Remedial Investigation Report

PSEG Nuclear, LLC
Salem Generating Station
Hancock's Bridge, New Jersey

March 2004

PREPARED FOR

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ARCADIS

Remedial Investigation Report

PSEG Nuclear LLC
Salem Generating Station
Hancock's Bridge, New Jersey

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Tables

Figures

Appendices

Executive Summary

ARCADIS, Inc. (ARCADIS), on behalf of PSEG Services Corporation ("PSEG SC"), has prepared this Remedial Investigation Report to document the findings of a remedial investigation conducted at the PSEG Nuclear, LLC Salem Generating Station (the "Station") located on Artificial Island in Lower Alloways Creek Township, Salem County, New Jersey. The groundwater investigation was conducted in accordance with the scope of work defined in the Remedial Investigation Work Plan ("June 2003 RIWP") and the Initial Groundwater Investigation Report and Remedial Investigation Work Plan Addendum ("RIWP Addendum") that were submitted to the New Jersey Department of Environmental Protection ("NJDEP") in June 2003 and January 2004, respectively. The scope of work outlined in these documents was designed to investigate the discovery of tritium in the shallow, water-bearing unit adjacent to Unit 1 of the Salem Generating Station.

The remedial investigation was initiated in September 2002 following the detection of low-level radioactive contaminants on the shoes of Station technicians. Initial investigations indicated that the source of the low-level radioactive contaminants was water seeping through small cracks in the 78-foot Mechanical Penetration Room of the Unit 1 Auxiliary Building. Further investigation revealed a second leak at the 92-foot elevation of the Unit 1 Spent Fuel Pool cooling line, adjacent to the pipe penetration through the concrete wall. Analytical results of water samples collected from the leaks indicated that the water had characteristics of Spent Fuel Pool water and that a leak from the Spent Fuel Pool system had likely occurred.

The Salem Generating Station Unit 1 Spent Fuel Pool is lined with stainless steel. Behind the stainless steel liner are liner drains (commonly referred to as "telltale drains") that are used as a combined leak monitoring, collection, and drainage mechanism. On January 31, 2003, a fiber optic examination of two of the telltale drains indicated that mineral deposits had formed a blockage in them. The blockage obstructed the flow of water in these drains resulting in the accumulation of Spent Fuel Pool water, which likely migrated along the paths of least resistance (e.g., a pipe conduit, construction joints, or cracks in the concrete) and ultimately manifested at the crack in the wall in the 78-foot elevation Mechanical Penetration Room and through the gap/penetration where the Spent Fuel Pool cooling return lines intersects the wall at the 92-foot elevation. The mineral deposits have subsequently been removed to restore flow in the telltale drains.

Further investigations conducted within the Station indicated that water from the Spent Fuel Pool had migrated to the Styrofoam-filled seismic gap located between the Unit 1 Fuel Handling Building and the Auxiliary Building. Along the narrow western and southern ends of the Seismic Gap, a flow path exists between the Styrofoam and foundation soils. As such, the potential exists for water in the seismic gap to migrate beyond the limits of the engineered structures of the Station. Remedial investigation activities were initiated to determine if the Spent Fuel Pool water that had accumulated in the seismic gap had migrated beyond the limits of the engineered features of the building and into the environment (i.e., soil and groundwater in contact with the seismic gap).

Initially, eight groundwater monitoring wells (Wells K through R) were installed in January and February 2003 at locations adjacent to and around the perimeter of the Salem Unit 1 Fuel Handling Building. Analytical results of groundwater samples collected from these monitoring wells indicated that a potential release of water from the Spent Fuel Pool or other plant source to the environment had likely occurred. At this time, the subject remedial investigation was initiated.

The scope of work proposed in the June 2003 RIWP and the RIWP Addendum was designed to determine if the tritium detected in groundwater samples collected from monitoring wells installed adjacent to Salem Unit 1 is a result of a release to the environment from the Unit 1 Spent Fuel Pool, a non-authorized release from other onsite operating or maintenance activities, or elevated background levels of tritium from authorized releases and other operating practices. The proposed scope of work was also designed to assess the potential for: 1) tritium to migrate beyond the property boundaries; 2) human health and environmental risks associated with the tritium detected in groundwater; and, 3) the need for any further action.

The scope of work presented in the June 2003 RIWP and the RIWP Addendum consisted of the following: 1) the installation of an additional 21 monitoring wells and two replacement monitoring wells; 2) the collection and analysis of groundwater samples from the monitoring well network, including a one time event for groundwater age determination and for technetium-99 to definitively identify the Spent Fuel Pool as the source of the tritium; 3) an evaluation of the local and regional geology and hydrogeology including a review of published information and the performance of water level gauging events, slug tests and pumping tests; 4) an evaluation of tidal influences on select water-bearing units beneath the Station; 5) an evaluation of possible sources of the tritium detected in groundwater; 6) an evaluation of facility construction details and the preparation of detailed cross sections to identify potential migration pathways from the seismic gap and to highlight the principal components of the conceptual site model; 7) fate and transport analysis including the refinement of the conceptual site model, the delineation of groundwater flow pathways, and fate and transport calculations to estimate the age of the tritium release and groundwater flow velocity; and, 8) to assess potential health risks to humans and potential impacts to aquatic and terrestrial biota. The following sections provide a summary of the details and results of the remedial investigation activities.

Well Installation, Groundwater Sampling and the Supplemental Investigation

The initial investigation included the installation and sampling of eight monitoring wells or direct-push points (Well K through Well R; M and R being direct-push points). Analytical results of groundwater samples collected from the monitoring wells indicated that tritium was detected at concentrations above 3,000 picocuries per liter (pCi/L), the interim further investigation criterion proposed in the June 2003 RIWP, in groundwater samples collected from Monitoring Wells M, N, O and R. Tritium was also detected in the groundwater sample collected from Well N on January 30, 2003 at a concentration above the New Jersey Groundwater Quality Criterion (GWQC) for tritium in groundwater of Class IIA aquifers (20,000 pCi/L).

Monitoring Wells S through W were installed between May 5 and June 18, 2003 and existing Monitoring Wells M and R were replaced with properly constructed and developed monitoring wells. **Figure ES-1** shows the monitoring well network installed during the remedial investigation. Following installation and development of the new monitoring wells, groundwater samples were collected from the wells and analyzed by Maplewood for tritium, sodium, boron, and gamma-emitting isotopes. All samples were non-detect for gamma-emitting isotopes. In July 2003, all tritium concentrations, with the exception of Monitoring Wells M and S, were below the GWQC of 20,000 pCi/L. The replacement well for Monitoring Well M, within the cofferdam, indicated a tritium concentration of approximately 62,000 pCi/L and Well S, screened in the shallow, water-bearing unit outside of the cofferdam, indicated a tritium concentration of 3,500,000 pCi/L.

A "supplemental" groundwater investigation was initiated in July 2003 in response to the detections of tritium in groundwater samples collected from Well S. The objectives of the supplemental investigation were as follows: 1) determine if the tritium measured in groundwater samples collected from Well S was migrating towards the property boundary; 2) delineate the vertical and horizontal extent of the tritium in groundwater in the vicinity of Well S; and 3) evaluate the potential sources of tritium in Well S. The supplemental investigation consisted of collecting grab groundwater samples from direct-push boreholes and temporary well points screened at various depths and locations along the site boundary, as well as surrounding Well S. Groundwater samples were submitted for analysis for tritium, boron, and gamma-emitting isotopes.

Figure ES-2 shows the 37 proposed boring locations; samples were collected at as many as three depths at each location. Borings 1 through 8 were proposed to evaluate concentrations along the site perimeter to assess the potential for off-site migration. Borings 9 through 18 and Borings 31 through 37 were proposed near Station infrastructure to identify possible sources of tritium. These potential sources include the liquid radioactive waste ("rad waste") line, the Unit 1 Spent Fuel Pool, the Unit 1 refueling water storage tank, and the Unit 1 primary water storage tank. Borings 19 through 30 were proposed in the vicinity and downgradient of Well S to determine the extent of tritium in groundwater.

The findings from the supplemental investigation are summarized as follows: (1) the limit of groundwater concentrations above the GWQC for tritium (20,000 pCi/L) was defined as shown on **Figure ES-2**; (2) an expanded area in the vicinity of Well S with tritium levels above 500,000 pCi/L was quantified as shown on **Figure ES-2**; (3) a completed pathway between a potential source and groundwater was not identified, but tritium concentrations and groundwater flow direction indicate that the southern end of the seismic gap is the likely source of tritium in groundwater; and (4) extensive on-site monitoring of shallow groundwater indicates no tritium above permissible levels has migrated to the Station boundary.

Following completion of the supplemental investigation, the RIWP Addendum was prepared and submitted to the NJDEP-BNE presenting the details and results of remedial investigation activities completed to date. The RIWP Addendum proposed additional remedial investigation activities designed to complete the delineation of groundwater impacts, and the hydrogeologic characterization of the shallow, water-bearing unit. The proposed remedial investigation activities included the installation of 16 additional groundwater monitoring wells.

Between September 2003 and February 2004, the 16 additional groundwater monitoring wells proposed in the RIWP Addendum were installed at the Station. Initially, Monitoring Well Y, Well Z, and Wells AA through AF were installed. Following the collection and analysis of groundwater samples from these wells, and a re-evaluation of groundwater flow dynamics within the shallow, water-bearing unit, Monitoring Well AG (Shallow and Deep), Well AH (Shallow and Deep), Well AI, Well AJ, Well AL, and Well AM were installed to fill data gaps identified. The locations of the wells are shown of **Figure ES-1**.

Groundwater monitoring activities have been ongoing since the installation of Wells K through R during initial Station investigation activities. Initially, groundwater samples were collected on a weekly basis. As the additional monitoring wells were installed, and as a database of groundwater analytical results for the monitoring wells was generated, the monitoring well sampling program was modified. The sampling program is being adaptively managed to provide the investigational data required to meet the current investigation objectives and evaluate changes in tritium concentrations. The adaptive sampling management program is designed to ensure representative data are collected that meet the objectives of the investigation and provide the information necessary to evaluate plume dynamics and migration. The current monitoring plan specifies either biweekly, monthly, or quarterly sampling based upon the analytical history of each well.

Groundwater samples are analyzed for tritium, major cations and anions, and gamma emitting isotopes. Analysis of groundwater samples collected from most of the Station Monitoring Wells has also included a single event analysis for groundwater age determination (by tritium – helium-3 age dating). As proposed in the RIWP Addendum, Tc-99 was also analyzed as a single-event analysis for select monitoring wells to assist in the determination of the source of the tritium.

Groundwater Flow

Groundwater elevations in monitoring wells screened in the shallow, water-bearing unit within the limits of the cofferdam are generally higher than groundwater elevations in monitoring wells screened in the shallow, water-bearing unit outside the limits of the cofferdam. Groundwater flow in the shallow, water-bearing formation is generally from the center of the island (northeast of the Salem Generating Station) towards the Delaware River. Due to permeability differences between the structural fill and the hydraulic fill, groundwater is mounded within the area of the cofferdam. Groundwater flows radially outward from the cofferdam, and the observed mounding effect dissipates quickly.

Water levels in the Vincentown Formation, because it is a confined-unit, are tidally influenced. Water levels can vary as much as four feet per tide cycle depending on the proximity of the well to the Delaware River. To more accurately assess groundwater flow conditions in the Vincentown Formation, water level and tide data were evaluated to characterize groundwater flow conditions during various stages of the tide cycle of the Delaware River. Groundwater flow direction in the Vincentown Formation oscillates with the tides. During the high tide stage of the tide cycle groundwater flow in the Vincentown Formation is perpendicular from the shoreline of the Delaware River in the west and south towards the center of Artificial Island. During the low tide stage of the tide cycle groundwater flow in the Vincentown Formation is from the center of Artificial Island towards the Delaware River. During an intermediate stage of the tide cycle, an observed groundwater saddle is present between the Station and the Delaware River. Groundwater flow to the north and east of the saddle is to the south and east. Groundwater flow to the south and west of the saddle is to the north and east.

Aquifer Testing

Eight pumping tests were performed on seven wells (Wells AB, AC, AD, AI, AJ, AM, and S) to quantify the hydrogeologic characteristics (e.g., hydraulic conductivity) of the shallow, water-bearing unit within the limits of and just south of the cofferdam. The pumping test results indicate a range of transmissivity of 0.337 ft^2/day to 27.7 ft^2/day and hydraulic conductivities of 0.03 ft/day to 2.77 ft/day.

Tidal Investigation

Pressure transducers were installed in Wells L, M, and W between July 29 and August 5, 2003 to evaluate the tidal influences of the Delaware River on site water levels. Well W installed in the riverbed sands and gravels, and Well M screened in the structural fill within the cofferdam showed no water-level response to tidal variations. Well L installed in the Vincentown Formation (the first confined aquifer beneath the site) has a four foot change in water level in response to a six foot change in tide. This response is likely caused by changes in the hydraulic head exerting force on the clay, confining-unit (the aquitard overlying the Vincentown), which based upon site lithology, extends westward beneath the Delaware River. These data indicate that tidal variations in the Delaware River have no effect on the movement of tritiated groundwater identified in the surficial aquifer (sediments above the clay, confining-unit).

Analytical Results

In accordance with the scope of work presented in the June 2003 RIWP and the RIWP Addendum, samples of environmental media (i.e., soil and groundwater) have been collected from various media at the Station to determine the magnitude and extent of the release of water from the Spent Fuel Pool. Additionally, samples were collected from the Spent Fuel Pool, the telltale drains, and from the various sample locations established within the facility. Collectively, the data indicate that water from the Spent Fuel Pool leaked behind the stainless-steel liner into the obstructed telltale drains, migrated through construction joints or minor cracks in the structural concrete and accumulated in the Styrofoam-filled seismic gap. Once there, the Spent Fuel Pool water seeped into the foundation soils along the southern side of the seismic gap. This release of Spent Fuel Pool water has resulted in an area of impacted groundwater extending from the south side of the seismic gap to the circulating water discharge pipes (see **Figure ES-2**).

The water samples collected from within the facility indicated concentrations of tritium, boron, and various gamma-emitting isotopes typical of Spent Fuel Pool water. Groundwater samples collected from outside the facility, which were analyzed for the same suite of parameters, have indicated concentrations of tritium, boron, and one slightly elevated concentration of Tc-99 that suggest that water from the Spent Fuel Pool is the likely source.

The area of groundwater containing elevated tritium extends from the southern end of the Styrofoam seismic gap located between the Salem Auxiliary Building and the Salem Unit 1 Auxiliary Building in a southerly direction toward the circulation water discharge pipes. Groundwater with tritium at concentrations exceeding any regulatory limit has not migrated to the property boundary of the Station. Elevated levels of tritium have only been detected in groundwater samples collected from the shallow, water-bearing unit. There is no evidence that suggests that water from the Spent Fuel Pool has migrated to an underlying aquifer as confirmed by groundwater samples collected from monitoring wells screened in the Vincentown Formation.

Fate and Transport Analysis

Shallow groundwater in the vicinity of the Station has been impacted by a release of water from the Spent Fuel Pool. The pathway from the building to the environment cannot be documented with absolute certainty; however, site evidence indicates the seismic gap between the Salem Unit 1 Fuel Handling Building and Auxiliary Building is the primary release point. The groundwater travel time between the primary release point and the 500,000 pCi/L contour was computed using observed water levels, aquifer properties, facility operations data, groundwater recharge, and helium to tritium ratios. Collectively, these data indicate that the groundwater plume is between 5 and 10 years old.

Health and Environmental Risk Assessment

The principal radionuclide of concern for this remedial investigation is tritium in shallow groundwater adjacent to Salem Generating Station Unit 1. To date, a completed exposure pathway to humans from tritium in shallow groundwater has not been established, nor is there any evidence that significant exposures of biota have occurred.

Conclusions

The results of remedial investigation activities conducted at the PSEG Nuclear, LLC Salem Generating Station, which were conducted in response to the detection of tritium in groundwater, indicate that the source of tritium detected in groundwater was the Spent Fuel Pool, the tritium release to the environment has been stopped, and that tritium has not migrated to the property boundary above any regulatory limit. The following bullets provide a more detailed description of the investigation findings:

- There was a release of water from the Spent Fuel Pool system resulting from blockage of the telltale drains by mineral precipitates. The telltale drains are a leak monitoring, collection, and drainage mechanism specifically designed to collect leakage that may accumulate behind the stainless steel liner of the Spent Fuel Pool and Refueling Canal. The blockage of the telltale drains resulted in the accumulation of water from the Spent Fuel Pool system (between the liner and the concrete wall) that created hydrostatic head and facilitated migration to the Styrofoam-filled seismic gap located between the Salem Unit 1 Fuel Handling Building and Auxiliary Building. The mineral precipitates have been physically removed to ensure the proper operation of the telltale drains. The process of monitoring the telltale drains is routinely performed to ensure that blockage does not reoccur. Permanent seismic gap drains are being installed on Salem Units 1 and 2, to permit identification, sampling, and drainage of any accumulated water in the seismic gap, and to create an ingradient to the gap;

- The release of water from the Spent Fuel Pool system was investigated through the sampling of monitoring wells installed in the area of Salem Unit 1. The groundwater analytical data collected from the monitoring well network were used to delineate an area of groundwater in the shallow, water-bearing unit that contains elevated tritium. Gamma-emitting isotopes were also monitored in the groundwater samples collected from the monitoring wells because the suspected source of the tritium was the Spent Fuel Pool. No plant related gamma-emitting isotopes have been detected in groundwater samples collected from the monitoring wells;

- The area of groundwater containing elevated tritium extends from the southern end of the Styrofoam seismic gap located between the Salem Unit 1 Fuel Handling Building and the Auxiliary Building in a southerly direction toward the circulation water discharge pipes. Groundwater with tritium at concentrations exceeding any regulatory limit has not migrated to the property boundary of the Station;

- Elevated levels of tritium have only been detected in groundwater samples collected from the shallow, water-bearing unit. There is no evidence that suggests that water from the Spent Fuel Pool has migrated to an underlying aquifer as confirmed by groundwater samples collected from monitoring wells screened in the Vincentown Formation; and,

- A completed exposure pathway to humans from tritium in shallow groundwater has not been established, nor is there any evidence that significant exposures of biota have occurred.

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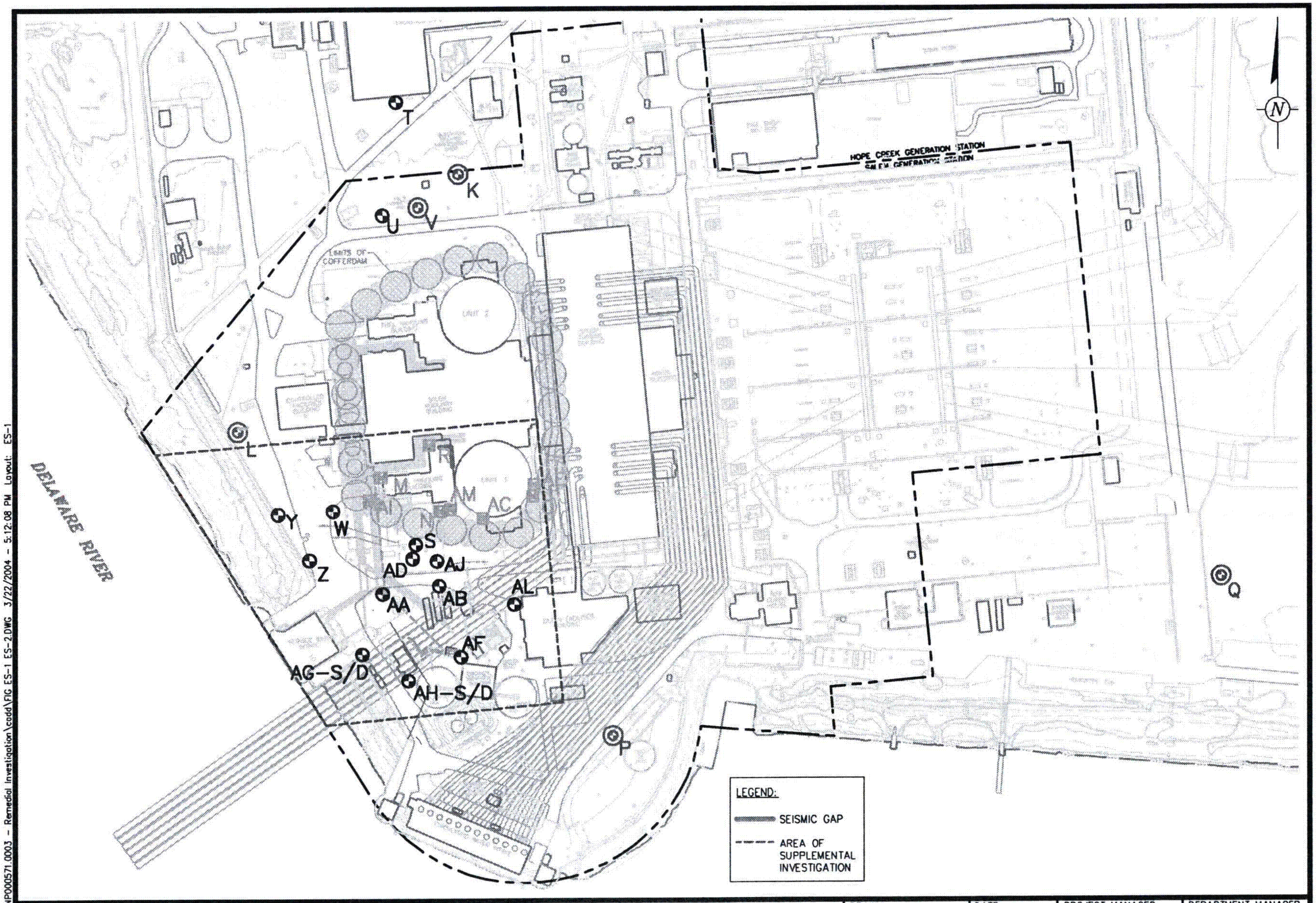


LEGEND:

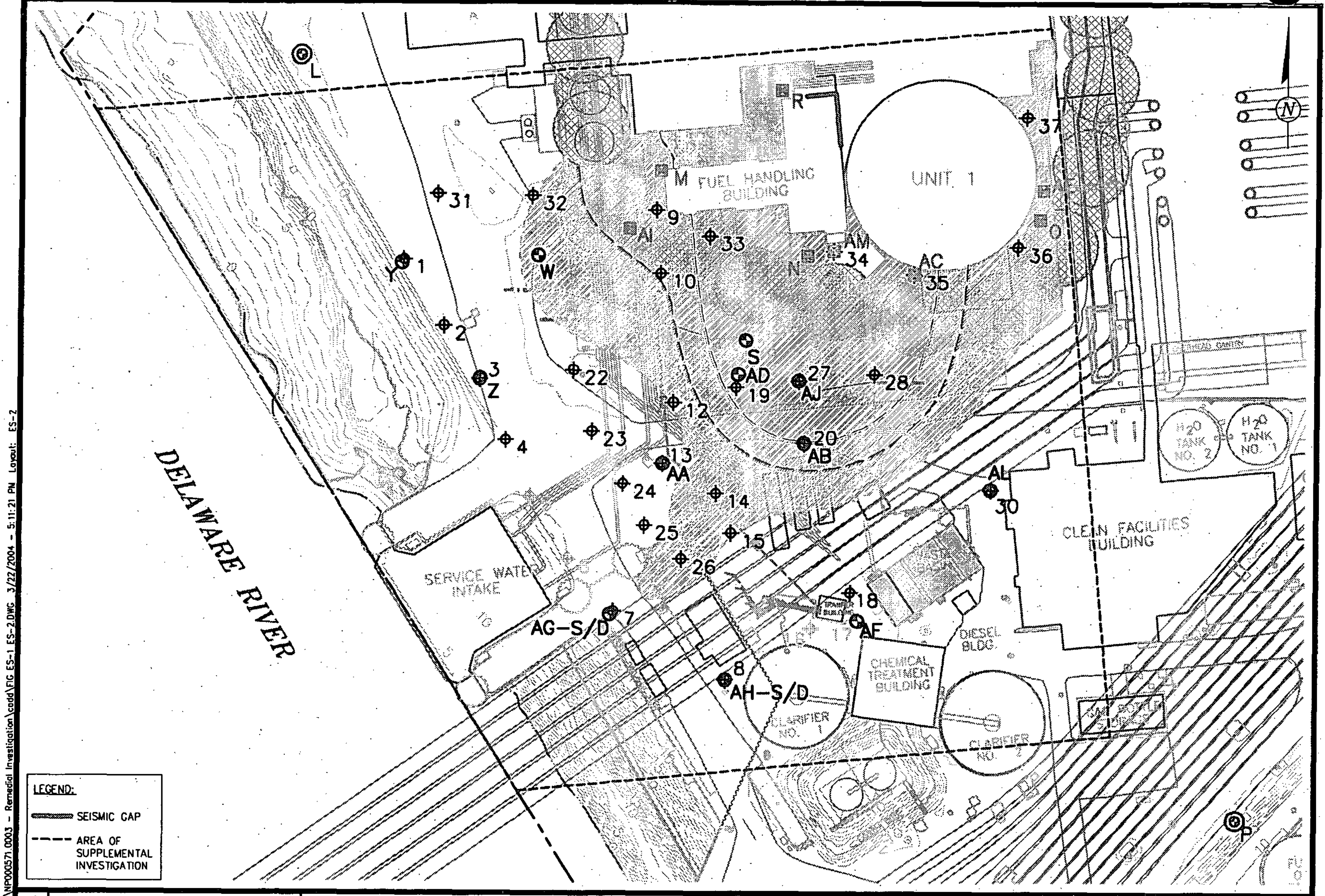
- ▬ SEISMIC GAP
- - - - AREA OF SUPPLEMENTAL INVESTIGATION

0 250
SCALE: 1"=250'

ARCADIS

DRAWN M. WASILEWSKI	DATE 9/16/03	PROJECT MANAGER P. MILIONIS	DEPARTMENT MANAGER D. FULTON
		LEAD DESIGN PROF. S. POTTER	CHECKED B. PIERCE
		PROJECT NUMBER NP000571.0003	DRAWING NUMBER ES-1

MONITORING WELL NETWORK FOR THE REMEDIAL INVESTIGATION
PSEG NUCLEAR, LLC
SALEM GENERATING STATION
ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY



G:\APROJECT\PSE&G\Salem\NP000571.0003 – Remedial Investigation\cadd\FIG ES-1 ES-2.DWG 3/22/2004 – 5:11:21 PM Layout: ES-2

0 100
SCALE: 1"=100'

ARCADIS

DRAWN M. WASILEWSKI	DATE 9/16/03	PROJECT MANAGER P. MILIONIS	DEPARTMENT MANAGER D. FULTON
AREA OF TRITIUM LEVELS ABOVE 500,000 pCi/L PSEG NUCLEAR, LLC SALEM GENERATING STATION ARTIFICIAL ISLAND HANCOCK'S BRIDGE, NEW JERSEY		LEAD DESIGN PROF. S. POTTER	CHECKED B. PIERCE
		PROJECT NUMBER NP000571.0003	DRAWING NUMBER ES-2

1 Introduction

ARCADIS, Inc. ("ARCADIS"), on behalf of PSEG Services Corporation ("PSEG SC"), has prepared this Remedial Investigation Report ("RIR") to document the findings of a remedial investigation conducted at the PSEG Nuclear, LLC Salem Generating Station (the "Station") located on Artificial Island in Lower Alloways Creek Township, Salem County, New Jersey. The Station location and layout are shown on **Figures 1** and **2**, respectively. The remedial investigation was conducted in accordance with the Remedial Investigation Work Plan ("June 2003 RIWP") that was submitted to the New Jersey Department of Environmental Protection Bureau of Nuclear Engineering ("NJDEP-BNE") in June 2003. The scope of work outlined in the June 2003 RIWP was designed to investigate the discovery of tritium in the shallow, water-bearing unit at the Station.

