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PPRP

Environmental Radionuclide Concentrations in the Vicinity of the Calvert Cliffs Nuclear Power Plant and the Peach Bottom Atomic Power Station: 2016-2017

December 2019

MARYLAND POWER PLANT RESEARCH PROGRAM

LARRY HOGAN, GOVERNOR
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The Maryland Department of Natural Resources seeks to preserve, protect and enhance the living resources of the state. Working in partnership with the citizens of Maryland, this worthwhile goal will become a reality. This publication provides information that will increase your understanding of how the department strives to reach that goal through its many diverse programs.

Jeannie Haddaway-Riccio, *Secretary*
Maryland Department of Natural Resources

Environmental Radionuclide Concentrations in the Vicinity of the Calvert Cliffs Nuclear Power Plant and the Peach Bottom Atomic Power Station: 2016-2017

PREPARED FOR:

POWER PLANT RESEARCH PROGRAM
MARYLAND DEPARTMENT OF NATURAL RESOURCES

PREPARED BY:

VERSAR, INC.

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FOREWORD

This report, *Environmental Radionuclide Concentrations in the Vicinity of the Calvert Cliffs Nuclear Power Plant and The Peach Bottom Atomic Power Station: 2016-2017*, contains the results of monitoring and research conducted by the Maryland Department of Natural Resources, Power Plant Research Program (PPRP), to evaluate the fate and effects of radionuclides released from the Calvert Cliffs Nuclear Power Plant and the Peach Bottom Atomic Power Station in 2016 and 2017. This is the 23rd in a series of radiological assessment reports detailing PPRP's monitoring efforts since 1975. This report was prepared under Contract Number K00B8400006 between the Maryland Department of Natural Resources, Power Plant Research Program, and Versar, Inc.

The authors thank Captain Rick Younger of the R/V Kerhin (Maryland Geological Survey) for assistance with collecting sediments 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 thank Martin Berlett, Kathy Dillow, Brent Hood, David Wong, Charles Tonkin, Michael Stephens, Colby Hause, and Neal Eshleman (Versar, Inc.) for collecting samples of sediment and biota, and Capt. Rick Younger and first mate Keith Lindemann (Maryland DNR) for vessel support. Brent Hood, Estuardo Monterroso, Magdelyn Glaudemans, Pooja Potti, Daniel Spradlin, István Turcsányi, and Charles Tonkin collected samples of air, water, and milk. We thank Exelon Generation Company for providing radionuclide release data for the Calvert Cliffs Nuclear Power Plant and for the Peach Bottom Atomic Power Station.

Brent Hood and István Turcsányi of the PPRP Radioecology Laboratory provided assistance with preparing samples, analyzing sediment particle size, and preparing tables and graphics from accumulated radiological data. The Radiation Chemistry Laboratory of the Maryland Department of Health and Mental Hygiene (DHMH) provided assistance with analyzing samples of air, water, and milk. Roberto J. Llansó (Versar's Coastal and Estuarine Scientist) contributed to report preparation, and Danielle Zaveta provided assistance with calculating results and managing the long-term database. Amanda Bromilow, István Turcsányi, and Brent Hood assisted with analytical data compilation. Karen Gontarek supervised the production of this report.

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ABSTRACT

The Maryland Power Plant Research Program monitors concentrations of radionuclides from natural sources, weapon-related sources, and power plants in samples collected from the vicinity of the Calvert Cliffs Nuclear Power Plant (CCNPP) and from the vicinity of Peach Bottom Atomic Power Station (PBAPS). The purpose of this monitoring is to evaluate the consequences of nuclear power generation for the environment and human health by determining the fate, transport, and potential effects of radionuclides released from these power plants. This report describes monitoring activities and data collected during the 2016 and 2017 calendar years, and is the 23rd in a series that documents results of monitoring studies conducted at CCNPP since 1975 and at PBAPS since 1979.

The concentrations of radionuclides in shellfish, finfish, aquatic vegetation, sediment, air, water, and milk were measured using high-resolution gamma spectrometry, liquid scintillation spectrometry, and proportional counting. Radionuclides in environmental samples originated from natural sources, historic atmospheric testing of weapons, and normal operations of CCNPP and PBAPS. 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 were typically orders of magnitude greater than those of radionuclides released from power plants. Cesium-137 was the only radionuclide associated with the fallout from weapons testing detected in environmental samples collected in 2016 and 2017.

Small concentrations (when compared to naturally occurring concentrations) of radionuclides originating from CCNPP and PBAPS were detected in many samples of sediment collected from the vicinity of the plants. The principal power plant-related radionuclide was an isotope of cobalt (^{60}Co) detected in sediments at PBAPS, but not at CCNPP. Radionuclides attributable to CCNPP and PBAPS represented a small fraction (i.e., less than 0.1% to 0.3% in CCNPP and PBAPS sediment) of the total radionuclides detected in the sediments and biota collected near CCNPP and PBAPS. The estimated dose of radiation that biota near power plants could deliver to humans did not exceed any of the U.S. Nuclear Regulatory Commission's action levels.

The concentrations of radionuclides found in sediments and biota during this monitoring period do not represent a risk to the ecological health of Chesapeake Bay or Susquehanna River. The concentrations of radionuclides in sediments and biota would increase the radiological dose to humans by no more than 0.0007% above the dose received from natural and other man-made sources. The incremental contribution of radioactivity and the corresponding dose of radiation attributable to the operation of CCNPP and PBAPS are minimal when compared with natural levels of radioactivity and the associated natural dose of radiation.

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ACRONYMS, CHEMICAL ABBREVIATIONS, AND UNITS OF MEASUREMENT

ACRONYMS

BGE	-	Baltimore Gas and Electric Company
BWR	-	Boiling water reactor
CCNPP	-	Calvert Cliffs Nuclear Power Plant
DHMH	-	Maryland Department of Health and Mental Hygiene
DNR	-	Maryland Department of Natural Resources
LLD	-	Lower limit of detection
MDE	-	Maryland Department of the Environment
NIST	-	National Institute of Science of Technology
PBAPS	-	Peach Bottom Atomic Power Station
PECO	-	Philadelphia Electric Company
PPRP	-	Power Plant Research Program
PWR	-	Pressurized water reactor
USAEC	-	United States Atomic Energy Commission
USEPA	-	United States Environmental Protection Agency
USGS	-	United States Geological Survey
USNRC	-	United States Nuclear Regulatory Commission
WSSC	-	Washington Suburban Sanitary Commission

CHEMICALS

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

UNITS OF MEASUREMENT

Ci	curies
cc	cubic centimeters
cm	centimeters
dpm	disintegrations per minute
fCi	femtocuries (10^{-15} Ci)
ft^3/s	cubic feet per second
GWe-yr	gigawatt-year
ha	hectares
keV	thousand electron volts
kg	kilograms (10^3 g)
km	kilometers
L	liters
m	meters
m^3	cubic meters
m^3/s	cubic meters per second
mCi	millicuries (10^{-3} Ci)
mGy/h	milligray per hour
mi^2	square miles
min	minutes
mm	millimeters
mrad/h	millirad per hour
mrem	millirem
MW	megawatts (10^6 W)
nCi	nanocuries (10^{-9} Ci)
pCi	picocuries (10^{-12} Ci)
ppm	parts per million
psu	practical salinity units
TBq	terabecqurel (27.027 Ci)
μCi	microcuries (10^{-6} Ci)
μm	micrometers
yr	years

RADIOLOGICAL DEFINITIONS

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

Becquerel. A SI-derived unit of radioactivity. One becquerel is defined as one disintegration per second.

Curie (Ci). A unit of radioactivity. One curie is defined as 3.7×10^{10} disintegrations per second.

Dose. The energy imparted to matter by ionizing radiation. The unit of absorbed dose is the rad, equal to 0.01 joules per kilogram for irradiated material in any medium.

Dose commitment. The dose that an organ or tissue would receive during a specified period of time (i.e., a 50-year period is used in dose calculations in this report) as a result of intake (by ingestion or inhalation) of one or more radionuclides from one year's release.

Environmentally significant. As used in this report, refers to radionuclides that are known to be assimilated by biological organisms and are discharged in detectable amounts. Aqueous releases of noble gases, tritium, and very short-lived radionuclides are not included because they are not bioaccumulated or decay rapidly to stable forms.

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

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.

Radioactive decay. The spontaneous transformation of one nuclide into a different radioactive or nonradioactive nuclide, or into a different energy state of the same nuclide.

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. The effective dose equivalent (i.e., the absorbed dose in rads multiplied by the quality factor associated with the type of radiation).

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

1.0 INTRODUCTION

The Calvert Cliffs Nuclear Power Plant (CCNPP) and the Peach Bottom Atomic Power Station (PBAPS) generate gaseous and liquid radioactive wastes that are discharged into the atmosphere, Chesapeake Bay, and lower Susquehanna River. Although atmospheric releases consist mainly of radioactive noble gases, which have little environmental significance, aqueous discharges to Chesapeake Bay and lower Susquehanna River may contain radionuclides that can become associated with sediments and can be accumulated by biota. Ultimately, these radionuclides may contribute to a radiation dose to humans by being transported through the food chain.

This report examines and summarizes the results of monitoring and assessment programs conducted in the vicinity of CCNPP, the vicinity of PBAPS, lower Susquehanna River, and upper Chesapeake Bay in 2016 and 2017 by the Maryland Department of Natural Resources (DNR), Power Plant Research Program (PPRP). The report includes:

- 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 384 samples of aquatic vegetation, shellfish, finfish, and sediment collected from lower Susquehanna River and Chesapeake Bay;
- concentrations of radionuclides measured in 1,152 samples of air, precipitation, water, and milk collected from the vicinity of CCNPP and PBAPS; and
- an assessment of the environmental and health-related effects of radioactive discharges from CCNPP and PBAPS that were detected in Susquehanna River, Chesapeake Bay, and elsewhere in the vicinity of CCNPP and PBAPS.

1.1 MONITORING OBJECTIVES

PPRP has conducted research and monitoring to assess the effects of radioactive material released from CCNPP (since 1975) and PBAPS (since 1979) on Maryland's environmental resources. These programs primarily evaluate radiological effects within individual trophic levels of the ecosystems of the Chesapeake Bay and the Susquehanna River and provide information concerning the behavior and fate of radionuclides released to the Chesapeake Bay and the Susquehanna River. These monitoring data also are used to estimate the radiological dose to human populations resulting from the discharge of radionuclides from these power plants.

Additionally, PPRP is responsible for the continuous monitoring of air and periodic sampling of precipitation, processed milk, and drinking water from the vicinities of CCNPP and PBAPS to assess the public health effects of non-aqueous pathways to humans. Testing of air, water, and milk is performed by the DHMH Radiation Chemistry Laboratory, and the results of the monitoring are presented in this report.

1.1.1 Sediment

Sediment sampling is part of PPRP's long-term monitoring program to 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 a determination of their potential availability to the food web and potential dose to humans.

1.1.2 Tray Oysters

PPRP exposes oysters to discharges from CCNPP for a variety of predefined exposure periods to determine the mechanisms that regulate uptake and elimination (if not bioaccumulated) of radionuclides. 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 accumulated heavy metals and radionuclides (McLean et al. 1987).

Despite the decline in the commercial oyster fishery, oysters are still an important indicator of potential radionuclide uptake in humans. Testing and analysis of oysters suspended in water on trays provide data on the potential for a dose to humans. The estimated dose is used to verify that CCNPP is in compliance with dose limits as required by its license (see Section 3.3.2).

1.1.3 Finfish

Testing of finfish provides data on radionuclide uptake directly from the water column, which provides a measure of the potential effect of releases from PBAPS that is analogous to tray-oyster testing at CCNPP. Past measurements of radionuclides in the muscle and gut contents of finfish helped to identify the pathway of radionuclides through the food web. Currently, the estimated dose to humans reported in the biennial environmental assessments published by PPRP is used to verify that PBAPS is in compliance with dose limits as required by its license.

1.1.4 Submerged Aquatic Vegetation

Measuring the concentrations of radionuclides in samples of submerged aquatic vegetation (SAV) provides a determination of radionuclide uptake in these aquatic plants. In recent years SAV in the sampling areas absorbed detectable amounts of ^{131}I. That isotope probably originates from sources that are not related to power plants.

1.1.5 Air and Air Particulates

Air is sampled to monitor the potential effects of airborne radiation on public health. Air monitoring also serves as an "early warning" indicator of the presence in Maryland of radioactive particles or gases from sources other than CCNPP or PBAPS. Sample results could provide an estimate of potential effect over a wide geographic area if an airborne release of radiation occurs in Maryland or elsewhere.

1.1.6 Potable Water

Testing drinking water from surface sources and wells in Calvert County near CCNPP provides assurance that operations at CCNPP do not compromise drinking water standards. Although such sampling is not a required element of nuclear power plant monitoring, Washington Suburban Sanitary Commission (WSSC) submits samples of potable and raw water as part of routine quality testing of its drinking water product, which also includes testing for chemical contaminants and other water quality parameters. Baltimore City tap water (taken within the DHMH Radiation Chemistry Laboratory) serves as a control for radioactive content in drinking water.

1.1.7 Precipitation

Sampling rainfall provides information about radionuclide deposition through precipitation. Such sampling has been used as an indicator of radioactive fallout during active, above-ground nuclear weapons testing. Presently, rainfall sampling is an auxiliary indicator of airborne radiation originating from nuclear power generation.

1.1.8 Milk

Monitoring locally produced raw and processed milk focuses on one portion of the ingestion pathway for power plant-related radionuclide emissions. Airborne radioactivity may be deposited on pastures, be ingested by cows, and become part of cow's milk.

Prior to 2009, monitoring consisted of composite, processed milk only. In 2009, DNR initiated collection of samples of raw milk from locations near CCNPP and PBAPS.

1.2 DESCRIPTION OF PLANTS AND STUDY SITES

1.2.1 Calvert Cliffs Nuclear Power Plant

Exelon Generation Company owns and operates CCNPP and PBAPS. CCNPP is in Calvert County, Maryland, on the western shore of Chesapeake Bay. Each of CCNPP's two units is a pressurized water reactor (PWR) with a combined operating capacity of 1829 megawatts (PPRP 2013). 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 (10 CFR Part 20, Appendix B; USNRC 1991). CCNPP withdraws cooling water from Chesapeake Bay at a rate of approximately 2.3 million gallons per minute (PPRP 2013), which is approximately four times the withdrawal rate of PBAPS.

The western shore of Chesapeake Bay is scoured by tides, wind, and waves. The bay in this area is approximately 4.5 km wide and relatively shallow. Water depth gradually increases from 10 m to 15 m about 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 cm/sec and 60 cm/sec (Lacy and Zeger 1979). Salinity varies seasonally and normally ranges from 7 to 17 psu. 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* (USAEC 1973) and in Baltimore Gas and Electric'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 which dive in the vicinity of the power plant in search of food (Swarth and Llansó 2012).

1.2.2 Peach Bottom Atomic Power Station

PBAPS began operations in 1974. The plant is jointly owned by Exelon Generation and Public Service Electric and Gas of New Jersey. The plant is located in York County, Pennsylvania, approximately 5 km north of the Pennsylvania-Maryland border, on the western shore of Conowingo Pond. Each of PBAPS's two units is a boiling water reactor (BWR) 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 a period of 30 years) from the United States Nuclear Regulatory Commission (10 CFR Part 20, Appendix B; USNRC 1991).

PBAPS withdraws cooling water from the portion of Susquehanna River known as Conowingo Pond at an average rate of 625,000 gallons per minute (1393 ft^3/s or 39 m^3/s; PBAPS Communications Office 1997). 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 above the northern reach of Conowingo Pond. It has an average surface area of approximately 3,700 ha (14 mi^2) 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 dam is approximately 1,170 m^3/s (41,270 ft^3/s; USGS 2008). Downriver flow may be affected by 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 and salt water fluctuates at the river mouth (Susquehanna Flats) or 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-Chesapeake Bay system.

The Susquehanna-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 below 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

Environmental samples taken from the vicinity of CCNPP and PBAPS, and in control areas, for radiological analysis are summarized in Table 2-1.

2.1.1 Sediments

Sediments were collected periodically from the series of transects shown in Figures 2-1 and 2-2. Station coordinates are given in Appendix A. A hydraulic box-grab was used to collect sediments in the vicinity of CCNPP (quarterly), whereas a hand-operated Young grab was used to collect sediments at stations surrounding PBAPS (semi-annually). The top 10 cm (or less) of sediment were recovered from each grab, and grabs were repeated until approximately 3,000 cc of sediment were collected at each station.

2.1.2 Biota

For the tray-oyster study at CCNPP, mature oysters were placed into partitioned trays (Abbe 1981) and submerged for a variety of exposure periods. Trays were placed at an indicator site at CCNPP Outfall (38° 23.640, -76° 26.537). In addition, control trays were placed in St. Leonard Creek at Morgan State University Benedict Laboratory (38° 23.640, -76° 30.203; Figure 2-1). Prior to 2010, control trays were placed north of the CCNPP cooling-water outfall at Kenwood Beach (38° 30.0105, -76° 29.11066), but the control location was moved in December 2009 due to low dissolved oxygen, dermo, 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. Oysters from individual compartments (50 per group) were retrieved and restocked on a schedule designed to evaluate radionuclide concentrations in oysters exposed to CCNPP discharges for 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 (38° 23.43516, -76° 33.5025; Figure 2-1). Additionally, tray oysters were placed at Camp Conoy (38° 26.133, -76° 25.75) by CCNPP and were analyzed as split samples. The results of analysis of Camp Conoy tray oysters are also provided in this report for comparison purposes.

Biota for radiological analysis collected from the PBAPS study site included forage finfish, recreationally and commercially important finfish, and SAV. Edible and forage finfish were collected by electrofishing or by gill net (1-, 2-, and 4-inch experimental mesh) near the outfall of PBAPS (Figure 2-2). Samples of SAV (Eurasian watermilfoil, *Myriophyllum spicatum*) were collected by hand at the Susquehanna Flats Fishing Battery

Station (Figure 2-2). The Conowingo Pond and the Susquehanna River-Interstate 95 Bridge Station SR-3 did not contain SAV in 2016 or 2017.

Table 2-1. Environmental samples for radiological analysis collected in 2016-2017 from the vicinity of CCNPP and PBAPS.

Sample Medium	Collection Frequency	Number of Sampling Locations	Description of Sampling Locations
Sediment	Quarterly	28	Chesapeake Bay in the vicinity of CCNPP along eight transects (Fig. 2-1).
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	1	Susquehanna Flats at Fishing Battery (Fig. 2-2), Summer only. Conowingo Pond at Station Little Yellow House and Susquehanna River-Interstate 95 Bridge Station SR-3 did not contain SAV in 2016 or 2017.
Glass Fiber Filter (air particulates)	Continuously (exchanged weekly)	8	Long Beach, Lusby, and Cove Point (Calvert Co.) Baltimore City (Baltimore Co.) 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 roof of 301 West Preston St.
Processed Milk	Quarterly	1	Baltimore City
Raw Milk	Quarterly	1	Kilby Farm (Cecil Co.)

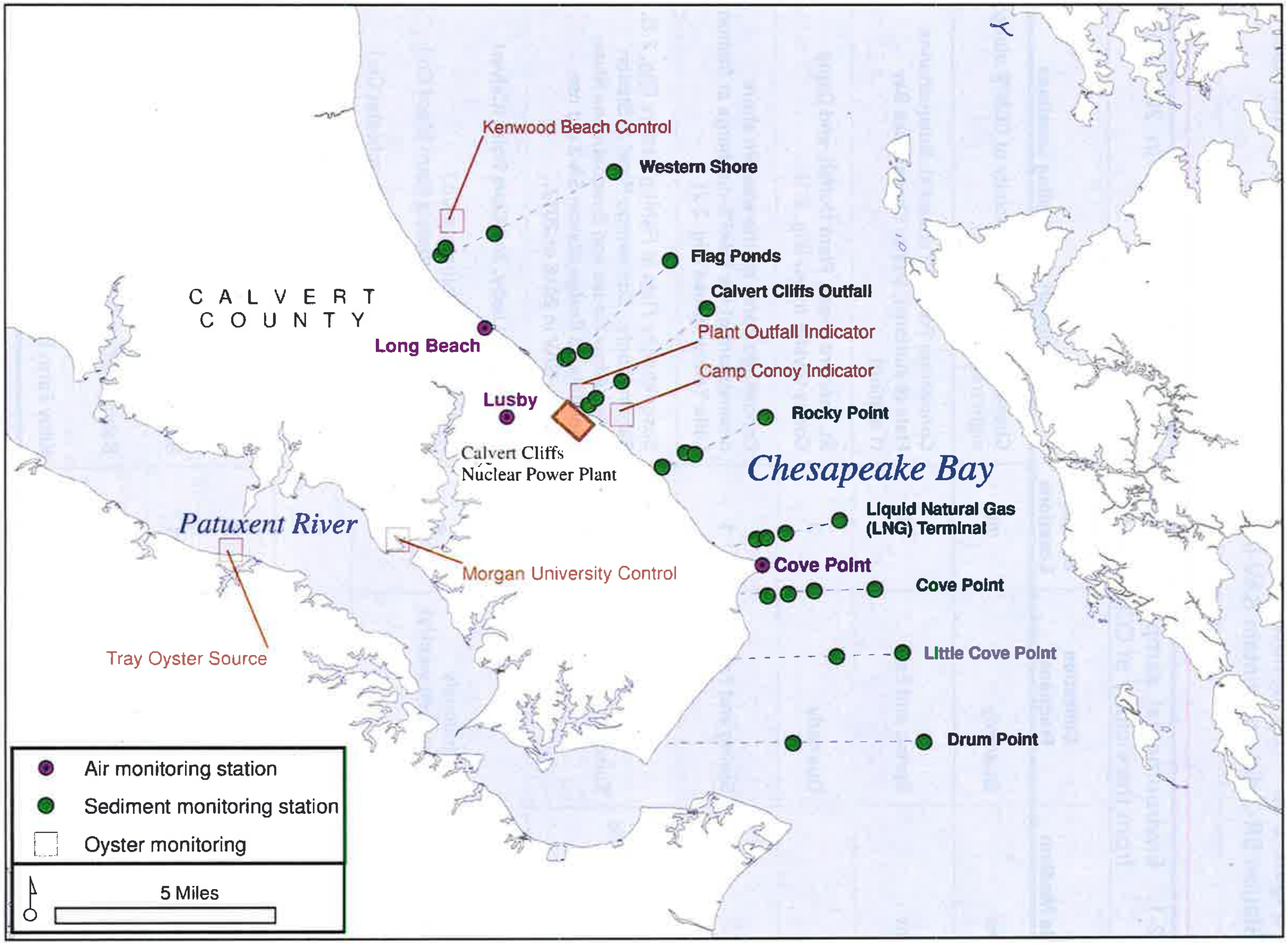


Figure 2-1. Transects and stations for samples collected from Chesapeake Bay Calvert Cliffs region. Appendix A contains a list of coordinates for the sediment monitoring stations. Previous (Kenwood Beach) and current location of control oyster trays (Morgan State University Benedict Laboratory) indicated in map

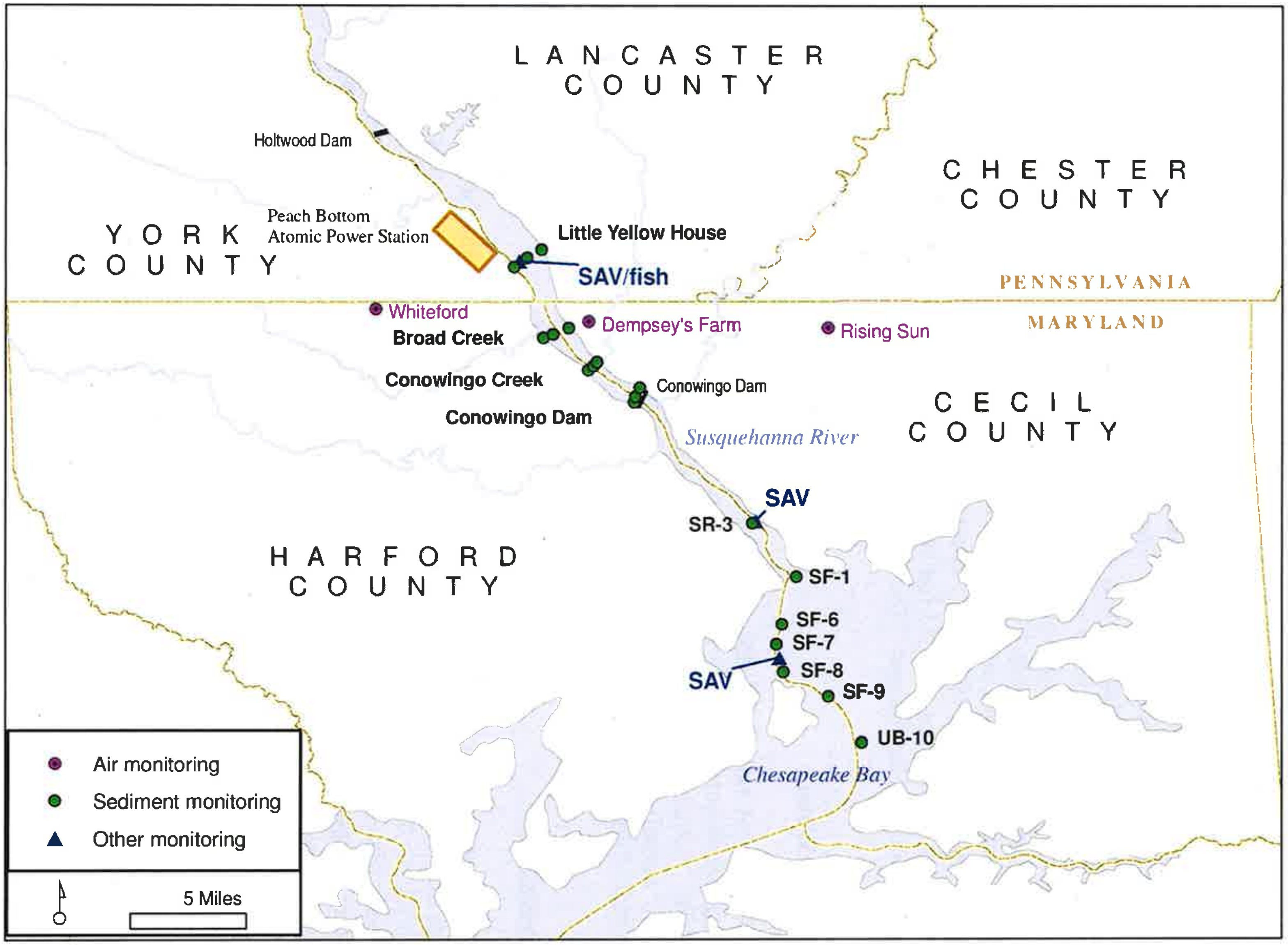


Figure 2-2. Transects and stations for samples collected from lower Susquehanna River and upper Chesapeake Bay. Appendix A contains a list of coordinates for the sediment monitoring stations

2.1.3 Air and Air Particulates

Samples of air and air particulates were collected using a permanently mounted 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 weather houses 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 57.7-mm diameter by 26.4-mm thick charcoal canisters and 47-mm glass fiber filters, respectively. Air sampling media were exchanged weekly. Figure 2-3 shows sampling locations. Weekly air and air particulate filters were counted for gross alpha, gross beta, and ^{131}I radiation. Air particulate filters were also combined monthly and counted for ^{7}Be and ^{137}Cs.

2.1.4 Potable Water

Samples of potable water were obtained quarterly from establishments (e.g., schools, 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 a 1-L plastic container. Control samples from Baltimore were collected monthly into 1-gallon cubitainers.

2.1.5 Precipitation

Precipitation was sampled weekly to monthly (when sufficient rain had been collected) from a 20-gallon carboy positioned below an aluminum funnel that is 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 analog rain gauge was read and the accumulated sample was transferred to a 1-gallon cubitainer (cube-shaped flexible plastic container, with screw cap).

2.1.6 Milk

Samples of processed milk were collected quarterly from Cloverland/Green Spring Dairy in Baltimore and samples of raw milk were collected quarterly from Kilby Farm in Cecil County (Figure 2-3).

