



Revision 1

HYDROGEOLOGIC INVESTIGATION REPORT

FLEETWIDE ASSESSMENT PEACH BOTTOM ATOMIC POWER STATION DELTA, PENNSYLVANIA

**Prepared For:
Exelon Generation Company, LLC**

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EXECUTIVE SUMMARY

This Hydrogeologic Investigation Report (HIR) documents the results of Conestoga-Rovers & Associates' (CRA's) May 2006 Hydrogeologic Investigation Work Plan (Work Plan) pertaining to the Peach Bottom Atomic Power Station. CRA prepared this HIR for Exelon Generation Company, LLC (Exelon) as part of its Fleetwide Program to determine whether groundwater at and in the vicinity of its nuclear power generating facilities has been adversely impacted by any releases of radionuclides.

CRA collected and analyzed information on any historical releases, the structures, components, and areas of the Station that have the potential to release tritium or other radioactive liquids to the environment and past hydrogeologic investigations at the Station. CRA used this information, combined with its understanding of groundwater flow at the Station to identify the Areas for Further Evaluation (AFEs) and sample locations for the Station.

CRA installed 14 new monitoring wells and eight surface water locations. CRA collected 18 groundwater samples, eight surface water samples, and three seep samples at the Station. CRA also collected a full round of water levels from the newly installed and existing wells and measured surface water levels. All groundwater and surface water samples were analyzed for tritium, strontium-89/90, and gamma-emitting radionuclides.

The results of the hydrogeologic investigation are:

- Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective Lower Limits of Detection (LLDs) in any of the groundwater or surface water samples obtained and analyzed during the course of this investigation;
- Strontium-89/90 was not detected at a concentration greater than the LLD of 2.0 picoCuries per liter (pCi/L) in any of the groundwater or surface water samples obtained and analyzed during the course of this investigation;
- Tritium was not detected at concentrations greater than within any area in or adjacent to the Station at levels above the United States Environmental Protection Agency Drinking Water Standard of 20,000 pCi/L in any of the groundwater or surface water samples obtained during the course of this investigation;
- Low levels of tritium were detected at concentrations greater than the LLD, which is considered background, but well below the applicable drinking water standard;

- Based on the results of this investigation, tritium is not migrating off the Station property at detectable concentrations;
- Based on the results of this investigation, there is no current risk from exposure to radionuclides associated with licensed plant operations through any of the identified potential exposure pathways; and
- Based on the results of this investigation, there are no known active releases into the groundwater at the Station.

Based upon the information collected to date, CRA recommends that Exelon conduct periodic monitoring of selected sample locations.

1.0 INTRODUCTION

Conestoga-Rovers & Associates (CRA) has prepared this Hydrogeologic Investigation Report (HIR) for Exelon Generation Company, LLC (Exelon) as part of its fleetwide program to determine whether groundwater at and in the vicinity of its nuclear power generating facilities has been adversely impacted by any releases of radionuclides. This report documents the results of CRA's May 2006 Hydrogeologic Investigation Work Plan (Work Plan). The investigation pertains to Exelon's Peach Bottom Atomic Power Station in Delta, Pennsylvania (Station) (see Figure 1.1). The Station is defined as all property, structures, systems, and components owned and operated by Exelon LLC located at 1848 Lay Road in Delta, Pennsylvania, Peach Bottom Township, York County, and Drumore and Fulton Townships, Lancaster County, Pennsylvania. The approximate property boundaries are depicted on Figure 1.2.

Pursuant to the Work Plan, CRA assessed groundwater quality at the Station in locations designated as Areas for Further Evaluation (AFEs). The process by which CRA identified AFEs is discussed in Section 3.0 of this report.

The objectives of the Work Plan were to:

- characterize the geologic and hydrogeologic conditions at the Station including subsurface soil types, the presence or absence of confining layers, and the direction and rate of groundwater flow;
- characterize the groundwater/surface water interaction at the Station, including a determination of the surface water flow regime;
- evaluate groundwater quality at the Station including the vertical and horizontal extent, quantity, concentrations, and potential sources of tritium and other radionuclides in the groundwater, if any;
- define the probable sources of any radionuclides released at the Station;
- evaluate potential human, ecological, or environmental receptors of any radionuclides that might have been released to the groundwater; and
- evaluate whether interim response activities are warranted.

2.0 STATION DESCRIPTION

The following section presents a general summary of the Station location and definition, overview of Station operations, surrounding land use, and an overview of both regional and Station-specific topography, surface water features, geology, hydrogeology, and groundwater flow conditions. This section also presents an overview of groundwater use in the area.

2.1 STATION LOCATION

The Station is located at 1848 Lay Road, Delta, Pennsylvania on the west bank of the Susquehanna River. All of the major Station structures are located in Peach Bottom Township. The Station consists of 620 acres. Figure 1.2 presents the Station property, which includes the key features.

2.2 OVERVIEW OF COOLING WATER OPERATIONS

Operations at the Station began in June 1967 with Unit 1, a 40-megawatt experimental high-temperature, helium cooled, graphite moderated reactor. Unit 1, located adjacent to Rock Run Creek, was permanently shut down on October 31, 1974 and is now maintained in the Nuclear Regulatory Commission's (NRC's) decommissioning method known as SAFSTOR (safe storage of components of the nuclear power plant).

Units 2 and 3 are boiling water reactors capable of generating 1,172 megawatts electric each. Units 2 and 3 were built between 1968 and 1973 and entered commercial service July 5, 1974 and December 23, 1974, respectively (Exelon, 2006). The Station's generating system consists of two boiling water reactors (Units 2 and 3), two steam turbine generators, heat-dissipation systems, and associated auxiliary facilities and engineering safeguards. The Station is capable of producing 2,344 megawatts of electricity pursuant to NRC Operating Licenses DPR-44 and DPR-56 (NRC, 2006).

Non-contact cooling water is withdrawn from the Conowingo Reservoir. Water withdrawn from the Conowingo Reservoir passes through a series of intake structures before it is circulated through two main condenser units (one for each unit). From the condensers, the cooling water is returned through a series of discharge structures and is discharged to the Conowingo Reservoir. Exelon has the ability to use three mechanical draft cooling towers, which have the capacity to cool approximately 60 percent of the circulating cooling water flow. During normal plant operations, circulating cooling

water moves through the plant from the intake structure to the discharge structure in approximately 88 minutes. When the three cooling towers are in operation, the travel time is approximately 109 minutes (NRC, 2003). The Conowingo Reservoir, located east of the Station, receives discharge from the Station outfalls via the Discharge Canal under the Station's National Pollution Discharge Elimination System (NPDES) permit (permit # PA0009733) and the NRC Operating Licenses.

2.3 SURROUNDING LAND USE

Land use in the area is predominantly rural and is characterized by farms and forests. Properties immediately adjacent to the Station consist of agricultural land to the south; undeveloped land, farms, and residences to the west; residences to the northwest; a picnic area and public boat dock to the north; and the Conowingo Reservoir to the immediate east. Based on the most recent aerial photos available through the web, the population density immediately adjacent (within one mile radius) to the Station is very low (Microsoft TerraServer, 1999).

2.4 STATION SETTING

The following sections present a summary of the topography, surface water features, geology, hydrogeology, and groundwater flow conditions in the region surrounding the Station. The information was primarily gathered from Sections 2.1 and 2.5 of the Peach Bottom Updated Final Safety Analysis Report (UFSAR) Revision 20 dated April 2005. The main references the UFSAR relies upon are listed in Section 10.0 of this HIR. CRA checked and verified all UFSAR references that apply to this HIR.

2.4.1 TOPOGRAPHY AND SURFACE WATER FEATURES

The Station lies within the Piedmont Upland Section of the Piedmont Physiographic Province of the Appalachian Highlands (Low and Hippe, 2002). The northeast-southwest trending Piedmont Province is an eroded plateau of low relief and rolling topography. Dendritic drainage patterns are prominent in the Piedmont Upland Section, which is characterized by broad, rounded to flat-topped hills and shallow valleys, with moderate to steep slopes. Near the Susquehanna River, steeper slopes and deeper, narrower valleys are more common (Low and Hippe, 2002). Surface elevations in the Upper Piedmont Section generally range from 100 to 300 feet above mean sea level

(AMSL). The general topography of the Station and surrounding area (USGS, 1995) is shown on Figure 1.1.

The original topography was characterized by rugged, heavily wooded terrain prior to Station development. Original elevations ranged from about 400 feet AMSL in the western portion of the Station property to about 110 feet AMSL near the Conowingo Reservoir. The ground surface sloped steeply to the east toward the Reservoir.

The area immediately to the west of the Station is a rock cliff that was created when a portion of the original hillside was cut away to construct the Station. The hillside rises to an elevation of nearly 300 feet above the Conowingo Reservoir. The main stack and the north switchyard are on this hilltop. The post-construction ground surface elevation at the base of the excavated hillside is approximately 135 feet Conowingo Datum (C.D.).¹ Excavation into bedrock for the foundations of the Turbine and Reactor Buildings extended to 80 feet C.D. The base level of the Station immediately east of the Turbine Building is approximately 116 feet C.D. From this area, the Station slopes gently downward to the east to an elevation of approximately 110 feet C.D. adjacent to the Conowingo Reservoir.

Construction slightly extended the land surface to the east beyond the original western bank of the Reservoir. Additionally, Station construction modified the course and the configuration of the mouth of Rock Run Creek.

The Station is located within the Susquehanna River Basin. Locally, the Susquehanna River is termed the Conowingo Reservoir. The Station is located adjacent to and on the west bank of the Conowingo Reservoir, about 14 miles north of the Susquehanna River's mouth at Chesapeake Bay. Conowingo Reservoir was formed by the construction of the Conowingo Dam across the Susquehanna River. The backwater formed by the dam is interchangeably termed the Conowingo Pool, Pond, or Reservoir.

