioaccumulated) of radionuclides by the organisms over time. Oysters are sessile; therefore, oysters in the vicinity of CCNPP are more likely than mobile biota such as finfish and crabs to be exposed to aqueous releases of radioactive material. Oysters filter large amounts of particulate material and plankton that may have adsorbed radionuclides and bioaccumulated heavy metals and radionuclides (McLean et al. 1987). Uptake of radionuclides by oysters is governed by physical, chemical, and environmental conditions.

1.1.3 Finfish

Finfish are exposed to radionuclides in the water column. In the vicinity of PBAPS, finfish represent a target for monitoring similar to the tray oysters placed near the CCNPP discharge port. Measurements of radionuclides in the muscle and gut contents of finfish help to identify the pathway of radionuclides through the food web.

1.1.4 Submerged Aquatic Vegetation

The monitoring aspect of the program includes collecting samples of submerged aquatic vegetation (SAV) and measuring the concentrations of radionuclides in the samples. The results provide a determination of radionuclide uptake in these aquatic plants.

1.1.5 Air and Air Particulates

The monitoring aspect of the program includes continuous air sampling in the regions surrounding CCNPP and PBAPS to monitor the distribution of airborne radiation from the two power plants. Air monitoring can also detect the presence in Maryland of radioactive particles or gases from sources other than CCNPP or PBAPS; the continuous readings thus may inform emergency management systems of potential threats to health in the region.

1.1.6 Potable Water

Samples of drinking water collected from municipal tap sources and wells in Calvert County near CCNPP are analyzed for the presence of radionuclides solely as a gauge of the continued passive protections of the County's drinking water by routine operations at CCNPP. The sampling and analysis of potable water is not a required element of nuclear power plant monitoring.

1.1.7 Precipitation

Scientists collect samples of rainfall and analyze them for the levels of radionuclides present. The results provide information about radionuclide deposition through precipitation and auxiliary information about the airborne radiation originating from nuclear power generation. Precipitation monitoring has been used as an indicator of radioactive fallout during active, above-ground nuclear weapons testing; thus, precipitation data are currently used to estimate levels of man-made radionuclides that did not derive from the two regional power plants.

1.1.8 Milk

Airborne radioactivity may be deposited on pastures, be ingested by cows, and become part of cow's milk. The monitoring aspect of the program includes collecting samples of raw and processed milk from dairy farms in the vicinities of CCNPP and PBAPS and analyzing the samples for radionuclides. The results contribute to understanding the behavior of radionuclides in the trophic ecosystem and provide an estimate of dose to humans through uptake of radiostrontium (i.e., ^{89}Sr or ^{90}Sr), which has similar chemical characteristics as calcium and targets human bone.

1.2 RISK ASSESSMENT OBJECTIVES

The Power Plant Assessment Division uses models to estimate the potential effects of radionuclides on individuals that may be exposed to radioactive materials in the vicinities of the two power plants, CCNPP and PBAPS, during the reporting period. The data collected for the radionuclide monitoring program contribute to human risk assessment models as input to the exposure components of the models. Each model accounts for concentrations of radionuclides in the medium of interest (e.g., finfish) as a factor of the pathway from environmental presence to biological absorption. The models also account for the duration of the individual's exposure to each of the affected media. The results of the models estimate the potential risks of exposure to the levels of radionuclides in the environment as documented during the study.

Quantifying radionuclide deposition in the sediment layer provides a measure of long-term storage of plant-released radionuclides compared to naturally occurring radionuclides. In an integrated exposure model scenario, the results could also serve as a component of estimates of the potential availability of radionuclides to the food web and the potential dose to humans through ingestion or dermal exposure.

The monitoring program includes collections of consumables that are likely to be exposed to radionuclides released from the facilities through the aqueous or gaseous pathways; for instance, oysters and milk. Despite the decline in the historic commercial oyster fishery, oysters are still an important indicator of potential radionuclide uptake in humans. Results from the analysis of the radionuclide content of oysters suspended in water on trays provide data that contribute to models of the potential for a dose to humans. The estimated dose from oyster consumption is one of the factors used to verify that CCNPP complies with dose limits as required by its license (see Section 3.3.2). The results from the analysis of the radioactive content of milk samples, collected from dairy farms in the vicinities of the power plants also contribute to an understanding of the ingestion pathway for power plant-related radionuclide emissions.

Measurements of radionuclides in the muscle and gut contents of finfish, from samples of fish collected from the waters near PBAPS, inform a component of the pathway of radionuclides through the food web that is specific to the receiving waters near the facility. Currently, the estimated exposure dose to humans through ingestion of fish that is reported in the biennial environmental assessments published by PPAD is used to verify that PBAPS complies with dose limits as required by its license (see Section 3.3.2).

1.3 DESCRIPTION OF POWER PLANTS AND STUDY SITES

1.3.1 Calvert Cliffs Nuclear Power Plant

Constellation Energy Corporation owns and operates CCNPP in Calvert County, Maryland, on the western shore of Chesapeake Bay (Exelon Generation Company owned the facility during the reporting period). Each of CCNPP's two electricity-generating units is a pressurized water reactor; the combined operating capacity is 1829 megawatts (Power Plant Research Program [PPRP] 2017). Unit 1 is licensed to operate until 2034, and Unit 2 until 2036. Controlled releases of radionuclides through the heat dissipation system are permitted at levels defined in CCNPP's license (issued July 31, 1974, for Unit 1 and November 30, 1976, for Unit 2, renewed March 23, 2000) from the United States Nuclear Regulatory Commission (USNRC, Standards for protection against radiation 1991). During routine operations, CCNPP withdraws cooling water from the Chesapeake Bay at a rate of approximately 2.3 million gallons per minute (PPRP 2017).

The western shore of Chesapeake Bay is scoured by tides, wind, and waves. The bay in this area is approximately 4.5 kilometers (km) wide and relatively shallow. Water depth gradually increases from 10 meters (m) to 15 m approximately 0.8 km from the shoreline. This depth extends approximately 3 km and increases to 20 m at mid-bay. The area is tidally influenced and has a mean tidal range of 0.3 m to 0.6 m. The velocity of the current in the vicinity ranges between 5 centimeters per second (cm/sec) and 60 cm/sec (Lacy and Zeger 1979). Salinity varies seasonally and normally ranges from 7 to 17 practical salinity units. Bottom sediments are characterized by medium-coarse sands at depths ranging between 0 m and 6 m, fine sands and clays at depths of 6 m to 9 m, and clays and organic silt at depths greater than 10 m (Domotor and McLean 1988). A detailed description of the Calvert Cliffs area can be found in the *Final Environmental Statement Related to the Operation of Calvert Cliffs Nuclear Power Plant, Units 1 and 2* (United States Atomic Energy Commission 1973) and in Baltimore Gas and Electric Company’s license renewal application (USNRC 1999).

The Calvert Cliffs region of Chesapeake Bay supports an abundant and diverse macrobenthic assemblage (Llansó et al. 2015) and populations of commercially important finfish and shellfish (Lippson and Lippson 2006). Oysters are present near CCNPP and are commercially harvested from the area. Blue crabs also are abundant throughout the site and are harvested both commercially and recreationally. This area of Chesapeake Bay supports a diverse finfish community, including forage species (e.g., menhaden, anchovies, and silversides) and commercially important predatory species (e.g., weakfish, striped bass, and bluefish), and abundant migratory waterfowl that dive in the vicinity of the power plant in search of food (Swarth and Llansó 2012).

1.3.2 Peach Bottom Atomic Power Station

Constellation Energy Corporation and Public Service Enterprise Group (PSEG) Power, LLC of New Jersey jointly own PBAPS in York County, Pennsylvania (Exelon Generation Company co-owned the facility with PSEG during the reporting period). The power plant, located approximately 5 km north of the Pennsylvania-Maryland border, on the western shore of Conowingo Pond, began operations in 1974. Each of PBAPS's two electricity-generating units is a boiling water reactor with a capacity of 1,140 megawatts (Exelon Generation Company 2012). Controlled releases of radionuclides are permitted at levels defined in PBAPS's license (issued October 25, 1973, for Unit 2 and July 2, 1974, for Unit 3, renewed May 7, 2003, for 30 years) from the USNRC (USNRC 1991, 10 CFR Part 20, Appendix B).

During normal operations, PBAPS withdraws cooling water from the portion of the Susquehanna River known as Conowingo Pond at a maximum rate of 1.5 million gallons per minute (3,342 cubic feet per second [ft^3/s] or 95 cubic meters per second [m^3/s]; Peach Bottom Atomic Power Station, Units 2 and 3, 2014). Conowingo Pond also receives radionuclides in aqueous discharges from the plant during normal operations. Conowingo Pond is an impoundment created by Conowingo Hydroelectric Dam (13 km downstream from PBAPS). Holtwood Dam (10 km upstream of PBAPS) is just upstream of the northern reach of Conowingo Pond. Conowingo Pond has an average surface area of approximately 3,700 hectares (14 square miles) and ranges in depth from about 3 m in upriver sections to a maximum of about 27 m at the face of Conowingo Dam. The annual average river flow at the Conowingo Dam is approximately 1,171 m^3/s (41,350 ft^3/s; U.S. Geological Survey 2020). Downriver flow may be affected by the withdrawal and discharge of cooling water for PBAPS; periodic cycling of water at the Muddy Run Pumped Storage Facility on the eastern shore, north of the plant; and operation of the turbines at Conowingo Dam.

The Susquehanna River enters the tidal portion of Chesapeake Bay approximately 6 km downstream from Conowingo Dam. The location of the resulting interface between fresh water and salt water fluctuates at the river mouth (Susquehanna Flats) or the upper Chesapeake Bay and is controlled principally by river volume. The transition from fresh to brackish water is accompanied by changes in physical and chemical factors that affect the degree to which metals and radionuclides become or remain associated with particles suspended in the water column (Olsen et al. 1989). These factors influence the dispersion and distribution of radionuclides in the Susquehanna River-Chesapeake Bay system.

The Susquehanna River-Chesapeake Bay system supports an abundant and diverse macrobenthic assemblage as well as populations of recreationally and commercially important finfish (PPRP 1998, Llansó et al. 2015). Conowingo Pond contains largemouth and smallmouth bass, walleye, sunfish, channel catfish, carp, and hybrids of white and striped bass, which are principal components of the recreational fishery downstream of Conowingo Dam. Further downstream, white perch, channel catfish, blueback herring, American shad, and American eels are commercially fished on Susquehanna Flats. The Susquehanna Flats area supports seasonal stands of SAV, primarily Eurasian milfoil (*Myriophyllum spicatum*), and is an important early wintering ground for migratory waterfowl (White 1989, Lippson and Lippson 2006).

2.0 METHODS AND MATERIALS

2.1 SAMPLE COLLECTION PROCEDURES

Teams of scientists collected environmental samples for radiological analysis from the vicinities of CCNPP and PBAPS and in control areas. The sample types included sediments, biota (oysters, finfish, and submerged aquatic vegetation), air and air particulates, potable water, precipitation (rain), and milk. The sample types, collection frequency, and number and distribution of collection sites are summarized in Table 2-1.

Table 2-1. Environmental samples for radiological analysis collected in the 2018–2019 period from the vicinities of CCNPP, PBAPS, and at control locations

Sample Medium	Collection Frequency Planned	Number of Sampling Locations Planned	Description of Target Sampling Locations and Qualifications on Sampling Efforts Applicable to the Period
Sediment	Quarterly*	28	Chesapeake Bay in the vicinity of CCNPP along eight transects (Fig. 2-1); * in 2018–2019, there were only three sediment collection efforts, due to issues with boat scheduling
Sediment	Spring and Fall	19	Conowingo Pond (12 stations); Susquehanna Flats (6 stations); Upper Chesapeake Bay (1 station)
Oysters	Quarterly	3	St. Leonard Creek, Plant Outfall, and Camp Conoy (oyster trays; Fig. 2-1)
Finfish	Spring and Fall	1	Conowingo Pond, on the western shore downstream of the PBAPS discharge at Station Little Yellow House (Fig. 2-2)
Submerged Aquatic Vegetation (SAV)	Summer and Fall (as per sampling plan)	3**	** SAV samples were only collected from the Susquehanna Flats at Fishing Battery station, in Fall 2019; other SAV stations not sampled in the period (Fig. 2-2)
Glass Fiber Filter (air particulates)	Continuously (exchanged weekly)	8	Long Beach, Lusby, and Cove Point (Calvert Co.) Baltimore City Rising Sun and Dempsey's Farm (Cecil Co.) Whiteford (Harford Co.) Horn Point (Eastern Shore, Dorchester Co.)
Charcoal Filter (air)	Continuously (exchanged weekly)	8	Same sampling locations as for air particulates (see above)
Potable Water	Monthly to Quarterly	8	Seven public drinking establishments in Calvert Co. (Fig 2-4); Baltimore City
Precipitation	Weekly to Monthly	1	Baltimore City, on the roof of the building at 301 West Preston St.
Processed Milk	Quarterly	1	Baltimore City
Raw Milk	Quarterly	1	Kilby Farm (Cecil Co.)

2.1.1 Sediments

Field teams collected sediments periodically from the series of transects shown in Figure 2-1 and Figure 2-2. Station coordinates are given in Appendix A. Each team used a hydraulic box-grab to collect sediments in the vicinity of CCNPP (quarterly). At stations surrounding PBAPS (semi-annually), teams used a hand-operated Young grab to collect sediments. For each sample, the teams recovered the top 10 cm (or less) of sediment from each grab. The teams repeatedly collected surface sediment samples, as needed, at each station and compiled the results to amass approximately 3,000 cubic centimeters of sediment for a successful sample. Teams delivered the sediment samples to the PPAD Radioecology Laboratory for radionuclide analysis.

2.1.2 Biota

For the tray-oyster study at CCNPP, scientists placed mature oysters into partitioned trays (Abbe 1981) and submerged the trays at indicator (test) and control locations for a variety of exposure periods (Figure 2-1). The primary indicator site was near the CCNPP outfall (coordinates: 38 23.640, -76 26.537) to evaluate radionuclide concentrations in oysters exposed to CCNPP discharges. The control site for the 2018–2019 reporting period was in St. Leonard Creek at Morgan State University's Benedict Laboratory (coordinates: 38 23.640, -76 30.203). Prior to 2010, the control site was north of the CCNPP cooling-water outfall at Kenwood Beach (coordinates: 38 30.0105, -76 29.11066), but the control location was moved in December 2009 due to low dissolved oxygen, dermo disease, and high mortality of oysters at the Kenwood site. Trays were supported by a platform resting approximately 0.5 m from the bottom (approximately 5 m to 5.5 m from the surface). Each tray had four compartments designed to hold 50 oysters each. Scientists retrieved and restocked the oysters from individual compartments (50 per group) on an approximate schedule: 3, 6, 9, and 12 months. Oysters destined for the tray study were dredged from the Patuxent River at the Gatton natural bar near St. Thomas Creek (coordinates: 38 23.43516, -76 33.5025). Field teams shuck the oysters, transfer the oyster flesh to a freezer, and deliver the oyster samples (frozen) to the PPAD Radioecology Laboratory for analysis. In addition, field teams under contract to Exelon harvested oysters at a site near Camp Conoy (coordinates: 38 26.133, -76 25.75). Teams delivered the oyster flesh samples (frozen) to the Radiation Chemistry Laboratory of the Maryland Department of Health (MDH) for analysis as split samples. The results of the analysis of oysters from Camp Conoy are provided in the 2018–2019 radionuclide report as indicator data, for comparison purposes.

Biota for radiological analysis collected from the PBAPS study site included forage finfish, recreationally and commercially important finfish, and SAV (Figure 2-2). Field teams collected edible and forage finfish by electrofishing or by gill net (1-, 2-, and 4-inch experimental mesh) near the outfall of the PBAPS facility. Teams collected samples of SAV by hand at the Susquehanna Flats Fishing Battery Station. The Conowingo Pond station and the Susquehanna River Interstate 95 Bridge Station SR-3 did not contain SAV in 2018

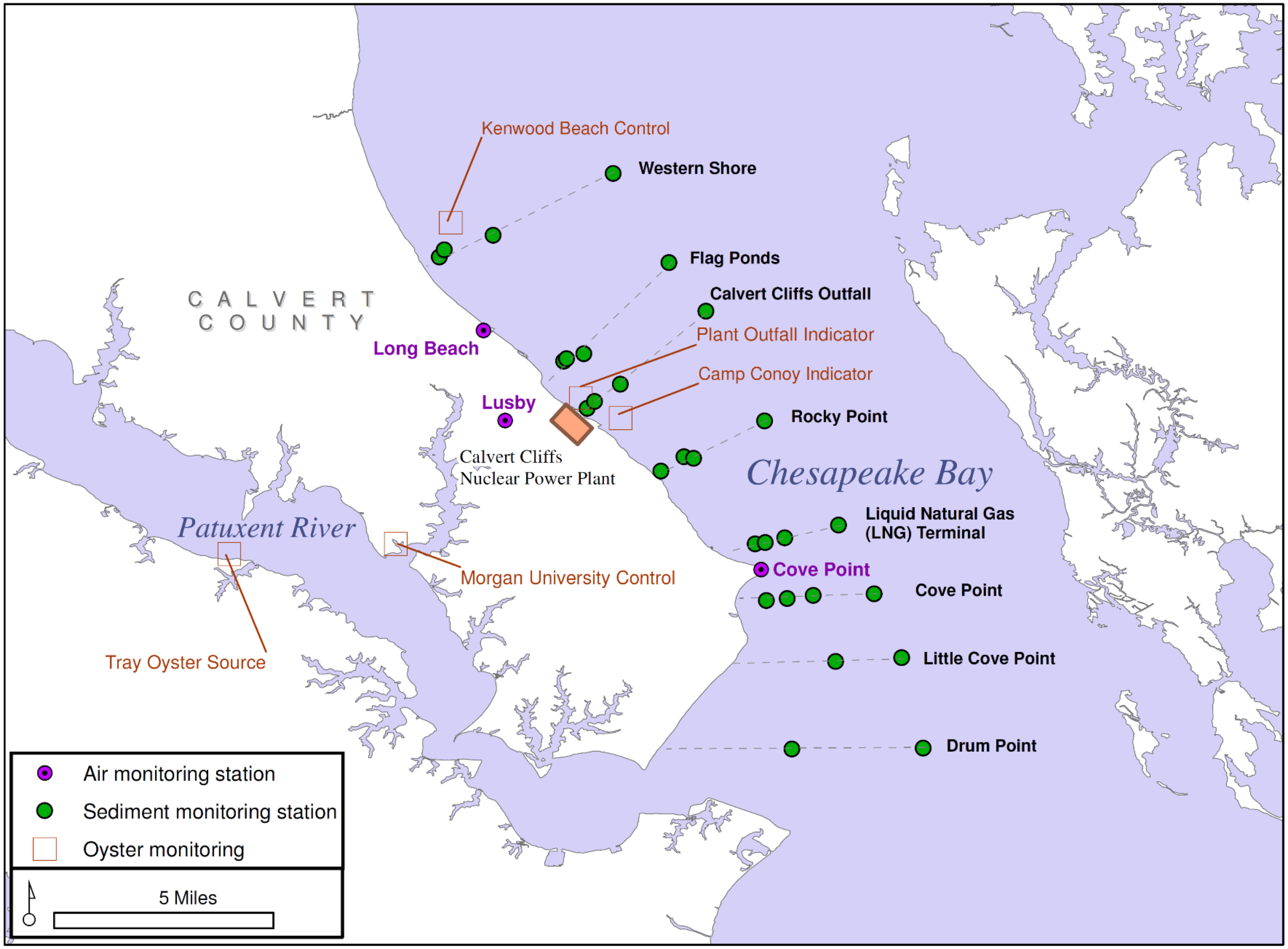


Figure 2-1. Transects and stations for samples collected from the Chesapeake Bay near the Calvert Cliffs Nuclear Power Plant

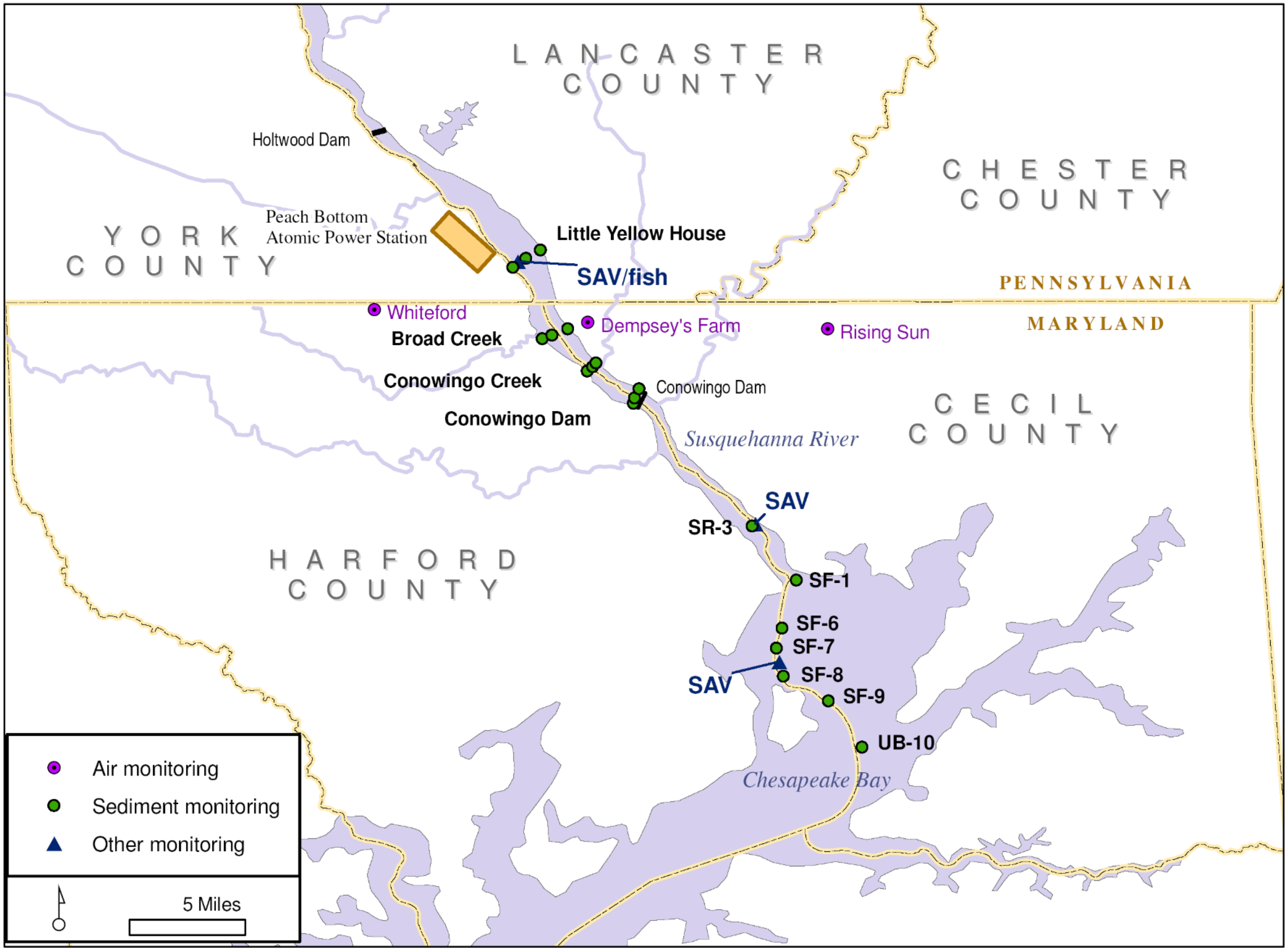


Figure 2-2. Transects and stations for samples collected from the lower Susquehanna River and upper Chesapeake Bay near the Peach Bottom Nuclear Power Plant

or 2019. Teams delivered the finfish and SAV samples to the PPAD Radioecology Laboratory for analysis.

2.1.3 Air and Air Particulates

Field teams collected samples of air and air particulates near CCNPP and PBAPS from permanently mounted air samplers (Figure 2-3). The continuously operating samplers were either an AVS-28A Portable Constant Flow Air Sampler or an HD-28A Portable Air Sampler manufactured by RADēCO (Plainfield, CT). The air samplers were mounted inside weatherproof housing affixed to utility poles or other permanent fixtures and connected to AC electric power. The samplers were fitted with holders for open-face cartridges and filters and calibrated to pump at a continuous air flow rate of 1 ft^3/min. Sampling media for monitoring air and air particulates were charcoal canisters that had the dimensions 57.7 millimeters (mm) in diameter by 26.4 mm in thickness and glass fiber filters that were 47 mm in diameter, respectively. Field teams exchanged the sampling media for both sample types weekly and delivered the sample media to the MDH Radiation Chemistry Laboratory for analysis.

2.1.4 Potable Water

Field teams collected samples of potable water quarterly from establishments (e.g., schools or government buildings) in the vicinity of CCNPP, north and south of the plant (Figure 2-4). Field personnel collected water from public drinking water fountains into 1-liter plastic containers. Staff collected the control samples monthly into 1-gallon cubitainers (i.e., a cube-shaped flexible plastic container with a screw-on cap). Teams delivered the potable water samples to the MDH Radiation Chemistry Laboratory for analysis. Baltimore City tap water (collected as a sample from within the MDH Radiation Chemistry Laboratory) served as a control for radioactive content in drinking water.

2.1.5 Precipitation

Field teams collected samples of precipitation weekly to monthly (when sufficient rain had been collected) from a 20-gallon carboy positioned below an aluminum funnel that was mounted permanently on the roof of the Maryland State office building at 301 West Preston Street in Baltimore (Figure 2-3). If sufficient precipitation had been collected in the carboy, the team documented the amount of rainfall measured by the analog rain gauge and transferred the accumulated sample to a 1-gallon cubitainer. Teams delivered the precipitation samples to the MDH Radiation Chemistry Laboratory for analysis.

2.1.6 Milk

Field teams collected samples of processed milk quarterly from Cloverland/Green Spring Dairy in Baltimore. Teams collected samples of raw milk quarterly from Kilby Farm in Cecil County (Figure 2-3). Teams delivered the milk samples to the MDH Radiation Chemistry Laboratory for analysis.

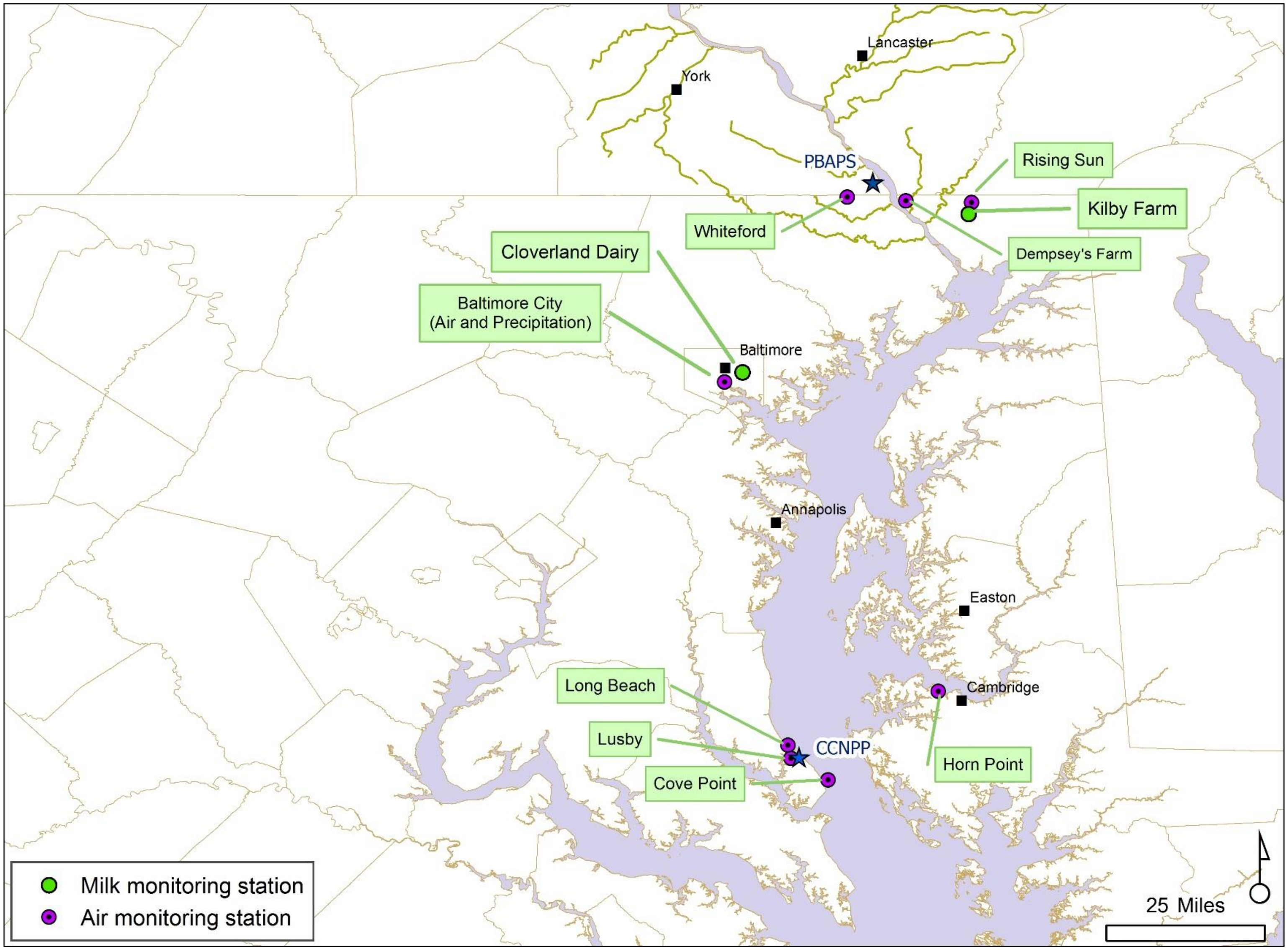


Figure 2-3. Air and milk monitoring stations monitored during the 2018–2019 reporting period

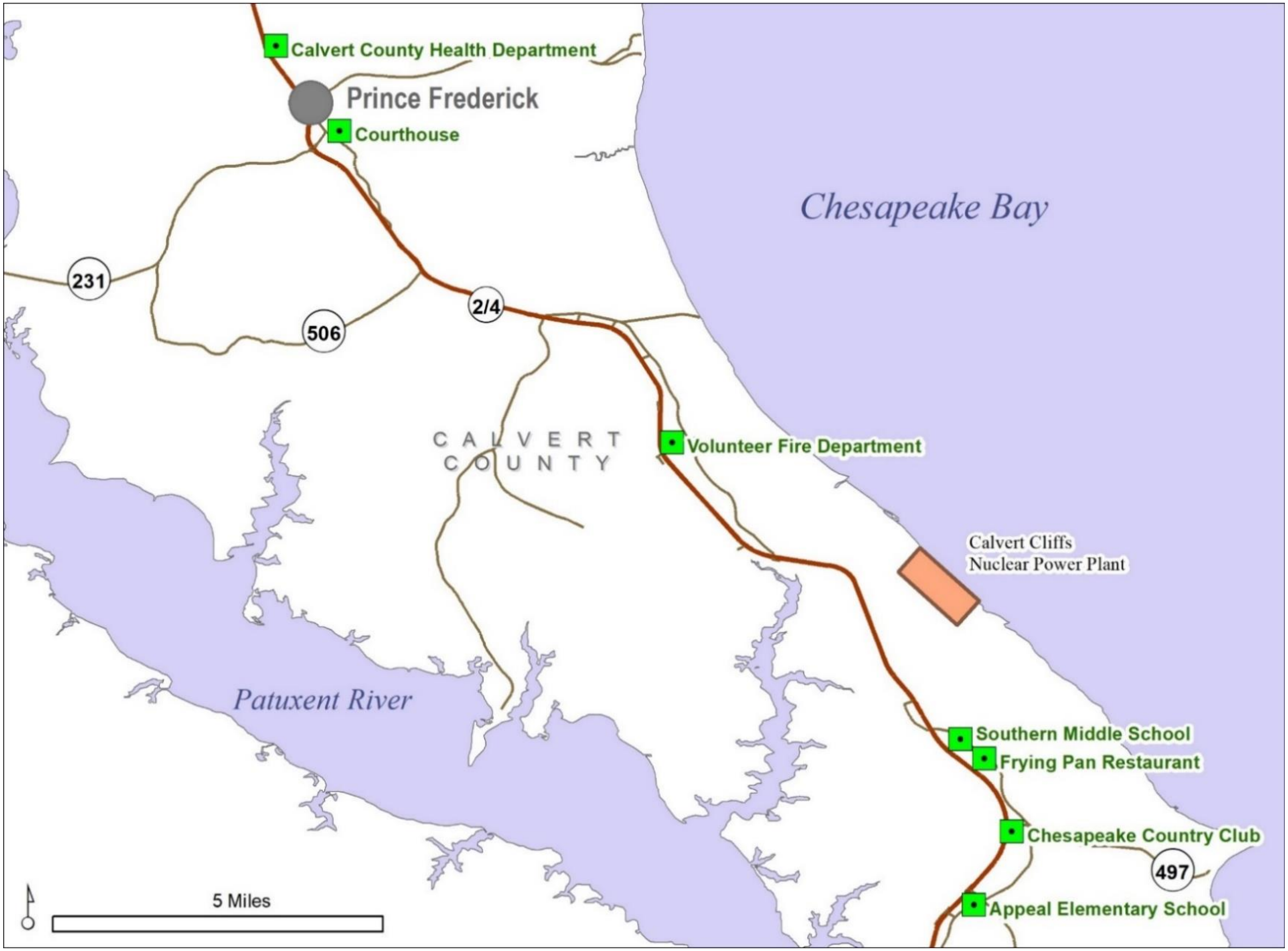


Figure 2-4. Potable water monitoring stations in Calvert County, Maryland

2.2 SAMPLE PREPARATION AND ANALYSIS PROCEDURES

The sample preparation and analysis procedures described below apply to sediment and biota samples analyzed by staff with the PPAD Radioecology Laboratory during the 2018–2019 reporting period. Staff with the MDH Radiation Chemistry Laboratory analyzed the other samples (i.e., air, air particulates, water, and milk) using a variety of methods of sample preparation (e.g., evaporating to dryness, wet chemistry), sample analysis (e.g., gas-flow proportional counting, liquid scintillation analysis, and gamma spectrometry), and data analysis. Descriptions of portions of these methods can be found in Jones (1994), Krieger and Whittaker (1980), and United States Department of Energy (1990).

2.2.1 Sample Preparation

To prepare a sediment sample for analysis of radionuclide content, staff at the PPAD Radioecology Laboratory transferred the sample to a 2-liter Marinelli beaker and placed the beaker into the analysis chamber of a gamma spectrometer. To analyze a sediment sample for particle size, staff dry and weigh the sample before conducting the analysis for particle size (see Section 2.3) to determine its composition type (e.g., sand, silt, or clay).

Biota samples were prepared for analysis as follows:

Oyster flesh: Staff thawed the oyster flesh, homogenized the flesh in a blender, transferred the material to a Marinelli beaker, diluted the material with deionized water to 1 or 2 liters (as appropriate for the sample), and preserved the slurry in a 10% formaldehyde solution.