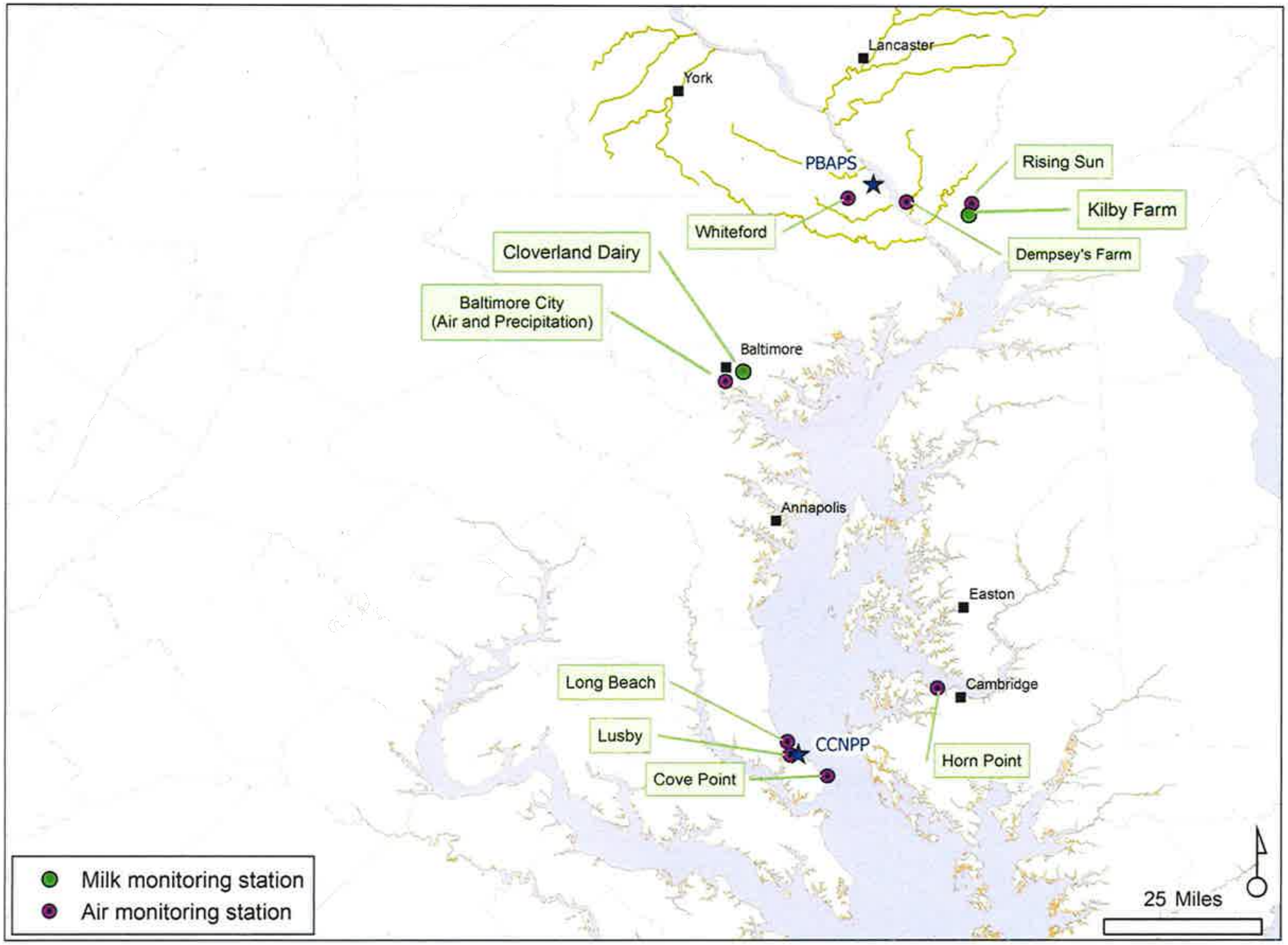


Figure 2-3. Air and milk monitoring stations near CCNPP and PBAPS

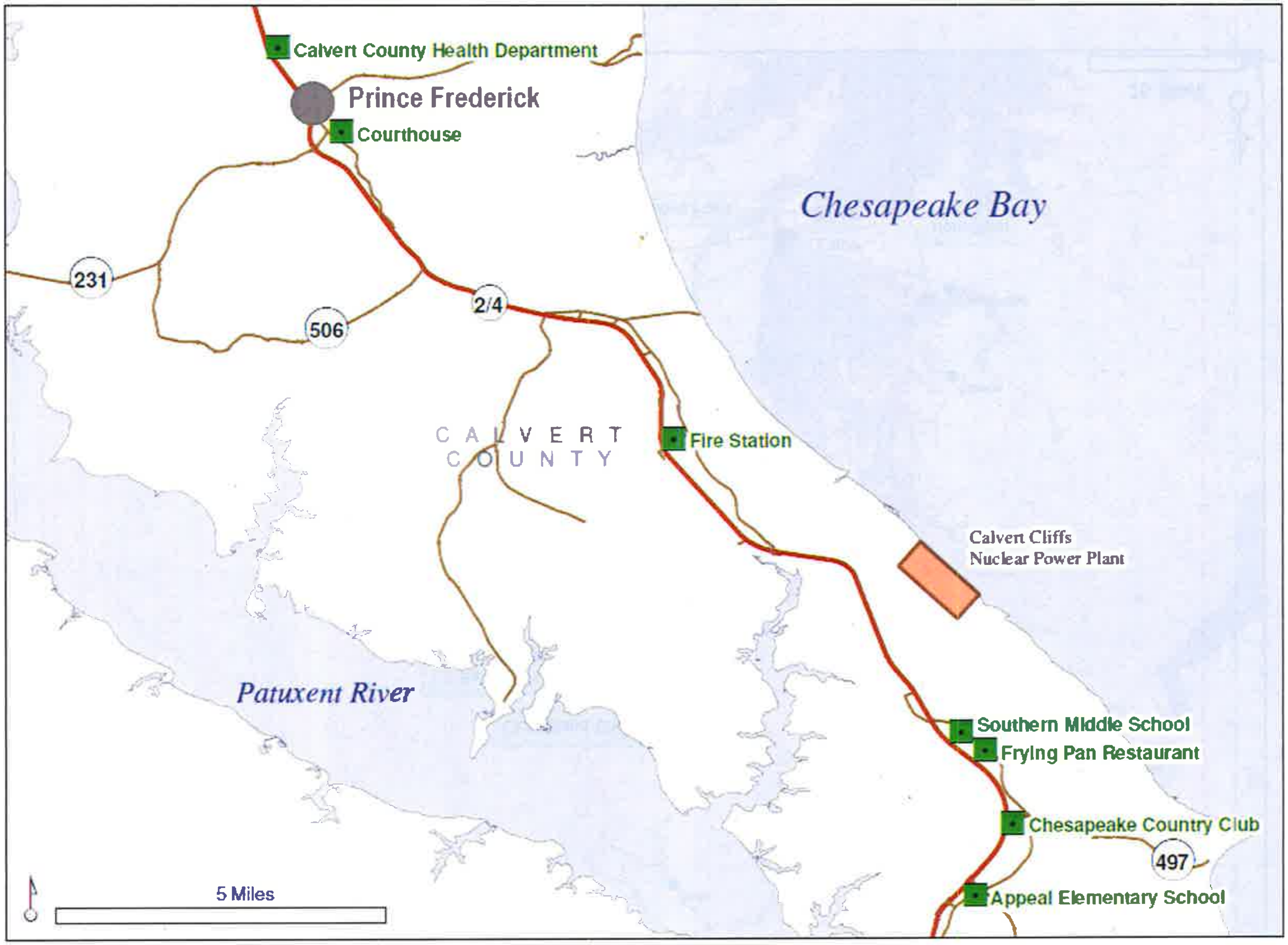


Figure 2-4. Potable water monitoring stations in Calvert County, Maryland

2.2 SAMPLE PREPARATION AND ANALYSIS PROCEDURES

The sample preparation and analysis procedures described below apply to sediment and biota samples analyzed by the PPRP Radioecology Laboratory. Other sample matrices, such as air, air particulates, water, and milk, were processed in the DHMH Radiation Laboratory 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 USDOE (1990).

2.2.1 Sample Preparation

Sediment samples were placed in a 2-liter Marinelli beaker and analyzed for radionuclide content using gamma spectrometry. After being counted, dried, and weighed, sediment samples were analyzed for particle size (Section 2.3) to determine their composition (e.g., sand, silt, or clay).

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. Finfish were analyzed to detect radioactivity that could be transferred through the food chain and potentially contribute to a radiation dose to humans. Specimens were filleted, and samples of flesh and gut were analyzed for gamma-emitting radionuclides.

Biological samples were prepared for analysis as follows:

Oyster flesh: Samples were homogenized in a blender, diluted to 1- or 2-liters with deionized water, and preserved in a 10% solution of formaldehyde.

Edible fish flesh and forage fish: Samples were diced into 3-cm cubes, packed to a volume of 1 or 2 liters, and preserved in a 10% formaldehyde solution.

Edible fish gut: Samples were wet-digested in nitric acid and diluted to 1- or 2-liters with deionized water.

SAV: Samples were packed to a volume of 1- or 2-liters and preserved in a 10% solution of formaldehyde.

The prepared samples of biota were placed in a 1- or 2-liter Marinelli beaker and analyzed for radionuclide content using gamma spectrometry.

2.2.2 Gamma Spectrometry

Sediment and biota samples were prepared and analyzed on a gamma-ray counting system consisting of high-resolution, intrinsic germanium detectors, one manufactured by Ortec (Ortec, Inc., Oak Ridge, TN) and the other by Canberra (Canberra, Inc., Meriden, CT). The detectors were 25% and 23% efficient, respectively, and were coupled to a Canberra Genie-2000 spectrum acquisition and analysis system (Stanek et al. 1996a).

Electronic files containing appropriate nuclide library data and counting efficiency curves by sample were used 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).

Counting efficiency curves were determined 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 (NIST). All spectra were acquired for 1,000 minutes. Radionuclide concentrations were corrected to collection date and time. Spectra for all samples were stored electronically for future reference.

For sediment and biota, radionuclide concentrations and pertinent sample-collection information and analysis parameters were entered into a SAS (Statistical Analysis System, Cary, NC) computer database according to established procedures (Frithsen et al. 1996). SAS software was used to perform quality control on the sample-collection information and analytical results.

Results for samples of air, air particulates, milk, and water were provided individually for compilation by DNR.

2.2.3 Quality Assurance

In 2009, the DNR Radioecology Laboratory implemented a formal Quality Assurance Plan. Plan elements, such as the use and frequency of analysis of control samples, standard samples, and performance samples, are described in Jones (2010).

A spiked intercomparison (i.e., "cross-check") sample from Eckert and Ziegler Analytics verified instrument performance independently. Laboratory results and known values for the intercomparison study sample are presented in Appendix B. All laboratory results for gamma emitters in the intercomparison samples were within 10% of the known results, except for ^{134}Cs (14.6% difference from known result).

2.3 DETERMINATION OF SEDIMENT CHARACTERISTICS

The sediment particle size value was determined to provide a basis for comparing radionuclide concentrations detected in sediments of different composition (i.e., sand versus clay). Sediment particle-size analysis accounts for composition changes that may affect measured radionuclide concentrations at a collection site. Sediments were classified as silt-clay if the mean grain size was less than 63 µm (Wentworth scale as published in Buchanan and Kain 1971). Sediments were classified as sand if the mean grain size was greater than 63 µm. Mean grain size was determined by wet- or dry-sieving 50-g (dry weight) aliquots through 250-µm, 125-µm, and 63-µm mesh screens. Each fraction was dried and weighed. That portion that passed through the 63-µm screen was determined by subtraction from the original 50g. Particle-size index values were calculated for each sample by multiplying the fraction (percent) of the total weight retained on the 250-µm mesh by 4, the fraction retained on 125-µm mesh by 5, the fraction retained on the 63-µm mesh by 6, and the fraction that passed through the 63-µm screen by 7. The sum of these products is the relative particle-size index for the sediment sample and ranges from the coarsest (400), in which all material was retained on the 250-µm screen, to the finest (700) in which all material passed through the 63-µm screen.

2.4 DATA ANALYSIS

Raw analytical results were calculated using gamma spectrum analysis software. Photopeaks distinguished from background were matched to radionuclide species and quantified based on factors such as instrument conditions, volume of sample, and radioactive decay. The concentration of a radionuclide of interest was reported as a value with a 2 sigma uncertainty.

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

2.5 IDENTIFICATION OF CESIUM-137 FROM POWER PLANTS

Cesium-137 (^{137}Cs) is a constituent of both fallout from historic weapons tests and aqueous effluent from nuclear power plants. The fraction of ^{137}Cs that is attributable to power plants is estimated by determining the activity of cesium-134 (^{134}Cs) in the environmental samples. Cesium-134 is chemically identical to ^{137}Cs, and power plants release both in a generally consistent ratio over time. Following a correction for decay of ^{134}Cs since the time of release, the ^{134}Cs activity is multiplied by the release ratio of ^{137}Cs to ^{134}Cs in the aqueous effluents of the plants to estimate the concentration of ^{137}Cs from power plants in a sample. If ^{134}Cs was not present in the sample, then the entire concentration of ^{137}Cs was assumed to be the result of fallout from weapons tests.

Table 2-2. Determination of the lower limit of detection (Canberra 1998).

Lower limit of detection is given by:

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

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)

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

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
^{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

2.6 DATA PRESENTATION

Appendix C contains concentration data for samples collected in the vicinity of CCNPP and PBAPS during the 2016-2017 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 (*Crassostrea virginica*), finfish, SAV, air, air particulates, water, precipitation, and milk. Within each table, specific sample stations are arranged approximately 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 $\pm$ 2 standard deviations (SD). Concentrations for alpha, beta, and specific gamma-emitters 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

Data for plant discharges and monitoring results collected in 2016-2017 were used to identify and quantify sources of radionuclides, determine the concentration of radionuclides in environmental samples, and estimate potential radiological risks to ecological resources and humans. The results of these assessments are presented in separate sections below.

The origins of the more commonly observed radionuclides in environmental samples were identified to assess the magnitude of the contribution of radionuclides from power plants relative to those from fallout and natural sources. The quantities of individual radionuclides released from CCNPP and PBAPS during 2016-2017 are provided to compare to quantities observed in environmental samples collected during the same period. Curie and millicurie levels of environmentally significant radionuclides discharged from power plants into the aqueous pathway generally translate into nanocurie and picocurie quantities of plant-related radionuclides in the environmental samples collected for this monitoring program.

3.1 SOURCES OF RADIONUCLIDES

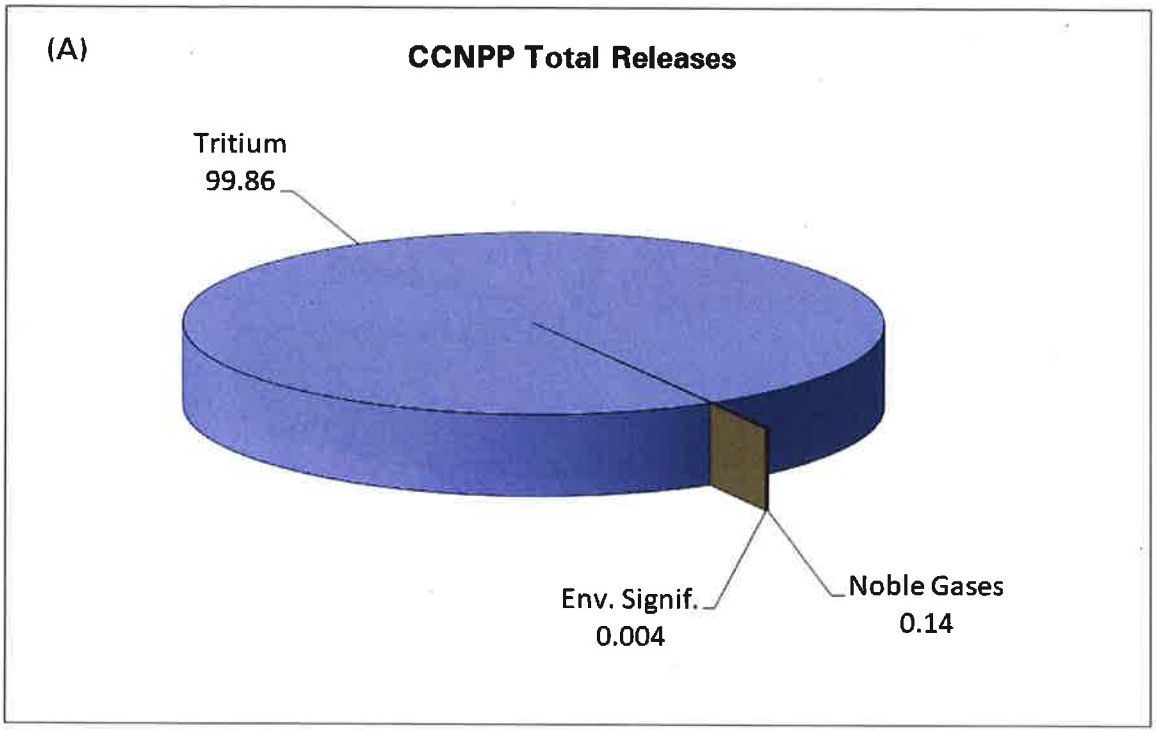
Natural occurrence, past atmospheric tests of nuclear weapons, and discharges from nuclear power plants are the three primary sources of radioactive material in Chesapeake Bay and Susquehanna River. Radionuclides attributable to each of these sources were detected in samples of biota and sediment collected in 2016-2017.

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 into waterways vary based on plant design (Figures 3-1, 3-2, and Table 3-1). PBAPS is a BWR, whereas CCNPP is a PWR.

During the 2016-2017 monitoring period, the most radioactive effluent from CCNPP was tritium (99.9% of total releases) released to the aqueous pathway. The most radioactive effluent from PBAPS was noble gases (92.6% of total releases) released to the atmosphere.



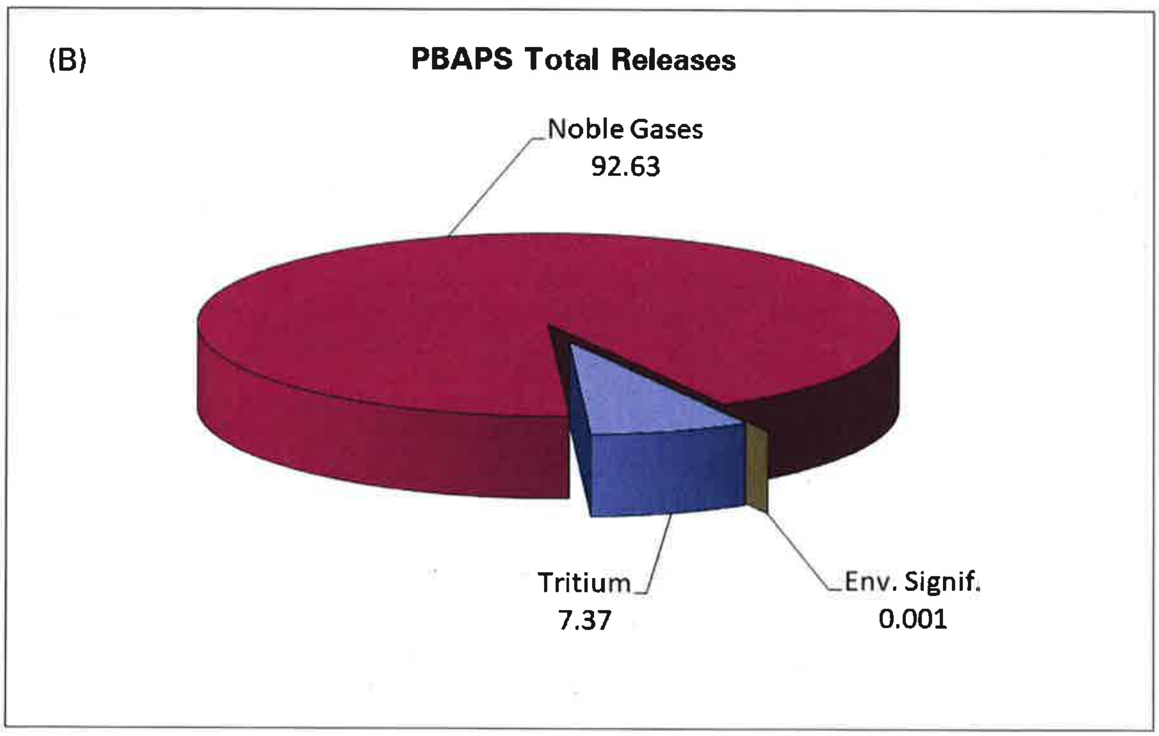
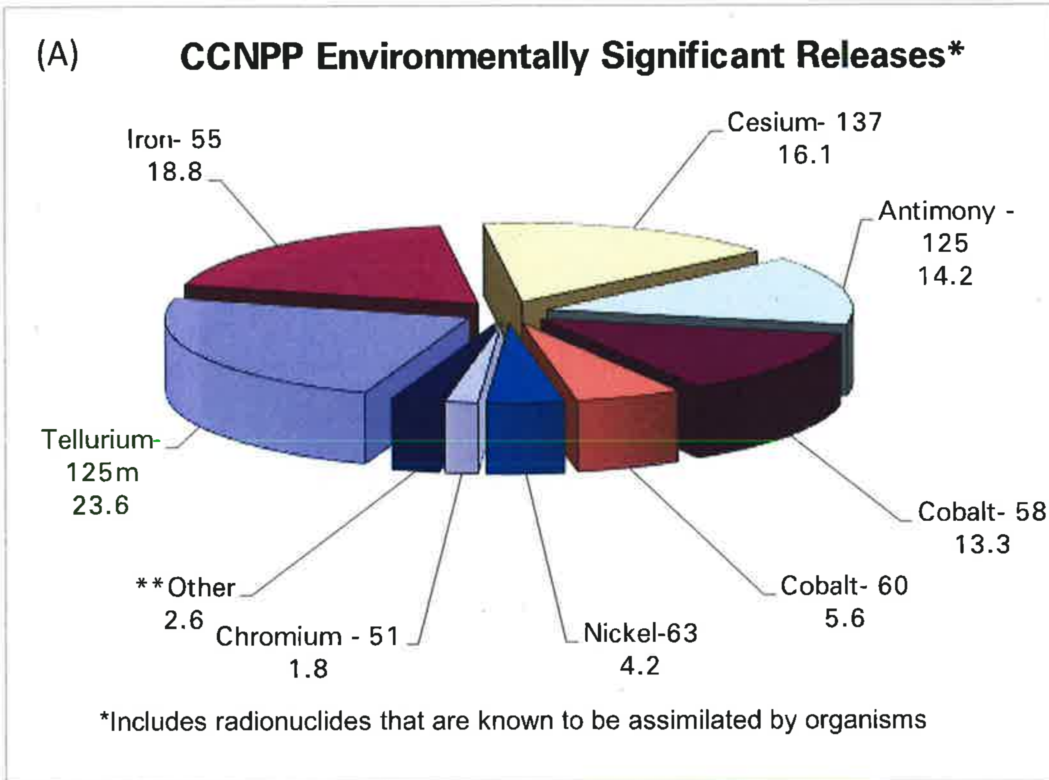


Figure 3-1. Relative contributions of noble gases, tritium, and environmentally significant radionuclides (percent) released from (A) Calvert Cliffs Nuclear Power Plant; and (B) Peach Bottom Atomic Power Station in 2016-2017, including air and liquid pathways



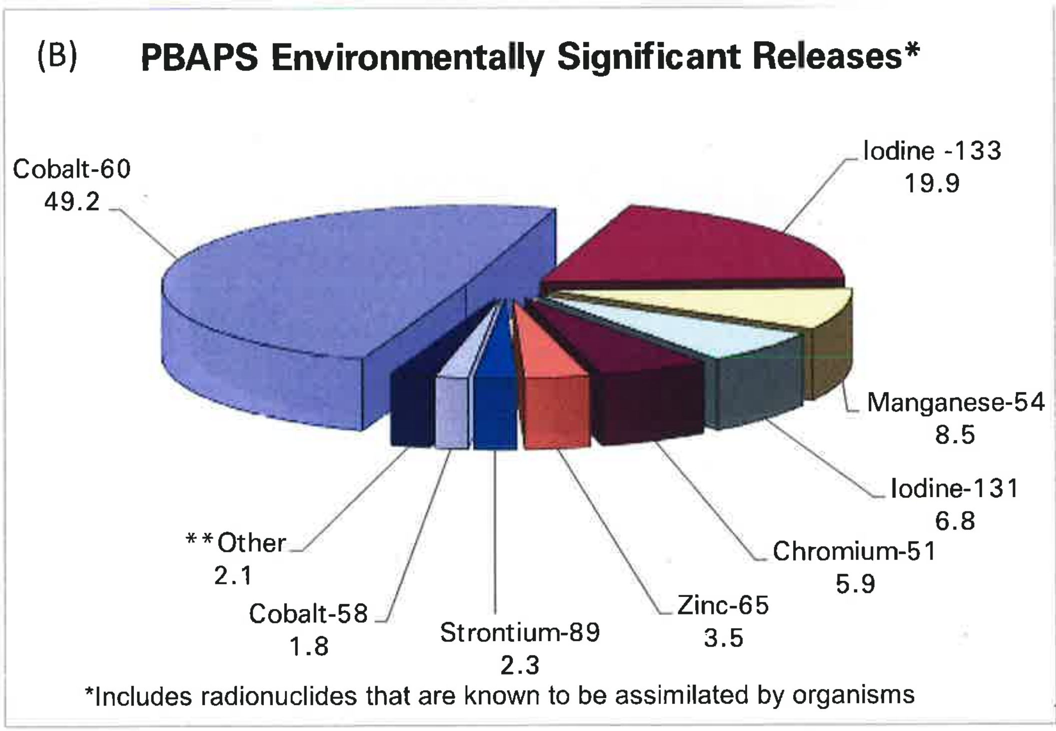


Figure 3-2. Environmentally significant radionuclides (percent) released from (A) Calvert Cliffs Nuclear Power Plant, and (B) Peach Bottom Atomic Power Station in 2016-2017, including air and liquid pathways. C-14 releases excluded. **Other category contains some radionuclides specified in Table 3-3

Table 3-1. Total releases (Ci) of noble gases, tritium, iodines and particulates from CCNPP and PBAPS through air and aqueous effluent pathways for 2016-2017, as reported by Exelon Generation Company. C-14 releases reported separately.

Type	CCNPP			PBAPS		
	Air	Liquid	Total	Air	Liquid	Total
Noble Gases	3.3	0.01	3.3	1053.3	0.00004	1053.3
Tritium	20.4	2364	2384	70.5	13.4	83.8
Iodines/Particulates	0.0002	0.102	0.102	0.004	0.008	0.013
C-14	40.3	0	40.3	76.5	0	76.5

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, decaying rapidly to stable forms. Tritium also disperses readily in the environment and rapidly reduces to background levels.

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 (Section 3.1.1.2).

The contribution of environmentally significant radionuclides (iodines and particulates) from air and liquid pathways was small, except for ^{14}C (Table 3-1). The CCNPP release of ^{14}C into the atmosphere during the 2016-2017 period (20 Ci each year) represented 2% of annual releases, and PBAPS release of ^{14}C into the atmosphere (38 Ci each year) represented 6% of annual releases. However, these releases were below the range of annual ^{14}C production rates expected for boiling water reactors: about 1 TBq/GWe-yr from coolant water, and up to 2 TBq/GWe-yr from coolant water and fuel (Yim and Caron 2006). Net power generation at CCNPP in 2017 was 14,107 GWh (U.S. Energy Information Administration). Therefore, using the conversion 1 GWe-yr = 8,760 GWh and the above production rates, the plant would have been expected to emit between 47 and 93 Ci (1.7-3.4 TBq) of ^{14}C in 2017. At PBAPS, net power generation in 2017 was 21,723 GWh (U.S. Energy Information Administration), and the plant would have been expected to emit between 67 and 134 Ci (2.5-5.0 TBq) of ^{14}C in 2017. The contribution to the global ^{14}C inventory of these power plant emissions is negligible (Yim and Caron 2006). USEPA (1981) estimated that 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.

Releases of environmentally significant radionuclides into the aqueous pathway from both CCNPP and PBAPS were very small. CCNPP and PBAPS released 102 mCi and 8.3 mCi of environmentally significant radionuclides, of which 16.47 mCi and 0.013 mCi were ^{137}Cs, respectively. CCNPP and PBAPS released 5.75 mCi and 5.8 mCi of ^{60}Co, respectively. Total releases of ^{137}Cs and ^{60}Co have been variable over time since 2000 (Figures 3-3 through 3-6). All releases of radionuclides from PBAPS and CCNPP were the result of normal operation and maintenance at the plants and were within regulatory limits established by the USNRC and USEPA[1]. Quantities of releases from CCNPP and PBAPS were obtained from Exelon Generation Annual Radioactive Effluent Release reports to the USNRC (Exelon Generation 2017a, 2017b, 2018a, 2018b).