A document entitled, "Initial Groundwater Investigation Report and Remedial Investigation Work Plan Addendum" ("RIWP Addendum") was submitted to the NJDEP in January 2004. The RIWP Addendum contained the initial results of the remedial investigation and, based on these results, proposed certain modifications to the June 2003 RIWP.

This RIR contains the results of remedial investigations as described in both the June 2003 RIWP and the RIWP Addendum. The remedial investigation produced a comprehensive body of knowledge regarding the tritium discharge, its fate in the environment, and the physical environment at and in the vicinity of the Station. The findings presented in this RIR will be used as the basis for the development of a remedial action strategy and work plan that will be submitted to the NJDEP-BNE under separate cover.

1.1 Project Background

On September 18, 2002, the Station Radiation Protection staff reported measuring low-level radioactivity on the shoes of technicians inside the radiologically controlled Auxiliary Building. An initial facility investigation led to the discovery of a radioactive "chalk-like" substance adhering to the west wall in the 78-foot Mechanical Penetration Room of the Unit 1 Auxiliary Building. The buildup of the "chalk-like" deposits was removed and an active seep of water into the 78-foot Mechanical Penetration Room was observed. Further investigation revealed a second leak at the 92-foot elevation of the Unit 1 Spent Fuel Pool cooling line, adjacent to the pipe penetration through the concrete wall.

As presented in Section 5, sample points were established for the collection and analysis of water samples from the observed leaks. Samples collected from the sample points were analyzed for tritium, major cations and anions, and gamma-emitting isotopes to determine the concentrations of constituents of concern in the water samples, to evaluate the potential age of the leak, and to evaluate a potential source of the water. Analytical results of the samples indicated that the water from both leaks had characteristics of Spent Fuel Pool water and that a leak from the Spent Fuel Pool system had likely occurred.

The Salem Generating Station Unit 1 Spent Fuel Pool is lined with stainless steel. Behind the stainless steel liner are liner drains (commonly referred to as "telltale drains") that are used as a combined leak monitoring, collection, and drainage mechanism. The telltale drains are specifically designed to collect leakage that may accumulate behind the stainless steel liner of the Spent Fuel Pool and Refueling Canal. There are ten telltale drains associated with the Salem Generating Station Unit 1 Spent Fuel Pool that are identified as Drain Nos. 1 through 10. There are seven telltale drains associated with the Salem Generating Station Unit 1 Refueling Canal that are identified as Drain Nos. 11 through 17. Drains No. 11 through 17 are designed to monitor, collect, and drain leakage from the Refueling Canal that is associated with the Spent Fuel Pool.

A series of water samples was collected from the telltale drains to characterize the water that had accumulated. Analytical results of the water samples, discussed in further detail in Section 5, indicated that the likely source of water in the Spent Fuel Pool telltale drains was Spent Fuel Pool water, while the source of water in the Refueling Canal telltale drains indicated a possible mixing of water from the Spent Fuel Pool system with sodium, which is uncharacteristic of water from the Spent Fuel Pool system. A lack of chloride detected in water samples collected from the Refueling Canal telltale drains suggests that the sodium concentrations are likely from the interaction of the Spent Fuel Pool water with the structural concrete.

On January 31, 2003, a fiber optic examination of the telltale drains indicated a blockage by mineral deposits of the No. 4 and No. 5 drains beneath the welds in the stainless-steel liner of the Spent Fuel Pool, which obstructed the flow of water that leaked behind the stainless-steel liner. While obstructed, the flow of water from leak(s) in the Spent Fuel Pool liner was likely forced between the liner plates and the structural concrete base and walls of the Fuel Handling Building to establish hydraulic equilibrium with the water level in the Spent Fuel Pool. The Spent Fuel Pool water likely migrated along the paths of least resistance (e.g., a pipe conduit, construction joints, or cracks in the concrete) and ultimately manifested at the crack in the wall in the 78-foot elevation Mechanical Penetration Room and through the gap/penetration where the Spent Fuel Pool cooling return lines intersects the wall at the 92-foot elevation.

The mineral deposits were physically removed from the telltale drains to restore flow, which was measured to be approximately 100 gallons per day (gpd), which is within the design parameters of the leak detection, collection and monitoring system and is processed through the routine waste treatment processes. The process of monitoring and removing the mineral deposits, as needed, has been and will continue to be conducted to ensure that the telltale drains do not become obstructed in the future.

Analytical results of water samples collected from the observed leaks (78-foot elevation Mechanical Penetration Room and through the gap where the Spent Fuel Pool cooling return lines intersects the wall at the 92-foot elevation) and subsequent investigations of the Unit 1 telltale drains indicated that further investigation was necessary to: 1) characterize the observed leaks and determine their source; 2) determine the extent of the leaks within the Salem Generating Station Auxiliary and Spent Fuel Pool Buildings; and, 3) determine the extent of the impact from the leak, if any, into the environment (soil and groundwater in contact with the engineered features of the Station).

Further investigations indicated that water from the Spent Fuel Pool had migrated to the Styrofoam-filled seismic gap located between the Unit 1 Fuel Handling Building and the Auxiliary Building. The details and results of sampling activities that were conducted within the facility to identify the source of the water observed in the 78-foot elevation Mechanical Penetration Room and through the gap where the Spent Fuel Pool cooling return lines intersects the wall at the 92-foot elevation are summarized in Section 5 and are presented in detail in the Investigations of Salem Unit 1 Fuel Pool Leakage – Final Report Summary provided in **Appendix A**.

The Styrofoam-filled seismic gap is approximately six-inches wide and extends vertically from grade (100 feet Plant Datum [PD]) to the top of the concrete foundation of the Fuel Handling Building. A discussion of the lean concrete foundation is presented in Section 4.2.1. The Styrofoam was originally used as a concrete form for the surrounding concrete pour. The Styrofoam was left in place to serve as a seismic gap. Along the narrow western and southern ends of the Seismic Gap, a flowpath exists between the Styrofoam and foundation soils. As such, the potential exists for water in the seismic gap to migrate beyond the limits of the engineered structures of the Station and into the environment.

Following the discovery of water characteristic of the Spent Fuel Pool in the Styrofoam-filled seismic gap, remedial investigation activities were initiated to determine if Spent Fuel Pool water that had accumulated in the seismic gap had migrated beyond the limits of the engineered features of the building and into the environment (i.e., soil and groundwater in contact with the seismic gap). Initially, eight groundwater monitoring wells (Wells K through R) were installed in January and February 2003 adjacent to and around the perimeter of the Fuel Handling Building. Analytical results of groundwater samples collected from these monitoring wells (discussed in more detail in Section 4.2) indicated that a potential release of water from the Spent Fuel Pool or other plant source to the environment had likely occurred. At this time, the subject remedial investigation was initiated.

1.2 Investigation Objectives

As presented in Section 5.3, analytical results of groundwater samples collected from monitoring wells installed adjacent to and around the perimeter of the Unit 1 Fuel Handling Building indicated concentrations of tritium above the New Jersey Groundwater Quality

Criteria ("GWQC") of 20,000 picocuries per liter ("pCi/L"). Other radionuclides were not detected in the groundwater samples at concentrations above background levels.

The scope of work proposed in the June 2003 RIWP and the RIWP Addendum was designed to determine if the tritium detected in groundwater samples collected from monitoring wells installed adjacent to Salem Unit 1 is a result of a release to the environment from the Unit 1 Spent Fuel Pool, a non-authorized release from other onsite operating or maintenance activities, or elevated background levels of tritium from authorized releases and other operating practices. The proposed scope of work was also designed to assess the potential for: 1) tritium to migrate beyond the property boundaries; 2) human health and environmental risks associated with the tritium detected in groundwater; and, 3) the need for any further action.

1.3 Report Organization

This report provides relevant background information, the details and results of remedial investigation activities conducted to date, and proposed activities in the following sections:

- Section 2 – History of Station Operations;
- Section 3 – Station Setting;
- Section 4 - Facility Construction and Local Geology;
- Section 5 – Initial Station Investigation Activities;
- Section 5 – Remedial Investigation Activities;
- Section 7 – Hydrogeologic Evaluation;
- Section 8 – Analytical Results
- Section 9 – Fate and Transport Results
- Section 10 – Health and Environmental Risk Assessment;
- Section 11 – Conclusions and Recommendations; and,
- Section 12 - References

The History of Station Operations section (Section 2) presents information on the Station operating history, historical releases, the area and constituents of concern, as well as regulatory information about the Station.

The Station Setting section (Section 3) presents a description of the setting of the Salem Generating Station, including land use, the estuarine location, topography and station drainage, climate and precipitation, and regional geology and hydrogeology.

The Facility Construction and Local Geology section (Section 4) presents conditions at Artificial Island prior to the construction of the Station and details how the facility construction has altered the local geology.

The Initial Station Investigation Activities section (Section 5) presents the details and results of the initial investigation activities conducted to identify a source of the radioactivity, to characterize the extent of the release within the facility, and to determine if the release of water from the Spent Fuel Pool system has migrated beyond the seismic gap.

The Remedial Investigation Activities section (Section 6) presents a detailed summary of the remedial investigation activities that have been conducted following the submittal of the June 2003 RIWP and the subsequent RIWP Addendum. This section includes the details for the initial station investigation activities, including sampling conducted.

The Hydrogeologic Evaluation section (Section 7) provides the results of hydrogeologic investigation activities, including slug tests and pumping tests, designed to characterize groundwater movement at the Station.

The Analytical Results section (Section 8) provides a summary of analytical results for samples collected to date. The analytical results section includes a discussion regarding the distribution of tritium in groundwater and the results of tritium age-dating analysis and technetium-99 (Tc-99) analysis.

The Fate and Transport Results section (Section 9) discusses potential flow pathways from the facility and the rate of migration of tritium in groundwater.

The Health and Environmental Risk Assessment section (Section 10) presents a discussion regarding potential exposure pathways and the methodology used for evaluating the risk associated with the exposure pathways.

The Conclusions and Recommendations section (Section 11) presents a summary of the findings of the remedial investigation and recommendations for further actions based on the findings.

A list of References is presented in Section 12.

2 History of Station Operations

The following sections present information on the operating history of the Station, the area and constituents of concern, historical spills and releases, as well as regulatory information about the Station.

2.1 Operating History

PSEG Nuclear, LLC operates and is part owner of the Salem Generating Station located on Artificial Island in Lower Alloways Creek Township, Salem County, New Jersey. PSEG Nuclear, LLC (57.41%) and Exelon (42.59%) jointly own the Station. The Salem Generating Station is adjacent to the Hope Creek Generating Station, also located on Artificial Island. Both the Salem and Hope Creek Generating Stations (the Stations) are located on the eastern bank of the Delaware River. The Salem Generating Station encompasses an approximate 26-acre portion of the approximately 740-acre Artificial Island site.

The Salem Generating Station is composed of two nuclear generating units (Units 1 and 2) and one distillate oil fueled combustion turbine unit (Unit 3). Commercial operations of Units 1 and 2 commenced in 1976 and 1981, respectively. The combustion turbine unit commenced operations in 1972. The nuclear generating units operate as base load units and the combustion turbine unit operates as a peaking unit. The Salem Generating Station has a combined generating capacity of over 2,300 MW. Over its operational life, the Salem Generating Station has experienced no significant changes in its operation.

A detailed description of Salem Generating Station's operations and operational history, was prepared for Exhibit C of the September 1999 Industrial Site Recovery Act (ISRA) Non-Applicability Application, as is included in this RIR as **Appendix B.**

2.1.1 Area of Concern

The remedial investigation proposed in the June 2003 RIWP focused on tritium detected in groundwater adjacent to the Salem Generating Station Unit 1 Fuel Handling Building. As stated in Section 1.2, the primary objective of the remedial investigation was to determine if the tritium detected in groundwater samples collected from monitoring wells installed adjacent to Salem Unit 1 is a result of a release to the environment from the Unit 1 Spent Fuel Pool, a non-authorized release from other onsite operating or maintenance activities, or elevated background levels of tritium from authorized releases and other operating practices. Although the suspected source of the tritium in groundwater was the Spent Fuel Pool water that had accumulated in the seismic gap, other potential sources of tritium were evaluated to determine if they were the primary source, or likely contributors to the elevated levels of tritium. These potential sources included the radioactive liquid waste discharge line, the Salem Unit 1 Fuel Transfer Canal, and the steam generator blowdown lines, each of which is shown on **Figure 1**.

To evaluate the radioactive liquid waste discharge line and the Unit 1 Fuel Transfer Canal, PSEG Nuclear, LLC, performed local leak rate tests. Additionally, a pressure test was performed on the radioactive liquid waste discharge line. According to PSEG Nuclear, LLC, the results of both the local leak rate tests and the pressure test indicated that the radioactive liquid waste discharge line and the Unit 1 Fuel Transfer Canal are functioning properly and are not considered sources of tritium (PSEG, verbal communication 2004). The steam generator blowdown lines, which typically contain tritium at concentrations of approximately 6,000 pCi/L, are not considered a significant source of tritium. As such, the steam generator blowdown lines were not tested for integrity.

In addition to the potential point-source contributors of tritium, potential non-point sources such as historical spills and releases were also considered. A summary of historical spills and releases reported within the area of investigation are presented in Section 2.1.2.

2.1.2 Historical Spills and Releases

To evaluate potential sources of the tritium detected in groundwater adjacent to the Salem Generating Station Unit 1 Spent Fuel Pool, PSEG Nuclear, LLC conducted a review of historical data and interviewed Station personnel regarding any historical spills or releases in the area of investigation. According to PSEG Nuclear, LLC, the results of the evaluation indicated that reported events in the area of investigation generally occurred during the early years of the Station's construction and operation (PSEG, verbal communication 2004). Historical spills or releases were reported to the appropriate agencies to the extent that they met the reporting thresholds in affect at the time and resulted in leaks that were managed through the Station's radioactive liquid waste system without entering the environment or to the soil that was removed and properly disposed off-site. These events did not likely result in the elevated levels of tritium detected in groundwater samples collected from Station monitoring wells. This is evidenced by the difference between the recent groundwater analytical results and the quantity and concentration of tritium reported during these events and the corrective actions taken at the time of the events.

2.1.3 Constituents of Concern

The remedial investigation was initiated when water samples collected from the Styrofoam-filled seismic gap indicated the presence of tritium, boron, and various gamma-emitting radioisotopes typical of water from the Spent Fuel Pool. The physical and chemical properties of the constituents detected in the water samples from the seismic gap, are summarized in **Table 1**. These constituents are routinely monitored in groundwater samples collected from the Station monitoring wells. Other than tritium and boron, the physical properties of the constituents identified in the seismic gap will limit their potential migration in the environment. For example, the gamma-emitting cations (e.g., strontium-90, cesium-137, and cobalt-60) in water will tend to bind strongly to soil particles causing them to migrate at least 100 times slower than groundwater. Tc-99, another constituent of spent fuel pool water, has "intermediate" mobility in groundwater (10 to 20 percent of the rate of groundwater). Tritium and boron do not adsorb strongly to soils and migrate with groundwater. No plant related gamma-emitting isotopes have been detected to date in groundwater samples collected from monitoring wells installed at the Station; however, PSEG SC continues to analyze groundwater samples collected from the monitoring wells for gamma-emitting isotopes because the suspected source of the tritium is the Spent Fuel Pool.

The primary constituent of concern for this investigation is tritium in groundwater. Tritium is a radioactive isotope of the element hydrogen. Molecular hydrogen can exist in over 40 forms, most commonly hydrogen, deuterium, and tritium. Tritium is a hydrogen atom that has two additional neutrons in its nucleus. Tritium occurs naturally in the upper atmosphere when high-energy cosmic radiation bombard atmospheric nitrogen and oxygen and splits off a tritium nucleus (spallation); however, the predominant sources of tritium in the post-nuclear era (i.e., anthropogenic tritium) are the explosions of nuclear weapons, the byproduct of nuclear reactors, and commercial production for use in various self-luminescent devices. Although tritium can occur as hydrogen gas, it is most commonly found as a liquid. Tritium, like non-radioactive hydrogen, reacts with oxygen to form tritiated water. Tritiated water is colorless and odorless, has a half-life of 12.3 years, and emits low-energy beta particles that can be measured by liquid scintillation. Standard scintillation methods can routinely detect tritium concentrations of 200 pCi/L and greater.

As proposed in the June 2003 RIWP, two action levels were defined for tritium in groundwater to assist in the evaluation of data generated through the investigation. These action levels are the Interim Further Investigation Criterion and the Further Action Criterion. The Interim Further Investigation Criterion for this investigation is 3,000 pCi/L. The Further Action Criterion for tritium in groundwater is 20,000 pCi/L, which is the New Jersey Groundwater Quality Criteria for tritium in Class II A aquifers. These criterion were used to evaluate the need for further delineation and characterization for tritium detected in groundwater, and the need for any further action (i.e., remediation).

2.2 Regulatory Review

Regulatory oversight for the Salem Generating Station, and other nuclear generating stations, is provided by both federal and state agencies. These agencies ensure that the stations are designed, constructed, licensed and operate in a manner that maximizes the safe containment and management of radioactive materials. These agencies also ensure that sufficient funding mechanisms have been established, are adequately funded, and will be available to decommission the nuclear generating stations at the end of their life cycle.

On the federal and state levels, the United States Nuclear Regulatory Commission (USNRC) and NJDEP-BNE conduct licensing and oversight of nuclear generating facilities. Oversight by the NJDEP-BNE and USNRC includes inspections of nuclear power plants and conducting environmental radiological monitoring.

3 Station Setting

The following sections provide information regarding the setting of the Salem Generating Station, including land use, the estuarine location, topography and station drainage, climate and precipitation, and regional geology and hydrogeology. A more detailed description of the setting of the Station is included in Section C of the ISRA Non-Applicability Application, which is provided in **Appendix B** to this report.

3.1 Land Use

PSEG Nuclear LLC owns and/or controls an approximately 740-acre area of Artificial Island that is situated adjacent to and surrounds the Salem and Hope Creek Generating Stations. This area contains administrative and support facilities used by the Stations, the Hope Creek Switch Yard, the Salem Switch Yard, and undeveloped vacant land. With the exception of the Salem Generating Stations (Units 1 through 3) and the Salem Switchyard, the remaining acreage is considered to be the Hope Creek Generating Station.

The zoning classification for the Salem Generating Station is industrial. The land adjacent to the Salem Generating Station is zoned for industrial and residential or agricultural use.

3.2 Estuarine Location

The Salem Generating Station is located on a portion of Artificial Island that borders the Delaware Estuary. The Estuary, in the location of the Salem Generating Station, is a tidal, brackish river, located in an area designated as Zone 5 by the Delaware River Basin Commission (DRBC).

The United States Army Corps of Engineers, beginning in the early twentieth century, created Artificial Island by depositing dredge spoils within a diked area established around a natural sand bar that projected into the Delaware River. Prior to construction of the Salem Generating Station, the property was vacant, undeveloped, low-lying land.

3.3 Topography and Station Drainage

The topography at the Salem Generating Station is relatively flat with limited local relief. Topographic contours for the Station are included on **Figure 2**.

Stormwater is managed in accordance with the Salem Generating Station New Jersey Pollution Discharge Elimination System (NJPDES) permit and Stormwater Pollution Prevention Plan. Stormwater is collected in storm drains and routed to the Delaware River for discharge. The locations of the storm drains are included on **Figure 2**. Stormwater from the principle petroleum storage and handling areas is routed to the oil/water separator prior to discharge.

3.4 Climate and Precipitation

Salem County is located in southwestern New Jersey. The county's climate is considered to be humid and temperate, as the climate in this county is readily influenced by its proximity to the Delaware Bay. Coastal storms are not uncommon in this region and can produce high winds and heavy rainfall, which can cause wind damage and flooding in low-lying areas (USDA, 1969).

Wind direction in this region is dependent upon the season; during the summer, winds are typically from the southwest while during the winter, winds are commonly from the northwest. Temperatures vary by season and the maximum expected high temperature for a given year is 96 degrees Fahrenheit, while the minimum expected yearly low temperature is minus 2 degrees Fahrenheit. The average annual precipitation total is 39.9 inches.

3.5 Regional Geology and Hydrogeology

The Salem Generating Station is located on the east edge of the Delaware River, seven miles north of the Delaware Bay, eight miles southeast of the City of Salem and about 40 miles south of Philadelphia, Pennsylvania. The Station is located in the Atlantic Coastal Plain Physiographic Province, approximately 19 miles southeast of the contact between the coastal plain sediments and the Appalachian Highlands. This area is characterized by relatively flat to gently undulating terrain, underlain by unconsolidated sediments that increase in thickness to the southeast.

The coastal plain sediments were deposited in marine and non-marine environments. The sediments are between 1,500 and 2,000 feet thick in the vicinity of the Station, and unconformably overlie bedrock. These sediments range in age from Holocene to Cretaceous (0 to 146 million years old), and are comprised of clay, silt, sand, and gravel. Published geologic mapping indicates that the basement rock beneath these sediments (in the area of the Station) is metamorphic schist of the Wissahickon Formation, which is Pre-Cambrian in age (570 to 900 million years old) (USGS 1999).

The shallow, water-bearing unit at the Station consists of approximately 25 to 35 feet of dredge spoils (hydraulic fill), structural fill material, tidal marsh deposits and riverbed deposits. The structural fill replaced the dredge spoils and natural deposits in select locations at the facility during construction of the Station. Additional information regarding the construction of the facility and the composition and nature of the structural fill are provided in Section 4.2.