The Conowingo Reservoir is the largest body of water in the area. The Susquehanna, from its source in Lake Otsego, New York, to the head of Chesapeake Bay is approximately 422 miles long and drains an area of about 27,500 square miles (sq. mi.). Approximately 27,000 sq. mi. of this area are upriver from the Station. Since 1910, three dams have been constructed in the lower 35 miles of the river. These are, from north to south, the Safe Harbor, Holtwood, and Conowingo Dams. The Station is approximately 9 miles above the Conowingo Dam and 6 miles below Holtwood Dam.

¹ Conowingo Datum is a local elevation reference; it corresponds to 0.702 feet AMSL.

The Conowingo Reservoir varies in width from about 0.6 to 1.5 miles and is slightly less than 1.5 miles wide in the Station area. The reservoir contains about 246,000 acre-feet (82 billion gallons) of water. The finished grade of the plant has been established at an elevation of 116 feet C.D., which is approximately 3 feet above the estimated 1936 flood level.

The normal reservoir elevation is between 104 feet and 109.25 feet C.D. The top 10 feet (80,000 acre-feet) of water in the reservoir are used to regulate power generation. Flows at the Conowingo Dam, which became operational in 1928, have ranged from a maximum of 972,000 cubic feet per second to a minimum of 1,400 cubic feet per second, averaging 37,400 cubic feet per second. This flow represents about 18 inches of runoff from the basin out of an average area rainfall of approximately 40 inches annually. The depth of water near and upstream of the Station area is variable, but averages about 12 to 15 feet. About 1 mile downstream from the Station, the water depth increases rapidly, reaching a maximum depth of over 100 feet near the Conowingo Dam.

The Conowingo Reservoir is immediately east of the Station. The reservoir is used for non-contact cooling water and receives discharge from the Station outfalls via the Discharge Canal under the Station's NPDES permit. The canal is approximately 5,000 feet in length to provide tempering for approved discharges. The Station maintains the flow in the canal at an elevation a few inches above the Conowingo Reservoir and at a sufficient rate to ensure discharge.

The surficial drainage within the Station is to Rock Run Creek, a perennial stream located south of the Unit 1 that flows in an easterly direction into the Discharge Canal. The creek divides the property into two sections. The watershed of Rock Run Creek is approximately four square miles.

2.4.2 **GEOLOGY**

Figure 2.1 presents a geologic map showing the regional area. The region is underlain by metamorphosed sedimentary and crystalline rocks of Paleozoic and Precambrian age (approximately 435 to 700 million years ago), which are known collectively as the Glenarm Series. For this HIR, the Group level nomenclature (e.g., Glenarm Series) presented on the 1980 edition of the Pennsylvania State Geologic Map and used in previous Station reports is retained for consistency. The metamorphosed sedimentary rocks include, in order of decreasing age, the Wissahickon and Peters Creek Schists,

Cardiff Conglomerate, and Peach Bottom Slate. The rocks are relatively resistant to erosion and support an uneven hilly surface (Schultz, 1999).

The rocks of the Piedmont Province have been repeatedly metamorphosed, intruded, folded, and faulted (Low and Hippe, 2002). Folding and faulting have been mapped in the northern part of the Pennsylvania Piedmont where the complex structural conditions are exposed. Toward the southern part of the Piedmont, structural relationships are not as well understood because of the much higher degree of metamorphism (Low and Hippe, 2002).

The soils in the region belong to the Manor-Glenelg Soil Association or the Cardiff-Whiteford Association (U.S. Department of Agriculture, 2006). The soils near the Station belong to the Manor-Glenelg Association. These soils are described as shallow and moderately deep, mostly moderately steep to very steep soils underlain by schist or phyllite. Soils south of Rock Run are mostly in the Cardiff-Whiteford Association and are described as shallow and moderately deep soils underlain by slate, hard shale, or hard phyllite (U.S. Department of Agriculture, 2006).

As part of pre-construction investigations, more than 100 borings were installed at the Station. The results and findings of these investigations were summarized in the UFSAR (Dames & Moore, 1968).

In descending order, the four following subsurface units have been identified and characterized during prior Station investigations:

- Fill;
- Unconsolidated Deposits;
- Weathered Bedrock (Peters Creek Schist); and
- Competent Bedrock (Peters Creek Schist).

The following provides a description of the subsurface units (Dames & Moore, 1968). At the Station, the Peters Creek Formation is a greenish-gray to white chlorite schist interbedded with seams and bands of quartzite that range up to 6 feet in thickness. In general, bedrock is encountered at depths ranging from zero to 30 feet below grade. Near the Station, the Peters Creek Formation has a southwest-northeast strike and dips northwest 60 to 70 degrees. The formation is characterized by tight isoclinal folds, thin lenticular bedding, a well developed schistosity, and many discontinuous joint sets.

The upper part of the Peters Creek Formation has been altered by weathering. The zones of severe weathering are generally limited to thicknesses of 25 feet or less, although excavation in the western portion of the construction area encountered highly weathered rock to depths in excess of 65 feet below the original rock surface. A few seams within the bedrock exhibit a high degree of weathering to known depths of up to 200 feet. These weathered zones are relatively thin and generally parallel the schistosity of the rock. The relatively fresh rock surface was encountered at depths ranging from about 15 feet below original grade, near the Conowingo Reservoir, to greater than 80 feet below grade in the higher western portion of the construction area.

This fill includes native unconsolidated deposits that were re-located during Station construction activities and re-distributed schist fragments resulting from bedrock excavation activities. In addition, silt, sand, and gravel from off the Station property were used as fill.

Some native undisturbed soils underlie the Station outside the construction area, and are up to 15 feet thick. These soils are described as consisting of compact silty sand and sandy silt containing gravel and weathered rock fragments (up to boulder size).

2.4.3 HYDROGEOLOGY

This section describes the hydrogeology at the Station, as known prior to completion of this hydrogeologic investigation. The results of this hydrogeologic investigation are discussed in Section 5.2, below.

The Peters Creek Schist has relatively low primary porosity. In consolidated bedrock with low primary porosity, such as the Peters Creek Schist, groundwater is stored in and transmitted through networks of cleavage planes, joints, fractures, and faults (Low and Hippe, 2002). The Peters Creek Schist typically has low yields capable of supporting domestic use (Low and Hippe, 2002). In the Peters Creek Schist, the dominant fracture system is along bedding planes with subvertical joints along strike (Exelon, 2004). When stressed (by pumping), groundwater flow is predominantly along strike and dip. Due to the dipping nature of the beds, resulting cones of depression appear to have an elongated shape parallel to strike.

Prior to this hydrogeologic investigation, a groundwater monitoring network capable of providing accurate groundwater flow direction information did not exist. Groundwater in the overburden deposits was hypothesized to flow from west to east and discharge to the Discharge Canal or to the Conowingo Reservoir directly.

The bedrock beneath the Station does not readily store or transmit groundwater. There are no known deep aquifers of any extent in the region and the bedrock becomes more competent with depth. The potential for groundwater flow inland from the Station is deemed highly improbable (Dames & Moore, 1968). This is corroborated by the fact that the two existing non-potable supply wells, for which data are available, at the Station yield only 2 to 6 gallons per minute (gpm). Based on the information provided above, the bedrock beneath the station does not constitute an aquifer.

Groundwater seeps exist at several locations along the rock face to the west of the Reactor Buildings. A subsurface porous drain dewatering system was installed immediately west of Units 2 and 3 Reactor Buildings (Figure 2.2). The purpose of the dewatering system is to prevent groundwater buildup from the seeps and infiltration from precipitation. The groundwater that enters the system is directed to one of two sumps (north and south), which pump the water to the Station's storm drain system. The water is ultimately discharged to the Discharge Canal or Conowingo Reservoir under the Station's NPDES permit. On September 8, 1995, the drain was removed from service. Groundwater intrusion into the Station buildings has occurred from 1995 until the system was recently reactivated in May 2006.

2.5 AREA GROUNDWATER USE

CRA conducted a search of the Pennsylvania Groundwater Information System (PaGWIS, 2006) database to identify wells within a 1-mile radius of the Station. Due to the size and irregular shape of the Station property, the coordinates for the approximate central portion of the property were entered into the database search. Eleven domestic wells, two water supply wells (located at the Station), one commercial well, and one agricultural (livestock) well were identified within the specified 1-mile radius. Figure 2.3 depicts the approximate locations of the water wells surrounding the Station. Information obtained from the PaGWIS database is in Appendix A.

Residences located within an approximate 1-mile radius of the Station use groundwater for potable water supplies. Many of these residences appear to be seasonal cottages. Drinking water for these residences is typically obtained from shallow overburden wells that generally yield less than 10 gpm. The USGS reports that the consolidated bedrock in southeastern Pennsylvania has negligible primary porosity (Low and Hippe, 2002); therefore, bedrock wells can be productive due to secondary porosity. The USGS reported the median yield of 29 domestic supply wells completed in the Peters Creek

Schist as 9 gpm, with minimum and maximum values of 0.2 and 60 gpm, respectively (Low and Hippe, 2002).

The well depths of the 15 wells identified within a 1-mile radius of the Station range from 30 to 260 feet below ground surface (bgs), and yield between 5 to 60 gpm. Except for one well (which had a total depth of 30 feet bgs), all of these wells are completed in the bedrock. All of the nearby well locations are hydraulically upgradient of the Station.

There are four non-potable water supply wells located on the Station property. Figure 2.3 presents a map of the existing non-potable water supply wells. The general locations of the four non-potable water supply wells are:

- North Substation;
- South Substation;
- Hazmat Storage Yard; and
- Salt Washdown Area.

Station personnel have documented that all four non-potable water supply wells are functional. Well construction information is available for only two (South Substation and Hazmat Storage Yard) of the four wells. The South Substation and Hazmat Storage Yard wells have been constructed in bedrock to depths of 300 and 200 feet, respectively. The South Substation well produces approximately 2 gpm and is used for toilet flushing. The Hazmat Storage Yard well produces approximately 6 gpm and is used to rinse equipment. No survey data were available for any of the supply wells. These wells are not used for drinking water and the Station obtains its drinking water from the reservoir.