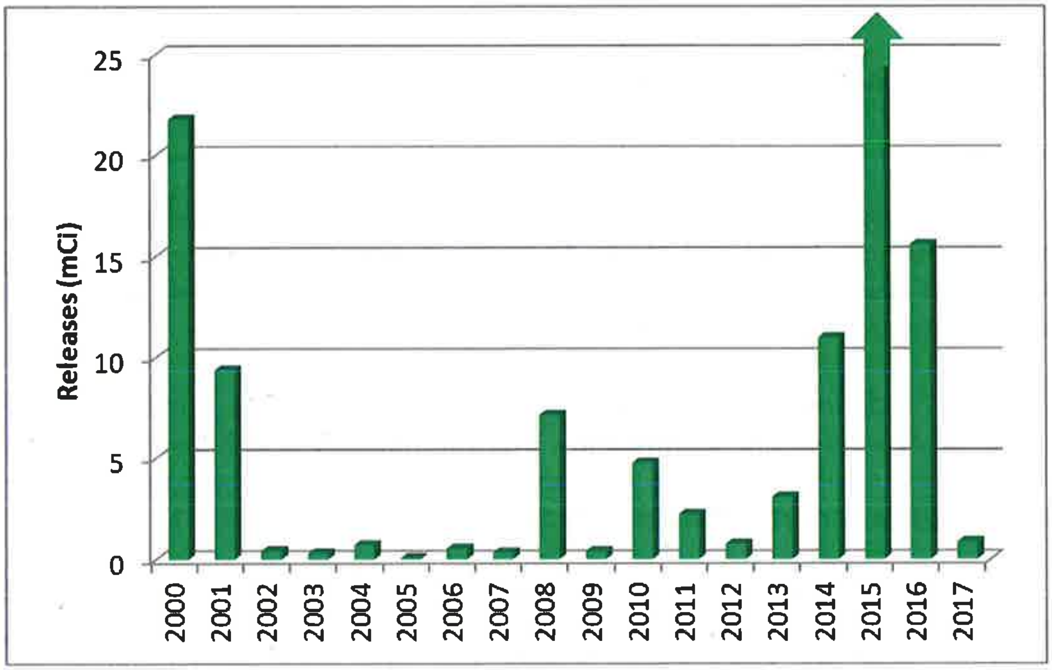


Figure 3-3. Annual aqueous releases of ^{137}Cs (mCi) from CCNPP, 2000-2017, as reported by Exelon Generation Company; the 2015 release was 525 mCi

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

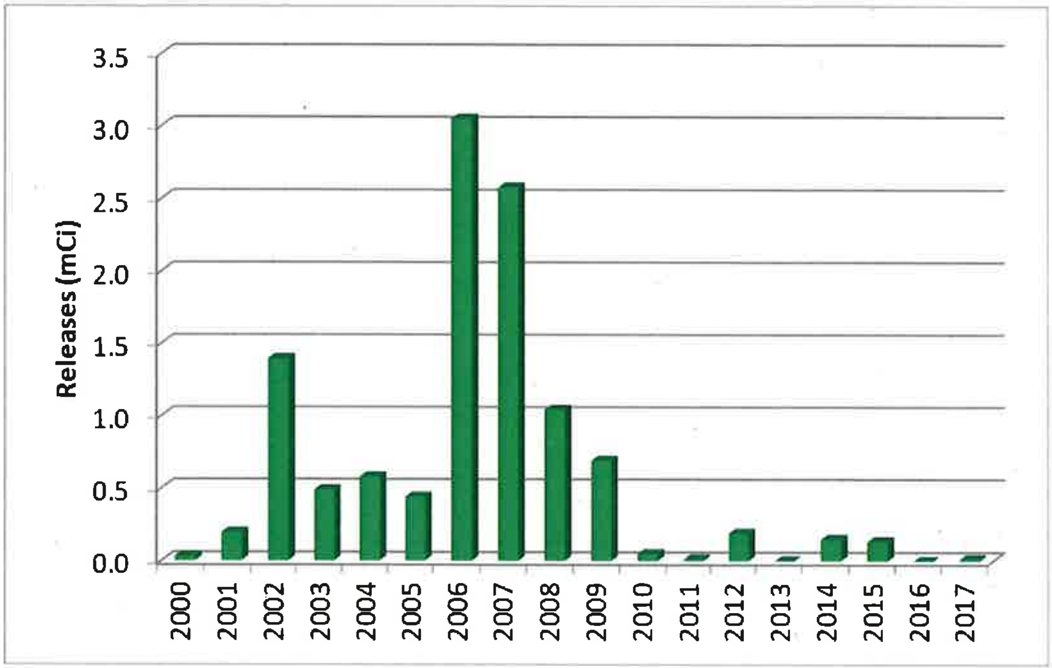


Figure 3-4. Annual aqueous releases of ^{137}Cs (mCi) from PBAPS, 2000-2017, as reported by Exelon Generation Company

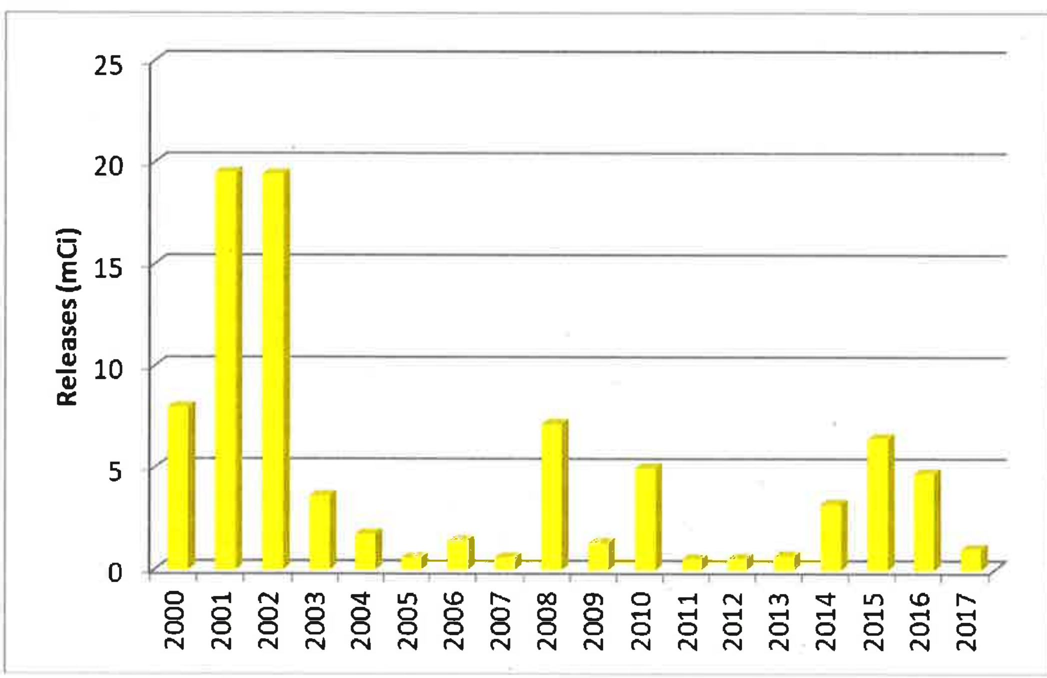


Figure 3-5. Annual aqueous releases of ^{60}Co (mCi) from CCNPP, 2000-2017, as reported by Exelon Generation Company

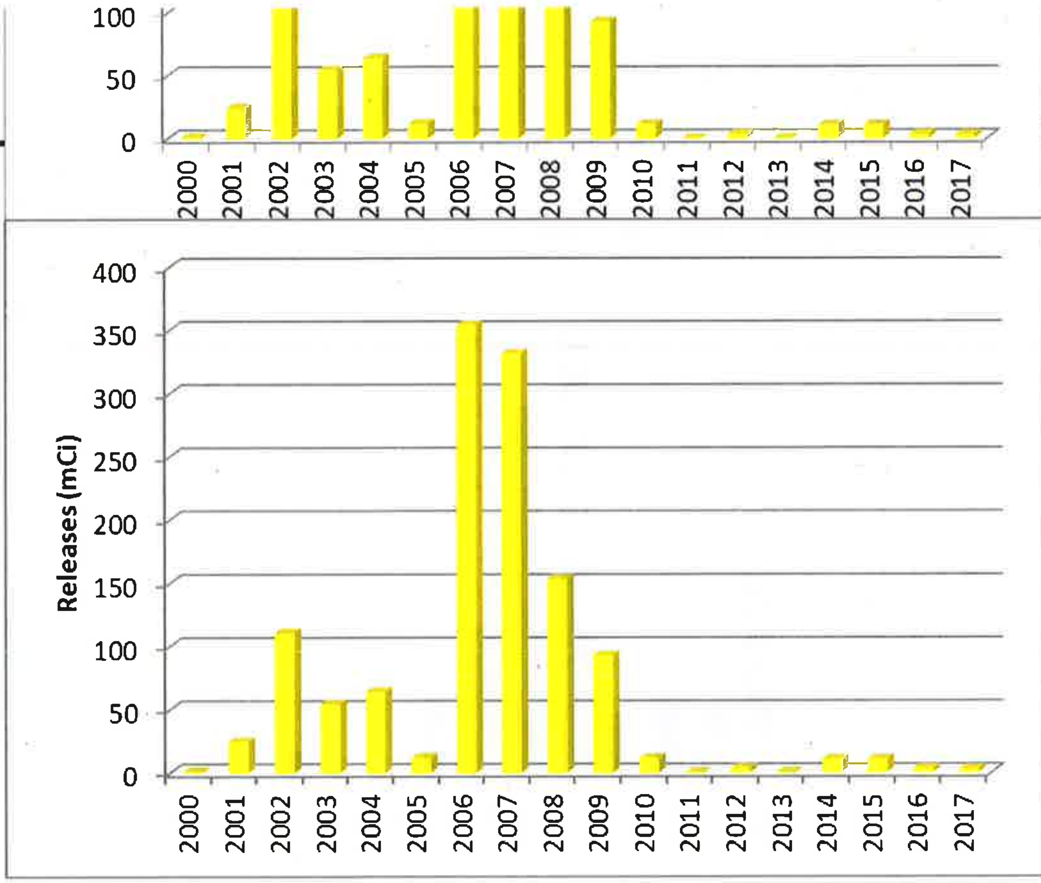


Figure 3-6. Annual aqueous releases of ^{60}Co (mCi) from PBAPS, 2000-2017, as reported by Exelon Generation Company

3.1.1.2 Environmentally Significant Radionuclides

During 2016-2017, CCNPP released 102 mCi (<0.01% of total liquid releases) of environmentally significant radionuclides to Chesapeake Bay through the aqueous pathway. PBAPS released 8.3 mCi (0.06% of total liquid releases) of environmentally significant radionuclides to Susquehanna River during the same period. 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, pers. com. August 17, 2005). Outages, minor leaks, and component maintenance and replacement efforts also impact annual release totals at CCNPP and PBAPS (B. Nuse, Constellation Energy Nuclear Group, LLC, pers. com. May 24, 2010; L. Lucas, Exelon Nuclear Company, pers. com., June 17, 2010). The overall 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 both CCNPP and PBAPS, releases of environmentally significant radionuclides have varied over time due to factors such as outages, fuel conditions, and minor leaks.

At CCNPP, liquid radioactive wastes are discharged through the cooling-water outfall approximately 0.3 km offshore and are 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 (mCi) of environmentally significant radionuclides (iodine and particulates) from CCNPP and PBAPS to the aqueous pathway, 1996-2017.

Period	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

Table 3-3 lists the quantities of the principal environmentally significant radionuclides released through the aqueous pathway during 2016-2017 and identifies which of these radionuclides were found in sediment samples (Section 3.2).

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 2013); therefore, radioiodines and particulates released to the atmosphere are not considered environmentally significant.

Table 3-3. Environmentally significant radionuclides released through the aqueous pathway from either CCNPP or PBAPS in quantities > 0.1 mCi during 2016-2017, as reported by Exelon Generation Company.

Radionuclide	Quantity Released (mCi)		Detected in Sediment	
	CCNPP	PBAPS	CCNPP	PBAPS
^{125}mTe	24.1	N.R.	No	No
^{55}Fe	19.27	0.034	No	No
^{137}Cs	16.47	0.013	*Yes*	*Yes*

Table 3-3. (Continued)

Radionuclide	Quantity Released (mCi)		Detected in Sediment	
	CCNPP	PBAPS	CCNPP	PBAPS
^{125}Sb	14.49	N.R.	No	No
^{58}Co	13.56	0.216	*Yes*	No
^{60}Co	5.75	5.808	No	*Yes*
^{63}Ni	4.25	N.R.	No	No
^{51}Cr	1.82	0.619	No	No
^{134}Cs	0.92	N.R.	No	No
^{124}Sb	0.22	0.012	No	No
^{54}Mn	0.174	1.080	No	No
^{59}Fe	0.169	0.028	No	No
^{95}Nb	0.151	N.R.	No	No
^{132}I	0.132	N.R.	No	No
^{138}Cs	0.13	N.R.	No	No
^{110}Sn	0.124	N.R.	No	No
^{110m}Ag	0.122	0.018	No	No
^{65}Zn	N.R.	0.438	No	No
Other (<0.1 mCi)	0.277	0.016	No	No

N.R. = Not released

3.1.2 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. Potassium-40 was detected in all samples of sediment, biota, and milk. 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, beryllium-7 (^{7}Be), was detected infrequently in sediments from CCNPP and PBAPS, and it was detected in oysters at CCNPP; however, the natural production of ^{7}Be (half-life = 53 days) in the atmosphere contributes only a small portion of the total radiation dose from natural background.

3.1.3 Radionuclides from Weapons Tests

Atmospheric tests of nuclear weapons conducted until 1980 have introduced a variety of man-made radionuclides into the environment. Cesium-137 was released by both power plants during the monitoring period, but its presence in the sediments can be attributed to weapons testing (see Sections 3.2.1.1 and 3.2.1.3 below). Cesium-137 was the only radionuclide attributable to weapons testing during the monitoring period. Due to its very long half-life (approx. 30 years), ^{137}Cs has persisted in the environment long after other testing-related radionuclides have decayed to stable states.

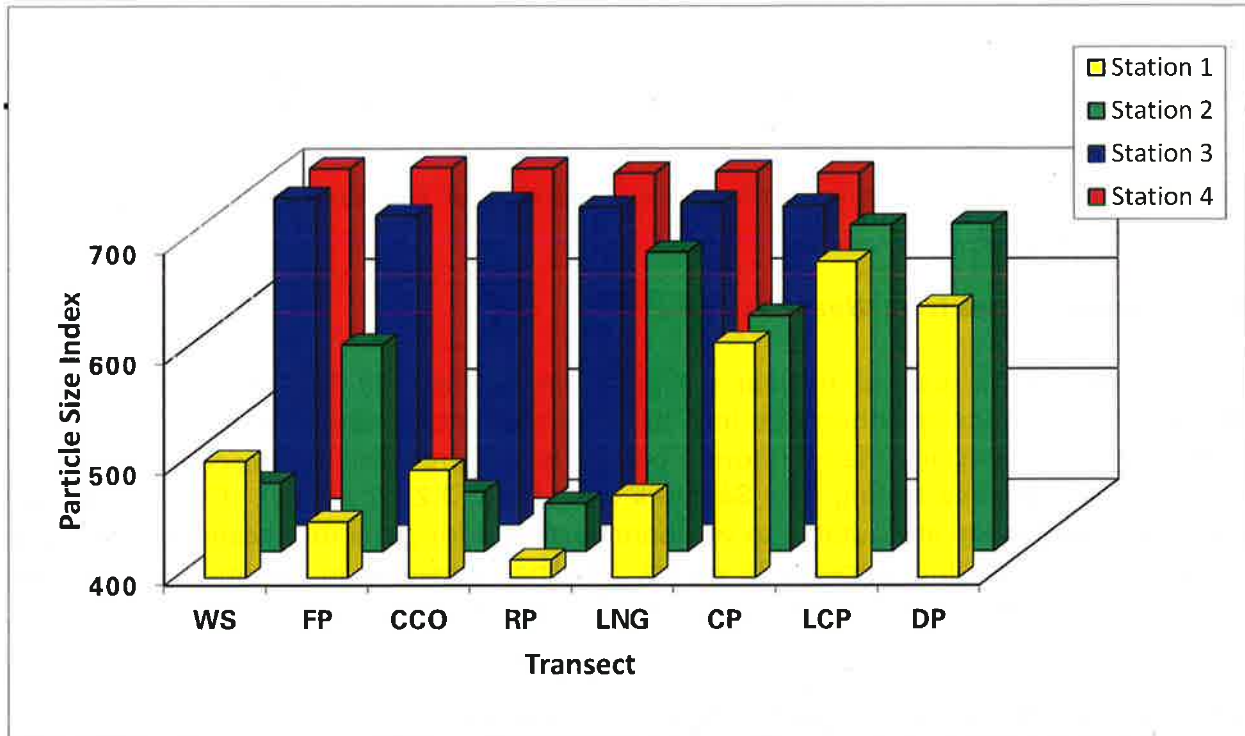
3.2 RADIONUCLIDES IN ENVIRONMENTAL SAMPLES

The environmentally significant radionuclides detected in samples from the study areas in this report consisted principally of ^{60}Co and ^{137}Cs. This has been the trend since the early 1990s, when reductions in radionuclide releases from both power plants were subsequently followed by a reduction in detection frequency and decline 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 Chesapeake Bay and 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. PPRP's monitoring results for sediment collected during 2016-2017 are summarized below. Appendix C presents concentrations of selected environmentally significant radionuclides detected in all of the sediment samples collected during 2016-2017.

A variety of factors influence the concentrations of radionuclides in sediments, including rate of input; geographic location in relation to the power plant (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. Sediment grain size was the only factor specifically analyzed for this report. Sediments collected at inshore stations of Chesapeake Bay and at Susquehanna Flats were composed predominantly of sand (particle size index values between 400 and 500). Sediments from Conowingo Pond and



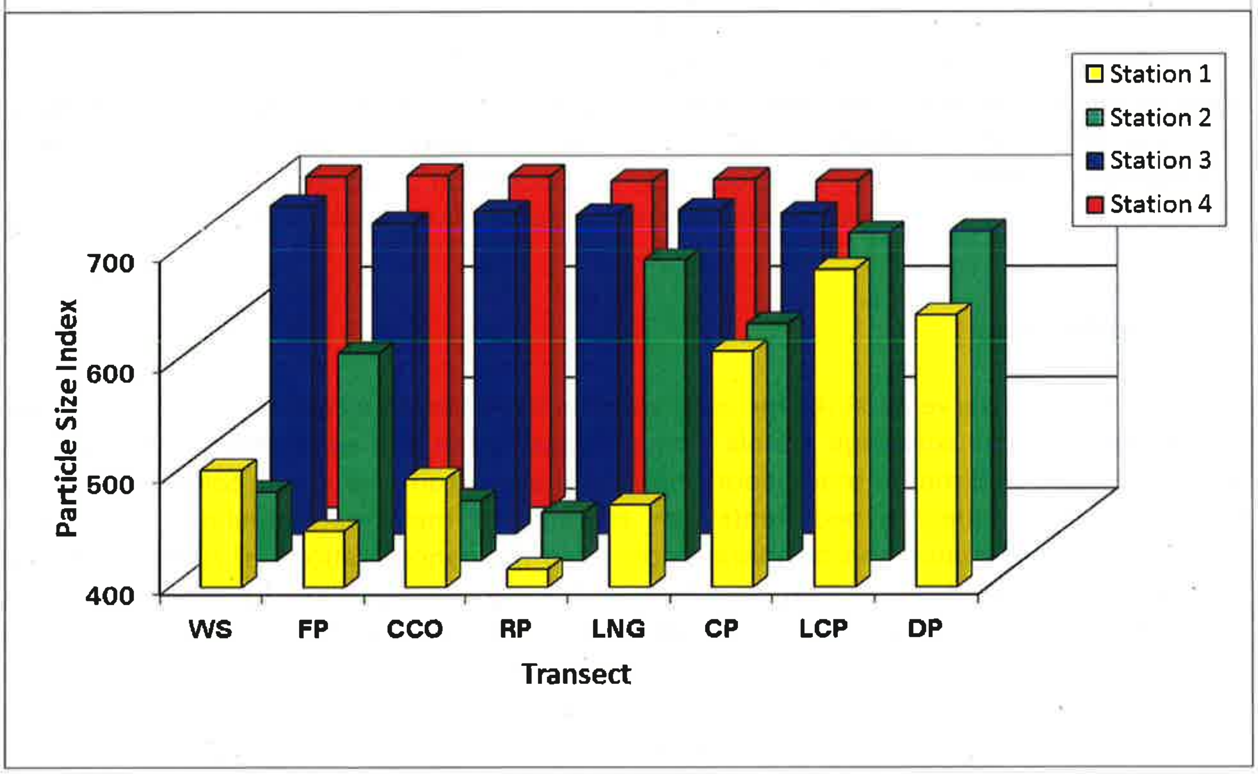


Figure 3-7. Particle Size Index (see Section 2.3) of sediments collected from the vicinity of CCNPP, 2016-2017. Transects arranged from north to south. See Figure 2-1 for transect names and locations

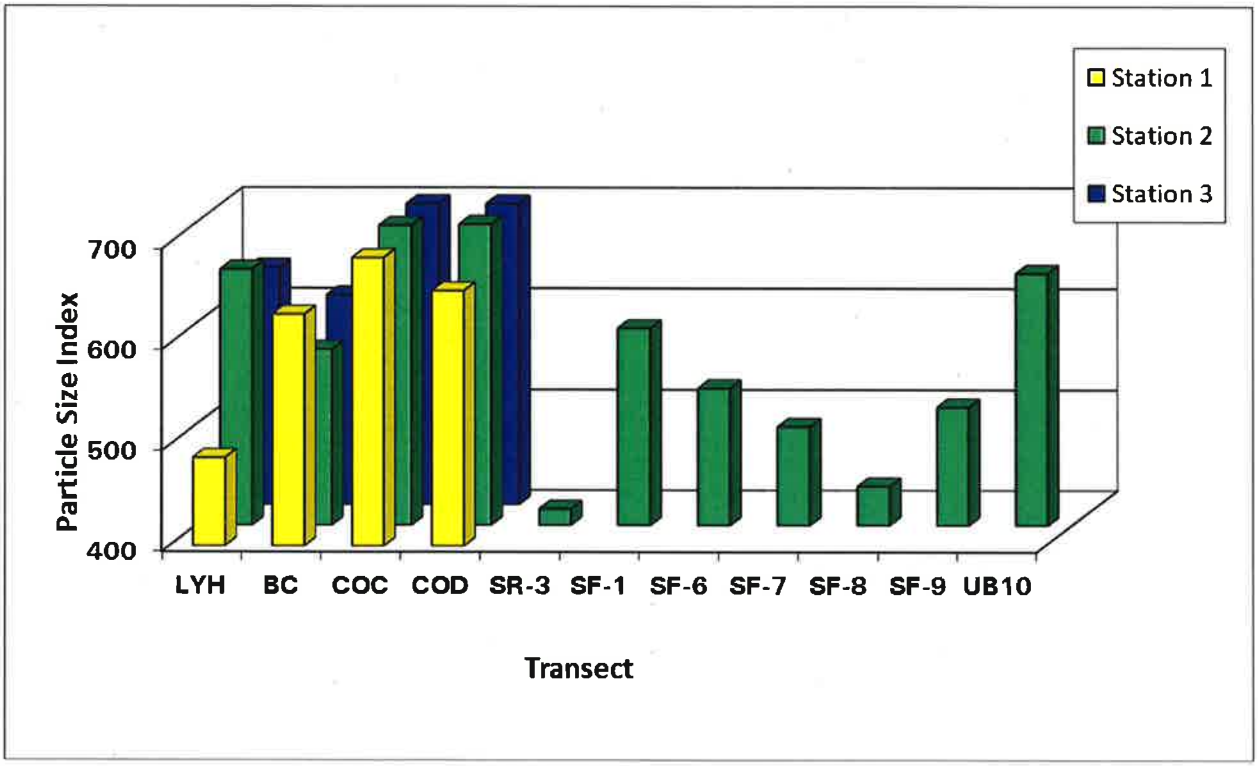


Figure 3-8. Particle Size Index (see Section 2.3) of sediments collected from the vicinity of PBAPS, 2016-2017. Transects arranged from north to south. See Figure 2-2 for transect names and locations

3.2.1.1 Power-Plant Radionuclides in Sediment

Cesium-137 and ^{60}Co made up most of the environmentally significant radionuclides from power plants found in the sediment. Cesium-137 was found in most sediment samples and was released through aqueous media by both power plants. However, all ^{137}Cs detected during this monitoring period is assumed to be from fallout because no ^{134}Cs was detected in samples collected during the period.

Cobalt-60 was not detected in any of the sediment samples from the CCNPP study area, although low detection rates occurred in previous years (Table 3-4). Decreases in ^{60}Co reflect decreased input of radiocobalt-labeled sediment, decay of legacy ^{60}Co, and burial. In the vicinity of PBAPS, PPRP detected ^{60}Co in 13% of the sediment samples during the 2016-2017 monitoring period (Table 3-4), within the long-term frequency detection rate. Cobalt-60 detection rates in sediments at PBAPS generally reflect increases or decreases of aqueous discharges of ^{60}Co from PBAPS: 16 mCi during 1996-2000, 246-685 mCi during 2001-2009, 3.5 mCi during 2012-2013, and 21.2 mCi during 2014-2015. In 2016-2017 ^{60}Co releases from PBAPS totaled 5.8 mCi. Thus reduced detection in sediments during the present reporting period reflected reduced discharges. Maximum ^{60}Co concentrations at PBAPS were observed at Conowingo Creek Station 1

(COC-1) and at Conowingo Dam Station 3 (COD-3, Figure 3-9), which suggests migration of ^{60}Co across the impoundment and downstream, out of the area nearest the outfall. Cobalt-58 was found in one sample in 2017 in the LNG transect of the CCNPP study area. Cobalt-58 was released by CCNPP to the aqueous pathway during 2016-2017. However, the concentration detected in sediment was very small, 66 pCi/kg of ^{58}Co, compared to 13.6 mCi released by the power plant.

Table 3-4. Detection frequency (percent sediment samples) of ^{60}Co in sediments from CCNPP and PBAPS for the period 1996-2017.

Monitoring Period	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

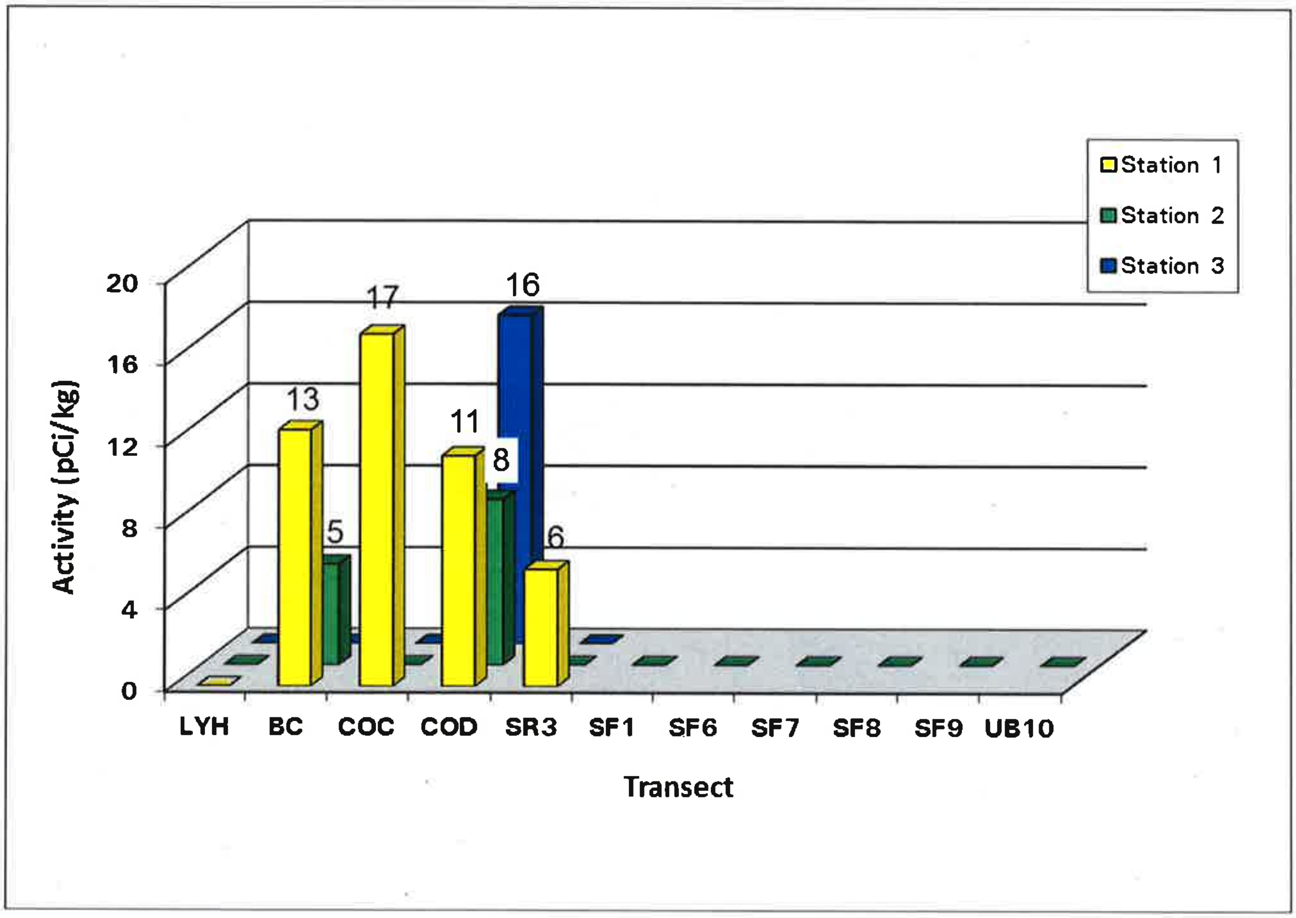


Figure 3-9. Geographical distribution of average activity of ^{60}Co near PBAPS, 2016-2017. Transects arranged from north to south. See Figure 2-2 for transect names

3.2.1.2 Natural Radionuclides in Sediment

Generally, the major components of sediment radioactivity were the naturally occurring radionuclides of the thorium and uranium decay chains, ^{40}K, and ^{7}Be. Naturally occurring radionuclides were responsible for more than 99% of the gamma-emitting radionuclides found in most sediment samples (Figures 3-10 and 3-11).

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) that accounted for most radionuclides present in sediments. The highest concentrations of these daughter radionuclides were observed at offshore stations with fine-grained sediment.

Potassium-40 is a primordial, naturally occurring radionuclide that was present in 100% of sediment samples collected during the monitoring period. Potassium-40 concentrations in nature are proportional to stable potassium content (0.0118%; CRC 1979). Potassium-40

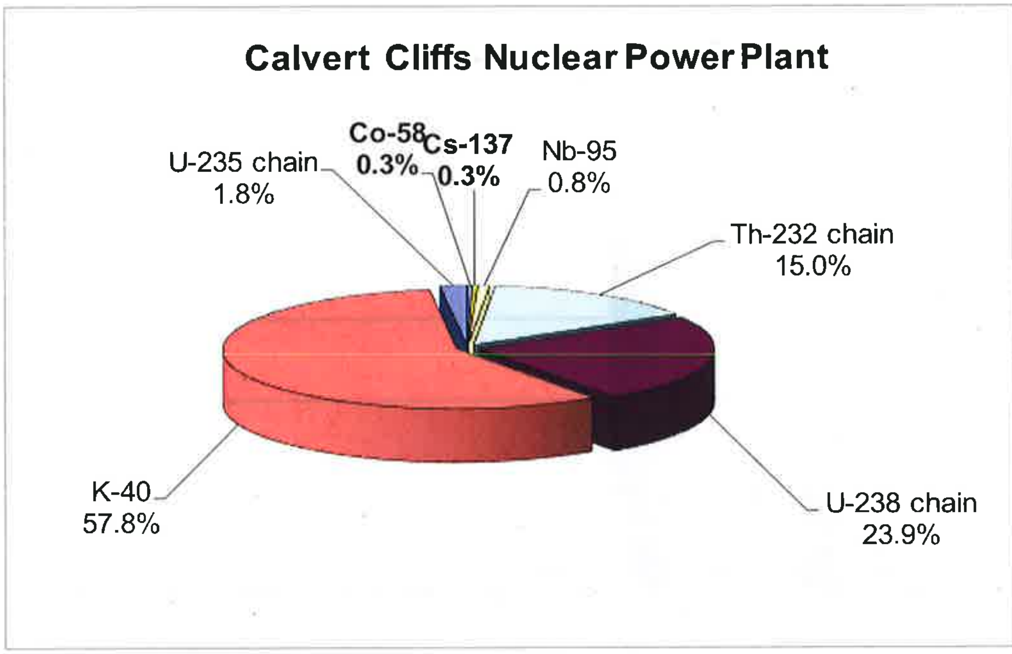


Figure 3-10. Proportion of gamma-emitting radionuclides in sediment samples from man-made (bold type) and natural (normal type) sources. Example from Liquid Natural Gas Terminal Station 2. Co-60 was not detected

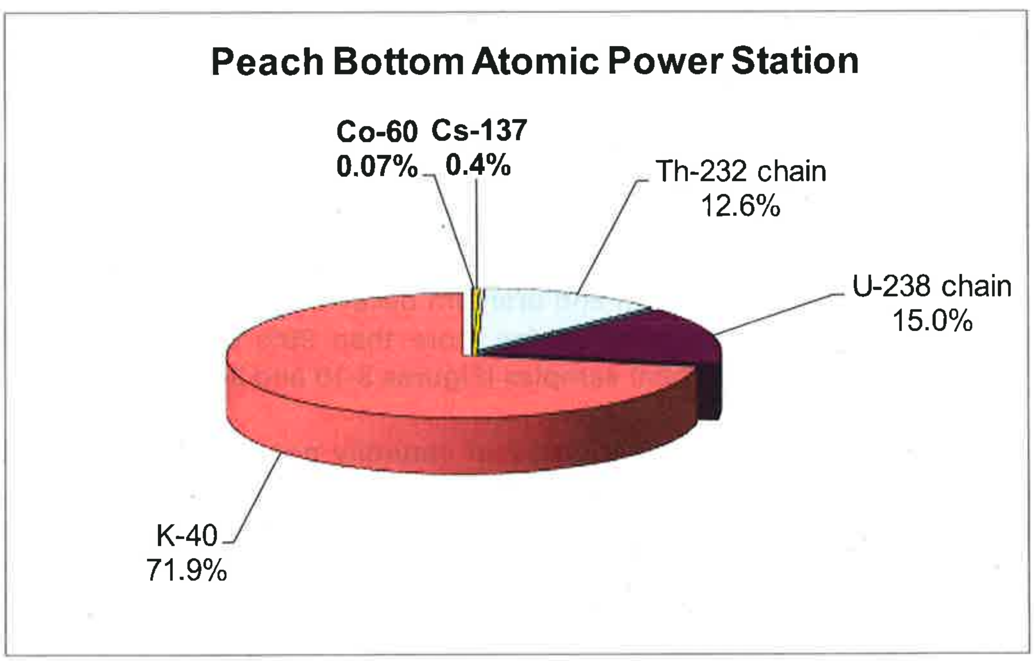


Figure 3-11. Proportion of gamma-emitting radionuclides in sediment samples from

man-made (bold type) and natural (normal type) sources. Example from Conowingo Creek Station 1

concentrations were highest in predominantly fine-grained sediments.