Edible fish flesh and forage fish: Staff filleted the fish, diced the flesh into 3-cm cubes, packed the cubes in a Marinelli beaker to a total volume of 1 or 2 liters (as appropriate for the sample), and preserved the flesh in a 10% formaldehyde solution.

Fish gut: Staff removed the guts from the collected finfish, transferred the material to a Marinelli beaker, wet-digested the material in nitric acid, and diluted the material with deionized water to a total volume of 1 or 2 liters (as appropriate for the sample).

SAV: Staff packed the vegetation samples into a Marinelli beaker; added deionized water to a total volume of 1 or 2 liters (as appropriate for the sample), and preserved the sample in a 10% formaldehyde solution.

Staff with the MDH Radiation Chemistry Laboratory analyzed the individual (weekly) air and air particulate filters for gross alpha, gross beta, and ^{131}I radiation. Staff also combined the air particulate filters into monthly sets and analyzed the samples for ^{7}Be and ^{137}Cs.

2.2.2 Gamma Spectrometry

Staff with the PPAD Radioecology Laboratory analyzed the sediment and biota samples for radionuclides using a gamma-ray counting system, which consisted of high-resolution, intrinsic germanium detectors. Two detectors were operating at the laboratory during the 2018–2019 reporting period: one manufactured by Ortec (Oak Ridge, TN) and the other manufactured by Canberra Industries, Inc. (Meriden, CT). The detectors were 25% and 23% efficient[1], respectively, and were coupled to a Canberra Genie-2000 spectrum acquisition and analysis system (Stanek et al. 1996a).

Laboratory staff applied appropriate nuclide library data and counting efficiency curves to the interim counting results by sample to produce reports of the concentrations of radionuclides in the samples. Gamma-ray energy and intensity values used in energy-to-channel calibration and in data reduction were based on library data incorporated into the Genie-2000 software, which were referenced to the National Nuclear Data Center of the Brookhaven National Laboratory (Stanek et al. 1996b). Staff determined counting efficiency curves using custom multi-gamma standards commercially purchased from Eckert and Ziegler Analytics, Atlanta, GA, which were traceable to the National Institute of Science and Technology. For each sample, staff set the counting system to acquire all spectra for 1,000 minutes. Staff then used nuclide identification software to determine the radionuclide concentrations in the interim results referenced to the sample collection date and time. Laboratory staff stored spectra and interim results for all samples in electronic format for future reference.

For sediment and biota, analysts used the R programming language and Microsoft Excel software tools to perform quality control on the sample collection information and analytical results. Staff then post-processed the data in Microsoft Excel to determine dry weight concentrations and to organize the data. Staff entered the results of the air, air particulates, milk, and water analysis into a Microsoft Access database and then exported the data to Microsoft Excel to perform quality control and organize the data.

2.2.3 Quality Assurance

In 2009, the Radioecology Laboratory implemented a formal Quality Assurance Plan (Plan); laboratory protocols for the 2018–2019 reporting period followed the guidance in the Plan. Plan elements are described in Jones (2010); examples include the use and frequency of analysis of control samples, standard samples, and performance samples. Relevant to the 2018–2019 reporting period, laboratory staff tested laboratory performance (November 2018) by analyzing a spiked intercomparison (also known as a cross-check) sample from Eckert and Ziegler Analytics; laboratory results and known values for the intercomparison study sample are presented in Appendix B. In general, laboratory results

[1] Detector efficiency refers to the rated sensitivity of the detector using a standard method of measurement; actual sample counting efficiencies can be higher, depending on the radionuclide, the shape of the sample, and the material analyzed.

for gamma emitters in the intercomparison sample were within ten percent of the known results; the two measurements with less accurate results were for ^{51}Cr and ^{134}Cs (18% and 16% difference from the known result, respectively).

2.3 DETERMINATION OF SEDIMENT CHARACTERISTICS

Laboratory staff with the Radioecology Laboratory determined the sediment particle size index value for each sediment sample to provide a basis for comparing radionuclide concentrations detected in sediments of different composition type categories (e.g., sand versus clay). Sediment particle-size analysis accounts for composition changes that may affect measured radionuclide concentrations at a collection site. Staff compared the results of particle size analysis to the Wentworth scale, as published in Buchanan and Kain (1971), to assign each sediment sample to a composition type category. Staff classified sediments as silt-clay if the mean grain size was less than 63 µm, and sand if the mean grain size was greater than 63 µm.

The process to determine mean sediment grain size index value involved several steps. Staff wet- or dry-sieved 50-gram (g; dry weight) aliquots through a series of mesh screens with 250-micrometer (µm), 125-µm, and 63-µm mesh sizes. Staff dried and weighed the material that remained in each sieve; staff derived the amount of sample that passed through the 63-µm screen by subtracting the summed result of the sieved contents from the original dry weight of the sample (50 grams). Staff then calculated the particle-size index values for each sample by multiplying the fraction (percent) of the total weight retained on the 250-µm-mesh screen by 4, the fraction retained on 125-µm-mesh screen by 5, the fraction retained on the 63-µm-mesh screen by 6, and the fraction that passed through the 63-µm-mesh screen by 7. The sum of these products was the relative particle-size index value for the sediment sample. Possible particle size index values could range from the coarsest (400), in which all material was retained on the 250-µm-mesh screen, to the finest (700) in which all material passed through the 63-µm-mesh screen.

2.4 DATA ANALYSIS

Laboratory staff calculated interim analytical results using gamma spectrum analysis software. Staff matched any photopeaks distinguished from background to radionuclide species and quantified the peaks based on factors such as instrument conditions, sample volume, and radioactive decay. The concentration of a radionuclide of interest was reported as a value with a 2-sigma uncertainty (i.e., a 95.4 % confidence level).

Staff calculated the lower limit of detection (LLD) for radionuclides of interest that were not detected. The equation given in Table 2-2 defines the LLD for data included in the 2018–2019 radionuclide report. Common LLD quantities produced by sample analyses are given in Table 2-3. Analysts disregarded LLD quantities when summarizing yearly averages of activity values.

Table 2-2. Determination of the lower limit of detection

The lower limit of detection is given by the following formula:

$$LLD = \frac{L_D}{VEBTK_w}$$

where

V = The mass or volume of sample
E = The counting efficiency for the peak of interest
B = The branching ratio of the gamma ray peak
T = The sample counting time (live) in seconds
K_w = The decay correction factor

$$K_w = e^{-\frac{\ln(2)t_w}{T_{1/2}}}$$

$T_{1/2}$ = The half-life of the nuclide
t_w = The elapsed clock time from the time the sample was taken to the beginning of the measurement
L_D = The uncertainty in the continuum count rate at the peak of interest

$$L_D = K^2 + 2L_c$$

$$L_c = K\sigma_O = K\sqrt{\mu_F + \mu_I + \sigma_F^2 + \sigma_I^2}$$

L_C = Critical level, below which a net signal cannot reliably be detected
σ_0 = Variance of a null net signal
K = 2.327 (based on a Poisson distribution at a confidence level of 99%)
μ_F = The "true" calculated continuum under the peak
μ_I = The "true" measured background interference -- net peak area
σ_F = The variance of F (calculated continuum under the peak due to Compton scattering)
σ_I = The variance of I (measured background interference -- net peak area)

Note: The source of these formulae is Canberra Industries 1998.

Table 2-3. Approximate lower limits (99%) of detection for selected counting geometries

Radionuclide	Energy (keV)*	Matrix: Biota	Biota	Sand	Clay
		Marinelli Beaker Size (liters)			
		1	2	2	2
		Approximate Wet Sample Mass (kg)			
		1	2	3	1.5
		Lower Limit of Detection (pCi/kg)			
^{7}Be	478	27	17	15	56
^{58}Co	811	3	2	3	6
^{60}Co	1333	4	2	3	7
^{65}Zn	1116	7	6	8	19
^{95}Nb	766	3	3	3	8
^{95}Zr	757	5	4	5	12
^{103}Ru	497	3	2	3	6
^{106}Ru	622	28	21	23	55
^{110m}Ag	885	3	2	3	8
^{125}Sb	601	8	6	7	17
^{134}Cs	605	3	2	3	8
^{137}Cs	662	3	2	2	5
^{144}Ce	134	19	13	26	52

* keV = 1000 electron-volts

Notes: A seven-day decay period between sample collection and counting is assumed.

kg = kilograms; pCi = picoCurie

2.5 IDENTIFICATION OF ^{137}Cs FROM POWER PLANTS

The radionuclide ^{137}Cs is a constituent of both fallout from historic weapons tests and aqueous effluent from nuclear power plants. The amounts of ^{137}Cs released in the power plants' effluents have historically been substantially higher than the quantities that the facilities are currently releasing. It is believed that the majority of ^{137}Cs found in sediments near the power plants would be primarily attributable to the long-standing and continued influence of legacy power plant operations and atmospheric fallout from historic weapons testing; thus, the relatively small amount of ^{137}Cs currently released by power plants is unlikely to have a demonstrable effect on the amounts of the radionuclide found in samples collected near the power plants.

2.6 DATA PRESENTATION

Appendix C contains concentration data for samples collected in the vicinity of CCNPP and PBAPS during the 2018–2019 monitoring period. The radioactivity reported in these tables includes specific radionuclides, gross alpha and gross beta from natural sources, historical weapons test fallout, and power plant effluent. Separate tables are provided for sediments, oysters, finfish, SAV, air, air particulates, water, precipitation, and milk. Within each table, specific sample stations are arranged approximately from north to south, and data are presented by date along with the yearly and overall means for the monitoring period.

Radiation concentration data are decay-corrected to the date of sample collection. The counting uncertainty is reported as ± 2 standard deviations (SD). Concentrations for alpha, beta, and specific gamma-emitting radionuclides of interest that were not detected in specific samples were recorded as less than (<) the lower limit of detection for that sample.

3.0 RESULTS AND DISCUSSION

Scientists used the data related to power plant discharges and laboratory analysis results for samples collected in the 2018–2019 reporting period to identify and quantify sources of radionuclides, determine the concentrations of radionuclides in environmental samples, and estimate potential radiological risks to ecological resources and humans that were relevant to the operations of each of the target power plants, CCNPP and PBAPS. The results of these assessments are presented in separate sections below.

The analysis team identified the origins of the more commonly observed radionuclides in environmental samples and used this information to determine the magnitude of the contribution of radionuclides from each power plant relative to radionuclides derived from weapons-testing fallout and natural sources. The team compared the quantities of individual radionuclides released from CCNPP and PBAPS during the 2018–2019 period with the quantities detected in environmental samples collected during the same period.

3.1 SOURCES OF RADIONUCLIDES

Discharges from the two nuclear power plants, past atmospheric tests of nuclear weapons, and natural occurrences are the three primary sources of radioactive material in the Chesapeake Bay and the Susquehanna River in the vicinities of CCNPP and PBAPS. Samples of biota and sediment collected during the 2018–2019 reporting period contained radionuclides that were attributable to each of these sources.

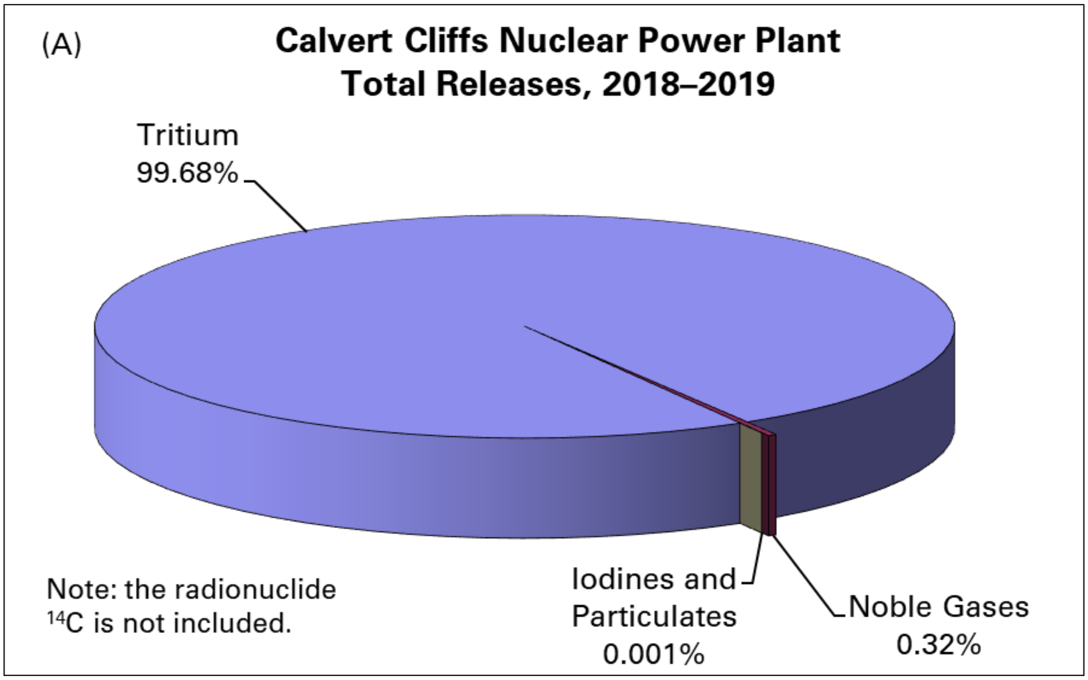
3.1.1 Radionuclides from CCNPP and PBAPS

3.1.1.1 Total Radionuclides

Radionuclide releases from nuclear power plants generally fall into three classes: noble gases, tritium, and iodines and particulates. The quantities and proportions of these three classes of radionuclides released into the atmosphere and waterways vary based on plant design. During the 2018–2019 monitoring period, the most common radioactive component of the combined (atmospheric and aqueous) discharges from CCNPP was tritium (99.9% of total releases); less common components included noble gases (0.32%) and a group of radionuclides that are considered to have environmentally significant consequences that included radioactive iodines and particulates (0.001%; Figure 3-1A). During the same period, the most common radioactive component of the combined discharges released by PBAPS was a combination of radionuclides in the category of noble gases (94.29% of total releases); less common components included tritium (5.71%) and the group of environmentally significant radionuclides (0.001%; Figure 3-1B). Note that these two charts do not show contributions of ^{14}C; the two power plants only released ^{14}C in atmospheric discharges. In the environment, noble gases are chemically inert, are not readily incorporated into biological tissues, and are not bioconcentrated. They disperse in the environment and generally have short half-lives (e.g., less than 5.3 days), decaying rapidly to stable forms. Tritium, as a form of hydrogen, can bond with oxygen to form water and thus can disperse readily in an aquatic environment. Tritium occurs naturally in the environment, and releases from nuclear power plants are estimated to represent less than 0.1 percent of the estimated typical total dose to humans from background sources (National Commission on Radiation Protection and Measurement, 2009, as reported by the USNRC at https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/tritium-radiation-fs.html).

During the reporting period, CCNPP released 60% of the combined radionuclides through the air and liquid pathways; PBAPS released approximately 40% of the total to the two pathways (Table 3-1). The releases to the aqueous pathway from CCNPP constituted 97.5% of the total releases from the power plant; the releases to the atmospheric pathway constituted 2.5% of the total. In contrast, the releases to the aqueous pathway from PBAPS constituted only 1% of the total releases from the power plant; the releases to the atmospheric pathway constituted 99% of the total.

Both power plants released ^{14}C in air emissions, exclusively, during the 2018–2019 reporting period, according to data provided by Exelon Generation Company (see Table 3-1). The CCNPP release of 40.7 Ci of ^{14}C into the atmosphere during the period represented 1.6% of total releases. The PBAPS release of ^{14}C into the atmosphere represented 5% of the plant's total releases for the period. The average annual release of ^{14}C from PBAPS (20.35 Ci) for the period was below the range of annual production rates expected for boiling water reactors: approximately 1 terabecquerel per gigawatt electrical year (TBq/GWe-yr) from coolant water, and up to 2 TBq/GWe-yr from coolant water and fuel (Yim and Caron 2006). At CCNPP, net power generation in 2019 was 15,013 gigawatt hour (GWh; U.S. Energy Information Administration 2021); this is equivalent to 1.7 GWe-yr (1 GWe-yr = 8,760 GWh); thus, the expected production rate would have been between 1.7 and 3.4 TBq, or 46 to 93 Ci. At PBAPS, net power generation in 2019 was 22,294 GWh (U.S. Energy Information Administration 2021); this is equivalent to 2.5 GWe-yr; thus, the expected production rate would have been between 2.5 and 5 TBq, or 69 to 138 Ci. The contribution to the global ^{14}C inventory from the two power plants' emissions is negligible (Yim and Caron 2006). According to estimates from the U.S. Environmental Protection Agency (USEPA; 1981), the risk of cancer from ^{14}C emissions to the atmosphere by light water reactors was very small, about three orders of magnitude lower than the risk from natural background radiation.



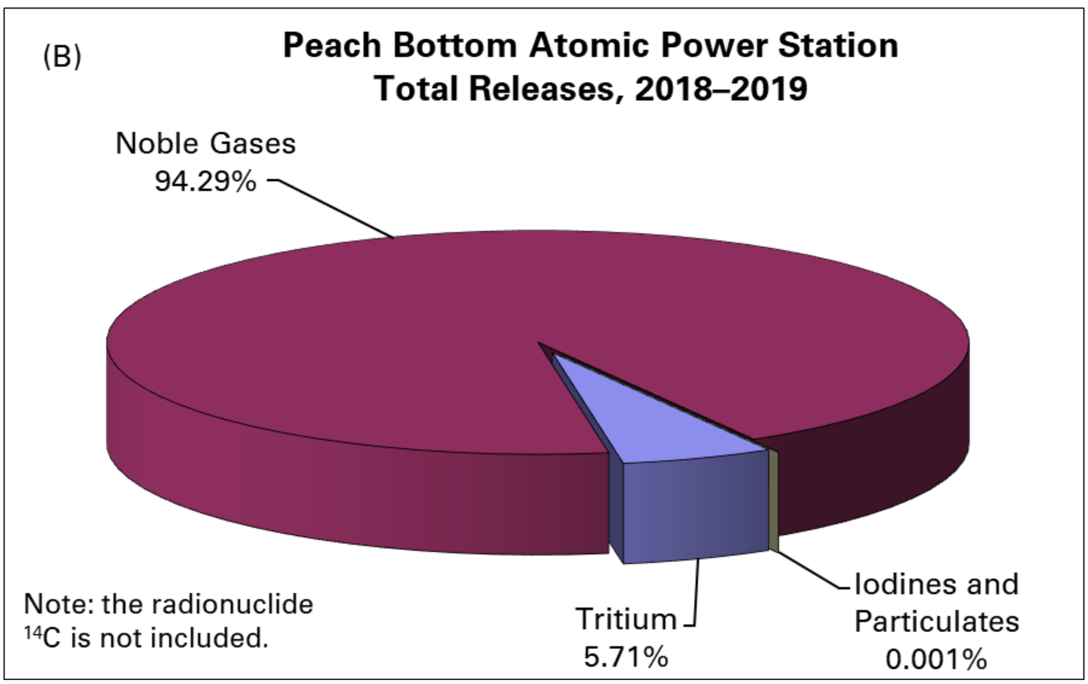


Figure 3-1. Relative contributions of radionuclides as noble gases, tritium, and iodines and particulates released from (A) Calvert Cliffs Nuclear Power Plant and (B) Peach Bottom Atomic Power Station in 2018–2019, including air and liquid pathways

Table 3-1. Total releases of radionuclides as noble gases, tritium, iodines and particulates, and ^{14}C from CCNPP and PBAPS through the air and aqueous effluent pathways during 2018–2019, as reported by Exelon Generation Company

Type	CCNPP Releases (Ci)			PBAPS Releases (Ci)		
	Air	Liquid	Total	Air	Liquid	Total
Noble Gases	7.3	0.004	7.4	1426.4	0.00003	1426.4
Tritium	15.0	2470	2485	143.8	16.9	160.8
Iodines and Particulates	0.0001	0.023	0.023	0.007	0.015	0.022
^{14}C	40.7	0	40.7	76.9	0	76.9

3.1.1.2 Environmentally Significant Radionuclides

Certain radioiodines and radioactive particulates (i.e., metal isotopes) are considered environmentally significant. Environmentally significant radionuclides are those that have a strong tendency to adsorb onto particles, can accumulate in biological tissues, and can be concentrated through trophic transfer. The concentrations and distributions of these materials have a particular influence, therefore, in the duration and magnitude of the potential environmental consequences and bodily risk of exposure to radioactive releases from power plants.

During the 2018–2019 reporting period, each power plant released several radionuclides, other than ^{14}C, that are considered to have environmentally significant consequences; these types of radioactive elements are known to be assimilated (bioaccumulated) by biological organisms, are discharged in detectable amounts, and do not decay rapidly to stable forms. The most common environmentally significant radionuclide released by CCNPP during the period was ^{58}Co (33.1%); other radionuclides in the category included ^{137}Cs (29.2%), ^{60}Co (23.7%), and ^{63}Ni (10.2%); the remainder constituted 3.8% (Figure 3-2A). The most common environmentally significant radionuclide released by PBAPS during the period was ^{60}Co (48.5%); other radionuclides in the category included ^{133}I (15.4%), ^{54}Mn (12.5%), ^{131}I (7.7%), and ^{65}Zn (5.5%); the remainder constituted 10.5% (Figure 3-2B).

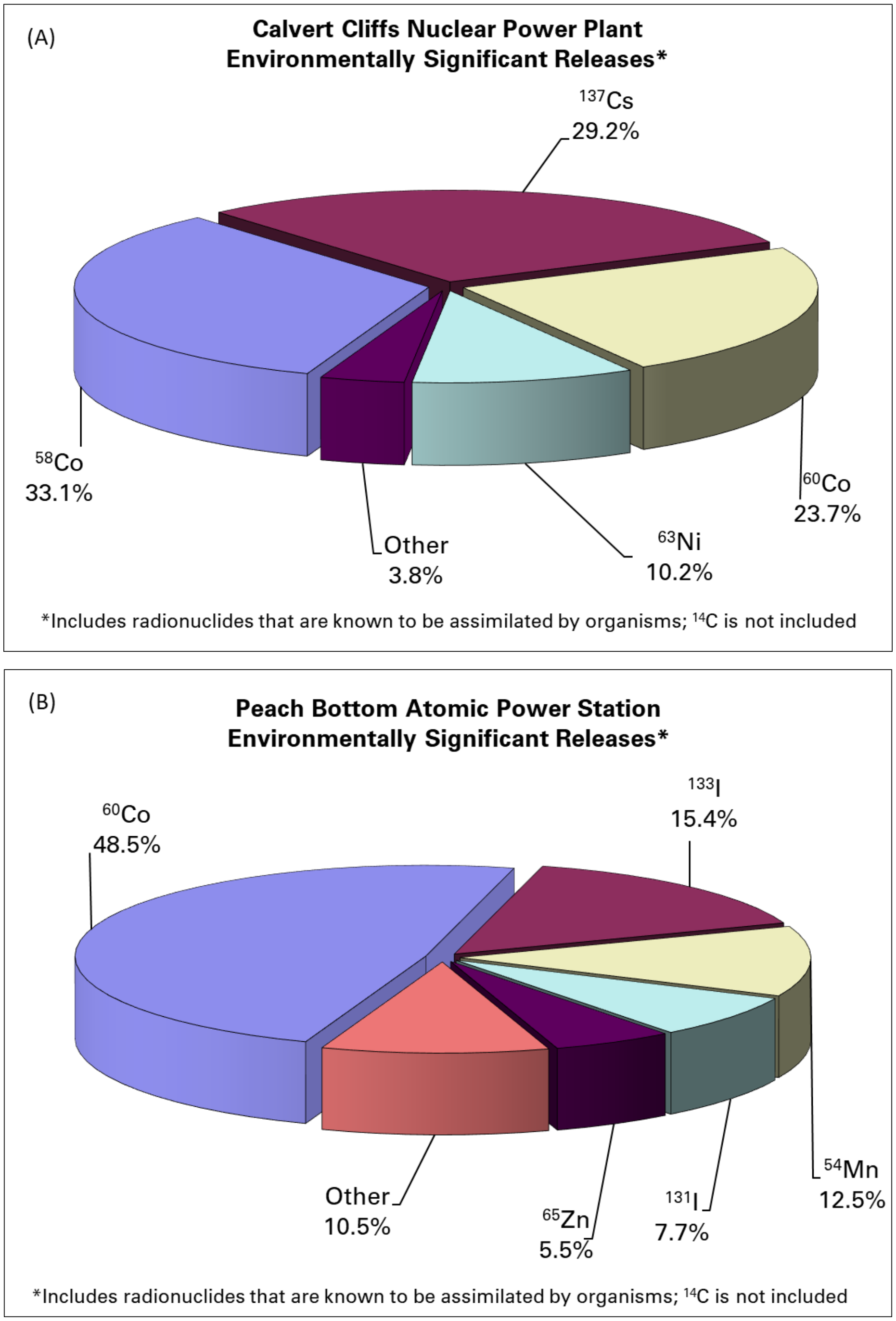


Figure 3-2. Environmentally significant radionuclides (percent) released from (A) Calvert Cliffs Nuclear Power Plant, and (B) Peach Bottom Atomic Power Station, 2018–2019, including air and liquid pathways

Total annual releases of ^{137}Cs and ^{60}Co from both power plants to the aqueous pathway have been variable since 2000. Releases of ^{137}Cs from CCNPP in the past 20 years peaked in 2015 (525 millicurie [mCi]); releases in 2018 and 2019 were 0.767 mCi (0.13% of the sum of ^{137}Cs releases at CCNPP since 2000 and 5.88 mCi (0.96%), respectively (Figure

3-3). Releases of ^{137}Cs from PBAPS in the past 20 years peaked in 2006 (3.05 mCi); releases in 2018 and 2019 were 0.01 mCi (0.09% of the sum of ^{137}Cs releases at PBAPS since 2000) and 0.002 mCi (0.02%), respectively (**Error! Reference source not found.**). Releases of ^{60}Co f rom CCNPP peaked in 2000 (19.5 mCi); releases in 2018 and 2019 were 2.2 mCi (2.44% of the sum of ^{60}Co releases at CCNPP since 2000) and 3.17 mCi (3.49%), respectively (**Error! R eference source not found.**). Releases of ^{60}Co from PBAPS peaked in 2006 (354 mCi); releases in 2018 and 2019 were 3.1 mCi (0.25% of the sum of ^{60}Co releases at PBAPS since 2000) and 6.7 mCi (0.53%), respectively (**Error! Reference source not found.**). All releases o f radionuclides from PBAPS and CCNPP were the result of normal operation and maintenance at the plants, were within regulatory limits established by the USNRC and USEPA[2], and resulted in negligible effects on the environment. Quantities of releases from CCNPP and PBAPS were obtained from Exelon Generation Annual Radioactive Effluent Release reports to the USNRC (Exelon Generation 2019a, 2019b, 2020a, 2020b).

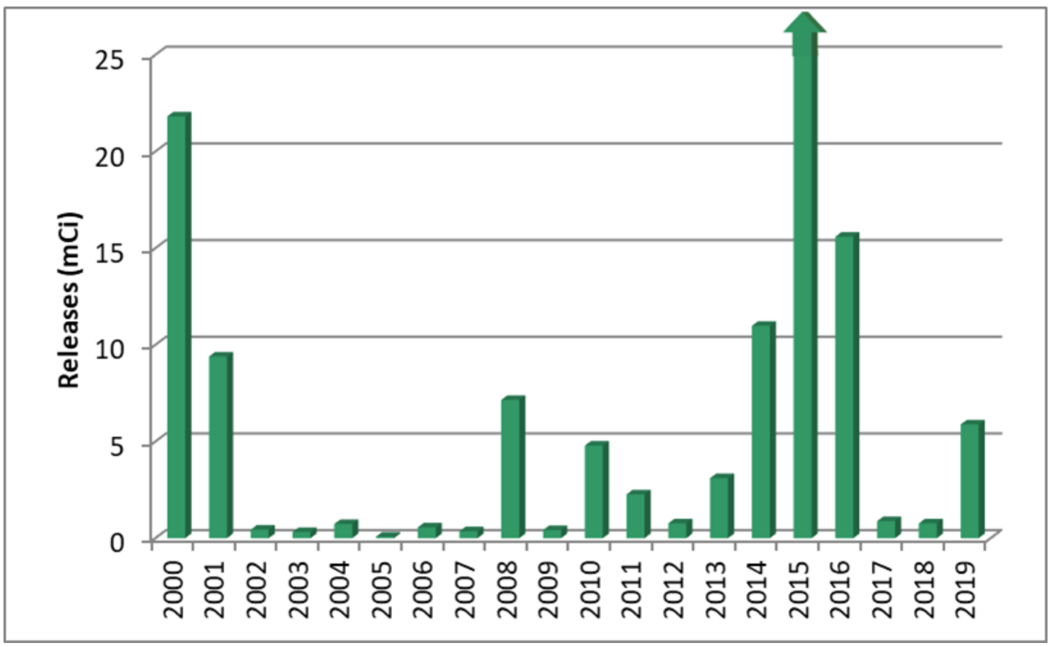


Figure 3-3. Annual aqueous releases of ^{137}Cs from CCNPP, 2000–2019, as reported by Exelon Generation Company; the 2015 release was 525 mCi

[2] USEPA 40CFR190 limits: 25 millirem (mrem) whole body or individual organ; USNRC 10CFR50 limits: 3 mrem whole body and 10 mrem individual organ.

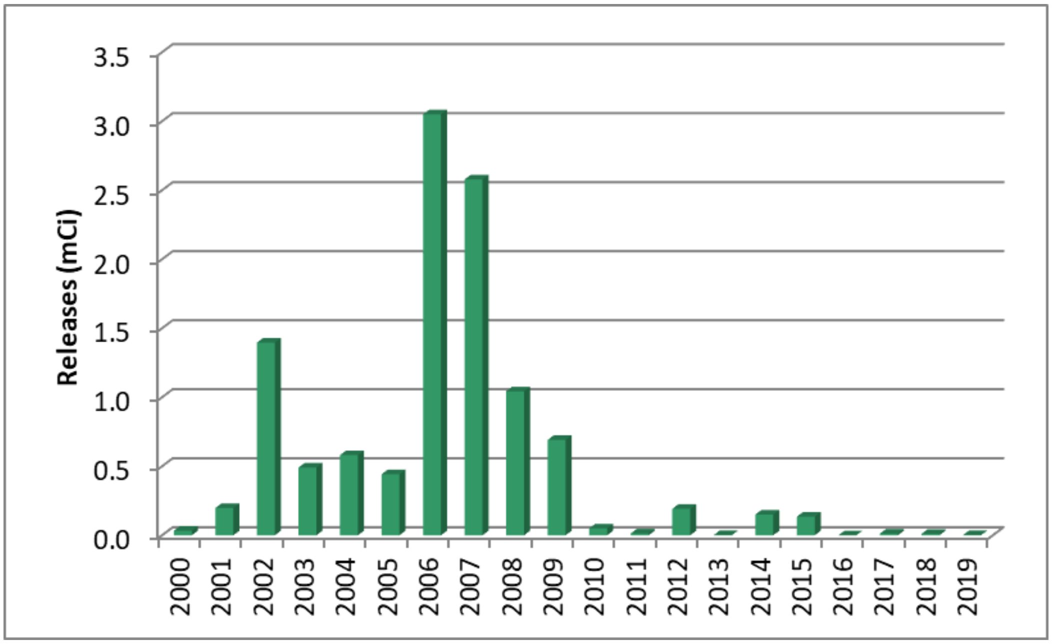


Figure 3-4. Annual aqueous releases of ^{137}Cs from PBAPS, 2000–2019, as reported by Exelon Generation Company

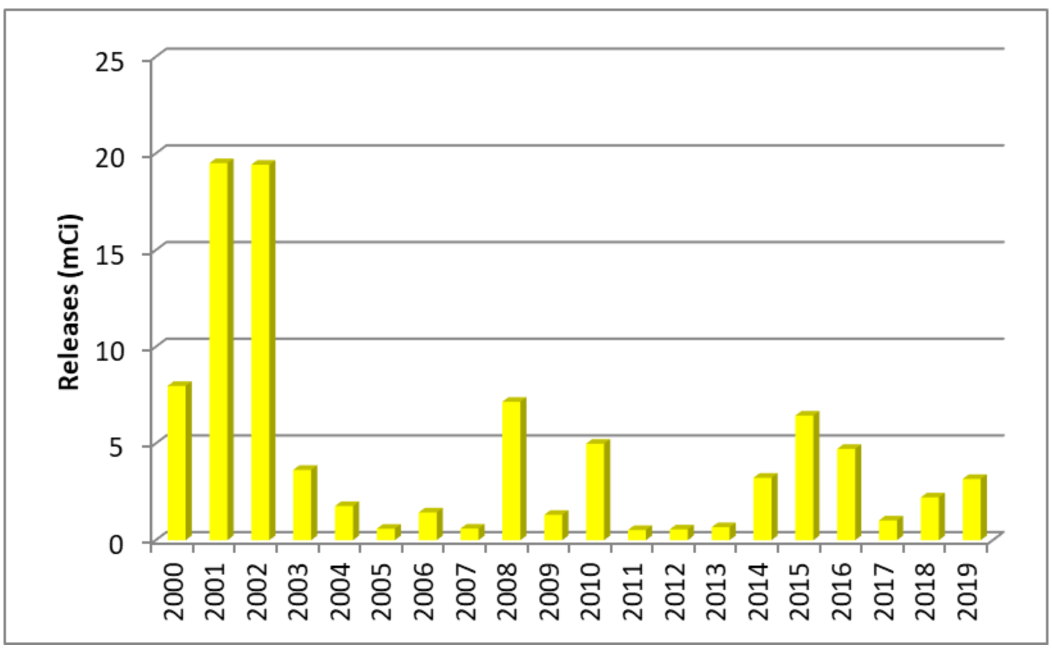


Figure 3-5. Annual aqueous releases of ^{60}Co from CCNPP, 2000–2019, as reported by Exelon Generation Company

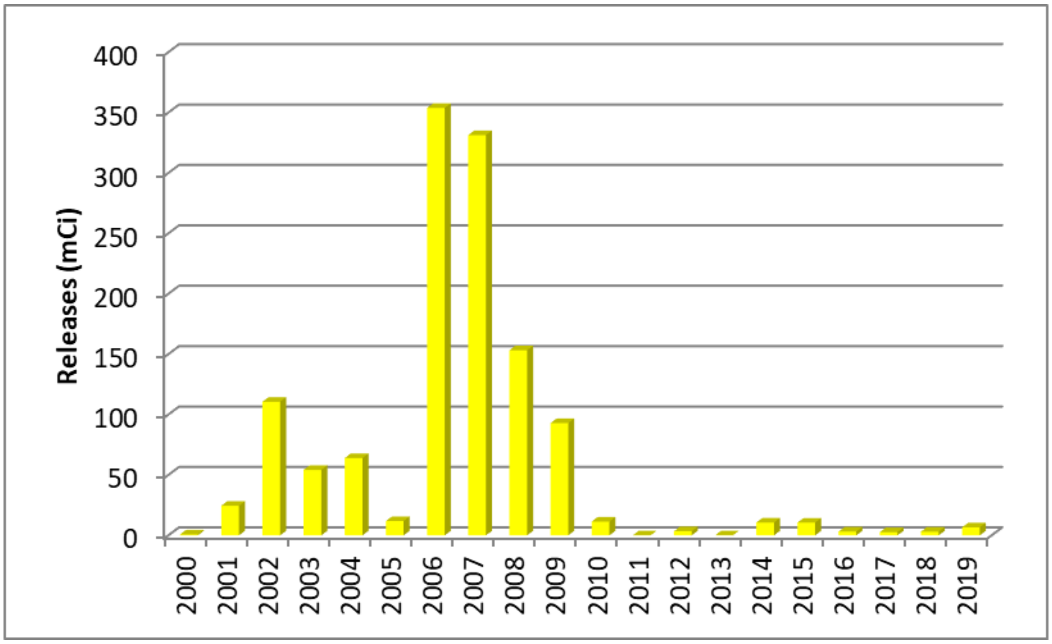


Figure 3-6. Annual aqueous releases of ^{60}Co from PBAPS, 2000–2019, as reported by Exelon Generation Company

Releases of environmentally significant radionuclides through the aqueous pathway vary annually (Table 3-2) due to changes in maintenance procedures, operating conditions, and waste filtration technology at the plants (R. Conatser, Constellation Energy Nuclear Group, LLC, personal communication, August 17, 2005). Outages, minor leaks, and component maintenance and replacement efforts also affect annual release totals at CCNPP and PBAPS (B. Nuse, Constellation Energy Nuclear Group, LLC, personal communication, May 24, 2010; L. Lucas, Exelon Nuclear Company, personal communication, June 17, 2010). During the 2018–2019 period, CCNPP released 23 mCi (less than 0.001% of total liquid releases) of environmentally significant radionuclides (iodines and particulates) to the Chesapeake Bay through the aqueous pathway. PBAPS released 15 mCi (less than 0.09% of total liquid releases) of environmentally significant radionuclides to the Susquehanna River during the same period. The overall relatively low release rate in recent years is due, in part, to improved ion-exchange technologies at the cooling water intake and more efficient use of existing methods for reducing radioactive waste.