Three former potable water supply wells existed at the Station; two were located at the former Information Center, and one was located at the former Presidential Utility Building (PUB). All three wells were constructed as open-rock boreholes. The total depths of the two Information Center wells, constructed as open rock-boreholes were 100 feet and 240 feet bgs. The total depth of the PUB well, constructed as an open-rock borehole, was 280 feet bgs. The Station properly abandoned the three former potable water supply wells by filling them with concrete (A.C. Reider, 1997)..

3.0 AREAS FOR FURTHER EVALUATION

CRA considered all Station operations in assessing groundwater quality at the Station. During this process, CRA identified areas at the Station that warranted further evaluation or "AFEs". This section discusses the process by which AFEs were selected.

CRA's identification of AFEs involved the following components:

- Station inspection on March 16, 17, and 20, 2006;
- interviews with Station personnel;
- evaluation of Station systems;
- investigation of confirmed and unconfirmed releases of radionuclides; and
- review of previous Station investigations.

CRA analyzed the information collected from these components combined with information obtained from CRA's study of hydrogeologic conditions at the Station to identify those areas where groundwater potentially could be impacted from operations at the Station.

CRA then designed an investigation to determine whether any confirmed or potential releases or any other release of radionuclides adversely affected groundwater. This entailed evaluating whether existing Station groundwater monitoring systems were sufficient to assess the groundwater quality at the AFEs. If the systems were not sufficient to adequately investigate groundwater quality associated with any AFE, additional monitoring wells were installed by CRA.

The following sections describe the above considerations and the identification of AFEs. The results of CRA's investigation are discussed in Section 5.0.

3.1 SYSTEMS EVALUATIONS

Exelon launched an initiative to systematically assess the structures, systems and components that store, use, or convey potentially radioactively contaminated liquids. Maps depicting each of these systems were developed and provided to CRA for review. The locations of these systems are presented on Figure 3.1. The Station identified a total of 21 systems that contain or could contain potentially radioactively contaminated liquids. The following presents a list of these systems.

<i>System Identification</i>	<i>Description</i>
02	Reactor Recirculation
03	Control Rod Drive
05	Condensate
06	Feedwater (controls/piping)
08	Off-gas and Recombiner
10	Residual Heat Removal
13	Reactor Core Isolation Cooling
14	Core Spray
19	Fuel Pool Cooling
20	Radwaste
23	High Pressure Coolant Injection
24	Aux Steam
25	Sewage Treatment Plant
27	Condensate Transfer and Refuel Transfer and Storage
28	Circulation Water and Cooling Towers
30	Service Water
32	High Pressure Service Water
33	Emergency Service Water
35	Reactor Building Closed Cooling Water
38	Water Treatment
48	Emergency Cooling Water and Tower

After these systems were identified, Exelon developed a list of the various structures, components and areas of the systems (e.g., piping, tanks, and process equipment) that handle or could potentially handle any radioactively contaminated liquids. The structures, components, and areas included:

- aboveground storage tanks;
- condensate vents;
- areas where confirmed or potential historical releases, spills, or accidental discharges may have occurred;
- pipes;
- pools;
- sumps;
- surface water bodies (i.e., basins, pits, ponds, or lagoons);
- trenches;

- underground storage tanks; and
- vaults.

The Station then individually evaluated the various system components to determine the potential for any release of radioactively contaminated liquid to enter the environment. Each structure or identified component was evaluated against the following seven primary criteria:

- location of the component (i.e., basement or second floor of building);
- component construction material (i.e., stainless steel or steel tanks);
- construction methodologies (i.e., welded or mechanical pipe joints);
- concentration of radioactively contaminated liquid stored or conveyed;
- amount of radioactively contaminated liquid stored or conveyed;
- existing controls (i.e., containment and detection); and
- maintenance history.

System components, which were located inside a building or that otherwise had some form of secondary containment, such that a release of radioactively contaminated liquid would not be discharged directly to the environment, were eliminated from further evaluation. System components that are not located within buildings or did not have some other form of secondary containment were retained for further qualitative evaluation of the risk of a release of a radioactively contaminated liquid to the environment and the potential magnitude of any release.

Exelon's risk evaluation took into consideration factors such as:

- the potential concentration of radionuclides;
- the volume of liquid stored or managed;
- the probabilities of the systems actually containing radioactively contaminated liquid; and
- the potential for a release of radioactively contaminated liquid from the system component.

These factors were then used to rank the systems and system components according to the risk for a potential release of a radioactively contaminated liquid to the environment. The evaluation process resulted in the identification of structures, components, and areas to be considered for further evaluation.

3.2 HISTORICAL RELEASES

CRA also reviewed information concerning confirmed or potential historical releases of radionuclides at the Station, including reports and documents previously prepared by Exelon and compiled for CRA's review. CRA evaluated this information in identifying the AFEs. Any historical releases identified during the course of this assessment that may have a current impact on Station conditions are further discussed in Section 3.4.

3.3 STATION INVESTIGATIONS

CRA considered previous Station investigations in the process of selecting the AFEs for the Station. This section presents a summary of the pre-operational radiological environmental monitoring program (pre-operational REMP), past station investigations, and the radiological environmental monitoring program.

3.3.1 PRE-OPERATIONAL RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

A pre-operational REMP was conducted to establish background radioactivity levels prior to operation of the Station. The environmental media sampled and analyzed during the pre-operational REMP were surface water, drinking water, atmospheric radiation, air particulates, and food. The results of the monitoring were detailed in the reports entitled, "Peach Bottom Atomic Power Station, Preoperational Radiological Environmental Monitoring Report for Units #2 & #3, September 1970 through August 1973", and "Peach Bottom Atomic Power Station - Environs Radiation Monitoring Program - Preoperational Summary Report for Units 2 and 3 - February 5, 1966 through August 8, 1973".

A monitoring program was initiated in 1960 for Unit 1. Five annual reports were completed prior to its initial operation. Tritium was not analyzed during the pre-operational REMP for Unit 1.

A monitoring program for Units 2 and 3 was performed between February 1966 and August 1973.

. The pre-operational REMP report was issued in 1974 (Radiation Management Corporation, 1974). The pre-operational REMP was implemented prior to Units 2 and 3 going online, but prior to and during Unit 1 operations, which began in 1967. Therefore, some of the pre-operational REMP data for Units 2 and 3 may have been influenced by Unit 1 and may not be indicative of true background conditions near the Station. The report included monitoring of atmospheric radiation, radioactivity in drinking water, surface water, and food.

Atmospheric radiation monitoring consisted of gas and air particulate radioactivity measurements; fall out monitoring consisted of radioactivity measurements of soil, vegetation, and rain water; domestic water monitoring consisted of well water sample analysis; surface water and silt samples from the Susquehanna River; and marine life monitoring included the flesh of two groups, catfish/bullhead (bottom feeder), and sunfish. The locations from which these samples were collected are defined in the 1974 pre-operational REMP report (Radiation Management Corporation, 1974).

The pre-operational REMP (Units 2 and 3) analytical results from samples collected from surface water and drinking water wells indicate that tritium was detected in both surface water and drinking water samples.

Tritium concentrations in surface water ranged from non-detect at the lower limit of detection (LLD) of 80 picoCuries per liter (pCi/L) to 1,300 pCi/L over the 3-year monitoring period (1970-1973). Tritium concentrations in drinking water ranged from non-detect at the LLD of 80 pCi/L to 790 ± 90 pCi/L.

Gross beta analytical results in surface water ranged from 1.2 ± 1.1 pCi/L to 9.6 ± 3.1 pCi/L. Gross beta analytical results in drinking water ranged from 1.4 ± 1.2 pCi/L to 6.6 ± 7.0 pCi/L. Gamma spectrometry analytical results in surface water and drinking water were found very sporadically and at concentrations nominally that exceed their respective LLD.

3.3.2 RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

The REMP was initiated in 1960 and includes the collection of multi-media samples including air, surface water, groundwater, fish, milk, sediment, and vegetation. The samples are analyzed for beta and gamma-emitting radionuclides, tritium, iodine-131, and/or strontium as established in the procedures developed for the REMP. The samples are collected at established locations, identified as stations, so that trends in the data can be monitored.

An annual report is prepared providing a description of the activities performed and the results of the analysis of the samples collected from the various media. The latest report reviewed by CRA was issued in 2005 by Station personnel and is entitled "Annual Radiological Environmental Operating Report No. 62, January 1, 2004 through December 31, 2004". This report concluded that the operation of the Station had no adverse radiological impact on the environment. The annual report is submitted to the NRC.

3.4 IDENTIFIED AREAS FOR FURTHER EVALUATION

CRA used the information presented in the above sections along with its understanding of the hydrogeology at the Station to identify AFEs, which were a primary consideration in the development of the scope of work in the Work Plan. The establishment of AFEs is a standard planning practice in hydrogeologic investigations to focus the investigation activities at areas where there is the greatest potential for impact to groundwater.

Specifically, AFEs were identified based on these six considerations:

- systems evaluations;
- risk evaluations;
- review of confirmed and/or potential releases;
- review of documents;
- review of the hydrogeologic conditions; and
- Station inspection completed on March 16, 17, and 20, 2006.

Prior to CRA completing its analysis and determination of AFEs, Station personnel completed an exhaustive review of all historic and current management of systems that may contain potentially radioactively contaminated liquids.

CRA reviewed the systems identified by the Station, which have the potential for the release of radioactively contaminated liquids to the environment, and groundwater flow at the Station. This evaluation allowed CRA to become familiar with Station operations and potential systems that may impact groundwater. CRA then evaluated information concerning historic releases as provided by the Station. This information, along with a review of the results from historic investigations, was used to refine CRA's understanding of areas likely to have the highest possibility of impacting groundwater. Where at risk systems or identified historical releases were located in close proximity or

were located in areas which could not be evaluated separately, the systems and historical releases were combined into a single AFE. At times, during the Station investigation, separate AFEs were combined into one or were otherwise altered based on additional information and consideration.

Finally, CRA used its understanding of known hydrogeologic conditions (prior to this investigation) to identify AFEs. Groundwater flow was an important factor in deciding whether to combine systems or historical releases into a single AFE or create separate AFEs. For example, groundwater beneath several systems that contain radioactively contaminated liquids that flows toward a common discharge point were likely combined into a single AFE.