Beryllium-7 is a natural radionuclide 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 18.4% and 8.5% of sediment samples collected at PBAPS and CCNPP, respectively. Concentrations of ^{7}Be were generally lower at CCNPP (mean = 317 pCi/kg; range = 61-1,012 pCi/kg) than at PBAPS (mean = 610 pCi/kg; range = 62-1,647 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 (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). Beryllium-7 was rarely detected at offshore stations with clay sediments. This contrast with results for clay sediments from the PBAPS study area may be due to a longer average settlement time at the offshore stations in relation to half-life.

3.2.1.3 Radionuclides from Weapons Tests in Sediment

The presence of ^{137}Cs in sediments is assumed to be from the fallout from atmospheric atomic weapons testing, which ended approximately three decades ago. Cesium-137 continued to be present in most sediment samples from Chesapeake Bay and the Susquehanna River (81% at CCNPP, 99% at PBAPS). New inputs to the local ecosystem related to weapons testing are insignificant (Prăvălie 2014); therefore, ^{137}Cs is likely to be the only fallout-related, gamma ray-emitting radionuclide to be considered in the future.

Concentrations of ^{137}Cs were smaller in sediments composed primarily of sand than in those composed primarily of clay. The concentrations of ^{137}Cs in sediments collected near PBAPS and CCNPP generally have decreased gradually since 1985 due to reductions in discharges, decay of the inventory of ^{137}Cs present in the sediment, and dilution by sedimentation (Figures 3-12 and 3-13). At most stations within representative study area transects (e.g., Flag Ponds at CCNPP and Broad Creek at PBAPS), average ^{137}Cs concentrations increased slightly during the 2006-2007 monitoring period but decreased afterwards. At Broad Creek there were further decreases in 2011. At Flag Ponds, average annual ^{137}Cs concentrations in sediments have decreased by between 67% and 84% since the initiation of the monitoring program in 1981 (Table 3-5). Concentrations at Broad Creek have decreased by between 74% and 90% since initiation of monitoring,

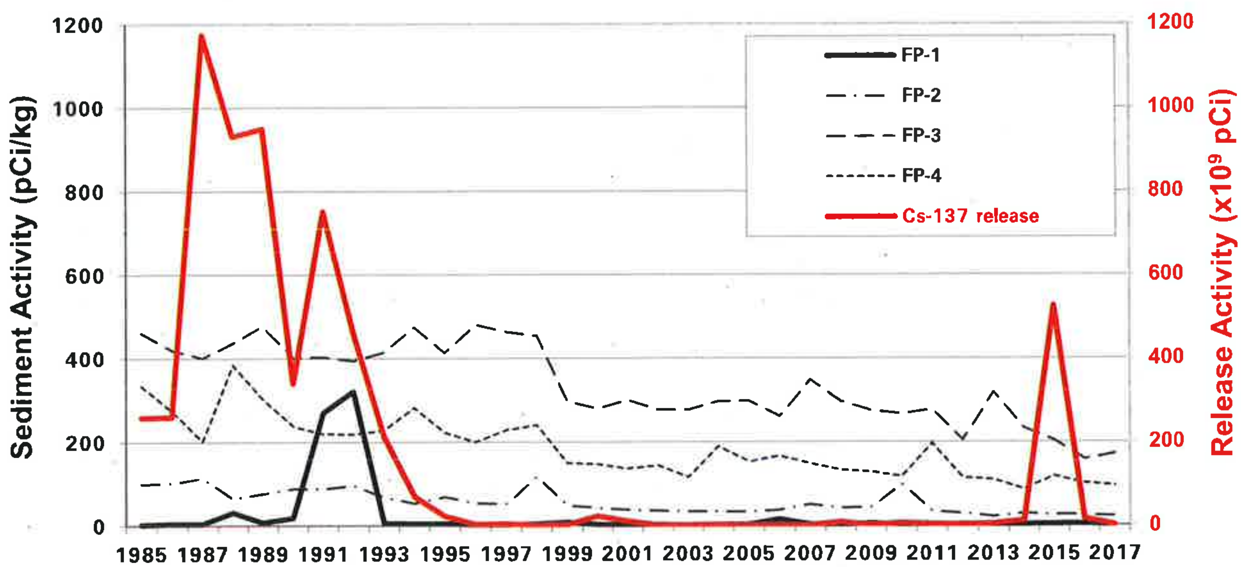


Figure 3-12. Annual liquid release of ^{137}Cs from CCNPP and average annual activity of ^{137}Cs in CCNPP sediments at Flag Ponds (FP) stations, 1985-2017. Units not on the same scale.

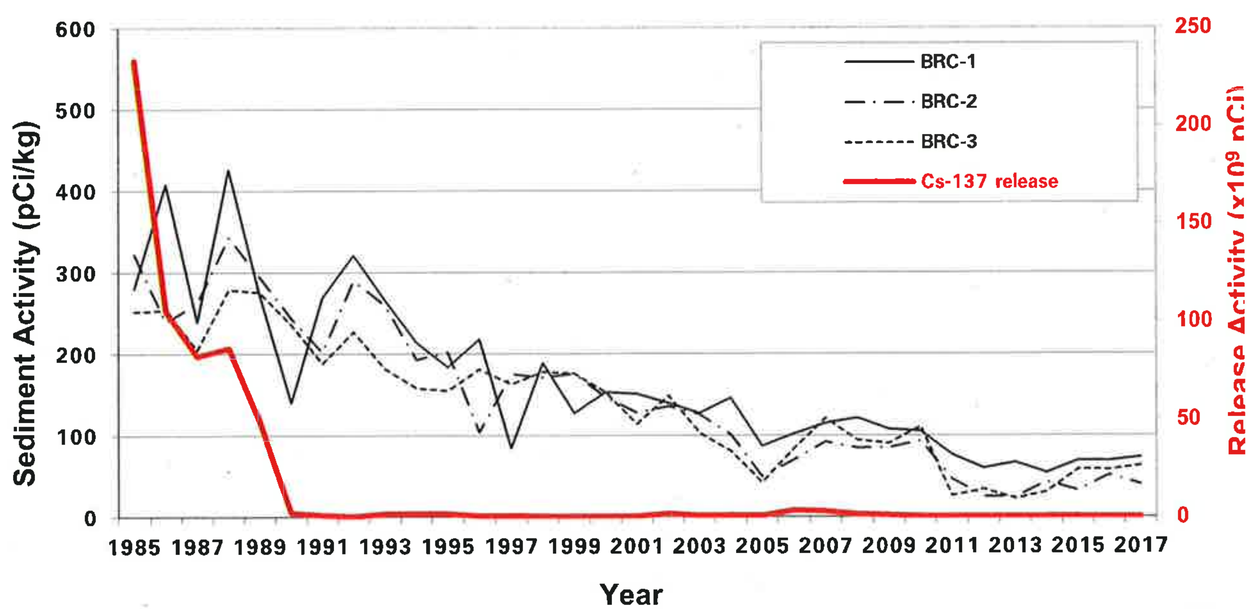


Figure 3-13. Annual liquid release of ^{137}Cs from PBAPS and average annual activity of ^{137}Cs

in PBAPS sediments at Broad Creek (BRC) stations, 1985-2017. Units not on the same scale.

Table 3-5. Percent reduction between 1981 and 2017 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	2017	% Reduction
CCNPP ^{137}Cs release	103	0.88	99.1
FP-1	7	1.1	84.3
FP-2	98	22	77.6
FP-3	522	172	67.0
FP-4	361	96	73.4
PBAPS ^{137}Cs release	170	0.0125	100
BRC-1	707	73	89.7
BRC-2	232	40	82.8
BRC-3	243	63	74.1

demonstrating the effect of sedimentation in reducing ^{137}Cs concentrations (Table 3-5). Releases from PBAPS have decreased by 99.9%, with the highest annual rates occurring early in the monitoring program. Releases from CCNPP have varied over time. While there was a pronounced increase in 2015, releases of ^{137}Cs in CCNPP effluents have generally declined since the 1980s (Figure 3-12).

Overall, the greater rate of decrease of ^{137}Cs concentrations over time in Conowingo Pond probably reflects the greater sedimentation rate due to surface water flow, especially during precipitation, compared to Chesapeake Bay.

3.2.2 Biota

Manmade radionuclides are infrequently detected in biological samples collected from the vicinity of CCNPP and PBAPS. During the present monitoring period ^{60}Co, ^{137}Cs, ^{131}I were not detected in biota, with the exception of low levels of ^{137}Cs detected in two samples of finfish collected from PBAPS Conowingo Pond (Appendix Table C-4). 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).

The ability of biota to absorb environmentally significant radionuclides differs by species, habitat, availability of radionuclides, and sensitivity of biota to radionuclides. At CCNPP, test oysters are confined in trays placed in the immediate vicinity of the discharge for periods of three months to one year, while many finfish are resident and may be found near the PBAPS outfall and zone of maximum effluent concentrations. Biota tend to absorb radionuclides such as ^{60}Co and ^{137}Cs from fallout and the sediments; however, the availability of these radionuclides in the sediment layer has been very low compared to historically high-release years such as 1989-1990.

PPRP's monitoring results for biota collected in 2016-2017 are summarized below.

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 Cobalt-58 (^{58}Co), Cobalt-60 (^{60}Co), Zinc-65 (^{65}Zn), and Silver-110m (^{110m}Ag) (McLean et al. 1987). Silver-110m has been the major radionuclide accumulated by oysters and the principal contributor to 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 present monitoring period, no ^{110m}Ag was 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 inability to detect ^{110m}Ag in tray-oysters since the spring of 2001 reflects very small releases of ^{110m}Ag from CCNPP compared to historical levels. Also, no ^{60}Co or ^{137}Cs concentrations were detected in oysters (Appendix Table C-2).

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 discussions of the tray-oyster study and statistical modeling of radionuclide concentrations in tray-oysters.

3.2.2.2 Radionuclides from PBAPS in Finfish

During 2016-2017, only a small concentration ^{137}Cs was detected in two samples of finfish flesh collected from Conowingo Pond (Appendix Table C-4). Historically, ^{137}Cs has been detected in samples of finfish flesh, but at low concentration levels and detection frequencies, and ^{60}Co has rarely been detected.

3.2.2.3 Radionuclides from PBAPS in SAV

Manmade radionuclides were not detected in SAV during the 2016-2017 period. In previous monitoring periods, ^{137}Cs was detected, albeit at very low concentrations.

Iodine-131 was also present in SAV in previous monitoring periods, but no ^{131}I was detected during the 2016-2017 period.

Historically, the source of concentrations of ^{131}I found in SAV is likely 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 wide 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 typically range as high as several hundred mCi (NCRPM 1996). PBAPS releases of ^{131}I were typically < 2 mCi; therefore, PBAPS contribution to the concentrations found in SAV is likely to have been insignificant.

Iodine-131 has been found 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 is thought to be medically-derived, from thyroid cancer treatment facilities and cancer patients undergoing treatment at home. The Potomac River study suggested a relatively continuous source of this radionuclide. Recently, ^{131}I was found at low concentrations in the Schuylkill River near Philadelphia (Philadelphia Water Department), and in trace amounts in sediments of the Delaware River estuary (C. Sommerfield, University of Delaware). Investigations are being carried out to determine the source of this iodine, possibly local medical facilities.

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 (IAEA 2003). However, 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.

3.2.3 Air, Potable Water, Precipitation, and Milk

Detectable radioactivity in samples of air and air particulates consisted of naturally occurring ^{7}Be and undifferentiated, naturally occurring alpha and beta emitters trapped on air-particulate filters for most samples (Appendix Tables C-6 and C-7). None of the samples showed detectable concentrations of ^{131}I or ^{137}Cs during the monitoring period (Table 3-6).

Naturally occurring alpha-emitting radioactivity was detected in one sample of potable water taken near the CCNPP study area during 2016-2017, but in none of the other monitoring stations or at the control Baltimore City station (Appendix Table C-8). Beta-emitting radioactivity was found in 38% of the control samples of potable water and in nearly all samples from the CCNPP study area during 2016-2017. Although average beta radioactivity near CCNPP was greater than in Baltimore City (Table 3-7), the difference may be due to varying levels of naturally occurring radioactive material within the aquifer that serves as the source of the water. None of the gross beta results exceeded the EPA's screening criterion of 50 pCi/L.

Measurements of radiostrontium in milk were conducted for samples of processed and raw milk (Appendix Table C-10). No radiostrontium was detected in any of the samples.

Samples of precipitation collected from the Baltimore station during the monitoring period contained gross alpha radioactivity in one sample (3.9 pCi/L) and an average gross beta radioactivity of 5.5 pCi/L, where detected (Appendix Table C-9). Tritium was below detection limit in all samples.

Table 3-6. Arithmetic means (fCi/m^3) ± 2 SD of analytical results from air monitoring stations, 2016-2017. Only samples where radioactivity was detected were used to calculate the mean. ND = not detected at the detection limit.

Station	Gross Alpha	Gross Beta	^{131}I	^{7}Be	^{137}Cs
Long Beach	0.8±0.0	17.5±1.0	ND	122.1±1	ND
Lusby	1.0±0.2	18.9±0.5	ND	134.6±1	ND
Cove Point	0.8±0.0	19.3±0.0	ND	135±9	ND
Horn Point	0.8±0.1	15.8±1.5	ND	109.2±5	ND
Baltimore City	0.8±0.1	18.5±10.5	ND	108.3±35	ND
Rising Sun	1.0±0.2	19.9±2.5	ND	137.9±6	ND
Whiteford	0.9±0.1	17.1±1.2	ND	113.3±0	ND
Dempsey Farm	1.0±0.2	19.4±1.2	ND	125.4±8	ND

Table 3-7. Arithmetic means (pCi/L) ± 2 SD of quarterly analytical results from potable water monitoring stations, 2016-2017. Only samples where radioactivity was detected were used to calculate the mean. ND = Not detected at the detection limit.

Station	Gross Alpha	Gross Beta	Tritium
Baltimore City	ND	7.1±2.5	ND
Chesapeake Country Club	ND	5.9±0.8	ND

Calvert Co. Courthouse	ND	10.7±2.4	ND
Appeal Elementary School	2.3±1.2	12.7±2.1	ND
Calvert Co. Health Department	ND	11.0±4.1	ND
Southern Middle School	ND	10.0±0.7	ND
Frying Pan Restaurant	ND	12.6±0.6	ND
Volunteer Fire Department	ND	13.2±0.2	145±99

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 were detected in biota collected during 2016-2017, 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. Adverse effects on sensitive aquatic vertebrates have been detected at dose rates as low as 0.4 mGy/h (40 mrad/h or approximately 350 rem in one year). Adverse effects on mollusks appear at doses of 87,660 rem in one year (Eisler 1994). Doses that cause adverse effects in these organisms are far greater than those that typically might be delivered to humans who ingest finfish from Conowingo Pond and oysters from Chesapeake Bay in given monitoring years (see Section 3.3.2).

3.3.2 Effect on Human Health

Potential radiation doses to human consumers of food were estimated based upon measured concentrations of radionuclides in edible finfish, oysters, and processed milk. Doses were expressed as "dose commitment," which refers to the total dose to a tissue or organ during a period of 50 years following ingestion of finfish, oysters, and 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 maximum, or worst-case, estimated concentration of plant-related radionuclides in finfish collected from Conowingo Pond, oysters collected from the vicinity of CCNPP, or processed milk sold locally; (2) the estimated maximum quantity of finfish, oysters, or milk consumed by an individual according to age (i.e., child = 6.9 kg/yr; teen = 16 kg/yr; adult = 21 kg/yr; USNRC 1977); and (3) the dose to the target organ per quantity of radionuclide ingested (USNRC 1977).

Table 3-8 presents estimated dose commitments for adults, teenagers, and children based on a diet of finfish (the dose estimate based on oyster consumption is calculated from minimum detectable concentrations of radionuclides from power plants in oyster tissue samples). The estimated maximum dose to a specific organ from consumption of finfish during 2016-2017 was 0.0066 mrem/yr to a teen's liver. The estimated maximum total body dose to an adult was 0.0041 mrem/yr.

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 10 CFR Part 50 Appendix I (USNRC 1996):

> 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.

Table 3-8. Estimated maximum dose commitments* in millirem per year to individuals who consume finfish from Conowingo Pond, 2016-2017. Recommended consumption values and conversion factors derived from USNRC 1977.

Age Group	2016-2017		
	Adult	**Teen**	**Child**
Total Body			
^{65}Zn	0.0000	0.0000	0.0000
^{134}Cs	0.0000	0.0000	0.0000
^{137}Cs	0.0041	0.0023	0.0009
TOTAL	0.0041	0.0023	0.0009
Bone			
^{65}Zn	0.0000	0.0000	0.0000
^{134}Cs	0.0000	0.0000	0.0000
^{137}Cs	0.0046	0.0049	0.0062
TOTAL	0.0046	0.0049	0.0062
Liver			
^{65}Zn	0.0000	0.0000	0.0000

^{134}Cs	0.0000	0.0000	0.0000
^{137}Cs	0.0063	0.0066	0.0060
TOTAL	0.0063	0.0066	0.0060
Kidney			
^{65}Zn	0.0000	0.0000	0.0000
^{134}Cs	0.0000	0.0000	0.0000
^{137}Cs	0.0021	0.0022	0.0019
TOTAL	0.0021	0.0022	0.0019
Gastrointestinal tract - lower large intestine			
^{65}Zn	0.0000	0.0000	0.0000
^{134}Cs	0.0000	0.0000	0.0000
^{137}Cs	0.0001	0.0001	0.0000
TOTAL	0.0001	0.0001	0.0000

* Dose commitment: $\frac{kg}{yr} \times \frac{mrem}{pCi} \times \frac{pCi}{kg}$

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. B) The total quantity of radioactive materials entering the general environment from the entire uranium fuel cycle, per gigawatt-year of electrical energy produced by the fuel cycle, contains less than 50,000 curies of krypton-85, 5 millicuries of iodine-129 and 0.5 millicuries combined of plutonium-239 and other alpha-emitting transuranic radionuclides with half-lives greater than one year.

Dose commitments calculated from radionuclide concentrations in biota vary annually. The figures given above show that the quantities of radionuclides found in sediment and biota, and which may be attributable to nuclear power plant operations, do not pose a threat to human health as measured by their consequent effective dose equivalent as they migrate through trophic layers to humans.

4.0 CONCLUSIONS

During the 2016-2017 monitoring period, CCNPP and PBAPS released radionuclides to the environment as a normal consequence of routine operations. All quantities released resulted in estimated doses that were no more than 10% of the regulatory limits set by the USNRC (Table 4-1). Radionuclides released from CCNPP were detected rarely in sediment samples collected from Chesapeake Bay. No radionuclides were detected in oysters collected near the CCNPP outfall. In the PBAPS study area, most plant-produced radionuclides were detected in sediment samples collected downstream of the plant outfall and upstream of Conowingo Dam. Cs-137 was detected in two finfish samples collected near the PBAPS outfall, but at very low concentrations.

Radionuclides from nuclear power plants, 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 2016-2017, man-made radionuclide levels in sediment were at historical low levels and continue a significant downward trend in radionuclide activity. Cobalt-60 was not detected in sediment samples from the CCNPP study area in 2016-2017 as a continued consequence of 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 13% of sediment samples in 2016-2017, in low concentrations. Silver-110m in tray oysters has not been detected since 2001, due to a reduction in available ^{110m}Ag released from CCNPP (compared to historical levels). Iodine-131 was not detected during the current monitoring period. Iodine-131 was detected in SAV collected from Susquehanna Flats in recent monitoring years, but the source is believed to be medical.

Concentrations of radionuclides in sediments and biota do not represent a risk to the ecological health of 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 0.0007% (NCRPM 2009) during 2016-2017. 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 (i.e., construction material used in residences), personal choices (e.g., smoking, occupation), routine medical procedures, and other sources of background radiation.

Table 4-1. Comparison of radiation doses to humans from nuclear power plant operations and applicable regulatory limits.

Exposure Route	Maximum Dose Estimate (2016)	Maximum Dose Estimate (2017)	EPA Regulatory Limit (40CFR190 Subpart B)	NRC Regulatory Limit (10CFR50 Appendix I)
Ingestion (mrem)				
Oyster ingestion, whole-body dose (from CCNPP)	<0.007 (child)		25	3
Oyster ingestion, other organ dose (from CCNPP)	<0.05 (adult GI tract)		25	10
Finfish ingestion, whole-body dose (from PBAPS)	0.0041 (adult)		25	3
Finfish ingestion, other organ dose (from PBAPS)	0.0066 (teen liver)		25	10
Inhalation (mrem)				
Whole-body dose (gaseous, from CCNPP)	0.00032 (child)[a]	0.00026 (child)[a]	25	3
Other organ dose (gaseous, from CCNPP)	0.00034 (child skin)[a]	0.00026 (child GI tract)[a]	25	10
Whole-body dose (gaseous, from PBAPS)	0.245 (any age class)[b]	0.214 (any age class)[b]	25	3
Other organ dose (gaseous, from PBAPS)	0.319 (any age class skin)[b]	0.279 (any age class skin)[b]	25	10

(a) Barnett and Ihnacik 2017, 2018
(b) Exelon Generation 2017c, 2018c

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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

INTERCOMPARISON RESULTS

Table B-1. Results of Laboratory Intercomparison Program.

Sample Date	Sample Type and Units	Radionuclide	Laboratory Results average ± 1 SD	Analytical Results average ± 1 SD
6/8/2017	Water-pCi/L	Cr-51	387 ± 64	413
		Mn-54	217 ± 8	225
		Co-58	192 ± 8	204
		Fe-59	140 ± 9	151
		Co-60	241 ± 8	250
		Zn-65	266 ± 12	267
		Cs-134	211 ± 7	247
		Cs-137	181 ± 7	197
		Ce-141	179 ± 12	199

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 2016-2017 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 ± 2 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 2 standard deviation units. Lower limits of detection were excluded from mean calculations.

Table C-1. Radionuclide Concentrations in Sediments at Calvert Cliffs (pCi/kg ± 2 SD).

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
Station CCWES010 - Calvert Cliffs Western Shore Station 1					
3/9/2016	<111	1022±114	<9	<4	<4
7/7/2016	<144	1066±131	<12	<4	3±1
10/20/2016	234±76	1382±159	<19	<5	<6
12/23/2016	<392	907±103	<25	<4	2±1
2016 Average	**234±76**	**1094±406**	--	--	**3±1**
4/28/2017	<110	961±109	<10	<4	3±1
8/10/2017	<608	876±99	<34	<4	3±1
10/27/2017	<287	1044±114	<17	<3	3±1
12/18/2017	<183	750±82	<12	<2	<3
2017 Average	--	**908±251**	--	--	**3±1**
Overall	**234±76**	**1001±264**	--	--	**3±1**
Station CCWES020 - Calvert Cliffs Western Shore Station 2					
3/9/2016	<130	2367±250	<11	<4	4±2
7/7/2016	<103	593±68	<7	<2	3±1
10/20/2016	797±154	5656±575	<31	<8	37±8
12/23/2016	<621	4535±465	<41	<6	21±3
2016 Average	**797±154**	**3288±4512**	--	--	**16±32**
4/28/2017	<100	1677±178	<9	<3	10±2
8/10/2017	<445	944±104	<22	<2	4±1
10/27/2017	<320	1742±206	<21	<4	9±2
12/18/2017	<527	4726±546	<37	<7	19±3
2017 Average	--	**2272±3351**	--	--	**11±13**
Overall	**797±154**	**2780±1436**	--	--	**13±8**
Station CCWES030 - Calvert Cliffs Western Shore Station 3					
3/9/2016	<482	18490±1874	<43	<19	212±27
7/7/2016	<641	18621±1910	<56	<22	187±25
10/20/2016	<1227	18954±1924	<89	<24	174±28
12/23/2016	<1488	16834±1712	<98	<17	164±19
2016 Average	--	**18225±1895**	--	--	**184±41**
4/28/2017	<436	17464±1780	<41	<17	169±19
8/10/2017	<2451	16385±1671	<145	<18	150±23
10/27/2017	<1412	19257±1952	<88	<17	208±23
12/18/2017	<626	12235±1237	<43	<10	110±14
2017 Average	--	**16335±5959**	--	--	**159±81**
Overall	--	**17280±2672**	--	--	**172±36**

Table C-1. (Continued)

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
Station CCWES040 - Calvert Cliffs Western Shore Station 4					
3/9/2016	<520	19068±1937	<47	<21	106±19
7/7/2016	<389	13435±1369	<36	<16	75±16
10/20/2016	<1143	18516±1877	<82	<23	93±19
12/23/2016	<1570	16881±1724	<103	<18	71±14
2016 Average	--	**16975±5072**	--	--	**86±32**
4/28/2017	<465	16899±1737	<42	<20	74±16
8/10/2017	<2064	15143±1541	<127	<16	82±10
10/27/2017	<1201	18347±1857	<75	<15	93±12
12/18/2017	<632	12661±1282	<45	<11	72±12
2017 Average	--	**15762±4896**	--	--	**80±19**
Overall	--	**16369±1715**	--	--	**83±8**
Station CCFLP010 - Calvert Cliffs Flag Ponds Station 1					
3/9/2016	<62	393±48	<5	<2	<3
7/7/2016	<54	319±41	<5	<2	<2
10/20/2016	<187	829±90	<13	<4	<4
12/23/2016	<291	729±94	<18	<3	3±1
2016 Average	--	**567±499**	--	--	**3±1**
4/28/2017	<215	503±69	<16	<3	<3
8/10/2017	<463	434±59	<26	<3	1±1
10/27/2017	<252	359±54	<17	<3	<3
12/18/2017	<171	521±62	<11	<2	<3
2017 Average	--	**454±147**	--	--	**1±1**
Overall	--	**511±160**	--	--	**2±3**
Station CCFLP020 - Calvert Cliffs Flag Ponds Station 2					
3/9/2016	<152	5484±571	<14	<6	27±7
7/7/2016	<122	5729±659	<15	<7	23±3
10/20/2016	236±84	5880±594	<26	<7	35±8
12/23/2016	<517	4311±443	<33	<6	15±2
2016 Average	**236±84**	**5351±1424**	--	--	**25±17**
4/28/2017	<466	5457±558	<33	<7	21±3
8/10/2017	<830	5954±601	<44	<5	26±3
10/27/2017	<411	5842±591	<27	<5	24±3
12/18/2017	<283	4298±435	<19	<4	17±2
2017 Average	--	**5388±1514**	--	--	**22±8**
Overall	**236±84**	**5369±52**	--	--	**24±2**

Table C-1. (Continued)					
Sample Date	**Be-7**	**K-40**	**Co-58**	**Co-60**	**Cs-137**
		Station CCFLP030 - Calvert Cliffs Flag Ponds Station 3			
3/9/2016	<344	14956±1512	<31	<14	231±29
7/7/2016	<260	7370±760	<24	<11	93±14
10/20/2016	<8	15163±1533	<2	<16	180±25
12/23/2016	<1262	13412±1371	<82	<15	130±15
2016 Average	--	**12725±7309**	--	--	**158±120**
4/28/2017	<986	14461±1467	<69	<15	207±22
8/10/2017	<2287	14057±1436	<138	<16	164±19
10/27/2017	<913	15298±1542	<59	<11	169±18
12/18/2017	<7	12066±1227	<2	<11	149±16
2017 Average	--	**13971±2742**	--	--	**172±50**
Overall	--	**13348±1761**	--	--	**165±20**
		Station CCFLP040 - Calvert Cliffs Flag Ponds Station 4			
3/9/2016	<423	18662±1888	<39	<18	120±21
7/7/2016	<322	18105±1848	<37	<19	99±12
10/20/2016	<1075	18940±1919	<79	<23	105±24
12/23/2016	<1597	16547±1696	<103	<19	78±15
2016 Average	--	**18063±2138**	--	--	**101±35**
4/28/2017	<1083	17209±1752	<80	<17	93±16
8/10/2017	<1875	17366±1795	<101	<12	95±14
10/27/2017	<1492	18777±1922	<107	<22	102±13
12/18/2017	<1197	17225±1764	<89	<19	94±17
2017 Average	--	**17644±1516**	--	--	**96±8**
Overall	--	**17854±593**	--	--	**98±7**
		Station CCCCO010 - Calvert Cliffs Outfall Station 1			
3/9/2016	<97	1168±129	<9	<4	<4
7/7/2016	<73	1115±138	<8	<4	<3
10/20/2016	217±42	1797±192	<11	<5	<5
12/23/2016	<239	708±81	<15	<3	1±1
2016 Average	**217±42**	**1197±899**	--	--	**1±1**
4/28/2017	<356	1047±132	<25	<5	<5
8/10/2017	<69991	1106±122	<1126	<4	2±1
10/27/2017	<222	775±85	<14	<3	<3
12/18/2017	<302	1145±141	<21	<4	<4
2017 Average	--	**1018±335**	--	--	**2±1**
Overall	**217±42**	**1108±252**	--	--	**2±1**

Table C-1. (Continued)