At CCNPP, liquid radioactive wastes are discharged through the cooling-water outfall, which is approximately 0.3 km offshore, and subsequently diluted in the receiving water. At PBAPS, the cooling-water outfall is located at the extreme downstream end of the power plant site along the western shore (near Station LYH-1).

Table 3-2. Total releases of environmentally significant radionuclides (iodine and particulates) from CCNPP and PBAPS to the aqueous pathway as summarized by two-year reporting periods, 1996–2019

Period	Combined Radionuclides as Iodines and Particulates in Aqueous Releases (mCi)	
	CCNPP	PBAPS
1996–1997	1028	13
1998–1999	958	25
2000–2001	990	57
2002–2003	342	324
2004–2005	138	182
2006–2007	78	1290
2008–2009	107	382
2010–2011	155	53
2012–2013	19	6
2014–2015	684	28
2016–2017	102	8
2018–2019	23	15

Gaseous radioactive effluent is captured and stored on site until it has decayed to lower levels. Air monitoring in the vicinity of PBAPS indicates that the effluent is diluted and disperses to less than detectable levels in the environment (PPRP 2017); therefore, radioiodines and particulates released to the atmosphere are not considered environmentally significant.

3.1.2 Radionuclides from Weapons Tests

Atmospheric tests of nuclear weapons conducted until 1980 have introduced a variety of man-made radionuclides into the environment. Both power plants released the radionuclide ^{137}Cs during the monitoring period, but its presence in the sediments can likely be primarily attributed to continued radioactivity from substantial legacy facility releases of ^{137}Cs to the environment and fallout from weapons testing (see Sections 3.2.1.1 and 3.2.1.3 below). Due to its relatively long half-life (approximately 30 years), ^{137}Cs has persisted in the environment; other testing-related radionuclides have decayed to stable states or are present at non-detectible concentrations.

3.1.3 Natural Radionuclides

Naturally occurring radionuclides are present everywhere in the environment. The principal naturally occurring radionuclides that result in measurable radiological doses to human populations include potassium-40 (^{40}K) and radionuclides in the thorium (^{232}Th) and uranium (^{235}U, ^{238}U) decay series. All samples of sediment, biota, and milk collected during the reporting period had detectable levels of ^{40}K. Specific gamma-emitting daughter radionuclides from the uranium and thorium decay series were detected less frequently.

Interactions between cosmic rays and oxygen and nitrogen in the atmosphere produce several radionuclides (Whicker and Schultz 1982). One of these, ^{7}Be, was detected occasionally in sediments from CCNPP and frequently in samples from PBAPS; the radionuclide was also detected in two of the 17 oyster samples at CCNPP and all four of the SAV samples collected near PBAPS. The natural production of ^{7}Be (which has a half-life of 53 days) in the atmosphere contributes only a small portion of the total radiation dose to humans from natural background sources (see Section 3.2.1.3).

3.2 RADIONUCLIDES IN ENVIRONMENTAL SAMPLES

The environmentally significant radionuclides detected in samples from the CCNPP and PBAPS study areas during the 2018–2019 reporting period other than ^{14}C consisted principally of ^{60}Co and ^{137}Cs. This has been the trend since the early 1990s. At that time, reductions in radionuclide releases from both power plants correlated with subsequent reductions in detection frequency and declines in concentrations of plant-related, environmentally significant radionuclides.

3.2.1 Sediments

Sediments serve as sinks for both stable and radioactive metals. Suspended particulate material can scavenge metals through flocculation and adsorption, or the surface layer of bottom sediments may adsorb metals directly from the water column (Santschi et al. 1983); consequently, sediments can accumulate metal radionuclides over time. Measurements of spatial and temporal patterns in the concentrations of radionuclides in sediments collected from the Chesapeake Bay and the Susquehanna River have been used to track the physical transport of radionuclides and intra-annual variability in the release of radionuclides from the two nuclear power plants since 1975 at CCNPP and 1979 at PBAPS. The results for monitoring radionuclides in sediment collected during the 2018–2019 reporting period are summarized below. Concentrations of selected environmentally significant radionuclides detected in the sediment samples collected during the 2018–2019 period are provided in Appendix C.

A variety of factors influence the concentrations of radionuclides in sediments, including the rate of input; spatial location in relation to the power plant discharge points (e.g., distance, if applicable); half-life of the radionuclide; natural processes, such as sedimentation, circulation, and bioturbation; and physical factors, such as depth of the sediment layer from the water surface and sediment grain size. Of the numerous influences, PPAD chose to focus on the results of the analysis of sediment grain size as the representative factor for reporting. Sediments collected at inshore stations of Chesapeake Bay near CCNPP were composed predominantly of sand (particle size index values between 400 and 500; see Section 2.3); sediments from offshore stations of the Chesapeake Bay, which were collected from depths greater than eight meters, were mostly clay (particle size index values between 600 and 700). In the vicinity of PBAPS, sediments collected at Susquehanna Flats were typically sand, and sediments from Conowingo Pond were generally clay. **Error! Reference source not found.** and **Error! Reference source not found.** sh ow the particle size index results for sediments collected from the Chesapeake Bay and the Susquehanna River, respectively, during the 2018–2019 period.

Radionuclides of natural origin (^{7}Be, ^{40}K, and the Th and U decay series) and from a combination of weapons tests and power plants (^{137}Cs) generally were detected at higher concentrations in clay sediments than in sand sediments collected for the 2018–2019 reporting period. Metal radionuclides have a greater affinity for clay than for sand due to the fine crystalline structure, greater surface area, and the higher cation exchange capacity of clay particles (Eisenbud 1987). Sandy sediments are coarser and less able to adsorb radionuclides (Olsen et al. 1989).

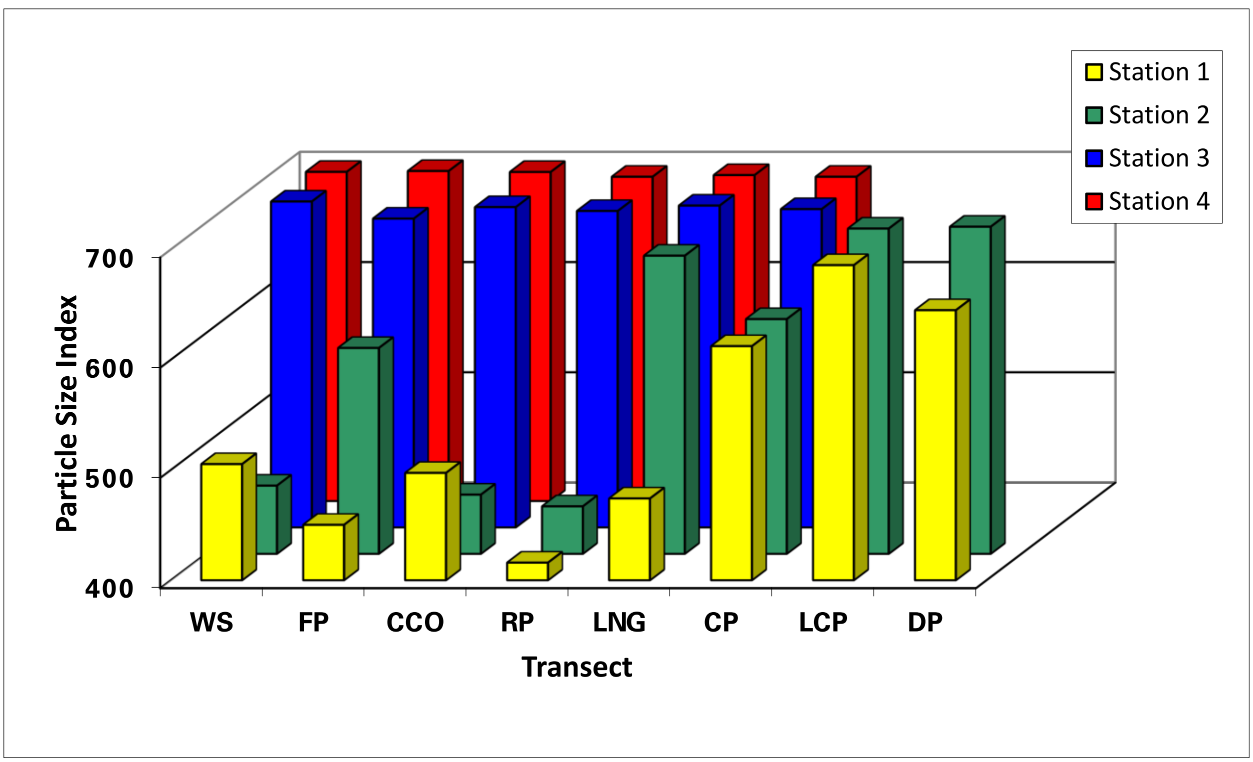


Figure 3-7. Mean particle size index values of sediments collected from the vicinity of CCNPP, 2018–2019

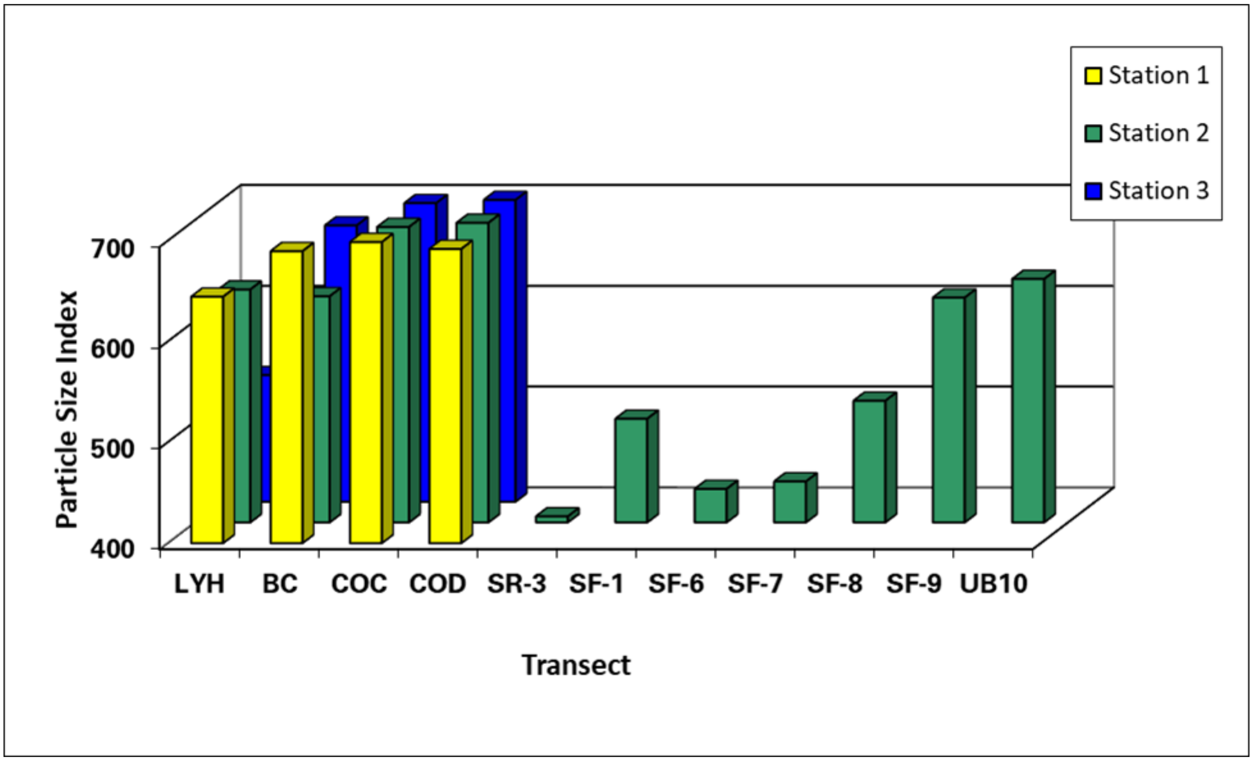


Figure 3-8. Mean particle size index values of sediments collected from the vicinity of PBAPS, 2018–2019

3.2.1.1 Power Plant Radionuclides in Sediment

The predominant environmentally significant radionuclide detected in the sediment samples collected in the vicinities of the two power plants was ^{137}Cs. Most of the sediment samples contained detectable amounts of ^{137}Cs (86% from CCNPP and 100% from PBAPS). Although both power plants released ^{137}Cs through the aqueous pathways during the 2018–2019 reporting period, the majority of the concentrations of the radionuclide found in the sediments were likely remnants of legacy power plant releases and fallout from historic weapons testing.

The sediment samples collected in the vicinity of CCNPP during the 2018–2019 reporting period did not contain detectable levels of ^{60}Co; sediments collected in some of the previous years near the facility had detectable levels of the radionuclide (Table 3-3). Decreases in ^{60}Co quantities in sediment reflect decreased input of radiocobalt-labeled sediment, decay of legacy ^{60}Co, and burial. Sediment samples collected in the vicinity of PBAPS during the reporting period contained detectable levels of ^{60}Co in 2.6% of the samples. The detection rates of ^{60}Co in sediments collected near PBAPS are generally positively correlated with the amounts of the radionuclide that are released by the facility through the aqueous pathway; since peaking during the 2001–2009, period, the levels of ^{60}Co released by the facility have been less than 25 mCi per two-year period (see **Error! R**

eference source not found.). During the 2018–2019 period, PBAPS released 9.76 mCi of ^{60}Co, as reported by Exelon Generation Company. Maximum ^{60}Co concentrations at PBAPS were observed at Broad Creek Station 3 (BCR-3) and at Susquehanna Flats Station 8 (SF-8, **Error! Reference source not found.**), which suggests migration of ^{60}Co across the impoundment and downstream, out of the area nearest the outfall.

The radionuclide ^{58}Co was not found in any sediment samples collected during the 2018–2019 reporting period. Both power plants released ^{58}Co to the aqueous pathway during the period; PBAPS also released ^{58}Co to the gaseous pathway.

Table 3-3. Detection frequency of ^{60}Co in sediments from CCNPP and PBAPS for the period 1996 through 2019

Monitoring Period	Detection Frequency of ^{60}Co in Sediment Samples (%)	
	CCNPP	**PBAPS**
1996–1997	25.0	5.0
1998–1999	12.5	2.6
2000–2001	6.3	6.6
2002–2003	3.6	15.8
2004–2005	0	18.4
2006–2007	0	31.6
2008–2009	1.3	41.3
2010–2011	2.2	19.7
2012–2013	0	6.6
2014–2015	0	18.4
2016–2017	0	13.2
2018–2019	0	2.6

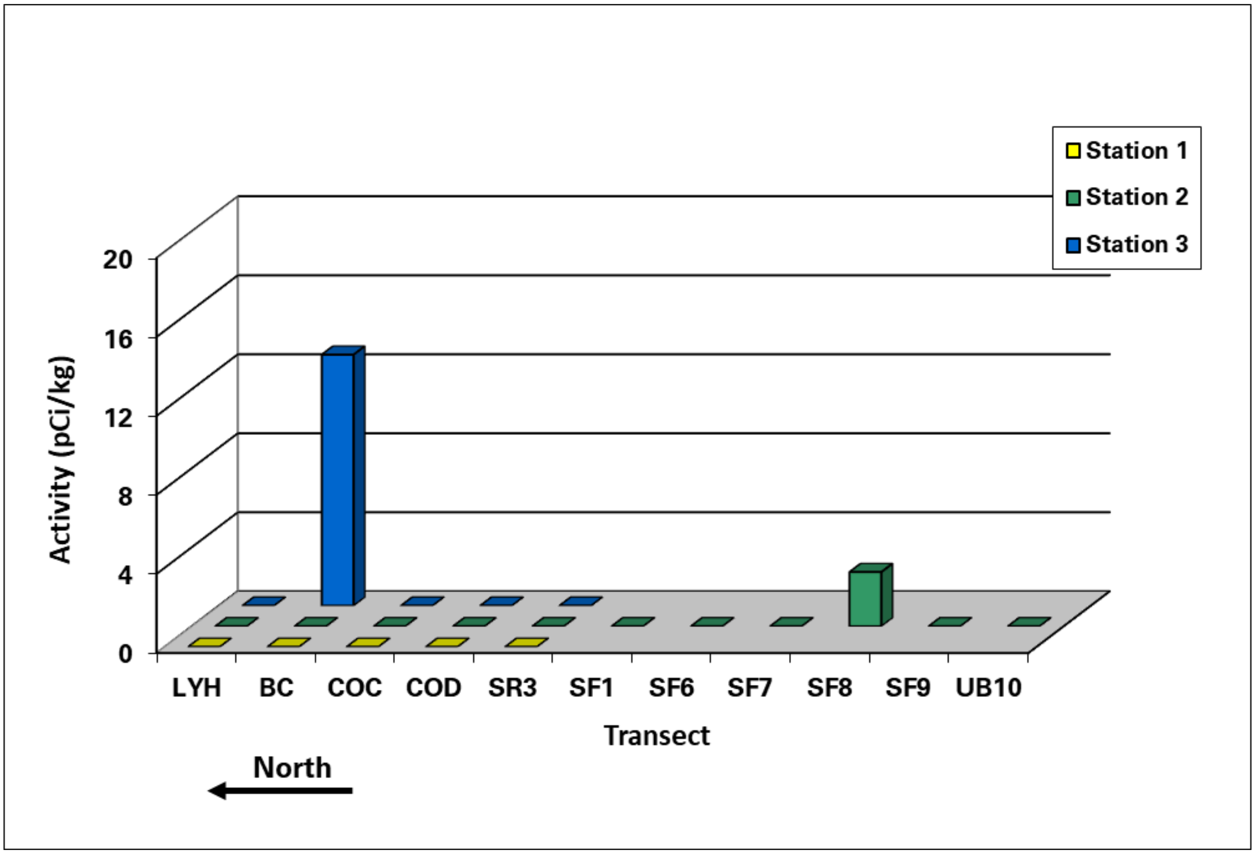


Figure 3-9. Geographical distribution of average activity of ^{60}Co near PBAPS, 2018–2019

3.2.1.2 Radionuclides from Weapons Tests in Sediment

Concentrations of ^{137}Cs detected in sediments are likely remnants of fallout from atmospheric atomic weapons testing, which ended approximately four decades ago, or from legacy releases of the radionuclide to the environment. Most sediment samples collected from the vicinities of CCNPP and PBAPS during the 2018–2019 reporting period contained detectable levels of ^{137}Cs; 86% and 100%, respectively. New inputs to the local ecosystem related to weapons testing are insignificant (Prăvălie 2014); therefore, PPAD will likely continue to consider and report ^{137}Cs as the only relevant gamma ray-emitting radionuclide to be related to fallout from weapons testing.

The concentrations of ^{137}Cs in sediments collected near PBAPS and CCNPP generally have decreased gradually since 1990 due to reductions in discharges, decay of the inventory of ^{137}Cs present in the sediment, and dilution by sedimentation (Figure 3-10 andFigure 3-11). Compared to the five-year period prior to 1990, the power plants reduced the amounts of ^{137}Cs in effluents by an average of 52% at CCNPP and 98% at PBAPS by 1990; in the subsequent six years (1990–1995), the reductions continued such that, by 1996, the power plants had further reduced the amounts of ^{137}Cs in releases by 99% at CCNPP and 75% at PBAPS. At most stations within the representative study area transects (i.e., Flag Ponds at CCNPP and Broad Creek at PBAPS), average concentrations of ^{137}Cs increased slightly during the 2006–2007 monitoring period but decreased afterward. At the Broad Creek stations, there were further decreases in 2011. At the Flag Ponds stations, average annual concentrations of ^{137}Cs in sediments have decreased by between approximately 65% and 82% since the initiation of the monitoring program in 1981 (Table 3-4). Concentrations at Broad Creek stations have decreased by between approximately 63% and 89% since the initiation of monitoring (Table 3-4).

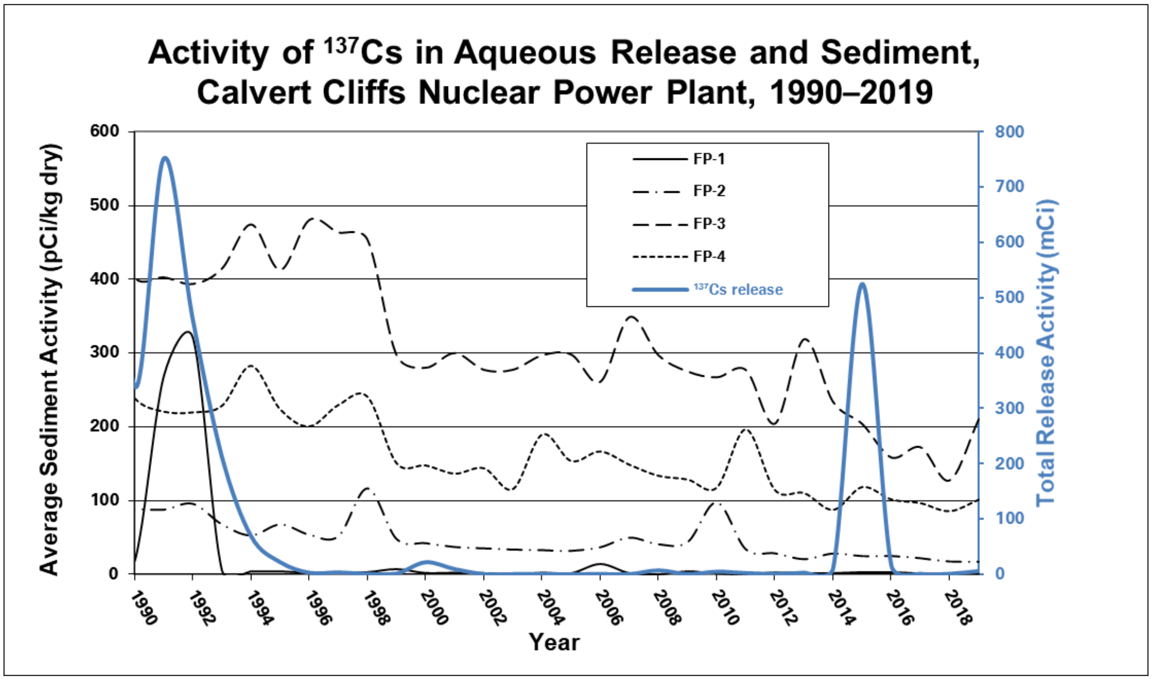


Figure 3-10. Annual liquid release of ^{137}Cs from CCNPP and average annual activity of ^{137}Cs in CCNPP sediments at Flag Ponds stations, 1990–2019

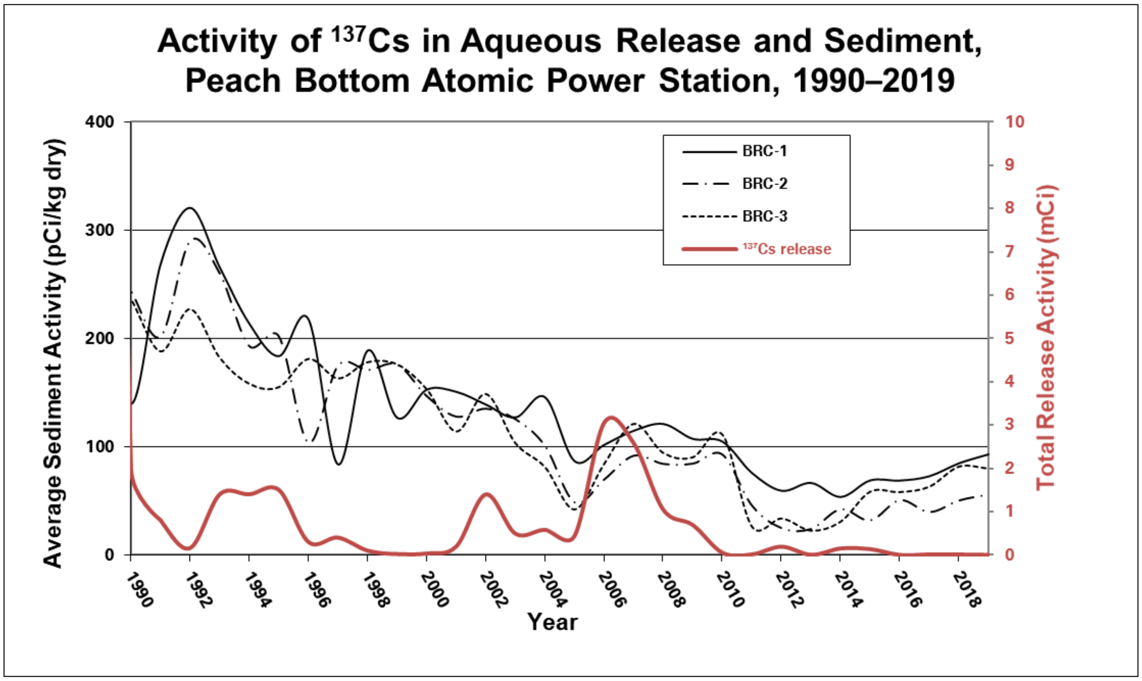


Figure 3-11. Annual liquid release of ^{137}Cs from PBAPS and average annual activity of ^{137}Cs in PBAPS sediments at Broad Creek stations, 1990–2019

Table 3-4. Percent reduction between 1981 and 2019 of ^{137}Cs released from CCNPP and PBAPS (mCi) and of ^{137}Cs activities in sediment (pCi/kg) at Flag Ponds (FP) and Broad Creek (BRC) stations

	1981	2019	Reduction (%)
CCNPP ^{137}Cs release (mCi)	103	5.88	94.3
Activity of ^{137}Cs in Sediment (pCi/kg) at Flag Ponds Monitoring Stations			
FP-1	7	2	71.4
FP-2	98	18	81.6
FP-3	522	181	65.3
FP-4	361	96	73.4
PBAPS ^{137}Cs release (mCi)	170	0.002	99.999
Activity of ^{137}Cs in Sediment (pCi/kg) at Broad Creek Monitoring Stations			
BRC-1	707	81	88.6
BRC-2	232	53	77
BRC-3	243	89	63.3

3.2.1.3 Natural Radionuclides in Sediment

Generally, the predominant components of sediment radioactivity detected in samples collected during the 2018–2019 reporting period were the naturally occurring radionuclides of potassium (^{40}K) and the thorium (Th) and uranium (U) decay chains. In a sediment sample collected from a representative station for CCNPP, Flag Ponds Station 4, the relative proportion of naturally occurring radionuclides was dominated by ^{40}K (56.7%), ^{238}U (21.6%), and ^{232}Th (20.4%; Figure 3-12). In a sediment sample collected from a representative station for PBAPS, Broad Creek Station 1, the relative proportion of naturally occurring radionuclides was dominated by ^{40}K (55%), ^{238}U (25.2%), and ^{232}Th (16.2%; Figure 3-13). Naturally occurring radionuclides were responsible for more than 99% of the gamma-emitting radionuclides found in most sediment samples collected during the 2018–2019 reporting period.

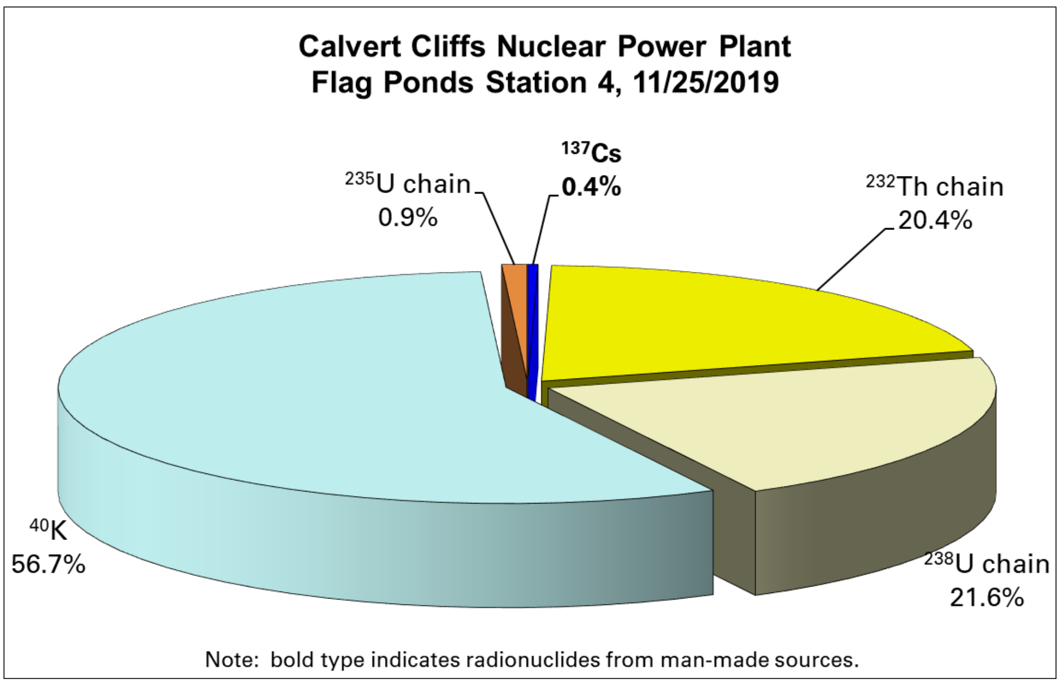


Figure 3-12. The proportion of gamma-emitting radionuclides in a sediment sample collected from Flag Ponds Station 4

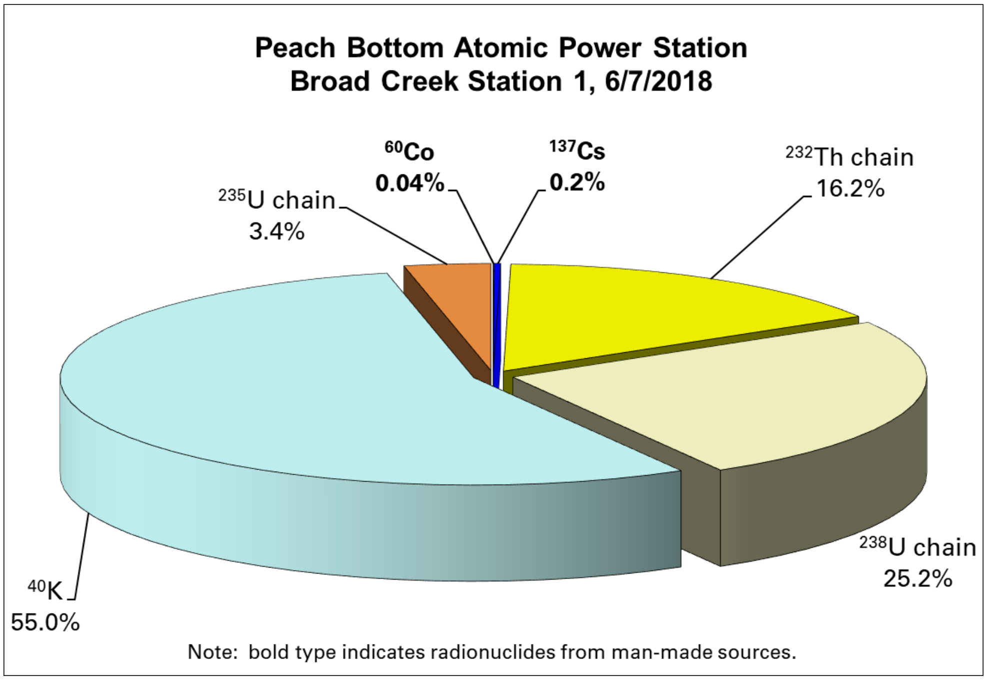


Figure 3-13. The proportion of gamma-emitting radionuclides in a sediment sample collected from Broad Creek Station 1

Thorium and Uranium. Nuclear decay of naturally occurring thorium (^{232}Th) and natural uranium (^{238}U) produces gamma-emitting daughter species (e.g., thorium: ^{228}Ac, ^{208}Tl, ^{212}Pb; uranium: ^{226}Ra, ^{214}Bi, ^{214}Pb). The two parent elements, ^{232}Th and ^{238}U, and their associated decay products accounted for most of the radionuclides detected in sediment samples during the reporting period. The highest concentrations of the daughter radionuclides were observed at offshore stations with fine-grained sediment.

Potassium. The radionuclide ^{40}K is a primordial, naturally occurring element. Concentrations of radioactive ^{40}K in nature are proportional to stable potassium content (0.0118%; CRC Handbook 1979). All sediment samples collected during the 2018–2019 reporting period had detectable levels of ^{40}K; concentrations were highest in predominantly fine-grained sediments.

Beryllium. The radionuclide ^{7}Be is naturally produced by the interaction of cosmic rays with atmospheric oxygen and nitrogen. It is deposited on water and soil surfaces through precipitation scavenging and may enter water systems through runoff from land. Particles suspended in the water column adsorb it rapidly, and it appears in sediments as a result of particulate deposition. Beryllium-7 was detected in 83% and 30% of sediment samples collected at PBAPS and CCNPP, respectively. Concentrations of ^{7}Be were generally lower at CCNPP (mean = 110 pCi/kg; range = 10–432 pCi/kg) than at PBAPS (mean = 561 pCi/kg; range = 34–1,670 pCi/kg). Beryllium-7 concentrations near PBAPS were generally greater in samples with greater proportions of clay particles, particularly those collected from stations in Conowingo Pond and near Conowingo Dam (Broad Creek, Conowingo Creek, and Conowingo Dam transects). Concentrations at sampling stations below Conowingo Dam (e.g., Susquehanna Flats) tended to be lower than at above-dam stations with comparable particle sizes, possibly due to station depth and resulting longer settlement time relative to half-life. Concentrations of ^{7}Be at CCNPP were generally greatest (when detected) in near-shore sediments, where most particles were silt-sized (e.g., LNG Plant Pipeline Station 2). In contrast, offshore stations with clay sediments rarely had detectable levels of ^{7}Be. This disparity with results for clay sediments from the PBAPS study area may be due to a longer average settlement time at the offshore stations near CCNPP in relation to half-life.