Based upon its review of information concerning confirmed or potential historical releases, historic investigations, and the systems at the Station that have the potential for release of radioactively contaminated liquids to the environment combined with its understanding of groundwater flow at the Station, CRA identified three AFEs (see Figure 3.1).

AFE-Peach Bottom-1: Condensate Storage Tank and Torus Dewatering Tank Area

On February 16, 1986, there was a release of water containing tritium from the Unit 3 Condensate Storage Tank (CST). The release volume was estimated between 34,000 and 36,000 gallons. Some of the leaked material was contained in the tank's secondary containment system, but two breaches allowed a significant portion of the tritiated water to infiltrate into the subsurface and ultimately reach the storm drain system. One storm drain led to the Conowingo Reservoir, and the other led to the northern Yard Drain Sump. The spilled water flowed from this sump into the porous Yard Drain system.

Based on these releases, CRA identified the Condensate Storage Tank and Torus Dewatering Tank Area an AFE.

AFE-Peach Bottom-2: Units 2 and 3 Reactor and Turbine Building Areas

This area was identified as an AFE to investigate any residual contamination related to three releases of radioactively contaminated liquids that occurred in 1981, 1982 and 1983 respectively.

AFE-Peach Bottom-3: Main Stack Sump

According to Station personnel, off-gases from normal system operations are discharged to the atmosphere via the main stack. The stack is located outside the protected area and is constructed with a sump to collect liquids that have may have condensed from the off-gases which have the potential to contain tritium. Liquids in the sump are redirected back to the Radwaste System for proper processing.

4.0 FIELD METHODS

The field investigations completed for this HIR were completed in May and June 2006. CRA supervised the installation of monitoring wells and collected samples from the newly-installed monitoring wells, existing water supply wells, seeps, and surface water locations. The field investigations were completed in accordance with the methodologies presented in the Work Plan (CRA, 2006).

4.1 SURFACE WATER ELEVATION MONITORING

CRA selected and surveyed eight surface water monitoring locations (SW-PB-1 through SW-PB-8): two locations (SW-PB-1 and SW-PB-8 within the Conowingo Reservoir, two locations (SW-PB-6 and SW-PB-7) within Rock Run Creek, three locations (SW-PB-3 through SW-PB-5) within the discharge canal, and one location (SW-PB-2) within the intake pond. Surface water level measurements were collected at the surface water monitoring locations during the groundwater level measurement event. The purpose of the surface water monitoring was to provide surface water elevation data to evaluate the groundwater/surface water interaction at the Station.

4.2 GROUNDWATER MONITORING WELL INSTALLATION

Prior to completing any ground penetration activities, CRA completed subsurface utility clearance procedures to minimize the potential of injury to workers and/or damage to subsurface utility structures. The subsurface clearance procedures consisted of completing an electronic survey within a minimum of 10-foot radius of the proposed location utilizing electromagnetic and ground penetrating radar technology. Additionally, an air knife was utilized to verify utilities were not present at the proposed location to a depth to 10 feet bgs.

Fourteen new monitoring wells (MW-PB-1 through MW-PB-14) were installed for the fleetwide hydrogeologic investigation. Monitoring well construction logs are provided in Appendix B. These locations were selected based on a review of the available information provided by the Station, the hydrogeology at the Station, the AFEs, and the location of usable existing wells. Table 4.1 summarizes the well completion details.

Eleven of the fourteen borings completed for monitoring well installation were installed using Hollow Stem Auger (HSA) drilling methods; the remainder were installed using air-rotary drilling techniques. The borehole depths ranged from 25 to 100 feet bgs. The

initial 1.5 to 12 feet of the soil was removed using the "soft dig" technique at each borehole. The removed soil was examined, and a description was added to each well log.

Specific installation protocols for the overburden monitoring wells are described below:

- the borehole was advanced to the target depth using 11-inch inside diameter HSA;
- a nominal 2-inch diameter (No. 10 slot) PVC screen, with 15 to 20 feet of screen, attached to a sufficient length of 2-inch diameter schedule 40 PVC riser pipe to extend to the surface, was placed into the borehole through the augers;
- a filter sand pack consisting of silica sand was installed to a minimum height of 2 feet above the top of the screen as the augers are removed;
- a minimum 2-foot thick seal consisting of 3/8-inch diameter bentonite pellets or chips was placed on top of the sand pack and hydrated using potable water;
- the remaining borehole annulus was sealed to within 3 feet of the surface using pure bentonite chips; and
- the remaining portion of the annulus was filled with concrete and a 6-inch diameter protective above-grade casing. The well head will be fitted with a watertight, lockable cap.

Specific installation protocols for the bedrock monitoring wells are described below.

For bedrock well MW-PB-1, a 10-inch diameter boring was advanced by air-rotary drilling method to 25 feet bgs. A 6-inch inside diameter steel casing was then set in the boring and tremie grouted. The boring was then advanced using a 6-inch outside diameter bit to a final depth of 100 feet bgs. For bedrock wells MW-PB-2 and MW-PB-3, a 6-inch diameter boring was advanced by air-rotary to 50 feet bgs. A 2-inch inside diameter PVC well screen and riser were then installed in the boring. Sand pack was placed in the annular space around the well screen, and the remainder of the annular space was tremie grouted.

Drill cuttings were containerized for Station characterization and disposal by Station personnel. Prior to use and between each borehole location, the drilling equipment was decontaminated.

4.3 GROUNDWATER MONITORING WELL DEVELOPMENT

In order to establish good hydraulic communication with the aquifer and reduce the volume of sediment in the monitoring well, monitoring well development was performed in accordance with the procedure outlined below:

- monitoring wells were surged using a submersible pump for at least 30 minutes; and
- development continued until visual observation confirmed the turbidity and silt content of the monitoring wells was significantly reduced.

4.4 SURVEY

The new monitoring wells and surface water monitoring locations were surveyed to establish reference elevations relative to mean sea level and adjusted to the C.D. The surface water measurement locations, top of each well casing, and ground elevation were surveyed to the nearest 0.01-foot relative to the North American Vertical Datum (NAVD) 1988. The survey points were marked. The surface water measurement locations and well locations were surveyed to the nearest 0.10-foot relative to North American Datum (NAD) 1983.

4.5 GROUNDWATER AND SURFACE WATER ELEVATION MEASUREMENTS

On May 22, 2006, CRA collected a round of water level measurements from the monitoring wells and the surface water monitoring locations in accordance with the Work Plan. Based on the measured depth to water from the reference point and the surveyed elevation of the reference point, the groundwater or surface water elevation was calculated. A summary of groundwater elevations for the event is provided in Table 4.2. A summary of surface water elevations for the event is provided in Table 4.3. Figures 4.1 and 4.2 show the surface water and groundwater monitoring locations.

Prior to collecting the water level measurements, the wells were identified and located. Once the wells were identified, CRA completed a thorough inspection of each well, and any noted any deficiencies. Water level measurements were collected using an electronic depth-to-water probe accurate to ± 0.01 foot. The measurements were made from the designated location on the inner riser or steel casing of each monitoring well and reference point on each surface water monitoring location. The water level measurements were obtained using the following procedures:

- the proper operation of the meter was checked by inserting the tip into water and noting if the contact was registering correctly;
- the tip was dried, and then slowly lowered into the well or surface water body until contact with the water was indicated;
- the tip was slowly raised until the light and/or buzzer just began to activate. This indicated the static water level;
- the reading at the reference point was noted to the nearest hundredth of a foot;
- the reading was then re-checked; and
- the water level was then recorded, and the water level meter decontaminated prior to use at the next location.

4.6 GROUNDWATER AND SURFACE WATER SAMPLE COLLECTION

CRA conducted one round of groundwater sampling during the completion of the Work Plan for this hydrogeologic investigation. A total of 14 monitoring wells, eight surface water sample locations, three seeps, and four non-potable water supply wells were sampled between May 23 and May 25, 2006. All of the 14 monitoring wells sampled were newly installed in accordance with the Work Plan. The sampling was scheduled to allow for two weeks to elapse between well development and groundwater sample collection. The existing wells were selected for inclusion in this investigation based on their proximity to AFEs.

At the monitoring well locations, CRA conducted the sampling using a steel bladder pump with a Teflon bladder and dedicated polyethylene tubing to employ low flow purging techniques as described in Puls and Barcelona (1996).

The groundwater in the monitoring wells was sampled by the following low-flow procedures:

- the wells were located and the well identification numbers were verified;
- a water level measurement was taken;
- the well was sounded by carefully lowering the water level tape to the bottom of the well (so as to minimize penetration and disturbance of the well bottom sediment), and comparing the sounded depth to the installed depth to assess the presence of any excess sediment or drill cuttings;

- the pump or tubing was lowered slowly into the well and fixed into place such that the intake was located at the mid-point of the well screen, or a minimum of 2 feet above the well bottom/sediment level;
- the purging was conducted using a pumping rate between 100 to 500 milliliters per minute (mL/min). Initial purging began using the lower end of this range. The groundwater level was monitored to ensure that a drawdown of less than 0.3 feet occurred. If this criterion was met, the pumping rate was increased dependent on the behavior of the well. During purging, the pumping rate and groundwater level were measured and recorded approximately every 10 minutes;
- the field parameters [pH, temperature, conductivity, oxidation-reduction potential (ORP), dissolved oxygen (DO), and turbidity] were monitored during the purging to evaluate the stabilization of the purged groundwater. Stabilization was considered to be achieved when three consecutive readings for each parameter, taken at 5-minute intervals, were within the following limits:

pH ± 0.1 pH units of the average value of the three readings,

Temperature ± 3 percent of the average value of the three readings,

Conductivity ± 0.005 milliSiemen per centimeter (mS/cm) of the average value of the three readings for conductivity <1 mS/cm and ± 0.01 mS/cm of the average value of the three readings for conductivity >1 mS/cm,

ORP ± 10 millivolts (mV) of the average value of the three readings,

DO ± 10 percent of the average value of the three readings, and

Turbidity ± 10 percent of the average value of the three readings, or a final value of less than 5 nephelometric turbidity units (NTUs);

- once purging was complete, the groundwater samples were collected directly from the pump/tubing directly into the sample containers; and
- in the event that the groundwater recharge to the monitoring well was insufficient to conduct the low-flow procedure, the well was pumped dry and allowed to sufficiently recharge prior to sampling.