The geologic formations beneath the shallow, water-bearing unit, in order of increasing depth, are as follows: the Kirkwood Formation; the Vincentown Formation; the Hornerstown-Navesink Aquitard; the Mount Laurel-Wenonah Formations; the Matawan Formation; the Magothy Formation; the Raritan Confining Unit and Aquifer; the Potomac Group; and, the Wissahickon Formation. Regional cross sections trending northeast to southwest (A-A') parallel to the Delaware River, and northwest to southeast (B-B') perpendicular to the river are provided on **Figure 3** (USGS 1999).

The following sections describe in more detail the units of the coastal plain sediments that are encountered in the vicinity of the Station.

3.5.1 Hydraulic Fill

Artificial Island is composed largely of hydraulically placed dredge spoils from construction and maintenance of nearby navigational channels by the United States Army Corps of Engineers. The hydraulic fill is not considered a source of drinking water.

3.5.2 Riverbed Deposits

A relatively thin layer of riverbed deposits underlies the more recent native and anthropogenic deposits composing Artificial Island. The layer consists of an approximate five- to ten-foot layer of discontinuous Quaternary Age deposits consisting primarily of sand with some gravel, silt and clay. The unit appears as a discrete deposit in some borings (Wells U and V). The results of aquifer tests conducted previously have shown the riverbed deposits to have a hydraulic conductivity on the order of 0.01 to 1 ft/day (Dames & Moore 1988, 1974).

3.5.3 Kirkwood Formation

The Kirkwood Formation, which consists of an upper clay-unit and a basal sand unit, separates the Vincentown Formation from the hydraulic fill and riverbed deposits of the shallow, water-bearing unit. The Kirkwood Formation consists of gray clay with trace silt and gravel, and is laterally extensive in the area of the investigation (see **Figure 4**). Conflicting geologic reports suggest that the geologic unit previously interpreted as the Kirkwood Formation may in fact be the Pleistocene Van Sciver Lake Bed deposits (USGS 1979 and 1999). To determine the relative age of this underlying unit, samples of the clay obtained during the drilling of Well V (see Section 6.5) were analyzed to determine the relative age of the unit, which is interpreted to be the Kirkwood Formation based on the age data.

The Kirkwood Formation occurs at or near the surface and is considered unconfined in Salem and Gloucester Counties (USGS 1999). The Kirkwood Formation is composed of micaceous sands and diatomaceous clay, trends from the northeast to the southwest, and dips to the east-southeast. The sand content increases to the east-northeast where the Kirkwood includes the Atlantic City 800-foot sand. In the vicinity of Artificial Island, the unit is primarily composed of hard clays with trace fine micaceous sand and a basal sand unit directly overlying the Vincentown Formation. The basal unit of the Kirkwood Formation is a fine to medium micaceous sand with varying silt content that coarsens with depth (Dames & Moore July 1976). The upper clay in the Kirkwood Formation is considered an aquitard for the Vincentown Formation and the overlying basal sand unit.

3.5.4 Vincentown Formation

The Vincentown Formation is an aquifer of minor importance in some areas. In the vicinity of the Station, the Vincentown Formation has chloride concentrations of 1,800 to 4,300 mg/L preventing the aquifer from being used as a potable water source (Dames & Moore 1988). The Vincentown Formation outcrops over a small area of central Salem County, and trends northeast to southwest and dips to the east-southeast. The Vincentown Formation is composed of sands to silty sand characterized by a glauconitic quality. Confined by the overlying Kirkwood Formation, the Vincentown Formation extends southeast from Keasby Creek to Stow Creek with the greatest thickness (approximately 60 feet) coinciding with Alloways Creek (USGS 1999). The Vincentown thins and narrows to the northeast reaching a minimum thickness between Glassboro and Berlin before again increasing in thickness and lateral extent. The results of aquifer and laboratory tests have shown the Vincentown Formation to have a hydraulic conductivity on the order of 1 to 10 ft/day (USGS 1999; Dames & Moore 1988). The Hornerstown-Navesink Aquitard underlies the Vincentown Formation.

3.5.5 Hornerstown-Navesink Aquitard

The Hornerstown-Navesink Aquitard is considered to be part of a composite confining unit that includes the less permeable portions of the Vincentown and Piney Point Formations. The aquitard is composed of clayey to silty glauconitic green and black sands with a relatively low permeability (USGS 1999). The results of aquifer tests indicate that the Hornerstown-Navesink Aquitard has a vertical hydraulic conductivity on the order of 0.01 ft/day in Salem County (USGS 1999). Qualitative evidence indicates that leakage occurs from the Vincentown through the Hornerstown-Navesink Aquitard to the underlying Mt. Laurel-Wenonah Aquifer (Dames & Moore 1988).

3.5.6 Mt. Laurel-Wenonah Aquifer

The Mt. Laurel-Wenonah Aquifer is considered to be a major aquifer for the region and is composed of slightly glauconitic sand and increasing silt with depth. The Mt. Laurel-Wenonah aquifer is also identified as existing in Delaware by the Delaware Geological

Survey (DGS). The depth to the top of the Mt. Laurel-Wenonah Aquifer is approximately 173 feet in the vicinity of the Station, with the outcrop area extending from slightly west of Salem and extending approximately halfway to Pennsville (Dames & Moore December16, 1968; USGS 1999). The aquifer has a strike of northeast-southwest and dips to the east-southeast. The maximum thickness of the aquifer is approximately parallel to strike and is coincident with Williamstown and Stow Creek. The results of aquifer tests have shown the Mt. Laurel-Wenonah Aquifer to have a hydraulic conductivity on the order of 0.01 to 10 ft/day and a storativity on the order of $1x10^{-5}$ to $1x10^{-4}$ (USGS 1999). The Matawan Aquitard underlies the Mt. Laurel-Wenonah Aquifer.

3.5.7 Matawan Aquitard

The Matawan Aquitard is a composite unit including the Woodbury Clay and Merchantville Formations. The aquitard is predominantly composed of micaceous and glauconitic clay with some sand present. This unit is a major aquitard, conforming to regional strike and dip that may contain a thin water bearing sand in some areas. The New Jersey Geologic Survey (1995) defined the leakance of the aquitard as being on the order of $1x10^{-11}$ to $1x10^{-8}$ feet/day/foot (day^{-1}) in Salem and Gloucester Counties with the greater values in the western portions of the counties. The Matawan Aquitard is the confining unit for the Magothy Aquifer.

3.5.8 Magothy Aquifer

The Magothy Aquifer is composed of fine to coarse-grained sand with local beds of dark gray lignitic clay, and is located at a depth of 445 feet with a thickness of 50 to 100 feet in the vicinity of the Station (Dames & Moore December16, 1968; USGS 1999). The Magothy outcrops just west of Pennsville with the outcrop area following the regional strike of the coastal plain sediments. The Magothy Aquifer dips and thickens to the southeast (USGS 1999), and has been documented by the DGS as existing in Delaware. The results of aquifer tests have shown the Magothy to have a hydraulic conductivity on the order of 100 ft/day and a storativity on the order of $1x10^{-3}$ (USGS 1999; NJGS 1995). The Magothy Formation is separated from the Raritan Formation by an unnamed confining unit.

3.5.9 Raritan Confining Unit

The confining unit separating the Magothy and Raritan aquifers is composed primarily of dense clay at an approximate depth of 490 feet with a thickness of 190 feet including a 22-foot thick sand unit (Dames & Moore December16, 1968; 1988). A leakance on the order of 10^{-11} day^{-1}, increasing up dip, has been used by the NJGS (1995) to characterize the movement of water through the confining unit to the underlying Raritan Aquifer.

3.5.10 Raritan Formation

The Raritan Formation is composed of sand with traces of silt and with occasional lenses of clay appear with increasing frequency down dip. The Raritan is a major aquifer for the region conforming to the regional strike and dip (USGS 1999). The Raritan Aquifer consists of two sandy zones beneath the Station. The first is the 22-foot thick sand mentioned above at a depth of 688 feet often identified with the Raritan Confining Unit. The second includes a 35- and a 24-foot sand located at depths of 766 and 811 feet below ground surface (bgs), respectively (Dames & Moore December 16, 1968). The total thickness of the Raritan Aquifer has not been well quantified in eastern New Jersey (USGS 1999); however, it tends to thicken down dip, has an approximate thickness of 100 feet beneath the Station, and its maximum identified thickness occurs between Pennsville and Salem. The results of aquifer tests have shown the hydraulic conductivity of the Raritan Formation to be on the order of 1 to 1,000 ft/ day and storativity to be on the order of $1x10^{-3}$ to $1x10^{-4}$ (USGS 1999; Dames & Moore 1988). The Raritan Formation is separated from the Potomac Group by a discontinuous confining unit (USGS 1999).

3.5.11 Potomac Group

The Potomac Group is an undifferentiated series of gravel, sand, silt and clay layers separated from the Raritan in some areas by a confining unit. Down dip, the Raritan and Potomac are undifferentiated (USGS 1983). The Potomac Formation is thought to be more than 250 feet thick and is located at a depth of approximately 836 feet beneath the Station with the uppermost sand occurring at 860 feet bgs (Dames & Moore December16, 1968; USGS 1999). The results of aquifer tests in Gloucester County have shown the group to have a hydraulic conductivity on the order of 100 ft/day and a storativity on the order of $1x10^{-5}$ to $1x10^{-4}$ (Barksdale et al. 1958). The Potomac Group is underlain by Pre-Cretaceous bedrock of the Wissahickon Formation (USGS 1999)

3.5.12 Wissahickon Formation

Located at a depth of approximately 1,400 feet, the Wissahickon Formation is primarily composed of metamorphic gneiss and schist (Hardt and Hilton 1969). The bedrock is not considered a significant source of groundwater.

4 Facility Construction and Local Geology

The construction of the Salem Generating Station has caused significant changes to the local geology and hydrogeology. Within the footprint of the cofferdam surrounding Units 1 and 2, the majority of original Artificial Island materials were removed to a depth of 70 feet bgs. Beyond the limits of the cofferdam, sheet piling was driven into the Kirkwood Formation and left in place, portions of the riverbed deposits were excavated and replaced with structural fill, other portions of the riverbed deposits were chemically grouted thereby changing their physical properties, and the foundations of structures, utilities, as well as various buried piping systems, extend below the water table affecting groundwater flow. These issues and their potential influence on groundwater flow and transport are discussed in further detail in Section 8. The following sections describe the conditions at Artificial Island prior to the construction of the Station, and detail how the construction of the Station has altered the local geology.

4.1 Pre-Facility Construction

The Station is located on the southern tip of what was once a natural sand bar projecting into the Delaware River. The area between the sand bar and the mainland had been used as a dredge spoil deposit area. In 1899, a timber sheetpile wall was installed around the perimeter of the sand bar. Over the next 50 or so years the area was used as a spoil deposit area for material collected during the dredging of the Delaware River. Riprap was added to the perimeter when the timbers began to degrade (Dames & Moore February 1974, June 1977). The area landward of Artificial Island has remained a tidal marsh.

4.2 Facility Construction

The construction of the Station has resulted in significant changes to the local geology. It was necessary to remove and rework much of the soil in the area of the present investigation in order to facilitate construction of the Station. This construction process was guided in part by the recommendations of the geotechnical investigation of Artificial Island (Dames and Moore August 28, 1968). This study recommended that the containment, fuel handling and auxiliary buildings be constructed upon a foundation mat placed at a depth of 50 to 70 feet bgs in the Vincentown Formation and recommended that the turbine, service and administration buildings be placed on pilings driven into the Vincentown Formation. This section describes the construction of the Station, which has had a significant impact on local hydrogeology in the area of the investigation. Facility construction details are highlighted on cross section diagrams through various Station features (**Figures 5** through **9**)

4.2.1 Construction of the Cofferdam

The recommendations for the containment, fuel handling, and auxiliary buildings (primary or Class I structures) were implemented by first constructing a cellular cofferdam of welded interlocking sheet piling. The extent of the cofferdam is shown on **Figure 2** and in profile on **Figures 5** and **6**. The cellular cofferdam, which encircled the excavation for all the Class I structures, was constructed at an approximate depth of 23 feet below existing grade (approximately 77 feet plant datum [PD] or -12.92 feet above mean sea level [amsl NAVD 1988]). The cofferdam consists of 24 circular cells, approximately 60.5 feet in diameter with connecting arcs, that were advanced approximately 10 feet into the Vincentown Formation to an elevation of 17 feet PD (-72.92 feet amsl). The cofferdam sections are of two different heights, 50 feet and 60 feet. The elevation of the top of the cofferdam is 77 feet PD (-12.92 feet amsl) on the north, south and west sides. The elevation of the eastern side is 67 feet PD (-22.92 feet amsl) providing access and a foundation for the return circulating water pipes and associated thrust block.

The inside area of the cofferdam sections were excavated to elevation 27 feet PD (-62.92 feet amsl). A vertical steel wall was added inside each individual cofferdam section to divide the sections approximately in half. The inner half of the individual cofferdam sections, or the section facing the building foundations, was then filled to the top with lean concrete. The area contained by the entire cofferdam structure was then excavated to the Vincentown Formation for placement of the lean concrete mat that served as the foundation for the construction of the structures within the cofferdam. During this stage of the excavation, qualified personnel visually inspected the bottom of the excavation to verify that the excavation had reached the top of Vincentown Formation prior to placing any lean concrete.

Prior to the completion of the excavation, at approximately elevation 45 feet PD (-44.92 feet amsl), 15 exploratory borings were drilled through the remaining Kirkwood Formation and into the underlying Vincentown to verify the depth to the formation. These additional borings showed no measurable differences from the study borings. After the Vincentown Formation had been exposed, an additional six test borings were advanced in the excavated area into the underlying Vincentown Formation to verify and ensure that the Vincentown Formation directly supported the foundation mat. Four of these borings were drilled under the Unit 2 Reactor Containment and two borings were drilled under the Unit 1 Reactor Containment. All of the borings penetrated a minimum of 20 feet into the underlying Vincentown Formation. Based on a review of available documents, the top of the Vincentown Formation in the area of the cofferdam ranges between 27 and 30 feet PD (-62.92 to –65.92 feet amsl).

When the surface of the Vincentown Formation was reached, the area was cleared of loose soil and lean concrete was poured directly onto the exposed Vincentown Formation.

Because the latter stages of the excavation were performed in freezing temperatures, a layer of material was left in place to insulate the Vincentown Formation until the concrete was ready to pour. In cases where the top of the Vincentown Formation did freeze prior to pouring of the concrete, the frozen soils were excavated or thawed prior to starting the pour. The station construction drawings indicate that the base of the first lean concrete pour was at 30 feet PD (-59.92).

4.2.1.1 Construction Within the Cofferdam

The cofferdam serves as a basin in which the Class I structures were constructed. Prior to construction of the primary structures, a lean concrete mat was placed on top of the Vincentown Formation for support of the structures. Following placement of the lean concrete, the Auxiliary Building, Fuel Handling Buildings and Reactor Containment Buildings were constructed. The remainder of the excavation within the cofferdam was then backfilled with structural fill meeting the design specifications of the Station. The following sections provide the details of these construction activities.

4.2.1.1.1 Lean Concrete

The lean concrete was placed in multiple pours. The initial lean concrete pour had a uniform thickness of 5.75 feet within the entire cofferdam area and went from elevation 30 feet to 35.75 feet PD (-59.92 to –54.17 feet amsl). As noted previously, the top of the Vincentown Formation in the area of the Station varies between 27 and 30 feet PD (-62.92 to –65.92 feet amsl). Review of available documentation indicates that the base for the first lean concrete pour was essentially uniform at 30 feet PD (-62.92 feet amsl) and that a soil blanket up to 3 feet thick in some areas was placed on top of the Vincentown Formation.

The second lean concrete pour went from elevation 35.75 feet PD (–54.17 feet amsl) to 45.75 feet PD (-44.17 feet amsl) for an overall thickness of 10 feet. The second pour covered the entire area within the cofferdam with the exception of the Reactor Pit within the Containment Building and the RHR pump pit within the Auxiliary Building. These areas did not receive additional lean concrete beyond the first pour.

The third lean concrete pour went from elevation 45.75 feet PD (-44.17 feet amsl) to 59.75 feet PD (-30.17 feet amsl) for an overall thickness of 14 feet. The third pour covered the entire area within the cofferdam except for the Reactor Pit within the Containment Building, and the residual heat removal (RHR) pump pit within the Auxiliary Building. In the area of the Auxiliary Building along the station centerline, the third pour only reached an elevation of 53.75 feet PD (- 36.17 feet amsl). There is also a sloped area running southeast from the RHR pump pit within the Auxiliary Building up to the cofferdam area that did not reach an elevation 53.75 feet PD (- 36.17 feet amsl).

The fourth and fifth lean concrete pours were limited to the area under the Fuel Handling Buildings and a portion of the Auxiliary Buildings. The fourth pour went from elevation 59.75 feet PD (-29.17 feet amsl) to an elevation of 69.75 feet PD (-19.17 feet amsl). The fifth pour brought the elevation of the lean concrete to 77.75 feet PD (-12.17 feet amsl). The overall thickness of the fourth and fifth pours combined was 18.25 feet 3 inches. The primary purpose of these pours was to provide the base for the Fuel Handling Building.

After the lean concrete pour was completed, the subgrade exterior walls and foundations were waterproofed. A rubber waterproof membrane was installed under all foundations and was extended vertically up to 6 inches below yard grade. The horizontal waterproofing membrane was constructed of 1/16-inch thick Ethylene Propylene Diene Monomers (EPDM rubber). A 1/8-inch thick hard board was installed over the membrane and then a concrete protection course approximately 3 inches thick was installed over the hard board. After construction, the waterproofing membrane was extended vertically up the foundation walls with 3/64-inch thick nylon reinforced rubber that was protected with 1/8-inch thick hardboard.

The individual foundations for the Reactor Containments, Auxiliary, and Fuel Handling Buildings were placed on top of the completed lean concrete. These buildings were designed to be separate structures sitting on the same base mat of lean concrete. To accomplish this design, the base mat structural concrete for these buildings was kept as separate structures with seismic clearance between the base mats.

4.2.1.1.2 Structural Concrete

Auxiliary Building

The base mat structural concrete under the Auxiliary Building in the area of the RHR pump pit starts at elevation 36 feet PD (-53.92 feet amsl) and extends up to approximate elevation 45 feet PD (-44.92 feet amsl). In the area of the Containment Building sumps this base mat extends from elevation 36 feet PD (-53.92 feet amsl) to an elevation of 60 feet PD (-29.92 feet amsl) where it completes the foundation structure for the Containment Building base mat. The base mat structural concrete under the center section of the Auxiliary Building starts at elevation 54 feet PD (-35.92 feet amsl) and extends up to elevation 64 feet PD (-25.92 feet amsl). The remainder of the Auxiliary Building walls and levels are continued up from these base mats to complete the structure.

Reactor Containment

The structural concrete base mat for the Containment Building that completed the reactor pit area to an approximate elevation of 52 feet PD (-37.92 feet amsl) and the remainder of the containment base mat to an elevation of 75.5 feet PD (-14.42 feet amsl). This surface was then covered with a stainless steel liner plate and topped with concrete. The total thickness of the stainless steel liner and concrete is 0.5 feet. Once the reactor pit area base mat was completed to an elevation of 59.75 feet PD (-30.17 feet amsl), the reactor containment base mats for Salem Units 1 and 2 were poured in 6 and 8 circular segments, respectively. Vertical construction joints were constructed with expanded wire mesh. No horizontal joints were permitted. This flat concrete base mat is approximately 16-feet thick with a liner plate located on top of this mat. Once the base mat and liner plate was completed, the finished concrete floor of the containment was poured and the containment structure completed.

The underground portion of the containment structure is waterproofed in order to avoid seepage of groundwater through cracks in the concrete. The waterproofing consists of an impervious membrane that is placed under the mat and on the outside of the walls. The EPDM membrane is designed to resist tearing during handling and when backfill is placed against it.

Fuel Handling Building

The Fuel Handling Building base mat structural concrete was poured from the top of the lean concrete at approximate elevation 77.75 feet PD (-12.17 feet amsl). The Spent Fuel Pool and the Fuel Transfer Pool were included in the first two structural concrete pours with approximate base elevations of 89.5 feet PD (-0.42 feet amsl) and 86 feet PD (-3.92 feet amsl), respectively.

4.2.1.1.3 Structural Fill

The soils removed from within the cofferdam were not used to backfill the completed structure because the hydraulically placed fill underlying Artificial Island did not meet the building design specifications for the Station. Therefore, it was necessary to import construction or structural fill to build the facility. The structural fill was placed between and around the Auxiliary Building, Fuel Handling Buildings, Units 1 and 2, portions of the cofferdam, above the return circulating water pipes, and from the top of the Kirkwood Formation to the land surface in the portions of the area between the cofferdam and the circulating water discharge pipes. This material was used extensively in the area of Unit 1 and the circulation water pipes.

4.2.2 Construction of the Service Water Intake Structure

The service water intake structure, shown on **Figure 2**, was constructed by driving sheet piles into the Vincentown Formation, and dewatering and excavating the enclosed soils (Dames & Moore August 28, 1968). The foundation of the structure lies upon a lean concrete pour placed upon the top of the Vincentown Formation. The base of the lean concrete is at elevation 45 to 50 feet PD (-44.92 to –39.92 feet amsl) (Dames & Moore June 3, 1970). This structure extends from the top of the Kirkwood Formation to the land surface preventing groundwater flow from this area to the Delaware River.

4.2.3 Construction of the Service Water Pipes

The original material in the locations of the service water pipes was excavated to the top of the riverbed deposits that overly the Kirkwood Formation. Structural backfill was placed above the riverbed deposits. The structural fill was compacted to 98 percent of optimum and used as the foundation for the service water lines (Dames & Moore August 28, 1968). Compaction is the process of increasing soil unit weight by forcing soil solids into a tighter state and reducing soil voids. This process strengthens soils and reduces hydraulic conductivity. Optimum compaction is the maximum soil weight that can be achieved at a given moisture content. The service water lines are two-foot diameter and are located at varying depths below ground surface throughout the area of investigation. The location of the lines is shown on **Figure 2**.

4.2.4 Construction of the Circulating Water Intake Structure

The circulating water intake structure is shown on **Figure 2**. The area of the intakes for the circulating water pipes was dredged to elevation 56 feet PD (-33.92 feet amsl). The surrounding structure was constructed on piles cut off at elevation 56 feet PD (-33.92 feet amsl). The top of the Vincentown Formation in this area is between elevation 40 and 53 feet PD (-49.92 and –36.92 feet amsl) (Dames & Moore June 3, 1970). This structure extends from the top of the Kirkwood Formation to the land surface preventing groundwater flow from this area to the Delaware River.

4.2.5 Construction of the Circulating Water Pipes

Water in the circulating water system is drawn from near shore, through 12, 7-foot diameter water intake lines. Water passes through the turbine building and returns to the Delaware River through 6, 10-foot diameter pipes extending approximately 500-feet off shore and discharging at an elevation of 53 feet PD (-36.92 feet amsl). The location of the lines is shown on **Figure 2**. The return circulating water lines are an important subsurface feature affecting groundwater flow in the area of investigation. They were constructed by sheet piling and excavation dewatering of the overlying sediments to the top of the Kirkwood Formation. Concrete footers were constructed perpendicular to the pipes from the turbine building to the shoreline. Between the concrete footers, crushed compacted concrete was placed. The surface of this foundation is sloped uniformly from an elevation of approximately 65 feet PD (-24.92 feet amsl) near the shore to about 75 feet PD (-14.92 feet amsl) near the turbine building. Following construction, lean concrete was poured between the pipes. These pipes and underlying foundations are a buried flow barrier, extending vertically 15 to 20 feet from the top of the Kirkwood Formation limiting southward groundwater movement. Construction of the return circulating water pipes were completed by placement and compaction of structural fill from near the top of the pipes to the present land surface.

4.2.6 Sheet Pile – Circulating Water Intake Structure to the Service Water Intake Structure

Groundwater movement toward the Delaware River is also restricted between the Circulating Water and the Service Water Intake Structures by interlocking sheet pile. The sheet piling is considered to be good barrier to flow as cathodic protection is used to control corrosion. The sheet piling was driven through the surficial aquifer into the first aquitard beneath Artificial Island (the Kirkwood Formation) during construction of the Salem Generating Station. The sheet piling is located as shown on **Figure 9**. Where the sheet piling is indicated using a dark black line, the elevation of the top is above the current water table; the sheet piling acts as a dam limiting the horizontal movement of water. Where the sheet piling is indicated using a gray line, the elevation of the top is below the current water table; groundwater is moving across the top of the sheet piling toward the Delaware River.

4.3 Local Geology

Certain information made available through the design and construction of the Station were used in conjunction with data obtained during the remedial investigation to define the geology as it currently exists. The Station geology is tied into the regional geology via the Vincentown Formation. During construction many areas were excavated down to the top of the Vincentown Formation, as such, it is a logical reference point. In the vicinity of the Station, the Vincentown Formation is overlain by the Kirkwood Formation, including the Kirkwood basal sand unit and the Kirkwood Aquitard, the riverbed deposits, hydraulically placed dredge spoils, and in some locations structural backfill. In most cases, the properties of these formations have been described in the above sections.