3.2.2 Radionuclides in Biota

The ability of biota to absorb environmentally significant radionuclides differs by organism species, age, and gender; habitat; availability of radionuclides; and sensitivity of the organism to radionuclides. The radionuclide monitoring program measures the levels of radioactive elements in oysters from the vicinity of CCNPP, and finfish and submerged aquatic vegetation (SAV) from the vicinity of PBAPS, in samples routinely collected during the two-year reporting periods. The monitoring results for biota collected during the 2018–2019 reporting period are summarized in the subsections below. At CCNPP, test oysters are confined in trays placed in the immediate vicinity of the discharge for periods of three months to one year; other oyster trays are placed near the power plant and at a site that is not directly affected by the power plant discharge. Oysters harvested from the Chesapeake Bay are consumed by humans. Near PBAPS, many finfish are resident and may be found near the plant outfall and in the zone of maximum effluent concentrations. Some forage finfish (e.g., shiners and silversides) and juveniles of other species (e.g., sunfish and gizzard shad) are important food sources for predatory finfish (e.g., smallmouth bass, largemouth bass, and striped bass) that are consumed by humans.

Radionuclides derived from man-made sources are infrequently detected in biological samples collected from the vicinities of CCNPP and PBAPS. During the 2018–2019 monitoring period, ^{60}Co, ^{137}Cs, ^{131}I were generally not detected in biota; the exceptions included low levels (average 11.8 pCi/kg) of ^{137}Cs detected in six samples of finfish collected from PBAPS Conowingo Pond (Appendix Table C-4), one sample of SAV containing a detectable level of ^{137}Cs (61 pCi/kg), and two samples of SAV containing detectable levels of ^{131}I (average 119 pCi/kg; Appendix Table C-5). In previous years, ^{131}I was consistently detected in SAV. The source of ^{131}I in SAV, however, was likely diagnostic and therapeutic procedures that discharge ^{131}I to the sanitary sewer system through the patients' excreta (Larsen et al. 2001).

3.2.2.1 Radionuclides from CCNPP in Oysters

Natural oyster populations in the vicinity of CCNPP have historically been found to accumulate fluctuating levels of ^{58}Co, ^{60}Co, ^{65}Zn, and ^{110m}Ag (McLean et al. 1987). Radioactive silver (^{110m}Ag) has been the major radionuclide accumulated by oysters and the principal contributor to the estimated radiation dose to a human consumer; however, ^{110m}Ag concentrations in oysters decrease rapidly through radioactive decay and biological excretion (McLean et al. 1987). During the 2018–2019 monitoring period, ^{110m}Ag was not detected in tray oysters placed in the vicinity of the cooling water discharge, in tray oysters placed at Camp Conoy near the plant site, or in continually exposed oysters at the control location (St. Leonard Creek). The absence of detectable levels of ^{110m}Ag in tray-oysters since the spring of 2001 reflects very small releases of ^{110m}Ag from CCNPP compared to historical levels. The radionuclides ^{60}Co, ^{137}Cs, and ^{65}Zn were not detected in any oyster samples during the reporting period.

Uptake of radionuclides, particularly ^{110m}Ag, by oysters is governed by physical, chemical, and environmental conditions (e.g., plant releases, water temperature, and season of exposure). McLean et al. (1987) and Rose et al. (1988, 1989) provided detailed descriptions of the tray oyster study and statistical modeling of radionuclide concentrations in tray oysters.

3.2.2.2 Radionuclides from PBAPS in Finfish

During the 2018–2019 reporting period, six samples of finfish flesh had detectable levels of the radionuclide ^{137}Cs (range 6–30, average 11.8 pCi/kg; Appendix Table C-4). The radionuclides ^{60}Co and ^{65}Zn were not detected in any finfish samples in the reporting period. Historically, ^{137}Cs has been detected in samples of finfish flesh at low concentration levels and detection frequencies, and ^{60}Co has rarely been detected.

3.2.2.3 Radionuclides from PBAPS in SAV

Radionuclides from man-made sources were not detected in the few SAV samples collected during the 2018–2019 reporting period. In earlier monitoring periods, ^{137}Cs was detected in SAV samples, albeit at very low concentrations. Radioactive iodine (^{131}I) was also present in SAV in previous monitoring periods, but ^{131}I was not detected during the 2018–2019 period.

Historically, the source of concentrations of ^{131}I found in SAV had likely been from releases of ^{131}I into the sanitary sewer system by patients undergoing nuclear medicine treatment (Jones 2003). The study prepared by Jones (2003) was conducted by ISCORS (Interagency Steering Committee on Radiation Standards) and found a widespread presence of ^{131}I in samples of sewage sludge collected from sewage treatment plants across the U.S. Therapeutic doses of ^{131}I administered in nuclear medicine can be typically as high as several hundred mCi (National Council on Radiation Protection and Measurements [NCRPM] 1996). Releases of ^{131}I from PBAPS were typically less than 2 mCi; therefore, the contributions of medicinal radioactive iodine in the waterway likely led to relatively insignificant accumulations of ^{131}I in SAV.

Other studies have suggested that ^{131}I is present in wastewater, surficial sediments, and suspended particle matter in New York Harbor (Smith et al. 2008), in mussels and fish of the Tagus River estuary (Malta et al. 2013), in sewage effluent from a Stony Brook (NY) wastewater treatment plant (Rose et al. 2012), and in water and sediments of the Potomac River estuary (Rose et al. 2013). The ^{131}I in each of these studies was thought to be medically derived; for instance, from thyroid cancer treatment facilities and cancer patients undergoing treatment at home. The Potomac River study suggested a relatively continuous source of this radionuclide.

One other possible source of ^{131}I is hydraulic fracturing. Gamma-emitting tracer isotopes are used in hydraulic fracturing to trace the movement of materials and determine the extent of fracturing (International Atomic Energy Agency 2003). To date, there is no evidence that ^{131}I is being used in the exploration and extraction of natural gas in the Marcellus Shale Formation (generally occurring in an arc along the Appalachian Basin west and north of Maryland); thus, this is not a likely source of ^{131}I that may affect the results in the radionuclide monitoring study.

3.2.2.4 Radionuclides from Natural Sources in Biota

In the 25 tray oyster samples collected from the CCNPP region and analyzed during the 2018–2019 reporting period, there were detectable levels of two naturally occurring radionuclides: ^{7}Be and ^{40}K (Appendix Table C-2). Two samples from the CCNPP Outfall station had detectable levels of ^{7}Be (170-day exposure in 2018, 366 pCi/kg dry weight; 142-day exposure in 2019, 451 pCi/kg dry weight). The radionuclide ^{40}K was detected in every oyster sample collected during the reporting period (CCNPP Outfall station, average 8,497 pCi/kg dry weight); Camp Conoy station, average 1,505 pCi/kg wet weight; Control station, average 8,764 pCi/kg dry weight).

Biota samples collected from the PBAPS area also had detectable levels of ^{7}Be and ^{40}K. The four SAV samples collected from the Fishing Battery station in 2019 had ^{7}Be in every sample (average 5,344 pCi/kg) and ^{40}K in every sample (average 36,844 pCi/kg). The radionuclide ^{40}K was detected in every finfish sample (flesh and guts) processed and analyzed during the period (flesh average 13,526 pCi/kg; guts average 5,411 pCi/kg).

3.2.3 Air, Potable Water, Precipitation, and Milk

Samples of air particulates exhibited detectable radioactivity of naturally occurring ^{7}Be and undifferentiated, naturally occurring alpha and beta emitters trapped on air-particulate filters for most samples; the samples did not exhibit detectable levels of ^{137}Cs during the monitoring period (Table 3-5 and Appendix Table C-6). Test results for ^{131}I in samples of air (gas) did not indicate detectable levels of the radionuclide (Table 3-5 and Appendix Table C-7).

Table 3-5. Analytical results from air monitoring stations, 2018–2019						
Releasing Power Plant	**Station**	**Gross Alpha (fCi/m^3; mean ± 2 SD)[a]**	**Gross Beta (fCi/m^3; mean ± 2 SD)[a]**	**^{131}I[b]**	**^{7}Be (fCi/m^3; mean ± 2 SD)[a]**	**^{137}Cs[a]**
CCNPP	Long Beach	1±0.8	16±3	ND	89±12	ND
CCNPP	Lusby	0.8±0.4	16±2	ND	88±23	ND
CCNPP	Cove Point	0.8±0.4	17±4	ND	90±18	ND
CCNPP	Horn Point	0.8±0.5	16±4	ND	85±4	ND
NA: Control	Baltimore City	0.9±0.4	16±1	ND	89±27	ND
PBAPS	Rising Sun	1±0.2	17±1	ND	92±20	ND
PBAPS	Whiteford	0.9±0.4	17±2	ND	98±28	ND
PBAPS	Dempsey Farm	0.9±0.3	17±2	ND	89±24	ND

Note: Only samples where radioactivity was detected were used to calculate the mean. [a] = results from air particulate sampling. [b] = results from air (gas) sampling. CCNPP = Calvert Cliffs Nuclear Power Plant. PBAPS = Peach Bottom Atomic Power Station. SD = standard deviation. NA = not applicable. ND = not detected at the applicable detection limit.

Laboratory analysis of potable water samples collected during the 2018–2019 reporting period indicated that alpha-emitting radiation was rare and beta-emitting radiation was common. Naturally occurring alpha-emitting radioactivity was detected in four samples of potable water collected at four different stations in the region around CCNPP; alpha radiation was not detected in samples from the control station in Baltimore City (Table 3-6 and Appendix Table C-8). Beta-emitting radioactivity was found in one sample collected from the control station (12.5%) and 48 of the samples (86%) of potable water collected near CCNPP (Table 3-6 and Appendix Table C-8). All of the positive gross beta results indicated levels of 20 picoCuries per liter (pCi/L) or less.

Samples of precipitation collected from the Baltimore station during the monitoring period contained gross alpha radioactivity (10 samples; 20%), gross beta radioactivity (13 samples; 26%) , and ^{7}Be (41 samples; 82%; Appendix Table C-9). Gross alpha levels ranged from 0.8 pCi/L to 3.8 pCi/L. Gross beta levels ranged from 1.5 pCi/L to 6 pCi/L. Tritium was below the detection limit in all samples.

Laboratory analysis indicated detectable levels of radiostrontium in processed and raw milk samples during the 2018–2019 reporting period. One sample of composite milk had a measured amount of ^{89}Sr (average 0.5 pCi/L) and one of the samples of raw milk had ^{89}Sr (average 1.1 pCi/L) and ^{90}Sr (average 0.2 pCi/L); both samples were collected in fall 2019 (Appendix Table C-10).

Table 3-6. Analytical results from potable water monitoring stations, 2018–2019			
Station	**Concentrations in Potable Water (pCi/L; mean ± 2 SD)**		
	Gross Alpha	**Gross Beta**	**Tritium**
Baltimore City (control)	ND	8±2	ND
Chesapeake Country Club	ND	6±4	ND
Calvert County Courthouse	3±1	13±3	ND
Appeal Elementary School	2±1	13±2	ND
Calvert County Health Department	ND	5±5	ND
Southern Middle School	4±2	10±1	ND
Frying Pan Restaurant	ND	12±1	ND
Volunteer Fire Department	2±1	15±3	ND
Notes: Only samples where radioactivity was detected were used to calculate the mean. SD = standard deviation. ND = not detected at the detection limit.			

3.3 RADIOLOGICAL EFFECTS ON THE ENVIRONMENT AND HUMAN HEALTH

3.3.1 Effect on the Environment

Although small concentrations of radionuclides attributable to fallout from weapons tests (i.e., ^{137}Cs) were detected in biota collected during 2018–2019, the maximum detected concentrations were orders of magnitude smaller than concentrations of natural radionuclides. Radiation doses to aquatic organisms attributable to discharges from power plants are an insignificant proportion of doses derived from natural radionuclides (Whicker and Schultz 1982). Living organisms normally receive most of their external and internal doses of radiation from naturally occurring radionuclides such as ^{40}K.

3.3.2 Potential Effect on Human Health

Radioactive substances are ubiquitous in the human environment. The USNRC estimates that humans receive approximately 0.31 rem of radiation each year from natural sources. Humans accumulate most of the annual radiation dose from radon in the air; other sources include the cosmos (i.e., the sun and stars), soil, food, water, and naturally derived ^{14}C and ^{40}K constantly shared among humans. According to the USNRC, annual doses at twice this level (i.e., 0.62 rem) do not cause harmful effects in humans (USNRC, 2022).

Humans come into contact with air, food, water, and soil every day, and each of these types of materials contain radionuclides from natural and man-made sources. The radionuclide monitoring studies that PPAD conducts every year evaluate samples of these media, in part to derive estimates of potential human exposure risk through direct contact with several target interactions, which coincide with the aqueous and gaseous pathways.

Relevant to the 2018–2019 reporting year, the results of the analyses to estimate human risk comprise the remainder of this sub-section.

Analysts applied measured concentrations of radionuclides in edible finfish and processed and raw milk, from test results compiled during the 2018–2019 reporting period, to simple models to estimate the potential radiation doses to human consumers of these materials as dietary intake. The outputs of the models were expressed as dose commitment, which referred to the total dose to a tissue or organ after a period of 50 years following ingestion of finfish or processed milk containing the maximum concentrations of radionuclides, after allowing for the metabolic processes of excretion and radioactive decay. The dose commitment calculations are based on three variables: (1) the estimated maximum quantity of finfish or milk consumed by an individual according to age (i.e., child = 6.9 kg/yr; teenager = 16 kg/yr; adult = 21 kg/yr; USNRC 1977); (2) the dose to the target organ per quantity of radionuclide ingested (USNRC 1977), and (3) the maximum, or worst-case, estimated concentration of plant-related radionuclides in finfish collected from Conowingo Pond or processed and raw milk produced locally, respectively. For the purposes of the 2018–2019 report, the target organs for each age group were bone, liver, kidney, and lower large intestine; the whole body was also a model target. Note that the dose commitment was not calculated for an oyster diet, although the model could accommodate input from analysis of oyster samples, because no man-made radionuclides were detected in samples collected during 2018 and 2019. The formula for the model had the following units and structure:

Calculation variable:		**1**		**2**		**3**
Dose commitment	=	$\frac{kg}{yr}$	x	$\frac{mrem}{pCi}$	x	$\frac{pCi}{kg}$

where kg is kilograms, yr is year, mrem is millirem, and pCI is picocuries.

Analysts conducted the model processing to derive estimated dose commitments for adults, teenagers, and children, based on a diet of finfish, which included the radionuclides ^{137}Cs, ^{134}Cs, and ^{65}Zn, when detected. Sample results indicated that ^{134}Cs, and ^{65}Zn were not present in fish tissue; thus, analysis results only showed relevant doses for ^{137}Cs (Table 3-7). The maximum estimated organ-specific dose commitment to a child, associated with ^{137}Cs in dietary finfish, was 0.022 mrem/yr in the bone target. The estimated maximum dose to a teenager was 0.023 mrem/yr in the liver. The estimated maximum dose to an adult was 0.022 mrem/yr in the liver. The maximum total body dose was 0.015 mrem/yr, which was calculated for an adult.

Analysts conducted a similar model processing to derive estimated dose commitments for adults, teenagers, and children, based on a diet of milk, which included the radionuclides ^{89}Sr and ^{90}Sr, when detected (Table 3-8). The maximum estimated organ-specific dose commitment, associated with radiostrontium in dietary milk, was 1.6 mrem/yr, 0.86 mrem/yr and 0.58 mrem/yr to a child, a teenager, and an adult, respectively, in the bone. The maximum total body dose was 0.30 mrem/yr, which was calculated for a child.

Table 3-7. Estimated maximum dose commitments for ^{137}Cs to humans who consume finfish from Conowingo Pond, 2018–2019, by age group

Affected Body Target	Maximum Dose Commitments from Finfish Consumption: 2018–2019 (mrem/yr)		
	Age Group		
	Adult	Teenager	Child
Total Body	0.0145	0.0080	0.0031
Bone	0.0162	0.0173	0.0218
Liver	0.0221	0.0231	0.0209
Kidney	0.0075	0.0078	0.0068
Gastrointestinal Tract; lower large intestine	0.0004	0.0003	0.0001

Note: The recommended consumption values and conversion factors were derived from USNRC 1977. The estimated doses for ^{65}Zn and ^{134}Cs for all scenarios were zero (0).

Table 3-8. Estimated maximum dose commitments for ^{89}Sr and ^{90}Sr to humans who consume processed and raw milk in the Baltimore area, 2018–2019, by age group

Affected Body Target	Maximum Dose Commitments from Milk Consumption: 2018–2019 (mrem/yr)		
	Age Group		
	Adult	Teenager	Child
Total Body	0.1183	0.1695	0.2981
Bone	0.5750	0.8576	1.6012
Gastrointestinal Tract; lower large intestine	0.0304	0.0417	0.0337

Note: The recommended consumption values and conversion factors were derived from USNRC 1977.

The two target power plants are required, by specifications in their permits, to maintain concentrations of radioactive materials released by the power plants (through the aqueous or gaseous pathways) within acceptable limits, as specified by the USNRC. The owners of the power plants are required to monitor the levels of radionuclides released in the facilities' effluents to maintain compliance with dose limits to individual members of the human population. The maximum annual effective dose equivalent allowed to the general population as a result of a licensee's activities involving the use of radioactive material is 100 mrem above background levels, exclusive of the dose contribution from the licensee's disposal of radioactive material (USNRC 1991). Plant-design objectives to maintain effective dose equivalents resulting from the release of radioactive material during normal operations to levels "as low as reasonably achievable" are stated in the USNRC's report, (1996), 10 CFR Part 50 Appendix I:

> The calculated annual total quantity of all radioactive material above background to be released from each light-water-cooled nuclear power reactor to unrestricted areas will not result in an estimated annual dose or dose commitment from liquid effluents for any individual in an unrestricted area from all pathways of exposure in excess of 3 millirems to the total body or 10 millirems to any organ.

The USEPA has set maximum permissible dose rules as part of the regulation of the uranium fuel cycle, which includes the mining of ore in addition to the operation of nuclear power plants (40 CFR Part 190 Subpart B; USEPA 1979):

> Operations covered by this subpart shall be conducted in such a manner as to provide reasonable assurance that: A) The annual dose equivalent does not exceed 25 millirems to the whole body, 75 millirems to the thyroid, and 25 millirems to any other organ of any member of the public as the result of exposures to planned discharges of radioactive materials, radon and its daughters excepted, to the general environment from uranium fuel cycle operations and to radiation from these operations.

Human dose commitments calculated from radionuclide concentrations in consumable biota vary with annual fluctuations in the measured concentrations. The model results from the 2018–2019 reporting period, compared to the industry expectations, as stated by the USNRC, show that the quantities of radionuclides found in biota during the period, and which may be attributable to nuclear power plant operations, would not pose a potential threat to human health, as estimated by their consequent effective dose equivalent as they migrate through trophic layers to humans. All quantities released resulted in estimated doses that were no more than 16% of the regulatory limits set by the USNRC (Table 3-9).

Table 3-9. Comparison of maximum estimated radiation doses to humans from nuclear power plant operations and applicable regulatory limits

Exposure Route	Maximum Dose Estimate (2018)	Maximum Dose Estimate (2019)	EPA Regulatory Limit (40CFR190 Subpart B)	NRC Regulatory Limit (10CFR50 Appendix I)
Ingestion (mrem)				
Milk ingestion, whole-body dose	0.30 (child)		25	3
Milk ingestion, other organ dose	1.6 (child bone)		25	10
Oyster ingestion, whole-body dose (from CCNPP)	NC		25	3
Oyster ingestion, other organ dose (from CCNPP)	NC		25	10
Finfish ingestion, whole-body dose (from PBAPS)	0.0145 (adult)		25	3
Finfish ingestion, other organ dose (from PBAPS)	0.0231 (teenager liver)		25	10
Gaseous Pathway (mrem)				
Whole-body dose (gaseous, from CCNPP)	0.00018 (child)[a]	0.000044 (child)[a]	25	NA
Other organ dose (gaseous, from CCNPP)	0.00018 (child skin)[a]	0.000048 (child skin)[a]	25	NA
Whole-body dose (gaseous, from PBAPS)	0.292 (any age class)[b]	0.234 (any age class)[b]	25	NA
Other organ dose (gaseous, from PBAPS)	0.38 (any age class, skin)[b]	0.316 (any age class, skin)[b]	25	NA

[a] Source: Barnett and Prosceo 2019, 2020
[b] Source: Exelon Generation 2019c, 2020c
NC = Not Calculated because no man-made radionuclides were detected in the samples
NA = Not Applicable because the quantity limit for atmospheric effluents is 10 millirads

4.0 CONCLUSIONS

During the 2018–2019 monitoring period, CCNPP and PBAPS released radionuclides to the environment as a normal consequence of routine operations. The only radionuclide released from CCNPP that was detected in sediment samples collected from Chesapeake Bay was ^{137}Cs; it was detected in the majority of the samples, but most of the influence on the concentrations in the sediment was due to radioactive decay of ^{137}Cs that was released many years ago and the fallout from weapons testing. No radionuclides from facility discharges were detected in oysters collected near the CCNPP outfall. In the PBAPS study area, most plant-produced radionuclides (predominantly ^{137}Cs and rarely ^{60}Co) were detected in sediment samples collected downstream of the plant outfall and upstream of Conowingo Dam. The radionuclide ^{137}Cs was detected in six samples of finfish (flesh) that were collected near the PBAPS outfall; the concentrations were very low. Radiostrontium was detected in one sample, each, of processed (Maryland composite) and raw milk (Peach Bottom region) samples.

Radionuclides from nuclear power plant operations, nuclear weapons testing, and natural sources contributed to the total radioactivity measured in environmental samples. Generally, radionuclides from natural sources (primarily radionuclides from the uranium and thorium decay series, ^{40}K, and ^{7}Be) constituted more than 99% of the total radioactivity of environmental samples.

As noted in Whalen and Jones (2000), and as was the case in 2018–2019, the levels of radionuclides from man-made sources detected in sediment samples were at historically low levels and continue a significant downward trend in radionuclide activity. The radionuclide ^{60}Co was not detected in sediment samples from the CCNPP study area in 2018–2019 as a consequence of continued reductions in power plant discharges, decay of inventory present in the sediment layer, and dilution by sedimentation. In the vicinity of PBAPS, ^{60}Co was detected in two sediment samples (2.6%) in the 2018–2019 period, in low concentrations. Tray oysters have not exhibited detectible levels of ^{110m}Ag since 2001, due to a reduction in available ^{110m}Ag released from CCNPP (compared to historical levels). The radionuclide ^{131}I was detected in two SAV samples during the current monitoring period. The source of ^{131}I in the waterways is believed to originate in medical treatments; however, the amount of the waste that is accumulated by the plants appears to be very small, relative to the typical amounts in medicine dosages.

Concentrations of radionuclides in sediments and biota do not represent a risk to the ecological health of the Chesapeake Bay or the Susquehanna River. The additional increment of radioactivity and radiation dose attributable to the operation of CCNPP and PBAPS is minimal when compared with natural levels of radioactivity and the associated natural radioactive dose (approximately 625 mrem/yr; NCRPM 2009).

The incremental increase in the dose to humans that could result from the consumption of biota from the vicinity of CCNPP and PBAPS, and which may be attributable to nuclear power production operations, was no more than 0.05% (NCRPM 2009) during the 2018–2019 period, according to model results. This increase is insignificant when compared to the total dose attributable to natural background and other sources, which varies according to geographic region and elevation, kind of habitat (e.g., construction material used in residences), personal choices (e.g., smoking, occupation), routine medical procedures, and other sources of background radiation.

5.0 REFERENCES

Abbe, G.R. 1981. Oyster Tray Studies. *In*: Non-radiological Environmental Report for the Calvert Cliffs Nuclear Power Plant: January-December 1980, 1–131. Academy of Natural Sciences of Philadelphia, Philadelphia, PA.

Barnett, A.M. and M. Prosceo. 2019. Annual Radiological Environmental Operating Report for the Calvert Cliffs Nuclear Power Plant Units 1 and 2 and the Independent Spent Fuel Storage Installation. January 1 – December 31, 2018. Exelon Generation, LLC, May 2019.

Barnett, A.M. and M. Prosceo. 2020. Annual Radiological Environmental Operating Report for the Calvert Cliffs Nuclear Power Plant Units 1 and 2 and the Independent Spent Fuel Storage Installation. January 1 – December 31, 2019. Exelon Generation, LLC, May 2020.

Buchanan, J.B. and J.M. Kain. 1971. Measurement of the Physical and Chemical Environment. *In:* Methods for the Study of Marine Benthos, 30–50. N.A. Holme and A.D. McIntyre, eds. Oxford, England: Blackwell Scientific Publications.

Canberra Industries. 1998. Model S500 Genie-2000 Spectroscopy System: Basic Operation, Advanced Topics, Application Options. Version 1.2. September 1998. Canberra Industries, Inc., Meriden, CT.

CRC Handbook of Chemistry and Physics. 1979. CRC Press, Boca Raton, FL.

Domotor, S.L. and R.I. McLean. 1988. Environmental Radionuclide Concentrations in the Vicinity of the Calvert Cliffs Nuclear Power Plant: 1985–1986. PPRP-R-10. November 1988. Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD.

Eisenbud, M. 1987. Environmental Radioactivity from Natural, Industrial, and Military Sources. Third edition. Orlando, FL: Academic Press, Inc.

Exelon Generation Company. 2012. Peach Bottom Atomic Power Station. http://www.exeloncorp.com/PowerPlants/peachbottom/Pages/profile.aspx. Accessed February 17, 2012.

Exelon Generation Company. 2019a. Annual Radioactive Effluent Release Report for Calvert Cliffs Nuclear Power Plant and Independent Spent Fuel Storage Installation - 2019. Exelon Generation Company, LLC, July 15, 2019.

Exelon Generation Company. 2019b. Annual Radioactive Effluent Release Report No. 61, January 1, 2018, through December 31, 2018, for Peach Bottom Atomic Power Station, Units 1, 2 and 3. Exelon Generation Company, LLC, April 26, 2019.

Exelon Generation Company. 2019c. Peach Bottom Atomic Power Station Unit Nos. 2 and 3 Annual Radiological Environmental Operating Report No. 76, January 1 through December 31, 2018. Prepared by Teledyne Brown Engineering Environmental Services for Exelon Generation Company, LLC, May 2019.

Exelon Generation Company. 2020a. Annual Radioactive Effluent Release Report for Calvert Cliffs Nuclear Power Plant and Independent Spent Fuel Storage Installation - 2019. Exelon Generation Company, LLC, July 15, 2020.

Exelon Generation Company. 2020b. Annual Radioactive Effluent Release Report No. 62, January 1, 2019, through December 31, 2019, for Peach Bottom Atomic Power Station, Units 1, 2 and 3. Exelon Generation Company, LLC, April 29, 2020.

Exelon Generation Company. 2020c. Peach Bottom Atomic Power Station Unit Nos. 2 and 3 Annual Radiological Environmental Operating Report No. 77, January 1 through December 31, 2019. Prepared by Teledyne Brown Engineering Environmental Services for Exelon Generation Company, LLC, May 2020.

International Atomic Energy Agency. 2003. Radiation Protection and the Management of Radioactive Waste in the Oil and Gas Industry. Safety Report Series No. 34, International Atomic Energy Agency, Vienna, Austria.

Jones, A.R. 2003. ISCORS Assessment of Radioactivity in Sewage Sludge: Radiological Survey Results and Analysis. EPA 832-R-03-002. November 2003. Interagency Steering Committee on Radiation Standards.

Jones, T.S. 1994. Radiation Laboratory Manual. April 1994. Maryland Department of Health and Mental Hygiene, Laboratories Administration, Environmental Chemistry Division, Baltimore, MD.

Jones, T.S. 2010. Maryland Department of Natural Resources Radioecology Laboratory Quality Assurance Plan. April 2010. Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD.

Krieger, H.L. and E. L. Whittaker. 1980. Prescribed Procedures for Measurement of Radioactivity in Drinking Water. Publication No. EPA-600/4-80-032. United States Environmental Protection Agency Environmental Monitoring and Support Laboratory, Cincinnati, OH.

Lacy, G. and S. Zeger. 1979. Thermal Plume Studies in the vicinity of Calvert Cliffs Nuclear Power Plant, April and May 1978. Academy of Natural Sciences of Philadelphia, Philadelphia, PA.

Larsen, I.L., E.A. Stetar, B.G. Giles, and B. Garrison. 2001. Concentrations of Iodine-131 Released from a Hospital Into a Municipal Sewer. *RSO Magazine,* 6: 13-18.

Lippson, A.J. and R.L. Lippson. 2006. Life in the Chesapeake Bay, 3rd ed. Johns Hopkins University Press, Baltimore, MD.

Llansó, R.J., D. Zaveta, and L.C. Scott. 2015. Chesapeake Bay Water Quality Monitoring Program: Long-Term Benthic Monitoring and Assessment Component, Level 1 Comprehensive Report, July 1984–December 2014. Prepared for the Maryland Department of Natural Resources by Versar, Inc., Columbia, MD.

Malta, M., J.M. Oliveira, L. Silva, and F.P. Carvalho. 2013. Radioactivity from Lisboa Urban Wastewater Discharges in the Tejo River Estuary. *Journal of Integrated Coastal Zone Management.* DOI: 10.5894/rgci339.

McLean, R.I., J.K. Summers, K.A. Rose, and S.L. Domotor. 1987. Silver-110m, ^{58}Co, and ^{65}Zn Concentrations in the American Oyster, *Crassostrea virginica* (Gmelin), Near the Calvert Cliffs Nuclear Power Plant. PPRP-R-7. December, 1987. Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD.

National Council on Radiation Protection and Measurements. 1996. Sources and Magnitude of Occupational and Public Exposure from Nuclear Medicine Procedures. National Council on Radiation Protection and Measurements, Bethesda, MD.

National Council on Radiation Protection and Measurements. 2009. Ionizing Radiation Exposure of the Population of the United States. National Council on Radiation Protection and Measurements. Bethesda, MD.

Olsen, C.R., I.L. Larsen, P.D. Lowry, R.I. McLean, and S.L. Domotor. 1989. Radionuclide Distributions and Sorption Behavior in the Susquehanna-Chesapeake Bay System. PPRP-R-12. January, 1989. Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD.

Peach Bottom Atomic Power Station, Units 2 and 3, 79 Fed. Reg. 10973–10883, (March 31, 2014).

Prăvălie, R. 2014. Nuclear weapons tests and environmental consequences: a global perspective. *AMBIO*, 43: 729-744.

Power Plant Research Program. 1998. Resolution of Winter Minimum Flow Issues at Conowingo Dam: Summary of Findings and Recommendation. February 1998. Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD.

Power Plant Research Program. 2017. Maryland Power Plants and the Environment: A Review of the Impacts of Power Plants and Transmission Lines on Maryland's Natural Resources. Maryland Power Plant Research Program. PPRP-CEIR-8 through PPRP-CEIR-19.

Rose, K.A., R.I. McLean, and J.K. Summers. 1989. Development and Monte Carlo Analysis of an Oyster Bioaccumulation Model Applied to Biomonitoring Data. *Ecological Modeling,* 45: 111-132.

Rose, K.A., R.I. McLean, J.K. Summers, and S.L. Domotor. 1988. Radiosilver (Ag-110m) Concentrations in Chesapeake Bay Oysters Maintained Near a Nuclear Power Plant: A Statistical Analysis. *Journal of Environmental Monitoring and Assessment,* 10: 205-218.

Rose, P.A., J.P. Smith, J.K. Cochran, R.C. Aller, and R.L. Swanson. 2013. Behavior of Medically-Derived ^{131}I in the Tidal Potomac River. *Science of the Total Environment*, 452–453: 87–97.

Rose, P.A., R.L. Swanson, and J.K. Cochran. 2012. Medically-Derived ^{131}I in Municipal Sewage Effluent. *Water Research*, 46: 5663–5671.

Santschi, P.H., D.M. Adler, and M. Amdurer. 1983. The Fate of Particles and Particle- reactive Metals in Coastal Waters: Radioisotope Studies in Microcosms. *In*: Trace Metals in Sea Water, 331-349. C.S. Wong, E. Boyle, K.W. Bruland, J.D. Burton, and E.D. Goldberg, eds., Plenum, NY.

Smith, J.P., S.D. Oktay, J. Kada, and C.R. Olsen. 2008. Iodine-131: A Potential Short-Lived, Wastewater-Specific Particle Tracer in an Urbanized Estuarine System. *Environmental, Science, and Technology*, 42: 5435–5440.

Standards for protection against radiation, 10 CFR Part 20 app. B, 1991.

Stanek, M.A., T.S. Jones, and J.B. Frithsen. 1996a. Comparison of the ND9900 and Genie-PC Data Acquisition and Spectrum Processing Systems. Technical Memorandum, November 11, 1996. Prepared for the Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD, by Versar, Inc., Columbia, MD.

Stanek, M.A., T.S. Jones, and J.B. Frithsen. 1996b. Documentation of the PPRP Gamma Spectrometry Methods: A Guide to Data Acquisition and Spectral Processing. PPRP-R-23. December 10, 1996. Maryland Department of Natural Resources, Power Plant Research Program, Annapolis, MD.

Swarth, C.W. and R.J. Llansó. 2012. Calvert Cliffs Diving Duck Study Report. Prepared for the Southern Maryland Resource Conservation and Development Board and Maryland Department of Natural Resources, Power Plant Research Program, by Versar, Inc., Columbia, MD.

United States Atomic Energy Commission. 1973. Final environmental statement related to the operation of Calvert Cliffs Nuclear Power Plant Units 1 and 2, Baltimore Gas and Electric Company. Dockets Nos. 50-317 and 50-31.

United States Department of Energy. 1990. EML Procedures Manual, HASL-300, 28th eds. HASL-300-ED.27-Vol 1. United States Department of Energy, Environmental Measurements Laboratory, New York, NY.

United States Department of Energy/The Energy Information Administration. 2021. Monthly Nuclear Utility Generation (MWh) by State and Reactor, 2019 December. https://www.eia.gov/nuclear/generation/archive/xls/usreact19.xlsx. Accessed September 11, 2021.

United States Environmental Protection Agency. 1979. 40 CFR Part 190. U.S. Government Printing Office, Washington, D.C.

United States Environmental Protection Agency. 1981. Health Impact Assessment of Carbon-14 Emissions from Normal Operations of Uranium Fuel Cycle Facilities. EPA 520/5-80-004. United States Environmental Protection Agency, Washington, DC.

United States Geological Survey. 2020. Water Data Report 2019. 01578310 SUSQUEHANNA RIVER AT CONOWINGO, MD. https://nwis.waterdata.usgs.gov/nwis. Accessed September 30, 2021.

United States Nuclear Regulatory Commission. 1977. Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I. Regulatory Guide 1.109. Washington, DC: U.S. Government Printing Office, Washington, D.C.