All groundwater samples were labeled with a unique sample number, the date and time, the parameters to be analyzed, the job number, and the sampler's initials. The samples were then screened by the Station for shipment to Teledyne Brown Engineering Inc. (Teledyne Brown).

A sample key is presented in Table 4.4; field measurements for the hydrogeologic investigation are presented in Table 4.5.

CRA containerized the water purged from the monitoring wells during the sampling, as well as the water purged from all of the wells during the hydrogeologic investigation. The water was placed into 55-gallon drums, which will be processed by the Station in accordance with its NPDES permit.

Surface water samples were collected on May 22 and 23, 2006 at the eight locations (SW-PB-1 through SW-PB-8): two locations (SW-PB-1 and SW-PB-8) within the Conowingo Reservoir, two locations (SW-PB-6 and SW-PB-7) within Rock Run Creek, three locations (SW-PB-3 through SW-PB-5) within the discharge canal, and one location (SW-PB-2) within the intake pond.

The surface water samples were collected by submerging a disposable bailer at the determined sample location and then transferred to the sample container. A sample key is presented in Table 4.4.

Seep samples were collected on May 23 and 24, 2006 at three locations (SP-PB-1 through SP-PB-3).

The seep samples were collected by directly filling the sample containers.

Water supply well samples were collected on May 22 and 23, 2006. Prior to sample collection, each of the water supply wells was purged for approximately 15 minutes to ensure representative water samples were collected from the well.

4.7 DATA QUALITY OBJECTIVES

CRA has validated the analytical data to establish the accuracy and completeness of the data reported. Teledyne Brown provided the analytical services. The Quality Assurance Program for the laboratory is described in Appendix C. Analytical data for groundwater and surface water samples collected in accordance with the Work Plan are presented in Appendix D. Data validation memorandums are presented in Appendix E. The data validation included the following information and evaluations:

- sample preservation;
- sample holding times;
- laboratory method blanks;
- laboratory control samples;

- laboratory duplicates;
- verification of laboratory qualifiers; and
- field quality control (field blanks and duplicates).

Following the completion of field activities, CRA compiled and reviewed the geologic, hydrogeologic, and analytical data.

The data were reviewed using the following techniques:

- data tables and databox figures;
- hydrogeologic cross-sections; and
- hydraulic analyses.

4.8 SAMPLE IDENTIFICATION

Systematic sample identification codes were used to uniquely identify all samples. The ID code format used in the filed are: WG - PB - MW-PB-1 - 052406- JAS - 027. A summary of sample identification numbers is presented in Table 4.4.

WG	-	Sample matrix -groundwater, surface water
WP	-	Sample matrix - seep sample
RB	-	Sample matrix - rinsate blank
PB	-	Station code
MW-PB-1	-	Well ID
052406	-	Date
JAS	-	Sampler's initials
027	-	Sample number

The four existing water supply wells were identified as follows:

North Substation	-	WG-PB-NS
South Substation	-	WG-PB-SS
Salt Washdown	-	WG-PB-SW
Hazmat Storage Yard	-	WG-PB-HAZ

4.9 CHAIN-OF-CUSTODY RECORD

The samples were delivered to Station personnel under chain-of-custody protocol. Subsequently, the Station shipped the samples under chain-of-custody protocol to Teledyne Brown for analyses.

4.10 QUALITY CONTROL SAMPLES

Quality control samples were collected to evaluate the sampling and analysis process.

Field Duplicates

Field duplicates were collected to verify the accuracy of the analytical laboratory by providing two samples collected at the same location and then comparing the analytical results for consistency. Field duplicate samples were collected at a frequency of one duplicate for every ten samples collected. A total of three duplicate samples were collected. The locations of duplicate samples were selected in the field during the performance of sample collection activities. The duplicate samples were collected simultaneously with the actual sample and were analyzed for the same parameters as the actual samples.

Rinsate Blank Samples

Rinsate blanks were collected to verify that decontamination procedures conducted in the field were adequate. Rinsate blanks were collected by routing Station-supplied demineralized water through decontaminated sampling equipment. Rinsate blanks were collected at a frequency of one rinsate blank for every day samples were collected using non-disposable or non-dedicated equipment. A total of three rinsate blanks were collected.

4.11 ANALYSES

Groundwater and surface water samples were analyzed for tritium and gamma-emitting radionuclides as listed in NUREG-1302 and strontium-89/90 as listed in 40 CFR 141.25.

5.0 RESULTS SUMMARY

This section provides a summary of Station-specific geology and hydrogeology, along with a discussion of hydraulic gradients, groundwater elevations, and flow directions in the vicinity of the Station. This section also presents and evaluates the analytical results obtained from activities performed in accordance with the Work Plan.

5.1 STATION GEOLOGY

The geology encountered during monitoring well installation is consistent with the geology described in Section 2.4.3. The geology beneath the Station consists of fill, weathered bedrock, and competent rock (Peters Creek Schist). The thickness of the fill (excavated rock) ranges from 2 to 34 feet. In general, the thickness of the fill increases from the base of the rock cliff west of the Station structures to the east towards the Conowingo Reservoir. The upper 10 to 20 feet of bedrock was typically weathered. More competent bedrock is encountered beneath the weathered rock.

Figure 5.1 identifies the location of the cross-section lines onto which the wells, buildings, and other features were projected. The geologic cross-sections shown on Figures 5.2 and 5.3 provide representative depictions of the geologic conditions at the Station. These profile locations were selected because of their close proximity to the AFEs and structures potentially influencing groundwater flow patterns.

These cross-sections show how the construction of the Station has significantly altered the original topography and subsurface. Prior to construction, the bedrock sloped from the plateau to the west steeply down to the Conowingo Reservoir. During construction, significant blasting and excavation was completed along the bank of the river to create a platform for construction of the Station. This created a rock cliff from the higher topographic areas down to the bank of the reservoir. The Station structures were then constructed on a competent bedrock platform with much of the excavated material being used for surrounding fill. The fill was also used to extend the existing land surface into the reservoir. The extended land surface was used for parking lots and buildings not related to Station operations.

5.2 STATION HYDROGEOLOGY

Figure 5.1 presents the monitoring well network in relationship to the geologic profile locations. Hydrogeologic profiles are presented on Figures 5.2 and 5.3.

5.2.1 GROUNDWATER FLOW DIRECTIONS

Figure 5.4 presents a potentiometric surface contour map based on the May 22, 2006 water level data collected by CRA. CRA used a commercially available contouring program (Surfer, Version 8.02, 2002) to provide an initial contouring of groundwater elevations. The initial contours were then modified using professional judgment to prepare final contour maps. Modification was necessary to include proper consideration of surface water body elevations and the limits of the saturated overburden. The limit of saturated overburden shown on Figure 5.4 is based on the identification of areas where overburden material is absent (i.e., bedrock is exposed at the ground surface) and where the overburden is thin due to steep slopes. Essentially, this limit defines the extent of the water table aquifer at the Station. Due to limited monitoring points, the inferred extent of the overburden aquifer south of Rock Run Creek is more subjective than in the area to the north.

Figure 5.4 indicates that lateral groundwater flow in the overburden aquifer is from west to east. Groundwater flows towards the surface water bodies and discharges either to the Conowingo Reservoir or the Discharge Canal, which subsequently discharges to the Conowingo Reservoir.

A potentiometric surface map for the bedrock aquifer could not be prepared as only three monitoring wells were completed entirely in the bedrock (MW-PB-1, MW-PB-2 and MW-PB-3). Based on a review of the groundwater elevation at well MW-PB-2, located at the base of the rock cliff, the vertical gradient is upward from the bedrock to the overburden. This is expected due to the location of the Station in a regional discharge area along the shore of the Susquehanna River.

5.2.2 MAN-MADE INFLUENCES ON GROUNDWATER FLOW

The groundwater flow is impacted by Station structures and local geology. The foundations of the Reactor and Turbine Buildings are completed into competent bedrock at depths greater than the surrounding area; therefore, groundwater flow in the overburden migrates around the buildings.

The Yard Drain Sump and Dewatering System influences groundwater flow immediately west of the Reactor and Turbine Buildings (see Figure 2.2). The purpose of the dewatering system (built during Station construction) is to prevent groundwater

buildup from the seeps and infiltration from precipitation. The dewatering system is constructed of a 12-inch diameter porous concrete pipe connected to two sumps at each end. The system is located under the service roadway within granular backfill west of the Reactor Buildings. The area is bounded on the west by the native bedrock, on the east by the Reactor and Radwaste Buildings, on the south by the concrete fill for the railroad, and on the north by the Recombiner Building and concrete fill. The dewatering system sump pumps have a capacity to pump up to 150 gpm and maintain a groundwater level between approximately 107 to 110 feet C.D. The invert elevation of the Unit 3 Yard Sump is at 105 feet C.D.

The Yard Drain Sump and Dewatering System was inactive from 1995 through May 2006. During this period, groundwater intruded into the Station structures when groundwater elevations exceeded approximately 128 feet C.D. (PECO Energy, 1999). The drain system was reactivated in May 2006. Groundwater level measurements for this investigation were collected on May 22, 2006 after the dewatering system had been off (not pumping) for approximately four days.

5.2.3 LATERAL GROUNDWATER FLOW AND VELOCITY

The horizontal hydraulic gradient is estimated to be 0.02 feet per foot based on a change in the water table elevation of approximately 12.58 feet over the 525 feet between MW-PB-13 and MW-PB-4. Although no Station-specific hydraulic conductivity data exist, the conductivity of the fill material as encountered during the drilling program (crushed rock, sands, and silts) near the Station was approximated to be 28 feet per day (Freeze and Cherry, 1979). Based on the hydraulic gradient, estimated permeability, and assumed effective porosity of 0.32, the rate of groundwater flow within the overburden is estimated to be 1.75 feet per day (638.75 feet per year).