The upper surface of the Vincentown Formation in the area of the Station ranges between 27 and 30 feet PD (-62.92 to –65.92 feet amsl). The Vincentown is composed of glauconitic sands to silty sands with varying degrees of calcite cementation. The Kirkwood basal sand overlies the Vincentown Formation in the vicinity of the Station.

The Kirkwood basal sand is a reddish brown fine to medium sand coarsening with depth. The sand is variable in thickness at the Station and has been misidentified as the deeper aquifer in previous investigations (Dames & Moore May 23, 1974). Pumping tests conducted in the Kirkwood basal sand and Vincentown Formation have shown the units to have a hydraulic conductivity on the order of $1x10^{-3}$ cm/s and a storativity with a magnitude on the order of $1x10^{-4}$ to $1x10^{-3}$ (Dames & Moore May 23, 1974).

The Kirkwood Aquitard extends from the top of the Kirkwood basal sand to approximately 60 feet PD (-30.53 feet amsl). The Kirkwood Aquitard is composed of hard tan to gray clay with some sand and silt ten to twenty feet in thickness. The Kirkwood Aquitard is overlain by the riverbed deposits of the shallow, water-bearing unit.

The riverbed deposits are a dense, dark gray to tan, fine to medium sand with varying gravel content. With an upper elevation of approximately 65 feet PD (-25.53 feet amsl), the riverbed sand and gravel ranges in thickness from approximately 1 to 9 feet at the facility. The riverbed sand and gravel is overlain by hydraulic fill in some areas and structural fill in others, and is considered a leaky confined aquifer (Dames & Moore February 27, 1981 and December 23, 1992).

The hydraulic fill is a dark gray estuarial silt and clay with a hydraulic conductivity 1,000 to 10,000 times less than the underlying riverbed sand and gravel unit (Dames & Moore December 23, 1992). The hydraulic fill extends approximately from an elevation of 35 feet PD (-55.53 feet amsl) to surface grade in areas that remained undisturbed during the construction of the generating station. In other areas, the hydraulic fill has been entirely removed and replaced with structural fill.

The structural fill used at the station was obtained from a number of sources in New Jersey and Delaware. One fill source used in the area of this investigation was the Hinchner Pit. While the location of the borrow source was not identified, the material was described as yellowish-brown fine to medium sand with a trace of silt and clay (Dames & Moore June 20, 1972).

5 Initial Station Investigation Activities

Samples of leaking water were collected from three locations in an effort to characterize the nature of the leak detected from the west wall of the 78-foot Mechanical Penetration Room of the Unit 1 Auxiliary Building and from the penetration of the Unit 1 Spent Fuel Pool cooling line at the 92-foot elevation. The three sample locations were as follows:

- A drip bag was installed at the crack in the wall of the 78-foot Mechanical Penetration Room;
- A catch tray with a sample tube was placed under the Spent Fuel Pool cooling line at the interface between the Auxiliary Building and the Fuel Handling Building; and,
- A sample tube was established in the water stop located at the penetration between the Auxiliary Building and the Fuel Handling Building.

Samples collected from these locations were analyzed for tritium, major cations and anions, and gamma-emitting isotopes to determine the concentrations of constituents of concern in the water samples and to evaluate a potential source of the water. Analytical results of the samples were compared with analytical results of water samples collected from the Spent Fuel Pool and the telltale drains. The analytical results of the initial samples from these locations indicated that the water from the leaks had characteristics of Spent Fuel Pool water and that a leak from the Spent Fuel Pool system had occurred.

A series of samples from these initially established locations, as well as other locations subsequently established within the Station were collected and analyzed to characterize the leak from the Spent Fuel Pool system within the limits of the facility structures. The results of these sampling activities are presented in the Investigations of Salem Unit 1 Fuel Pool Leakage – Final Report Summary, which is provided in **Appendix A**.

An investigation of environmental media (i.e., groundwater and soil) in response to the leak from the Spent Fuel Pool was initiated in October 2002. These activities were conducted in three distinct phases (herein identified as Phase I, II, and III) each designed to determine the nature and extent of the release of water from the Spent Fuel Pool. Phases I and II of the investigation consisted of the collection and analysis of samples from within the facility structures, from the shallow, groundwater unit beneath the Station, and from select production and monitoring wells located adjacent to the Station. Sections 5.1 and 5.2 present the details of Phases I and II, respectively. Details of Phase III investigation activities, which included the installation and sampling of eight groundwater monitoring wells (Wells K through R), are presented in Section 5.3.

5.1 Phase I

The objectives of Phase I of the investigation were to further characterize the leak in the 78-foot elevation Mechanical Penetration Room, and to assess the likelihood that the leak had migrated to other locations within the Station, or beyond the limits of the Station structures and into the environment. The sampling program that comprised Phase I of the investigation included the following:

- Two groundwater samples were collected from inside the area through the "Door to Nowhere" in the 100-foot elevation Auxiliary Building. The sample locations consisted of the following:
    - Above the fuel transfer canal in the space between the Containment Building and the Fuel Handling Building (Sample A1). This required the removal of sandbags to a depth that groundwater was encountered.
    - Immediately inside the door to the right and next to the Fuel Handling Building (Sample A2).
- A groundwater sample was collected from inside the security gate at the northeast corner of the Fuel Handling Building yard area (Sample B).
- Water samples were collected from catch basins numbers 26 (Sample C26) and 33 (Sample C33).
- A water sample was collected from the drain line located in the 78-foot elevation Mechanical Penetration Room (Sample D).
- An additional water sample was collected from the active drip located in the area of the crack observed in the 78-foot elevation Penetration Room (Sample E).

The Phase I sample locations are shown on **Figure 10**. The groundwater samples (Samples A1, A2, and B) were discrete samples collected from a depth of four to five feet bgs (plant datum, [PD], 96 to 95 feet) in the area surrounding the Mechanical Penetration Room. The water samples collected from the catch basins (Samples C26 and C33), the drain line located in the 78-foot elevation Mechanical Penetration Room (Sample D), and the active drip from the crack in the wall of the 78-foot elevation Mechanical Penetration Room were grab samples. The samples (both water and groundwater) were analyzed onsite for gamma emitting isotopes. The analysis of Sample E included boron.

Analytical results of the water samples collected during Phase I are summarized in **Table 2**. Analytical results of water samples collected in the shallow subsurface (five feet bgs) did not indicate concentrations of target analytes that would indicate a release of water from the Spent Fuel Pool.

Analytical results of Sample E, collected from the active drip in the crack observed in the 78-foot elevation penetration room, indicated a boron concentration of 2,600 milligrams-per liter (mg/L), a cesium-134 (Cs-134) concentration of 118,000 pCi/L, and a cesium-137 (Cs-137) concentration of 320,000 pCi/L. These concentrations are characteristic of water from the Spent Fuel Pool.

5.2 Phase II

The objective of Phase II of the investigation was to evaluate the extent of contamination in groundwater and the Styrofoam-filled seismic gap between the Salem Auxiliary Building and the Salem Unit 1 Fuel Handling Building. The sampling program that comprised Phase II of the investigation is described in more detail below:

- On December 12 and 13, 2002, the PSEG Salem Generating Station Chemistry Division (PSEG Chemistry) collected groundwater samples from select production and monitoring wells installed within the vicinity of the Station. The samples were collected to assess whether the leak detected within the facility had migrated beyond the engineered structures of the Station. The groundwater samples were submitted to the PSEG SC Maplewood Laboratory and Testing Services (Maplewood) for analysis for tritium and gamma-emitting isotopes. The water sample collected from Well G was also analyzed for sodium, chloride, and boron. Analytical results of the groundwater samples, summarized in **Table 3**, did not indicate concentrations of constituents of concern above expected background concentrations. Although the radium detected in the Hope Creek and Salem production wells is naturally occurring, the concentrations indicated by groundwater samples collected from the wells were above the New Jersey Drinking Water Standard. Since the production wells may be used for drinking water, the NJDEP requested that PSEG Nuclear, LLC collect water samples from the facility water distribution network and submit those samples for gross alpha analysis. Analytical results of the water samples did not indicate gross alpha activity above 5 pCi/L. As such, further radium analysis of the wells is not required.

- On December 19 and 20, 2002, two direct-push discrete water samplers (DP-1 and DP-2) were advanced into the Styrofoam-filled Seismic Gap between the Salem Auxiliary Building and the Salem Unit 1 Fuel Handling Building. The water samplers consisted of one and one quarter-inch steel rods with a two-foot mill slotted sample screen. Water samples were obtained using quarter-inch polyethylene tubing and a peristaltic pump. The locations of DP-1 and DP-2 are shown on **Figure 10**. DP-1 was installed vertically along the northeast exterior wall of the Fuel Handling Building. DP-2 was installed on a 45-degree angle from the area of the "door to nowhere" into the Styrofoam to a depth that corresponded with the leak observed at the 78-foot elevation in the Mechanical Penetration Room. Analytical results of water samples collected from DP-1 and DP-2, summarized in **Table 3**, indicated concentrations of constituents of concern (primarily boron and tritium) that are consistent with Spent Fuel Pool water.

Results of the Phase II investigation indicated that water in the Styrofoam-filled Seismic Gap and the water observed leaking into the 78-foot elevation of the Mechanical Penetration Room had characteristics of Spent Fuel Pool water and likely had accumulated when the Spent Fuel Pool telltale drains had become obstructed.

5.3 *Phase III*

Phase III of the investigation was initiated following the discovery of water containing boron and various radioisotopes characteristic of water from the Spent Fuel Pool in the Styrofoam-filled Seismic Gap and was designed to determine if water leaking from the Spent Fuel Pool had migrated into the environment (i.e., soil and groundwater underlying the facility) adjacent to the Fuel Handling Building. This phase of the investigation involved the installation and collection of groundwater samples from eight monitoring wells adjacent to and around the perimeter of the Fuel Handling Building.

The installation of the eight monitoring wells was completed in two sub-phases (III (a) and III (b)). The locations of the Sub-Phase III (a) and Sub-Phase III (b) Monitoring Wells are shown on **Figure 11**. Monitoring Wells M, N, O, and R installed during Phase III (a), were installed at locations between the Phase II direct push discrete water samplers (DP-1 and DP-2) and the cofferdam, which bounds the perimeter of the Salem Generating Station foundation. The Sub-Phase III (a) wells were installed to a total depth of 20 feet bgs. The depths of the wells considered the elevation of the lean concrete foundation within the cofferdam. As discussed in Section 4.2.2, the elevation of the lean concrete foundation is approximately 78 feet PD. Each monitoring well was constructed with a ten-foot screened interval (10 to 20-feet bgs). Monitoring Wells M and R are constructed of 1¼-inch steel and were installed using direct push (i.e., Geoprobe®) technology due to access restrictions. Monitoring Wells N and O are constructed of two-inch PVC and were installed using hollow-stem auger drilling equipment.

Monitoring Wells K, L, P, and Q installed during Phase III (b), were installed outside the limits of the cofferdam. The Sub-Phase III (b) wells were installed into the Vincentown Formation using hollow-stem auger drilling equipment to a total depth of 80 feet bgs (20 feet PD), which corresponds with an elevation of ten feet below the Salem Generating Station foundation. The Sub-Phase III (b) monitoring wells, designed to monitor groundwater quality outside of the cofferdam, were constructed with a ten-foot screened interval (70 to 80-feet bgs) and are constructed of two-inch diameter PVC well materials. A summary of the well construction details for the Station monitoring wells is presented in **Table 4,** and well construction logs and boring logs are included in **Appendix C**.

Following installation and development of the monitoring wells, groundwater samples were collected on a periodic basis to assess groundwater quality. Details of the groundwater sampling activities are presented in Section 6.5. Analytical Results of the groundwater sampling activities, which are discussed in detail in Section 8, indicate that tritium was detected above the Interim Further Investigation Criterion for tritium (3,000 pCi/L) in groundwater samples collected from Monitoring Wells M, N, O, and R. In addition, tritium was detected above the laboratory detection limit in the groundwater samples collected from Monitoring Well K. Tritium was detected in the groundwater sample collected from Monitoring Well N on January 30, 2003 at a concentration above the New Jersey Groundwater Quality Criterion for tritium in Class IIA aquifers (20,000 pCi/L). Analytical results of groundwater samples collected from the Phase III monitoring wells indicated that the release of water from the Salem Generating Station Unit 1 Spent Fuel Pool had potentially migrated beyond the Styrofoam-filled Seismic Gap and into the environment. Additional investigation activities were then initiated to determine the source of the tritium detected in groundwater.

6 Remedial Investigation - March 2003 through February 2004

The remedial investigation of the release of water from the Spent Fuel Pool system was conducted between March 2003 and February 2004 in accordance with the June 2003 RIWP and the RIWP Addendum. The remedial investigation proposed in the June 2003 RIWP and the RIWP Addendum was based on the results of the three-phased initial investigation that was described in Section 5 of this report. The remedial investigation was designed to determine: 1) the source of the tritium in groundwater; 2) the extent of tritium in groundwater; 3) the fate and transport of tritium in groundwater; 4) the potential for tritium to migrate beyond the property boundaries; 5) human health and environmental risks associated with the tritium detected in groundwater; and, 6) the need for any further action.

The following sections provide the details of the remedial investigation. The results of remedial investigation activities are presented in subsequent sections of this report.

6.1 New Monitoring Well Installation – May through June 2003

Five locations were identified for the installation of additional monitoring wells. Details regarding these wells and their installation are provided in the following sections.

6.1.1 Objectives

Five additional groundwater monitoring wells (Wells S through W) and two replacement groundwater monitoring wells (Wells M and R) were installed at pre-determined locations surrounding Salem Unit 1 to evaluate the extent of tritium in groundwater, and to evaluate groundwater flow dynamics in the shallow, water-bearing unit. The locations of the monitoring wells are shown on **Figure 11**. The specific purposes for each of the monitoring wells are as follows:

- Monitoring Wells S and W were installed south and southwest of the cofferdam to characterize groundwater quality and flow conditions in an area downgradient of the Salem Generating Station Unit 1 Spent Fuel Pool between the cofferdam and the Delaware River;
- Monitoring Wells T, U, and V were installed north of the cofferdam to characterize groundwater quality and flow conditions upgradient of the cofferdam both in the shallow water-bearing unit and the Vincentown Formation; and,
- Replacements for the existing Monitoring Wells M and R were installed to allow for the collection of groundwater samples in the area of these wells from properly constructed and developed monitoring wells.

6.1.2 Field Implementation

Between May 5 and June 18, 2003, Monitoring Wells S through W were installed. In addition, existing Monitoring Wells M and R, which were originally installed as temporary wells constructed of mill-slotted Geoprobe® sample rods, were replaced with properly constructed and developed monitoring wells. The monitoring wells were installed by CT&E Environmental Services, Inc. of West Creek, New Jersey using a combination of direct-push, hollow-stem auger, and mud rotary drilling equipment. ARCADIS personnel supervised monitoring well installation activities. A summary of the well construction details for the Station monitoring wells is presented in **Table 4**. **Appendix C** presents the boring logs, well completion details, NJDEP Bureau of Water Allocation Monitoring Well Records, and Monitoring Well Certification Forms (Form B) for the wells.

Monitoring Wells S through W were constructed with two-inch diameter Schedule 40 PVC casing and well screen (0.010 slot). Well V, which is screened in the Vincentown Formation, is constructed with a six-inch diameter Schedule 40 PVC outer casing. The replacement monitoring wells for Well M and Well R were constructed of one-inch diameter Schedule 40 PVC casing and well screen (0.010 slot). A gravel pack consisting of Morie No. 1 sand was installed to a minimum of one foot above the top of the well screen. The remainder of the borehole was grouted with neat cement containing approximately five percent bentonite. The grout was installed in the annular space around the casing using a grout pump and a tremie-pipe.

Monitoring Wells S, T, U, and W were installed at various locations outside of the cofferdam. The wells were constructed with screened intervals in the hydraulic fill and riverbed deposits encountered above the Kirkwood Formation. The screened intervals for these wells range from 22 to 37 feet bgs. Monitoring Well V, installed north of the cofferdam, is constructed with a screened interval from 70 to 80 feet bgs in the deeper Vincentown Formation.

The monitoring wells were developed using a combination of surging and pumping techniques. Development of the monitoring wells was considered complete when the discharge appeared to be sediment free. Following installation, Stires Associates, P.A., a licensed New Jersey surveyor, surveyed the monitoring wells. Top of casing elevations, reported in elevations relative to plant datum, are included in **Table 4**. Monitoring Well Certification Form Bs for the wells are included in **Appendix C**. In August 2003, PSEG Nuclear, LLC conducted a separate survey to determine the relationship between plant datum and mean sea level (NAVD 1988). The results of the survey indicate that the conversion factor from plant datum to NAVD 1988 is -89.92 (i.e., to convert from plant datum to NAVD 1988 subtract 89.92 feet).

Investigation-derived waste (IDW) (i.e., drill cuttings, purge water, and decontamination materials) generated during the installation of the monitoring wells was containerized in 55-

gallon steel drums and labeled for identification. Characterization and disposal of the IDW was in accordance with Station radiological controls and waste management programs. During monitoring well installation activities, Station personnel from radiation protection monitored radioactivity in the work area to ensure the safety of project personnel and as a preliminary screening measure for IDW.

6.2 Supplemental Remedial Investigation – July through September 2003

Following installation of Monitoring Wells S through W and replacement monitoring wells for Wells M and R, an initial round of groundwater samples was collected during the weeks of June 30 and July 7, 2003. Analytical results of these groundwater samples, which are discussed in detail in Section 8, indicated that tritium was detected in the groundwater sample collected from Monitoring Well S at a concentration of 3,530,000 pCi/L. Based on the results of the groundwater sample collected from Monitoring Well S, a supplemental remedial investigation was implemented to assess the extent of tritium as indicated by this well. The details and results of the supplemental remedial investigation are presented in the following sections.

6.2.1 Objectives

In an effort to characterize groundwater in the vicinity of Monitoring Well S and to investigate the source of tritium detected in groundwater samples collected from the well, a supplemental remedial investigation was initiated. The objectives of the supplemental remedial investigation were to: 1) determine if the tritium indicated by the groundwater sample collected from Monitoring Well S had migrated to the river; 2) delineate the vertical and horizontal extent of the tritium in groundwater in the vicinity of Monitoring Well S; and 3) evaluate the potential sources of tritium in Monitoring Well S.

To achieve the objectives of the supplemental investigation, the groundwater sampling program was expanded significantly. The expanded groundwater sampling program consisted of the collection of grab groundwater samples from various depths at locations along the Delaware River, and surrounding Well S. The samples were then submitted for analysis for tritium, boron, and gamma-emitting isotopes. The groundwater sampling program designed to achieve the objectives of the investigation consisted of the collection of three proposed groundwater samples from discrete intervals in 37 proposed borings. The locations of the borings are shown on **Figure 12**. The specific purposes of the proposed borings were as follows:

- Borings 1 through 8 were advanced along the Station boundary with the Delaware River. The purpose of the borings was to evaluate concentrations of tritium and other analytes in groundwater as it approached the Delaware River.

- Borings 9 through 18 and Borings 31 through 37 were advanced within the vicinity of Station infrastructure identified as possible sources of tritium in groundwater. These potential sources include the "rad-waste" line, the Unit 1 Spent Fuel Pool, the Unit 1 refueling water storage tank, and the Unit 1 primary water storage tank.
- Borings 19 through 30 were advanced in the vicinity and downgradient of Well S to evaluate the extent of tritium indicated by groundwater samples collected from the well.

The following sections provide the details of the field implementation and analytical results obtained through the implementation of the supplemental remedial investigation.

6.2.2 Field Implementation

The supplemental remedial investigation was initiated in July 2003 following the detection of elevated concentrations of tritium in Monitoring Well S. As stated previously, the objectives of the supplemental investigation were to determine the extent of migration of the tritium, as indicated by Well S, and to assess the lateral and vertical extent and potential sources of the tritium in groundwater.

Borings were advanced at the locations shown on **Figure 12** using truck mounted Hurricane® direct-push drilling equipment to the sample target depths. The Hurricane® rig was operated by ADT Diamond Drilling, Inc. of Neptune, New Jersey. Prior to advancing the borings, Underground Services, Inc. of West Chester, Pennsylvania cleared the borings to a depth of ten feet bgs using SoftDig® technology (a vacuum excavation system). Subsurface structures, which prohibited the advancement of borings, were encountered in the locations of Borings 5, 6, 11, 16, 17, 21, and 29 through the use of SoftDig®. In these circumstances, attempts to advance the borings were abandoned.

Once cleared, groundwater samples were collected from the borings through the use of a Geoprobe® SP-15 screened point sampler advance to select target depths. Typically, the target depths for the collection of groundwater samples were as follows: 1) 11 to 15 feet bgs; 2) 21 to 25 feet bgs; and, 3) 31 to 35 feet bgs. These target intervals were chosen to evaluate groundwater at or near the water table surface, in the riverbed deposits or other sediments encountered just above the Kirkwood Formation, and some intermediate sample interval. The target sample intervals were modified in the field based on field conditions and observations, as necessary.

In several locations, the shallower target intervals (11 to 15 feet and 21 to 25 feet) yielded too little groundwater to collect a sufficient volume of water for analysis. In these locations, one-inch diameter Schedule 40 PVC temporary wells were installed to facilitate the collection of groundwater. The temporary wells were installed using two and a quarter inch diameter Geoprobe® well installation rods with an expendable point. Drilling equipment and sampling devices (e.g., the SP-15 sampler) were decontaminated between sample locations.

Maplewood Testing Services personnel (Maplewood) collected the groundwater samples using peristaltic pumps. New sample tubing was used at each sample location to prevent cross contamination between sample locations. A sufficient volume of water was collected from each sample location to analyze for tritium. Groundwater samples were collected from select borings to be analyzed for major cations and anions and gamma emitting isotopes.

The groundwater samples were submitted to the Salem Generating Station Chemistry Department (Chemistry) for initial screening for tritium and gamma-emitting isotopes. If groundwater samples did not indicate a concentration of tritium above the Station Chemistry lower level of detection (LLD), the sample was sent to the Maplewood laboratory for analysis using more sensitive equipment.

The advancement and subsequent sampling of 30 out of the 37 proposed borings was completed successfully. **Table 5** presents a summary of the details of the supplemental remedial investigation. The results of the investigation are presented in the following section.

6.2.3 Results

The laboratory analytical results for the supplemental remedial investigation are summarized in **Table 6** and are included on **Figure 13** along with the analytical results of groundwater samples collected from the Station monitoring wells. Groundwater analytical results for samples collected from the borings advanced beyond the limits of the defined plume demonstrate that there has not been a release of tritium or gamma-emitting isotopes to the river above any regulatory limits. In addition, the groundwater analytical results for samples collected from borings located at the southern and eastern limits of the supplemental investigation generally define the extent of groundwater containing tritium; however, the results of the supplemental investigation have identified an expanded area in the vicinity of Monitoring Well S with elevated levels of tritium in groundwater. This area of groundwater has been identified on **Figure 13** as an area with tritium levels above 500,000 pCi/L. Gamma-emitting isotopes were not detected at concentrations above expected background concentrations in groundwater samples collected during the supplemental investigation.

The results of the supplemental investigation were not able to complete a pathway between a potential source of primary water and Well S. Based on the distribution of tritium, and water levels observed in Monitoring Wells R and N (i.e., the hydraulic gradient in the seismic gap is from the northern to southern end), the likely source of tritium in the shallow, water-bearing unit is the southern end of the Seismic Gap, which is in direct contact with foundation soils. In order to further characterize groundwater flow within the shallow, water-bearing unit, and to establish permanent groundwater monitoring points, additional monitoring wells were required. Following completion of the supplemental investigation, the RIWP Addendum was prepared and submitted to the NJDEP-BNE presenting the details and results of remedial investigation activities completed to date. The RIWP Addendum proposed additional remedial investigation activities designed to complete the delineation of groundwater impacts, and the hydrogeologic characterization of the shallow, water-bearing unit. The proposed remedial investigation activities included the installation of 16 additional groundwater monitoring wells.

Between September 2003 and February 2004, the 16 additional groundwater monitoring wells proposed in the RIWP Addendum were installed at the Station. Initially, Monitoring Well Y, Well Z, and Wells AA through AF were installed. Following the collection and analysis of groundwater samples from these wells, and a re-evaluation of groundwater flow dynamics within the shallow, water-bearing unit, Monitoring Well AG (Shallow and Deep), Well AH (Shallow and Deep), Well AI, Well AJ, Well AL, and Well AM were installed to fill data gaps identified. Sections 6.3 and 6.4 provide the details of these monitoring well installation activities.