United States Nuclear Regulatory Commission. 1999. Generic Environmental Impact Statement for License Renewal of Nuclear Plants: Regarding Calvert Cliffs Nuclear Power Plant - Final Report. NUREG-1437, Supplement 1. Division of Regulatory Improvement Programs, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C.

United States Nuclear Regulatory Commission. 2022. "Doses in Our Daily Lives." https://www.nrc.gov/about-nrc/radiation/around-us/doses-daily-lives.html. Accessed: July 19, 2022.

Whalen, K.G. and T.S. Jones. 2000. Integrative Evaluation of PPRP's Radionuclide Sampling Program and Database. PPRP-R-26. July 10, 2000. Maryland Power Plant Research Program, Annapolis, MD.

Whicker, F.W. and V. Schultz. 1982. Radioecology: Nuclear Energy and the Environment. Vol. 1. CRC Press, Inc., Boca Raton, FL.

White, C.P. 1989. Chesapeake Bay Nature of the Estuary: A Field Guide. Tidewater Publishers, Centreville, MD.

Yim, M-S. and F. Caron. 2006. Life Cycle and Management of Carbon-14 from Nuclear Power Generation. *Progress in Nuclear Energy*, 48: 2-36.

APPENDIX A

COORDINATES OF SEDIMENT SAMPLING STATIONS

Table A-1. Coordinates of sediment sampling stations in the vicinity of CCNPP and PBAPS

Chesapeake Bay Calvert Cliffs Region

Transect Name/Location	Station	North Latitude	West Longitude
Western Shores	WS-1	38° 29.321′	76° 29.336′
	WS-2	38° 29.460′	76° 29.239′
	WS-3	38° 29.752′	76° 28.272′
	WS-4	38° 30.975′	76° 25.897′
Flag Ponds	FP-1	38° 27.254′	76° 26.873′
	FP-2	38° 27.302′	76° 26.820′
	FP-3	38° 27.402′	76° 26.476′
	FP-4	38° 29.211′	76° 24.790′
Calvert Cliffs Outfall	CCO-1	38° 26.316′	76° 26.412′
	CCO-2	38° 26.455′	76° 26.266′
	CCO-3	38° 26.795′	76° 25.753′
	CCO-4	38° 28.245′	76° 24.055′
Rocky Point	RP-1	38° 25.074′	76° 24.949′
	RP-2	38° 28.356′	76° 24.490′
	RP-3	38° 25.327′	76° 24.300′
	RP-4	38° 26.068′	76° 22.896′
Liquid Natural Gas Terminal	LNG-1	38° 22.625′	76° 23.083′
	LNG-2	38° 23.652′	76° 22.882′
	LNG-3	38° 23.745′	76° 22.495′
	LNG-4	38° 23.997′	76° 21.431′
Cove Point	CP-1	38° 22.500′	76° 22.859′
	CP-2	38° 22.541′	76° 22.446′
	CP-3	38° 22.601′	76° 21.934′
	CP-4	38° 22.635′	76° 20.725′
Little Cove Point	LCP-1	38° 21.292′	76° 21.490′
	LCP-2	38° 21.368′	76° 20.180′
Drum Point	DP-1	38° 19.553′	76° 22.354′
	DP-2	38° 19.574′	76° 19.757′

Table A-1. (Continued)

Lower Susquehanna River and Upper Chesapeake Bay

Transect Name/Location	Station*	North Latitude	West Longitude
Little Yellow House	LYH-1	39°44.592′	76°15.120'
	LYH-2	39°44.929′	76°14.635'
	LYH-3	39°45.242'	76°14.082'
Broad Creek	BC-1	39°41.909'	76°14.017'
	BC-2	39°42.044'	76°13.657'
	BC-3	39°42.280'	76°13.063'
Conowingo Creek	COC-1	39°40.690'	76°12.327'
	COC-2	39°40.848'	76°12.124'
	COC-3	39°40.997'	76°11.996'
Conowingo Dam	COD-1	39°39.475'	76°10.591'
	COD-2	39°39.675'	76°10.546'
	COD-3	39°40.026'	76°10.383'
Susquehanna River Rt. 95 Bridge	SR-3	39°34.858'	76°06.127'
Susquehanna Flats River Mouth	SF-1	39°32.827'	76°04.467'
Susquehanna Flats Buoy R "14"	SF-6	39°31.027'	76°05.007'
Susquehanna Flats Buoy N "12"	SF-7	39°30.274'	76°05.216'
Susquehanna Flats Buoy N "8"	SF-8	39°29.215'	76°04.955'
Susquehanna Flats Buoy N "2"	SF-9	39°28.294'	76°03.261'
Upper Bay Buoy RB "A"	UB-10	39°26.555'	76°01.997'

*Note:
Station 1, West of Reservoir
Station 2, Center of Reservoir
Station 3, East of Reservoir

APPENDIX B

LABORATORY INTERCOMPARISON RESULTS

Table B-1. Results of the Laboratory Intercomparison Program

Sample Date	Sample Type and Units	Radionuclide	Laboratory Results average ± 1 SD	Analytical Results average ± 1 SD
11/15/2018	Water-pCi/L	Cr-51	47 ± 9	57 ± 1
		Mn-54	151 ± 6	151 ± 3
		Co-58	83 ± 3	81 ± 1
		Fe-59	44 ± 3	46.6 ±0.8
		Co-60	182 ± 6	193 ± 3
		Zn-65	177 ± 8	175 ± 3
		Cs-134	101 ± 3	120 ± 2
		Cs-137	146 ± 6	153 ± 3
		Ce-141	36 ± 2	34.8 ± 0.6

APPENDIX C

CONCENTRATIONS OF RADIONUCLIDES IN ENVIRONMENTAL SAMPLES

INTRODUCTION

This appendix contains data for most of the radionuclides detected in the environmental samples collected in the vicinity of the Calvert Cliffs Nuclear Power Plant and the Peach Bottom Atomic Power Station during the 2018–2019 monitoring period. The radionuclides reported in these tables include the naturally occurring radionuclides ^{7}Be and ^{40}K, the weapons test fallout radionuclides ^{137}Cs and ^{90}Sr, and the power plant-produced radionuclides ^{89}Sr, ^{110m}Ag, ^{58}Co, ^{60}Co, ^{131}I, and ^{65}Zn. Radionuclide concentrations in sediments and biological samples are reported as pCi/kg dry weight, except for finfish gut samples and Camp Conoy oysters, which are reported as pCi/kg wet weight. Data are organized in the following tables:

Within each table, specific sample stations are arranged approximately north to south and data are presented by date along with the mean for the monitoring period. Radionuclide data are decay-corrected to the date of sample collection. Counting error is reported as plus or minus two standard deviations. Concentrations for radionuclides that were not detected in specific samples are recorded as less than (<) the lower level of detection for that sample as determined by spectrum analysis programs. Annual means were calculated as a simple arithmetic average of concentrations and variability was expressed as two standard deviation units. Lower limits of detection were excluded from mean calculations.

Table C-1. Radionuclide concentrations in sediments collected near Calvert Cliffs Nuclear Power Plant, 2018 and 2019

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
Station CCWES010 - Calvert Cliffs Western Shore Station 1					
3/19/2018	<189	1239±137	<14	<3	3±1
7/2/2018	52±19	1007±111	<6	<3	3±1
8/10/2018	<93	835±107	<8	<4	2±1
1/3/2019	<33	969±123	<4	<4	<4
2018 Average	**52±19**	**1013±336**	**--**	**--**	**3±1**
4/5/2019	31±12	849±94	<4	<3	<3
9/19/2019	71±52	921±113	<6	<3	3±1
11/25/2019	<89	775±97	<8	<3	1±1
2019 Average	**51±56**	**848±146**	**--**	**--**	**2±2**
Overall	**52±2**	**930±232**	**--**	**--**	**2±1**
Station CCWES020 - Calvert Cliffs Western Shore Station 2					
3/19/2018	<170	1473±176	<14	<4	7±1
7/2/2018	46±32	1097±133	<7	<3	5±1
8/10/2018	304±80	3753±392	<10	<4	14±2
1/3/2019	189±37	2858±300	<3	<3	13±2
2018 Average	**180±258**	**2295±2463**	**--**	**--**	**10±9**
4/5/2019	90±43	1271±152	<5	<3	5±1
9/19/2019	102±38	1069±125	<4	<2	5±1
11/25/2019	<129	4409±501	<11	<4	24±3
2019 Average	**96±16**	**2250±3746**	**--**	**--**	**11±21**
Overall	**138±118**	**2272±65**	**--**	**--**	**11±2**
Station CCWES030 - Calvert Cliffs Western Shore Station 3					
3/19/2018	<603	15991±1618	<44	<13	136±18
7/2/2018	<295	18028±1820	<26	<14	279±31
8/10/2018	<401	16341±1676	<38	<19	203±29
1/3/2019	<138	16542±1696	<17	<18	141±20
2018 Average	**--**	**16726±1795**	**--**	**--**	**190±133**
4/5/2019	<207	17503±1770	<20	<14	173±20
9/19/2019	<330	18432±1836	<32	<20	158±23
11/25/2019	<495	19417±1929	<45	<20	419±48
2019 Average	**--**	**18451±1914**	**--**	**--**	**250±294**
Overall	**--**	**17588±2440**	**--**	**--**	**220±85**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Table C-1. (Continued)

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
Station CCWES040 - Calvert Cliffs Western Shore Station 4					
3/19/2018	<631	16892±1709	<45	<13	71±12
7/2/2018	<350	17836±1824	<35	<19	94±18
8/10/2018	<299	16063±1625	<26	<12	74±12
1/3/2019	108±112	17751±1821	<18	<20	71±16
2018 Average	**108±112**	**17136±1665**	**--**	**--**	**78±22**
4/5/2019	<198	18033±1827	<20	<15	89±15
9/19/2019	<264	18458±1820	<25	<15	77±13
11/25/2019	<430	18564±1845	<43	<20	97±16
2019 Average	**--**	**18351±562**	**--**	**--**	**88±20**
Overall	**108±112**	**17744±1720**	**--**	**--**	**83±14**
Station CCFLP010 - Calvert Cliffs Flag Ponds Station 1					
3/19/2018	<93	405±50	<7	<2	1±1
7/2/2018	<58	376±55	<5	<3	1±1
8/10/2018	<69	518±70	<6	<3	<3
12/20/2018	<27	469±63	<3	<3	<3
2018 Average	**--**	**442±128**	**--**	**--**	**1.2±0.2**
4/5/2019	69±23	1011±110	<3	<2	2±1
9/9/2019	<42	519±64	<4	<2	<2
11/25/2019	<72	481±63	<7	<3	<3
2019 Average	**69±23**	**670±591**	**--**	**--**	**2±1**
Overall	**69±23**	**556±323**	**--**	**--**	**2±2**
Station CCFLP020 - Calvert Cliffs Flag Ponds Station 2					
3/19/2018	<232	5563±564	<17	<5	21±3
7/2/2018	240±80	5271±533	<9	<5	21±3
8/10/2018	309±106	4597±465	<9	<4	17±2
12/20/2018	137±39	4829±490	<5	<4	16±2
2018 Average	**229±174**	**5065±868**	**--**	**--**	**19±5**
4/5/2019	<75	5234±537	<9	<7	20±3
9/19/2019	<109	5081±508	<11	<7	19±3
11/25/2019	55±66	4377±496	<9	<4	13±2
2019 Average	**55±66**	**4897±915**	**--**	**--**	**17±7**
Overall	**142±245**	**4981±237**	**--**	**--**	**18±2**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Table C-1. (Continued)

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
Station CCFLP030 - Calvert Cliffs Flag Ponds Station 3					
3/19/2018	<485	14440±1456	<35	<11	168±18
7/2/2018	<265	13303±1360	<26	<15	124±17
8/10/2018	<286	13707±1397	<27	<14	168±19
1/3/2019	<111	13645±1395	<13	<15	150±19
2018 Average	**--**	**13773±957**	**--**	**--**	**153±42**
4/5/2019	<150	14659±1482	<14	<11	214±23
9/9/2019	<224	15461±1520	<21	<12	168±18
11/25/2019	<393	16601±1646	<36	<17	248±26
2019 Average	**--**	**15574±1952**	**--**	**--**	**210±80**
Overall	**--**	**14674±2546**	**--**	**--**	**181±81**
Station CCFLP040 - Calvert Cliffs Flag Ponds Station 4					
3/19/2018	<708	17485±1786	<58	<18	94±18
7/2/2018	<283	17400±1762	<25	<14	92±12
8/10/2018	<285	16916±1709	<25	<13	99±12
1/3/2019	270±105	18211±1847	<14	<15	82±13
2018 Average	**270±105**	**17503±1069**	**--**	**--**	**92±14**
4/5/2019	<253	18055±1851	<28	<21	99±19
9/19/2019	<314	18039±1802	<31	<20	81±16
11/25/2019	<358	19184±1883	<30	<14	122±14
2019 Average	**--**	**18426±1313**	**--**	**--**	**101±41**
Overall	**270±105**	**17965±1305**	**--**	**--**	**96±12**
Station CCCCO010 - Calvert Cliffs Outfall Station 1					
3/19/2018	<178	1187±145	<15	<5	2±1
7/2/2018	59±20	1185±131	<7	<3	2±1
8/10/2018	72±23	1317±142	<7	<3	3±1
12/20/2018	36±23	1768±189	<4	<3	2±1
2018 Average	**56±36**	**1364±552**	**--**	**--**	**2±1**
4/5/2019	32±13	1112±136	<6	<4	<5
9/9/2019	<83	1200±146	<8	<4	<5
11/25/2019	<89	1254±147	<7	<3	2±1
2019 Average	**32±13**	**1189±143**	**--**	**--**	**2±1**
Overall	**44±33**	**1276±248**	**--**	**--**	**2.1±0.4**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Table C-1. (Continued)

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
Station CCCCO020 - Calvert Cliffs Outfall Station 2					
3/19/2018	<76	1047±114	<7	<2	2±1
7/2/2018	57±35	1997±211	<7	<4	6±1
8/10/2018	<77	1308±157	<7	<4	5±1
12/20/2018	40±23	1862±221	<4	<4	6±1
2018 Average	**48±24**	**1554±902**	**--**	**--**	**5±3**
4/5/2019	12±15	1483±158	<3	<2	6±1
9/19/2019	49±28	1516±175	<4	<3	5±1
11/25/2019	<80	1097±132	<7	<3	4±1
2019 Average	**30±53**	**1365±466**	**--**	**--**	**5±2**
Overall	**39±25**	**1459±266**	**--**	**--**	**5±0**
Station CCCCO030 - Calvert Cliffs Outfall Station 3					
3/19/2018	<253	12986±1310	<23	<9	98±11
7/2/2018	<283	15696±1602	<28	<17	111±17
8/10/2018	<307	16081±1638	<31	<16	127±18
12/20/2018	<137	15319±1569	<17	<18	106±16
2018 Average	**--**	**15021±2783**	**--**	**--**	**110±25**
4/5/2019	<143	16295±1648	<15	<13	172±19
9/19/2019	<164	17291±1700	<17	<13	145±16
11/25/2019	<350	17940±1765	<30	<14	174±19
2019 Average	**--**	**17175±1657**	**--**	**--**	**164±33**
Overall	**--**	**16098±3047**	**--**	**--**	**137±75**
Station CCCCO040 - Calvert Cliffs Outfall Station 4					
3/12/2018	<407	14670±1492	<36	<14	72±13
7/2/2018	<257	18433±1860	<23	<14	158±18
8/10/2018	<286	18298±1846	<25	<13	160±22
12/20/2018	<116	18046±1824	<13	<13	114±14
2018 Average	**--**	**17362±3603**	**--**	**--**	**126±84**
4/5/2019	<174	18026±1841	<20	<18	141±20
9/19/2019	<200	18242±1813	<23	<19	106±13
11/25/2019	<389	19183±1903	<38	<19	164±22
2019 Average	**--**	**18484±1231**	**--**	**--**	**137±58**
Overall	**--**	**17923±1586**	**--**	**--**	**132±15**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Table C-1. (Continued)

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
		Station CCROP010 - Calvert Cliffs Rocky Point Station 1			
3/19/2018	<84	331±47	<7	<3	<3
7/2/2018	38±13	503±59	<4	<2	<3
8/10/2018	86±33	637±72	<4	<2	<2
12/20/2018	16±14	654±75	<2	<2	<2
2018 Average	**47±72**	**531±300**	**--**	**--**	**--**
4/5/2019	39±19	779±98	<4	<3	<4
9/19/2019	53±19	932±110	<3	<2	<3
11/25/2019	<66	466±63	<6	<3	<3
2019 Average	**46±20**	**726±475**	**--**	**--**	**--**
Overall	**46±1**	**629±275**	**--**	**--**	**--**
		Station CCROP020 - Calvert Cliffs Rocky Point Station 2			
3/19/2018	<76	915±102	<7	<3	<3
7/2/2018	<60	666±87	<6	<3	2±1
8/10/2018	<65	406±57	<6	<3	<3
12/20/2018	10±13	402±56	<3	<3	<3
2018 Average	**10±13**	**597±490**	**--**	**--**	**2±1**
4/5/2019	13±12	842±93	<3	<2	3±1
9/19/2019	55±30	437±59	<3	<3	<3
11/25/2019	<49	397±51	<4	<2	<2
2019 Average	**34±60**	**559±493**	**--**	**--**	**3±1**
Overall	**22±34**	**578±55**	**--**	**--**	**2±2**
		Station CCROP030 - Calvert Cliffs Rocky Point Station 3			
3/19/2018	<435	14616±1495	<40	<17	97±12
7/2/2018	<231	15543±1573	<21	<12	120±14
8/10/2018	<226	15338±1546	<20	<11	129±14
12/20/2018	<98	15379±1556	<12	<12	97±12
2018 Average	**--**	**15219±823**	**--**	**--**	**111±33**
4/5/2019	<150	14986±1534	<18	<17	80±15
9/19/2019	<198	16377±1635	<22	<19	100±13
11/25/2019	<343	16700±1660	<33	<17	129±15
2019 Average	**--**	**16021±1821**	**--**	**--**	**103±50**
Overall	**--**	**15620±1135**	**--**	**--**	**107±11**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Table C-1. (Continued)

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
Station CCROP040 - Calvert Cliffs Rocky Point Station 4					
3/19/2018	<331	18716±1833	<30	<12	183±21
7/2/2018	<216	14170±1439	<21	<13	176±21
8/10/2018	<290	17898±1814	<29	<15	84±15
12/20/2018	<125	16913±1719	<15	<17	152±22
2018 Average	**--**	**16924±3958**	**--**	**--**	**149±91**
4/5/2019	<121	16653±1678	<12	<11	185±21
9/19/2019	<154	18776±1841	<16	<13	141±16
11/25/2019	<235	18421±1800	<21	<11	159±17
2019 Average	**--**	**17950±2274**	**--**	**--**	**162±45**
Overall	**--**	**17437±1451**	**--**	**--**	**155±18**
Station CCLNG010 - Calvert Cliffs LNG Plant Pipeline Station 1					
3/19/2018	<55	572±65	<5	<2	1±1
7/2/2018	59±43	1060±129	<6	<3	2±1
8/10/2018	41±42	452±62	<6	<3	<3
11/21/2018	81±26	1326±142	<3	<2	2±1
2018 Average	**60±41**	**853±821**	**--**	**--**	**2±1**
4/5/2019	46±17	834±92	<2	<2	1±1
9/19/2019	87±22	1355±161	<4	<4	<3
11/25/2019	<53	545±67	<5	<2	<3
2019 Average	**66±58**	**911±820**	**--**	**--**	**1±1**
Overall	**63±8**	**882±83**	**--**	**--**	**2±1**
Station CCLNG020 - Calvert Cliffs LNG Plant Pipeline Station 2					
3/19/2018	<300	10810±1102	<27	<11	57±7
7/2/2018	<157	10807±1091	<14	<8	56±7
8/10/2018	209±111	11160±1127	<14	<9	56±7
11/21/2018	249±83	10974±1118	<11	<11	54±7
2018 Average	**229±56**	**10938±335**	**--**	**--**	**56±3**
4/5/2019	148±80	10147±1035	<11	<11	46±6
9/19/2019	164±60	10551±1036	<8	<8	46±6
11/25/2019	<231	11488±1140	<22	<12	61±8
2019 Average	**156±23**	**10729±1376**	**--**	**--**	**51±17**
Overall	**192±103**	**10833±296**	**--**	**--**	**54±7**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Table C-1. (Continued)

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
Station CCLNG030 - Calvert Cliffs LNG Plant Pipeline Station 3					
3/19/2018	<294	15238±1542	<27	<12	87±11
7/2/2018	150±97	16932±1716	<23	<14	100±12
8/10/2018	<258	15371±1574	<27	<18	88±12
11/21/2018	<119	16209±1641	<13	<13	92±11
2018 Average	**150±97**	**15937±1580**	**--**	**--**	**92±11**
4/5/2019	<109	14622±1481	<12	<12	84±10
9/19/2019	<120	17657±1740	<14	<14	97±12
11/25/2019	<340	17337±1724	<34	<18	101±13
2019 Average	**--**	**16538±3335**	**--**	**--**	**94±18**
Overall	**--**	**16238±850**	**--**	**--**	**93±3**
Station CCLNG040 - Calvert Cliffs LNG Plant Pipeline Station 4					
3/19/2018	<199	10929±1100	<18	<8	5±2
7/2/2018	<191	18340±1848	<20	<13	<13
8/10/2018	<133	18334±1836	<13	<9	10±3
11/21/2018	<94	17552±1771	<12	<13	13±3
2018 Average	**--**	**16289±7184**	**--**	**--**	**9±8**
4/5/2019	67±53	17439±1748	<9	<9	<9
9/19/2019	<105	19667±1926	<14	<15	8±6
11/25/2019	<184	19992±1945	<18	<10	<10
2019 Average	**67±53**	**19033±2779**	**--**	**--**	**8±6**
Overall	**67±53**	**17661±3881**	**--**	**--**	**9±1**
Station CCCOV010 - Calvert Cliffs Cove Point Station 1					
3/19/2018	<123	5582±578	<11	<5	16±2
7/2/2018	170±73	4911±501	<10	<6	13±2
8/10/2018	<92	5630±645	<10	<7	19±3
11/21/2018	51±38	5266±537	<6	<6	16±3
2018 Average	**111±170**	**5347±665**	**--**	**--**	**16±5**
4/5/2019	23±19	5228±528	<4	<4	15±2
9/19/2019	176±50	4931±563	<6	<6	12±2
11/25/2019	146±71	5870±663	<9	<5	17±3
2019 Average	**115±163**	**5343±959**	**--**	**--**	**15±6**
Overall	**113±7**	**5345±6**	**--**	**--**	**15±2**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Table C-1. (Continued)

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
Station CCCOV020 - Calvert Cliffs Cove Point Station 2					
3/19/2018	<892400000	9694±1277	<2777000	<62	31±22
7/2/2018	128±57	6688±674	<8	<5	27±3
8/10/2018	107±82	7606±778	<13	<9	31±4
11/21/2018	432±65	7487±756	<6	<6	29±4
2018 Average	**222±364**	**7869±2566**	**--**	**--**	**29±3**
4/5/2019	204±47	7245±739	<8	<8	27±4
9/19/2019	69±25	6979±685	<6	<5	24±3
11/25/2019	<143	6710±765	<14	<7	23±4
2019 Average	**136±190**	**6978±535**	**--**	**--**	**25±4**
Overall	**179±122**	**7424±1260**	**--**	**--**	**27±7**
Station CCCOV030 - Calvert Cliffs Cove Point Station 3					
3/19/2018	<987300000	19614±2389	<2836000	<55	81±32
7/2/2018	140±153	16219±1662	<28	<19	90±12
8/10/2018	<184	15482±1565	<17	<12	91±11
11/21/2018	74±93	16017±1642	<17	<18	73±16
2018 Average	**107±94**	**16833±3760**	**--**	**--**	**84±17**
4/5/2019	<114	16041±1626	<13	<13	89±11
9/19/2019	70±60	17812±1783	<20	<22	105±15
11/25/2019	<256	17278±1700	<25	<14	103±12
2019 Average	**70±60**	**17044±1817**	**--**	**--**	**99±17**
Overall	**89±52**	**16938±298**	**--**	**--**	**91±21**
Station CCCOV040 - Calvert Cliffs Cove Point Station 4					
3/19/2018	<273	26510±2655	<27	<13	<11
7/2/2018	<176	18580±1865	<17	<11	13±3
8/10/2018	<162	18110±1823	<18	<13	14±4
11/21/2018	<90	17488±1758	<10	<10	29±5
2018 Average	**--**	**20172±8498**	**--**	**--**	**19±17**
4/5/2019	<93	17064±1721	<12	<12	<12
9/19/2019	<85	19190±1871	<10	<10	19±4
11/25/2019	<226	18861±1846	<23	<13	7±3
2019 Average	**--**	**18372±2289**	**--**	**--**	**13±17**
Overall	**--**	**19272±2546**	**--**	**--**	**16±8**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Table C-1. (Continued)

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
Station CCLCP010 - Calvert Cliffs Little Cove Point Station 1					
3/19/2018	<344	18494±1821	<32	<15	122±14
7/2/2018	<196	15894±1606	<19	<12	121±14
8/10/2018	<205	20105±2027	<20	<14	215±23
11/21/2018	197±105	17003±1721	<13	<13	117±14
2018 Average	**197±105**	**17874±3658**	**--**	**--**	**144±95**
4/5/2019	<128	15869±1627	<16	<18	93±12
9/19/2019	<110	17527±1726	<13	<13	91±16
11/25/2019	<195	12227±1208	<20	<11	67±8
2019 Average	**--**	**15208±5423**	**--**	**--**	**84±29**
Overall	**197±105**	**16541±3771**	**--**	**--**	**114±85**
Station CCLCP020 - Calvert Cliffs Little Cove Point Station 2					
3/19/2018	<427	17436±1780	<41	<18	107±18
7/2/2018	<221	14911±1525	<23	<16	70±15
8/10/2018	<158	12694±1297	<18	<13	105±12
11/21/2018	<129	17314±1766	<15	<18	105±13
2018 Average	**--**	**15589±4506**	**--**	**--**	**97±36**
4/5/2019	245±103	17226±1741	<12	<13	97±14
9/19/2019	<146	18623±1854	<19	<22	110±18
11/25/2019	<247	19374±1899	<23	<13	178±19
2019 Average	**245±103**	**18408±2180**	**--**	**--**	**129±87**
Overall	**245±103**	**16998±3987**	**--**	**--**	**113±45**
Station CCDRP010 - Calvert Cliffs Drum Point Station 1					
3/19/2018	<260	10895±1111	<25	<12	69±9
7/2/2018	<159	10396±1060	<17	<11	63±8
8/10/2018	<95	9971±1003	<9	<7	107±11
11/21/2018	112±65	11169±1137	<10	<11	72±9
2018 Average	**112±65**	**10608±1064**	**--**	**--**	**78±40**
4/5/2019	<77	10364±1055	<9	<9	67±8
9/19/2019	<151	19374±1932	<19	<23	121±16
11/25/2019	<134	10620±1038	<12	<7	72±8
2019 Average	**--**	**13453±10259**	**--**	**--**	**86±60**
Overall	**112±65**	**12030±4024**	**--**	**--**	**82±13**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Table C-1. (Continued)

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
Station CCDRP020 - Calvert Cliffs Drum Point Station 2					
3/19/2018	<301	18562±1876	<29	<14	100±15
7/2/2018	<215	17526±1773	<21	<14	103±12
8/10/2018	<211	16908±1726	<23	<18	115±14
11/21/2018	<110	17278±1748	<12	<13	114±13
2018 Average	**--**	**17568±1419**	**--**	**--**	**108±15**
4/5/2019	<104	17528±1770	<11	<12	116±14
9/19/2019	<64	11197±1097	<8	<8	78±9
11/25/2019	<357	19641±1958	<37	<21	110±20
2019 Average	**--**	**16122±8788**	**--**	**--**	**102±41**
Overall	**--**	**16845±2045**	**--**	**--**	**105±9**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Table C-2. Radionuclide concentrations in tray oysters, 2018 and 2019

Sample Date	Exposure	Be-7	K-40	Ag-110m	Co-60	Cs-137
Station CCSTL000 - St. Leonard Creek Control Station						
4/6/2018	291	<540	8705±1039	<39	<35	<37
5/30/2018	54	<1094	7124±1072	<75	<69	<74
2018 Average		**--**	**7914±2235**	**--**	**--**	**--**
2/6/2019	252	<603	7494±1075	<59	<56	<64
6/28/2019	142	<507	7384±1116	<60	<66	<64
11/25/2019	136	<438	13114±1628	<45	<58	<51
2019 Average		**--**	**9331±6554**	**--**	**--**	**--**
Overall		**--**	**8623±2003**	**--**	**--**	**--**
Station CCPLS000 - Calvert Cliffs Plant Outfall Indicator Station						
4/6/2018	116	<521	9291±1101	<38	<36	<37
4/6/2018	116	<354	8281±915	<25	<25	<25
5/30/2018	352	<356	7602±857	<25	<23	<24
5/30/2018	54	<248	5445±611	<18	<17	<18
5/30/2018	170	366±320	7587±905	<31	<29	<31
2018 Average		**366±320**	**7641±2821**	**--**	**--**	**--**
2/6/2019	252	<315	7116±871	<31	<32	<33
2/6/2019	300	<297	7558±860	<26	<25	<28
6/28/2019	394	<294	8748±1030	<29	<33	<33
6/28/2019	142	<407	10039±1170	<41	<42	<45
6/28/2019	142	<448	8736±1152	<46	<51	<52
6/28/2019	142	451±207	8743±991	<29	<28	<32
11/25/2019	136	<382	12817±1483	<37	<44	<41
2019 Average		**451±207**	**9108±3777**	**--**	**--**	**--**
Overall		**408±120**	**8375±2074**	**--**	**--**	**--**
Calvert Cliffs Camp Conoy Indicator Station						
3/29/2018	NA	NT	2130±170	<10	<10	NT
6/13/2018	NA	NT	1560±130	<7	<8	NT
8/15/2018	NA	NT	900±80	<5	<6	NT
10/3/2018	NA	NT	1500±100	<4	<5	NT
2018 Average			**1523±1006**	--	--	--
3/19/2019	NA	NT	1400±90	<5	<5	NT
6/25/2019	NA	NT	1550±50	<5	<5	NT
8/12/2019	NA	NT	1500±150	<6	<7	NT
2019 Average		**--**	**1483±153**	**--**	**--**	**--**
Overall		**--**	**1503±55**	**--**	**--**	**--**

Note: Concentrations in pCi/kg ± 2 Standard deviations. Exposure in days. Concentrations in dry weight (St. Leonard Creek, Outfall) and wet weight (Camp Conoy). NA = Not Available. NT = Not Tested.