5.3 GROUNDWATER QUALITY

CRA personnel collected groundwater samples from 18 wells. The samples were analyzed for tritium and additional radionuclides. Teledyne Brown provided the analytical services. The Quality Assurance Program for the laboratory is described in Appendix C. The analytical data reports are provided in Appendix D.

The analytical data presented herein have been subjected to CRA's data validation process. CRA has used the data with appropriate qualifiers where necessary.

The data reported in the figures and tables do not include the results of recounts that the laboratory completed, except if those results ultimately replaced an initial report. The tables and figures, therefore, include only the first analysis reported by the laboratory. Where multiple samples were collected over time, then the most recent result has been used in the discussion, below.

5.3.1 **SUMMARY OF BETA-EMITTING RADIONUCLIDES** **ANALYTICAL RESULTS**

A summary of the tritium results for the groundwater samples collected during this investigation is provided in Table 5.1 and shown on Figure 5.5.

All tritium concentrations were below the United States Environmental Protection Agency (USEPA) drinking water standard of 20,000 pCi/L. Tritium was not detected at concentrations greater than the LLD of 200 pCi/L in 13 of the 18 groundwater samples collected.

Five of the fourteen groundwater samples collected from the newly installed monitoring wells had concentrations of tritium exceeding the LLD of 200 pCi/L. Two of these wells are bedrock wells: MW-PB-1 (225 ± 113 pCi/L) and MW-PB-3 (382 ± 111 pCi/L). The other three wells are overburden wells, which are either adjacent to or downgradient of the northern end of Unit 3: MW-PB-4 (575 ± 131 pCi/L), MW-PB-12 (250 ± 109 pCi/L), and MW-PB-13 (266 ± 115 pCi/L). No tritium was detected in the groundwater samples collected from the four non-potable water supply wells.

Strontium-89/90 was not detected at concentrations greater than the LLD of 2.0 pCi/L. A summary of the strontium-89/90 results for the groundwater samples collected as part of this investigation that is the subject of this HIR is provided in Table 5.2 and shown on Figure 5.6.

5.3.2 **SUMMARY OF GAMMA-EMITTING RADIONUCLIDES** **ANALYTICAL RESULTS**

Gamma-emitting target radionuclides were not detected at concentrations that exceeded their respective LLD. A summary of the gamma-emitting radionuclides results for the groundwater samples collected as part of the investigation that is the subject of this HIR is provided in Table 5.2 and shown on Figure 5.6.

Other non-targeted radionuclides were also included in the tables but excluded from discussion in this report. These radionuclides were either a) naturally occurring and thus not produced by the Station, or b) could be definitively evaluated as being naturally occurring due to the lack of presence of other radionuclides, which would otherwise indicate the potential of production from the Station.

5.3.3 SUMMARY OF FIELD MEASUREMENTS

Table 4.5 presents a summary of field measurements collected during the well purging and sampling activities. The field measurements included pH, dissolved oxygen, conductivity, turbidity, and temperature. Of note was the drawdown observed during purging of monitoring well MW-PB-2. During low-flow purging of MW-PB-2, a stable water level could not be achieved. Specifically, the water level dropped from an initial water level of 11.99 feet to 21.18 feet during 60 minutes of purging. The purging rate was continually adjusted down; however, a stable water level could not be maintained at a lower pumping rate. The increased drawdown may have been due to the nearby Yard Drain sump and dewatering system located directly behind the Unit 3 Reactor Building. Station personnel notified CRA that the dewatering system was active during the purging activities at MW-PB-2.

5.4 SURFACE WATER QUALITY

Eight surface water samples and three seep samples were collected from the locations shown on Figure 4.1. The samples were analyzed for tritium, gamma-emitting radionuclides, and strontium-89/90. Teledyne Brown provided the analytical services. The Quality Assurance Program for the laboratory is described in Appendix C. The analytical data reports are provided in Appendix D.

5.4.1 SUMMARY OF BETA-EMITTING RADIONUCLIDES ANALYTICAL RESULTS

Tritium was not detected at concentrations greater than the LLD of 200 pCi/L. A summary of the tritium results for the surface water samples collected in this investigation is provided in Table 5.3 and shown on Figure 5.7.

A summary of the tritium results for the seep samples collected in this investigation is provided in Table 5.3 and shown on Figure 5.7. Two of the three seep samples had

tritium concentrations that were greater than the LLD of 200 pCi/L. The tritium concentration in seep sample from SP-PB-1 was 278 ± 109 pCi/L and SP-PB-2 was 278 ± 109 pCi/L. Strontium-89/90 was not detected at concentrations greater than the LLD of 2.0 pCi/L in any of the seep samples.

Strontium-89/90 was not detected at concentrations greater than the LLD of 2.0 pCi/L. A summary of the strontium-89/90 results for the surface water samples collected in this investigation is provided in Table 5.4 and shown on Figure 5.8.

5.4.2 SUMMARY OF GAMMA-EMITTING RADIONUCLIDES ANALYTICAL RESULTS

Gamma-emitting target radionuclides were not detected at concentrations greater than their respective LLDs. A summary of the gamma-emitting radionuclides results for the surface water and seep samples collected during this investigation is provided in Table 5.4 and shown on Figure 5.8.

Other non-targeted radionuclides were also included in the tables but excluded from discussion in this report. These radionuclides were either a) naturally occurring and thus not produced by the Station, or b) could be definitively evaluated as being naturally occurring due to the lack of presence of other radionuclides which would otherwise indicate the potential of production from the Station.

6.0 RADIONUCLIDES OF CONCERN AND SOURCE AREAS

This section discusses radionuclides evaluated in this investigation, potential sources of the radionuclides detected, and their distribution.

6.1 GAMMA-EMITTING RADIONUCLIDES

Gamma-emitting target radionuclides were not detected at concentrations greater than their respective LLDs. Other non-targeted radionuclides were also included in the tables but excluded from discussion in this report. These radionuclides were either a) naturally occurring and thus not produced by the Station, or b) could be definitively evaluated as being naturally occurring due to the lack of presence of other radionuclides which would otherwise indicate the potential of production from the Station.

6.2 BETA-EMITTING RADIONUCLIDES

Strontium-89/90 was not detected in any of the 29 samples collected at concentrations that were greater than the LLD of 2.0 pCi/L. Tritium was detected in 7 of the 29 total sample locations. Concentrations of tritium ranged between 225 ± 113 pCi/L to 575 ± 131 pCi/L.

Since only tritium was detected at concentrations greater than its LLD, the following sections focus on tritium; specifically, providing general characteristics of tritium, potential sources, distribution in groundwater, and a conceptual model for migration.

6.3 TRITIUM

This section discusses the general characteristics of tritium, the distribution of tritium in groundwater and surface water, and the conceptual model of tritium release and migration.

6.3.1 GENERAL CHARACTERISTICS

Tritium (chemical symbol H-3) is a radioactive isotope of hydrogen. The most common forms of tritium are tritium gas and tritium oxide, which is also called "tritiated water." The chemical properties of tritium are essentially those of ordinary hydrogen. Tritiated

water behaves the same as ordinary water in both the environment and the body. Tritium can be taken into the body by drinking water, breathing air, eating food, or absorption through skin. Once tritium enters the body, it disperses quickly and is uniformly distributed throughout the body. Tritium is excreted primarily through urine within a month or so after ingestion. Organically bound tritium (tritium that is incorporated in organic compounds) can remain in the body for a longer period.

Tritium is produced naturally in the upper atmosphere when cosmic rays strike air molecules. Tritium is also produced during nuclear weapons explosions, as a by-product in reactors producing electricity, and in special production reactors, where the isotopes lithium-7 and/or boron-10 are bombarded to produce tritium.

Although tritium can be a gas, its most common form is in water because, like non-radioactive hydrogen, radioactive tritium reacts with oxygen to form water. Tritium replaces one of the stable hydrogen atoms in the water molecule and is called tritiated water. Like normal water, tritiated water is colorless and odorless. Tritiated water behaves chemically and physically like non-tritiated water in the subsurface, and therefore, tritiated water will travel at the same velocity as the average groundwater velocity.

Tritium has a half-life of approximately 12.3 years. It decays spontaneously to helium-3 (^3He). This radioactive decay releases a beta particle (low-energy electron). The radioactivity of tritium is the source of the risk of exposure.

Tritium is one of the least dangerous radionuclides because it emits very weak radiation and leaves the body relatively quickly. Since tritium is almost always found as water, it goes directly into soft tissues and organs. The associated dose to these tissues is generally uniform and is dependent on the water content of the specific tissue.

6.3.2 DISTRIBUTION IN STATION GROUNDWATER

This section provides an overview of the lateral and vertical distribution of tritium detected in groundwater at the Station. Tritium was detected in groundwater at concentrations greater than the LLD of 200 pCi/L.

Tritium concentrations marginally greater than the LLD of 200 pCi/L were detected during the hydrogeologic investigation that is the subject of this HIR in groundwater samples collected from the following five monitoring wells: MW-PB-1, MW-PB-3,

MW-PB-4, MW-PB-12, and MW-PB-13. The tritium concentrations ranged from 225 ± 113 pCi/L (MW-PB-1) to 575 ± 131 pCi/L (MW-PB-4).

6.3.3 DISTRIBUTION IN STATION SURFACE WATER

This section provides an overview of the lateral distribution of tritium detected in surface water at the Station. Tritium was not detected in surface water at concentrations greater than the LLD of 200 pCi/L.

Two of the three seep samples, located on the western rock cliff face, adjacent to the main stack, had tritium concentrations greater than the LLD of 200 pCi/L. The tritium concentrations in seep samples from SP-PB-1 and SP-PB-2 were 278 ± 109 pCi/L and 245 ± 108 pCi/L, respectively

6.3.4 CONCEPTUAL MODEL OF TRITIUM RELEASE AND MIGRATION

This section presents CRA's conceptual model of groundwater and tritium migration at the Station.