6.3 Monitoring Well Installation Activities – September through October 2003

Between September 22 and October 8, 2003, eight additional groundwater monitoring wells (Wells Y, Z and AA through AF) were installed at various locations adjacent to Salem Unit 1 to establish permanent groundwater monitoring locations between the Station and the Delaware River, to further characterize the extent of tritium in groundwater with concentrations above the New Jersey Groundwater Quality Criterion of 20,000 pCi/L, and to evaluate groundwater flow dynamics in the shallow, water-bearing unit. The following sections present the details of the well installation activities.

6.3.1 Objectives

The specific purposes for each of the Monitoring Wells are as follows:

- Monitoring Wells Y and Z were installed in the locations of supplemental investigation Borings 1 and 3, respectively. These wells were installed to characterize groundwater quality and flow conditions in an area downgradient of the Salem Generating Station Unit 1 Spent Fuel Pool between the cofferdam and the Delaware River;

- Monitoring Wells AA and AB were installed in the locations of supplemental investigation Borings 13 and 20, respectively. These wells were installed to characterize groundwater quality and flow conditions in an area south and southeast of Monitoring Well S, respectively;
- Monitoring Well AC was installed near the location of supplemental investigation Boring 35, as close to the Styrofoam-filled seismic gap as practical. This well was installed to characterize groundwater quality and flow conditions directly south of the Styrofoam-filled seismic gap and to the east of the Unit 1 equipment hatch;
- Monitoring Well AD was installed at a location outside of the cofferdam and within the area of groundwater containing tritium to further characterize groundwater quality and flow conditions. This well was also used for performing a pumping test to evaluate aquifer parameters;
- Monitoring Well AE was installed in the location of supplemental investigation Boring 37. This well was installed in a location east of the Salem Generating Station Unit 1 to characterize groundwater quality and flow conditions in this area; and,
- Monitoring Well AF was installed in the location of supplemental investigation Boring 18. This well was installed to characterize groundwater quality and flow conditions in an area south of the circulating water discharge pipes.

6.3.2 Field Implementation

Monitoring Wells Y, Z and AA through AF were installed by A.C. Schultes, Inc. of Woodbury Heights, New Jersey using hollow-stem auger drilling equipment. ARCADIS personnel supervised monitoring well installation activities. The locations of the monitoring wells are shown on **Figure 11**. A summary of the well construction details for the Station monitoring wells is presented in **Table 4. Appendix C** presents the boring logs, well completion details, NJDEP Bureau of Water Allocation Monitoring Well Records, and Monitoring Well Certification Forms (Form B) for the wells.

Other than Well AD, the monitoring wells were constructed with two-inch diameter Schedule 40 PVC casing and well screen (0.010 slot). Well AD was constructed with six-inch diameter Schedule 40 PVC casing and well screen (0.010 slot). A gravel pack consisting of Morie No. 1 sand was installed to a minimum of one foot above the top of the well screen. The remainder of the borehole was grouted with neat cement containing approximately five percent bentonite. The grout was installed in the annular space around the casing using a grout pump and a tremie-pipe.

Other than Well AC and Well AE, which were installed within the limits of the cofferdam, the boreholes for the wells were advanced to the depth that the Kirkwood Formation was encountered. The Kirkwood Formation was confirmed at each of the monitoring well locations through the collection of split-spoon samples. The wells were then constructed with ten-foot screened intervals exposed to the hydraulic fill and riverbed deposits directly above the Kirkwood Formation. The screened intervals for these wells ranges from a minimum top of casing depth of 26 feet bgs to a maximum bottom of screen depth of 42 feet bgs. This screened interval was chosen to monitor groundwater directly above the Kirkwood Formation in the zone of the shallow, water-bearing unit that had the potential for exhibiting the highest hydraulic conductivity (i.e., the riverbed deposits).

Well AC and Well AE, installed within the limits of the cofferdam, were advanced to the lean concrete foundation. The lean concrete was encountered at depths of 25 and 27.5 feet bgs in Well AC and Well AE, respectively. The wells were constructed with ten-foot screened intervals directly above the lean concrete. This screened interval was chosen to monitor groundwater directly above the lean concrete.

The monitoring wells were developed using a combination of surging and pumping techniques. Well AD, which was originally being considered for use during a long-term pumping test, was also developed using a chemical development agent (BMR®). Development of the monitoring wells was considered complete when the discharge appeared to be sediment free. Following installation, Stires Associates, P.A., a licensed New Jersey surveyor, surveyed the monitoring wells. IDW was handled in a manner similar to the description provided in Section 6.1.

6.4 Monitoring Well Installation Activities – January through February 2004

Following installation and development of the additional monitoring wells in September and October 2003 (Wells Y, Z and AA through AF), groundwater monitoring activities were initiated to determine the extent of delineation, and to identify data gaps that may be present in the existing monitoring well network. Groundwater monitoring activities consisted of the collection and analysis of groundwater samples from the recently installed wells and the collection and evaluation of two rounds of synoptic water levels from all of the Station monitoring wells. Based on the results of the groundwater monitoring activities, several data gaps were identified within the existing monitoring well network. As a result, eight additional monitoring wells (Wells AG-Shallow, AG-Deep, AH-Shallow, AH-Deep, AI, AJ, AL, and AM) were installed at the Salem Generating Station.

6.4.1 Objectives

The purposes for the additional monitoring wells are as follows:

- The well cluster consisting of Monitoring Wells AG-Shallow and AG-Deep was installed at the location of supplemental investigation Boring 7. The well cluster was installed to characterize groundwater quality and flow conditions in an area downgradient of the Salem Generating Station Unit 1 Spent Fuel Pool and immediately north of the circulation water discharge pipes;

- The well cluster consisting of Monitoring Wells AH-Shallow and AH-Deep was installed at the location of supplemental investigation Boring 8. The well cluster was installed to characterize groundwater quality and flow conditions in an area downgradient of the Salem Generating Station Unit 1 Spent Fuel Pool and immediately south of the circulation water discharge pipes;

- Monitoring Well AI was installed in the location of supplemental investigation Boring 9. This well was installed to further characterize groundwater quality and flow conditions within the cofferdam. Following installation, a pump test was performed on this well to evaluate aquifer parameters and potential remedial alternatives for the tritium in groundwater (e.g., capture of the tritiated water through pumping and permitted discharge);

- Monitoring Well AJ was installed outside of the cofferdam within the area of groundwater indicating relatively high concentrations of tritium. This well was used for performing a pumping test to evaluate aquifer parameters, and potentially may be incorporated into a remedial action designed to capture the groundwater containing tritium;

- Monitoring Well AL was installed in the location of supplemental investigation Boring 30. This well was installed to characterize groundwater quality and flow conditions south of the Salem Generating Station Unit 1 Spent Fuel Pool and the circulation water discharge pipes; and,

- Monitoring Well AM was installed near the location of supplemental investigation Boring 34, as close to the Styrofoam-filled seismic gap as practical. This well was installed to characterize groundwater quality and flow conditions directly south of the Styrofoam-filled seismic gap and to the west of the Unit 1 equipment hatch.

An additional monitoring well (Well AK) was proposed for the location of supplemental investigation Boring 28; however, due to plans for an additional structure to be erected at the proposed well location, the well was not installed. Other locations for the well were considered, but attempts to install the well were abandoned due to the existence of significant subsurface infrastructure in this location and the proximity of the proposed well to existing wells.

6.4.2 Field Implementation

Between January 14 and February 18, 2004, Monitoring Wells AG-Shallow, AG-Deep, AH-Shallow, AH-Deep, AI, AJ, AL, and AM were installed. Talon Drilling of West Trenton, New Jersey installed the monitoring wells using hollow-stem auger drilling equipment. ARCADIS personnel supervised monitoring well installation activities. The locations of the monitoring wells are shown on **Figure 11**. A summary of the well construction details for the Station monitoring wells is presented in **Table 4**. **Appendix C** presents the boring logs, well completion details, NJDEP Bureau of Water Allocation Monitoring Well Records, and Monitoring Well Certification Forms (Form B) for the wells.

Well clusters were installed at the locations of Well AG (Shallow and Deep) and Well AH (Shallow and Deep). The well clusters, completed within the same borehole, were constructed with screened intervals from 15 to 25 feet bgs and 30 to 40 feet bgs. The screened intervals, which were designed to provide a vertical profile of tritium immediately downgradient of the sheetpiling through which the circulation water discharge pipes penetrate, are separated by approximately four-feet of grout. The wells within each cluster are constructed of one-inch diameter Schedule 40 PVC casing and well screen (0.010 slot). A gravel pack consisting of Morie No. 1 sand, which grades to Morie No. 00 sand over the last foot, was installed to approximately one foot above the top of the well screen. The remainder of each borehole was grouted with neat cement containing approximately five percent bentonite. The grout was installed in the annular space around the casing using a grout pump and a tremie-pipe. Details regarding the installation of the remaining wells are as follows:

- Well AI and AM were installed within the limits of the cofferdam. The boreholes for these wells were advanced to the depth that lean concrete was encountered. The wells were then constructed with ten-foot screened intervals immediately above the lean concrete. These wells were constructed with four-inch diameter Schedule 40 PVC casing and well screen (0.010 slot).

- Well AJ was installed outside of the limits of the cofferdam within the area exhibiting elevated (greater than 500,000 pCi/L) levels of tritium. The borehole for well AJ was advanced to the depth that the Kirkwood Formation was encountered, which was confirmed through the collection of split-spoon samples. Well AJ was constructed with four-inch diameter Schedule 40 PVC casing and well screen (0.010 slot). The well was constructed with a 25-foot screened interval installed immediately above the Kirkwood Formation.

- Well AL, installed beyond the limits of the cofferdam and directly south of the circulation water discharge pipes, was installed to a depth of 25 feet bgs. Well AL was completed with a ten-foot screened interval designed to monitor groundwater above and downgradient of the circulation water discharge pipes. The well was constructed with two-inch diameter Schedule 40 PVC casing and well screen (0.010 slot).

A gravel pack consisting of Morie No. 1 sand was installed to a minimum of one foot above the top of the well screens. The remainder of each borehole was grouted with neat cement containing approximately five percent bentonite. The grout was installed in the annular space around the casing using a grout pump and a tremie-pipe. The monitoring wells were developed using a combination of surging and pumping techniques. Development of the monitoring wells was considered complete when the discharge appeared to be sediment free. Following installation, Stires Associates, P.A., a licensed New Jersey surveyor, surveyed the monitoring wells. IDW was handled in a manner similar to the description provided in Section 6.1.

6.5 Monitoring Well Sampling and Analysis

Groundwater monitoring activities have been ongoing since the installation of Wells K through R during Phase III of the initial Station investigation activities. Initially, groundwater samples were collected on a weekly basis. As additional monitoring wells were installed, and as a database of groundwater analytical results for the monitoring wells was generated, the monitoring well sampling program was modified. Groundwater samples are analyzed for tritium, major cations and anions, and gamma emitting isotopes. The sampling program is being adaptively managed to provide the investigational data required to meet the current investigation objectives and evaluate changes in tritium concentrations. Currently, the sampling program design for the Station monitoring wells consists of the following:

- Due to the relatively low levels of tritium (typically less than 1,000 pCi/L) historically detected in groundwater samples collected from Wells L, P, Q, T, U, and V, and the "natural" (or ambient) levels of tritium detected using low-level tritium in-growth techniques (detection limit approximately 1.5 pCi/L), these wells are currently sampled on a quarterly basis and the frequency may be reduced to semi-annual in the near future;

- Wells K, R, W, and AF are currently sampled on a monthly basis but are being evaluated for a reduced frequency based on consistent analytical results below the level of detection;

- Wells such as M, N, O, AA, AB, AC, AD, and AE, which indicate concentrations of tritium above 20,000 pCi/L, are currently sampled on a monthly basis. These wells are monitored to evaluate current plume dynamics and migration; and,

- Recently installed monitoring wells, such as Wells AG through AM, are currently sampled on a bi-weekly basis to establish an analytical history for these wells. Following development of the analytical history, the sample frequency will be modified based on similar factors as explained above.

The adaptive sampling management program is designed to ensure representative data are collected that meet the objectives of the investigation and provide the information necessary to evaluate plume dynamics and migration.

Analysis of groundwater samples collected from most of the Station Monitoring Wells has also included a single event analysis for groundwater age determination (by tritium – helium-3 age dating). As proposed in the RIWP Addendum, Tc-99 was also analyzed as a single-event analysis. The Tc-99 analysis, which was performed in lieu of iodine-129, was performed to assist in the determination of the source of the tritium. The iodine-129 analysis could not be performed due to unavailability of analysis equipment at Purdue University. Analytical results of groundwater samples collected through December 2003 are discussed in Section 8 of this report.

To minimize the influence of turbidity, groundwater samples are collected in accordance with the low-flow sampling procedure outlined in the Quality Assurance Project Plan (QAPP), which was included as an appendix to the June 2003 RIWP. The use of low-flow purging and sampling procedures results in the collection of groundwater samples from monitoring wells that are representative of groundwater conditions in the geologic formation. This is accomplished by minimizing stress on the geologic formation and minimizing disturbance of sediment that has collected in the well (*Groundwater Sampling Procedure, Low Stress (Low Flow) Purging and Sampling*, United States Environmental Protection Agency Region II, March 1998).

As outlined in the low-flow sampling standard operating procedure (SOP) provided in the QAPP, low-flow purging and sampling involves lowering a QED® Micropurge ¾-inch diameter bladder pump (model SP-¾-P) to the midpoint of the screened interval of the monitoring wells. The wells are then purged at a constant rate maintained at or below 200 milliliters per minute. The water level in the well being sampled is monitored during purging, and the pumping rate is adjusted to minimize drawdown. A properly calibrated Micropurge Basics Flow Cell Model MP20DT is used to collect field parameter measurements every five minutes from the recovered groundwater. The parameters include dissolved oxygen (DO), oxidation-reduction potential (ORP), specific conductivity, pH, and temperature.

Once the field parameters stabilize (no more than 10 percent fluctuation over three measurements), a sample is collected. The sample is collected directly from the pump discharge line, which is disconnected from the influent line of the flow-through cell to facilitate sample collection. A summary of stabilized field parameters (final readings) for groundwater samples collected from the monitoring wells is provided in **Table 7**. The field parameter measurements collected during sample collection activities indicated the following:

- Temperature ranged from 12.50 to 32.69 degrees Centigrade (°C).
- Specific conductivity ranged from 15.10 to 0.19 millisiemens per centimeter (mS/cm).
- pH ranged from 4.96 to 8.32 standard units (su).
- ORP ranged from –219 to +484 millivolts (mV).
- DO concentrations ranged from 0.04 to 8.02 milligrams per liter (mg/L).

The relatively wide range of temperatures is likely due to the influence of the facility infrastructure. The wells indicating higher temperatures are screened in the shallow, water-table aquifer in areas adjacent to subsurface structures that cause an increase in subsurface temperature (e.g., steam blow down lines).

Before sampling and between each well, all non-dedicated field equipment (e.g., submersible pumps and water-level indicators) is decontaminated following the procedures outlined in the QAPP. Purge water generated during sampling is containerized pending disposal in accordance with Station radiological controls and waste management programs.

6.6 Hydrogeologic Investigation Activities

The following sections provide the details of the site-specific hydrogeologic investigation activities detailed in the June 2003 RIWP and RIWP Addendum. These activities include the collection of groundwater elevation data from Station monitoring wells to evaluate groundwater flow conditions in the shallow, water-bearing unit; the monitoring of groundwater elevations in the Vincentown Formation to evaluate groundwater flow conditions during various points in the tide cycle; the performance of slug tests and pumping tests on various monitoring wells; the evaluation of tidal influences on the various hydrogeologic units encountered beneath the Station; and, the evaluation of a clay sample from the Kirkwood Formation to accurately characterize this unit. The results of the site-specific hydrogeologic investigation activities are presented in Section 6.

6.6.1 Evaluation of Tidal Influence

Between July 29 and August 5, 2003, data logging miniTROLL pressure transducers were installed in Monitoring Wells L, M, and W to evaluate the tidal influences of the Delaware River on water levels in the Vincentown Formation (Well L), the hydraulic fill and river bed deposits (Well W), and the structural fill within the cofferdam (Well M). The miniTROLLs were programmed to record data on 15-minute intervals throughout the period of record. In addition to the water-level information from the wells, actual tidal data from the Reedy Point, Delaware tidal station (USGS Station No. 8551910), and precipitation data from the weather station located approximately 0.9 miles east of the Salem Generating Station were obtained.

Following completion of the tests, the data were downloaded from the miniTROLLs and evaluated using Win-Situ software. The tidal data from Reedy Point and precipitation data obtained from the Station were also evaluated. An analysis of the tidal evaluation data and results are presented in Section 7.3.

6.6.2 Evaluation of Groundwater Elevations

As presented in Section 7.3, water levels in the Vincentown Formation are influenced by tidal fluctuations in the Delaware River, while water levels in the shallow, water-bearing unit are not tidally influenced. As such, the approach to evaluating groundwater elevations in these units varied. The following sections provide the details for the evaluation of groundwater elevations in these units.

6.6.2.1 Shallow, Water-Bearing Unit

To characterize groundwater flow conditions in the shallow, water-bearing unit, water level measurements were collected from the monitoring wells during six synoptic events conducted on June 26, July 28, August 15, October 14, and November 6, 2003 and February 20, 2004. A summary of the water level measurements is presented in **Table 8**. The results of the water level measurement events are discussed in Section 7.2.1.

6.6.2.2 Vincentown Formation

To characterize groundwater flow conditions in the Vincentown Formation, continuous data logging pressure transducers were installed in Well K, Well L, Well P, Well Q, and Well V from January 12 through 19, 2004. Tide data for the same time period were obtained from the tide station located at the Hope Creek Generating Station. The data obtained from these wells and the tide station were evaluated to characterize groundwater flow conditions in the Vincentown Formation during various stages of the tide in the Delaware River. The results of the groundwater elevation data for the Vincentown Formation are presented in Section 7.2.2.

6.6.2.3 Evaluation of Vertical Groundwater Gradients

To evaluate the vertical gradient between the shallow, water-bearing unit, relative groundwater elevations for the units, calculated from water level measurements obtained on June 26, July 28, August 15, October 14, and November 6, 2003, were compared. The results of this evaluation are presented in Section 7.2.3.

6.6.3 Evaluation of the Kirkwood Formation

Conflicting geologic reports suggest that the clay, confining unit that separates the riverbed deposits and hydraulic fill of the shallow, water-bearing unit from the Vincentown Formation is either the Miocene Kirkwood Formation or the Pleistocene Van Sciver Lake Bed deposits (USGS 1979 and 1999). In order to determine the relative age of the clay, confining-unit, samples of the clay obtained during the drilling of Well V were submitted to Lehigh University for pollen analysis. Results of the age determination analysis are presented in Section 7.4.

6.6.4 Aquifer Characterization

To evaluate aquifer parameters (e.g., hydraulic conductivity) for the shallow, water-bearing unit and the Vincentown Formation, slug tests and pumping tests were performed on various monitoring wells. The details of these tests are presented in the following sections.

6.6.4.1 Slug Tests

ARCADIS collected slug test data from Monitoring Wells N, O, and U in August 2003. The purpose of the slug tests was to obtain preliminary estimates of hydraulic conductivity for the structural fill encountered within the cofferdam and the hydraulic fill and riverbed deposits. Pumping tests were performed to obtain a more refined estimate of the hydraulic conductivity and other aquifer parameters for the various components of the shallow, water-bearing unit. Details regarding the proposed pumping tests are included in Section 7.4.1.

The slug tests were performed by first programming and installing an In-Situ® miniTROLL-30 PSIA pressure transducer and data logger (miniTROLL) in the test well. Programming the miniTROLLs consisted of entering the test start time (projected to be approximately 15 minutes following installation of the miniTROLLs into the test well) and data collection interval (minimum of 1.5 seconds). Following installation of the miniTROLL into the test well, the water level in the well was allowed to stabilize. (If the water level had stabilized by the time the miniTROLL was scheduled to start recording data, the slug was introduced to the well. If the water level had not stabilized, the water level was allowed to stabilize before introducing the slug.) The slug that was used for the tests is a three-foot long, one and a half (1.5) inch diameter, solid Schedule 80 PVC rod. In a two-inch diameter well, the slug will displace the water table approximately 1.7 feet (i.e., 0.27 gallons).

Upon introducing the slug to the test well to start the falling head test, the time and depth to water were recorded. During the test, the depth to water was periodically recorded to compare the water-level readings recorded by the miniTROLL. Once the water table had recovered to within 90 percent of static, the slug was removed to start the rising head test. Again, depth to water measurements and the time were recorded initially after removing the slug and periodically during the test. The test was considered complete once the water table had recovered to within 90 percent of static. The same process was repeated for each test well. An analysis of the slug test data and results are presented in Section 7.4.1.

6.6.4.2 Pumping Tests

Between January 30 and February 4, 2004, eight aquifer pumping tests were conducted on seven monitoring wells (Wells AB, AC, AD, AI, AJ, AM, and S) screened in the shallow, water-bearing unit. The tests, which consisted of both a pumping phase and a recovery phase, were performed to quantify the hydrogeologic characteristics (e.g., hydraulic conductivity) of this unit within the limits of and just south of the cofferdam.

The pumping tests were performed by first installing a variable rate two-inch submersible Grundfos® pump in the test well. A miniTROLL data logging pressure transducer was then programmed and installed in the test well. Programming the miniTROLLs consisted of entering the test start time (projected to be approximately 15 minutes following installation of the miniTROLLs into the test well) and data collection interval (logarithmic). Following installation of the miniTROLL into the test well, the water level in the well was measured and manually recorded. The pumping test was then initiated.

The wells were tested at pumping rates ranging from 0.25 to 2.0 gallons per minute (gpm). Pumping rates maintained during the pumping portion of the test were confirmed through the use of a digital flow meter and through manual flow rate calculations using a calibrated receptacle and a stopwatch. Recovery data were monitored until the water level in the well had recovered to a minimum of 85% of the static water level measured at the start of the test. The water generated during the tests was pumped directly into 55-gallon steel drums. Following completion of the tests, water in the drums was transferred to a storage tank pending characterization and disposal, which was coordinated by PSEG Nuclear, LLC personnel. Details regarding the pumping tests performed on the individual wells are provided in the following sections. Field observations made during the tests are summarized in **Table 9**. Results of the pumping tests are presented in Section 7.4.2.

6.6.4.2.1 Well AB

The pumping test conducted on Well AB consisted of a 304-minute step-drawdown test. The steps of the test were performed at the following pumping rates: 0.25 gpm; 0.5 gpm; 1.0 gpm; and, 2.0 gpm. Drawdown stabilized in the well during each pumping rate. The total volume of water recovered during the pumping test was approximately 280 gallons. The maximum drawdown observed in the well was approximately 16 feet from the static water level.

6.6.4.2.2 Well AC

The pumping test conducted on Well AC consisted of a 283-minute step-drawdown test, which was conducted concurrently with a pumping test on Well AM. The steps of the test were performed at the following pumping rates: 0.25 gpm; 0.5 gpm; and, 0.75 gpm. Drawdown stabilized in the well during the 0.25 gpm and 0.5 gpm pumping rates but the well was not able to maintain a pumping rate of 0.75 gpm. The total volume of water recovered during the pumping test was approximately 116 gallons. The maximum drawdown observed in the well was approximately 10.3 feet from the static water level.

6.6.4.2.3 Well AD

The pumping test conducted on Well AD consisted of a 331-minute step-drawdown test, which was conducted concurrently with the development of Well AJ. A noticeable effect of the development of Well AJ was observed in the water levels measured in Well AD. The steps of the test were performed at the following pumping rates: 0.25 gpm and 0.5 gpm. Drawdown stabilized in the well during the 0.25 gpm pumping rate but the well was not able to maintain a pumping rate of 0.5 gpm. The total volume of water recovered during the pumping test was approximately 85 gallons. The maximum drawdown observed in the well was approximately 17 feet from the static water level.

6.6.4.2.4 Well AI

The pumping test conducted on Well AI consisted of a 315-minute step-drawdown test. The steps of the test were performed at the following pumping rates: 0.25 gpm; 0.5 gpm; and, 0.75 gpm. Drawdown stabilized in the well during the 0.25 gpm and the 0.5 gpm pumping rates but the well was not able to maintain a pumping rate of 0.75 gpm. The total volume of water recovered during the pumping test was approximately 145 gallons. The maximum drawdown observed in the well was approximately 11.6 feet from the static water level.

6.6.4.2.5 Well AJ

The pumping test conducted on Well AJ consisted of a 275-minute step-drawdown test, which was conducted concurrently with the pumping test on Well S. The steps of the test were performed at the following pumping rates: 0.25 gpm and 0.5 gpm. Drawdown stabilized in the well during the 0.25 gpm pumping rate but the well was not able to maintain a pumping rate of 0.5 gpm. The total volume of water recovered during the pumping test was approximately 75 gallons. The maximum drawdown observed in the well was approximately 23.2 feet from the static water level.