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
Station CCCCO020 - Calvert Cliffs Outfall Station 2					
3/9/2016	<73	1277±138	<6	<3	<3
7/7/2016	<82	1370±147	<7	<3	31±4
10/20/2016	364±93	2532±296	<9	<5	12±2
12/23/2016	<1332	8003±845	<90	<17	24±5
2016 Average	**364±93**	**3295±6380**	--	--	**22±20**
4/28/2017	<270	1964±232	<19	<4	8±2
8/10/2017	<632	2065±243	<36	<4	5±1
10/27/2017	<280	1865±197	<20	<4	8±1
12/18/2017	<220	2374±250	<14	<3	8±1
2017 Average	--	**2067±441**	--	--	**7±2**
Overall	**364±93**	**2681±1737**	--	--	**15±21**
Station CCCCO030 - Calvert Cliffs Outfall Station 3					
3/9/2016	<327	16942±1715	<32	<16	181±25
7/7/2016	<251	16521±1689	<32	<17	131±19
10/20/2016	<293	15990±1637	<31	<18	96±17
12/23/2016	<264	3159±324	<18	<4	25±3
2016 Average	--	**13153±13348**	--	--	**108±131**
4/28/2017	<908	14761±1514	<70	<17	89±16
8/10/2017	<1926	14274±1457	<115	<16	120±14
10/27/2017	<923	13923±1419	<66	<15	121±14
12/18/2017	<798	16688±1684	<55	<14	171±19
2017 Average	--	**14911±2466**	--	--	**125±68**
Overall	--	**14032±2487**	--	--	**117±24**
Station CCCCO040 - Calvert Cliffs Outfall Station 4					
3/9/2016	<318	17895±1825	<33	<18	141±19
7/7/2016	<328	18366±1855	<30	<17	170±24
10/20/2016	214±191	17568±1775	<34	<18	110±18
12/23/2016	<1200	16811±1714	<81	<17	102±13
2016 Average	**214±191**	**17660±1308**	--	--	**131±62**
4/28/2017	<815	16788±1716	<65	<19	98±16
8/10/2017	<1577	15874±1614	<104	<16	93±14
10/27/2017	<633	14406±1449	<42	<9	87±10
12/18/2017	<1090	17468±1783	<82	<19	133±16
2017 Average	--	**16134±2648**	--	--	**103±41**
Overall	**214±191**	**16897±2158**	--	--	**117±40**

Table C-1. (Continued)

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
Station CCROP010 - Calvert Cliffs Rocky Point Station 1					
3/9/2016	<62	385±56	<6	<3	<3
7/7/2016	<54	324±42	<5	<3	<3
10/20/2016	<70	588±68	<6	<3	<3
12/23/2016	<227	298±45	<15	<3	<3
2016 Average	--	**399±262**	--	--	--
4/28/2017	<125	366±55	<10	<3	<3
8/10/2017	<315	297±45	<20	<3	<3
10/27/2017	<215	1208±130	<13	<3	<3
12/18/2017	<211	432±58	<15	<3	<3
2017 Average	--	**576±850**	--	--	--
Overall	--	**487±250**	--	--	--
Station CCROP020 - Calvert Cliffs Rocky Point Station 2					
3/9/2016	<58	433±54	<5	<3	<3
7/7/2016	<52	421±58	<5	<3	<3
10/20/2016	140±49	699±88	<5	<3	2±1
12/23/2016	<208	589±71	<14	<3	<3
2016 Average	**140±49**	**535±266**	--	--	**2±1**
4/28/2017	<127	452±63	<10	<3	<3
8/10/2017	<344	462±66	<22	<3	<3
10/27/2017	<210	782±99	<15	<3	3±1
12/18/2017	<157	517±60	<10	<2	<2
2017 Average	--	**553±311**	--	--	**3±1**
Overall	**140±49**	**544±25**	--	--	**2±1**
Station CCROP030 - Calvert Cliffs Rocky Point Station 3					
3/9/2016	<289	15495±1582	<31	<16	101±16
7/7/2016	<309	16186±1639	<29	<16	131±23
10/20/2016	<395	16817±1701	<35	<18	117±19
12/23/2016	<1103	14339±1468	<77	<16	96±12
2016 Average	--	**15709±2122**	--	--	**111±32**
4/28/2017	<587	15558±1589	<49	<16	94±14
8/10/2017	<1508	15174±1545	<99	<16	79±15
10/27/2017	<923	16613±1679	<61	<13	111±13
12/18/2017	<1090	16309±1669	<82	<19	115±19
2017 Average	--	**15914±1326**	--	--	**100±33**
Overall	--	**15812±289**	--	--	**106±16**

Table C-1. (Continued)					
Sample Date	**Be-7**	**K-40**	**Co-58**	**Co-60**	**Cs-137**
Station CCROP040 - Calvert Cliffs Rocky Point Station 4					
3/9/2016	<296	18190±1832	<28	<15	220±27
7/7/2016	<257	17760±1800	<26	<16	83±11
10/20/2016	<249	17688±1798	<27	<17	128±15
12/23/2016	<1032	16324±1655	<71	<15	180±23
2016 Average	--	**17490±1617**	--	--	**153±120**
4/28/2017	<729	17144±1741	<57	<16	206±24
8/10/2017	<1408	16389±1658	<91	<15	183±21
10/27/2017	<838	14568±1480	<63	<14	115±13
12/18/2017	<705	17330±1743	<48	<12	105±12
2017 Average	--	**16358±2521**	--	--	**152±100**
Overall	--	**16924±1601**	--	--	**153±0.3**
Station CCLNG010 - Calvert Cliffs LNG Plant Pipeline Station 1					
3/9/2016	<55	898±99	<5	<3	3±1
7/7/2016	61±25	804±100	<5	<3	3±1
10/20/2016	<52	785±100	<6	<3	<3
12/23/2016	<190	603±77	<13	<3	1±1
2016 Average	**61±25**	**772±247**	--	--	**2.3±2**
4/28/2017	<116	1045±128	<10	<3	<3
8/10/2017	<312	415±57	<20	<3	<3
10/27/2017	<206	879±109	<15	<3	2±1
12/18/2017	<183	778±87	<12	<3	<3
2017 Average	--	**779±533**	--	--	**2±0.8**
Overall	**61±25**	**776±10**	--	--	**2±0.2**
Station CCLNG020 - Calvert Cliffs LNG Plant Pipeline Station 2					
3/9/2016	276±117	12019±1228	<24	<14	67±9
7/7/2016	703±166	13472±1363	<22	<14	89±18
10/20/2016	579±216	12743±1287	<24	<13	83±15
12/23/2016	<826	11357±1160	<57	<13	61±8
2016 Average	**519±440**	**12398±1825**	--	--	**75±27**
4/28/2017	<438	11415±1169	<38	<13	64±8
8/10/2017	<787	11249±1144	66±28	<11	65±8
10/27/2017	<774	13877±1400	<50	<11	78±9
12/18/2017	<569	11698±1183	<40	<11	61±8
2017 Average	--	**12060±2451**	**66±28**	--	**67±15**
Overall	**519±440**	**12229±478**	**66±28**	--	**71±11**

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					
3/9/2016	<312	16419±1666	<30	<17	101±19
7/7/2016	242±172	16836±1703	<22	<17	115±20
10/20/2016	<357	16705±1695	<33	<19	106±21
12/23/2016	<1143	15857±1628	<81	<19	90±12
2016 Average	**242±172**	**16454±869**	--	--	**103±21**
4/28/2017	<603	15387±1582	<51	<18	89±16
8/10/2017	<1024	13914±1426	<73	<16	77±13
10/27/2017	<492	9077±916	<32	<7	50±6
12/18/2017	<548	12694±1286	<41	<11	60±10
2017 Average	--	**12768±5391**	--	--	**69±35**
Overall	**242±172**	**14611±5213**	--	--	**86±48**
Station CCLNG040 - Calvert Cliffs LNG Plant Pipeline Station 4					
3/9/2016	<207	19017±1916	<23	<14	7±3
7/7/2016	<165	18739±1887	<18	<12	<13
10/20/2016	<168	18981±1914	<20	<14	10±3
12/23/2016	<743	17803±1791	<54	<12	<11
2016 Average	--	**18635±1137**	--	--	**8±4**
4/28/2017	<392	17865±1801	<35	<13	15±4
8/10/2017	290±338	18142±1828	<48	<13	9±3
10/27/2017	<674	16498±1660	<50	<12	12±3
12/18/2017	<705	18170±1831	<56	<13	14±4
2017 Average	**290±338**	**17669±1585**	--	--	**13±6**
Overall	**290±338**	**18152±1366**	--	--	**10±6**
Station CCCOV010 - Calvert Cliffs Cove Point Station 1					
3/9/2016	<46	5710±580	<6	<6	18±3
7/7/2016	80±29	5657±648	<7	<6	18±3
10/20/2016	178±35	6210±712	<10	<7	19±3
12/23/2016	<323	5292±538	<23	<5	18±3
2016 Average	**129±139**	**5717±755**	--	--	**18±1**
4/28/2017	<205	5643±576	<18	<7	18±3
8/10/2017	<312	5293±540	<24	<6	15±2
10/27/2017	<335	4378±446	<25	<5	11±2
12/18/2017	<155	3200±324	<11	<3	9±1
2017 Average	--	**4628±2183**	--	--	**13±8**
Overall	**129±139**	**5173±1540**	--	--	**16±7**

Table C-1. (Continued)

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
Station CCCOV020 - Calvert Cliffs Cove Point Station 2					
3/9/2016	148±52	6979±706	<7	<8	38±8
7/7/2016	172±65	7739±782	<8	<7	48±9
10/20/2016	<87	7776±786	<11	<9	43±8
12/23/2016	<392	7059±719	<28	<7	27±4
2016 Average	**160±34**	**7388±856**	--	--	**39±18**
4/28/2017	<247	7132±728	<22	<8	31±4
8/10/2017	<393	6967±712	<30	<8	30±4
10/27/2017	<253	4966±500	<17	<4	18±2
12/18/2017	<396	6560±669	<30	<7	26±4
2017 Average	--	**6406±1979**	--	--	**26±12**
Overall	**160±34**	**6897±1389**	--	--	**33±18**
Station CCCOV030 - Calvert Cliffs Cove Point Station 3					
3/9/2016	<109876543	19947±2497	<644444	<81	105±42
7/7/2016	<183	17011±1740	<20	<18	109±14
10/20/2016	<196	17832±1811	<28	<21	133±22
12/23/2016	<1006	15544±1592	<74	<17	80±17
2016 Average	--	**17583±3677**	--	--	**107±43**
4/28/2017	<538	15739±1614	<48	<17	86±16
8/10/2017	<783	16075±1639	<61	<17	79±15
10/27/2017	<1062	16073±1649	<80	<19	92±12
12/18/2017	<716	16655±1687	<53	<15	98±12
2017 Average	--	**16136±761**	--	--	**89±16**
Overall	--	**16860±2047**	--	--	**98±25**
Station CCCOV040 - Calvert Cliffs Cove Point Station 4					
3/9/2016	<86	18987±1902	<12	<14	<12
7/7/2016	<110	18967±1900	<13	<12	<12
10/20/2016	<164	19618±1975	<20	<14	<12
12/23/2016	<739	17661±1779	<54	<13	<12
2016 Average	--	**18808±1645**	--	--	--
4/28/2017	<378	17813±1795	<34	<12	<13
8/10/2017	<619	17810±1797	<50	<14	<13
10/27/2017	<656	19088±1912	<45	<10	5±2
12/18/2017	<715	18410±1856	<56	<14	<13
2017 Average	--	**18280±1216**	--	--	**5±2**
Overall	--	**18544±747**	--	--	**5±2**

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					
3/9/2016	<126	17353±1759	<17	<21	143±23
7/7/2016	<119	16041±1620	<14	<14	139±21
10/20/2016	<225	17623±1808	<24	<18	100±13
12/23/2016	<796	15458±1582	<57	<14	83±14
2016 Average	--	**16619±2075**	--	--	**116±59**
4/28/2017	<384	15868±1620	<35	<17	100±16
8/10/2017	<741	16085±1640	<58	<17	109±13
10/27/2017	<700	15438±1556	<47	<11	107±12
12/18/2017	<930	16257±1672	<73	<19	90±18
2017 Average	--	**15912±708**	--	--	**101±17**
Overall	--	**16266±999**	--	--	**109±21**
Station CCLCP020 - Calvert Cliffs Little Cove Point Station 2					
3/9/2016	<124	18189±1859	<16	<20	132±17
7/7/2016	<139	18135±1841	<16	<15	148±19
10/20/2016	<167	18337±1852	<18	<17	137±22
12/23/2016	<683	16910±1722	<54	<14	108±14
2016 Average	--	**17893±1322**	--	--	**131±33**
4/28/2017	<378	16548±1688	<36	<16	121±14
8/10/2017	<714	17083±1737	<57	<17	122±14
10/27/2017	<939	16850±1716	<70	<17	95±18
12/18/2017	<884	17149±1749	<70	<18	129±18
2017 Average	--	**16908±543**	--	--	**117±29**
Overall	--	**17400±1393**	--	--	**124±20**
Station CCDRP010 - Calvert Cliffs Drum Point Station 1					
3/9/2016	<63	9614±977	<8	<9	79±9
7/7/2016	90±65	11412±1159	<11	<11	82±10
10/20/2016	1012±374	11407±1152	<33	<11	81±12
12/23/2016	<633	10879±1098	<45	<12	85±15
2016 Average	**551±1305**	**10828±1694**	--	--	**82±5**
4/28/2017	<202	9402±958	<19	<10	62±8
8/10/2017	<424	10480±1063	<34	<10	63±8
10/27/2017	<623	10136±1033	<47	<11	56±7
12/18/2017	<479	9514±968	<36	<10	55±7
2017 Average	--	**9883±1025**	--	--	**59±8**
Overall	**551±1305**	**10356±1337**	--	--	**71±32**

Table C-1. (Continued)

Sample Date	Be-7	K-40	Co-58	Co-60	Cs-137
Station CCDRP020 - Calvert Cliffs Drum Point Station 2					
3/9/2016	<122	18253±1849	<17	<21	119±20
7/7/2016	<133	18185±1837	<16	<16	161±24
10/20/2016	<162	19277±1968	<20	<19	111±17
12/23/2016	<938	17567±1772	<67	<18	101±20
2016 Average	--	**18321±1417**	--	--	**123±53**
4/28/2017	<388	15997±1642	<37	<17	99±13
8/10/2017	<780	17267±1764	<62	<18	108±17
10/27/2017	<769	16949±1709	<52	<12	108±13
12/18/2017	<647	17353±1753	<48	<14	105±15
2017 Average	--	**16892±1242**	--	--	**105±8**
Overall	--	**17606±2021**	--	--	**114±26**

Table C-2. Radionuclide Concentrations in Tray Oysters (pCi/kg± 2 SD). Exposure in days. Concentrations in dry weight (St. Leonard Creek, Outfall) and wet weight (Camp Conoy). NA = Not Available. NT = Not Tested.

Sample Date	Exposure	Be-7	K-40	Ag-110m	Co-60	Cs-137
Station CCSTL000 - St. Leonard Creek Control Station						
3/25/2016	144	<764	8318±1063	<49	<46	<47
6/7/2016	74	<706	8994±1214	<57	<54	<59
9/9/2016	92	<1815	12118±1544	<83	<64	<72
12/5/2016	87	<3056	13464±1614	<119	<83	<100
2016 Average		--	**10724±4930**	--	--	--
3/24/2017	109	<740	9744±1185	<43	<37	<39
6/19/2017	81	<7123	9281±1199	<90	<57	<55
9/8/2017	87	<3077	10338±1451	<95	<75	<75
12/11/2017	95	<1095	12542±1511	<55	<49	<51
2017 Average		--	**10476±2887**	--	--	--
Overall		--	**10600±350**	--	--	--
Station CCPLS000 - Calvert Cliffs Plant Outfall Indicator Station						
3/25/2016	144	<394	8785±945	<25	<24	<24
6/7/2016	74	400±199	8673±931	<22	<22	<22
6/7/2016	181	218±165	8327±954	<27	<27	<28
6/7/2016	344	<334	10124±1100	<29	<27	<30
9/9/2016	92	<732	11824±1311	<41	<42	<36
9/9/2016	312	<1293	12925±1533	<56	<43	<49
12/5/2016	87	<1268	10739±1157	<50	<35	<43
12/5/2016	181	<942	8743±935	<36	<25	<30
2016 Average		**309±257**	**10018±3385**	--	--	--
3/24/2017	109	<603	8857±1064	<34	<30	<29
6/19/2017	81	<3503	6850±805	<43	<27	<27
6/19/2017	196	<4895	7901±918	<47	<26	<28
6/19/2017	284	<4829	8526±976	<47	<30	<27
6/19/2017	378	<5066	8084±936	<48	<29	<27
9/8/2017	87	<1648	9597±1144	<50	<39	<38
12/11/2017	95	<548	8514±969	<29	<26	<27
12/11/2017	176	<555	8682±976	<28	<26	<25
2017 Average		--	**8376±1603**	--	--	--
Overall		**309±257**	**9197±2321**	--	--	--
Calvert Cliffs Camp Conoy Indicator Station						
3/29/2016	NA	NT	1760±120	<6	<6	NT
6/14/2016	NA	NT	2040±120	<5	<6	NT
8/17/2016	NA	NT	2320±190	<9	<11	NT
10/20/2016	NA	NT	2900±170	<7	<8	NT
2016 Average			**2255±974**	--	--	--

Table C-2. (Continued)

Sample Date	Exposure	Be-7	K-40	Ag-110m	Co-60	Cs-137
3/21/2017	NA	NT	1400±100	<5	<6	NT
6/29/2017	NA	NT	2110±180	<10	<11	NT
8/22/2017	NA	NT	2060±180	<10	<10	NT
10/17/2017	NA	NT	2820±150	<7	<8	NT
2017 Average		--	**2098±130**	--	--	--
Overall		--	**2176±223**	--	--	--

Table C-3. Radionuclide Concentrations in Sediments at Peach Bottom (pCi/kg ± 2 SD).

Sample Date	Be-7	K-40	Co-60	Cs-137	Zn-65
Station PBLYH010 - Peach Bottom Little Yellow House Station 1					
5/19/2016	< 177	15266±1531	< 11	272±30	< 40
11/17/2016	< 950	14994±1501	< 12	243±27	< 51
2016 Average	--	**15130±385**	--	**257±42**	--
6/13/2017	< 772	11776±1186	< 9	15±3	< 48
11/7/2017	< 747	15314±1532	< 8	241±24	< 36
2017 Average	--	**13545±5004**	--	**128±320**	--
Overall	--	**14337±2242**	--	**193±183**	--
Station PBLYH020 - Peach Bottom Little Yellow House Station 2					
5/19/2016	646±168	15523±1571	< 14	115±14	< 52
11/17/2016	< 835	13158±1318	< 11	55±10	< 46
2016 Average	**646±168**	**14341±3344**	--	**85±86**	--
6/13/2017	1040±720	16497±1671	< 16	78±10	< 79
11/7/2017	<930	14095±1423	< 12	52±7	< 60
2017 Average	**1040±720**	**15296±3396**	--	**65±37**	--
Overall	**843±557**	**14818±1351**	--	**75±28**	--
Station PBLYH030 - Peach Bottom Little Yellow House Station 3					
5/19/2016	<120	8703±901	<8	42±9	<27
11/17/2016	<588	7514±778	<9	30±9	<35
2016 Average	--	**8108±1680**	--	**36±17**	--
6/13/2017	<681	8132±929	<9	21±3	<42
11/7/2017	<574	8274±855	<6	27±4	<28
2017 Average	--	**8203±202**	--	**24±9**	--
Overall	--	**8156±134**	--	**30±17**	--
Station PBBRC010 - Peach Bottom Broad Creek Station 1					
5/19/2016	<177	13257±1340	14±6	53±7	<42
11/17/2016	<971	15413±1551	<16	86±16	<63
2016 Average	--	**14335±3050**	**14±6**	**69±46**	--
6/13/2017	<635	15671±1587	12±7	75±9	<64
11/7/2017	<1109	16182±1635	<15	70±9	<73
2017 Average	--	**15926±723**	**12±7**	**73±7**	--
Overall	--	**15131±2250**	**13±2.8**	**71±5**	--

Table C-3. (Continued)

Sample Date	Be-7	K-40	Co-60	Cs-137	Zn-65
Station PBBRC020 - Peach Bottom Broad Creek Station 2					
5/19/2016	<122	10318±1037	<9	50±9	<29
11/17/2016	<652	11936±1228	<10	52±11	<40
2016 Average	--	**11127±2288**	--	**51±2**	--
6/13/2017	462±483	11266±1142	<11	43±6	<49
11/7/2017	<602	10338±1065	5±4	38±5	<30
2017 Average	**462±483**	**10802±1312**	**5±4**	**40±7**	--
Overall	**462±483**	**10965±460**	**5±4**	**46±15**	--
Station PBBRC030 - Peach Bottom Broad Creek Station 3					
5/19/2016	97±107	12119±1230	<12	56±8	<44
11/17/2016	<778	11003±1137	<12	60±12	<48
2016 Average	**97±107**	**11561±1579**	--	**58±6**	--
6/13/2017	581±521	11860±1204	<12	55±7	<56
11/7/2017	<1125	15275±1546	<15	71±9	<74
2017 Average	**581±521**	**13568±4829**	--	**63±21**	--
Overall	**339±685**	**12564±2838**	--	**60±7**	--
Station PBCOC010 - Peach Bottom Conowingo Creek Station 1					
5/19/2016	<240	21370±2149	20±7	126±22	<59
11/17/2016	<1080	20438±2050	15±7	114±20	<71
2016 Average	--	**20904±1318**	**17±7**	**120±16**	--
6/13/2017	<1528	20036±2032	<21	103±13	<94
11/7/2017	<1055	18803±1888	<12	95±11	<55
2017 Average	--	**19419±1744**	--	**99±12**	--
Overall	--	**20162±2100**	**17±7**	**109±30**	--
Station PBCOC020 - Peach Bottom Conowingo Creek Station 2					
5/19/2016	1193±231	20156±2040	<18	108±14	<63
11/17/2016	<1037	19516±1959	<18	120±19	<70
2016 Average	**1193±231**	**19836±905**	--	**114±17**	--
6/13/2017	1647±930	17776±1797	<17	90±11	<79
11/7/2017	<1227	20207±2039	<18	99±12	<83
2017 Average	**1647±930**	**18992±3437**	--	**95±13**	--
Overall	**1420±641**	**19414±1194**	--	**104±27**	--

Table C-3. (Continued)

Sample Date	Be-7	K-40	Co-60	Cs-137	Zn-65
Station PBCOC030 - Peach Bottom Conowingo Creek Station 3					
5/19/2016	<198	17903±1801	<15	106±18	<50
11/17/2016	<975	17963±1804	<17	116±22	<66
2016 Average	--	**17933±85**	--	**111±13**	--
6/13/2017	<1223	17416±1766	<17	82±10	<82
11/7/2017	<577	12671±1269	<7	57±7	<33
2017 Average	--	**15043±6711**	--	**70±35**	--
Overall	--	**16488±4087**	--	**90±58**	--
Station PBCOD010 - Peach Bottom Conowingo Dam Station 1					
5/19/2016	100±38	12511±1266	12±6	59±8	<40
11/17/2016	<790	13038±1314	11±6	74±14	<56
2016 Average	**100±38**	**12775±745**	**11±1**	**66±21**	--
6/13/2017	<1108	17564±1784	<18	85±11	<85
11/7/2017	<900	13319±1348	<13	67±8	<63
2017 Average	--	**15442±6003**	--	**76±27**	--
Overall	**100±38**	**14108±3771**	**11±1**	**71±14**	--
Station PBCOD020 - Peach Bottom Conowingo Dam Station 2					
5/19/2016	839±215	21590±2168	8±6	138±22	<53
11/17/2016	<1042	20372±2044	<19	116±20	<72
2016 Average	**839±215**	**20981±1722**	**8±6**	**127±30**	--
6/13/2017	1061±632	18910±1920	<19	107±13	<89
11/7/2017	373±179	14063±1414	<9	65±8	<42
2017 Average	**717±974**	**16487±6854**	--	**86±60**	--
Overall	**778±173**	**18734±6356**	**8±6**	**106±58**	--
Station PBCOD030 - Peach Bottom Conowingo Dam Station 3					
5/19/2016	<208	19802±1995	16±8	90±11	<53
11/17/2016	<1017	19243±1931	<18	113±19	<70
2016 Average	--	**19523±791**	**16±8**	**102±33**	--
6/13/2017	<1253	18822±1907	<18	89±11	<86
11/7/2017	<1112	19044±1921	<16	92±11	<76
2017 Average	--	**18933±314**	--	**91±3**	--
Overall	--	**19228±834**	**16±8**	**96±16**	--

Table C-3. (Continued)

Sample Date	Be-7	K-40	Co-60	Cs-137	Zn-65
Station PBSRV030 - Peach Bottom Susquehanna River Station 3					
4/27/2016	<79	3495±403	<5	7±2	<16
11/18/2016	<293	3945±411	6±3	12±5	<21
2016 Average	--	**3720±636**	**6±3**	**9±7**	--
6/13/2017	<305	3492±404	<5	8±2	<23
11/8/2017	<303	3347±386	<4	7±1	<20
2017 Average	--	**3419±206**	--	**7±1**	--
Overall	--	**3570±425**	**6±3**	**8±3**	--
Station PBSFL010 - Peach Bottom Susquehanna Flats Station 1					
4/27/2016	<100	6860±710	<6	23±6	<21
11/18/2016	<437	8181±845	<9	38±5	<33
2016 Average	--	**7520±1868**	--	**31±21**	--
6/13/2017	<479	8581±871	<9	18±3	<40
11/8/2017	226±132	12847<1287	<7	8±2	<33
2017 Average	**226±132**	**10714±6034**	--	**13±14**	--
Overall	**226±132**	**9117±4517**	--	**22±25**	--
Station PBSFL060 - Peach Bottom Susquehanna Flats Station 6					
4/27/2016	62±45	3527±407	<5	4±1	<17
11/18/2016	<277	3321±347	<5	<6	<19
2016 Average	**62±45**	**3424±291**	--	**4±1**	--
6/13/2017	<259	3438±397	<5	6±1	<22
11/8/2017	<331	3226±373	<5	3±1	<22
2017 Average	--	**3332±299**	--	**4±4**	--
Overall	**62±45**	**3378±130**	--	**4±0.1**	--
Station PBSFL070 - Peach Bottom Susquehanna Flats Station 7					
4/27/2016	<97	5439±565	<6	55±9	<20
11/18/2016	<334	5765±598	<7	54±8	<27
2016 Average	--	**5602±461**	--	**54±3**	--
6/13/2017	<289	4037±465	<5	15±2	<25
11/8/2017	<258	3109±324	<3	3±1	<14
2017 Average	--	**3573±1312**	--	**9±17**	--
Overall	--	**4588±2869**	--	**32±64**	--

Table C-3. (Continued)

Sample Date	Be-7	K-40	Co-60	Cs-137	Zn-65
Station PBSFL080 - Peach Bottom Susquehanna Flats Station 8					
4/27/2016	82±64	5955±681	<7	15±3	<26
11/18/2016	<394	6504±673	<8	28±8	<29
2016 Average	**82±64**	**6230±777**	--	**22±18**	--
6/13/2017	<285	5329±543	<6	11±2	<29
11/8/2017	<462	5621±643	<7	14±3	<33
2017 Average	--	**5475±413**	--	**13±4**	--
Overall	**82±64**	**5852±1067**	--	**17±12**	--
Station PBSFL090 - Peach Bottom Susquehanna Flats Station 9					
4/27/2016	<127	9106±914	<8	45±8	<28
11/18/2016	<458	9829±992	<11	63±13	<41
2016 Average	--	**9468±1023**	--	**54±24**	--
6/13/2017	<346	7626±774	<8	22±3	<37
11/8/2017	<545	10291±1033	<7	38±5	<33
2017 Average	--	**8959±3769**	--	**30±22**	--
Overall	--	**9213±720**	--	**42±33**	--
Station PBUPB100 - Peach Bottom Upper Bay Station 10					
4/27/2016	<168	11073±1121	<10	51±7	<38
11/18/2016	<492	12313±1239	<13	63±13	<46
2016 Average	--	**11693±1754**	--	**57±17**	--
6/13/2017	<453	11435±1159	<12	57±7	<51
11/8/2017	<695	10555±1070	<11	47±6	<51
2017 Average	--	**10995±1245**	--	**52±14**	--
Overall	--	**11344±988**	--	**54±8**	--

Table C-4. Radionuclide Concentrations in Finfish at Peach Bottom (pCi/kg ± 2 SD). *C. carpio* = *Cyprinus carpio*; *I. punctatus* = *Ictalurus punctatus*; *D. cepedianum* = *Dorosoma cepedianum*; *Lepomis* spp. = *Lepomis gibbosus* & *Lepomis macrochirus*; *M. saxatilis* = *Morone saxatilis*; *M. dolomieu* = *Micropterus dolomieu*.