The analytical results for the groundwater samples collected at the Station indicate that the groundwater impacts are minimal and there are no active tritium releases to groundwater. However, tritium concentrations in the groundwater indicate that nominal residual tritium may be present from historical releases.

Hydrogeologic Framework

The groundwater that flows in the overburden is affected by the building foundations, which extend into the competent bedrock. The overburden aquifer pinches out to the west behind the building structures at the base of the rock cliff. In addition, groundwater flow on the west side of the Reactor Buildings is affected by accumulation of groundwater in the overburden. Pumping of the drain system on the west side of the Units 2 and 3 Reactor Buildings serves to lower the groundwater table and reduce mounding conditions and infiltration into the structures.

The Peters Creek Schist, which is the competent bedrock beneath the Station, has relatively low primary and secondary porosity. Therefore, the bedrock does not readily store and transmit groundwater. This is supported by documented low well yields in the non-potable water supply wells ranging from 2 to 6 gpm. The vertical gradient is

upward from the bedrock to the overburden as expected due to the location of the Station in a regional discharge area.

Sources and Migration of Tritium

The most likely source of tritium at well MW-PB-4 is from the historical release associated with the 1986 Unit 3 Condensate Storage Tank overflow (AFE-Peach Bottom-1). There is no indication from the HIR investigation that tritium impacted groundwater from the area of MW-PB-4 is migrating off-site.

7.0 EXPOSURE PATHWAY ASSESSMENT

This section addresses the groundwater impacts from tritium and other radionuclides at the Station and potential risks to human health and the environment.

Based upon historical knowledge and data related to the Station operations, and based upon radionuclide analyses of groundwater samples, the primary constituent of concern (COC) is tritium. The discussions that follow are restricted to the exposure pathways related to tritium.

Teledyne Brown reports all samples on their hardcopy reports to their statistically derived minimum detectable concentration (MDC) of approximately 150 to 170 pCi/L, which is associated with 95 percent confidence interval on their hard-copy reports. However, the laboratory uses a 99 percent confidence range (± 3 sigma) for determining whether to report the sample activity concentration as detected or not. This 3-sigma confidence range typically equates to 150 (± 135.75) pCi/L.

Exelon has specified a LLD of 200 pCi/L for the Fleetwide Assessment. Exelon has also required the laboratory to report related peaks identified at the 95 percent confidence level (2-sigma).

This HIR, therefore, screens and assesses data using Exelon's LLD of 200 pCi/L. As is outlined below, this concentration is also a reasonable approximation of the background concentration of tritium in groundwater at the Station.

7.1 HEALTH EFFECTS OF TRITIUM

Tritium is a radionuclide that decays by emitting a low-energy beta particle that cannot penetrate deeply into tissue or travel far in air. A person's exposure to tritium is primarily through the ingestion of water (drinking water) or through ingestion of water bearing food products. Inhalation of tritium requires the water to be in a vapor form (i.e., through evaporation or vaporization due to heating). Inhalation is a minor exposure route when compared to direct ingestion or drinking of tritiated water. Absorption of tritium through skin is possible, but tritium exposure is more limited here versus direct ingestion or drinking of tritiated water.

7.2 BACKGROUND CONCENTRATIONS OF TRITIUM

The purpose of the following paragraphs is to establish a background concentration through review of various media.

7.2.1 GROUNDWATER

Tritium is created in the environment from naturally occurring processes both cosmic and subterranean, as well as from anthropogenic (i.e., man-made) sources. In the upper atmosphere, "cosmogenic" tritium is produced from the bombardment of stable nuclides and combines with oxygen to form tritiated water, which will then enter the hydrologic cycle. Below ground, "lithogenic" tritium is produced by the bombardment of natural lithium isotopes ${}^6\text{Li}$ (92.5% abundance) and ${}^7\text{Li}$ (7.5% abundance) present in crystalline rocks by neutrons produced by the radioactive decay of uranium and thorium. Lithogenic production of tritium is usually negligible compared to other sources due to the limited abundance of lithium in rock. The lithogenic tritium is introduced directly to groundwater.

A major anthropogenic source of tritium comes from the former atmospheric testing of thermonuclear weapons. Levels of tritium in precipitation increased during the 1950 and early 1960s, coinciding with the release of significant amounts of tritium to the atmosphere during nuclear weapons testing prior to the signing of the Limited Test Ban Treaty in 1963, which prohibited atmospheric nuclear tests.

7.2.2 PRECIPITATION DATA

Precipitation samples are routinely collected at stations around the world for the analysis of tritium and other radionuclides. Two publicly available databases that provided tritium concentrations in precipitation are Global Network of Isotopes in Precipitation (GNIP) and USEPA's RadNet database. GNIP provides tritium precipitation concentration data for samples collected world wide from 1960 to 2006. RadNet provides tritium precipitation concentration data for samples collected at stations through the U.S. from 1960 up to and including 2006.

Based on GNIP data for sample stations located in the eastern U.S. including Boston, Washington, and Hatteras, North Carolina, tritium concentrations peaked around 1963. This peak, which approached 10,000 pCi/L for some stations, coincided with the atmospheric testing of thermonuclear weapons during the 1950s and early 1960s before

the 1963 test ban treaty. Tritium concentrations showed a sharp decline up until about 1975 and continued to exhibit a gradual decline since that time. Tritium concentrations in the precipitation collected at these stations have typically been less than 100 pCi/L since around 1982 to 1983.

The RadNet database for several Pennsylvania and area stations (Washington, Philadelphia, New York, Harrisburg, Wilmington, and Trenton) did not show the same trend, which can be attributed to pre-1995 data handling procedures. The pre-1995 data were rounded to the nearest 100 pCi/L, which damped out variances in the data. The post-1995 RadNet data, where rounding was not applied, exhibit much more scatter, and similar to the GNIP data, most of the data were less than 100 pCi/L.

An upper tolerance limit on the 95th percentile (with 95 percent confidence) of tritium in precipitation for the Pennsylvania and surrounding area stations RadNet Data between 2000 and 2005 were calculated as per Section 5.3 of USEPA, 1989. The assumption of normal distribution of the data was verified using the Studentized Range test (Section 4.2.4.1 of USEPA, 2006), and the data were confirmed to be normally distributed. The resulting upper tolerance limit is 98.2 pCi/L, which indicates that we are 95 percent confident that 95 percent of the ambient precipitation concentration results are below 98.2 pCi/L. The statistical confidence, however, must be compared with the limitations of the underlying RadNet data, which does not include the minimum detectable concentration for a majority of the measurements. Some of the RadNet values below 200 pCi/L may be approximated. Nevertheless, these results show a background contribution from precipitation of up to 98.2 pCi/L.

7.2.3 SURFACE WATER DATA

Surface water tritium concentration data from the RadNet database for Pennsylvania sampling stations Danville (Susquehanna River), Philadelphia/Baxter (Delaware River), Philadelphia/Queen (Schuylkill River), and Philadelphia/Belmont (Schuylkill River) show the same trend as the precipitation data for the above noted Pennsylvania and surrounding area sampling stations. As is the case for the RadNet precipitation data, the pre-September 1995 Pennsylvania surface water data was rounded to the nearest 100 pCi/L, creating a dampening of variances in the data. The post-1995 Pennsylvania surface water data, similar to the post-1995 precipitation data, were typically less than 100 pCi/L with exception of three samples collected at the Schuylkill River Stations (128 to 363 pCi/L) and one sample from the Susquehanna River Station (124 pCi/L). These results indicate that there is a background tritium concentration in surface water

that is typically less than 100 pCi/L but have approached 400 pCi/L in the Schuylkill River.

The post-1995 RadNet data for Peach Bottom are all reported below 100 pCi/L. These results indicate that there is a background tritium concentration in surface water that is typically less than 100 pCi/L.

Pre-Operational REMP tritium concentrations in surface water ranged from non-detect (LLD of <80 pCi/L) to 1,300 pCi/L over the 3-year monitoring period. Gross beta analytical results in surface water ranged from 1.2 ± 1.1 pCi/L to 9.6 ± 3.1 pCi/L.

The USEPA RadNet surface water data typically has a reported 'Combined Standard Uncertainty' of 35 to 50 pCi/L. According to USEPA, this corresponds to a ± 70 to 100 pCi/L 95 percent confidence bound on each given measurement. Therefore, the typical background data provided may be subject to measurement uncertainty of approximately ± 70 to 100 pCi/L.

7.2.4 DRINKING WATER DATA

Tritium concentrations in drinking water from the RadNet data base for six Pennsylvania and surrounding area stations (Washington, Philadelphia, New York, Dover, Wilmington, and Trenton) exhibit similar trends as the precipitation and surface water data. As with the precipitation and surface water data, the pre-1995 drinking water data has dampened out variances due to rounding the data to the nearest 100 pCi/L. The post-1995 results show tritium concentrations below 100 pCi/L.

Pre-operational REMP tritium concentrations in drinking water ranged from <80 pCi/L to 790 ± 90 pCi/L. Gross beta analytical results in drinking water ranged from 1.4 ± 1.2 pCi/L to 6.6 ± 7.0 pCi/L.

7.2.5 EXPECTED TRITIUM BACKGROUND FOR THE STATION

As reported in the GNIP and RadNet databases, tritium concentrations in eastern U.S. precipitation has typically been less than 100 pCi/L since 1980. Tritium concentrations reported in the RadNet database for select eastern U.S. stations, at least since 1995, have typically been less than 100 pCi/L. Based on the 2000 to 2005 RadNet precipitation data for the Pennsylvania stations, 95 percent of the ambient concentrations of tritiated water are expected to be less than 98.2 pCi/L, based on a

95 percent upper tolerance limit. Tritium concentrations in surface water and drinking water are expected to be comparable or less based on historical data or trends.

Concentrations in groundwater are similar to surface water and drinking water and are expected to be less than precipitation values. The lower groundwater concentrations are related to the age of the groundwater as compared to the half-life of tritium. However, deep aquifers in proximity to crystalline basement rocks may potentially show elevated concentrations of tritium due to lithogenic sources.