Table C-3. Radionuclide concentrations in sediments collected from stations near Peach Bottom Atomic Power Station, 2018 and 2019

Sample Date	Be-7	K-40	Co-60	Cs-137	Zn-65
Station PBLYH010 - Peach Bottom Little Yellow House Station 1					
6/7/2018	<186	15511±1553	<8	266±27	<33
11/19/2018	46±16	7641±788	<5	9±2	<16
2018 Average	**46±16**	**11576±11130**	**--**	**137±363**	**--**
7/16/2019	<75	14368±1438	<7	177±18	<25
10/28/2019	<75	14287±1390	<7	86±11	<18
2019 Average	**--**	**14327±115**	**--**	**131±129**	**--**
Overall	**46±16**	**12952±3891**	**--**	**134±9**	**--**
Station PBLYH020 - Peach Bottom Little Yellow House Station 2					
6/7/2018	456±170	12846±1299	<12	49±6	<42
11/19/2018	1222±158	17556±1759	<9	62±7	<30
2018 Average	**839±1083**	**15201±6660**	**--**	**55±18**	**--**
7/16/2019	313±85	14903±1502	<12	52±7	<38
10/28/2019	397±138	15670±1539	<13	53±7	<48
2019 Average	**355±119**	**15287±1085**	**--**	**52±1**	**--**
Overall	**597±684**	**15244±121**	**--**	**54±4**	**--**
Station PBLYH030 - Peach Bottom Little Yellow House Station 3					
6/7/2018	332±126	8782±884	<6	28±4	<26
11/19/2018	222±77	8485±969	<8	20±4	<28
2018 Average	**277±156**	**8634±420**	**--**	**24±10**	**--**
7/16/2019	402±69	9678±972	<6	30±4	<22
10/28/2019	<78	11913±1163	<7	21±5	<18
2019 Average	**402±69**	**10795±3160**	**--**	**26±12**	**--**
Overall	**340±178**	**9714±3057**	**--**	**25±2**	**--**
Station PBBRC010 - Peach Bottom Broad Creek Station 1					
6/7/2018	663±266	16066±1628	<15	80±10	<56
11/19/2018	1524±166	20658±2072	<12	83±10	<39
2018 Average	**1094±1217**	**18362±6495**	**--**	**82±4**	**--**
7/16/2019	798±149	17046±1723	<16	72±9	<48
10/28/2019	417±234	18643±1833	<16	87±11	<59
2019 Average	**607±539**	**17845±2259**	**--**	**80±21**	**--**
Overall	**850±688**	**18103±732**	**--**	**81±3**	**--**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Table C-3. (Continued)

Sample Date	Be-7	K-40	Co-60	Cs-137	Zn-65
Station PBBRC020 - Peach Bottom Broad Creek Station 2					
6/7/2018	148±106	10355±1045	<9	32±4	<32
11/19/2018	1503±235	18195±1836	<15	69±9	<48
2018 Average	**826±1917**	**14275±11088**	**--**	**51±53**	**--**
7/16/2019	717±135	16234±1640	<14	70±9	<44
10/28/2019	<100	17031±1660	<9	42±9	<25
2019 Average	**717±135**	**16632±1128**	**--**	**56±39**	**--**
Overall	**771±154**	**15454±3334**	**--**	**53±8**	**--**
Station PBBRC030 - Peach Bottom Broad Creek Station 3					
6/7/2018	<256	18626±1872	13±6	84±10	<49
11/19/2018	1222±212	19027±1917	<15	86±10	<49
2018 Average	**1222±212**	**18827±567**	**13±6**	**85±3**	**--**
7/16/2019	656±102	17988±1803	<10	88±10	<33
10/28/2019	188±187	19545±1921	<17	98±12	<60
2019 Average	**422±662**	**18766±2202**	**--**	**93±14**	**--**
Overall	**822±1131**	**18797±85**	**13±6**	**89±12**	**--**
Station PBCOC010 - Peach Bottom Conowingo Creek Station 1					
6/7/2018	150±150	19884±1998	<13	95±11	<46
11/19/2018	596±127	20405±2050	<13	95±11	<40
2018 Average	**373±631**	**20145±737**	**--**	**95±1**	**--**
7/16/2019	1586±188	18828±1890	<11	93±11	<36
10/28/2019	536±196	20260±1992	<17	98±12	<62
2019 Average	**1061±1485**	**19544±2025**	**--**	**96±7**	**--**
Overall	**717±973**	**19844±849**	**--**	**95±1**	**--**
Station PBCOC020 - Peach Bottom Conowingo Creek Station 2					
6/7/2018	1303±302	16097±1634	<16	77±10	<59
11/19/2018	1600±236	18881±1906	<15	75±9	<49
2018 Average	**1452±420**	**17489±3936**	**--**	**76±3**	**--**
7/16/2019	1396±174	15740±1592	<15	68±9	<44
10/28/2019	408±126	17806±1739	<11	81±9	<41
2019 Average	**902±1398**	**16773±2921**	**--**	**74±17**	**--**
Overall	**1177±777**	**17131±1013**	**--**	**75±2**	**--**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Table C-3. (Continued)

Sample Date	Be-7	K-40	Co-60	Cs-137	Zn-65
Station PBCOC030 - Peach Bottom Conowingo Creek Station 3					
6/7/2018	336±177	17854±1796	<12	86±10	<45
11/19/2018	1569±190	19568±1963	<11	93±11	<36
2018 Average	**952±1743**	**18711±2424**	**--**	**89±11**	**--**
7/16/2019	758±111	18147±1820	<11	80±9	<34
10/28/2019	<225	20052±1970	<17	98±12	<56
2019 Average	**758±111**	**19100±2694**	**--**	**89±26**	**--**
Overall	**855±275**	**18906±549**	**--**	**89±1**	**--**
Station PBCOD010 - Peach Bottom Conowingo Dam Station 1					
6/7/2018	400±211	19020±1928	<18	85±11	<65
12/19/2018	837±143	22791±2295	<17	90±11	<52
2018 Average	**619±619**	**20905±5333**	**--**	**87±7**	**--**
7/16/2019	807±138	19590±1977	<17	93±11	<50
10/28/2019	346±130	21133±2057	<11	94±11	<41
2019 Average	**576±652**	**20361±2183**	**--**	**94±1**	**--**
Overall	**597±60**	**20633±769**	**--**	**90±9**	**--**
Station PBCOD020 - Peach Bottom Conowingo Dam Station 2					
6/7/2018	1381±241	17207±1731	<12	85±10	<42
12/19/2018	1334±180	20908±2098	<12	81±10	<38
2018 Average	**1357±67**	**19058±5234**	**--**	**83±6**	**--**
7/16/2019	1670±196	19486±1957	<12	97±11	<37
10/28/2019	594±173	20626±2031	<18	100±12	<59
2019 Average	**1132±1522**	**20056±1612**	**--**	**99±5**	**--**
Overall	**1245±319**	**19557±1412**	**--**	**91±22**	**--**
Station PBCOD030 - Peach Bottom Conowingo Dam Station 3					
6/7/2018	734±226	17518±1776	<17	86±11	<59
12/19/2018	1550±199	19466±1969	<17	84±11	<53
2018 Average	**1142±1153**	**18492±2755**	**--**	**85±2**	**--**
7/16/2019	664±135	17817±1803	<16	81±10	<48
10/28/2019	432±126	19930±1943	<12	91±10	<42
2019 Average	**548±327**	**18874±2989**	**--**	**86±15**	**--**
Overall	**845±840**	**18683±540**	**--**	**85±1**	**--**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Table C-3. (Continued)

Sample Date	Be-7	K-40	Co-60	Cs-137	Zn-65
Station PBSRV030 - Peach Bottom Susquehanna River Station 3					
6/7/2018	52±46	3180±367	<4	4±1	<15
11/19/2018	34±16	2496±261	<2	2±1	<8
2018 Average	**43±25**	**2838±967**	**--**	**3±3**	**--**
7/2/2019	124±33	3142±363	<4	5±1	<13
10/28/2019	60±35	3029±345	<3	6±1	<10
2019 Average	**92±91**	**3085±159**	**--**	**6±1**	**--**
Overall	**67±69**	**2962±349**	**--**	**4±4**	**--**
Station PBSFL010 - Peach Bottom Susquehanna Flats Station 1					
6/7/2018	158±74	7664±770	<5	7±2	<19
11/19/2018	47±32	7485±853	<7	6±2	<22
2018 Average	**103±157**	**7574±252**	**--**	**7±2**	**--**
7/2/2019	322±58	5747±594	<4	15±2	<13
10/28/2019	185±77	7188±817	<7	21±3	<23
2019 Average	**253±194**	**6467±2039**	**--**	**18±9**	**--**
Overall	**178±213**	**7021±1566**	**--**	**13±16**	**--**
Station PBSFL060 - Peach Bottom Susquehanna Flats Station 6					
6/7/2018	<76	3280±379	<4	5±1	<16
11/19/2018	<34	3146±328	<3	3±1	<10
2018 Average	**--**	**3213±190**	**--**	**4±2**	**--**
7/2/2019	73±27	3050±353	<4	2±2	<14
10/28/2019	<62	6672±753	<5	3±1	<17
2019 Average	**73±27**	**4861±5123**	**--**	**2±1**	**--**
Overall	**73±27**	**4037±2331**	**--**	**3±2**	**--**
Station PBSFL070 - Peach Bottom Susquehanna Flats Station 7					
6/7/2018	121±56	3413±346	<3	14±2	<12
11/19/2018	<74	9307±939	<8	119±13	<26
2018 Average	**121±56**	**6360±8335**	**--**	**67±148**	**--**
7/2/2019	86±26	3328±346	<3	4±1	<10
10/28/2019	<112	8933±884	<9	110±12	<32
2019 Average	**86±26**	**6130±7927**	**--**	**57±150**	**--**
Overall	**104±49**	**6245±325**	**--**	**62±14**	**--**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Table C-3. (Continued)

Sample Date	Be-7	K-40	Co-60	Cs-137	Zn-65
Station PBSFL080 - Peach Bottom Susquehanna Flats Station 8					
6/7/2018	120±33	5949±682	<7	13±2	<27
11/19/2018	85±33	4153±432	<4	4±1	<14
2018 Average	**102±50**	**5051±2540**	**--**	**9±13**	**--**
7/2/2019	240±55	5203±595	<6	9±2	<19
10/28/2019	186±49	5812±656	3±2	12±2	<16
2019 Average	**213±77**	**5507±861**	**3±2**	**10±4**	**--**
Overall	**158±156**	**5279±645**	**3±2**	**10±3**	**--**
Station PBSFL090 - Peach Bottom Susquehanna Flats Station 9					
6/7/2018	327±95	10382±1044	<7	37±5	<28
11/19/2018	196±34	10093±1022	<10	35±5	<31
2018 Average	**261±185**	**10238±408**	**--**	**36±3**	**--**
7/2/2019	176±65	10816±1086	<7	35±4	<23
10/28/2019	125±71	10978±1081	<10	39±5	<34
2019 Average	**150±72**	**10897±228**	**--**	**37±6**	**--**
Overall	**206±157**	**10567±932**	**--**	**37±1**	**--**
Station PBUPB100 - Peach Bottom Upper Bay Station 10					
6/7/2018	182±120	10460±1060	<10	46±6	<37
11/19/2018	170±47	9827±987	<7	39±5	<22
2018 Average	**176±16**	**10144±896**	**--**	**43±9**	**--**
7/2/2019	<81	10703±1085	<11	41±5	<34
10/28/2019	111±27	10089±987	<7	43±5	<26
2019 Average	**111±27**	**10396±869**	**--**	**42±3**	**--**
Overall	**144±92**	**10270±357**	**--**	**42±2**	**--**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Table C-4. Radionuclide concentrations in finfish collected from stations near Peach Bottom Atomic Power Station, 2018 and 2019

Species	Tissue	Sample Date	Be-7	K-40	Co-60	Cs-137	Zn-65
Station PBLYH010 - Peach Bottom Little Yellow House Station 1							
C. carpio	flesh	6/6/2018	<2737	12083±1273	<23	<20	<90
C. carpio	flesh	11/19/2018	<174	5549±577	<9	<9	<23
C. carpio	flesh	11/19/2018	<222	6491±692	<13	<12	<36
C. carpio	flesh	11/19/2018	<243	9040±930	<13	<12	<34
C. carpio	flesh	11/19/2018	<260	9782±1006	<13	<13	<37
I. punctatus	flesh	6/6/2018	<2041	13366±1363	<17	<16	<67
I. punctatus	flesh	11/19/2018	<392	12571±1316	<22	9±9	<58
P. olivaris	flesh	6/6/2018	<2566	13053±1365	<21	10±9	<93
P. olivaris	flesh	6/6/2018	<1833	10169±1042	<14	8±7	<58
P. olivaris	flesh	6/6/2018	<2059	10893±1115	<14	8±8	<58
D. cepedianum	flesh	6/6/2018	<3175	11376±1201	<21	<20	<91
D. cepedianum	flesh	11/19/2018	<343	12179±1247	<16	<16	<44
D. cepedianum	flesh	11/19/2018	<407	12214±1284	<21	<20	<61
D. cepedianum	flesh	11/19/2018	<386	14994±1530	<17	<18	<52
Morone spp.	flesh	11/19/2018	<355	11952±1250	<20	<18	<56
Morone spp.	flesh	11/19/2018	<315	12250±1250	<14	<15	<43
Mixed freshwater fish	flesh	11/19/2018	<515	16111±1683	<26	<25	<80
M. dolomieu	flesh	6/6/2018	<2843	11964±1257	<21	<21	<92
M. saxatilis	flesh	11/19/2018	<394	12138±1275	<20	<20	<58
M. saxatilis	flesh	11/19/2018	<286	10238±1050	<13	30±14	<37
		2018 Average	**--**	**11421±4949**	**--**	**13±19**	**--**
C. carpio	flesh	6/12/2019	<145	12074±1273	<21	<18	<53
C. carpio	flesh	6/12/2019	<140	14401±1469	<18	<17	<43
C. carpio	flesh	6/12/2019	<156	12080±1267	<20	<18	<50
C. carpio	flesh	10/30/2019	<356	14568±1521	<24	<20	<71
C. carpio	flesh	10/30/2019	<275	13816±1400	<18	<15	<52
C. carpio	flesh	10/30/2019	<322	12562±1312	<21	<17	<62
I. punctatus	flesh	6/12/2019	<208	14770±1543	<25	<21	<62
I. punctatus	flesh	6/12/2019	<179	15137±1541	<18	<18	<43
I. punctatus	flesh	10/30/2019	<275	14995±1512	<16	<15	<50
P. olivaris	flesh	6/12/2019	<188	15611±1595	<20	<20	<48
P. olivaris	flesh	6/12/2019	<270	16604±1757	<32	<28	<76
P. olivaris	flesh	6/12/2019	<145	11874±1210	<15	<15	<36
P. olivaris	flesh	10/30/2019	<297	15941±1607	<17	6±6	<53
P. olivaris	flesh	10/30/2019	<340	15284±1579	<24	<18	<70
D. cepedianum	flesh	6/12/2019	<217	14759±1546	<25	<22	<62
D. cepedianum	flesh	6/12/2019	<206	16281±1658	<19	<20	<47
M. salmoides	flesh	10/30/2019	<349	17673±1784	<19	<17	<60
Micropterus spp.	flesh	10/30/2019	<466	17062±1771	<26	<22	<80

Note: Concentrations in pCi/kg ± 2 Standard deviations; dry weight for flesh, wet weight for guts. A species list is provided at the bottom of the table.

Table C-4. (Continued)

Species	Tissue	Sample Date	Be-7	K-40	Co-60	Cs-137	Zn-65
Mixed freshwater fish	flesh	10/30/2019	<443	13549±1413	<21	<20	<68
Mixed freshwater fish	flesh	10/30/2019	<574	16027±1684	<29	<24	<90
M. dolomieu	flesh	6/12/2019	<302	20731±2202	<39	<34	<97
M. dolomieu	flesh	10/30/2019	<328	16167±1628	<18	<15	<54
S. vitreum	flesh	10/30/2019	<431	21243±2133	<22	<19	<69
		2019 Average	**--**	**15357±4772**	**--**	**6±6**	**--**
		Overall	**--**	**13389±5567**	**--**	**9±10**	**--**
C. carpio	gut	6/6/2018	<7061	3583±653	<60	<53	<235
C. carpio	gut	11/19/2018	<1052	4143±774	<68	<54	<159
C. carpio	gut	11/19/2018	<862	4334±661	<48	<43	<113
C. carpio	gut	11/19/2018	<938	3409±634	<51	<46	<132
C. carpio	gut	11/19/2018	<980	3702±603	<47	<46	<127
I. punctatus	gut	6/6/2018	<6152	3287±659	<57	<51	<195
I. punctatus	gut	11/19/2018	<1123	3825±597	<39	<39	<117
P. olivaris	gut	6/6/2018	<5444	3704±605	<42	<44	<163
P. olivaris	gut	6/6/2018	<5877	3579±592	<46	<41	<166
P. olivaris	gut	6/6/2018	<7500	2891±639	<56	<48	<209
D. cepedianum	gut	6/6/2018	<8632	4365±764	<61	<52	<244
D. cepedianum	gut	11/19/2018	<1378	4170±724	<55	<50	<156
D. cepedianum	gut	11/19/2018	<1338	5058±742	<48	<44	<134
D. cepedianum	gut	11/19/2018	<1463	4244±772	<58	<53	<161
Morone spp.	gut	11/19/2018	<1408	3696±677	<51	<50	<150
Morone spp.	gut	11/19/2018	<1122	2410±500	<49	<42	<123
M. dolomieu	gut	6/6/2018	<6157	3852±576	<42	<38	<161
M. dolomieu	gut	11/19/2018	<1096	3070±669	<50	<50	<140
M. saxatilis	gut	11/19/2018	<1231	3709±610	<44	<43	<123
M. saxatilis	gut	11/19/2018	<1469	3196±631	<64	<57	<167
S. vitreum	gut	11/19/2018	<1075	3559±585	<41	<43	<119
		2018 Average	**--**	**3704±1159**	**--**	**--**	**--**
C. carpio	gut	6/12/2019	<342	3389±638	<58	<46	<119
C. carpio	gut	6/12/2019	<409	4429±704	<54	<50	<114
C. carpio	gut	6/12/2019	<314	2909±570	<47	<38	<95
C. carpio	gut	10/30/2019	<1174	4381±818	<73	<67	<193
C. carpio	gut	10/30/2019	<1003	4034±738	<58	<55	<150
C. carpio	gut	10/30/2019	<469	4817±706	<41	<32	<97
I. punctatus	gut	6/12/2019	<405	3928±620	<48	<43	<103
I. punctatus	gut	6/12/2019	<529	2843±619	<69	<55	<140
I. punctatus	gut	6/12/2019	<704	4151±664	<53	<61	<120

Note: Concentrations in pCi/kg ± 2 Standard deviations; dry weight for flesh, wet weight for guts. A species list is provided at the bottom of the table.

Table C-4. (Continued)

Species	**Tissue**	**Sample Date**	**Be-7**	**K-40**	**Co-60**	**Cs-137**	**Zn-65**
I. punctatus	gut	10/30/2019	<1166	4735±768	<57	<58	<157
P. olivaris	gut	6/12/2019	<465	4425±767	<54	<52	<127
P. olivaris	gut	6/12/2019	<467	2726±588	<63	<52	<144
P. olivaris	gut	10/30/2019	<935	2841±623	<58	<51	<141
P. olivaris	gut	10/30/2019	<569	3541±641	<47	<36	<101
D. cepedianum	gut	6/12/2019	<583	5721±1019	<66	<50	<147
D. cepedianum	gut	6/12/2019	<585	6062±906	<52	<49	<126
D. cepedianum	gut	10/30/2019	<1548	71260±7398	<58	<59	<181
M. salmoides	gut	10/30/2019	<1540	3968±852	<73	<68	<197
Moxostama sp.	gut	10/30/2019	<1722	4425±863	<80	<73	<209
M. dolomieu	gut	6/12/2019	<434	4577±707	<54	<50	<120
M. dolomieu	gut	10/30/2019	<1268	4782±777	<58	<54	<158
M. dolomieu	gut	10/30/2019	<1632	3922±826	<74	<70	<192
S. vitreum	gut	10/30/2019	<1358	4934±798	<53	<53	<160
		2019 Average	**--**	**6905±27472**	**--**	**--**	**--**
		Overall	**--**	**5305±4526**	**--**	**--**	**--**

Note: Concentrations in pCi/kg ± 2 Standard deviations; dry weight for flesh, wet weight for guts.
Species List:
C. carpio = *Cyprinus carpio* (Common carp)
I. punctatus = *Ictalurus punctatus* (Channel catfish)
D. cepedianum = *Dorosoma cepedianum* (American gizzard shad)
M. saxatilis = *Morone saxatilis* (Striped bass)
Morone spp. = *Morone saxatilis* and *Morone chrysops* (Striped bass and White bass)
M. dolomieu = *Micropterus dolomieu* (Smallmouth bass)
M. salmoides = Micropterus salmoides (Largemouth bass)
Micropterus spp. *= Micropterus salmoides* and *Micropterus dolomieu* (Largemouth bass and Smallmouth bass)
S. vitreum = *Stizostedion vitreum* (Walleye)
P. olivaris = *Pylodictis olivaris* (Flathead catfish).

Table C-5. Radionuclide concentrations in Submerged Aquatic Vegetation collected from a station near Peach Bottom Atomic Power Station, 2019

Species	Sample Date	Be-7	K-40	Co-60	Cs-137	I-131
Station PBFBT000 - Peach Bottom Susquehanna Flats Fishing Battery Station						
H. dubia	10/30/2019	3984±848	39941±4845	<100	<121	<145
H. dubia	10/30/2019	3934±754	40545±4751	<71	<86	92±71
M. spicatum	10/30/2019	6685±1072	30140±3812	<108	61±43	146±106
M. spicatum	10/30/2019	6775±1079	36752±4382	<78	<92	<125
	2019 Average	**5344±3201**	**36844±9539**	**--**	**61±43**	**119±76**
	Overall	**5344±3201**	**36844±9539**	**--**	**61±43**	**119±76**

Note: Concentrations in pCi/kg ± 2 Standard deviations.

Species list:

M. spicatum = *Myriophyllum spicatum* (Eurasian watermilfoil)

H. dubia = Heteranthera dubia (Grassleaf mud-plantain or Water stargrass).

Table C-6. Radionuclide concentrations in air particulate and air, 2018 and 2019

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
Calvert Cliffs Long Beach Station					
1/2/2018	1/9/2018	285	0.8±0.2	18±1	<8
1/9/2018	1/17/2018	326	0.4±0.3	18±1	<7
1/17/2018	1/22/2018	204	1.6±0.3	29±1	<11
1/22/2018	1/30/2018	326	0.7±0.2	14±1	<8
1/30/2018	2/6/2018	285	0.6±0.3	11±1	<9
2/6/2018	2/13/2018	285	0.7±0.2	17±1	<8
2/13/2018	2/21/2018	325	1±0.1	16±1	<7
2/21/2018	2/27/2018	246	0.3±0.3	9±1	<9
2/27/2018	3/6/2018	285	1.1±0.1	15±1	<8
3/6/2018	3/13/2018	283	0.7±0.2	11±1	<8
3/13/2018	3/20/2018	285	0.9±0.2	19±1	<8
3/20/2018	3/27/2018	286	0.7±0.3	9±1	<8
3/27/2018	4/3/2018	285	0.6±0.3	14±1	<8
4/3/2018	4/10/2018	288	1.3±0.2	18±1	<8
4/10/2018	4/24/2018	570	1.1±0.2	14±0.4	<5
4/24/2018	5/1/2018	286	0.5±0.3	13±1	<8
5/1/2018	5/9/2018	329	0.4±0.2	18±1	<8
5/9/2018	5/15/2018	241	0.9±0.4	11±1	<10
5/15/2018	5/22/2018	287	0.4±0.3	6±1	<8
5/22/2018	5/30/2018	325	0.3±0.2	10±1	<8
5/30/2018	6/5/2018	245	0.3±0.3	7±1	<9
6/5/2018	6/12/2018	285	0.7±0.2	11±1	<8
6/12/2018	6/19/2018	285	<0.3	13±1	<8
6/19/2018	6/27/2018	330	0.3±0.3	11±1	<7
6/27/2018	7/3/2018	243	1.3±0.2	20±1	<9
7/3/2018	7/10/2018	288	0.5±0.2	14±1	<8
7/10/2018	7/18/2018	328	1.3±0.2	20±1	<8
7/18/2018	7/24/2018	240	<0.4	8±1	<9
7/24/2018	7/31/2018	286	<0.3	15±1	<8
7/31/2018	8/7/2018	285	<0.3	12±1	<8
8/7/2018	8/14/2018	281	0.9±0.3	24±1	<8
8/14/2018	8/21/2018	290	0.5±0.3	20±1	<8
8/21/2018	8/28/2018	286	1.1±0.2	21±1	<10
8/28/2018	9/5/2018	326	1.4±0.2	19±1	<8
9/5/2018	9/11/2018	245	0.6±0.3	14±1	<9
9/11/2018	9/18/2018	285	0.3±0.3	9±1	<10
9/18/2018	9/25/2018	286	0.8±0.2	15±1	<8
9/25/2018	10/2/2018	285	1±0.2	19±1	<8
10/2/2018	10/10/2018	326	1±0.2	22±1	<7
10/10/2018	10/16/2018	245	0.7±0.4	10±1	<10
10/16/2018	10/24/2018	326	0.5±0.2	16±1	<8
10/24/2018	10/30/2018	245	<0.3	7±1	<8
10/30/2018	11/6/2018	285	<0.4	15±1	<9

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
Calvert Cliffs Long Beach Station (Continued)					
11/6/2018	11/14/2018	327	1.7±0.2	14±1	<6
11/14/2018	11/20/2018	249	1.2±0.3	19±1	<9
11/20/2018	11/27/2018	281	1.4±0.2	20±1	<8
11/27/2018	12/4/2018	286	0.9±0.2	14±1	<9
12/4/2018	12/11/2018	286	0.7±0.2	19±1	<9
12/11/2018	12/18/2018	285	1.5±0.3	23±1	<9
12/18/2018	12/26/2018	325	0.5±0.3	14±1	<8
12/26/2018	1/2/2019	286	0.5±0.3	22±1	<9
	2018 Average		**0.7±0.9**	**15±10**	**--**
1/2/2019	1/8/2019	244	1.8±0.3	17±1	<10
1/8/2019	1/15/2019	286	0.7±0.2	15±1	<8
1/15/2019	1/23/2019	326	0.8±0.2	17±1	<7
1/23/2019	1/29/2019	244	1.8±0.4	18±1	<13
1/29/2019	2/5/2019	285	1.9±0.3	24±1	<9
2/5/2019	2/12/2019	287	0.7±0.3	19±1	<10
2/12/2019	2/19/2019	285	1.3±0.2	17±1	<8
2/19/2019	2/27/2019	326	3.1±0.3	18±1	<14
2/27/2019	3/5/2019	244	2.3±0.4	14±1	<43
3/5/2019	3/13/2019	326	2.5±0.3	16±1	<8
3/13/2019	3/19/2019	245	1±0.4	16±1	<10
3/19/2019	3/26/2019	285	0.8±0.3	12±1	<8
3/26/2019	4/2/2019	308	0.8±0.3	10±1	<9
4/2/2019	4/9/2019	260	1.3±0.3	17±1	<9
4/9/2019	4/16/2019	285	0.4±0.3	24±1	<8
4/16/2019	4/23/2019	274	1.6±0.2	14±1	<9
4/23/2019	4/30/2019	288	1.6±0.4	14±1	<11
4/30/2019	5/7/2019	286	1.1±0.3	12±1	<9
5/7/2019	5/14/2019	285	0.6±0.1	8±1	<9
5/14/2019	5/21/2019	286	1.9±0.3	21±1	<8
5/21/2019	5/29/2019	326	1.2±0.2	13±1	<8
5/29/2019	6/4/2019	245	1±0.4	16±1	<11
6/4/2019	6/12/2019	326	0.9±0.3	15±1	<5
6/12/2019	6/19/2019	284	1±0.4	10±1	<7
6/19/2019	6/26/2019	308	0.9±0.3	12±1	<9
6/26/2019	7/2/2019	223	1.1±0.4	20±1	<7
7/2/2019	7/9/2019	285	0.9±0.2	17±1	<8
7/9/2019	7/16/2019	286	0.5±0.3	16±1	<8
7/16/2019	7/23/2019	287	0.7±0.3	17±1	<10
7/23/2019	7/30/2019	284	0.6±0.2	19±1	<7
7/30/2019	8/5/2019	251	1.2±0.3	25±1	<8
8/5/2019	8/13/2019	323	0.9±0.3	25±1	<7
8/13/2019	8/20/2019	287	1±0.2	22±1	<9
8/20/2019	8/27/2019	281	1.1±0.3	14±1	<7
8/27/2019	9/4/2019	327	0.9±0.3	19±1	<6
9/4/2019	9/10/2019	243	1.9±0.2	23±1	<8

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
		Calvert Cliffs Long Beach Station (Continued)			
9/10/2019	9/17/2019	287	1.6±0.3	23±1	<8
9/17/2019	9/24/2019	285	1.1±0.3	18±1	<7
9/24/2019	10/1/2019	279	1.3±0.2	19±1	<6
10/1/2019	10/8/2019	285	1.1±0.2	16±1	<7
10/8/2019	10/15/2019	286	1.6±0.2	18±1	<10
10/15/2019	10/23/2019	327	0.7±0.3	16±1	<6
10/23/2019	10/29/2019	244	1.8±0.3	20±1	<9
10/29/2019	11/5/2019	286	1.7±0.3	15±1	<7
11/5/2019	11/12/2019	284	1.5±0.4	24±1	<9
11/12/2019	11/19/2019	285	0.9±0.3	16±1	<9
11/19/2019	11/26/2019	286	1.3±0.3	22±1	<9
11/26/2019	12/3/2019	287	1.2±0.4	11±1	<9
12/3/2019	12/10/2019	286	1.7±0.3	13±1	<9
12/10/2019	12/17/2019	286	1.1±0.3	16±1	<7
12/17/2019	12/24/2019	285	2.2±0.3	34±1	<8
12/24/2019	12/30/2019	258	1.6±0.4	27±1	<7
	2019 Average		**1.3±1.1**	**18±10**	**--**
	Overall		**1±0.8**	**16±3**	**--**
		Calvert Cliffs Lusby Station			
1/2/2018	1/9/2018	285	1.3±0.4	22±1	<8
1/9/2018	1/17/2018	326	0.5±0.3	18±1	<7
1/17/2018	1/22/2018	204	0.8±0.4	32±1	<11
1/22/2018	1/30/2018	326	0.6±0.3	15±1	<8
1/30/2018	2/6/2018	285	0.6±0.3	13±1	<9
2/6/2018	2/13/2018	285	1±0.2	19±1	<8
2/13/2018	2/21/2018	326	0.9±0.2	17±1	<7
2/21/2018	2/27/2018	245	0.3±0.3	12±1	<9
2/27/2018	3/6/2018	285	0.8±0.3	19±1	<8
3/6/2018	3/13/2018	285	0.8±0.2	11±1	<8
3/13/2018	3/20/2018	286	1±0.3	18±1	<8
3/20/2018	3/27/2018	286	0.4±0.3	10±1	<8
3/27/2018	4/3/2018	285	0.8±0.3	14±1	<8
4/3/2018	4/10/2018	286	1.2±0.3	16±1	<8
4/10/2018	4/24/2018	572	1.2±0.2	13±0.4	<5
4/24/2018	5/1/2018	284	<0.3	13±1	<8
5/1/2018	5/9/2018	329	1.1±0.3	20±1	<8
5/9/2018	5/15/2018	242	0.3±0.3	14±1	<10
5/15/2018	5/22/2018	286	<0.4	7±1	<8
5/22/2018	5/30/2018	326	0.4±0.4	12±1	<8
5/30/2018	6/5/2018	244	0.8±0.3	9±1	<9
6/5/2018	6/12/2018	286	<0.4	13±1	<8
6/12/2018	6/19/2018	284	0.9±0.3	17±1	<8
6/19/2018	6/27/2018	331	0.6±0.3	14±1	<7
6/27/2018	7/3/2018	242	<0.5	22±1	<9

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
Calvert Cliffs Lusby Station (Continued)					
7/3/2018	7/10/2018	286	0.9±0.3	16±1	<8
7/10/2018	7/18/2018	328	1.5±0.3	20±1	<8
7/18/2018	7/24/2018	240	0.5±0.4	11±1	<9
7/24/2018	7/31/2018	287	<0.4	12±1	<8
7/31/2018	8/7/2018	285	0.5±0.3	12±1	<8
8/7/2018	8/14/2018	282	0.6±0.3	24±1	<8
8/14/2018	8/21/2018	291	1±0.3	19±1	<8
8/21/2018	8/28/2018	286	0.9±0.3	19±1	<10
8/28/2018	9/5/2018	326	0.6±0.3	19±1	<8
9/5/2018	9/11/2018	245	0.5±0.4	13±1	<9
9/11/2018	9/18/2018	284	0.7±0.2	9±1	<10
9/18/2018	9/25/2018	287	<0.2	14±1	<8
9/25/2018	10/2/2018	284	<0.3	18±1	<8
10/2/2018	10/10/2018	327	0.7±0.3	21±1	<7
10/10/2018	10/16/2018	244	<0.3	10±1	<10
10/16/2018	10/24/2018	327	0.3±0.3	15±1	<8
10/24/2018	10/30/2018	245	0.6±0.2	9±1	<8
10/30/2018	11/6/2018	285	0.3±0.3	11±1	<9
11/6/2018	11/14/2018	326	1.1±0.3	13±1	<6
11/14/2018	11/20/2018	249	1.2±0.4	19±1	<9
11/20/2018	11/27/2018	281	0.6±0.3	17±1	<8
11/27/2018	12/4/2018	285	0.7±0.4	13±1	<9
12/4/2018	12/11/2018	286	0.8±0.4	18±1	<9
12/11/2018	12/18/2018	285	<0.3	2±1	<9
12/18/2018	12/26/2018	247	0.5±0.4	17±1	<3
12/26/2018	1/2/2019	286	1.2±0.2	19±1	<9
	2018 Average		**0.6±0.8**	**15±10**	**--**
1/2/2019	1/8/2019	244	0.5±0.4	20±1	<10
1/8/2019	1/15/2019	286	0.5±0.2	14±1	<9
1/15/2019	1/23/2019	326	1.4±0.2	18±1	<8
1/23/2019	1/29/2019	244	0.5±0.4	20±1	<13
1/29/2019	2/5/2019	285	0.9±0.3	24±1	<9
2/5/2019	2/12/2019	326	0.8±0.2	19±1	<7
2/12/2019	2/19/2019	285	1.4±0.3	14±1	<11
2/19/2019	2/27/2019	326	3.7±0.3	20±1	<14
2/27/2019	3/5/2019	245	2.6±0.4	15±1	<43
3/5/2019	3/13/2019	323	3.4±0.3	19±1	<8
3/13/2019	3/19/2019	244	3±0.4	19±1	<10
3/19/2019	3/26/2019	286	1.8±0.3	10±1	<8
3/26/2019	4/2/2019	309	0.9±0.3	12±1	<9
4/2/2019	4/9/2019	260	0.8±0.4	17±1	<9
4/9/2019	4/16/2019	286	0.4±0.3	11±1	<8
4/16/2019	4/23/2019	273	0.5±0.3	10±1	<9
4/23/2019	4/30/2019	288	0.7±0.3	14±1	<11
4/30/2019	5/7/2019	285	0.3±0.3	7±1	<9

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m^3)	Gross Alpha	Gross Beta	I-131
	Calvert Cliffs Lusby Station (Continued)				
5/7/2019	5/14/2019	285	<0.3	9±1	<9
5/14/2019	5/21/2019	286	0.6±0.3	18±1	<8
5/21/2019	5/29/2019	336	0.6±0.3	12±1	<8
5/29/2019	6/4/2019	246	0.6±0.4	14±1	<11
6/4/2019	6/12/2019	326	0.3±0.3	13±1	<5
6/12/2019	6/19/2019	283	0.5±0.3	14±1	<7
6/19/2019	6/26/2019	309	0.2±0.3	12±1	<9
6/26/2019	7/2/2019	235	0.4±0.2	11±1	<7
7/2/2019	7/9/2019	284	0.6±0.4	16±1	<8
7/9/2019	7/16/2019	286	0.5±0.3	13±1	<8
7/16/2019	7/23/2019	286	0.8±0.3	19±1	<10
7/23/2019	7/30/2019	285	0.6±0.3	17±1	<7
7/30/2019	8/5/2019	251	0.7±0.4	21±1	<8
8/5/2019	8/13/2019	323	1±0.2	19±1	<7
8/13/2019	8/20/2019	286	1.1±0.3	21±1	<9
8/20/2019	8/27/2019	281	0.4±0.3	13±1	<7
8/27/2019	9/4/2019	328	1±0.2	20±1	<6
9/4/2019	9/10/2019	243	1±0.3	21±1	<8
9/10/2019	9/17/2019	286	0.8±0.4	21±1	<8
9/17/2019	9/24/2019	285	1.1±0.3	19±1	<7
9/24/2019	10/1/2019	285	0.7±0.3	19±1	<6
10/1/2019	10/8/2019	285	0.2±0.3	18±1	<7
10/8/2019	10/15/2019	285	0.2±0.3	20±1	<10
10/15/2019	10/23/2019	327	0.3±0.3	5±1	<6
10/23/2019	10/29/2019	244	0.9±0.3	20±1	<9
10/29/2019	11/5/2019	287	0.4±0.3	13±1	<7
11/5/2019	11/12/2019	285	1.5±0.2	26±1	<9
11/12/2019	11/19/2019	285	0.6±0.3	14±1	<9
11/19/2019	11/26/2019	286	1.2±0.3	19±1	<9
11/26/2019	12/3/2019	286	0.7±0.3	12±1	<9
12/3/2019	12/10/2019	285	0.1±0.3	13±1	<9
12/10/2019	12/17/2019	285	0.5±0.3	19±1	<7
12/17/2019	12/24/2019	287	1±0.5	30±1	<8
12/24/2019	12/30/2019	259	1.5±0.3	30±1	<7
	2019 Average		**0.9±1.5**	**17±10**	**--**
	Overall		**0.8±0.4**	**16±2**	**--**
	Calvert Cliffs Cove Point Station				
1/2/2018	1/9/2018	285	1±0.3	22±1	<8
1/9/2018	1/17/2018	326	0.6±0.3	20±1	<7
1/17/2018	1/22/2018	204	1±0.5	29±1	<11
1/22/2018	1/30/2018	326	0.9±0.2	17±1	<8
1/30/2018	2/6/2018	285	0.7±0.3	15±1	<9
2/6/2018	2/13/2018	285	0.9±0.1	16±1	<8
2/13/2018	2/21/2018	325	0.3±0.2	11±1	<7