Species	Tissue	Sample Date	Be-7	K-40	Co-60	Cs-137	Zn-65
C. carpio	flesh	5/19/2016	<3843750	10249±1086	<25	<19	<426
C. carpio	flesh	5/19/2016	<2566038	9687±998	<17	<14	<298
C. carpio	flesh	10/26/2016	<374663	6379±682	<15	<13	<182
C. carpio	flesh	10/26/2016	<410169	9036±930	<15	<13	<169
I. punctatus	flesh	5/19/2016	<3095395	8177±871	<20	<17	<345
I. punctatus	flesh	5/19/2016	<2829457	11630±1189	<19	<15	<297
Ictalurus sp.	flesh	5/19/2016	<3529412	11924±1239	<23	12±8	<408
Ictalurus sp.	flesh	5/19/2016	<2734317	12087±1231	<17	<14	<308
Ictalurus sp.	flesh	10/26/2016	<604348	13213±1386	<27	<23	<324
I. punctatus	flesh	10/26/2016	<455939	11253±1150	<17	<15	<195
I. punctatus	flesh	10/26/2016	<586345	12705±1330	<25	<20	<301
D. cepedianum	flesh	5/19/2016	<4071146	13006±1354	<26	<21	<455
D. cepedianum	flesh	5/19/2016	<2632509	11990±1219	<18	11±9	<289
		2016 Average	--	**10872±4105**	--	**11±1**	--
Lepomis spp.	flesh	6/12/2017	<54074	8317±863	<15	<14	<115
C. carpio	flesh	6/12/2017	<119565	11286±1261	<36	<33	<260
C. carpio	flesh	11/16/2017	<11340	12259±1301	<26	<23	<142
I. punctatus	flesh	6/12/2017	<63095	12262±1283	<24	<19	<183
Ictalurus sp.	flesh	6/12/2017	<62727	14851±1514	<20	<18	<155
Ictalurus sp.	flesh	11/16/2017	<9777	14163±1444	<18	<17	<96
I. punctatus	flesh	11/16/2017	<10988	12387±1300	<22	<21	<127
M. dolomieu	flesh	6/12/2017	<69091	14610±1490	<19	<18	<154
M. dolomieu	flesh	11/16/2017	<9870	13853±1412	<18	<17	<97
M. saxatilis	flesh	11/16/2017	<10892	14800±1509	<20	<19	<106
Moxostoma sp.	flesh	11/16/2017	<10551	13402±1368	<18	<16	<99
D. cepedianum	flesh	11/16/2017	<11440	13166±1378	<23	<20	<125
Moxostoma sp.	flesh	11/16/2017	<16181	17911±1844	<26	<26	<149
		2017 Average	--	**13328±4494**	--	--	--
		Overall	--	**12100±3474**	--	**11±1**	--

Table C-4. (Continued)

Species	Tissue	Sample Date	Be-7	K-40	Co-60	Cs-137	Zn-65
C. carpio	gut	5/19/2016	<7725000	3111±553	<60	<45	<880
C. carpio	gut	5/19/2016	<6493151	3190±532	<51	<37	<751
C. carpio	gut	10/26/2016	<1688525	3238±649	<72	<55	<772
C. carpio	gut	10/26/2016	<1268919	3613±556	<47	<36	<500
I. punctatus	gut	5/19/2016	<9774194	2873±616	<73	<54	<1148
I. punctatus	gut	5/19/2016	<7222222	3313±588	<56	<41	<848
Ictalurus sp.	gut	5/19/2016	<10058824	2750±578	<67	<51	<1041
Ictalurus sp.	gut	5/19/2016	<8258065	3326±578	<59	<42	<889
Ictalurus sp.	gut	10/26/2016	<1364384	2269±501	<63	<47	<599
I. punctatus	gut	10/26/2016	<1333333	3919±596	<51	<43	<555
I. punctatus	gut	10/26/2016	<1271605	2905±524	<53	<43	<546
D. cepedianum	gut	5/19/2016	<13163636	4753±846	<88	<65	<1282
D. cepedianum	gut	5/19/2016	<10520000	5373±851	<70	<53	<1098
		2016 Average	--	**3433±1675**	--	--	--
C. carpio	gut	6/12/2017	<167647	3967±677	<64	<51	<440
C. carpio	gut	11/16/2017	<24194	4127±622	<50	<42	<229
I. punctatus	gut	6/12/2017	<155781	3182±640	<62	<51	<430
I. punctatus	gut	6/12/2017	<186207	3758±618	<55	<47	<390
I. punctatus	gut	11/16/2017	<24521	2705±562	<55	<48	<251
I. punctatus	gut	11/16/2017	<24928	3411±563	<44	<39	<228
M. dolomieu	gut	6/12/2017	<191045	3420±631	<59	<54	<443
Ictalurus sp.	gut	11/16/2017	<23421	2794±546	<52	<44	<266
Ictalurus sp.	gut	11/16/2017	<26000	3564±602	<45	<42	<231
Moxostoma sp.	gut	11/16/2017	<36667	3972±719	<70	<60	<356
D. cepedianum	gut	11/16/2017	<29375	3654±661	<60	<55	<316
Moxostoma sp.	gut	11/16/2017	<27826	2870±557	<58	<49	<293
		2017 Average	--	**3452±962**	--	--	--
		Overall	--	**3443±26**	--	--	--

Table C-5. Radionuclide Concentrations in Submerged Aquatic Vegetation (pCi/kg ± 2 SD) at Peach Bottom. *M. spicatum* = *Myriophyllum spicatum*

Species	Sample Date	Be-7	K-40	Co-60	Cs-137	I-131
	Station PBFBT000 - Peach Bottom Susquehanna Flats Fishing Battery Sta.					
M. spicatum	6/12/17	<2380	14514±1827	<49	<45	<26279070
	2017 Average	--	**14514±1827**	--	--	--
	Overall	--	**14514±1827**	--	--	--

Table C-6. Radionuclide Concentrations in Air Particulate and Air (fCi/m^3) ± 2 SD. Sample volume is in m^3. n/a = data not available due to mechanical/power failure.

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
		Calvert Cliffs Long Beach Station			
12/29/2015	1/12/2016	570	1.1±0.1	19±0.4	<5
1/12/2016	1/26/2016	572	1.4±0.2	24±0.3	<7
1/26/2016	2/2/2016	285	1.2±0.3	29±1	<14
2/2/2016	2/10/2016	325	0.6±0.2	14±1	<7
2/10/2016	2/17/2016	285	0.4±0.3	13±1	<8
2/17/2016	2/23/2016	245	0.6±0.3	17±1	<9
2/23/2016	3/1/2016	285	0.4±0.4	15±1	<8
3/1/2016	3/8/2016	285	0.4±0.3	18±1	<8
3/8/2016	3/15/2016	287	1.3±0.2	14±1	<9
3/15/2016	3/22/2016	284	<0.3	14±1	<8
3/22/2016	3/29/2016	287	1±0.2	13±1	<8
3/29/2016	4/5/2016	284	1.1±0.2	14±1	<8
4/5/2016	4/12/2016	284	1.5±0.2	15±1	<8
4/12/2016	4/18/2016	248	0.4±0.4	13±1	<11
4/18/2016	4/26/2016	324	0.7±0.2	19±1	<6
4/26/2016	5/3/2016	284	0.8±0.2	12±1	<7
5/3/2016	5/10/2016	283	<0.3	6±1	<7
5/10/2016	5/18/2016	328	0.7±0.2	15±1	<8
5/18/2016	5/24/2016	250	0.5±0.3	16±1	<10
5/24/2016	5/31/2016	280	0.9±0.3	20±1	<18
5/31/2016	6/7/2016	285	0.5±0.3	12±1	<10
6/7/2016	6/13/2016	259	0.7±0.2	11±1	<10
6/13/2016	6/21/2016	309	0.7±0.2	14±1	<9
6/21/2016	6/28/2016	289	0.9±0.2	18±1	<8
6/28/2016	7/5/2016	284	0.7±0.3	14±1	<9
7/5/2016	7/12/2016	286	0.8±0.2	14±1	<8
7/12/2016	7/19/2016	292	0.6±0.3	17±1	<42
7/19/2016	7/26/2016	282	1.2±0.2	25±1	<47
7/26/2016	8/2/2016	285	0.8±0.3	20±1	<7
8/2/2016	8/9/2016	280	0.7±0.2	14±1	<38
8/9/2016	8/15/2016	255	0.4±0.4	13±1	<10
8/15/2016	8/23/2016	321	0.8±0.2	16±1	<8
8/23/2016	8/31/2016	321	0.6±0.3	17±1	<8
8/31/2016	9/7/2016	285	0.6±0.3	20±1	<9
9/7/2016	9/13/2016	256	1±0.3	29±1	<10
9/13/2016	9/21/2016	319	0.8±0.2	16±1	<8
9/21/2016	9/28/2016	284	1.3±0.3	26±1	<8
9/28/2016	10/2/2016	162	<0.5	5±1	<14
10/2/2016	10/12/2016	409	0.7±0.2	17±1	<6
10/12/2016	10/18/2016	245	1±0.4	22±1	<9
10/18/2016	10/24/2016	246	0.9±0.4	19±1	<10
10/24/2016	10/31/2016	283	1±0.3	21±1	<8
10/31/2016	11/8/2016	326	1.1±0.3	21±1	<9

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
	Calvert Cliffs Long Beach Station (Continued)				
11/8/2016	11/15/2016	286	1.4±0.2	20±1	<9
11/15/2016	11/22/2016	285	1.5±0.2	34±1	<9
11/22/2016	11/30/2016	327	1±0.2	24±1	<8
11/30/2016	12/7/2016	286	0.5±0.3	21±1	<9
12/7/2016	12/13/2016	244	<0.4	21±1	<43
12/13/2016	12/20/2016	285	1.3±0.2	23±1	<8
12/20/2016	12/27/2016	284	1.3±0.3	28±1	<9
12/27/2016	1/3/2017	291	0.6±0.3	16±1	<10
	2016 Average		**0.9±0.6**	**18±11**	--
1/3/2017	1/10/2017	280	0.8±0.2	16±1	<9
1/10/2017	1/18/2017	325	0.8±0.2	21±1	<8
1/18/2017	1/24/2017	246	0.4±0.3	6±1	<9
1/24/2017	1/31/2017	285	0.6±0.2	12±1	<9
1/31/2017	2/7/2017	285	0.9±0.3	22±1	<9
2/7/2017	2/14/2017	284	1.1±0.3	19±1	<20
2/14/2017	2/21/2017	285	0.8±0.3	20±1	<8
2/21/2017	2/28/2017	285	0.8±0.2	17±1	<9
2/28/2017	3/7/2017	284	0.7±0.2	17±1	<8
3/7/2017	3/13/2017	244	0.9±0.3	15±1	<9
3/13/2017	3/21/2017	326	0.9±0.2	17±1	<8
3/21/2017	3/28/2017	286	1±0.3	20±1	<9
3/28/2017	4/4/2017	285	<0.4	10±1	<17
4/4/2017	4/10/2017	245	0.7±0.3	13±1	<10
4/10/2017	4/17/2017	289	1±0.2	10±1	<9
4/17/2017	4/26/2017	363	0.4±0.2	9±1	<7
4/26/2017	5/3/2017	288	0.6±0.3	17±1	<9
5/3/2017	5/9/2017	241	<0.4	11±1	<7
5/9/2017	5/16/2017	286	0.4±0.2	10±1	<7
5/16/2017	5/23/2017	286	0.8±0.3	16±1	<7
5/23/2017	5/30/2017	292	<0.3	8±1	<43
5/30/2017	6/6/2017	279	1.1±0.2	20±1	<9
6/6/2017	6/13/2017	286	0.4±0.3	16±1	<9
6/13/2017	6/20/2017	285	1.5±0.1	15±1	<17
6/20/2017	6/27/2017	284	0.8±0.2	19±1	<17
6/27/2017	7/5/2017	326	0.4±0.3	20±1	<8
7/5/2017	7/12/2017	286	1.3±0.2	20±1	<9
7/12/2017	7/19/2017	284	0.7±0.2	20±1	<8
7/19/2017	7/25/2017	245	1.2±0.4	24±1	<9
7/25/2017	8/1/2017	286	0.4±0.3	15±1	<9
8/1/2017	8/8/2017	285	0.8±0.3	15±1	<8
8/8/2017	8/15/2017	285	1.1±0.2	18±1	<8
8/15/2017	8/22/2017	285	0.8±0.2	21±1	<8
8/22/2017	8/29/2017	287	0.6±0.3	17±1	<8
8/29/2017	9/5/2017	285	0.6±0.4	16±1	<9
9/5/2017	9/12/2017	286	0.6±0.4	13±1	<8

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
		Calvert Cliffs Long Beach Station (Continued)			
9/12/2017	9/19/2017	285	1±0.3	19±1	<8
9/19/2017	9/26/2017	287	1.3±0.2	25±1	<8
9/26/2017	10/3/2017	285	0.6±0.3	12±1	<8
10/3/2017	10/10/2017	285	0.4±0.3	15±1	<9
10/10/2017	10/17/2017	285	0.5±0.3	13±1	<8
10/17/2017	10/24/2017	286	0.8±0.3	21±1	<8
10/24/2017	10/31/2017	285	0.9±0.3	14±1	<8
10/31/2017	11/7/2017	287	1.4±0.3	22±1	<8
11/7/2017	11/14/2017	286	0.7±0.3	15±1	<9
11/14/2017	11/21/2017	286	1±0.2	16±1	<39
11/21/2017	11/28/2017	285	0.7±0.3	23±1	<8
11/28/2017	12/4/2017	245	1.5±0.3	27±1	<10
12/4/2017	12/12/2017	326	1.1±0.2	27±1	<10
12/12/2017	12/19/2017	287	0.8±0.3	21±1	<9
12/19/2017	12/26/2017	283	1.2±0.4	27±1	<10
	2017 Average		**0.8±0.6**	**17±10**	--
	Overall		**0.8±0**	**17±1**	--
		Calvert Cliffs Lusby Station			
12/29/2015	1/12/2016	570	1.2±0.1	17±0.3	<5
1/12/2016	1/26/2016	572	1.4±0.2	22±0.4	<7
1/26/2016	2/2/2016	284	1.3±0.3	24±1	<14
2/2/2016	2/10/2016	325	0.6±0.3	16±1	<7
2/10/2016	2/17/2016	285	0.7±0.3	13±1	<8
2/17/2016	2/23/2016	246	0.8±0.4	19±1	<9
2/23/2016	3/1/2016	284	0.6±0.2	13±1	<8
3/1/2016	3/8/2016	286	<0.4	17±1	<8
3/8/2016	3/15/2016	287	1±0.2	16±1	<9
3/15/2016	3/22/2016	284	0.3±0.3	13±1	<8
3/22/2016	3/29/2016	286	1.3±0.3	16±1	<8
3/29/2016	4/5/2016	284	1.3±0.2	18±1	<8
4/5/2016	4/12/2016	285	1.1±0.3	16±1	<8
4/12/2016	4/18/2016	248	<0.3	7±1	<11
4/18/2016	4/26/2016	325	1.3±0.3	21±1	<6
4/26/2016	5/3/2016	284	1±0.2	12±1	<7
5/3/2016	5/10/2016	283	<0.3	6±1	<7
5/10/2016	5/18/2016	328	1.1±0.3	17±1	<8
5/18/2016	5/24/2016	250	1.5±0.3	16±1	<10
5/24/2016	5/31/2016	280	2±0.3	19±1	<18
5/31/2016	6/7/2016	285	0.6±0.3	14±1	<10
6/7/2016	6/13/2016	260	0.8±0.2	18±1	<10
6/13/2016	6/21/2016	308	0.9±0.2	13±1	<9
6/21/2016	6/28/2016	290	0.7±0.4	19±1	<8
6/28/2016	7/5/2016	284	0.8±0.3	17±1	<9
7/5/2016	7/12/2016	286	0.5±0.3	16±1	<8

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
	Calvert Cliffs Lusby Station (Continued)				
7/12/2016	7/19/2016	292	0.9±0.3	19±1	<42
7/19/2016	7/26/2016	282	1.6±0.3	27±1	<47
7/26/2016	8/2/2016	285	0.7±0.3	24±1	<7
8/2/2016	8/9/2016	280	0.3±0.3	15±1	<38
8/9/2016	8/15/2016	255	1.4±0.3	15±1	<10
8/15/2016	8/23/2016	320	1.1±0.2	17±1	<8
8/23/2016	8/31/2016	322	1.2±0.3	24±1	<8
8/31/2016	9/7/2016	285	0.7±0.3	25±1	<9
9/7/2016	9/13/2016	256	1.7±0.4	31±1	<10
9/13/2016	9/21/2016	319	0.8±0.3	17±1	<8
9/21/2016	9/28/2016	284	0.5±0.3	25±1	<8
9/28/2016	10/2/2016	163	<0.6	3±1	<14
10/2/2016	10/12/2016	409	1.1±0.2	17±1	<6
10/12/2016	10/18/2016	245	1.5±0.3	20±1	<9
10/18/2016	10/24/2016	246	1±0.3	21±1	<10
10/24/2016	10/31/2016	282	0.3±0.3	23±1	<8
10/31/2016	11/8/2016	327	1±0.2	24±1	<9
11/8/2016	11/15/2016	286	1.5±0.3	22±1	<9
11/15/2016	11/22/2016	285	2±0.3	41±1	<9
11/22/2016	11/30/2016	327	1.9±0.2	27±1	<8
11/30/2016	12/7/2016	285	0.6±0.4	22±1	<9
12/7/2016	12/13/2016	244	<0.4	22±1	<43
12/13/2016	12/20/2016	286	1.2±0.3	24±1	<8
12/20/2016	12/27/2016	284	1±0.4	34±1	<9
12/27/2016	1/3/2017	292	0.8±0.3	17±1	<10
2016 Average			**1±0.9**	**19±13**	--
1/3/2017	1/10/2017	280	1.2±0.3	17±1	<9
1/10/2017	1/18/2017	325	0.4±0.2	22±1	<8
1/18/2017	1/24/2017	246	<0.4	7±1	<9
1/24/2017	1/31/2017	285	0.7±0.4	12±1	<9
1/31/2017	2/7/2017	285	0.9±0.3	26±1	<9
2/7/2017	2/14/2017	285	1.3±0.4	21±1	<20
2/14/2017	2/21/2017	286	0.5±0.3	19±1	<8
2/21/2017	2/28/2017	285	0.6±0.3	16±1	<9
2/28/2017	3/7/2017	285	0.7±0.3	18±1	<8
3/7/2017	3/13/2017	246	0.7±0.3	18±1	<9
3/13/2017	3/21/2017	326	1.4±0.2	19±1	<8
3/21/2017	3/28/2017	286	1.1±0.3	21±1	<9
3/28/2017	4/4/2017	285	<0.3	9±1	<17
4/4/2017	4/10/2017	245	0.4±0.4	13±1	<10
4/10/2017	4/17/2017	289	1.1±0.3	16±1	<9
4/17/2017	4/26/2017	363	0.5±0.3	10±1	<7
4/26/2017	5/3/2017	288	0.9±0.3	18±1	<9
5/3/2017	5/9/2017	242	0.7±0.4	12±1	<7
5/9/2017	5/16/2017	286	0.4±0.3	13±1	<7
5/16/2017	5/23/2017	285	0.6±0.3	19±1	<7

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
	Calvert Cliffs Lusby Station (Continued)				
5/23/2017	5/30/2017	292	0.7±0.3	11±1	<43
5/30/2017	6/6/2017	278	1.3±0.4	23±1	<9
6/6/2017	6/13/2017	286	0.4±0.3	18±1	<9
6/13/2017	6/20/2017	284	0.3±0.3	20±1	<17
6/20/2017	6/27/2017	284	0.6±0.4	21±1	<17
6/27/2017	7/5/2017	326	1±0.3	24±1	8
7/5/2017	7/12/2017	286	0.8±0.2	23±1	<9
7/12/2017	7/19/2017	285	1.4±0.2	22±1	<8
7/19/2017	7/25/2017	245	1.8±0.3	29±1	<9
7/25/2017	8/1/2017	286	0.5±0.3	14±1	<9
8/1/2017	8/8/2017	284	1.4±0.3	17±1	<8
8/8/2017	8/15/2017	286	0.3±0.3	20±1	<8
8/15/2017	8/22/2017	285	0.8±0.4	26±1	<8
8/22/2017	8/29/2017	286	1.2±0.3	19±1	<8
8/29/2017	9/5/2017	285	1±0.4	18±1	<9
9/5/2017	9/12/2017	286	0.8±0.3	14±1	<8
9/12/2017	9/19/2017	284	0.9±0.2	19±1	<8
9/19/2017	9/26/2017	287	1.2±0.3	22±1	<8
9/26/2017	10/3/2017	284	0.7±0.3	14±1	<8
10/3/2017	10/10/2017	286	0.9±0.4	15±1	<9
10/10/2017	10/17/2017	285	0.6±0.3	11±1	<8
10/17/2017	10/24/2017	286	1.2±0.3	23±1	<8
10/24/2017	10/31/2017	285	0.5±0.3	16±1	<8
10/31/2017	11/7/2017	288	1.3±0.3	23±1	<8
11/7/2017	11/14/2017	286	1.2±0.3	18±1	<9
11/14/2017	11/21/2017	286	<0.4	24±1	<39
11/21/2017	11/28/2017	285	0.8±0.3	22±1	<8
11/28/2017	12/4/2017	245	1.4±0.3	25±1	<10
12/4/2017	12/12/2017	325	1.3±0.3	26±1	<10
12/12/2017	12/19/2017	287	0.9±0.3	25±1	<9
12/19/2017	12/26/2017	284	1.8±0.3	26±1	<10
	2017 Average		**0.9±0.8**	**19±10**	--
	Overall		**1±0.2**	**19±0**	--
	Calvert Cliffs Cove Point Station				
12/29/2015	1/12/2016	570	0.8±0.1	19±0.4	<5
1/12/2016	1/26/2016	571	1.3±0.1	24±0.4	<7
1/26/2016	2/2/2016	285	0.8±0.2	26±1	<14
2/2/2016	2/10/2016	325	0.7±0.2	16±1	<7
2/10/2016	2/17/2016	285	0.9±0.3	12±1	<8
2/17/2016	2/23/2016	245	0.9±0.3	19±1	<9
2/23/2016	3/1/2016	285	0.3±0.3	15±1	<8
3/1/2016	3/8/2016	285	0.6±0.3	13±1	<8
3/8/2016	3/15/2016	287	<0.4	16±1	<9

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
		Calvert Cliffs Cove Point Station (Continued)			
3/15/2016	3/22/2016	283	0.5±0.3	14±1	8
3/22/2016	3/29/2016	286	0.9±0.3	17±1	<8
3/29/2016	4/5/2016	284	0.8±0.3	17±1	<8
4/5/2016	4/12/2016	285	1.2±0.1	15±1	<8
4/12/2016	4/18/2016	248	0.6±0.3	17±1	<11
4/18/2016	4/26/2016	324	1.5±0.2	19±1	<6
4/26/2016	5/3/2016	284	<0.3	12±1	<7
5/3/2016	5/10/2016	283	0.7±0.2	7±1	<7
5/10/2016	5/18/2016	328	0.7±0.3	17±1	<8
5/18/2016	5/24/2016	250	0.8±0.3	17±1	<10
5/24/2016	5/31/2016	280	0.9±0.3	20±1	<18
5/31/2016	6/7/2016	285	0.6±0.4	11±1	<10
6/7/2016	6/13/2016	260	0.8±0.3	18±1	<10
6/13/2016	6/21/2016	308	0.4±0.3	14±1	<9
6/21/2016	6/28/2016	290	0.7±0.3	21±1	<8
6/28/2016	7/5/2016	284	0.8±0.1	14±1	<9
7/5/2016	7/12/2016	286	0.3±0.3	12±1	<8
7/12/2016	7/19/2016	292	n/a	n/a	<42
7/19/2016	7/26/2016	282	1±0.3	25±1	<47
7/26/2016	8/2/2016	285	0.7±0.3	20±1	<7
8/2/2016	8/9/2016	280	0.6±0.3	15±1	<38
8/9/2016	8/15/2016	255	1±0.3	14±1	<10
8/15/2016	8/23/2016	321	0.6±0.3	21±1	<8
8/23/2016	8/31/2016	321	0.7±0.3	25±1	<8
8/31/2016	9/7/2016	285	1.4±0.3	27±1	<9
9/7/2016	9/13/2016	256	1.3±0.4	35±1	<10
9/13/2016	9/21/2016	319	0.4±0.3	16±1	<8
9/21/2016	9/28/2016	284	1.2±0.3	27±1	<8
9/28/2016	10/2/2016	162	1.2±0.4	4±1	<14
10/2/2016	10/12/2016	409	0.5±0.2	18±1	<6
10/12/2016	10/18/2016	245	1.4±0.3	23±1	<9
10/18/2016	10/24/2016	246	1.2±0.3	22±1	<10
10/24/2016	10/31/2016	283	0.7±0.3	23±1	<8
10/31/2016	11/8/2016	326	0.9±0.2	21±1	<9
11/8/2016	11/15/2016	286	0.5±0.3	20±1	<9
11/15/2016	11/22/2016	285	1.6±0.3	36±1	<9
11/22/2016	11/30/2016	327	1.2±0.2	27±1	<8
11/30/2016	12/7/2016	286	<0.4	21±1	<9
12/7/2016	12/13/2016	244	0.4±0.4	21±1	<43
12/13/2016	12/20/2016	286	1±0.3	28±1	<8
12/20/2016	12/27/2016	284	0.6±0.3	36±1	<9
12/27/2016	1/3/2017	291	0.3±0.3	19±1	<10
	2016 Average		**0.8±0.7**	**19±13**	**--**

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
		Calvert Cliffs Cove Point Station (Continued)			
1/3/2017	1/10/2017	280	0.4±0.3	18±1	<9
1/10/2017	1/18/2017	325	1±0.2	23±1	<8
1/18/2017	1/24/2017	246	<0.2	8±1	<9
1/24/2017	1/31/2017	285	0.5±0.2	16±1	<9
1/31/2017	2/7/2017	285	0.8±0.3	26±1	<9
2/7/2017	2/14/2017	284	1.1±0.3	24±1	<20
2/14/2017	2/21/2017	286	0.7±0.3	20±1	<8
2/21/2017	2/28/2017	285	<0.3	17±1	<9
2/28/2017	3/7/2017	285	0.5±0.3	20±1	<8
3/7/2017	3/13/2017	244	0.5±0.4	17±1	<9
3/13/2017	3/21/2017	326	1.1±0.1	19±1	<8
3/21/2017	3/28/2017	286	1.3±0.2	21±1	<9
3/28/2017	4/4/2017	285	0.6±0.2	8±1	<17
4/4/2017	4/10/2017	245	<0.3	12±1	<10
4/10/2017	4/17/2017	289	0.7±0.3	19±1	<9
4/17/2017	4/26/2017	363	0.6±0.2	9±1	<7
4/26/2017	5/3/2017	288	0.7±0.3	14±1	<9
5/3/2017	5/9/2017	242	0.5±0.3	10±1	<7
5/9/2017	5/16/2017	286	<0.4	12±1	<7
5/16/2017	5/23/2017	286	1±0.3	18±1	<7
5/23/2017	5/30/2017	292	<0.3	8±1	<43
5/30/2017	6/6/2017	278	1.4±0.3	19±1	<9
6/6/2017	6/13/2017	286	0.3±0.3	18±1	<9
6/13/2017	6/20/2017	284	0.6±0.3	18±1	<17
6/20/2017	6/27/2017	284	0.4±0.2	21±1	<17
6/27/2017	7/5/2017	326	1.4±0.2	26±1	<8
7/5/2017	7/12/2017	286	0.8±0.2	21±1	<9
7/12/2017	7/19/2017	285	0.5±0.4	19±1	<8
7/19/2017	7/25/2017	245	1.3±0.2	29±1	<9
7/25/2017	8/1/2017	286	0.4±0.3	16±1	<9
8/1/2017	8/8/2017	285	<0.4	18±1	<8
8/8/2017	8/15/2017	285	0.4±0.3	21±1	<8
8/15/2017	8/22/2017	285	0.9±0.3	27±1	<8
8/22/2017	8/29/2017	286	0.6±0.3	20±1	<8
8/29/2017	9/5/2017	285	1.8±0.3	18±1	<9
9/5/2017	9/12/2017	286	0.9±0.3	17±1	<8
9/12/2017	9/19/2017	284	0.8±0.3	22±1	<8
9/19/2017	9/26/2017	287	1.5±0.2	26±1	<8
9/26/2017	10/3/2017	285	0.3±0.3	16±1	<8
10/3/2017	10/10/2017	285	1±0.3	17±1	<9
10/10/2017	10/17/2017	285	0.4±0.2	13±1	<8
10/17/2017	10/24/2017	286	1.1±0.2	29±1	<8
10/24/2017	10/31/2017	285	1.2±0.3	17±1	<8
10/31/2017	11/7/2017	287	1.4±0.3	26±1	<8

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
	Calvert Cliffs Cove Point Station (Continued)				
11/7/2017	11/14/2017	286	0.3±0.3	19±1	<9
11/14/2017	11/21/2017	286	0.7±0.3	22±1	<39
11/21/2017	11/28/2017	285	1.2±0.3	24±1	<8
11/28/2017	12/4/2017	245	0.8±0.4	28±1	<10
12/4/2017	12/12/2017	326	1±0.3	29±1	<10
12/12/2017	12/19/2017	286	0.7±0.2	25±1	<9
12/19/2017	12/26/2017	284	1±0.3	25±1	<10
	2017 Average		**0.8±0.7**	**19±11**	--
	Overall		**0.8±0**	**19±0**	--
	Calvert Cliffs Horn Point Station				
12/29/2015	1/11/2016	535	0.8±0.1	16±0.4	<2
1/11/2016	1/25/2016	575	1.7±0.1	22±0.4	<10
1/25/2016	2/2/2016	319	0.8±0.2	17±1	<14
2/2/2016	2/8/2016	253	0.4±0.3	16±1	<12
2/8/2016	2/14/2016	237	0.6±0.3	9±1	<13
2/14/2016	2/22/2016	330	1.1±0.2	15±1	<8
2/22/2016	2/29/2016	293	0.6±0.3	14±1	<10
2/29/2016	3/7/2016	277	0.5±0.3	16±1	<9
3/7/2016	3/13/2016	241	0.6±0.4	14±1	<13
3/13/2016	3/21/2016	325	0.6±0.2	11±1	<9
3/21/2016	3/28/2016	285	1.2±0.3	14±1	<9
3/28/2016	4/4/2016	287	0.6±0.3	15±1	<9
4/4/2016	4/10/2016	243	1.5±0.1	14±1	<12
4/10/2016	4/18/2016	323	1±0.3	17±1	<5
4/18/2016	4/25/2016	289	1.4±0.2	17±1	<3
4/25/2016	5/2/2016	285	0.4±0.3	13±1	<7
5/2/2016	5/9/2016	284	0.7±0.2	5±1	<7
5/9/2016	5/15/2016	246	0.4±0.3	12±1	<13
5/15/2016	5/23/2016	327	0.9±0.2	9±1	<18
5/23/2016	5/29/2016	243	1±0.4	20±1	<12
5/29/2016	6/8/2016	407	0.2±0.2	10±1	<4
6/8/2016	6/13/2016	214	0.7±0.4	17±1	<6
6/13/2016	6/20/2016	273	0.3±0.3	11±1	<21
6/20/2016	6/27/2016	286	0.8±0.3	17±1	<5
6/27/2016	7/3/2016	249	0.8±0.2	12±1	<6
7/3/2016	7/11/2016	339	0.6±0.2	13±1	<16
7/11/2016	7/19/2016	313	N/A	N/A	<3
7/19/2016	7/24/2016	203	1.5±0.4	21±1	<8
7/24/2016	8/2/2016	364	0.8±0.2	19±1	<4
8/2/2016	8/8/2016	250	0.9±0.3	13±1	<6
8/8/2016	8/14/2016	258	1±0.3	13±1	<1
8/14/2016	8/23/2016	367	0.7±0.2	12±1	<2
8/23/2016	8/29/2016	254	1±0.3	16±1	<3
8/29/2016	9/6/2016	321	0.7±0.3	17±1	<16
9/6/2016	9/12/2016	244	1.2±0.4	25±1	<22