6.6.4.2.6 Well AM

The pumping test performed on Well AM consisted of a 202-minute test that was effectively separated into two separate time frames (i.e., an initial portion and a subsequent portion). The test on Well AM was also performed concurrently with the pumping test performed on Well AC.

The initial portion of the test was performed at the following pumping rates: 0.25 gpm and 0.5 gpm. Drawdown stabilized in the well during the 0.25 gpm pumping rate but the well was not able to maintain a pumping rate of 0.5 gpm. The total volume of water recovered during the initial portion of the test was approximately 40 gallons. The maximum drawdown observed in the well during this portion was approximately 12.3 feet from the static water level.

Prior to initiating the subsequent portion of the test, the water level in the well was allowed to recover to within 90-percent of the static water level. This required approximately 90 minutes. The subsequent portion of the test on Well AM was conducted at a pumping rate of 0.33 gpm. Drawdown in the well had not stabilized at the time the subsequent portion of the test was terminated, and approximately 18 gallons of water were recovered during this portion of the test.

6.6.4.2.7 Well S

The pumping test conducted on Well S consisted of a 305-minute test, which was conducted concurrently with the pumping test on Well AJ. The pumping test was conducted at a pumping rate of 0.25 gpm. Drawdown in the well began to stabilize at this pumping rate near the end of the pumping phase of the test. The total volume of water recovered during the pumping test was approximately 77 gallons. The maximum drawdown observed in the well was approximately 20 feet from the static water level.

7 Hydrogeologic Evaluation

The following sections provide the results of the site-specific hydrogeologic investigation activities detailed in the June 2003 RIWP and RIWP Addendum, as well as a hypothesis regarding groundwater flow at the facility prior to construction of the cofferdam and other facility structures, which have had a significant impact on groundwater flow. As presented in Section 5, the site-specific hydrogeologic investigation activities included the collection of groundwater elevation data from Station monitoring wells to evaluate groundwater flow conditions in the shallow, water-bearing unit; the monitoring of groundwater elevations in the Vincentown Formation to evaluate groundwater flow conditions during various points in the tide cycle; the performance of slug tests and pumping tests on various monitoring wells; the evaluation of tidal influences on the various hydrogeologic units encountered beneath the Station; and, the evaluation of a clay sample from the Kirkwood Formation to accurately characterize this unit.

7.1 Local Hydrogeology – Pre-Facility Construction

The Station is located on the southern tip of what was once a natural bar projecting into the Delaware River. The groundwater flow conditions present in the natural bar would have been typical of those present on any island composed of unconsolidated materials. Water would move away from the axis of the bar in either direction with semi-radial flow occurring at the ends of the bar.

The area between the bar and the mainland had been formerly used as a dredge spoil area. In 1899, a timber sheetpile wall was installed around the perimeter of the bar. Over the next 50 or so years the area was used as a spoil deposit area for material obtained during the dredging of the Delaware River by the United States Army Corps of Engineers. Riprap was added to the perimeter when the timbers began to degrade (Dames & Moore February 1974, June 1977). The area landward of Artificial Island has remained a tidal marsh.

7.2 Local Hydrogeology - Current

The following sections provide the results of the site-specific hydrogeologic investigation activities. Detailed water level measurements have been collected from site monitoring wells as well as the site tidal station to determine groundwater flow directions and surface water/groundwater interactions. The results of these activities are summarized below.

7.2.1 Groundwater Flow - Shallow, Water-Bearing Unit

ARCADIS personnel performed site-wide monitoring well gauging events on June 26, July 28, August 15, October 14, and November 6, 2003 and February 20, 2004. The depth-to-water in each well was measured relative to the top of the well casing using an electronic water-level indicator. Using the gauging measurements and the surveyed top of casing elevations, groundwater elevations were calculated for each well. **Table 8** provides a summary of the groundwater elevation data.

As summarized in **Table 8**, groundwater elevations in monitoring wells screened in the shallow, water-bearing unit within the limits of the cofferdam are generally higher than groundwater elevations in monitoring wells screened in the shallow, water-bearing unit outside the limits of the cofferdam. Water-table elevations have generally decreased across the site since June 2003. A groundwater elevation contour map for the shallow, water-bearing unit based on the February 20, 2004 data is presented on **Figure 14**. Groundwater flow is generally from the center of the island (northeast of the Salem Generating Station) towards the Delaware River. Due to permeability differences between the structural fill and the hydraulic fill, groundwater is mounded within the area of the cofferdam. Groundwater flows radially outward from the cofferdam, and the observed mounding effect dissipates quickly.

7.2.2 Groundwater Flow - Vincentown Formation

As presented in Section 7.3, water levels in the Vincentown Formation, because it is a confined-unit, are tidally influenced. Water levels can vary as much as four feet per tide cycle depending on the proximity of the well to the Delaware River. To more accurately assess groundwater flow conditions in the Vincentown Formation, data logging pressure transducers were installed in Well K, Well L, Well P, Well Q, and Well V from January 12 through 19, 2004. Tide data for the same time period were obtained from the tide station located at the Hope Creek Generating Station. The water level and tide data were evaluated to characterize groundwater flow conditions during various stages of the tide cycle of the Delaware River.

Graphs of water levels for the individual wells and the tide data are presented as Figures E–1 through E–6 in **Appendix D**. The tide data was evaluated to determine the highest tide (high-high tide), the lowest tide (low-low-tide), and an intermediate high tide (low-high tide) observed during the monitoring period. Corresponding water levels in the monitoring wells were noted for these stages of the tide cycle, and groundwater elevations were calculated. Groundwater elevation contours for the high-high tide, the low-high tide, and the low-low tide are presented on **Figures 15**, **16**, and **17**, respectively.

Groundwater flow direction in the Vincentown Formation oscillates with the tides. During the high-high tide stage of the tide cycle (**Figure 15**), groundwater flow in the Vincentown Formation is perpendicular to the shoreline of the Delaware River in the west and south towards the center of Artificial Island. During the low-high tide stage of the tide cycle (**Figure 16**), an observed groundwater saddle is present between the Station and the Delaware River. Groundwater flow to the north and east of the saddle is to the south and east. Groundwater flow to the south and west of the saddle is to the north and east. During the low-low tide stage of the tide cycle (**Figure 17**), groundwater flow in the Vincentown Formation is from the center of Artificial Island towards the Delaware River.

7.2.3 Vertical Gradients

As summarized in **Table 8**, groundwater elevations in the Vincentown Formation are generally two to four feet lower than the hydraulic head in the shallow, water-bearing unit. This indicates that the potential for downward vertical migration of groundwater exists.

7.3 Tidal Evaluation Results

The results of the tidal investigation were consistent with previous tidal studies (Dames & Moore January 4, 1968). Approximately four feet of tidal response was observed in Well L (screened within the Vincentown Formation). Well W, screened within the shallow, water-bearing unit, showed a negligible tidal response. Similarly, Well M, located within the cofferdam on the west end of the Salem Unit 1 Fuel Handling Building exhibited no discernable tidal response. These tidal data indicate that the Kirkwood Aquitard effectively isolates the riverbed deposits from tidal fluctuations in the Vincentown Formation and there are no tidal influences in the aquifer where tritium has been detected. Plots depicting the tidal evaluation analyses are provided in **Appendix E**.

7.4 Evaluation of the Kirkwood Formation

Conflicting geologic reports suggest that the clay, confining unit that separates the riverbed deposits and hydraulic fill of the shallow, water-bearing unit from the Vincentown Formation is either the Miocene Kirkwood Formation or the Pleistocene Van Sciver Lake Bed deposits (USGS 1979 and 1999). In order to determine the relative age of the clay, confining-unit, samples of the clay obtained during the drilling of Well V were submitted to Lehigh University for pollen analysis. Results of the age determination analysis indicate that the clay, confining-unit is late Miocene or Pliocene in age (Yu 2003). As such, the clay, confining-unit is interpreted as the Kirkwood Formation.

7.5 Aquifer Characteristics

The following sections provide the results of the slug tests and pumping tests performed on the various monitoring wells at the Station.

7.5.1 Slug Test Results

Slug tests were performed on Monitoring Wells N, O, and U to quantify hydraulic properties in the unconfined aquifer. The field procedure followed for these tests are discussed in Section 6.6.4.1. The slug test data generated from these wells were evaluated using the Bouwer and Rice (1976) method. The primary assumptions of this analysis are: 1) the flow field is steady and laminar near the well; 2) the aquifer is homogenous and isotropic within the zone of influence; and 3) the well screen is clean.

Table 10 provides a summary of the hydraulic conductivity values estimated from the slug tests. Plots of the slug test analyses are provided in **Appendix F**. Monitoring Wells N and O are screened in the structural fill. The estimated hydraulic conductivity at Well N is between 0.09 and 0.14 ft/day. The estimated hydraulic conductivity at Well O is between 3.6 and 4.3 ft/day. The variation in hydraulic conductivity between wells reflects not only differences between soils and well construction, but also slug test procedures in general. Slug tests displace only a small volume of water in the vicinity of the well, thereby stressing only a small portion of the aquifer. The discrepancy between sampling points is not atypical. The estimated hydraulic conductivity value for Monitoring Well U screened in the riverbed deposits was 2.95 ft/day.

7.5.2 Pumping Test Results

As presented in Section 6.6.4.2, eight pumping tests were performed on seven wells (Wells AB, AC, AD, AI, AJ, AM, and S) to quantify the hydrogeologic characteristics (e.g., hydraulic conductivity) of the shallow, water-bearing unit within the limits of and just south of the cofferdam. The data collected during the pumping and recovery phases of the pumping tests were analyzed using AQTESLOV for Windows (HydroSOLVE, 1996). The results of the individual pumping tests, which are discussed in the following sections, are summarized in **Table 11**. The pumping test results indicate a range of transmissivity of 0.337 ft^2/day to 27.7 ft^2/day and hydraulic conductivities of 0.03 ft/day to 2.77 ft/day.

7.5.2.1 Well AB

Details of the analysis of the pumping and recovery phases of the step-drawdown test performed on Well AB are presented on Figures H-1 and H-2 in **Appendix G**, respectively. The average transmissivity and hydraulic conductivity calculated from the pumping data for the various steps are 27.7 ft^2/day and 2.77 ft/day, respectively. The transmissivity and hydraulic conductivity calculated from the recovery data are 22.7 ft^2/day and 2.27 ft/day, respectively.

7.5.2.2 Well AC

Details of the analysis of the pumping and recovery phases of the step-drawdown test performed on Well AC are presented on Figures H-3 and H-4 in **Appendix G**, respectively. The average transmissivity and hydraulic conductivity calculated from the pumping data for the various steps are 12.6 ft^2/day and 1.26 ft/day, respectively. The transmissivity and hydraulic conductivity calculated from the recovery data are 1.67 ft^2/day and 0.17 ft/day, respectively.

7.5.2.3 Well AD

Details of the analysis of the pumping and recovery phases of the step-drawdown test performed on Well AD are presented on Figures H-5 and H-6 in **Appendix G**, respectively. The average transmissivity and hydraulic conductivity calculated from the pumping data for the various steps are 0.942 ft^2/day and 0.09 ft/day, respectively. The transmissivity and hydraulic conductivity calculated from the recovery data are 0.937 ft^2/day and 0.09 ft/day, respectively.

7.5.2.4 Well AI

Details of the analysis of the pumping and recovery phases of the step-drawdown test performed on Well AI are presented on Figures H-7 and H-8 in **Appendix G**, respectively. The average transmissivity and hydraulic conductivity calculated from the pumping data for the various steps are 7.97 ft^2/day and 0.80 ft/day, respectively. The transmissivity and hydraulic conductivity calculated from the recovery data are 2.10 ft^2/day and 0.21 ft/day, respectively.

7.5.2.5 Well AJ

Details of the analysis of the pumping and recovery phases of the step-drawdown test performed on Well AJ are presented on Figures H-9 and H-10 in **Appendix G**, respectively. The average transmissivity and hydraulic conductivity calculated from the pumping data for the various steps are 1.73 ft^2/day and 0.09 ft/day, respectively. The transmissivity and hydraulic conductivity calculated from the recovery data are 0.56 ft^2/day and 0.03 ft/day, respectively.

7.5.2.6 Well AM

Details of the analysis of the first portion of the pumping and recovery phases of the step-drawdown test performed on Well AM are presented on Figures H-11 and H-12 in **Appendix G**, respectively. The average transmissivity and hydraulic conductivity calculated from the pumping data for the various steps are 1.40 ft^2/day and 0.14 ft/day, respectively. The transmissivity and hydraulic conductivity calculated from the recovery data are 0.572 ft^2/day and 0.06 ft/day, respectively.

Details of the analysis of the second portion of the pumping and recovery phases of the step-drawdown test performed on Well AM are presented on Figures H-13 and H-14 in **Appendix G**, respectively. The transmissivity and hydraulic conductivity calculated from the pumping data are 1.08 ft^2/day and 0.11 ft/day, respectively. The transmissivity and hydraulic conductivity calculated from the recovery data are 0.338 ft^2/day and 0.03 ft/day, respectively.

7.5.2.7 Well S

Details of the analysis of the pumping and recovery phases of the constant-rate test performed on Well S are presented on Figures H-15 and H-16 in **Appendix G**, respectively. The transmissivity and hydraulic conductivity calculated from the pumping data are 1.70 ft^2/day and 0.17 ft/day, respectively. The transmissivity and hydraulic conductivity calculated from the recovery data are 1.10 ft^2/day and 0.11 ft/day, respectively.

8 Analytical Results

In accordance with the scope of work presented in the June 2003 RIWP and the RIWP Addendum, samples have been collected from various media at the Station to determine the magnitude and extent of the release of water from the Spent Fuel Pool. Soils samples were obtained during the installation of the monitoring wells, grab groundwater samples were collected at various depths using direct push methods, and groundwater samples were collected using low flow sampling methods from the Station monitoring wells. Throughout the investigation, samples were also collected from the Spent Fuel Pool, the telltale drains, and from the various sample locations established within the facility (see **Appendix A**). Collectively, the data indicate that water from the Spent Fuel Pool leaked behind the stainless-steel liner into the obstructed telltale drains, migrated through curing cracks in the structural concrete and accumulated in the Styrofoam-filled seismic gap. Once there, the Spent Fuel Pool water, for which there is a flowpath to foundation soils, seeped into the foundation soils along the southern side of the seismic gap. This release of Spent Fuel Pool water has resulted in an area of impacted groundwater extending from the south side of the seismic gap to the circulating water discharge pipes.

The water samples collected from within the facility indicated concentrations of tritium, boron, and various gamma-emitting isotopes typical of Spent Fuel Pool water. Groundwater samples collected from outside the facility, which were analyzed for the same suite of parameters, have indicated concentrations of tritium, boron, and one slightly elevated concentration of Tc-99 that suggest that water from the Spent Fuel Pool is the probable source. The data generated during the remedial investigation, both from within the facility and groundwater samples collected from the Station monitoring wells, indicate that the removal of the mineral deposits from the telltale drains has resulted in the proper operation of the leak detection, collection and monitoring system. Analytical results of water samples collected from the drill points established within the seismic gap (DP-1 and DP-2), which initially indicated that the water in the gap was mostly Spent Fuel Pool water, have indicated decreasing concentration trends of Spent Fuel Pool constituents. As presented in **Appendix B**, the most recent water samples collected from the seismic gap indicate that the water is approximately three-percent Spent Fuel Pool water.

Additional evidence that suggests that the hydraulic head created by the blockage in the telltale drains has been removed and that Spent Fuel Pool water is no longer migrating to the seismic gap is the concentration trend of tritium in groundwater samples collected from Well AC. This well, which is installed near the contact of the southern end of the seismic gap with foundation soils, has indicated the highest concentrations of tritium and boron in groundwater and is therefore considered the source area monitoring well. Groundwater samples collected from Well AC have indicated stable concentrations of tritium indicating that the source of the tritium has been removed. Future groundwater samples collected from Well AC should indicate a decreasing trend for tritium and boron concentrations.

As stated in Section 1.1, the telltale drains are routinely monitored to ensure that mineral deposits do not accumulate and result in an additional discharge of tritium and other constituents to the seismic gap. To further ensure that the seismic gap does not provide a pathway for the migration of constituents of concern to the environment, gap drains are currently being designed and will be installed to permit detection, sampling, and draining of water (both groundwater and water from other sources) that accumulates in the seismic gaps of both Salem Units 1 and 2. The water that accumulates in the seismic gaps will be characterized by Salem Chemistry and will be handled in accordance with Station procedures. Characterization samples collected from the seismic gap drains will provide an additional line of evidence to suggest that the corrective actions taken by PSEG Nuclear, LLC have resulted in the proper functioning of the telltale drains. The drain will also provide control for residual contamination within the Unit 1 seismic gap resulting from the accumulation of Spent Fuel Pool water by permitting controlled draining of the residual contamination.

The analytical results of soil and groundwater samples collected following the initiation of the remedial investigation are presented in the following sections. Radiation protection personnel screened soil samples obtained during the installation of the Station monitoring wells for gamma-emitting isotopes. Groundwater samples collected from the monitoring wells following installation were submitted to Salem Chemistry, Maplewood and the University of Rochester for various analyses. Collectively, the data generated during the investigation was evaluated to determine that the investigation objectives were meet. As discussed previously, the investigation objectives were to determine the source, the extent, and the risk associated with the tritium in groundwater.

8.1 Soil Samples

Salem Chemistry analyzed soil samples collected from the borehole cuttings of the Station monitoring wells for gamma-emitting isotopes to determine the appropriate disposal technique based on Station procedures. The soil samples were composite samples (one sample per drum) of cuttings obtained during the monitoring well installation and vacuum excavation activities. According to PSEG, soil samples were non-detect for plant related gamma-emitting isotopes, with the exception of one of the nine soil samples collected from the cuttings of Well T (PSEG, verbal communication 2004). Well T is located to the north of the Salem Generating Station. The plant related gamma-emitting isotope identified in the Well T cuttings is not related to the tritium investigation based on the distance and orientation from the area of concern. Gamma-emitting isotopes were not detected in the other well installation soil samples.

8.2 Groundwater Samples

A total of 29 monitoring wells have been installed at various locations surrounding the Station to delineate the extent of groundwater impacts from the release of water from the Spent Fuel Pool. Numerous water quality samples have been collected from the Station monitoring wells. The groundwater samples have been analyzed to assess natural geochemistry, as well as facility-related constituents. As presented in Section 6.5, groundwater samples were initially collected on a weekly basis; however, as the number of monitoring wells increased and the analytical history of the individual monitoring wells was established, the sampling program was modified. The current monitoring plan specifies either biweekly, monthly, or quarterly sampling based upon the analytical history of each well.

Groundwater samples were submitted to Maplewood and/or Salem Chemistry for analysis for tritium, major cations and anions (sodium and boron), and gamma-emitting isotopes. A summary of the analytical results obtained from Maplewood and Salem Chemistry is presented in **Table 12**, and the analytical results for tritium are shown on **Figure 13**. As presented in Section 5.2.5, a separate set of groundwater samples was collected to perform a one-time analysis for groundwater age determination (by tritium – helium-3 ratio), dissolved gases, and Tc-99. The research analytical laboratory at the University of Rochester performed these analyses. Analytical results obtained from the University of Rochester are provided in **Appendix H**.

Analytical results for the groundwater samples, which are discussed in the following sections, were evaluated based on the water-bearing zone in which the monitoring wells are screened. The three primary water-bearing units being investigated beneath the Station are: 1) the Vincentown Formation; 2) the shallow, water-bearing unit within the limits of the cofferdam; and, 3) the shallow, water-bearing unit outside of the limits of the cofferdam.

8.2.1 Summary of Analytical Data for Wells Screened in the Vincentown Formation (Wells L, K, P, Q, and V)

With the exception of Wells K and V, analytical results of groundwater samples collected from monitoring wells screened in the Vincentown Formation do not indicate concentrations of tritium above regional background concentrations. Analytical results of groundwater samples collected from Wells K and V indicate tritium concentrations between 185 pCi/L and 1,200 pCi/L, which may be a result of tritiated water from Station activities 20 years ago that recharged to the aquifer. Analytical results of the groundwater samples obtained from the Vincentown Formation indicate concentrations of Tc-99 (0.8 pCi/L) consistent with the ambient abundance of this constituent in precipitation in the 1970s. Plant-related gamma-emitting isotopes have not been detected in groundwater samples collected from the monitoring wells screened in the Vincentown Formation. Based on groundwater flow directions and dissolved methane concentrations detected in the groundwater samples, recharge to the Vincentown Formation is likely to occur from areas north and east of the plant. The following bullets provide an evaluation of the analytical results for the individual monitoring wells screened in the Vincentown Formation.

- **Well K** – Tritium has not been detected in groundwater samples collected from Well K at concentrations above the further investigation criterion (3,000 pCi/L). A trend graph of tritium concentrations is presented on Figure I-1, in **Appendix I**. Analytical results of groundwater samples collected from Well K consistently indicate tritium concentrations between 500 and 1,200 pCi/L. The groundwater age investigation (**Appendix H**) of Well K indicates that tritiated water recharged at about 3,000 to 5,000 pCi/L approximately 19 years ago and has traveled to the upper part of the Vincentown Formation. The most likely source for this recharge is east of Well K. The level of Tc-99 is 0.8 pCi/L, consistent with post-nuclear background for the eastern United States 25 years ago.

- **Well L** – Tritium has not been detected in groundwater samples collected from Well L at concentrations above the further investigation criterion (3,000 pCi/L). Analytical results from Maplewood for groundwater samples collected from Well L are below the laboratory detection limit. Results from the University of Rochester indicate a tritium concentration of 45 pCi/L. The groundwater age analysis indicates that the water at Well L recharged about 21 years ago consistent with local precipitation 20 to 25 years ago. Groundwater at Well L is approximately the same age as groundwater at Well K, consistent with recharge that occurred 20 years ago. The absence of tritium above the laboratory detection limit suggests that there is no major pathway for tritiated water into the Vincentown Formation.

- **Well P** – Tritium has not been detected in groundwater samples collected from Well P at concentrations above the further investigation criterion (3,000 pCi/L). Analytical results from Maplewood for groundwater samples collected from Well P indicate tritium concentrations between 465 pCi/L and the laboratory detection limit. Results from the University of Rochester measured 58 pCi/L with a groundwater age of about 13 years. Well P is located downgradient, south of Salem Unit 1.

- **Well Q** – Tritium has not been detected in groundwater samples collected from Well Q at concentrations above the further investigation criteria (3,000 pCi/L). Analytical results from Maplewood for groundwater samples collected from Well Q are all below the laboratory detection limit. Low-level tritium analysis performed at the University of Rochester indicates a tritium concentration of 1.5 pCi/L, which is typical of precipitation that recharges prior to the onset of the nuclear era (ca. 1950). Elevated levels of dissolved methane in Well Q at 38 cc/kg (1.7mmol/kg) and less than solubility levels for argon and nitrogen indicate the point of recharge to be within the marshes that border the plant to the east.

- **Well V** – Tritium has not been detected in groundwater samples collected from Well V at concentrations above the further investigation criterion (3,000 pCi/L). A trend graph of tritium concentrations is presented on Figure I-8, in **Appendix I**. Analytical results from Maplewood for groundwater samples collected from Well V indicate tritium concentrations between 185 pCi/L and 549 pCi/L. Laboratory analyses from the University of Rochester were 549 pCi/L. Groundwater age dating indicates the local groundwater in Well V is 15.4 years old. Groundwater samples collected from this well indicated a dissolved methane concentration of 15.4 cc/kg methane and dissolved neon and argon concentrations below atmospheric solubility, indicating recharge from the marshes to the east.

8.2.2 Summary of Analytical Data for Wells Screened in the Shallow, Water Bearing Unit Within the Limits of the Cofferdam (Wells M, N, O, R, AC, and AE)

Analytical results of the groundwater samples indicate that tritium has been detected above 3,000 pCi/L (the Interim Further Investigation Criterion for Tritium) in groundwater samples collected from Monitoring Wells M, N, O, AC, AE and R installed within the limits of the cofferdam. Analytical results of groundwater samples collected from Well M, N, and AC have indicated concentrations of tritium above the further action criteria of 20,000 pCi/L. While they indicate elevated concentrations of tritium, they do not indicate elevated levels of plant related gamma-emitting isotopes or Tc-99. Tritium concentrations have been steady throughout the period of investigation, consistent with the hypothesis that draining of the seismic gap and the unplugging of the telltale drains has stopped the further migration of Spent Fuel Pool water out of the seismic gap. Tc-99 has been detected between 0.2 to 0.7 pCi/L, consistent with background concentrations.