As was noted in Section 7.0, the analytical laboratory is reporting tritium results to a LLD of 200 pCi/L. This concentration also represents a reasonable representation of background groundwater quality, given the data for precipitation, surface water, and drinking water.

Based on the evaluation presented above, the background concentration for tritium at the Station is reasonably represented by the LLD of 200 pCi/L.

7.3 IDENTIFICATION OF POTENTIAL EXPOSURE PATHWAYS AND POTENTIAL RECEPTORS

Two potential exposure pathways were considered during the evaluation of tritium in groundwater.

- potential groundwater migration off the Station property to private and public groundwater users; and
- potential groundwater migration off the Station property to a surface water body.

The following section provides an overview of both of these two potential exposure pathways for tritium in groundwater.

7.3.1 POTENTIAL GROUNDWATER MIGRATION TO DRINKING WATER USERS OFF THE STATION PROPERTY

The concentrations of tritium in groundwater are less than the USEPA Drinking Water Standard of 20,000 pCi/L. Consequently, there is no tritium in the groundwater that could migrate off the Station at concentrations exceeding the USEPA Drinking Water Standards.

Groundwater samples collected from monitoring wells installed on the Station indicate tritium concentrations in groundwater above background at five of the 18 sample locations. However, these concentrations are likely related to historical releases that are not ongoing.

Evaluation of groundwater flow at the Station indicates that the groundwater discharges to the Conowingo Reservoir or to the Discharge Canal, which subsequently discharges to the Conowingo Reservoir.

The Peters Creek Schist, which is a low yielding formation, is used for domestic water supply in the surrounding area. There are domestic wells upgradient of the Station, however, there are no off-site domestic water supply wells between the Station and discharge points. Therefore, it is highly unlikely that off-site water supply wells could be impacted from a potential tritium release to groundwater. In summary, there is no complete exposure pathway for groundwater, therefore, there is no current risk of exposure associated with groundwater ingestion off the Station property..

7.3.2 POTENTIAL GROUNDWATER MIGRATION TO SURFACE WATER USERS

Evaluation of groundwater flow at the Station indicates that the groundwater discharges to Conowingo Reservoir or to the Discharge Canal, which subsequently discharges to the Conowingo Reservoir. Therefore, there is a potentially complete exposure route to recreational users of surface water including boating, fishing, and swimming.

Tritium results for surface water samples collected as part of this investigation are below the LLD of 200 pCi/L. Although two of the three seep samples had tritium concentrations exceeding the LLD of 200 pCi/L (SP-PB-2 had 245 ± 108 pCi/L and SP-PB-1 had 278 ± 109 pCi/L), the seeps are not a direct source of tritium to surface water. Furthermore, the seeps do not represent a surface water exposure point for recreational users.

Although a potential exposure route exists, there is minimal potential for tritium exposure from recreational activities in surface water from migration of groundwater based on the analytical results. In summary, a potential exposure pathway to surface water exists; however, the tritium concentrations detected at the Station present no current risk to the potential surface water receptors.

7.4 SUMMARY OF POTENTIAL TRITIUM EXPOSURE PATHWAYS

In summary, there are two potential exposure pathways for tritium originating at the Station:

- potential groundwater migration off the Station property to private and public groundwater users; and
- potential groundwater migration off the Station property to a surface water body.

Based upon the groundwater and surface water data provided and referenced in this investigation, none of the potential receptors are at risk of exposure to concentrations of tritium in excess of the USEPA drinking water standard (20,000 pCi/L).

7.5 OTHER RADIONUCLIDES

Target radionuclides were not detected at concentrations greater than their respective LLD in the groundwater and surface water samples collected. Other non-targeted radionuclides were also included in the tables but excluded from discussion in this report. These radionuclides were either a) naturally occurring and thus not produced by the Station, or b) could be definitively evaluated as being naturally occurring due to the lack of presence of other radionuclides which would otherwise indicate the potential of production from the Station.

8.0 CONCLUSIONS

Based on this hydrogeologic investigation, CRA concludes:

Groundwater Flow

- Groundwater is stored and transmitted primarily in the overburden material beneath the Station. The overburden groundwater flows from west to east across the Station with discharge to the Conowingo Reservoir.
-
- There are several seeps at the rock cliff face, west of Units 2 and 3. These seeps are indicative of a higher groundwater surface within the bedrock west of the Station.
- Minimal groundwater flow is believed to occur in the overlying bedrock (Peters Creek).

Groundwater Quality

- Tritium results in groundwater were not detected at concentrations greater than the USEPA drinking water standard of 20,000 pCi/L.
- Tritium was not detected at concentrations greater than the LLD (200 pCi/L) in 13 of the 18 samples collected as part of this investigation.
- Tritium was detected in groundwater samples collected from new monitoring wells MW-PB-1 (225 ± 113 pCi/L), MW-PB-3 (382 ± 111 pCi/L sample and 345 ± 110 pCi/L duplicate sample), MW-PB-4 (575 ± 131 pCi/L), MW-PB-12 (250 ± 109 pCi/L), and MW-PB-13 (266 ± 115 pCi/L).
- Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective LLDs in any samples collected as part of this investigation.
- Strontium-89/90 was not detected at a concentration greater than the LLD of 2.0 pCi/L in any samples collected as part of this investigation.
- Tritium concentrations in groundwater are consistent with background.

Surface Water and Seep Quality

- Tritium results in surface water and seep samples were not detected at concentrations greater than the USEPA drinking water standard of 20,000 pCi/L.
- Tritium was not detected at concentrations greater than the LLD (200 pCi/L) in any surface water samples collected as part of this investigation.

- Tritium was detected in seep samples collected from seep locations SEEP SP-1 (278 ± 109 pCi/L), and SEEP SP-2 (245 ± 108 pCi/L). Tritium was not detected above the LLD (200 pCi/L) in the seep sample collected from seep location SEEP SP-3 as part of this investigation.
- Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective LLDs in any surface water or seep samples collected as part of this investigation.
- Strontium-89/90 was not detected at a concentration greater than the LLD of 2.0 pCi/L in any surface water or seep samples collected as part of this investigation.
- Tritium concentrations in surface water and seeps are consistent with background.

AFE-Peach Bottom-1: Condensate Storage Tank and Torus Dewatering Tank Area

- Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective LLDs in any of the groundwater samples collected from the monitoring wells in the vicinity of AFE-Peach Bottom-1.
- Strontium-89/90 was not detected at a concentration greater than the LLD of 2.0 pCi/L in any of the groundwater samples collected from the monitoring wells in the vicinity of AFE-Peach Bottom-1.
- Tritium was detected in the groundwater samples from downgradient monitoring wells MW-PB-12 and MW-PB-13 at concentrations of 260 ± 115 pCi/L and 250 ± 109 pCi/L, respectively.
- The maximum tritium concentration was detected in the groundwater sample from MW-PB-4 (575 ± 131 pCi/L). Monitoring well MW-PB-4 is located immediately east of the Administration Building and approximately 200 feet downgradient of the Unit 3 Turbine Building. The tritium detected in the groundwater sample collected from well MW-PB-4 is likely residual impact from the historical release at the Condensate Storage Tank.

AFE-Peach Bottom-2: Units 2 and 3 Reactor and Turbine Building Areas

- Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective LLDs in any of the groundwater samples collected from the monitoring wells in the vicinity of AFE-Peach Bottom-2.
- Strontium-89/90 was not detected at a concentration greater than the LLD of 2.0 pCi/L in any of the groundwater samples collected from the monitoring wells in the vicinity of AFE-Peach Bottom-2.

- There are four monitoring wells (MW-4, MW-7, MW-11, and MW-12) downgradient of the Reactor and Turbine Building Area. Groundwater samples from the two eastern wells (MW-4 and MW-12) contain tritium; however, they are related to the CST Area. No tritium was detected in the groundwater samples from wells MW-PB-7 and MW-PB-11 at concentrations greater than the LLD of 200 pCi/L.
- There is no current impact from this AFE to groundwater.

AFE-Peach Bottom-3: Main Stack Sump

- Gamma-emitting radionuclides associated with licensed plant operations were not detected at concentrations greater than their respective LLDs in any of the groundwater samples collected from the monitoring wells in the vicinity of AFE-Peach Bottom-3.
- Strontium-89/90 was not detected at a concentration greater than the LLD of 2.0 pCi/L in any of the groundwater samples collected from the monitoring wells in the vicinity of AFE-Peach Bottom-3.
- There is one monitoring well (MW-PB-3) downgradient of the Main Stack Sump. Tritium was detected in the groundwater sample from upgradient monitoring well MW-PB-1 at a concentration of 225 ± 113 pCi/L and downgradient well MW-PB-3 at a concentration of 382 ± 111 pCi/L. These values are slightly greater than the LLD of 200 pCi/L.
- Tritium was detected in the seep samples collected from downgradient locations SP-PB-1 and SP-PB-2 at concentrations of 278 ± 109 pCi/L and $245 \pm 1,108$ pCi/L, respectively. These concentrations are consistent with low-level historical tritium detections in groundwater.
- There is no current impact from this AFE to groundwater.

Potential Receptors

- Based upon the results of this investigation², there is no current risk of exposure to radionuclides associated with licensed plant operations through any of the identified potential exposure pathways.

² Using the LLD specified in this HIR.

General Conclusions

- Based on the results of this investigation, tritium is not migrating off the Station property at detectable concentrations.
- Based upon the results of this investigation, there are no known active releases into the groundwater at the Station.

9.0 RECOMMENDATIONS

The following presents CRA's recommendations for proposed activities to be completed at the Station.

9.1 FILL DATA GAPS

Based on the results of this hydrogeologic investigation, there are no data gaps remaining to support CRA's conclusions regarding the characterization of the groundwater regime and potential impacts from radionuclides at the Station.

9.2 GROUNDWATER MONITORING

Based upon the information collected to date, CRA recommends that Exelon conduct periodic monitoring of selected sample locations.

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