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
	Calvert Cliffs Horn Point Station (Continued)				
9/12/2016	9/19/2016	292	<0.3	15±1	<20
9/19/2016	9/28/2016	359	0.3±0.2	15±1	<2
9/28/2016	10/1/2016	140	0.5±0.4	6±1	<11
10/1/2016	10/10/2016	358	0.7±0.2	13±1	<5
10/10/2016	10/18/2016	319	0.6±0.2	15±1	<2
10/18/2016	10/24/2016	256	0.3±0.3	17±1	<6
10/24/2016	10/30/2016	246	0.6±0.3	15±1	<6
10/30/2016	11/6/2016	278	1.2±0.3	18±1	<23
11/6/2016	11/13/2016	293	0.6±0.3	11±1	<22
11/13/2016	11/21/2016	318	0.9±0.3	26±1	<17
11/21/2016	11/28/2016	296	0.7±0.2	17±1	<3
11/28/2016	12/5/2016	292	0.9±0.4	22±1	<3
12/5/2016	12/10/2016	195	<0.5	13±1	<12
12/10/2016	12/19/2016	357	0.7±0.2	21±1	<15
12/19/2016	12/26/2016	299	0.7±0.3	27±1	<19
12/26/2016	1/3/2017	325	0.4±0.3	12±1	<5
2016 Average			**0.8±0.7**	**15±9**	--
1/3/2017	1/9/2017	233	<0.4	16±1	<7
1/9/2017	1/17/2017	334	0.4±0.2	17±1	<39
1/17/2017	1/21/2017	170	<0.4	11±1	<9
1/21/2017	1/29/2017	320	0.6±0.2	8±1	<3
1/29/2017	2/6/2017	325	0.9±0.3	17±1	<19
2/6/2017	2/13/2017	279	1±0.3	19±1	<11
2/13/2017	2/19/2017	255	0.5±0.4	18±1	<6
2/19/2017	2/27/2017	319	<0.3	15±1	<5
2/27/2017	3/5/2017	251	<0.3	16±1	<6
3/5/2017	3/12/2017	280	0.5±0.3	14±1	<6
3/12/2017	3/19/2017	287	1.3±0.1	17±1	<5
3/19/2017	3/27/2017	317	1±0.2	19±1	<2
3/27/2017	4/2/2017	252	0.9±0.2	9±1	<9
4/2/2017	4/10/2017	319	0.4±0.3	7±1	<5
4/10/2017	4/17/2017	295	0.9±0.3	14±1	<5
4/17/2017	4/26/2017	358	0.2±0.2	7±1	<14
4/26/2017	5/1/2017	214	0.6±0.4	13±1	<27
5/1/2017	5/8/2017	271	0.4±0.2	9±1	<6
5/8/2017	5/15/2017	301	<0.3	9±1	<3
5/15/2017	5/22/2017	285	1±0.3	15±1	<3
5/22/2017	5/29/2017	283	<0.3	5±1	<7
5/29/2017	6/5/2017	282	1±0.3	15±1	<19
6/5/2017	6/12/2017	293	0.6±0.3	18±1	<19
6/12/2017	6/20/2017	329	1±0.3	19±1	<4
6/20/2017	6/26/2017	241	1.4±0.3	18±1	<3
6/26/2017	7/4/2017	325	1±0.2	18±1	<5
7/4/2017	7/10/2017	246	0.6±0.2	19±1	<3
7/10/2017	7/17/2017	270	<0.4	21±1	<14

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
		Calvert Cliffs Horn Point Station (Continued)			
7/17/2017	7/24/2017	287	1±0.2	20±1	<9
7/24/2017	7/31/2017	284	<0.3	13±1	<9
7/31/2017	8/7/2017	287	<0.4	17±1	<9
8/7/2017	8/14/2017	284	<0.3	16±1	<9
8/14/2017	8/21/2017	286	0.7±0.3	22±1	<9
8/21/2017	8/27/2017	246	1.1±0.3	19±1	<11
8/27/2017	9/4/2017	322	0.8±0.3	14±1	<9
9/4/2017	9/10/2017	250	0.7±0.4	19±1	<10
9/10/2017	9/17/2017	284	0.7±0.3	16±1	<10
9/17/2017	9/24/2017	287	1.6±0.2	19±1	<10
9/24/2017	10/1/2017	285	0.8±0.3	14±1	<10
10/1/2017	10/8/2017	284	1.1±0.3	18±1	<9
10/8/2017	10/15/2017	293	0.7±0.2	9±1	<9
10/15/2017	10/23/2017	317	1.2±0.2	19±1	<8
10/23/2017	10/29/2017	250	0.9±0.3	16±1	<11
10/29/2017	11/5/2017	290	1.1±0.3	21±1	<10
11/5/2017	11/12/2017	281	<0.3	19±1	<10
11/12/2017	11/19/2017	284	1.3±0.3	23±1	<10
11/19/2017	11/26/2017	284	1±0.3	25±1	<9
11/26/2017	12/3/2017	288	0.9±0.3	26±1	<9
12/3/2017	12/10/2017	287	0.6±0.4	28±1	<11
12/10/2017	12/18/2017	322	0.9±0.2	21±1	<9
	2017 Average		**0.9±0.6**	**16±10**	--
	Overall		**0.8±0.1**	**16±1**	--
		Baltimore City Station			
12/29/2015	1/12/2016	571	0.8±0.2	18±0.4	<5
1/12/2016	1/29/2016	688	1.6±0.1	22±0.3	<3
1/29/2016	2/2/2016	168	1.3±0.4	22±1	<14
2/2/2016	2/10/2016	325	0.7±0.2	15±1	<7
2/10/2016	2/17/2016	286	0.3±0.3	12±1	<8
2/17/2016	2/23/2016	244	0.7±0.3	16±1	<9
2/23/2016	3/1/2016	286	0.4±0.3	11±1	<8
3/1/2016	3/8/2016	284	0.8±0.3	15±1	<8
3/8/2016	3/15/2016	286	0.8±0.2	13±1	<9
3/15/2016	3/22/2016	284	0.9±0.3	11±1	<8
3/22/2016	3/29/2016	286	1±0.3	12±1	<8
3/29/2016	4/5/2016	285	0.8±0.3	18±1	<8
4/5/2016	4/12/2016	285	1±0.2	14±1	<8
4/12/2016	4/20/2016	323	0.3±0.3	8±1	<2
4/20/2016	4/26/2016	248	0.9±0.4	24±1	<3
4/26/2016	5/3/2016	285	1.1±0.2	16±1	<7
5/3/2016	5/10/2016	282	<0.3	10±1	<7
5/10/2016	5/18/2016	329	0.9±0.2	17±1	<8
5/18/2016	5/25/2016	285	1.3±0.3	22±1	<5

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
		Baltimore City Station (Continued)			
5/25/2016	5/31/2016	244	1±0.4	31±1	<6
5/31/2016	6/7/2016	286	1.3±0.2	19±1	<10
6/7/2016	6/14/2016	278	<0.4	16±1	<5
6/14/2016	6/22/2016	327	0.9±0.2	16±1	<4
6/22/2016	6/28/2016	251	1.2±0.2	24±1	<5
6/28/2016	7/5/2016	284	0.7±0.3	14±1	<9
7/5/2016	7/12/2016	287	0.7±0.3	17±1	<8
7/12/2016	7/20/2016	322	N/A	N/A	<2
7/20/2016	7/27/2016	282	0.6±0.3	25±1	<3
7/27/2016	8/3/2016	286	0.7±0.3	22±1	<3
8/3/2016	8/9/2016	247	0.4±0.2	17±1	<3
8/9/2016	8/16/2016	283	1.2±0.3	13±1	<4
8/16/2016	8/23/2016	294	0.8±0.3	16±1	<5
8/23/2016	8/31/2016	320	0.9±0.3	24±1	<8
8/31/2016	9/7/2016	285	1.7±0.3	25±1	<9
9/7/2016	9/14/2016	281	1.3±0.3	27±1	<2
9/14/2016	9/21/2016	295	0.8±0.3	18±1	<3
9/21/2016	9/28/2016	284	0.4±0.3	28±1	<3
9/28/2016	10/3/2016	198	<0.4	5±1	<3
10/3/2016	10/12/2016	373	0.8±0.2	17±1	<2
10/12/2016	10/18/2016	245	1±0.3	22±1	<9
10/18/2016	10/25/2016	283	0.9±0.3	18±1	<3
10/25/2016	10/31/2016	248	0.9±0.3	19±1	<3
10/31/2016	11/9/2016	368	0.9±0.3	21±1	<2
11/9/2016	11/15/2016	245	0.6±0.3	19±1	<3
11/15/2016	11/22/2016	284	0.7±0.3	27±1	<9
11/22/2016	11/30/2016	327	1.1±0.2	223±1	<8
11/30/2016	12/7/2016	286	1.1±0.3	18±1	<9
12/7/2016	12/13/2016	245	<0.4	16±1	<43
12/13/2016	12/20/2016	284	0.9±0.3	22±1	<8
12/20/2016	12/27/2016	285	1±0.3	26±1	<9
12/27/2016	1/4/2017	323	<0.3	12±1	<2
	2016 Average		**0.9±0.6**	**22±58**	--
1/4/2017	1/10/2017	248	1.1±0.3	16±1	<5
1/10/2017	1/18/2017	325	0.5±0.3	18±1	<8
1/18/2017	1/24/2017	247	<0.3	5±1	<9
1/24/2017	1/31/2017	285	0.5±0.3	11±1	<9
1/31/2017	2/8/2017	320	0.5±0.3	19±1	<2
2/8/2017	2/14/2017	249	0.7±0.3	17±1	<6
2/14/2017	2/21/2017	286	0.5±0.3	16±1	<8
2/21/2017	2/28/2017	287	0.6±0.3	13±1	<9
2/28/2017	3/7/2017	283	0.7±0.3	15±1	<8
3/7/2017	3/13/2017	245	<0.4	11±1	<9

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
		Baltimore City Station (Continued)			
3/13/2017	3/21/2017	327	0.7±0.2	15±1	<8
3/21/2017	3/28/2017	285	1.4±0.3	15±1	<9
3/28/2017	4/4/2017	287	0.5±0.3	8±1	<17
4/4/2017	4/10/2017	243	<0.4	7±1	<10
4/10/2017	4/17/2017	290	0.7±0.3	12±1	<9
4/17/2017	4/26/2017	363	<0.3	7±1	<7
4/26/2017	5/3/2017	288	1±0.3	12±1	<9
5/3/2017	5/9/2017	235	0.5±0.3	9±1	<7
5/9/2017	5/16/2017	287	0.4±0.3	8±1	<7
5/16/2017	5/23/2017	284	0.6±0.3	13±1	<7
5/23/2017	5/31/2017	321	0.5±0.2	6±1	<2
5/31/2017	6/6/2017	250	1±0.3	17±1	<5
6/6/2017	6/13/2017	287	0.6±0.3	13±1	<9
6/13/2017	6/20/2017	284	0.6±0.3	15±1	<17
6/20/2017	6/27/2017	284	0.5±0.3	16±1	<17
6/27/2017	7/5/2017	326	0.6±0.2	16±1	<8
7/5/2017	7/12/2017	286	0.9±0.2	16±1	<9
7/12/2017	7/19/2017	285	0.6±0.3	17±1	<8
7/19/2017	7/25/2017	243	0.6±0.4	22±1	<9
7/25/2017	8/1/2017	287	0.6±0.3	11±1	<9
8/1/2017	8/8/2017	285	0.4±0.3	14±1	<8
8/8/2017	8/15/2017	286	0.7±0.3	16±1	<8
8/15/2017	8/22/2017	284	0.8±0.3	21±1	<8
8/22/2017	8/29/2017	285	<0.3	13±1	<8
8/29/2017	9/5/2017	286	1.5±0.3	13±1	<9
9/5/2017	9/12/2017	286	0.7±0.3	10±1	<8
9/12/2017	9/19/2017	287	<0.3	18±1	<8
9/19/2017	9/26/2017	283	1.4±0.2	26±1	<8
9/26/2017	10/3/2017	286	1.1±0.2	11±1	<8
10/3/2017	10/10/2017	285	0.8±0.3	16±1	<9
10/10/2017	10/17/2017	285	<0.3	12±1	<8
10/17/2017	10/24/2017	285	1.4±0.1	19±1	<8
10/24/2017	10/31/2017	285	0.5±0.2	11±1	<8
10/31/2017	11/7/2017	289	1.7±0.3	18±1	<8
11/7/2017	11/14/2017	285	0.5±0.3	17±1	<9
11/14/2017	11/21/2017	286	1±0.3	18±1	<39
11/21/2017	11/28/2017	284	0.9±0.3	20±1	<8
11/28/2017	12/4/2017	245	0.7±0.2	19±1	<10
12/4/2017	12/12/2017	329	1±0.2	23±1	<10
12/12/2017	12/19/2017	284	0.9±0.3	21±1	<9
12/19/2017	12/26/2017	284	1.6±0.2	22±1	<10
	2017 Average		**0.8±0.7**	**15±9**	--
	Overall		**0.8±0.1**	**18±10**	--

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
		Peach Bottom Rising Sun Station			
12/28/2015	1/11/2016	566	1±0.2	18±0.4	<6
1/11/2016	1/25/2016	575	1.5±0.2	25±0.3	<10
1/25/2016	2/2/2016	319	1.2±0.3	25±1	<14
2/2/2016	2/8/2016	245	0.4±0.3	16±1	<12
2/8/2016	2/14/2016	244	0.8±0.3	14±1	<13
2/14/2016	2/22/2016	331	1±0.2	15±1	<8
2/22/2016	2/29/2016	294	<0.4	15±1	<10
2/29/2016	3/7/2016	276	0.9±0.3	18±1	<9
3/7/2016	3/13/2016	243	1.2±0.3	19±1	<13
3/13/2016	3/21/2016	325	<0.3	10±1	<9
3/21/2016	3/28/2016	285	1.3±0.2	16±1	<9
3/28/2016	4/4/2016	287	0.9±0.2	18±1	<9
4/4/2016	4/10/2016	243	0.8±0.3	14±1	<12
4/10/2016	4/17/2016	294	1.1±0.3	17±1	<9
4/17/2016	4/25/2016	318	1.5±0.3	22±1	<7
4/25/2016	5/2/2016	285	0.8±0.2	17±1	<7
5/2/2016	5/9/2016	284	<0.3	5±1	<7
5/9/2016	5/15/2016	246	1±0.3	13±1	<13
5/15/2016	5/23/2016	327	1.2±0.2	15±1	<18
5/23/2016	5/29/2016	224	1.2±0.4	31±1	<12
5/29/2016	6/7/2016	397	1.2±0.2	16±	<15
6/7/2016	6/13/2016	233	0.7±0.3	16±1	<20
6/13/2016	6/20/2016	298	0.5±0.3	14±1	<21
6/20/2016	6/26/2016	249	1.4±0.2	24±1	<22
6/26/2016	7/3/2016	273	0.8±0.3	17±1	<20
7/3/2016	7/11/2016	328	1.4±0.2	19±1	<16
7/11/2016	7/18/2016	290	N/A	N/A	<50
7/18/2016	7/24/2016	244	2±0.2	25±1	<55
7/24/2016	8/1/2016	349	1.6±0.3	27±1	<42
8/1/2016	8/8/2016	288	0.8±0.2	17±1	<18
8/8/2016	8/15/2016	270	<0.4	15±1	<19
8/15/2016	8/22/2016	299	1.2±0.2	23±1	<20
8/22/2016	8/29/2016	286	1.6±0.3	26±1	<20
8/29/2016	9/6/2016	321	1±0.2	25±1	<16
9/6/2016	9/12/2016	243	2±0.3	39±1	<22
9/12/2016	9/19/2016	293	1±0.2	20±1	<20
9/19/2016	9/26/2016	282	1.2±0.3	28±1	<19
9/26/2016	10/1/2016	216	0.6±0.4	13±1	<25

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
Peach Bottom Rising Sun Station (Continued)					
10/1/2016	10/9/2016	326	0.7±0.3	20±1	<19
10/9/2016	10/17/2016	318	0.5±0.3	20±1	<17
10/17/2016	10/25/2016	314	0.4±0.3	22±1	<15
10/25/2016	10/30/2016	218	0.6±0.3	24±1	<23
10/30/2016	11/6/2016	282	0.9±0.3	26±1	<23
11/6/2016	11/13/2016	289	1.4±0.2	21±1	<22
11/13/2016	11/21/2016	319	2.1±0.2	42±1	<17
11/21/2016	11/27/2016	253	1±0.3	25±1	<25
11/27/2016	12/5/2016	324	1±0.3	26±1	<19
12/5/2016	12/10/2016	205	0.5±0.5	19±1	<12
12/10/2016	12/19/2016	358	1.4±0.2	31±1	<15
12/19/2016	12/26/2016	298	1.4±0.3	33±1	<19
12/26/2016	1/4/2017	351	0.5±0.3	20±1	<14
2016 Average			**1.1±0.8**	**21±14**	--
1/4/2017	1/9/2017	208	1.2±0.3	24±1	<24
1/9/2017	1/17/2017	336	1.1±0.2	23±1	<39
1/17/2017	1/22/2017	207	0.6±0.4	13±1	<27
1/22/2017	1/29/2017	283	<0.2	10±1	<21
1/29/2017	2/6/2017	325	0.8±0.3	21±1	<19
2/6/2017	2/13/2017	282	1.6±0.3	23±1	<11
2/13/2017	2/20/2017	280	1.4±0.3	25±1	<18
2/20/2017	2/27/2017	292	1.2±0.2	18±1	<18
2/27/2017	3/6/2017	273	1.3±0.3	21±1	<19
3/6/2017	3/12/2017	256	0.7±0.3	19±1	<20
3/12/2017	3/18/2017	244	1.6±0.3	22±1	<25
3/18/2017	3/27/2017	362	1.4±0.2	23±1	<15
3/27/2017	4/2/2017	256	0.5±0.4	12±1	<9
4/2/2017	4/11/2017	353	0.7±0.2	13±1	<7
4/11/2017	4/17/2017	244	1.1±0.2	22±1	<20
4/17/2017	4/26/2017	358	0.5±0.2	8±1	<14
4/26/2017	5/1/2017	215	0.4±0.4	11±1	<27
5/1/2017	5/7/2017	244	<0.4	10±1	<12
5/7/2017	5/14/2017	274	0.7±0.2	10±1	<46
5/14/2017	5/22/2017	339	0.6±0.3	15±1	<38
5/22/2017	5/29/2017	284	<0.3	8±1	<10
5/29/2017	6/5/2017	281	1.2±0.2	18±1	<19
6/5/2017	6/12/2017	293	1.1±0.3	18±1	<19
6/12/2017	6/21/2017	347	1.1±0.1	15±1	<12
6/21/2017	6/27/2017	247	0.5±0.3	21±1	<20
6/27/2017	7/5/2017	318	0.9±0.3	22±1	<15
7/5/2017	7/10/2017	230	0.5±0.3	18±1	<13
7/10/2017	7/17/2017	270	1.3±0.3	21±1	<14
7/17/2017	7/24/2017	288	0.8±0.3	26±1	<9
7/24/2017	7/31/2017	284	0.4±0.3	13±1	<9

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
	Peach Bottom Rising Sun Station (Continued)				
7/31/2017	8/7/2017	287	0.8±0.3	21±1	<9
8/7/2017	8/14/2017	284	1±0.2	22±1	<9
8/14/2017	8/21/2017	286	1.2±0.2	26±1	<9
8/21/2017	8/27/2017	245	1.2±0.3	21±1	<11
8/27/2017	9/4/2017	321	1±0.3	14±1	<9
9/4/2017	9/10/2017	251	0.9±0.4	23±1	<10
9/10/2017	9/17/2017	284	1.3±0.3	16±1	<10
9/17/2017	9/24/2017	288	1.1±0.2	24±1	<10
9/24/2017	10/1/2017	285	0.8±0.3	16±1	<10
10/1/2017	10/8/2017	284	1.4±0.3	22±1	<9
10/8/2017	10/15/2017	293	0.5±0.3	13±1	<9
10/15/2017	10/23/2017	318	0.7±0.3	24±1	<8
10/23/2017	10/29/2017	250	0.6±0.3	15±1	<11
10/29/2017	11/5/2017	290	1.2±0.3	18±1	<10
11/5/2017	11/12/2017	281	0.8±0.3	18±1	<10
11/12/2017	11/19/2017	284	1±0.2	24±1	<10
11/19/2017	11/26/2017	284	1.3±0.3	24±1	<9
11/26/2017	12/3/2017	287	0.7±0.3	26±1	<9
12/3/2017	12/10/2017	287	1.4±0.3	28±1	<11
12/10/2017	12/18/2017	321	0.7±0.2	24±1	<9
12/18/2017	12/24/2017	240	1.1±0.4	26±1	<12
	2017 Average		**1±0.7**	**19±11**	--
	Overall		**1±0.2**	**20±3**	--
	Peach Bottom Whiteford Station				
12/28/2015	1/11/2016	569	0.9±0.1	15±0.3	<6
1/11/2016	1/26/2016	598	1.2±0.2	22±0.3	<4
1/26/2016	2/2/2016	296	0.7±0.3	21±1	<5
2/2/2016	2/8/2016	242	<0.4	15±1	<12
2/8/2016	2/14/2016	248	0.4±0.4	12±1	<13
2/14/2016	2/22/2016	331	0.5±0.3	15±1	<8
2/22/2016	2/29/2016	294	0.7±0.2	12±1	<10
2/29/2016	3/7/2016	276	<0.4	17±1	<9
3/7/2016	3/13/2016	244	1.4±0.2	17±1	<13
3/13/2016	3/21/2016	325	0.4±0.1	11±1	<9
3/21/2016	3/28/2016	284	1±0.3	14±1	<9
3/28/2016	4/4/2016	287	1.1±0.2	18±1	<9
4/4/2016	4/10/2016	243	0.4±0.4	14±1	<12
4/10/2016	4/17/2016	289	0.9±0.3	15±1	<9
4/17/2016	4/25/2016	323	0.8±0.3	18±1	<7
4/25/2016	5/2/2016	285	1.2±0.2	14±1	<7
5/2/2016	5/9/2016	284	0.6±0.3	4±1	<7
5/9/2016	5/15/2016	246	<0.4	13±1	<13
5/15/2016	5/23/2016	327	0.9±0.2	14±1	<18
5/23/2016	5/29/2016	244	1.1±0.3	22±1	<12

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
	Peach Bottom Whiteford Station (Continued)				
5/29/2016	6/7/2016	397	0.8±0.2	13±0.3	<15
6/7/2016	6/13/2016	232	0.8±0.3	13±1	<20
6/13/2016	6/20/2016	299	0.7±0.2	12±1	<21
6/20/2016	6/26/2016	249	0.8±0.4	16±1	<22
6/26/2016	7/3/2016	276	0.8±0.3	15±1	<20
7/3/2016	7/11/2016	325	0.5±0.3	16±1	<16
7/11/2016	7/18/2016	290	N/A	N/A	<50
7/18/2016	7/23/2016	214	1.1±0.4	18±1	<8
7/23/2016	8/1/2016	349	0.8±0.3	20±1	<2
8/1/2016	8/8/2016	291	0.6±0.3	14±1	<18
8/8/2016	8/15/2016	271	1.4±0.3	14±1	<19
8/15/2016	8/22/2016	297	0.8±0.2	18±1	<20
8/22/2016	8/29/2016	289	1±0.3	21±1	<20
8/29/2016	9/6/2016	331	0.8±0.2	19±1	<16
9/6/2016	9/12/2016	243	1.2±0.4	29±1	<22
9/12/2016	9/19/2016	293	0.6±0.3	18±1	<20
9/19/2016	9/26/2016	280	0.8±0.3	25±1	<19
9/26/2016	10/1/2016	219	<0.5	11±1	<25
10/1/2016	10/9/2016	323	0.7±0.3	14±1	<19
10/9/2016	10/17/2016	318	0.6±0.2	16±1	<17
10/17/2016	10/25/2016	317	0.9±0.2	21±1	<15
10/25/2016	10/30/2016	218	0.6±0.4	18±1	<23
10/30/2016	11/6/2016	282	0.7±0.3	20±1	<23
11/6/2016	11/13/2016	290	1.5±0.3	17±1	<22
11/13/2016	11/21/2016	319	<0.3	2±1	<17
11/21/2016	11/27/2016	250	1.1±0.3	23±1	<25
11/27/2016	12/5/2016	324	0.7±0.3	24±1	<19
12/5/2016	12/10/2016	207	1±0.5	16±1	<12
12/10/2016	12/19/2016	353	1±0.2	25±1	<15
12/19/2016	12/26/2016	298	1.2±0.3	27±1	<19
12/26/2016	1/4/2017	351	0.6±0.2	15±1	<14
	2016 Average		**0.8±0.5**	**17±10**	--
1/4/2017	1/9/2017	208	0.9±0.4	19±1	<24
1/9/2017	1/17/2017	336	1±0.2	21±1	<39
1/17/2017	1/22/2017	204	0.6±0.4	9±1	<27
1/22/2017	1/29/2017	283	<0.4	10±1	<21
1/29/2017	2/6/2017	324	0.8±0.3	18±1	<19
2/6/2017	2/13/2017	279	1.1±0.4	19±1	<11
2/13/2017	2/20/2017	280	0.7±0.3	19±1	<18
2/20/2017	2/27/2017	292	0.8±0.3	17±1	<18
2/27/2017	3/6/2017	273	1.3±0.4	18±1	<19
3/6/2017	3/12/2017	256	1.2±0.3	15±1	<20
3/12/2017	3/18/2017	241	1.5±0.3	19±1	<25
3/18/2017	3/27/2017	365	1.5±0.2	22±1	<15
3/27/2017	4/2/2017	253	0.7±0.3	9±1	<9

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Beta	I-131
	Peach Bottom Whiteford Station (Continued)				
4/2/2017	4/11/2017	356	0.3±0.3	12±1	<7
4/11/2017	4/17/2017	254	0.4±0.4	16±1	<20
4/17/2017	4/26/2017	358	0.3±0.3	7±1	<14
4/26/2017	5/1/2017	215	0.4±0.4	12±1	<27
5/1/2017	5/7/2017	241	<0.4	8±1	<12
5/7/2017	5/14/2017	277	<0.4	11±1	<46
5/14/2017	5/22/2017	339	0.6±0.3	13±1	<38
5/22/2017	5/29/2017	284	0.6±0.3	8±1	<10
5/29/2017	6/5/2017	281	0.4±0.4	17±1	<19
6/5/2017	6/12/2017	293	0.4±0.3	15±1	<19
6/12/2017	6/21/2017	347	0.5±0.3	17±1	<12
6/21/2017	6/27/2017	247	<0.4	19±1	<20
6/27/2017	7/5/2017	317	0.7±0.3	17±1	<15
7/5/2017	7/10/2017	230	0.7±0.3	14±1	<13
7/10/2017	7/17/2017	271	0.8±0.2	22±1	<14
7/17/2017	7/24/2017	288	1.3±0.3	28±1	<9
7/24/2017	7/31/2017	284	0.6±0.3	12±1	<9
7/31/2017	8/7/2017	287	1.2±0.3	21±1	<9
8/7/2017	8/14/2017	284	0.5±0.3	21±1	<9
8/14/2017	8/21/2017	286	0.7±0.4	24±1	<9
8/21/2017	8/27/2017	245	0.5±0.4	18±1	<11
8/27/2017	9/4/2017	322	0.5±0.4	14±1	<9
9/4/2017	9/10/2017	249	1.6±0.4	18±1	<10
9/10/2017	9/17/2017	284	1.2±0.2	15±1	<10
9/17/2017	9/24/2017	288	1.9±0.3	25±1	<10
9/24/2017	10/1/2017	285	0.9±0.3	17±1	<10
10/1/2017	10/8/2017	284	<0.4	20±1	<9
10/8/2017	10/15/2017	293	0.4±0.3	12±1	<9
10/15/2017	10/23/2017	318	1.2±0.2	22±1	<8
10/23/2017	10/29/2017	250	1±0.4	15±1	<11
10/29/2017	11/5/2017	290	0.8±0.3	19±1	<10
11/5/2017	11/12/2017	281	1.1±0.4	19±1	<10
11/12/2017	11/19/2017	267	1.1±0.4	24±1	<10
11/19/2017	11/26/2017	283	1.8±0.3	29±1	<9
11/26/2017	12/3/2017	288	1.2±0.3	25±1	<9
12/3/2017	12/10/2017	287	1.1±0.4	28±1	<11
12/10/2017	12/18/2017	320	0.7±0.3	20±1	<9
12/18/2017	12/24/2017	240	1.1±0.4	24±1	<12
	2017 Average		**0.9±0.8**	**18±11**	--
	Overall		**0.9±0.1**	**17±1**	--