- **Well M** – Prior to the replacement of Well M in May 2003, tritium concentrations detected in groundwater samples collected from Well M indicated a steady decrease in concentrations from 18,700 pCi/L on February 12, 2003 to 8,800 pCi/L on April 30, 2003. This well was replaced to conform to New Jersey well construction requirements with the new screen interval a few feet deeper than the original; the well was drilled to refusal. The analytical results of groundwater samples collected from the replacement well were initially 126,000 pCi/L, and have steadily declined to 11,400 pCi/L. Current concentrations are consistent with concentrations measured before the well was replaced. A trend graph of tritium concentrations is presented on Figure I-2, in **Appendix I**. The groundwater age dating indicates the water became isolated from the atmosphere less than 0.1years ago. Boron concentrations in Well M are between 0.222 mg/L and 0.320 mg/L, consistent with background for Artificial Island. The Tc-99 concentration for this well is 0.5 pCi/L, also consistent with background.

- **Well N** – Initial groundwater samples collected from Well N indicated concentrations of tritium above the further action criteria for tritium (20,000 pCi/L). A groundwater sample collected from Well N on January 30, 2003 indicated a concentration of tritium of 69,000 pCi/L. Concentrations detected in groundwater samples collected from Well N have declined steadily in subsequent monitoring to 6,460 pCi/L. A trend graph of tritium concentrations is presented on Figure I-3, in **Appendix I.** Boron concentrations are between 0.197 and 0.409 mg/L consistent with background levels for Artificial Island. Groundwater age dating suggests an age of about 1 year. The Tc-99 concentration in this well is 0.4 pCi/L, near the background value of 0.5 pCi/liter.

- **Well O** – Analytical results of groundwater samples collected from Well O have consistently indicated concentrations of tritium above the further investigation criterion (3,000 pCi/L) during 2003. Analytical results of groundwater samples collected from Well O by Maplewood indicate tritium concentrations between 1,220 and 13,400 pCi/L. A trend graph of tritium concentrations is presented on Figure I-4, in **Appendix I.** Concentration fluctuations have stabilized and are approximately 7,000 pCi/L. Boron concentrations have ranged from 0.071 and 0.305 mg/L consistent with background levels for Artificial Island. Groundwater age dating indicates the water is 0.22 years old. The Tc-99 concentration in this well is 0.2 pCi/L, near the background value of 0.5 pCi/liter.

- **Well R** – Analytical results of groundwater samples collected from Well R have detected concentrations of tritium at or above the further investigation criterion (3,000 pCi/L). Tritium concentrations have steadily decreased from 13,900 pCi/L on February 26, 2003 to 2,550 pCi/L on December 12, 2003. A trend graph of tritium concentrations is presented on Figure I-5, in **Appendix I.** Groundwater age dating results suggest an age of about 1.2 years. Boron concentrations have ranged from 0.229 and 0.511 mg/L consistent with background levels for Artificial Island. The Tc-99 concentration in this well is 0.4 pCi/L, near the background value of 0.5 pCi/liter.

- **Well AC** – Analytical results of groundwater samples collected from Well AC have indicated the highest concentrations of tritium in Site monitoring wells (15,000,000 pCi/L). Tritium concentrations have ranged from 10,700,000 pCi/L and 15,000,000 pCi/L. A trend graph of tritium concentrations is presented on Figure I-13, in **Appendix I.** Groundwater age dating and Tc-99 analysis have not been completed in this well because of the high levels of tritium. The boron concentration was measured between 253 mg/L and 332 mg/L. Comparison of tritium concentrations in Well AC to the Spent Fuel Pool indicates local groundwater is 5.5 to 7.5 percent Spent Fuel Pool. Comparison of the boron concentrations in Well AC to Spent Fuel Pool indicates that local groundwater is between 11 and 15 percent Spent Fuel Pool water. The difference in the percentages of Spent Fuel Pool water indicates either a 50% degradation in tritium (the water is about 12 years old) or that the plume is stratified across the well screen. Given the close proximity of Well AC to the seismic gap, the most likely interpretation is that the plume is stratified.

- **Well AE** – Analytical results of groundwater samples collected from Well AE have detected concentrations of tritium at or above the further investigation criterion (3,000 pCi/L). Tritium concentrations have ranged from 5,990 pCi/L to 16,100 pCi/L. A trend graph of tritium concentrations is presented on Figure I-15, in **Appendix I**. Groundwater age dating results suggest an age of about 0.33 years. The boron concentration was measured at 0.234 mg/L consistent with background levels for Artificial Island. The Tc-99 concentration in this well is 0.7 pCi/L, near the background value of 0.5 pCi/liter.

8.2.3 Summary of Analytical Data for Wells Screened in the Shallow, Water-Bearing Unit Outside of the Cofferdam (Wells S, T, U, V, W, Y, Z, AA, AB, AD, and AF)

The wells installed in the shallow, water-bearing unit outside of the limits of the cofferdam are screened either just above the Kirkwood Formation, or in the interval indicating the highest tritium concentrations during the Supplemental Investigation. The samples indicate that tritium has been detected above 3,000 pCi/L (the Interim Further Investigation Criterion for Tritium) in Wells S, W, AB, and AD. Wells S, AB, and AD also have indicated concentrations of tritium above the further action criteria of 20,000 pCi/L. Groundwater samples collected from these monitoring wells did not indicate concentrations of plant-related gamma-emitting isotopes. Groundwater samples collected from Well W indicated a concentration of Tc-99 above background for Artificial Island. When analyzed, there are elevated levels of boron where tritium is greater than 20,000 pCi/L. Consistent with conditions inside the cofferdam, tritium concentrations have been steady throughout the period of investigation. Tc-99 has been detected between 0.2 and 4.1 pCi/L, consistent with background concentrations or slightly higher in the groundwater sample from Well W.

- **Well S** – Groundwater samples collected from Well S detected concentrations of tritium above the further action criteria for tritium (20,000 pCi/L). Concentrations of tritium in Well S have ranged from 1,420,000 to 3,530,000 pCi/L with a declining trend over the period of investigation. A trend graph of tritium concentrations is presented on Figure I-6, in **Appendix I**. Boron concentration has been sampled once at 57.4 mg/L, indicating Spent Fuel Pool water. Comparing tritium concentrations in local groundwater to SFP indicate 0.7% to 1.7% Spent

Fuel Pool water. The boron sample indicates a composition of about 2.5% Spent Fuel Pool water. This reduced tritium concentration indicates an age of approximately 6.9 years. Groundwater age dating comparing helium to tritium ratios suggests an age of about 0.7 years. No plant related gamma-emitting isotopes have been detected in Well S. The Tc-99 concentration in this well is 0.5 pCi/L, equal to the background value. Groundwater samples collected from Well S were also analyzed for strontium-89 and strontium-90. Analytical results of these groundwater samples did not indicate concentrations of these constituents above the laboratory detection limit.

- **Well T** – Groundwater samples collected from Well T have been below the further investigation criteria for tritium (3,000 pCi/L). All samples sent to Maplewood were non-detect for tritium while the one sample sent to the University of Rochester detected 257 pCi/L. Boron concentrations ranged from 0.601 mg/L to 0.680 mg/L consistent with background levels for Artificial Island. Groundwater age dating suggests an age of about 1.6 years. No plant related gamma-emitting isotopes have been detected in Well T. The Tc-99 concentration in this well is 0.7 pCi/L, slightly above the background value of 0.5 pCi/L.

- **Well U** – Groundwater samples collected from Well U been below the further investigation criterion for tritium (3,000 pCi/L). Tritium results from samples sent to Maplewood ranged from non-detect to 203 pCi/L while the one sample sent to the University of Rochester detected 78 pCi/L. A trend graph of tritium concentrations is presented on Figure I-7, in **Appendix I**. Boron concentrations ranged from 0.341 mg/L to 0.421 mg/L consistent with background for Artificial Island. Groundwater age dating suggests an age of about 4.1 years. No plant related gamma-emitting isotopes have been detected in Well U. The Tc-99 concentration in this well is 0.5 pCi/L, equal to the background value.

- **Well W** – Groundwater samples collected from Well W have been above the further investigation criterion for tritium (3,000 pCi/L). Tritium results from samples ranged from 6,010 pCi/L to 15,500 pCi/L. The one sample sent to the University of Rochester detected 13,062 pCi/L. A trend graph of tritium concentrations is presented on Figure I-9, in **Appendix I**. Boron concentrations range from 0.464 mg/L to 0.591 mg/L consistent with background levels for Artificial Island. The groundwater age determination for a groundwater sample collected in July 2003 had a significant uncertainty likely related to the monitoring well installation. The groundwater age determination for a groundwater sample collected in November 2003 indicated an age of 4.1 years. No plant related gamma-emitting isotopes have been detected in Well U. The Tc-99 concentration in this well is 4.1 pCi/L, slightly above the expected background value.

- **Well Y** – Groundwater samples collected from Well Y have been below the further investigation criterion for tritium (3,000 pCi/L). Tritium results from samples sent to Maplewood have been non-detect. The boron concentration was measured at 0.822 mg/L, consistent with background levels for Artificial Island. The well was not sampled for groundwater age dating or Tc-99. No plant related gamma-emitting isotopes have been detected in Well Y.

- **Well Z** – Groundwater samples collected from Well Z have been below the further investigation criterion for tritium (3,000 pCi/L). Tritium results from samples sent to Maplewood ranged from non-detect to 729 pCi/L while the one sample sent to the University of Rochester detected 729 pCi/L. A trend graph of tritium concentrations is presented on Figure I-10, in **Appendix I**. The boron concentration was 0.498 mg/L, which is consistent with the background level for Artificial Island. Groundwater age dating suggests an age of about 3.2 years. No plant related gamma-emitting isotopes have been detected in Well U. The Tc-99 concentration of the groundwater sample collected from this well is 0.4 pCi/L, slightly below the background value of 0.5 pCi/L.

- **Well AA** – Tritium concentrations in groundwater samples collected from Monitoring Well AA have been below the further investigation criterion for tritium (3,000 pCi/L). Tritium results from samples sent to Maplewood ranged from 613 pCi/L to 785 pCi/L while the one sample sent to the University of Rochester detected 734 pCi/L. A trend graph of tritium concentrations is presented on Figure I-11, in **Appendix I**. The boron concentration was 0.247 mg/L, which is consistent with the background level for Artificial Island. Groundwater age dating suggests an age of about 2.1 years. No plant related gamma-emitting isotopes have been detected in Well AA. The Tc-99 concentration of the groundwater sample collected from this well is 0.5 pCi/L, equal to the background value.

- **Well AB** – Groundwater samples collected from Well AB detected concentrations of tritium above the further action criterion for tritium (20,000 pCi/L). Concentrations of tritium detected in groundwater samples collected from Well AB have ranged from 280,000 to 409,000 pCi/L. A trend graph of tritium concentrations is presented on Figure I-12, in **Appendix I**. Boron analysis has not been performed on groundwater samples collected from this well due to elevated tritium results. Comparing tritium concentrations in local groundwater to Spent Fuel Pool indicate that the groundwater is 0.14% to 0.20% Spent Fuel Pool water. Groundwater age dating suggests an age of about 1.38 years. No plant related gamma-emitting isotopes have been detected in Well AB. The Tc-99 concentration in the groundwater sample collected from this well is 0.4 pCi/L, slightly below the background value of 0.5 pCi/L.

- **Well AD** – Groundwater samples collected from Well AD detected concentrations of tritium above the further action criterion for tritium (20,000 pCi/L). Concentrations of tritium detected in groundwater samples collected from Well AD have ranged from 220,000 to 487,000 pCi/L. A trend graph of tritium concentrations is presented on Figure I-1, in **Appendix I**. Boron analysis has not been performed on groundwater samples collected from this well due to elevated tritium results. Comparing tritium concentrations in local groundwater to Spent Fuel Pool indicates that 0.11% to 0.24% of the ground water is Spent Fuel Pool water. Water samples from this well were not analyzed for age dating or Tc-99. No plant related gamma-emitting isotopes have been detected in Well AD.

- **Well AF** – Groundwater samples collected from Well AF did not detect tritium concentrations above the further investigation criterion for tritium (3,000 pCi/L). Concentrations in Well AF have ranged from non-detect to 330 pCi/L. The analytical results of the low-level tritium analysis performed at the University of Rochester indicated a tritium concentration of 245 pCi/L. The groundwater age determination for the sample collected from Well AF indicates an age of approximately 10 years. A trend graph of tritium concentrations is presented on Figure I-14, in **Appendix I**. Boron has been detected at concentrations between 0.380 mg/L and 0.429 mg/L consistent with background levels for Artificial Island. The Tc-99 concentration detected in the groundwater sample collected in this well is consistent with regional background concentrations. No plant related gamma-emitting isotopes have been detected in Well AF.

8.3 Delaware River Tritium Concentrations

Based on the analytical results of groundwater samples collected from the monitoring wells placed near the Station boundary with the Delaware River, the tritium detected in the shallow, water-bearing unit is not releasing to the Delaware River at concentrations that could violate any exiting standard.

A groundwater model is being developed that will provide a quantitative assurance that the tritium in the shallow, water-bearing unit will continue to meet all off-site regulatory standards for tritium. Sampling and analysis of the Delaware River in the vicinity of Salem is routinely conducted and reported under the Radiological Environmental Monitoring Program ("REMP"). A surface water sampling program was evaluated and determined to be impracticable. The tritium contamination in the shallow, water-bearing unit would not be expected to be discernable in the Delaware River even if a release occurred because:

1. Based on the location and extent of the plume as determined by site sampling, tritium concentrations from the shallow, water-bearing unit would not be detected in the Delaware River;

2. The ambient tritium levels fluctuate in the environment as shown in the historical Radiological Environmental Monitoring Reports (RERRs) submitted annually. There is no viable method of distinguishing low level ambient tritium in the Delaware River from any shallow, water-bearing unit discharge;

3. The volume, velocity, and bi-directional tidal flow of the Delaware River prevent making generalizations regarding the transport of tritium in the river and distinguishing between potential sources including routine permitted discharges; and,

4. Analyses conducted on shallow, water-bearing unit show the only facility related parameter to be tritium; no plant related gamma emitters have been detected. Therefore, there are no "tracer" parameters that can be used to define the source of any tritium detected; and,

5. Delaware River sediment sampling would not provide any useful data regarding a potential release of tritium from the shallow, water-bearing unit as tritium is water and will not adsorb to soil or sediment.

Based on these evaluations, no sampling of the Delaware River water or sediment for tritium has been conducted for this remedial investigation. A mathematical model of the potential concentrations in the Delaware River will be developed to provide the information for adapting the remedial action plan to ensure there is no release to the Delaware River above a regulatory standard as well as validating that there is no significant impact to the environment. The model will serve as the basis for evaluating tritium mass flux to the Delaware River and to assess remedial system performance.

The groundwater flow model will be constructed using the computer program MODFLOW, a publicly available groundwater flow simulation program developed by the USGS. MODFLOW is thoroughly documented, widely used by consultants, government agencies and researchers, and is consistently accepted in regulatory proceedings. The hydrogeologic studies conducted and samples collected for the tritium investigation will be used to define model parameters.

A solute transport model will be used to simulate the movement of tritium considering the processes advection, dispersion, and radioactive decay. The solute transport modeling will be performed using MT3D, a three-dimensional solute transport program developed by the US Environmental Protection Agency. MT3D is used in conjunction with MODFLOW, thereby providing a seamless transition from the groundwater flow model to the solute transport modeling. Similar to MODFLOW, MT3D is thoroughly documented and routinely used in regulatory proceeding.

9 Fate and Transport Analysis

Shallow groundwater in the vicinity of the Station has been impacted by a release of water from the Spent Fuel Pool. The pathway from the building to the environment cannot be documented with absolute certainty; however, site evidence indicates the seismic gap between the Salem Unit 1 Fuel Handling Building and Auxiliary Building is the primary release point. The origin of the water in the seismic gap is the Spent Fuel Pool and the pathway from the Spent Fuel Pool is discussed in Section 5. This release has resulted in a plume of boron and tritium extending south-southwest from this point-of-origin as shown on Figure 13; no other contaminates of significance have been detected in the affected area. The fate and transport of this plume is assessed in this section to determine flow pathways and the rate of migration.

Quantification of solute migration requires specification of various transport parameters and processes that control the rate, movement, mixing, sorption, and degradation of a contaminant in the subsurface. Advection defines the process of contaminant migration due to the movement of groundwater. Dispersion accounts for the spreading and mixing of the constituent due to heterogeneities and non-ideal flow paths in the soil that cause variations in the groundwater velocity as well as Fickian diffusion driven by concentration gradients. Sorption refers to the partitioning of a contaminant between the liquid and solid phases of the aquifer. Degradation is the mass decay of a contaminant as a result of physical, chemical, and biological activity within the aquifer. Each of these processes and their effect on the movement of site related constituents along flow pathways are summarized in the following sections.

9.1 Constituent Pathways – Advective Water Movement

Water-level measurements taken in monitoring wells distributed spatially across the site and distributed within several depth intervals provide the necessary information to describe the direction of groundwater movement. These water-level measurements are combined with effective porosity and hydraulic conductivity measurements to determine the rate or speed of groundwater movement. In general, water-level measurements are used to define the slope of the water table (gradient) and direction of movement; groundwater moves down the slope or gradient from high water table elevations to lower water table elevations. Water level elevations, hydraulic gradients, and groundwater flow directions for the shallow, water-bearing unit are presented on **Figure 14**. Based upon both water levels and constituent concentrations, the primary flow pathways are away from the seismic gap toward the south-southwest. Along individual flow paths there is a decrease in both water-level elevations and concentrations of isotopes of interest.

The movement of a solute with the groundwater, or advective transport, can be computed using Darcy's Law. Darcy's Law is written as follows:

$$q = K i \qquad (1)$$

where, q is the Darcian flux (ft^3/day/ft^2 or ft/day), K is the hydraulic conductivity (ft/day), and i is the hydraulic gradient (ft/ft). Aquifer testing at the Site (Section 7.5) has determined that the mean hydraulic conductivity of the soils affected by tritium to be approximately 0.4 ft/day. The average hydraulic gradients are approximately 0.008 ft/ft and 0.004 ft/ft inside and outside the cofferdam, respectively. Therefore, the specific discharge of groundwater inside and outside the cofferdam is 0.0032 ft/day and 0.0016 ft/day, respectively. Since water can only move through the pore spaces, these values are not the velocities at which groundwater is moving. The average linear velocity of groundwater is higher as water moves only through the voids or pore spaces of the soil:

$$v = {}^{q}\!/_{\theta_e} \qquad (2)$$

where v is the velocity (ft/day) and θ_e is the effective porosity (ft^3/ft^3). The effective porosity for the unconsolidated sediments at the site was assumed to be 0.20. This value is consistent with estimates developed by the USEPA (1989) that indicate most medium to coarse-grained soils (Unified Soil Classification System textural groups GW, GP, GM, GC, SW, SP, SM, and SC) have an effective porosity of approximately 0.2. The groundwater velocity inside and outside the cofferdam computed from the average flow rates and an effective porosity of 0.2, are 5.8 ft/yr (0.0032/0.2*365) and 2.9 ft/yr (0.0016/0.2*365), respectively. Applying the higher of these velocities over the groundwater pathway between the seismic gap and the 500,000 pCi/L contour, indicates the plume is 31 years old. This travel time or age of the tritium plume is inconsistent with facility data, other observed, modeled, and calculated data, and it is longer than the facility has been in operation. These slow travel velocities indicate that the hydraulic conductivity value from the pumping tests are biased low; the use of drawdown data in the pumping well as the only observation point for each test precludes assessment of well efficiency which increase drawdown in the pumping well. The pumping test data and analysis did provide accurate information concerning sustained yield for the design of a groundwater containment system.

9.2 Water Balance Estimate of Groundwater Velocities

To assess this discrepancy and develop a better estimate of groundwater velocities and travel times, an alternative method based upon continuity and a water balance approach, was used to estimate the hydraulic conductivity and groundwater velocities. The plume and the impacted groundwater are located in a hydrologically isolated portion of the facility; the source for all of the groundwater within the plume, originates from within the plume. Therefore, if we know how much water is moving along a flow path (the recharge rate), the length of the flow path (seismic gap to the 500,000 pCi/L isopleth), the saturated thickness of the aquifer (about 15 feet within the cofferdam and 35 feet outside the cofferdam), and hydraulic gradient (the water table slope is 0.008 inside the cofferdam and 0.004 outside the cofferdam), an effective or mean hydraulic conductivity can be computed.

Figure 18 illustrates the idealized flow path from the seismic gap to the 500,000 pCi/L isopleth. The total flow per unit width at a point along this pathline is:

$$q' = K\,i\,b \qquad (3)$$

where b is the saturated aquifer thickness. Equation (3) is also equal to the cumulative recharge upgradient from a point where (3) is applied:

$$q' = L\,N \qquad (4)$$

where N is the recharge and L is the upgradient flow path length. Recharge or percolation is the flux to the water table; a portion of precipitation impacts the land surface, a portion runs off, the remainder infiltrates into the groundwater, and the fraction that infiltrates which does not become evapotranspiration is recharge. The total length of a flow path from the seismic gap to the 500,000 pCi/L isopleth is approximately 186 feet, 102 feet from the seismic gap to the limit of the cofferdam (section 1), with an additional 84 feet from the limit of the cofferdam to the 500,000 pCi/L contour (section 2). If we equate equations (3) and (4), assume a recharge rate of 8 in/year, and apply them to section 1 of the flowpath on **Figure 18**, we can write the following:

$$K_1\,i_1\,b_1 = L_1\,N$$

$$K_1 \times 0.008\,{}^{ft}\!/_{ft} \times 15\,ft = 102\,ft \times 0.67\,{}^{ft}\!/_{yr}$$

$$K_1 = \frac{102 \times 0.67}{0.008 \times 15} = 570\,{}^{ft}\!/_{yr} \text{ or } 1.6\,{}^{ft}\!/_{day}$$

In summary, if the percolation rate is approximately 8 in/yr, the effective hydraulic conductivity of the saturated soils above the cofferdam is about 1.6 ft/day. Similarly, if the recharge rate were 16 in/yr, the effective hydraulic conductivity of the saturated soils above the cofferdam would be double or about 3.2 ft/day.

Repeating these calculations for Section 2 of the flowpath on **Figure 18**, and noting that the total amount of water through this section also includes the flow through section 1, we can write the following:

$$K_2\,i_2\,b_2 = L_1\,N + L_2\,N = N\left(L_1 + L_2\right)$$

$$K_2 \times 0.004 \, {}^{ft}\!/_{ft} \times 35\,ft = 0.67 \, {}^{ft}\!/_{yr} (102\,ft + 84\,ft)$$

$$K_2 = \frac{186 \times 0.67}{0.004 \times 35} = 890 \, {}^{ft}\!/_{yr} \; or \; 2.4 \, {}^{ft}\!/_{day}$$

In summary, if the percolation rate is approximately 8 in/yr, the effective hydraulic conductivity of the saturated soils outside the cofferdam is about 2.4 ft/day. Similarly, if the recharge rate were 16 in/yr, the effective hydraulic conductivity of the saturated soils outside the cofferdam would be double or 4.8 ft/day.

Consistent with Section 9.1 above, groundwater velocities were computed using these alternative hydraulic conductivity values developed using equations (3) and (4). The groundwater velocity inside and outside the cofferdam computed from the average hydraulic gradients, an effective porosity of 0.2, and a recharge rate of 8 in/yr are 23.4 ft/yr (1.6*0.008/0.2*365) and 17.5 ft/yr (2.4*0.004/0.2*365), respectively. Similarly, if the recharge rate were 16 in/yr, then the groundwater velocity inside and outside the cofferdam would be 46.7 ft/yr (3.2*0.008/0.2*365) and 35.0 ft/yr (4.8*0.004/0.2*365), respectively. Applying these velocities over the groundwater pathway between the seismic gap and the 500,000 pCi/L contour, the plume is between 4.6 and 9.2 years old. This estimated age of the tritium plume is consistent with general hydrogeologic conditions and available facility operation records, and groundwater age results.

9.3 Sorptive Processes

The term sorption refers to the removal of a solute from solution through association with a solid surface. This attraction between a soil surface and a solute can result from a number of forces. The effects of these forces or processes are commonly described by sorption isotherms. These isotherms assume that when a solution contacts a solid, the solute will tend to transfer from liquid to solid until the concentration of solute in solution is in equilibrium with the soil concentration. These processes, especially for inorganic compounds, tend to be pH dependent, not always completely irreversible, and site specific. With respect to the constituents found in groundwater at the Salem site, this process has no effect on the movement of tritiated water and only a minor effect on the movement of boron; however, this process is important to understanding why the other dissolved constituents identified in the seismic gap have not been found in Site monitoring wells.