Note: Concentrations in fCi/m^3 ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
Calvert Cliffs Cove Point Station (Continued)					
2/21/2018	2/27/2018	247	0.4±0.3	12±1	<9
2/27/2018	3/6/2018	285	0.9±0.3	20±1	<8
3/6/2018	3/13/2018	283	0.6±0.3	11±1	<8
3/13/2018	3/20/2018	285	0.5±0.3	20±1	<8
3/20/2018	3/27/2018	286	0.8±0.3	10±1	<8
3/27/2018	4/3/2018	285	0.9±0.2	15±1	<8
4/3/2018	4/10/2018	286	0.8±0.3	19±1	<8
4/10/2018	4/24/2018	572	1.1±0.2	15±0.4	<5
4/24/2018	5/1/2018	284	0.6±0.3	12±1	<8
5/1/2018	5/9/2018	329	1±0.2	21±1	<8
5/9/2018	5/15/2018	241	0.5±0.3	14±1	<10
5/15/2018	5/22/2018	287	<0.4	8±1	<8
5/22/2018	5/30/2018	326	0.3±0.2	12±1	<8
5/30/2018	6/5/2018	245	0.4±0.4	10±1	<9
6/5/2018	6/12/2018	285	0.4±0.4	15±1	<8
6/12/2018	6/19/2018	284	0.9±0.3	16±1	<8
6/19/2018	6/27/2018	330	0.4±0.2	14±1	<7
6/27/2018	7/3/2018	243	0.9±0.3	23±1	<9
7/3/2018	7/10/2018	286	<0.2	<1	<8
7/10/2018	7/18/2018	328	1±0.2	21±1	<8
7/18/2018	7/24/2018	240	0.7±0.3	8±1	<9
7/24/2018	7/31/2018	287	0.9±0.2	15±1	<8
7/31/2018	8/7/2018	285	<0.3	12±1	<8
8/7/2018	8/14/2018	282	1.2±0.3	25±1	<8
8/14/2018	8/21/2018	290	1±0.2	21±1	<8
8/21/2018	8/28/2018	286	0.6±0.4	19±1	<8
8/28/2018	9/5/2018	326	0.8±0.3	19±1	<8
9/5/2018	9/11/2018	245	0.8±0.3	15±1	<9
9/11/2018	9/18/2018	285	<0.3	10±1	<10
9/18/2018	9/25/2018	286	0.4±0.3	15±1	<8
9/25/2018	10/2/2018	285	1.2±0.2	17±1	<8
10/2/2018	10/10/2018	326	0.8±0.3	15±1	<7
10/10/2018	10/16/2018	244	<0.4	<1	<10
10/16/2018	10/24/2018	326	0.4±0.3	18±1	<8
10/24/2018	10/30/2018	245	<0.3	9±1	<8
10/30/2018	11/6/2018	285	0.4±0.2	16±1	<9
11/6/2018	11/14/2018	327	0.8±0.2	15±1	<6
11/14/2018	11/20/2018	249	<0.2	1±1	<9
11/20/2018	11/27/2018	n/a	n/a	n/a	n/a
11/27/2018	12/4/2018	283	0.5±0.3	12±1	<9
12/4/2018	12/11/2018	286	0.5±0.3	21±1	<9
12/11/2018	12/18/2018	285	1.6±0.2	29±1	<9
12/26/2018	1/2/2019	286	0.6±0.3	24±1	<9
	2018 Average		**0.6±0.8**	**15±13**	**--**

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
Calvert Cliffs Cove Point Station (Continued)					
1/2/2019	1/8/2019	244	0.3±0.3	22±1	<10
1/8/2019	1/15/2019	286	1.6±0.2	15±1	<8
1/15/2019	1/23/2019	326	0.7±0.2	15±1	<8
1/23/2019	1/29/2019	282	1.3±0.3	20±1	<9
1/29/2019	2/5/2019	285	1.1±0.3	26±1	<9
2/5/2019	2/12/2019	326	1.6±0.2	18±1	<7
2/12/2019	2/19/2019	286	0.7±0.3	16±1	<11
2/19/2019	2/27/2019	326	4±0.2	21±1	<14
2/27/2019	3/5/2019	245	2.1±0.3	17±1	<43
3/5/2019	3/13/2019	324	2.8±0.2	21±1	<8
3/13/2019	3/19/2019	245	2.5±0.3	20±1	<10
3/19/2019	3/26/2019	286	1.2±0.3	13±1	<8
3/26/2019	4/2/2019	307	0.9±0.2	25±1	<9
4/2/2019	4/9/2019	260	0.9±0.3	16±1	<9
4/9/2019	4/16/2019	285	<0.3	13±1	<8
4/16/2019	4/23/2019	273	0.4±0.2	11±1	<9
4/23/2019	4/30/2019	288	0.6±0.3	14±1	<11
4/30/2019	5/7/2019	286	0.9±0.2	11±1	<9
5/7/2019	5/14/2019	285	0.9±0.3	9±1	<9
5/14/2019	5/21/2019	286	0.7±0.3	21±1	<8
5/21/2019	5/29/2019	326	0.7±0.2	13±1	<8
5/29/2019	6/4/2019	245	0.6±0.3	17±1	<11
6/4/2019	6/12/2019	326	0.5±0.3	16±1	<5
6/12/2019	6/19/2019	284	0.4±0.3	15±1	<7
6/19/2019	6/26/2019	309	0.5±0.2	12±1	<9
6/26/2019	7/2/2019	223	0.3±0.2	9±1	<7
7/2/2019	7/9/2019	283	0.7±0.3	14±1	<8
7/9/2019	7/16/2019	287	0.7±0.2	36±1	<8
7/16/2019	7/23/2019	287	0.6±0.3	19±1	<10
7/23/2019	7/30/2019	284	0.6±0.3	18±1	<7
7/30/2019	8/5/2019	251	0.9±0.4	25±1	<8
8/5/2019	8/13/2019	323	0.8±0.2	22±1	<7
8/13/2019	8/20/2019	286	1±0.2	25±1	<9
8/20/2019	8/27/2019	281	0.6±0.3	14±1	<7
8/27/2019	9/4/2019	327	0.6±0.2	20±1	<6
9/4/2019	9/10/2019	243	1±0.2	21±1	<8
9/10/2019	9/17/2019	287	1±0.3	21±1	<8
9/17/2019	9/24/2019	285	0.6±0.2	19±1	<7
9/24/2019	10/1/2019	286	0.8±0.2	20±1	<6
10/1/2019	10/8/2019	285	1±0.3	18±1	<7
10/8/2019	10/15/2019	285	0.9±0.2	19±1	<10
10/15/2019	10/23/2019	409	0.3±0.1	12±1	<6

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
Calvert Cliffs Cove Point Station (Continued)					
10/23/2019	10/29/2019	243	0.5±0.3	21±1	<9
10/29/2019	11/5/2019	288	0.7±0.3	13±1	<7
11/5/2019	11/12/2019	284	0.5±0.3	24±1	<9
11/12/2019	11/19/2019	285	0.4±0.3	16±1	<9
11/19/2019	11/26/2019	286	0.6±0.3	22±1	<9
11/26/2019	12/3/2019	286	0.3±0.2	11±1	<9
12/3/2019	12/10/2019	284	0.4±0.3	14±1	<9
12/10/2019	12/17/2019	286	<0.4	15±1	<7
12/17/2019	12/24/2019	285	1.7±0.3	28±1	<8
12/24/2019	12/30/2019	257	1.5±0.3	24±1	<7
	2019 Average		**0.9±1.4**	**18±11**	**--**
	Overall		**0.8±0.4**	**17±4**	**--**
Calvert Cliffs Horn Point Station					
12/31/2017	1/6/2018	248	1.2±0.4	22±1	<12
1/6/2018	1/16/2018	401	1±0.3	21±1	<7
1/16/2018	1/21/2018	204	<0.5	23±1	<12
1/21/2018	1/29/2018	327	0.8±0.2	15±1	<8
1/29/2018	2/5/2018	285	0.5±0.3	13±1	<9
2/5/2018	2/12/2018	285	0.5±0.1	15±1	<9
2/12/2018	2/20/2018	326	0.7±0.2	18±1	<8
2/20/2018	2/26/2018	245	<0.3	7±1	<10
2/26/2018	3/5/2018	285	0.7±0.3	17±1	<9
3/5/2018	3/12/2018	284	0.3±0.3	8±1	<9
3/12/2018	3/19/2018	286	0.6±0.3	11±1	<9
3/19/2018	3/26/2018	285	0.9±0.3	10±1	<9
3/26/2018	4/2/2018	285	1.1±0.2	15±1	<9
4/2/2018	4/9/2018	286	<0.3	12±1	<9
4/9/2018	4/16/2018	285	0.6±0.3	16±1	<11
4/16/2018	4/23/2018	289	0.5±0.3	9±1	<9
4/23/2018	4/30/2018	283	0.4±0.3	11±1	<9
4/30/2018	5/8/2018	324	0.8±0.2	16±1	<8
5/8/2018	5/14/2018	248	0.7±0.3	13±1	<10
5/14/2018	5/21/2018	284	<0.4	8±1	<9
5/21/2018	5/29/2018	326	0.5±0.2	11±1	<8
5/29/2018	6/4/2018	244	<0.5	3±1	<10
6/4/2018	6/11/2018	379	<0.3	7±1	<9
6/11/2018	6/18/2018	283	0.6±0.3	12±1	<9
6/18/2018	6/26/2018	326	0.3±0.2	14±1	<8
6/26/2018	7/2/2018	245	0.4±0.3	13±1	<10
7/2/2018	7/9/2018	285	1±0.2	15±1	<9
7/9/2018	7/17/2018	328	0.9±0.2	19±1	<8
7/17/2018	7/23/2018	244	0.3±0.3	8±1	<10
7/23/2018	7/30/2018	286	0.9±0.2	15±1	<9
7/30/2018	8/6/2018	284	<0.3	11±1	<9
8/6/2018	8/13/2018	288	0.6±0.2	18±1	<9

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
Calvert Cliffs Horn Point Station (Continued)					
8/13/2018	8/20/2018	286	1.4±0.2	21±1	<9
8/20/2018	8/27/2018	285	<0.4	12±1	<9
8/27/2018	9/4/2018	326	1.1±0.3	21±1	<8
9/4/2018	9/10/2018	244	0.8±0.3	15±1	<8
9/10/2018	9/17/2018	286	<0.3	10±1	<9
9/17/2018	9/24/2018	285	0.6±0.2	13±1	<9
9/24/2018	10/1/2018	286	0.7±0.2	15±1	<9
10/1/2018	10/9/2018	327	0.9±0.3	26±1	<9
10/9/2018	10/15/2018	243	0.4±	10±1	<11
10/15/2018	10/23/2018	286	0.4±0.3	18±1	<7
10/23/2018	10/28/2018	258	<0.3	10±1	<3
10/28/2018	11/5/2018	312	0.7±0.2	18±1	<7
11/5/2018	11/13/2018	332	0.4±0.2	14±1	<9
11/13/2018	11/18/2018	215	0.6±0.3	17±1	<15
11/18/2018	11/25/2018	294	1.4±0.2	21±1	<9
11/25/2018	12/3/2018	303	0.6±0.3	17±1	<5
12/3/2018	12/10/2018	286	0.7±0.3	18±1	<8
12/10/2018	12/17/2018	269	1.1±0.2	32±1	<3
12/17/2018	12/23/2018	282	0.9±0.2	14±1	<4
12/23/2018	12/30/2018	280	0.8±0.3	25±1	<10
	2018 Average		**0.6±0.8**	**15±11**	**--**
12/30/2018	1/7/2019	312	0.7±0.3	20±1	<8
1/8/2019	1/15/2019	286	0.7±0.2	17±1	<9
1/15/2019	1/23/2019	326	0.6±0.2	16±1	<7
1/23/2019	1/29/2019	244	0.7±0.4	17±1	<13
1/29/2019	2/5/2019	287	1.5±0.3	26±1	<8
2/5/2019	2/12/2019	286	0.6±0.3	13±1	<10
2/12/2019	2/19/2019	286	1.1±0.3	16±1	<8
2/19/2019	2/25/2019	246	4.2±0.3	21±1	<30
2/25/2019	3/4/2019	285	2.7±0.3	16±1	<8
3/4/2019	3/11/2019	284	3.3±0.3	19±1	<8
3/11/2019	3/18/2019	291	3.1±0.3	23±1	<7
3/18/2019	3/25/2019	280	1±0.3	14±1	<8
3/25/2019	4/1/2019	286	0.9±0.3	14±1	<8
4/1/2019	4/8/2019	286	0.9±0.3	18±1	<7
4/8/2019	4/15/2019	303	<0.3	9±1	<9
4/15/2019	4/22/2019	285	0.3±0.2	12±1	<7
4/22/2019	5/1/2019	370	0.7±0.2	13±1	<6
5/1/2019	5/6/2019	201	0.9±0.3	11±1	<10
5/6/2019	5/13/2019	285	<0.3	10±1	<7
5/13/2019	5/20/2019	284	0.5±0.3	18±1	<7
5/20/2019	5/28/2019	330	0.5±0.2	10±1	<7
5/28/2019	6/3/2019	243	0.7±0.3	16±1	<9
6/3/2019	6/10/2019	285	0.3±0.3	18±1	<10
6/10/2019	6/16/2019	243	0.2±0.3	13±1	<13

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
Calvert Cliffs Horn Point Station (Continued)					
6/16/2019	6/23/2019	304	0.5±0.2	16±1	<13
6/23/2019	6/30/2019	267	0.1±0.3	17±1	<10
6/30/2019	7/7/2019	284	0.9±0.3	16±1	<8
7/7/2019	7/15/2019	339	0.7±0.2	15±1	<6
7/15/2019	7/21/2019	249	0.8±0.3	22±1	<11
7/21/2019	7/28/2019	279	0.6±0.3	17±1	<9
7/28/2019	8/6/2019	356	1.2±0.3	26±1	<7
8/6/2019	8/12/2019	248	0.7±0.3	22±1	<11
8/12/2019	8/19/2019	293	1.6±0.2	26±1	<14
8/19/2019	8/26/2019	276	0.7±0.3	17±1	<9
8/26/2019	9/3/2019	325	0.6±0.2	18±1	<12
9/3/2019	9/9/2019	246	1.1±0.2	19±1	<12
9/9/2019	9/16/2019	297	1.1±0.3	23±1	<7
9/16/2019	9/23/2019	286	0.8±0.3	18±1	<9
9/23/2019	9/30/2019	282	0.6±0.3	21±1	<9
9/30/2019	10/7/2019	284	0.5±0.3	19±1	<9
10/7/2019	10/14/2019	284	1.1±0.2	17±1	<9
10/14/2019	10/21/2019	285	0.7±0.3	21±1	<10
10/21/2019	10/28/2019	288	0.8±0.3	20±1	<9
10/28/2019	11/4/2019	284	0.4±0.3	15±1	<8
11/4/2019	11/11/2019	278	0.3±0.3	21±1	<8
11/11/2019	11/18/2019	278	0.9±0.3	21±1	<8
11/18/2019	11/25/2019	316	1.1±0.3	22±1	<8
11/25/2019	12/2/2019	280	1.1±0.2	13±1	<8
12/2/2019	12/9/2019	268	0.4±0.3	13±1	<8
12/9/2019	12/16/2019	287	<0.4	18±1	<9
12/16/2019	12/22/2019	245	1.1±0.2	27±1	<14
12/22/2019	12/29/2019	288	1.3±0.2	25±1	<10
	2019 Average		**0.9±1.6**	**18±9**	**--**
	Overall		**0.8±0.5**	**16±4**	**--**
Baltimore City Station					
1/2/2018	1/9/2018	286	1.4±0.3	20±1	<8
1/9/2018	1/17/2018	326	1.5±0.2	21±1	<7
1/17/2018	1/22/2018	204	1.3±0.4	33±1	<11
1/22/2018	1/30/2018	325	1±0.3	15±1	<8
1/30/2018	2/6/2018	286	1.1±0.2	15±1	<9
2/6/2018	2/13/2018	285	0.8±0.2	20±1	<8
2/13/2018	2/21/2018	327	0.3±0.3	18±1	<7
2/21/2018	2/27/2018	244	<0.4	11±1	<9
2/27/2018	3/6/2018	286	0.9±0.3	17±1	<8
3/6/2018	3/13/2018	284	1±0.2	9±1	<8
3/13/2018	3/20/2018	285	0.7±0.3	18±1	<8
3/20/2018	3/27/2018	286	0.9±0.3	13±1	<8
3/27/2018	4/3/2018	285	0.6±0.2	14±1	<8

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
		Baltimore City Station (Continued)			
4/3/2018	4/10/2018	286	1.1±0.3	18±1	<8
4/10/2018	4/24/2018	572	1.7±0.1	15±0.3	<5
4/24/2018	5/1/2018	286	0.3±0.3	14±1	<8
5/1/2018	5/9/2018	326	1.6±0.2	22±1	<8
5/9/2018	5/15/2018	245	0.8±0.3	14±1	<10
5/15/2018	5/22/2018	285	0.5±0.3	9±1	<8
5/22/2018	5/30/2018	325	0.5±0.3	12±1	<8
5/30/2018	6/5/2018	245	0.3±0.3	8±1	<9
6/5/2018	6/12/2018	285	<0.4	13±1	<8
6/12/2018	6/19/2018	287	0.6±0.2	15±1	<8
6/19/2018	6/27/2018	327	0.3±0.2	11±1	<7
6/27/2018	7/3/2018	243	1±0.3	23±1	<9
7/3/2018	7/10/2018	286	0.8±0.3	15±1	<8
7/10/2018	7/18/2018	328	1±0.3	19±1	<8
7/18/2018	7/24/2018	240	0.6±0.3	11±1	<9
7/24/2018	7/31/2018	286	<0.4	15±1	<8
7/31/2018	8/7/2018	311	0.6±0.3	19±1	<8
8/7/2018	8/14/2018	282	<0.3	4±1	<8
8/14/2018	8/21/2018	289	1.3±0.2	23±1	<8
8/21/2018	8/28/2018	288	1±0.3	20±1	<8
8/28/2018	9/5/2018	326	0.6±0.3	20±1	<8
9/5/2018	9/11/2018	245	0.3±0.3	13±1	<9
9/11/2018	9/18/2018	286	<0.3	9±1	<10
9/18/2018	9/25/2018	286	<0.4	16±1	<8
9/25/2018	10/2/2018	285	0.4±0.3	18±1	<8
10/2/2018	10/10/2018	325	0.6±0.2	24±1	<7
10/10/2018	10/16/2018	245	0.7±0.2	12±1	<10
10/16/2018	10/24/2018	326	<0.3	14±1	<8
10/24/2018	10/30/2018	245	0.6±0.3	8±1	<8
10/30/2018	11/7/2018	325	0.5±0.3	12±1	<4
11/7/2018	11/14/2018	287	1.8±0.2	14±1	<4
11/14/2018	11/20/2018	279	1.3±0.2	20±1	<9
11/20/2018	11/27/2018	251	1±0.2	18±1	<8
11/27/2018	12/4/2018	285	0.3±0.3	10±1	<9
12/4/2018	12/11/2018	285	0.6±0.2	16±1	<9
12/11/2018	12/18/2018	285	0.9±0.4	20±1	<9
12/18/2018	12/26/2018	326	0.8±0.2	16±1	<8
12/26/2019	1/2/2019	286	0.3±0.2	17±1	<9
	2018 Average		**0.7±0.9**	**16±10**	**--**
1/2/2019	1/8/2019	244	0.7±0.3	15±1	<10
1/8/2019	1/15/2019	286	0.8±0.2	16±1	<9
1/15/2019	1/23/2019	326	1±0.2	19±1	<8
1/23/2019	1/29/2019	244	0.6±0.4	17±1	<9
1/29/2019	2/5/2019	247	1.7±0.3	23±1	<3

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
Baltimore City Station (Continued)					
2/5/2019	2/12/2019	326	1.1±0.3	21±1	<7
2/12/2019	2/19/2019	286	1±0.2	15±1	<11
2/19/2019	2/27/2019	326	2.9±0.3	19±1	<14
2/27/2019	3/5/2019	244	2.3±0.4	13±1	<43
3/5/2019	3/13/2019	326	2.9±0.3	19±1	<8
3/13/2019	3/19/2019	245	1.6±0.4	16±1	<10
3/19/2019	3/26/2019	286	1.3±0.3	10±1	<8
3/26/2019	4/2/2019	320	1±0.3	11±1	<9
4/2/2019	4/9/2019	247	0.9±0.5	16±1	<9
4/9/2019	4/16/2019	325	0.6±0.3	12±1	<2
4/16/2019	4/23/2019	244	0.7±0.3	10±1	<3
4/23/2019	4/30/2019	287	0.6±0.3	16±1	<11
4/30/2019	5/7/2019	289	0.5±0.3	12±1	<9
5/7/2019	5/14/2019	285	<0.3	8±1	<9
5/14/2019	5/21/2019	284	1.4±0.3	22±1	<8
5/21/2019	5/29/2019	326	1±0.3	12±1	<8
5/29/2019	6/4/2019	244	1.4±0.4	14±1	<11
6/4/2019	6/12/2019	326	0.7±0.3	16±1	<5
6/12/2019	6/19/2019	285	0.6±0.3	15±1	<7
6/19/2019	6/27/2019	326	1±0.2	15±1	<4
6/27/2019	7/2/2019	205	1±0.3	18±1	<5
7/2/2019	7/9/2019	285	1.4±0.2	16±1	<8
7/9/2019	7/16/2019	285	0.3±0.3	15±1	<8
7/16/2019	7/23/2019	286	1.1±0.3	16±1	<10
7/23/2019	7/30/2019	286	0.9±0.3	19±1	<7
7/30/2019	8/6/2019	286	1±0.2	26±1	<8
8/6/2019	8/13/2019	287	1±0.3	16±1	<7
8/13/2019	8/20/2019	286	0.5±0.1	20±1	<9
8/20/2019	8/27/2019	282	1.5±0.3	16±1	<7
8/27/2019	9/4/2019	327	0.7±0.3	18±1	<6
9/4/2019	9/10/2019	244	1.2±0.2	21±1	<8
9/10/2019	9/17/2019	286	1.3±0.3	23±1	<8
9/17/2019	9/24/2019	285	1.2±0.1	16±1	<7
9/24/2019	10/1/2019	287	0.8±0.2	16±1	<6
10/1/2019	10/8/2019	285	0.5±0.3	12±1	<7
10/8/2019	10/15/2019	285	0.7±0.2	19±1	<10
10/15/2019	10/22/2019	332	0.5±0.2	14±1	<6
10/22/2019	10/29/2019	281	1±0.3	18±1	<4
10/29/2019	11/5/2019	286	0.6±0.3	16±1	<7
11/5/2019	11/12/2019	285	0.8±0.4	22±1	<9
11/12/2019	11/19/2019	285	0.5±0.3	16±1	<9
11/19/2019	11/26/2019	286	1.5±0.2	23±1	<9
11/26/2019	12/3/2019	286	0.8±0.2	12±1	<9
12/3/2019	12/10/2019	285	0.6±0.3	14±1	<9

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
12/10/2019	12/17/2019	286	0.7±0.3	18±1	<7
12/17/2019	12/24/2019	362	0.5±0.3	16±1	<8
	2019 Average		**1±1.1**	**16±7**	**--**
	Overall		**0.9±0.4**	**16±1**	**--**
		Peach Bottom Rising Sun Station			
12/31/2017	1/6/2018	240	1.3±0.2	20±1	<12
1/6/2018	1/16/2018	408	0.9±0.2	19±0.5	<7
1/16/2018	1/21/2018	206	2.2±0.3	30±1	<12
1/21/2018	1/29/2018	326	0.8±0.2	19±1	<8
1/29/2018	2/5/2018	285	0.8±0.3	15±1	<9
2/5/2018	2/12/2018	285	0.9±0.2	19±1	<9
2/12/2018	2/20/2018	337	0.9±0.1	21±1	<8
2/20/2018	2/26/2018	245	0.4±0.3	10±1	<10
2/26/2018	3/5/2018	285	1.5±0.1	18±1	<9
3/5/2018	3/12/2018	284	0.2±0.2	9±1	<9
3/12/2018	3/19/2018	303	1.1±0.2	19±1	<9
3/19/2018	3/26/2018	285	0.6±0.3	12±1	<9
3/26/2018	4/2/2018	285	0.9±0.3	17±1	<9
4/2/2018	4/9/2018	286	1.4±0.2	16±1	<9
4/9/2018	4/16/2018	285	1.6±0.2	20±1	<11
4/16/2018	4/23/2018	290	0.9±0.3	11±1	<9
4/23/2018	4/30/2018	282	<0.3	11±1	<9
4/30/2018	5/8/2018	325	1±0.2	22±1	<8
5/8/2018	5/14/2018	248	0.4±0.4	17±1	<10
5/14/2018	5/21/2018	284	<0.3	9±1	<9
5/21/2018	5/29/2018	327	0.9±0.2	12±1	<8
5/29/2018	6/4/2018	245	0.3±0.3	8±1	<10
6/4/2018	6/11/2018	286	0.8±0.2	13±1	<9
6/11/2018	6/18/2018	283	0.5±0.3	15±1	<9
6/18/2018	6/26/2018	328	0.8±0.3	16±1	<8
6/26/2018	7/2/2018	247	1.4±0.2	21±1	<10
7/2/2018	7/9/2018	283	1.1±0.2	18±1	<9
7/9/2018	7/17/2018	329	0.9±0.2	19±1	<8
7/17/2018	7/23/2018	244	0.3±0.4	11±1	<10
7/23/2018	7/30/2018	286	0.6±0.3	11±1	<9
7/30/2018	8/6/2018	285	0.3±0.3	17±1	<9
8/6/2018	8/13/2018	287	1.2±0.3	26±1	<9
8/13/2018	8/20/2018	288	0.9±0.3	22±1	<9
8/20/2018	8/27/2018	286	1.4±0.2	18±1	<9
8/27/2018	9/4/2018	325	0.8±0.2	24±1	<8
9/4/2018	9/10/2018	244	0.9±0.3	16±1	<10
9/10/2018	9/17/2018	286	<0.3	8±1	<9
9/17/2018	9/24/2018	285	0.6±0.2	13±1	<9

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
Peach Bottom Rising Sun Station (Continued)					
9/24/2018	10/1/2018	284	0.9±0.2	18±1	<9
10/1/2018	10/9/2018	327	1.2±0.2	27±1	<9
10/9/2018	10/15/2018	242	<0.4	11±1	<11
10/15/2018	10/23/2018	325	0.7±0.2	18±1	<7
10/23/2018	10/28/2018	211	0.4±0.4	9±1	<11
10/28/2018	11/5/2018	311	0.5±0.4	18±1	<7
11/5/2018	11/13/2018	334	1.1±0.2	14±1	<9
11/13/2018	11/18/2018	215	1.3±0.3	21±1	<15
11/18/2018	11/25/2018	292	1±0.2	21±1	<9
11/25/2018	12/3/2018	301	0.8±0.2	15±1	<6
12/3/2018	12/10/2018	309	2.1±0.2	20±1	<8
12/10/2018	12/16/2018	245	1.6±0.4	30±1	<9
12/16/2018	12/23/2018	282	1.4±0.3	17±1	<9
12/23/2018	12/30/2018	280	2.4±0.3	25±1	<10
	2018 Average		**0.9±1.1**	**17±11**	**--**
12/30/2018	1/7/2019	320	1.1±0.2	21±1	<8
1/8/2019	1/15/2019	286	0.8±0.2	14±1	<9
1/15/2019	1/23/2019	326	1±0.3	12±1	<8
1/23/2019	1/29/2019	244	<4	22±1	<9
1/29/2019	2/5/2019	287	1±0.3	27±1	<8
2/5/2019	2/12/2019	286	0.9±0.3	19±1	<10
2/12/2019	2/19/2019	286	0.9±0.3	14±1	<11
2/19/2019	2/25/2019	231	4.2±0.4	25±1	<30
2/25/2019	3/4/2019	284	3±0.3	18±1	<8
3/4/2019	3/11/2019	284	2.3±0.3	22±1	<8
3/11/2019	3/18/2019	243	3.2±0.3	27±1	<7
3/18/2019	3/25/2019	287	1.3±0.3	14±1	<8
3/25/2019	4/1/2019	287	1±0.3	13±1	<8
4/1/2019	4/8/2019	285	1.3±0.3	17±1	<3
4/8/2019	4/15/2019	303	0.5±0.3	8±1	<9
4/16/2019	4/23/2019	285	0.8±0.2	16±1	<7
4/23/2019	5/1/2019	371	<0.3	13±1	<6
5/1/2019	5/6/2019	201	1±0.4	20±1	<10
5/6/2019	5/13/2019	285	1.5±0.1	12±1	<7
5/13/2019	5/20/2019	284	<0.3	3±1	<7
5/20/2019	5/28/2019	330	0.8±0.2	11±1	<7
5/28/2019	6/3/2019	243	1.1±0.4	17±1	<9
6/3/2019	6/10/2019	284	0.1±0.3	16±1	<10
6/10/2019	6/16/2019	243	0.3±0.4	10±1	<13
6/19/2019	6/23/2019	305	0.6±0.3	14±1	<13
6/23/2019	6/30/2019	267	1.3±0.3	22±1	<10
6/30/2019	7/7/2019	285	1.7±0.2	17±1	<8
7/7/2019	7/15/2019	331	1.2±0.3	18±1	<6
7/15/2019	7/21/2019	247	1.7±0.3	20±1	<11

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
Peach Bottom Rising Sun Station (Continued)					
7/21/2019	7/28/2019	280	1.2±0.2	16±1	<9
7/28/2019	8/6/2019	356	1.7±0.2	29±1	<7
8/6/2019	8/12/2019	249	1.2±0.3	17±1	<11
8/12/2019	8/19/2019	293	1±0.3	33±1	<14
8/19/2019	8/26/2019	278	1.1±0.3	18±1	<9
8/26/2019	9/3/2019	323	0.4±0.3	18±1	<12
9/3/2019	9/9/2019	228	1±0.2	23±1	<12
9/9/2019	9/16/2019	297	0.8±0.3	20±1	<7
9/16/2019	9/23/2019	286	0.7±0.3	23±1	<9
9/23/2019	9/30/2019	283	0.6±0.2	19±1	<9
9/30/2019	10/7/2019	282	0.9±0.2	16±1	<9
10/7/2019	10/14/2019	285	1.3±0.2	19±1	<9
10/14/2019	10/21/2019	286	0.9±0.2	18±1	<10
10/21/2019	10/28/2019	288	0.6±0.3	18±1	<9
10/28/2019	11/4/2019	284	0.4±0.3	11±1	<8
11/4/2019	11/11/2019	276	0.4±0.4	21±1	<8
11/11/2019	11/18/2019	279	0.9±0.3	19±1	<8
11/18/2019	11/25/2019	308	1.1±0.3	23±1	<8
11/25/2019	12/2/2019	264	0.1±0.4	13±1	<8
12/2/2019	12/9/2019	293	0.8±0.2	16±1	<8
12/9/2019	12/16/2019	286	1.1±0.3	19±1	<9
12/16/2019	12/22/2019	244	1±0.2	14±1	<14
12/22/2019	12/31/2019	287	1.3±0.3	24±1	<10
	2019 Average		**1.1±1.6**	**18±11**	**--**
	Overall		**1±0.2**	**17±1**	**--**
Peach Bottom Whiteford Station					
12/31/2017	1/6/2018	236	0.7±0.4	19±1	<12
1/6/2018	1/16/2018	412	0.9±0.3	19±0.5	<7
1/16/2018	1/21/2018	206	1.5±0.4	29±1	<12
1/21/2018	1/29/2018	325	0.4±0.3	17±1	<8
1/29/2018	2/5/2018	n/a	n/a	n/a	n/a
2/5/2018	2/12/2018	285	0.7±0.1	15±0.4	<3
2/12/2018	2/20/2018	337	0.8±0.2	22±1	<8
2/20/2018	2/26/2018	245	0.5±0.3	9±1	<10
2/26/2018	3/5/2018	285	0.7±0.3	24±1	<9
3/5/2018	3/12/2018	284	1.1±0.2	11±1	<9
3/12/2018	3/19 /2018	286	1.2±0.3	22±1	<9
3/19/2018	3/26/2018	285	0.5±0.3	13±1	<9
3/26/2018	4/2/2018	285	0.8±0.3	17±1	<9
4/2/2018	4/9/2018	286	0.7±0.3	18±1	<9
4/9/2018	4/16/2018	285	1.9±0.3	20±1	<11
4/16/2018	4/23/2018	290	0.9±0.4	15±1	<9
4/23/2018	4/30/2018	282	0.4±0.4	15±1	<9
4/30/2018	5/8/2018	325	1.7±0.3	26±1	<8

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
	Peach Bottom Whiteford Station (Continued)				
5/8/2018	5/14/2018	248	1.4±0.3	13±1	<10
5/14/2018	5/21/2018	284	<0.4	11±1	<9
5/21/2018	5/29/2018	327	<0.4	13±1	<8
5/29/2018	6/4/2018	245	1.4±0.3	9±1	<10
6/4/2018	6/11/2018	286	<0.4	12±1	<9
6/11/2018	6/18/2018	283	1±0.3	17±1	<9
6/18/2018	6/26/2018	326	0.7±0.3	14±1	<8
6/26/2018	7/2/2018	247	0.7±0.4	21±1	<10
7/2/2018	7/9/2018	283	0.8±0.3	17±1	<9
7/9/2018	7/17/2018	329	0.6±0.3	17±1	<8
7/17/2018	7/23/2018	244	<0.4	10±1	<10
7/23/2018	7/30/2018	286	<0.4	13±1	<9
7/30/2018	8/6/2018	285	0.8±0.3	16±1	<9
8/6/2018	8/13/2018	287	1.2±0.3	24±1	<9
8/13/2018	8/20/2018	286	1.3±0.4	22±1	<9
8/20/2018	8/27/2018	286	0.9±0.3	15±1	<9
8/27/2018	9/4/2018	325	0.7±0.3	24±1	<8
9/4/2018	9/10/2018	244	1±0.4	17±1	<10
9/10/2018	9/17/2018	286	0.7±0.2	9±1	<9
9/17/2018	9/24/2018	n/a	n/a	n/a	n/a
9/24/2018	10/1/2018	284	1.1±0.3	17±1	<9
10/1/2018	10/9/2018	327	0.5±0.3	27±1	<9
10/9/2018	10/15/2018	244	<0.3	10±1	<11
10/15/2018	10/23/2018	326	0.6±0.3	18±1	<7
10/23/2018	10/28/2018	206	0.6±0.3	9±1	<11
10/28/2018	11/5/2018	311	0.9±0.3	18±1	<7
11/5/2018	11/13/2018	334	0.9±0.3	14±1	<9
11/13/2018	11/18/2018	215	1.2±0.4	21±1	<15
11/18/2018	11/25/2018	293	1.2±0.3	21±1	<9
11/25/2018	12/3/2018	301	<0.3	14±1	<6
12/3/2018	12/10/2018	309	0.3±0.3	20±1	<8
12/10/2018	12/16/2018	245	1.2±0.4	30±1	<9
12/16/2018	12/23/2018	282	0.5±0.3	16±1	<9
12/23/2018	12/30/2018	280	1.6±0.2	25±1	<10
	2018 Average		**0.8±1**	**17±12**	**--**
12/30/2018	1/9/2019	323	0.9±0.3	20±1	<8
1/8/2019	1/15/2019	286	1.2±0.2	16±1	<8
1/15/2019	1/23/2019	326	0.5±0.2	19±1	<7
1/23/2019	1/29/2019	245	<0.4	21±1	<9
1/29/2019	2/5/2019	286	1.7±0.3	27±1	<8
2/5/2019	2/12/2019	286	1.6±0.2	19±1	<10
2/12/2019	2/19/2019	286	0.6±0.3	19±1	<8
2/19/2019	2/25/2019	245	4±0.4	25±1	<30
2/25/2019	3/4/2019	284	3.8±0.3	16±1	<8
3/4/2019	3/11/2019	286	3±0.3	20±1	<8