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Bata	I-131
		Peach Bottom Dempsey Farm Station			
12/28/2015	1/11/2016	567	0.5±0.2	18±0.4	<6
1/11/2016	1/25/2016	575	1.9±0.1	24±0.3	<10
1/25/2016	2/2/2016	319	1.2±0.2	25±1	<14
2/2/2016	2/8/2016	243	0.7±0.3	15±1	<12
2/8/2016	2/14/2016	246	0.7±0.4	13±1	<13
2/14/2016	2/22/2016	331	1.2±0.2	17±1	<8
2/22/2016	2/29/2016	294	0.3±0.3	15±1	<10
2/29/2016	3/7/2016	276	1.1±0.3	18±1	<9
3/7/2016	3/13/2016	242	1±0.3	20±1	<13
3/13/2016	3/21/2016	325	0.5±0.2	12±1	<9
3/21/2016	3/28/2016	285	1.2±0.3	17±1	<9
3/28/2016	4/4/2016	287	1±0.3	19±1	<9
4/4/2016	4/10/2016	243	1.6±0.3	15±1	<12
4/10/2016	4/17/2016	292	1.3±0.3	17±1	<9
4/17/2016	4/25/2016	320	1.8±0.3	22±1	<7
4/25/2016	5/2/2016	285	1.2±0.2	17±1	<7
5/2/2016	5/9/2016	284	<0.3	5±1	<7
5/9/2016	5/15/2016	246	0.9±0.3	13±1	<13
5/15/2016	5/23/2016	327	0.7±0.2	17±1	<18
5/23/2016	5/29/2016	242	0.7±0.5	27±1	<12
5/29/2016	6/7/2016	397	1.2±0.2	15±0.3	<15
6/7/2016	6/13/2016	230	0.5±0.4	15±1	<20
6/13/2016	6/20/2016	299	1.2±0.2	15±1	<21
6/20/2016	6/26/2016	249	0.9±0.2	21±1	<22
6/26/2016	7/3/2016	274	<0.3	16±1	<20
7/3/2016	7/11/2016	327	0.4±0.3	18±1	<16
7/11/2016	7/18/2016	290	N/A	N/A	<50
7/18/2016	7/24/2016	244	0.5±0.4	22±1	<55
7/24/2016	8/1/2016	348	0.6±0.3	23±1	<42
8/1/2016	8/8/2016	289	0.9±0.2	15±1	<18
8/8/2016	8/15/2016	270	0.6±0.3	15±1	<19
8/15/2016	8/22/2016	298	0.3±0.3	18±1	<20
8/22/2016	8/29/2016	287	1.3±0.3	18±1	<20
8/29/2016	9/6/2016	321	0.8±0.2	23±1	<16
9/6/2016	9/12/2016	243	1.2±0.4	30±1	<22
9/12/2016	9/19/2016	292	0.8±0.3	18±2	<20
9/19/2016	9/26/2016	281	0.4±0.3	25±1	<19
9/26/2016	10/1/2016	217	<0.4	13±1	<25
10/1/2016	10/9/2016	325	0.5±0.3	15±1	<19
10/9/2016	10/17/2016	318	1.2±0.3	18±1	<17
10/17/2016	10/25/2016	315	0.7±0.3	22±1	<15
10/25/2016	10/30/2016	218	0.8±0.4	22±1	<23
10/30/2016	11/6/2016	281	1.1±0.3	20±1	<23

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Bata	I-131
Peach Bottom Dempsey Farm Station (Continued)					
11/6/2016	11/13/2016	290	0.9±0.3	18±1	<22
11/13/2016	11/21/2016	319	2±0.3	38±1	<17
11/21/2016	11/27/2016	252	0.6±0.3	21±1	<25
11/27/2016	12/5/2016	324	0.9±0.3	22±1	<19
12/5/2016	12/10/2016	206	<0.5	17±1	<12
12/10/2016	12/19/2016	358	0.8±0.3	27±1	<15
12/19/2016	12/26/2016	298	1.2±0.3	26±1	<19
12/26/2016	1/4/2017	351	0.2±0.2	17±1	<14
	2016 Average		**0.9±0.8**	**19±11**	--
1/4/2017	1/9/2017	208	0.7±0.3	19±1	<24
1/9/2017	1/17/2017	336	1.2±0.3	20±1	<39
1/17/2017	1/22/2017	206	<0.4	11±1	<27
1/22/2017	1/29/2017	284	<0.4	8±1	<21
1/29/2017	2/6/2017	325	1±0.3	22±1	<19
2/6/2017	2/13/2017	282	1±0.3	23±1	<11
2/13/2017	2/20/2017	280	1±0.3	22±1	<18
2/20/2017	2/27/2017	291	0.8±0.3	18±1	<18
2/27/2017	3/6/2017	273	1.3±0.3	22±1	<19
3/6/2017	3/12/2017	256	0.8±0.4	20±1	<20
3/12/2017	3/18/2017	242	1.6±0.3	24±1	<25
3/18/2017	3/27/2017	363	1.4±0.2	24±1	<15
3/27/2017	4/2/2017	255	0.8±0.3	11±1	<9
4/2/2017	4/11/2017	356	0.5±0.3	14±1	<7
4/11/2017	4/17/2017	252	1.4±0.4	19±1	<20
4/17/2017	4/26/2017	358	0.3±0.3	9±1	<14
4/26/2017	5/1/2017	215	0.3±0.3	16±1	<27
5/1/2017	5/7/2017	242	0.6±0.3	11±1	<12
5/7/2017	5/14/2017	275	0.4±0.3	11±1	<46
5/14/2017	5/22/2017	339	0.6±0.2	18±1	<38
5/22/2017	5/29/2017	284	0.8±0.2	9±1	<10
5/29/2017	6/5/2017	281	1.6±0.2	21±1	<19
6/5/2017	6/12/2017	293	0.5±0.3	21±1	<19
6/12/2017	6/21/2017	347	1.1±0.2	20±1	<12
6/21/2017	6/27/2017	247	1±0.3	21±1	<20
6/27/2017	7/5/2017	317	0.9±0.3	24±1	<15
7/5/2017	7/10/2017	230	0.9±0.2	19±1	<13
7/10/2017	7/17/2017	271	1±0.4	25±1	<14
7/17/2017	7/24/2017	287	1±0.3	28±1	<9
7/24/2017	7/31/2017	284	<0.3	14±1	<9
7/31/2017	8/7/2017	287	1.5±0.3	20±1	<9
8/7/2017	8/14/2017	284	1.6±0.3	22±1	<9
8/14/2017	8/21/2017	286	0.9±0.3	26±1	<9
8/21/2017	8/27/2017	245	0.8±0.4	18±1	<11
8/27/2017	9/4/2017	322	1±0.2	15±1	<9
9/4/2017	9/10/2017	250	1.8±0.4	18±1	<10

Table C-6. (Continued)

Sample Date Start	End	Volume	Gross Alpha	Gross Bata	I-131
	Peach Bottom Dempsey Farm Station (Continued)				
9/10/2017	9/17/2017	284	1.2±0.3	18±1	<10
9/17/2017	9/24/2017	288	1.6±0.2	27±1	<10
9/24/2017	10/1/2017	285	1±0.2	18±1	<10
10/1/2017	10/8/2017	284	1.1±0.3	25±1	<9
10/8/2017	10/15/2017	293	0.3±0.3	13±1	<9
10/15/2017	10/23/2017	318	1.4±0.1	25±1	<8
10/23/2017	10/29/2017	250	0.9±0.3	17±1	<11
10/29/2017	11/5/2017	290	1.5±0.3	20±1	<10
11/5/2017	11/12/2017	281	1.5±0.3	21±1	<10
11/12/2017	11/19/2017	284	0.7±0.3	25±1	<10
11/19/2017	11/26/2017	284	1.9±0.3	28±1	<9
11/26/2017	12/3/2017	287	1.1±0.2	30±1	<9
12/3/2017	12/10/2017	287	2.2±0.3	32±1	<11
12/10/2017	12/18/2017	321	0.8±0.3	22±1	<9
12/18/2017	12/24/2017	240	0.6±0.4	28±1	<12
	2017 Average		**1±0.9**	**20±11**	--
	Overall		**1±0.2**	**19±1**	--

Table C-7. Radionuclide Concentrations in Monthly Composite Air Particulate (fCi/m^3) ± 2 SD. Sample volume is in m^3.

Sample Date Start	End	Volume	Be-7	Cs-137
	Calvert Cliffs Long Beach Station			
12/29/2015	1/26/2016	1143	120±10	<1
1/26/2016	3/1/2016	1426	80±10	<1
3/1/2016	3/29/2016	1144	120±20	<2
3/29/2016	4/26/2016	1140	180±20	<2
4/26/2016	5/31/2016	1425	140±20	<2
5/31/2016	6/28/2016	1142	130±10	<1
6/28/2016	7/26/2016	1144	120±10	<1
7/26/2016	8/31/2016	1462	110±10	<1
8/31/2016	9/28/2016	1144	140±10	<1
9/28/2016	10/31/2016	1345	130±10	<1
10/31/2016	11/30/2016	1185	110±10	<1
11/30/2016	12/27/2016	1099	90±10	<1
	2016 Average		**122.5±51**	--
12/27/2016	1/31/2017	1428	90±10	<4
1/31/2017	2/28/2017	1140	170±20	<2
2/28/2017	3/28/2017	1140	160±20	<1
3/28/2017	4/26/2017	1182	90±10	<1
4/26/2017	5/30/2017	1393	110±10	<1
5/30/2017	6/27/2017	1139	160±10	<1
6/27/2017	7/25/2017	1143	140±10	<1
7/25/2017	8/29/2017	1428	120±20	<2
8/29/2017	10/3/2017	1428	100±10	<1
10/3/2017	10/31/2017	1141	110±10	<1
10/31/2017	11/28/2017	1144	100±10	<1
11/28/2017	1/2/2018	1428	110±20	<1
	2017 Average		**121.7±57**	--
	Overall		**122.1±1**	--
	Calvert Cliffs Lusby Station			
12/29/2015	1/26/2016	1143	110±10	<1
1/26/2016	3/1/2016	1425	100±10	<1
3/1/2016	3/29/2016	1144	140±20	<1
3/29/2016	4/26/2016	1142	160±20	<1
4/26/2016	5/31/2016	1425	150±20	<1
5/31/2016	6/28/2016	1143	160±20	<1
6/28/2016	7/26/2016	1144	120±20	<1
7/26/2016	8/31/2016	1462	120±10	<1
8/31/2016	9/28/2016	1144	170±20	<2
9/28/2016	10/31/2016	1345	130±20	<1
10/31/2016	11/30/2016	1225	140±20	<1
11/30/2016	12/27/2016	1099	120±20	<2
	2016 Average		**135±44**	--

Table C-7. (Continued)

Sample Date Start	End	Volume	Be-7	Cs-137
	Calvert Cliffs Lusby Station (Continued)			
12/27/2016	1/31/2017	1428	100±10	<1
1/31/2017	2/28/2017	1141	180±20	<1
2/28/2017	3/28/2017	1143	170±20	<2
3/28/2017	4/26/2017	1182	110±20	<1
4/26/2017	5/30/2017	1392	130±20	<2
5/30/2017	6/27/2017	1134	160±20	<1
6/27/2017	7/25/2017	1142	180±20	<2
7/25/2017	8/29/2017	1427	120±10	<1
8/29/2017	10/3/2017	1426	110±10	<1
10/3/2017	10/31/2017	1142	120±20	<2
10/31/2017	11/28/2017	1145	130±20	<1
11/28/2017	1/2/2018	1428	100±10	<1
	2017 Average		**134.2±61**	--
	Overall		**134.6±1**	--
	Calvert Cliffs Cove Point Station			
12/29/2015	1/26/2016	1143	130±10	<1
1/26/2016	3/1/2016	1426	90±10	<1
3/1/2016	3/29/2016	1143	130±10	<1
3/29/2016	4/26/2016	1141	170±10	<1
4/26/2016	5/31/2016	1420	150±10	<1
5/31/2016	6/28/2016	1143	140±10	<1
6/28/2016	7/26/2016	852	90±10	<1
7/26/2016	8/31/2016	1462	130±10	<1
8/31/2016	9/28/2016	1144	160±10	<1
9/28/2016	10/31/2016	1345	130±10	<1
10/31/2016	11/30/2016	1224	150±10	<1
11/30/2016	12/27/2016	1100	110±10	<1
	2016 Average		**131.7±50**	--
12/27/2016	1/31/2017	1427	110±10	<1
1/31/2017	2/28/2017	1141	200±20	<1
2/28/2017	3/28/2017	1141	190±20	<1
3/28/2017	4/26/2017	1182	100±10	<1
4/26/2017	5/30/2017	1393	110±10	<1
5/30/2017	6/27/2017	1134	160±10	<1
6/27/2017	7/25/2017	1143	160±10	<1
7/25/2017	8/29/2017	1427	140±10	<1
8/29/2017	10/3/2017	1427	120±10	<1
10/3/2017	10/31/2017	1141	130±10	<1
10/31/2017	11/28/2017	1144	120±10	<1
11/28/2017	1/2/2018	1428	120±10	<1
	2017 Average		**138.3±65**	--
	Overall		**135±9**	--

Table C-7. (Continued)

Sample Date Start	End	Volume	Be-7	Cs-137
	Calvert Cliffs Horn Point Station			
12/29/2015	1/25/2016	1110	110±20	<2
1/25/2016	2/29/2016	1433	80±10	<1
2/29/2016	3/28/2016	1130	110±20	<2
3/28/2016	4/25/2016	1143	140±20	<1
4/25/2016	5/29/2016	1385	110±20	<1
5/29/2016	6/27/2016	1180	140±20	<1
6/27/2016	7/24/2016	1104	110±10	<1
7/24/2016	8/29/2016	1470	100±20	<2
8/29/2016	9/28/2016	1216	120±20	<2
9/28/2016	10/30/2016	1319	110±20	<2
10/30/2016	11/27/2016	1185	90±10	<1
11/27/2016	12/26/2016	1143	70±10	<1
	2016 Average		**107.5±42**	--
12/26/2016	1/29/2017	1386	80±10	<1
1/29/2017	2/27/2017	1180	130±20	<1
2/27/2017	3/27/2017	1134	140±20	<1
3/27/2017	4/26/2017	1224	90±10	<1
4/26/2017	5/28/2017	1354	90±20	<2
5/28/2017	6/27/2017	1147	150±20	<1
6/27/2017	7/24/2017	1128	140±20	<1
7/24/2017	8/27/2017	1387	100±20	<2
8/27/2017	10/1/2017	1428	90±10	<1
10/1/2017	10/29/2017	1144	110±20	<2
10/29/2017	11/26/2017	1139	110±20	<2
11/26/2017	12/31/2017	1203	100±10	<1
	2017 Average		**110.8±47**	--
	Overall		**109.2±5**	--
	Baltimore City Station			
12/29/2015	1/29/2016	1260	100±10	<1
1/29/2016	3/1/2016	1310	80±10	<1
3/1/2016	3/29/2016	1142	110±10	<1
3/29/2016	4/26/2016	1141	160±10	<1
4/26/2016	5/31/2016	1425	180±20	<1
5/31/2016	6/28/2016	1142	150±10	<1
6/28/2016	7/27/2016	1175	120±10	<1
7/27/2016	8/31/2016	1430	110±10	<1
8/31/2016	9/28/2016	1143	140±10	<1
9/28/2016	10/31/2016	1347	120±10	<1
10/31/2016	11/30/2016	1224	100±10	<1
11/30/2016	12/27/2016	1100	80±10	<1
	2016 Average		**120.8±62**	--

Table C-7. (Continued)

Sample Date Start	End	Volume	Be-7	Cs-137
	Baltimore City Station (Continued)			
12/27/2016	1/31/2017	1428	70±10	<1
1/31/2017	2/28/2017	1143	120±10	<1
2/28/2017	3/28/2017	1140	120±10	<1
3/28/2017	4/26/2017	1183	80±10	<1
4/26/2017	5/31/2017	1415	80±10	<1
5/31/2017	6/27/2017	1107	120±10	<1
6/27/2017	7/25/2017	1141	120±10	<1
7/25/2017	8/29/2017	1427	90±10	<1
8/29/2017	10/3/2017	1428	90±10	<1
10/3/2017	10/31/2017	1140	90±10	<1
10/31/2017	11/28/2017	1144	90±10	<1
11/28/2017	1/2/2018	1428	80±10	<1
	2017 Average		**95.8±38**	--
	Overall		**108.3±35**	--
	Peach Bottom Rising Sun Station			
12/28/2015	1/25/2016	1143	120±20	<1
1/25/2016	2/29/2016	1433	90±20	<1
2/29/2016	3/28/2016	1131	120±10	<1
3/28/2016	4/25/2016	1142	170±20	<1
4/25/2016	5/29/2016	1366	140±20	<1
5/29/2016	6/26/2016	1177	190±20	<1
6/26/2016	7/24/2016	1105	150±20	<2
7/24/2016	8/29/2016	1492	140±10	<1
8/29/2016	9/26/2016	1139	160±20	<1
9/26/2016	10/30/2016	1392	160±20	<1
10/30/2016	11/27/2016	1143	140±20	<1
11/27/2016	12/26/2016	1185	100±10	<1
	2016 Average		**140±58**	--
12/26/2016	1/29/2017	1386	110±20	<1
1/29/2017	2/27/2017	1179	180±20	<1
2/27/2017	3/27/2017	1135	180±20	<1
3/27/2017	4/26/2017	1211	130±20	<2
4/26/2017	5/29/2017	1356	100±10	<1
5/29/2017	6/27/2017	1169	170±20	<1
6/27/2017	7/24/2017	1106	160±20	<1
7/24/2017	8/27/2017	1386	130±20	<1
8/27/2017	10/1/2017	1429	120±10	<1
10/1/2017	10/29/2017	1145	130±20	<2
10/29/2017	11/26/2017	1139	110±20	<2
11/26/2017	12/31/2017	1430	110±10	<1
	2017 Average		**135.8±58**	--
	Overall		**137.9±6**	--

Table C-7. (Continued)

Sample Date Start	End	Volume	Be-7	Cs-137
	Peach Bottom Whiteford Station			
12/28/2015	1/26/2016	1168	100±10	<1
1/26/2016	2/29/2016	1411	80±10	<1
2/29/2016	3/28/2016	1130	110±10	<1
3/28/2016	4/25/2016	1142	150±10	<1
4/25/2016	5/29/2016	1363	130±10	<1
5/29/2016	6/26/2016	1177	160±20	<2
6/26/2016	7/23/2016	1105	120±20	<1
7/23/2016	8/29/2016	1497	100±10	<1
8/29/2016	9/26/2016	1137	120±20	<1
9/26/2016	10/30/2016	1395	110±10	<1
10/30/2016	11/27/2016	1141	90±10	<1
11/27/2016	12/26/2016	1182	90±10	<1
	2016 Average		**113.3±48**	--
12/26/2016	1/29/2017	1386	90±10	<1
1/29/2017	2/27/2017	1177	140±10	<1
2/27/2017	3/27/2017	1135	140±20	<2
3/27/2017	4/26/2017	1220	90±10	<1
4/26/2017	5/29/2017	1356	90±10	<1
5/29/2017	6/27/2017	1169	140±20	<2
6/27/2017	7/24/2017	1107	130±20	<2
7/24/2017	8/27/2017	1386	120±10	<1
8/27/2017	10/1/2017	1428	100±10	<1
10/1/2017	10/29/2017	1145	100±10	<1
10/29/2017	11/26/2017	1121	110±10	<1
11/26/2017	12/31/2017	1430	110±10	<1
	2017 Average		**113.3±40**	--
	Overall		**113.3±0**	--
	Peach Bottom Dempsey Farm Station			
12/28/2015	1/25/2016	1164	100±10	<5
1/25/2016	2/29/2016	1434	90±10	<1
2/29/2016	3/28/2016	1129	120±20	<1
3/28/2016	4/25/2016	1142	180±20	<1
4/25/2016	5/29/2016	1364	150±20	<1
5/29/2016	6/26/2016	1175	150±20	<1
6/26/2016	7/24/2016	1105	130±20	<1
7/24/2016	8/29/2016	1492	100±10	<1
8/29/2016	9/26/2016	1138	130±20	<1
9/26/2016	10/30/2016	1393	120±10	<1
10/30/2016	11/27/2016	1143	120±20	<1
11/27/2016	12/26/2016	1186	80±10	<1
	2016 Average		**122.5±57**	--

Table C-7. (Continued)

Sample Date Start	End	Volume	Be-7	Cs-137
Peach Bottom Dempsey Farm Station (Continued)				
12/26/2016	1/29/2017	1312	80±10	<1
1/29/2017	2/27/2017	1179	150±10	<1
2/27/2017	3/27/2017	1134	180±20	<1
3/27/2017	4/26/2017	1223	110±10	<1
4/26/2017	5/28/2017	1355	100±10	<1
5/28/2017	6/27/2017	1169	170±20	<1
6/27/2017	7/24/2017	1106	160±20	<1
7/24/2017	8/27/2017	1386	140±20	<1
8/27/2017	10/1/2017	1429	130±10	<1
10/1/2017	10/29/2017	1145	110±20	<1
10/29/2017	11/26/2017	1139	110±10	<1
11/26/2017	12/31/2017	1473	100±10	<1
	2017 Average		**128.3±63**	--
	Overall		**125.4±8**	--

Table C-8. Radionuclide Concentrations in Potable Water (pCi/L) ± 2 SD. n/a = data not available or not collected.

Sample Date	Gross Alpha	Gross Beta	Tritium
	Baltimore City Station		
1/5/2016	<2	<4	<100
2/1/2016	<2	<4	<100
3/7/2016	<2	<4	<100
n/a			
5/2/2016	<2	<4	<100
6/13/2016	<2	15.1±2	<100
7/5/2016	<2	6.4±2	<100
8/1/2016	<2	<4	<100
9/1/2016	<2	5.2±2	<100
n/a			
11/1/2016	<2	5.2±2	<100
12/8/2016	<2	<4	<100
2016 Average	--	**8±9.6**	--
n/a			
2/1/2017	<2	<4	<100
3/1/2017	<2	5.8±2	<100
4/4/2017	<2	4.5±2	<100
5/1/2017	<2	<4	<100
6/1/2017	<2	<4	<100
7/5/2017	<2	<4	<100
8/8/2017	<2	8.2±2	<100
9/6/2017	<2	6.2±2	<100
10/5/2017	<2	<4	<100
11/2/2017	<2	<4	<100
12/1/2017	<2	<4	<100
2017 Average	--	**6.2±3**	--
Overall	--	**7.1±2.5**	--
	Calvert Cliffs Chesapeake Country Club Station		
3/1/2016	<2	5.5±2	<100
6/7/2016	<2	5.5±2	<100
8/23/2016	<2	5.4±2	<100
10/31/2016	<2	8.4±2	<100
2016 Average	--	**6.2±2.9**	--
2/28/2017	<2	<4	<100
5/3/2017	<2	6.2±2	<100
9/19/2017	<2	<4	<100
12/13/2017	<2	5±2	<100
2017 Average	--	**5.6±1.7**	--
Overall	--	**5.9±0.8**	--

Table C-8. (Continued)

Sample Date	Gross Alpha	Gross Beta	Tritium
Calvert Cliffs Calvert County Courthouse Station			
3/1/2016	<2	12.8±2	<100
6/7/2016	<2	11.1±2	<100
8/23/2016	<2	11.8±2	<100
10/31/2016	<2	10.7±2	<100
2016 Average		**11.6±1.8**	
2/28/2017	<2	5.2±2	<100
5/3/2017	<2	11.4±2	<100
9/19/2017	<2	10.3±2	<100
12/13/2017	<2	12.6±2	<100
2017 Average	--	**9.9±6.5**	--
Overall	--	**10.7±2.4**	--
Calvert Cliffs Appeal Elementary School Station			
3/1/2016	<2	10.7±2	<100
6/7/2016	<2	17.5±2	<100
8/23/2016	<2	11.1±2	<100
10/31/2016	<2	14.5±2	<100
2016 Average		**13.5±6.4**	
2/28/2017	2±1	14.5±2	<100
5/3/2017	<2	11.3±2	<100
9/19/2017	<2	10.5±2	<100
12/13/2017	<2	11.7±2	<100
2017 Average	**2.3±1.2**	**12±3.5**	--
Overall	**2.3±1.2**	**12.7±2.1**	--
Calvert Cliffs Calvert County Health Department Station			
3/1/2016	<2	10.9±2	<100
6/7/2016	<2	12.5±2	<100
8/23/2016	<2	12.5±2	<100
10/31/2016	<2	8.2±2	<100
2016 Average		**11±4.1**	
2/28/2017	<2	<4	<100
5/3/2017	<2	<4	<100
9/19/2017	<2	<4	<100
12/13/2017	<2	<4	<100
2017 Average	--	--	--
Overall	--	**11±4.1**	--

Table C-8. (Continued)

Sample Date	Gross Alpha	Gross Beta	Tritium
Calvert Cliffs Southern Middle School Station			
3/1/2016	<2	8.9±2	<100
6/7/2016	<2	11.4±2	<100
8/23/2016	<2	9.2±2	<100
10/31/2016	<2	9.6±2	<100
2016 Average		**9.8±2.2**	
2/28/2017	<2	9.4±2	<100
5/3/2017	<2	10.3±2	<100
9/19/2017	<2	10.7±2	<100
12/13/2017	<2	10.8±2	<100
2017 Average	--	**10.3±1.3**	--
Overall	--	**10±0.7**	--
Calvert Cliffs Frying Pan Restaurant Station			
3/1/2016	<2	13.6±2	<100
6/7/2016	<2	13.4±2	<100
9/19/2017	<2	11.2±2	<100
10/31/2016	<2	13.2±2	<100
2016 Average		**12.9±2.2**	
2/28/2017	<2	11.8±2	<100
5/3/2017	<2	13.4±2	<100
8/11/2015	<2	13.2±2	<100
12/13/2017	<2	11.2±2	<100
2017 Average	--	**12.4±2.1**	--
Overall	--	**12.6±0.6**	--
Calvert Cliffs Volunteer Fire Department Station			
3/1/2016	<2	13.4±2	<100
6/7/2016	<2	13.3±2	<100
8/23/2016	<2	12.3±2	<100
10/31/2016	<2	13.9±2	<100
2016 Average		**13.2±1.3**	
2/28/2017	<2	12.9±2	145±99
5/3/2017	<2	13.9±2	<100
9/19/2017	<2	12.1±2	<100
12/13/2017	<2	13.5±2	<100
2017 Average	--	**13.1±1.6**	**145±99**
Overall	--	**13.2±0.2**	**145±99**

Table C-9. Radionuclide Concentrations in Precipitation (pCi/L) ± 2 SD. Depth in inches.

Sample Date	Depth	Gross Alpha	Gross Beta	Tritium	Be-7
		Baltimore City Station			
2/10/2016	1.15	<2	<4	<100	60±10
2/17/2016	1.14	<2	6.4±0.6	<100	100±20
2/23/2016	0.49	<2	<4	<100	50±20
3/1/2016	2.89	<2	<4	<100	40±10
3/29/2016	0.75	<2	<4	<100	40±20
4/5/2016	0.43	<2	6.5±0.6	<100	60±20
4/12/2016	1.14	<2	<4	<100	50±10
5/3/2016	1.13	<2	<4	<100	60±20
5/10/2016	1.42	<2	<4	<100	30±10
5/18/2016	0.98	<2	<4	<100	30±10
5/27/2016	0.94	<2	<4	<100	30±10
6/22/2016	1.55	<2	4.6±0.5	<100	50±10
6/28/2016	1.30	<2	<4	<100	50±10
7/5/2016	2.46	<2	<4	<100	50±20
7/20/2016	0.21	<2	4±0.5	<100	50±20
8/3/2016	4.82	<2	<4	<100	60±20
8/16/2016	0.91	<2	5±0.5	<100	50±20
8/23/2016	3.45	<2	5.8±1.8	<100	20±20
9/7/2016	1.33	<2	<4	<100	40±20
9/21/2016	0.53	<2	<4	<100	<30
10/3/2016	3.51	<2	<4	<100	<30
10/31/2016	0.07	<2	6.5±0.6	<100	50±20
11/30/2016	1.04	<2	4.8±0.5	<100	60±20
12/7/2016	1.68	<2	<4	<100	30±20
12/20/2016	0.89	<2	<4	<100	30±10
2016 average		--	**5±2**	--	**47±33**
1/18/2017	0.71	<2	<4	<100	90±20
1/24/2017	0.88	<2	<4	<100	60±20
3/7/2017	0.54	<2	5.2±0.5	<100	30±20
3/21/2017	0.53	<2	<4	<100	20±10
3/28/2017	0.35	3.9±1	9.1<0.7	<100	40±20
4/4/2017	1.65	<2	4.6±0.5	<100	30±10
4/10/2017	1.66	<2	<4	<100	50±20
4/26/2017	1.23	<2	<4	<100	<20
5/9/2017	1.52	<2	<4	<100	30±20
5/16/2017	1.35	<2	<4	<100	<30
5/23/2017	0.99	<2	<4	<100	30±10
5/31/2017	1.80	<2	<4	<100	40±20
7/12/2017	0.86	<2	<4	<100	50±10
7/25/2017	0.77	<2	4.2±0.5	<100	40±20
8/1/2017	4.10	<2	<4	<100	20±10
8/8/2017	2.16	<2	<4	<100	50±20
8/15/2017	3.53	<2	<4	<100	30±20
8/22/2017	1.00	<2	5.7<0.5	<100	30±20

Table C-9. (Continued)

Sample Date	Depth	Gross Alpha	Gross Beta	Tritium	Be-7
8/29/2017	0.50	<2	<4	<100	30±20
9/5/2017	1.28	<2	<4	<100	20±10
9/12/2017	1.17	<2	5.1±0.5	<100	70±20
10/10/2017	0.77	<2	<4	<100	140±30
10/17/2017	0.94	<2	<4	<100	<30
10/31/2017	0.97	<2	<4	<100	50±20
11/7/2017	0.98	<2	<4	<100	20±15
11/14/2017	0.84	<2	<4	<100	<30
12/19/2017	0.42	<2	<4	<100	60±20
2017 average		**3.9±0.5**	**6±4**	--	**45±55**
Overall		**3.9±0.5**	**5.6±0.3**	--	**46±4**

Table C-10. Radionuclide Concentrations in Processed and Raw Milk (pCi/L) ± 2 SD

Sample Date	I-131	Ba-140	Cs-137	Sr-90	Sr-89
		Maryland Composite Processed Milk			
3/10/2016	<4	<14	<5	<2	<10
6/13/2016	<4	<14	<4	<2	<10
10/10/2016	<5	<15	<4	<2	<10
12/12/2016	<4	<14	<4	<2	<10
2016 Average	--	--	--	--	--
4/4/2017	<4	<13	<4	<2	<10
6/19/2017	<3	<10	<3	<2	<10
9/15/2017	<7	<13	<2	<2	<10
12/9/2017	<2	<2	<2	<2	<10
2017 Average	--	--	--	--	--
Overall	--	--	--	--	--
		Peach Bottom Kilby Farm Raw Milk			
3/7/2016	<4	<15	<5	<2	<10
6/13/2016	<4	<13	<4	<2	<10
10/4/2016	<5	<15	<4	<2	<10
12/12/2016	<3	<11	<3	<2	<10
2016 Average	--	--	--	--	--
3/20/2017	<4	<14	<4	<2	<10
6/19/2017	<13	<12	<4	<2	<10
9/11/2017	<4	<13	<4	<2	<10
12/11/2017	<4	<3	<3	<2	<10
2017 Average	--	--	--	--	--
Overall	--	--	--	--	--

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