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m^3)	Gross Alpha	Gross Beta	I-131
Peach Bottom Whiteford Station (Continued)					
3/11/2019	3/18/2019	282	4.3±0.4	27±1	<3
3/18/2019	3/25/2019	291	1.8±0.3	14±1	<8
3/25/2019	4/1/2019	287	1±0.4	15±1	<8
4/1/2019	4/8/2019	285	0.9±0.4	17±1	<7
4/8/2019	4/15/2019	303	0.8±0.3	11±1	<9
4/15/2019	4/22/2019	284	0.8±0.3	14±1	<7
4/22/2019	5/1/2019	371	0.3±0.3	14±1	<6
5/1/2019	5/6/2019	200	1.1±0.4	10±1	<10
5/6/2019	5/13/2019	285	0.3±0.3	10±1	<7
5/13/2019	5/20/2019	285	1±0.3	21±1	<7
5/20/2019	5/28/2019	330	0.6±0.3	11±1	<7
5/28/2019	6/3/2019	243	0.3±0.4	14±1	<9
6/3/2019	6/10/2019	284	0.5±0.4	14±1	<10
6/10/2019	6/16/2019	243	0.6±0.4	9±1	<13
6/16/2019	6/23/2019	305	1±0.3	11±1	<13
6/23/2019	6/30/2019	268	0.2±0.4	17±1	<10
6/30/2019	7/7/2019	284	0.3±0.4	14±1	<8
7/7/2019	7/15/2019	328	0.7±0.2	15±1	<6
7/15/2019	7/21/2019	259	0.6±0.4	20±1	<11
7/21/2019	7/28/2019	280	0.6±0.3	16±1	<9
7/28/2019	8/6/2019	356	1±0.3	27±1	<7
8/6/2019	8/12/2019	250	0.7±0.3	21±1	<11
8/12/2019	8/19/2019	294	1±0.3	33±1	<14
8/19/2019	8/26/2019	279	0.9±0.3	19±1	<9
8/26/2019	9/3/2019	322	0.7±0.2	21±1	<12
9/3/2019	9/9/2019	245	1.7±0.3	22±1	<12
9/9/2019	9/16/2019	295	0.8±0.4	26±1	<7
9/16/2019	9/23/2019	286	1.2±0.3	24±1	<9
9/23/2019	9/30/2019	282	0.9±0.3	15±1	<9
9/30/2019	10/7/2019	285	0.3±0.3	17±1	<9
10/7/2019	10/14/2019	286	<0.3	20±1	<9
10/14/2019	10/21/2019	286	1.1±0.3	18±1	<10
10/21/2019	10/28/2019	288	0.6±0.3	18±1	<9
10/28/2019	11/4/2019	284	0.7±0.3	15±1	<8
11/4/2019	11/11/2019	278	0.6±0.2	23±1	<8
11/11/2019	11/18/2019	279	0.5±0.3	18±1	<8
11/18/2019	11/25/2019	304	1.4±0.3	23±1	<8
11/25/2019	12/2/2019	285	0.8±0.3	15±1	<8
12/2/2019	12/9/2019	297	0.3±0.3	15±1	<8
12/9/2019	12/16/2019	286	0.6±0.3	18±1	<9
12/16/2019	12/22/2019	244	0.1±0.3	13±1	<14
12/22/2019	12/29/2019	287	1.3±0.2	26±1	<10
	2019 Average		**1±1.8**	**18±10**	**--**
	Overall		**0.9±0.4**	**17±2**	**--**

Note: Concentrations in fCi/m^3 ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
Peach Bottom Dempsey Farm Station					
12/31/2017	1/6/2018	238	0.7±0.4	16±1	<12
1/6/2018	1/16/2018	410	1.1±0.1	17±0.5	<7
1/16/2018	1/21/2018	206	1.1±0.4	29±1	<12
1/21/2018	1/29/2018	326	0.6±0.3	18±1	<8
1/29/2018	2/5/2018	285	0.9±0.2	13±1	<9
2/5/2018	2/12/2018	285	0.8±0.2	19±1	<9
2/12/2018	2/20/2018	327	0.7±0.3	23±1	<8
2/20/2018	2/26/2018	245	<0.4	9±1	<10
2/26/2018	3/5/2018	280	0.6±0.3	18±1	<9
3/5/2018	3/12/2018	284	0.5±0.2	10±1	<9
3/12/2018	3/19/2018	286	<0.3	20±1	<9
3/19/2018	3/26/2018	285	0.7±0.3	12±1	<9
3/26/2018	4/2/2018	285	0.6±0.2	16±1	<9
4/2/2018	4/9/2018	286	0.7±0.3	16±1	<9
4/9/2018	4/16/2018	285	1.1±0.3	20±1	<11
4/16/2018	4/23/2018	290	0.8±0.3	11±1	<9
4/23/2018	4/30/2018	282	1.1±0.3	11±1	<9
4/30/2018	5/8/2018	325	1.5±0.2	25±1	<8
5/8/2018	5/14/2018	248	0.6±0.3	16±1	<10
5/14/2018	5/21/2018	285	0.8±0.3	9±1	<9
5/21/2018	5/29/2018	327	<0.3	14±1	<8
5/29/2018	6/4/2018	245	0.3±0.3	7±1	<10
6/4/2018	6/11/2018	269	<0.4	13±1	<9
6/11/2018	6/18/2018	277	0.5±0.2	15±1	<9
6/18/2018	6/26/2018	326	0.6±0.2	14±1	<8
6/26/2018	7/2/2018	247	0.5±0.2	19±1	<10
7/2/2018	7/9/2018	264	0.9±0.3	16±1	<9
7/9/2018	7/17/2018	329	1±0.3	22±1	<8
7/17/2018	7/23/2018	244	0.7±0.3	11±1	<10
7/23/2018	7/30/2018	285	<0.4	13±1	<9
7/30/2018	8/6/2018	285	0.6±0.3	16±1	<9
8/6/2018	8/13/2018	287	1.4±0.3	22±1	<9
8/13/2018	8/20/2018	286	1.1±0.2	21±1	<9
8/20/2018	8/27/2018	286	0.6±0.3	15±1	<9
8/27/2018	9/4/2018	326	1.5±0.3	22±1	<8
9/4/2018	9/10/2018	244	0.8±0.4	16±1	<8
9/10/2018	9/17/2018	259	0.3±0.3	8±1	<9
9/17/2018	9/24/2018	286	0.6±0.3	14±1	<9
9/24/2018	10/1/2018	284	0.5±0.3	16±1	<9
10/1/2018	10/9/2018	327	1.4±0.2	25±1	<9
10/9/2018	10/15/2018	243	0.5±0.2	11±1	<11
10/15/2018	10/23/2018	330	1±0.3	18±1	<7
10/23/2018	10/28/2018	210	0.5±0.4	9±1	<11

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m³)	Gross Alpha	Gross Beta	I-131
Peach Bottom Dempsey Farm Station (Continued)					
10/28/2018	11/5/2018	311	0.8±0.3	17±1	<7
11/5/2018	11/13/2018	334	1.4±0.2	15±1	<9
11/13/2018	11/18/2018	215	1.5±0.3	21±1	<15
11/18/2018	11/25/2018	292	0.7±0.2	23±1	<9
11/25/2018	12/3/2018	301	0.4±0.3	15±1	<6
12/3/2018	12/10/2018	309	1.2±0.2	17±1	<8
12/10/2018	12/16/2018	245	0.7±0.4	29±1	<9
12/16/2018	12/23/2018	282	0.9±0.2	18±1	<9
12/23/2018	12/30/2018	280	1.2±0.2	23±1	<10
	2018 Average		**0.8±0.8**	**17±10**	**--**
12/30/2018	1/7/2019	323	1.3±0.2	19±1	<8
1/7/2019	1/14/2019	284	1±0.2	15±1	<8
1/14/2019	1/22/2019	326	<0.3	20±1	<7
1/22/2019	1/28/2019	244	1.1±0.3	18±1	<13
1/28/2019	2/4/2019	286	1.4±0.3	26±1	<8
2/4/2019	2/12/2019	326	1.3±0.3	18±1	<7
2/12/2019	2/19/2019	284	0.9±0.3	19±1	<8
2/19/2019	2/25/2019	245	4±0.4	23±1	<30
2/25/2019	3/4/2019	285	2.7±0.3	19±1	<8
3/4/2019	3/11/2019	286	3.8±0.3	22±1	<8
3/11/2019	3/18/2019	281	4.2±0.3	26±1	<7
3/18/2019	3/25/2019	288	0.9±0.3	15±1	<8
3/25/2019	4/1/2019	287	<0.4	9±1	<8
4/1/2019	4/8/2019	285	0.5±0.4	19±1	<7
4/8/2019	4/15/2019	286	0.8±0.3	11±1	<9
4/15/2019	4/22/2019	284	0.7±0.2	13±1	<7
4/22/2019	5/1/2019	370	1±0.2	12±1	<6
5/1/2019	5/6/2019	201	<0.4	12±1	<10
5/6/2019	5/13/2019	285	<0.3	3±1	<7
5/13/2019	5/20/2019	285	0.4±0.3	18±1	<7
5/20/2019	5/28/2019	330	<0.3	9±1	<7
5/28/2019	6/3/2019	243	0.6±0.4	16±1	<9
6/3/2019	6/10/2019	284	0.3±0.3	14±1	<10
6/10/2019	6/16/2019	243	0.5±0.3	11±1	<13
6/16/2019	6/23/2019	304	0.9±0.2	13±1	<13
6/23/2019	6/30/2019	268	0.6±0.2	20±1	<10
6/30/2019	7/7/2019	284	0.8±0.2	19±1	<8
7/7/2019	7/15/2019	330	0.8±0.2	14±1	<6
7/15/2019	7/21/2019	257	0.6±0.3	17±1	<11
7/21/2019	7/28/2019	280	0.9±0.3	15±1	<9
7/28/2019	8/6/2019	357	1.1±0.2	26±1	<7
8/6/2019	8/12/2019	249	1.2±0.4	19±1	<11
8/12/2019	8/19/2019	293	1.8±0.2	31±1	<14
8/19/2019	8/26/2019	278	1.1±0.3	16±1	<9
8/26/2019	9/3/2019	322	0.5±0.3	17±1	<12

Note: Concentrations in fCi/m³ ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-6. (Continued)

Sample Date Start	End	Volume (m^3)	Gross Alpha	Gross Beta	I-131
Peach Bottom Dempsey Farm Station (Continued)					
9/3/2019	9/9/2019	246	1.2±0.2	22±1	<12
9/9/2019	9/16/2019	297	0.6±0.3	23±1	<7
9/16/2019	9/23/2019	286	1±0.2	23±1	<9
9/23/2019	9/30/2019	283	0.8±0.2	19±1	<9
9/30/2019	10/7/2019	286	0.5±0.3	16±1	<9
10/7/2019	10/14/2019	284	1.5±0.2	21±1	<9
10/14/2019	10/21/2019	286	0.8±0.3	18±1	<10
10/21/2019	10/28/2019	288	0.7±0.3	16±1	<9
10/28/2019	11/4/2019	283	0.7±0.3	14±1	<8
11/4/2019	11/11/2019	275	0.3±0.4	21±1	<8
11/11/2019	11/18/2019	279	0.9±0.3	21±1	<8
11/18/2019	11/25/2019	307	1.3±0.2	24±1	<8
11/25/2019	12/2/2019	264	0.6±0.2	14±1	<8
12/2/2019	12/9/2019	295	0.5±0.3	15±1	<8
12/9/2019	12/16/2019	286	0.5±0.3	17±1	<9
12/16/2019	12/22/2019	244	0.5±0.3	15±1	<14
12/22/2019	12/29/2019	287	1.1±0.2	32±1	<10
12/22/2019	12/29/2019	287	1.1±0.2	32±1	<10
	2019 Average		**1±1.8**	**18±11**	**--**
	Overall		**0.9±0.3**	**17±2**	**--**

Note: Concentrations in fCi/m^3 ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-7. Radionuclide concentrations in monthly composite air particulate, 2018 and 2019

Sample Date Start	End	Volume (m^3)	Be-7	Cs-137
	Calvert Cliffs Long Beach Station			
1/2/2018	1/30/2018	1144	90±10	<1
1/30/2018	2/27/2018	1141	90±10	<1
2/27/2018	3/27/2018	1139	90±20	<2
3/27/2018	5/1/2018	1427	130±10	<1
5/1/2018	5/30/2018	1182	90±10	<1
5/30/2018	6/27/2018	1145	90±10	<1
6/27/2018	7/31/2018	1383	150±20	<1
7/31/2018	8/27/2018	1142	120±20	<1
8/27/2018	10/2/2018	1427	80±10	<1
10/2/2018	10/30/2018	1142	70±10	<1
10/30/2018	11/27/2018	1142	61±10	<1
11/27/2018	1/2/2019	1485	50±8	<1
	2018 Average		**93±57**	**--**
1/2/2019	1/29/2019	1101	80±10	<1
1/29/2019	2/19/2019	857	90±20	<1
2/19/2019	3/26/2019	1426	80±10	<1
3/26/2019	4/30/2019	1433	110±10	<1
4/30/2019	5/29/2019	1183	80±10	<1
5/29/2019	6/26/2019	1162	80±10	<1
6/26/2019	7/30/2019	1362	80±10	<1
7/30/2019	8/27/2019	1134	80±10	<1
8/27/2019	9/24/2019	1144	90±10	<1
9/24/2019	10/29/2019	1140	90±10	<1
10/29/2019	11/26/2019	1140	90±10	<1
11/26/2019	12/17/2019	1151	63±10	<2
	2019 Average		**84±22**	**--**
	Overall		**89±12**	**--**
	Calvert Cliffs Lusby Station			
1/2/2018	1/30/2018	1141	110±20	<1
1/30/2018	2/27/2018	1141	90±10	<1
2/27/2018	3/27/2018	1141	90±10	<1
3/27/2018	5/1/2018	1427	130±20	<1
5/1/2018	5/30/2018	1183	120±10	<1
5/30/2018	6/27/2018	1145	120±20	<2
6/27/2018	7/31/2018	1383	130±10	<1
7/31/2018	8/28/2018	1143	130±20	<1
8/28/2018	10/2/2018	1426	70±9	<1
10/2/2018	10/30/2018	1143	70±10	<2
10/30/2018	11/27/2018	1141	55±11	<1
11/27/2018	1/2/2019	1389	40±6	<1
	2018 Average		**96±63**	**--**

Note: Concentrations in fCi/m^3 ± 2 Standard deviations.

Table C-7. (Continued)

Sample Date Start	End	Volume (m³)	Be-7	Cs-137
Calvert Cliffs Lusby Station (Continued)				
1/2/2019	1/29/2019	1100	90±10	<1
1/29/2019	2/19/2019	857	70±20	<1
2/19/2019	3/26/2019	1424	100±10	<1
3/26/2019	4/30/2019	1431	100±10	<1
4/30/2019	5/29/2019	1182	80±10	<1
5/29/2019	6/26/2019	1161	90±10	<1
6/26/2019	7/30/2019	1670	60±10	<1
7/30/2019	8/27/2019	1134	90±10	<1
8/27/2019	9/24/2019	1144	70±10	<1
9/24/2019	10/29/2019	1140	80±10	<2
10/29/2019	11/26/2019	1140	70±10	<2
11/26/2019	12/17/2019	1150	58±9	<2
	2019 Average		**80±29**	**--**
	Overall		**88±23**	**--**
Calvert Cliffs Cove Point Station				
1/2/2018	1/30/2018	1141	120±10	<1
1/30/2018	2/27/2018	1142	80±10	<1
2/27/2018	3/27/2018	1139	100±10	<1
3/27/2018	5/1/2018	1427	140±10	<1
5/1/2018	5/30/2018	1183	110±10	<1
5/30/2018	6/27/2018	1144	110±10	<1
6/27/2018	7/31/2018	1384	100±10	<1
7/31/2018	8/28/2018	1143	140±10	<1
8/28/2018	10/2/2018	1427	80±7	<1
10/2/2018	10/30/2018	1141	60±6	<1
10/30/2018	11/27/2018	861	45±7	<1
11/27/2018	1/2/2019	1465	70±6	<1
	2018 Average		**96±60**	**--**
1/2/2019	1/29/2019	1101	100±10	<1
1/29/2019	2/19/2019	857	80±10	<1
2/19/2019	3/26/2019	1426	110±10	<1
3/26/2019	4/30/2019	1431	100±10	<1
4/30/2019	5/29/2019	1183	90±10	<1
5/29/2019	6/26/2019	1179	90±10	<1
6/26/2019	7/30/2019	1670	70±10	<1
7/30/2019	8/27/2019	1134	70±10	<1
8/27/2019	9/24/2019	1144	80±10	<1
9/24/2019	10/29/2019	1222	80±10	<1
10/29/2019	11/26/2019	1140	70±10	<1
11/26/2019	12/17/2019	1151	60±10	<2
	2019 Average		**83±30**	**--**
	Overall		**90±18**	**--**

Note: Concentrations in fCi/m³ ± 2 Standard deviations.

Table C-7. (Continued)

Sample Date Start	End	Volume (m³)	Be-7	Cs-137
		Calvert Cliffs Horn Point Station		
12/31/2017	1/29/2018	1180	100±10	<1
1/29/2018	2/26/2018	1141	80±10	<1
2/26/2018	3/26/2018	1140	70±10	<1
3/26/2018	4/30/2018	1429	110±10	<1
4/30/2018	5/29/2018	1183	100±20	<2
5/29/2018	6/26/2018	1232	70±20	<2
6/26/2018	7/30/2018	1388	110±20	<2
7/30/2018	8/27/2018	1143	120±20	<1
8/27/2018	10/1/2018	1427	70±10	<1
10/1/2018	10/28/2018	1114	80±10	<1
10/28/2018	11/25/2018	1153	61±9	<1
11/25/2018	12/31/2018	1418	60±9	<1
	2018 Average		**86±42**	**--**
1/2/2019	1/29/2019	1168	90±10	<1
1/29/2019	2/19/2019	898	80±20	<1
2/19/2019	3/25/2019	1386	110±10	<1
3/25/2019	5/1/2019	1512	100±10	<1
5/1/2019	5/28/2019	1100	70±10	<1
5/28/2019	6/23/2019	1073	90±10	<1
6/23/2019	7/28/2019	1415	70±10	<1
7/28/2019	8/26/2019	1186	80±10	<1
8/26/2019	9/24/2019	1144	70±10	<1
9/24/2019	10/28/2019	1140	90±10	<1
10/28/2019	11/25/2019	1140	80±10	<2
11/25/2019	12/16/2019	1150	67±9	<1
	2019 Average		**83±27**	**--**
	Overall		**85±4**	**--**
		Baltimore City Station		
1/2/2018	1/30/2018	1141	120±10	<1
1/30/2018	2/27/2018	1142	100±10	<1
2/27/2018	3/27/2018	1141	100±10	<1
3/27/2018	5/1/2018	1429	140±10	<1
5/1/2018	5/30/2018	1181	120±10	<1
5/30/2018	6/27/2018	1144	110±10	<1
6/27/2018	7/31/2018	1383	140±10	<1
7/31/2018	8/28/2018	1144	110±10	<1
8/28/2018	10/2/2018	1428	70±7	<1
10/2/2018	10/30/2018	1141	60±7	<1
10/30/2018	11/27/2018	1642	61±7	<1
11/27/2018	1/2/2019	1468	50±5	<1
	2018 Average		**98±62**	**--**

Note: Concentrations in fCi/m³ ± 2 Standard deviations.

Table C-7. (Continued)

Sample Date Start	End	Volume (m³)	Be-7	Cs-137
		Baltimore City Station (Continued)		
1/2/2019	1/29/2019	1138	80±10	<1
1/29/2019	2/19/2019	819	70±10	<1
2/19/2019	3/26/2019	1427	90±10	<1
3/26/2019	4/30/2019	1423	100±10	<1
4/30/2019	5/29/2019	1184	90±10	<1
5/29/2019	6/26/2019	1105	99±13	<1
6/26/2019	7/30/2019	1345	80±10	<1
7/30/2019	8/27/2019	1097	70±10	<1
8/27/2019	9/24/2019	1144	80±10	<1
9/24/2019	10/29/2019	1189	80±10	<1
10/29/2019	11/26/2019	1140	70±10	<1
11/26/2019	12/17/2019	1151	45±12	<2
	2019 Average		**80±30**	**--**
	Overall		**89±27**	**--**
		Peach Bottom Rising Sun Station		
12/31/2017	1/29/2018	1180	110±10	<1
1/29/2018	2/26/2018	1152	100±10	<1
2/26/2018	3/26/2018	1140	80±10	<1
3/26/2018	4/30/2018	1428	120±20	<1
4/30/2018	5/29/2018	1184	120±20	<1
5/29/2018	6/26/2018	1142	110±20	<1
6/26/2018	7/30/2018	1389	130±20	<1
7/30/2018	8/27/2018	1146	130±20	<1
8/27/2018	10/1/2018	1424	80±10	<1
10/1/2018	10/28/2018	1105	80±10	<1
10/28/2018	11/25/2018	1152	68±11	<1
11/25/2018	1/2/2019	1419	60±10	<1
	2018 Average		**99±49**	**--**
1/2/2019	1/29/2019	1174	110±10	<1
1/29/2019	2/19/2019	899	90±20	<1
2/19/2019	3/25/2019	1382	120±10	<1
3/25/2019	5/1/2019	1513	100±10	<1
5/1/2019	5/28/2019	1100	65±10	<1
5/28/2019	6/23/2019	1073	90±10	<1
6/23/2019	7/28/2019	1409	80±10	<1
7/28/2019	8/26/2019	1186	70±10	<1
8/26/2019	9/24/2019	1144	70±10	<1
9/24/2019	10/28/2019	1142	80±10	<1
10/28/2019	11/25/2019	1140	80±10	<1
11/25/2019	12/16/2019	1142	61±10	<2
	2019 Average		**85±36**	**--**
	Overall		**92±20**	**--**

Note: Concentrations in fCi/m³ ± 2 Standard deviations.

Table C-7. (Continued)

Sample Date Start	End	Volume (m³)	Be-7	Cs-137
Peach Bottom Whiteford Station				
12/31/2017	1/29/2018	1179	100±20	<1
1/29/2018	2/26/2018	1091	110±20	<2
2/26/2018	3/26/2018	1140	100±10	<1
3/26/2018	4/30/2018	1428	140±20	<1
4/30/2018	5/29/2018	1184	150±20	<1
5/29/2018	6/26/2018	1140	120±20	<1
6/26/2018	7/30/2018	1389	150±20	<1
7/30/2018	8/27/2018	1144	130±20	<1
8/27/2018	10/1/2018	1139	70±10	<1
10/1/2018	10/28/2018	1103	90±10	<2
10/28/2018	11/25/2018	1153	63±14	<2
11/25/2018	1/2/2019	1417	70±10	<1
	2018 Average		**108±62**	**--**
1/2/2019	1/29/2019	1179	90±10	<1
1/29/2019	2/19/2019	898	100±20	<1
2/19/2019	3/25/2019	1349	130±10	<1
3/25/2019	5/1/2019	1513	100±10	<1
5/1/2019	5/28/2019	1100	97±10	<1
5/28/2019	6/23/2019	1073	90±10	<1
6/23/2019	7/28/2019	1407	70±10	<1
7/28/2019	8/26/2019	1186	80±10	<1
8/26/2019	9/24/2019	1144	90±10	<1
9/24/2019	10/28/2019	1142	70±10	<1
10/28/2019	11/25/2019	1140	70±10	<2
11/25/2019	12/16/2019	1150	67±12	<2
	2019 Average		**88±36**	**--**
	Overall		**98±28**	**--**
Peach Bottom Dempsey Farm Station				
12/31/2017	1/29/2018	1180	110±20	<1
1/29/2018	2/26/2018	1143	90±10	<1
2/26/2018	3/26/2018	1135	80±10	<1
3/26/2018	4/30/2018	1428	130±20	<1
4/30/2018	5/29/2018	1183	130±20	<1
5/29/2018	6/26/2018	1117	100±20	<1
6/26/2018	7/30/2018	1369	130±10	<1
7/30/2018	8/27/2018	1143	120±20	<2
8/27/2018	10/1/2018	1398	70±10	<1
10/1/2018	10/28/2018	1110	80±10	<1
10/28/2018	11/25/2018	1152	63±12	<1
11/25/2018	1/2/2019	1417	70±10	<1
	2018 Average		**98±51**	**--**

Note: Concentrations in fCi/m³ ± 2 Standard deviations.

Table C-7. (Continued)

Sample Date				
Start	**End**	**Volume (m^3)**	**Be-7**	**Cs-137**
Peach Bottom Dempsey Farm Station (Continued)				
1/2/2019	1/29/2019	1174	80±10	<1
1/29/2019	2/19/2019	896	90±20	<1
2/19/2019	3/25/2019	1398	120±10	<1
3/25/2019	5/1/2019	1512	90±10	<1
5/1/2019	5/28/2019	1101	70±10	<1
5/28/2019	6/23/2019	1073	90±10	<1
6/23/2019	7/28/2019	1416	80±10	<1
7/28/2019	8/26/2019	1186	70±10	<1
8/26/2019	9/24/2019	1144	70±10	<1
9/24/2019	10/28/2019	1143	80±10	<1
10/28/2019	11/25/2019	1140	70±10	<2
11/25/2019	12/16/2019	1141	58±11	<2
	2019 Average		**81±32**	**--**
	Overall		**89±24**	**--**

Note: Concentrations in fCi/m^3 ± 2 Standard deviations.

Table C-8. Radionuclide concentrations in potable water, 2018 and 2019

Sample Date	Gross Alpha	Gross Beta	Tritium
	Baltimore City Station (control)		
1/3/2018	<2	<4	<100
2/7/2018	<2	<4	<100
3/6/2018	<2	<4	<100
4/2/2018	<2	<4	<100
5/2018	n/a	n/a	n/a
6/2018	n/a	n/a	n/a
7/2018	n/a	n/a	n/a
8/13/2018	<2	<4	<100
9/5/2018	<2	<4	<100
10/22/2018	<2	<4	<100
11/13/2018	<2	8±2	<100
12/2018	n/a	n/a	n/a
2018 Average		**8±2**	
1/7/2019	<2	4±2	<100
2/7/2019	<2	<4	<100
3/2019	n/a	n/a	n/a
4/2019	n/a	n/a	n/a
5/14/2019	<2	<4	<100
6–12/2019	n/a	n/a	n/a
2019 Average		**4±2**	
Overall		**6±5**	
	Chesapeake Country Club Station		
2/27/2018	<2	4±2	<100
6/19/2018	<2	<4	<100
9/18/2018	<2	5±2	<100
12/4/2018	<2	5±2	<100
2018 Average	**--**	**5±1**	
3/19/2019	<2	9±2	<100
6/19/2019	<2	7±2	<100
9/24/2019	<2	6±2	<100
12/19/2019	<2	7±2	<100
2019 Average		**7±3**	
Overall		**6±4**	

Note: Concentrations in pCi/L ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-8. (Continued)

Sample Date	Gross Alpha	Gross Beta	Tritium
Calvert County Courthouse Station			
2/21/2018	<2	12±2	<100
6/19/2018	<2	<4	<100
9/18/2018	<2	13±2	<100
12/4/2018	<2	11±2	<100
2018 Average		**12±2**	
3/19/2019	<2	13±2	<100
6/19/2019	<2	12±2	<100
9/24/2019	<2	14±2	<100
12/19/2019	3±1	17±2	<100
2019 Average		**14±4**	
Overall		**13±3**	
Appeal Elementary School Station			
2/21/2018	<2	12±2	<100
6/19/2018	<2	11±2	<100
9/18/2018	<2	12±2	<100
12/4/2018	<2	13±2	<100
2018 Average		**12±2**	
3/19/2019	<2	13±2	<100
6/19/2019	<2	13±2	<100
9/24/2019	<2	14±2	<100
12/19/2019	2±1	12±2	<100
2019 Average	**2±1**	**13±2**	
Overall	**2±1**	**13±2**	
Calvert County Health Department Station			
2/21/2018	<2	<4	<100
6/19/2018	<2	<4	<100
9/18/2018	<2	6±2	<100
12/4/2018	<2	<4	<100
2018 Average		**6±2**	
3/19/2019	<2	<4	<100
6/19/2019	<2	<4	<100
9/24/2019	<2	3±2	<100
12/19/2019	<2	<4	<100
2019 Average		**3±2**	
Overall		**5±5**	

Note: Concentrations in pCi/L ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-8. (Continued)

Sample Date	Gross Alpha	Gross Beta	Tritium
Southern Middle School Station			
2/21/2018	<2	9±2	<100
6/19/2018	<2	8±2	<100
9/18/2018	<2	11±2	<100
12/4/2018	<2	9±2	<100
2018 Average		**9±2**	
3/19/2019	<2	10±2	<100
6/19/2019	<2	8±2	<100
9/24/2019	4±2	11±2	<100
12/19/2019	<2	11±2	<100
2019 Average	**4±2**	**10±3**	
Overall	**4±2**	**10±1**	
Frying Pan Restaurant Station			
2/21/2018	<2	13±2	<100
6/19/2018	<2	13±2	<100
9/18/2018	<2	13±2	<100
12/4/2018	<2	12±2	<100
2018 Average		**13±1**	
3/19/2019	<2	12±2	<100
6/19/2019	<2	11±2	<100
9/24/2019	<2	12±2	<100
12/19/2019	<2	12±2	<100
2019 Average		**12±1**	
Overall		**12±1**	
Calvert Cliffs Volunteer Fire Department Station			
2/21/2018	<2	14±2	<100
6/19/2018	<2	12±2	<100
9/18/2018	<2	13±2	<100
12/4/2018	<2	16±2	<100
2018 Average		**14±3**	
3/19/2019	<2	14±2	<100
6/19/2019	<2	15±2	<100
9/24/2019	<2	14±2	<100
12/19/2019	2±1	20±3	<100
2019 Average	**2±1**	**16±6**	
Overall	**2±1**	**15±3**	

Note: Concentrations in pCi/L ± 2 Standard deviations. n/a = not applicable or not collected.

Table C-9. Radionuclide concentrations in precipitation, 2018 and 2019

Sample Date	Depth (in.)	Gross Alpha	Gross Beta	Tritium	Be-7
		Baltimore City Station			
1/19/2018	0.57	3.4±0.5	6±0.6	<100	<26
2/6/2018	1.23	<2	<4	<100	70±20
2/13/2018	2.12	<2	<4	<100	20±17
2/21/2018	1.06	<2	<4	<100	<30
2/27/2018	0.99	<2	<4	<100	40±20
3/6/2018	0.73	<2	<4	<100	20±10
3/27/2018	2.30	<2	<4	<100	40±20
5/1/2018	1.84	<2	<4	<100	30±10
5/15/2018	1.30	<2	4.9±0.5	<100	30±10
5/22/2018	4.28	<2	<4	<100	50±20
5/30/2018	3.26	<2	<4	<100	20±20
6/5/2018	1.48	<2	<4	<100	60±20
6/12/2018	1.74	<2	<4	<100	30±10
7/18/2018	0.80	2.5±0.5	4.9±0.5	<100	40±10
7/24/2018	6.12	<2	<4	<100	30±20
8/7/2018	1.41	<2	<4	<100	40±20
8/14/2018	1.36	<2	<4	<100	60±10
8/28/2018	1.82	<2	<4	<100	10±10
9/5/2018	4.20	<2	<4	<100	30±20
9/11/2018	4.14	<2	<4	<100	30±20
9/18/2018	3.92	<2	<4	<100	20±10
9/25/2018	1.82	<2	<4	<100	40±20
10/2/2018	1.76	<2	<4	<100	35±10
10/16/2018	1.14	<2	<4	<100	20±10
10/30/2018	1.27	<2	<4	<100	9±8
11/7/2018	2.92	<2	<4	<100	50±30
11/14/2018	1.75	<2	<4	<100	<20
11/21/2018	1.51	<2	<4	<100	20±10
11/27/2018	2.03	<2	<4	<100	<20
12/4/2018	0.62	<2	<4	<100	<74
12/18/2018	3.15	<2	<4	<100	30±10
12/26/2018	1.62	<2	<4	<100	20±10
2018 average		**3±1.3**	**5.3±1.3**	**--**	**33±30**
1/2/2019	1.28	<2	<4	<100	44±8
1/15/2019	0.64	<2	<4	<100	30±10
3/5/2019	1.49	<2	±0.5	<100	30±10
3/26/2019	2.43	<2	<4	<100	40±20
4/17/2019	0.74	<2	<4	<100	40±20
4/30/2019	0.68	<2	<4	<100	30±20
5/7/2019	1.25	<2	<4	<100	<20
5/21/2019	3.19	<2	<4	<100	20±10
5/29/2019	0.45	3.4±0.5	5±0.6	<100	30±6
6/27/2019	0.56	3.8±0.6	4.5±0.5	<100	40±20
7/9/2019	2.38	0.9±0.3	2.3±0.4	<100	<30

Note: Concentrations in pCi/L ± 2 Standard deviations.

Table C-9. (Continued)

Sample Date	Depth (in.)	Gross Alpha	Gross Beta	Tritium	Be-7
7/23/2019	1.68	2.1±0.4	2.9±0.4	<100	20±6
8/6/2019	0.52	3.3±0.5	3.5±0.5	<100	40±10
8/21/2019	0.42	2.2±0.4	3.6±0.5	<100	30±10
8/27/2019	1.86	1±0.3	2.6±0.4	<100	30±10
10/29/2019	1.92	0.8±0.3	1.5±0.4	<100	<30
12/3/2019	0.76	<2	2.7±0.4	<100	<30
12/10/2019	0.89	<2	<4	<100	30±10
2019 Average		**2.2±2.4**	**3.2±2.2**	**--**	**32±15**
Overall		**2.6±1.1**	**4.2±3**	**--**	**33±1**

Note: Concentrations in pCi/L ± 2 Standard deviations.

Table C-10. Radionuclide concentrations in processed and raw milk, 2018 and 2019

Sample Date	I-131	Ba-140	Cs-137	Sr-90	Sr-89
Maryland Composite Processed Milk					
3/9/2018	<5	<4	<3	<2	<10
6/11/2018	<3	<3	<3	<2	<10
9/13/2018	<3	<3	<3	<2	<10
12/7/2018	<6	<4	<3	<2	<10
2018 Average	--	--	--	--	--
4/22/2019	<3	<3	<3	<2	<10
7/31/2019	<3	<4	<3	<2	<10
12/12/2019	<4	<4	<4.4	<0.8	0.5±0.5
2019 Average	--	--	--	--	**0.5±0.5**
Overall	--	--	--	--	**0.5±0.5**
Peach Bottom Kilby Farm Raw Milk					
3/5/2018	<9	<6	<4	<2	<10
6/4/2018	<3	<3	<3	<2	<10
9/10/2018	<3	<3	<3	<2	<10
12/3/2018	<9	<19	<3	<2	<10
2018 Average	--	--	--	--	--
4/11/2019	<5	<5	<4	<2	<10
7/15/2019	<3	<3	<3	<2	<10
10/21/2019	<3	<12	<3	0.2±0.4	1.1±0.7
2019 Average	--	--	--	**0.2±0.4**	**1.1±0.7**
Overall	--	--	--	**0.2±0.4**	**1.1±0.7**

Note: Concentrations in pCi/L ± 2 Standard deviations.