Table 1 summarizes the complete list of constituents found in the Spent Fuel Pool and potentially in the seismic gap and adjacent groundwater as well as their sorptive characteristics to soil. Columns 4 and 5 summarize the range in literature reported distribution coefficients. The distribution coefficient (K_d) is defined as follows:

$$K_d = \frac{Soil\,Concentration}{Dissolved\,Concentration} \qquad (5)$$

Therefore, the higher the distribution coefficient, the more strongly a constituent will stick (i.e., adsorb and absorb) to soils. The range in values reported in **Table 1** is most strongly correlated to pH and amount of clay or fines in site soils. Solutes dissolved in low pH water in soils without fine materials will tend to adsorb to soils and have K_d in the lower reported range. Solutes dissolved in neutral pH water (consistent with site conditions) with a quantifiable fraction of fine sediments (the site soils have a minimum of 5% silt and clay) will tend not to adsorb to soils and have K_d in the lower reported range. This process of exchange and interaction between solute and soil will also cause solutes to move slower than the groundwater. This ratio of the groundwater velocity to the solute velocity is caused the retardation factor. The retardation factor can be computed from the distribution coefficient using the following equation:

$$R_f = 1 + \frac{\rho_b K_d}{\theta_e} \qquad (6)$$

where ρ_b is the bulk density. Gamma emitting isotopes are absent from site monitoring wells because they have adsorbed to soils near the seismic gap and are moving at only a fraction of the speed of the tritium and boron.

9.4 Degradation

With the exception of boron, all site related constituents degrade. **Table 1** summarizes the half-lives for each constituent.

9.5 Dispersion

Dispersion is the process whereby contaminants spread over a greater region than would be predicted solely from the average linear groundwater velocity. Dispersion occurs at multiple scales. The primary cause of dispersion is variations in groundwater velocity, on a microscale by variations in pore size and on a macroscale by variations in hydraulic conductivity. The hydrodynamic dispersion tensor is complex. For isotropic media, the dispersion coefficient written to incorporate molecular diffusion (described by Fick's Law), is calculated as follows:

$$D_c = \alpha_d v + D \qquad (7)$$

where D_c is the dispersion coefficient $[L^2/T]$, α_d is the dispersivity [L], v is the groundwater velocity [L/T], and D the molecular diffusion coefficient $[L^2/T]$.

While the general process of dispersion is understood, the dispersivity of a formation is not easily measured or quantified at the field scale. Therefore, as dispersion is related to porewater velocities, plume travel distance is the single most important factor that can be correlated to dispersivity. This general relationship is best illustrated in a figure developed by Gelhar et al. (1992). If we consider Figure 19, the scale of the plume is about 180 ft (60 m), which corresponds to a longitudinal dispersivity of approximately 3.3 m. The groundwater velocity is about 9 m/yr, and molecular diffusion for most common ions is on the order of $2x10^{-9}$ m^2/s (or 0.0631 m^2/yr). Substituting these values into equation (7), yields:

$$D_c = 3.3m \times 9 {}^{m}\!/_{yr} + 0.0631 {}^{m^2}\!/_{yr}$$

$$D_c = 29.7 {}^{m^2}\!/_{yr} + 0.0631 {}^{m^2}\!/_{yr}$$

Comparison of the above two terms, indicates that movement of the primary constituents at the site (tritium and boron) is primarily an advectively driven process as the first term is approximately 500 times larger than the second. The site data also reflects this, with slightly elevated levels of tritium extending approximately 75 feet downgradient of the leading edge of the center of mass of the plume.

9.6 Tritium Age Dating and Groundwater Travel Time

The most effective use of groundwater age dating in transport analyses is in the determination of the vertical component of groundwater velocity and the recharge rate to the aquifer. The shallow wells inside of the cofferdam (Wells N, O, M, and AE) have effectively "zero tritium-^{3}He ages" because of the shallow depth of the wells below the water table, the screened interval's exposure to air (i.e., interval above the water table) and the introduction of atmospheric gases during monitoring well installation activities. The wells outside of the cofferdams (Wells S, AA, and AB) that are directly downgradient from the seismic gap have ages from which one can estimate recharge. For Well S, the calculation of age determination has tritium moving over the top of the cofferdam (at –13 feet and zero tritium-^{3}He age) to the mid-point of the screened interval at S (-18 feet) or 5 vertical feet in 0.7 years (7 +/- 2 feet/yr). This change in vertical elevation for the tritium plume is equivalent to a recharge of 16 in/yr (assumes a porosity of 0.2). A similar calculation for Well AB, as the plume moves from –13 feet at the cofferdam to –23 feet at the well, yields a recharge rate of 17 in/yr (vertical movement of 10 feet in 1.4 years). A similar calculation can be made for Well AA. Because AA is not tritium contaminated, the flow line did not originate at the lean concrete at the top of the cofferdam but rather at the seasonally low water table in the vicinity of well S. The "clock" for this age system is not set until approximately 3 feet below the water table. Thus, we have the flow from –3 feet to –18 feet (mid-point of screen) in 2.1 years or 7 feet/yr, equal to 16 in/yr of recharge. The agreement in recharge estimates for the three wells is somewhat fortuitous but it can reasonably be characterized as 16 +/- 4 in/yr or about 40% of annual precipitation. This estimate of 40% is consistent with other flow systems that have limited evapotransporation (i.e., no grass or trees). Other wells that are screened at the 35-foot level (Wells Z, U, T, and W) have ages of about 3 to 4 years for 20-25 feet of vertical travel, equal to a vertical velocity of 6 to 8 feet/yr. The recharge estimate can then be used in the water balance calculation (Section 9.2) to estimate horizontal transport. The calculations based on groundwater ages agree with the estimates based on the physical properties of the structural fill (e.g., aquifer pumping tests) and water balance calculations.

10 Health and Environmental Risk Assessment

The principal radionuclide of concern for this remedial investigation is tritium in shallow groundwater adjacent to Salem Generating Station Unit 1. To date, a completed exposure pathway to humans from tritium in shallow groundwater has not been established, nor is there any evidence that significant exposures of biota have occurred. However, since the remedial investigation is continuing, there is a still a possibility that findings might indicate that significant amounts of tritium have migrated to off-site locations, or could be expected to do so, under certain conditions. Therefore, there should be a conceptual approach that outlines the methodology that will be followed in assessing potential impacts on human health and the environment from any such occurrence. This conceptual approach is presented in Section 6.3, following brief discussions of on-site and off-site environmental data for tritium.

10.1 On-Site Environmental Data for Tritium

Concentrations of tritium in groundwater samples taken over time from monitoring wells on the Salem Site provide the most important data set for characterizing the inventory of tritium that could potentially migrate to off-site locations. If transport from shallow groundwater to off-site locations were observed or assumed to occur, data from monitoring wells would be used as input to an analysis of environmental transport to locations where humans or biota could be exposed. Data on concentrations over time at various on-site locations could be used to calibrate a dynamic environmental transport model to project future releases. Knowledge of the age of tritium in on-site environmental samples is needed to determine if releases occurred many years ago or are recent and, perhaps, continuing at the present time.

10.2 Off-Site Environmental Data for Tritium

The program of off-site environmental monitoring at the Salem Station has not detected tritium in environmental media or biota at concentrations above the lower limit of detection in routine sampling procedures. Routine off-site environmental monitoring data will continue to be examined for indications that tritium in shallow groundwater at the Salem Station has migrated beyond the Station boundary.

In evaluating environmental monitoring data, it is important to recognize that all environmental media and living organisms contain low levels of tritium from two sources that are unrelated to operations at the Salem Station: (1) naturally occurring tritium that is continually produced by interactions of cosmic radiation with constituents of the earth's atmosphere, and (2) tritium that was injected into the atmosphere during the period of above-ground testing of nuclear weapons that ended in the early 1960s. Tritium from those sources occurs as tritiated water, which is transported in the environment and incorporated into tissues of all organisms by the natural movement of water. This remedial investigation is concerned only with uncontrolled or unexpected releases of tritium to off-site locations, but not with levels due to natural production in the atmosphere and residual contamination from nuclear-weapons testing.

10.3 Methodology for Health and Environmental Risk Assessment

The following sections discuss the steps to be taken to perform a health and environmental risk assessment if tritium were released, or assumed to be released, to locations beyond the site boundary under uncontrolled or unpermitted conditions.

10.3.1 Identification of Exposure Pathways

Since tritium in the environment normally is in the form of tritiated water, exposures of humans and biota occur as a result of intakes of contaminated water by various pathways. When tritium is found in groundwater or surface water, the most important pathway of exposure of humans often is direct consumption of tritium in drinking water obtained from a contaminated source. Consumption of contaminated plant and animal products, including fish, also can be important exposure pathways for humans. A third potential exposure pathway for humans is inhalation and skin absorption of tritiated water vapor. This pathway can be important if an on-site release of tritiated water vapor occurs and airborne tritium is transported to off-site receptor locations. External exposure to tritium is not a concern, because tritium emits only very low-energy electrons (beta particles) that cannot penetrate the outer dead layer of skin.

Doses and risks to humans occur only when there is a completed exposure pathway. If no exposure pathways are known to exist, an assumption that humans are being exposed to known sources of tritium in the environment (either on-site or off-site) can be made for the purpose of obtaining bounding estimates of potential doses and risks. For example, direct consumption of tritium in shallow groundwater at the Salem site can be assumed, even though that pathway is precluded by institutional controls that are maintained at the site. Such bounding analyses are hypothetical, but they are useful in evaluating the potential importance of assumed levels of environmental contamination. However, it is important to emphasize that calculated doses are credible only if there is a completed exposure pathway.

Doses to aquatic and terrestrial biota due to tritium in the environment normally can be estimated on the basis of an assumption that organisms reside in a contaminated medium (e.g., surface water) and that concentrations of tritium in tissues of organisms are the same as concentrations of tritium in water in the medium. Since tritium in the environment behaves in the same way as water, tritium is not concentrated in tissues of organisms compared with levels in contaminated environmental media.

10.3.2 Identification and Characterization of Potentially Exposed Individuals and Biota

A realistic assessment of doses and risks to humans requires knowledge of the locations and living habits of potentially exposed individuals. However, for purposes of a bounding analysis, it is often assumed that humans are exposed at locations of highest concentrations in the environment beyond the site boundary, even though there may be no receptors at those locations at the present time. Assumptions about locations and exposures of potential receptors can be based on readily available demographic information on the local population, augmented by standard assumptions about living habits of typical members of the general public. The level of detail in characterizing potential receptors should be commensurate with expected levels of environmental contamination and associated doses and risks.

A detailed characterization of local flora and fauna is not required in evaluating impacts of tritium (and other radionuclides) on biota, because current guidance on protection of biota is based on assumptions about the effects of ionizing radiation on the most sensitive species of aquatic animals and terrestrial plants and animals. Thus, an assessment of potential impacts on biota can be based on an assumption that all organisms are located where the highest concentrations of tritium in environmental media occur.

10.3.3 Approach to Calculation of Doses to Humans and Comparisons with Applicable Standards

On the basis of estimated concentrations of tritium in environmental media, including their dependence on time, and assumptions about exposure pathways, it is a straightforward procedure to estimate radiation doses to humans. In general, dose is calculated as the product of an activity concentration of tritium in a material (air, water, or foodstuff) used by humans, an assumed intake of that material by ingestion, inhalation, or skin absorption, and estimated doses per unit activity intake of tritium by each route.

Using the drinking water pathway as an example, the dose to an exposed individual is calculated as the product of (1) the concentration of tritium in the source of water being consumed, (2) the quantity of water consumed over the period of concern, and (3) the dose per unit activity intake of tritium by ingestion. The first factor is based on environmental measurements or projections of future contamination; the second factor is an appropriate assumption for the exposure pathway of concern, such as a consumption rate of 2 liters (L) per day of drinking water; and the third factor is a standard value calculated by the International Commission on Radiological Protection (ICRP), with an appropriate modification that takes into account the biological effectiveness of beta particles emitted in tritium decay. An example dose calculation for tritium in drinking water is given in **Appendix I** (Kocher 2003).

A number of regulatory standards are applicable to control of exposures to tritium at the Salem Station. In regard to releases of tritium beyond the Station boundary, the applicable standards include (1) the NRC's radiation protection standards for the public in 10 CFR Part 20, which specify limits on concentrations of tritium (and other radionuclides) in air or water at the boundary and also specify that annual doses to individual members of the public from airborne releases shall comply with standards established by the EPA under the Clean Air Act in 40 CFR Part 61, and (2) the EPA's uranium fuel-cycle standards in 40 CFR Part 190, which specify limits on annual doses to individual members of the public from all release and exposure pathways combined. The two EPA standards differ from the NRC standards in 10 CFR Part 20 in that they apply at locations where members of the public are exposed, rather than at the Station boundary. The standard for airborne releases of tritium in EPA's Clean Air Act standards is a limit on annual effective dose equivalent of 10 mrem, and the limit for all release pathways in EPA's fuel-cycle standards is an annual dose equivalent to the whole body of 25 mrem. The effective dose equivalent and dose equivalent to the whole body are assumed to be the same for tritium.

The NRC's 10 CFR Part 20 also includes requirements for protection of workers within the Station boundary in the form of limits on annual effective dose equivalent and limits on concentrations of radionuclides in air and water. In addition, the EPA's drinking water standards in 40 CFR Part 141, which specify concentration limits for individual radionuclides in drinking water, are applied as groundwater protection requirements by the State of New Jersey. The drinking water standard for tritium is a concentration limit of 20,000 pCi/L. A comprehensive assessment of potential impacts of releases on humans should include comparisons of measured or calculated concentrations or doses with relevant regulatory requirements.

10.3.4 Approach to Calculation of Doses to Biota and Comparisons with Applicable Guidance

Measured or calculated concentrations of tritium in environmental media, especially surface water, also are used to estimate doses to aquatic and terrestrial biota. Because tritium in the environment behaves the same as water, doses to biota are calculated on the basis of an assumption that the activity per unit mass of water in tissues of organisms is the same as the activity per unit mass of water in the environmental medium to which an organism is exposed. Bounding estimates of dose to biota can be based on the highest measured or projected concentrations in water.

The NRC and EPA have not established standards to limit radiation exposures of biota. However, guidance on dose limits for biota, which are intended to ensure adequate protection of populations of the most sensitive species, has been developed by expert groups and adopted by the U.S. Department of Energy; this guidance is summarized in **Appendix I**. The consensus dose limits for biota, which are 0.1 or 1 rad/day depending on the type of organism, are much higher than applicable dose limits for individual workers or members of the public.

10.3.5 Approach to Calculation of Health Risks to Humans

Once doses to humans are estimated, the associated risks to human health, specifically the risks of cancer incidence associated with an exposure, can be estimated on the basis of an assumption about the cancer risk per unit dose. Estimates of cancer risk assume that any additional dose entails some risk and that risk is proportional to the dose from exposure to the source of concern. For purposes of assessing cancer risks in general terms, exposure over a lifetime often is assumed, and the assumed risk per unit dose is an average value over an individual's normal life span of about 70 years. An example calculation of the lifetime risk of cancer incidence from consumption of tritium in drinking water is given in **Appendix I**.

Estimates of health risks from exposure to tritium, or any other environmental contaminant, can be used to provide a perspective on the significance of estimated exposures. By comparing calculated cancer risks with other risks experienced in everyday life, including unavoidable risks from exposure to natural background radiation, a frame of reference that would allow affected individuals to judge the significance of potential exposures is provided.

For example, a useful frame of reference for evaluating the significance of doses due to releases of tritium would be to compare estimated doses with doses from exposure to naturally occurring tritium produced in the atmosphere and tritium produced by atmospheric testing of nuclear weapons. Doses from these sources are unavoidable and are experienced by all members of the public. The National Council on Radiation Protection and Measurements (NCRP) has estimated that the annual dose from exposure to naturally occurring tritium produced in the atmosphere is about 0.001 millirem (mrem), and the annual dose from exposure to tritium produced by atmospheric testing of nuclear weapons currently is about 0.003 mrem (NCRP 1979). In comparison, the total annual dose from all sources of natural background radiation is about 100 mrem, excluding indoor radon, and about 300 mrem if indoor radon is included.

Estimates of health risks as described above are not relevant for biota, because cancer is not a biological effect of concern and current guidance on dose limits is based on an assumption that all species will be adequately protected if doses are maintained below specified limits, even though individual members of species may be harmed. Potential impacts on species can be indicated in a general way by comparing estimated doses with dose limits in the guidance. The lower the estimated doses relative to the limits, the greater the margin of safety in protecting species of aquatic and terrestrial biota.

10.4 Assessment of Potential Off-Site Exposures of Humans and Biota

There is no evidence to date to indicate that a significant quantity of tritium in groundwater has migrated or is presently migrating beyond the boundary of the Salem site. Elevated levels of tritium have been found only in the water table aquifer on the site, and there is no evidence that tritium in shallow groundwater has migrated directly to the Delaware River or to an underlying aquifer that provides a source of drinking water for the local population. Thus, on the basis of present knowledge, an exposure pathway to humans beyond the site boundary or to biota has not been completed, and there is no basis for performing an assessment of potential off-site exposures of humans and biota.

11 Conclusions and Recommendations

The following sections provide conclusions and recommendations based on the results of remedial investigation activities conducted to date.

11.1 Conclusions

The following detailed conclusions are presented that support the evidence that the source of tritium detected in groundwater was the Spent Fuel Pool, the tritium released to the environment has been stopped, and that tritium has not migrated to the property boundary above any regulatory limit:

1. There was a release of water from the Spent Fuel Pool system resulting from blockage of the telltale drains by mineral precipitates. The telltale drains are a leak monitoring, collection, and drainage mechanism specifically designed to collect leakage that may accumulate behind the stainless steel liner of the Spent Fuel Pool and Refueling Canal. The blockage of the telltale drains resulted in the accumulation of water from the Spent Fuel Pool system (between the liner and the concrete wall) that created hydrostatic head and facilitated migration to the Styrofoam-filled seismic gap located between the Salem Unit 1 Fuel Handling Building and Auxiliary Building. The mineral precipitates have been physically removed to ensure the proper operation of the telltale drains. The process of monitoring the telltale drains is routinely performed to ensure that blockage does not reoccur. Permanent seismic gap drains are being installed to facilitate control of the accumulation of water in the seismic gap, and to create an ingradient to the gap;

2. The release of water from the Spent Fuel Pool system was investigated through the sampling of monitoring wells installed in the area of Salem Unit 1. The groundwater analytical data collected from the monitoring well network were used to delineate an area of groundwater in the shallow, water-bearing unit that contains elevated concentrations of tritium. Gamma-emitting isotopes were also monitored in the groundwater samples collected from the monitoring wells because the suspected source of the tritium was the Spent Fuel Pool. No plant related gamma-emitting isotopes have been detected in groundwater samples collected from the monitoring wells;

3. The area of groundwater containing elevated tritium extends from the southern end of the Styrofoam seismic gap located between the Salem Auxiliary Building and the Salem Unit 1 Reactor Containment Building in a southerly direction toward the circulation water discharge pipes. Groundwater with tritium at concentrations

exceeding any regulatory limit has not migrated to the property boundary of the Station;

4. Elevated levels of tritium have only been detected in groundwater samples collected from the shallow, water-bearing unit. There is no evidence that suggests that water from the Spent Fuel Pool has migrated to an underlying aquifer as confirmed by groundwater samples collected from monitoring wells screened in the Vincentown Formation;

5. A completed exposure pathway to humans from tritium in shallow groundwater has not been established, nor is there any evidence that significant exposures of biota have occurred.

11.2 Recommendations

Based on the conclusions of the remedial investigation, the following recommendations are presented:

1. Continued groundwater monitoring should be conducted on a periodic basis. This groundwater monitoring should include the collection of groundwater samples from monitoring wells screened in the shallow, water-bearing unit on a monthly or quarterly basis, to be determined based on quantitative parameters. During these sampling events, depth to water-level measurements should be collected from site monitoring wells. Groundwater samples should also be collected from monitoring wells screened in the Vincentown Formation on a semi-annual basis.

2. A pilot test should be conducted to evaluate the feasibility of groundwater extraction, to provide engineering data to support the extraction system design, and to initially contain the further migration of tritium in groundwater near Salem Unit 1.

3. A Remedial Action Workplan (RAW) should be prepared in accordance with the Technical Requirements for Site Remediation (N.J.A.C. 7:26E). The RAW will be submitted within 90 days of approval of the Remedial Investigation Report.

12 References

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Table 01. Physical and Chemical Properties of Constituents of Concern, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

			K_d (mL/g)			Retardation Factor[1]				
Constituent of Concern	**Molecular Weight (g/mol)**	**Specific Gravity[2]**	**Minumum**	**Maximum**	**Recommended[3]**	**Minimum**	**Maximum**	**Recommended[3]**	**Half-Life**	**Half-Life Units**
Antimony-125	124.905	6.68	0	10,000	3,981	1	68,901	27,431	2.758	years
Barium-133	132.906	3.62	NR	NR	–	–	–	–	10.53	years
Barium-140/Lanthanum-140	139.911/139.909	3.62	NR	NR	–	–	–	–	12.75/1.678	days
Berium-7	7.0169		NR	NR	–	–	–	–	53.28	days
Boron	10.811	2.34	0	3,990	0	1.00	27,492	1	NR	
Cerium-141	140.908	6.77	10	10,000	1,000	69.9	68,901	6,891	32.5	days
Cerium-144	143.914	6.77	10	10,000	1,000	69.9	68,901	6,891	284.6	days
Cesium-133	132.906	1.93	1	100,000	501	7.89	689,001	3,454	NR	
Cesium-134	133.907	1.93	1	100,000	501	7.89	689,001	3,454	2.065	years
Cesium-137	136.907	1.93	1	100,000	501	7.89	689,001	3,454	30.2	years
Chromium-51	50.945	7.15	1	1,000	40	7.89	6,891	275	27.7	days
Cobalt-58	57.936	8.86	0.1	1,000	10	1.689	6,891	70	70.88	days
Cobalt-60	59.934	8.86	0.1	1,000	10	1.689	6,891	70	5.271	years
Iodine-129	128.904	4.93	0.001	1	0.20	1.00689	9	2	1.70E+07	years
Iodine-131	130.906	4.93	0.001	2	0.20	1.00689	15	2	8.04	days
Iron-59	58.935	7.87	NR	NR	–	–	–	–	44.51	days
Manganese-54	53.94	7.3	NR	NR	–	–	–	–	312.1	days
Molybdenum-99	98.908	10.2	0	100	–	1	690	–	2.748	days
Potassium-40	39.964	0.89	NR	NR	–	–	–	–	1.26E+09	years
Radium-Natural (Ra-226)	226.0254	5	5	1,000,000	100	35.45	6,890,001	690	1599	years
Ruthenium-103	102.906	12.1	100	1,000	158	690	6,891	1,093	39.27	days
Ruthenium-106	105.907	12.1	100	1,000	158	690	6,891	1,093	1.02	years
Silver-110M	109.906	10.5	10	1,000	100	69.9	6,891	690	249.8	days
Sodium-22	21.994	0.97	NR	NR	–	–	–	–	2.605	years
Technetium-99	98.906	11	0	100	0.001	1	690	1	2.13E+05	years
Tellurium-129M	128.906	6.24	NR	NR	–	–	–	–	33.6	days
Tellurium-132	131.909	6.24	NR	NR	–	–	–	–	3.26	days
Thorium-232	232.038	11.7	10	100,000	100	69.9	689,001	690	1.40E+10	years
Thorium-234	234.044	11.7	10	100,000	100	69.9	689,001	690	24.1	days
Tritium	3.016	0.2693	0.001	0	0.001	1.00689	1	1	12.33	years
Uranium-235	235.044	19.1	0.1	1,000,000	40	1.689	6,890,001	275	7.04E+08	years
Zinc-65	64.929	7.14	0.1	10,000	16	1.689	68,901	110	243.8	days
Zirconium-95/Niobium-95	94.908	6.52	260	500	–	1792.4	3,446	–	64.02	days

NOTES:

[1] Assumes an effective porosity of 0.25 and a bulk density of 1.7225

NR Not Reported

[2] Value for the stable isotope

[3] Based on Looney et al., 1988

Boron K_d values The table presents the entire range reported in the literature, mostly derived from soil systems. It is likely that K_d is negligible in low clay, sandy aquifer sediments.

References:

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Table 02. Groundwater Analytical Results, Phase I Investigation, October through November 2002, PSEG Salem Generating Station, Hancock's Bridge, New Jersey.

Constituent of Concern	Sample Identification[1] and Collection Date							
	A2 10/02/02	B 10/03/02	C26 10/04/02	C33 10/04/02	A1 10/04/02	E 10/05/02	A2 11/22/02	A2 11/22/02
Major Cations and Anions (mg/L)								
Boron	NA	NA	NA	NA	NA	**2,600**	NA	NA
Gamma Emmitting Isotopes (pCi/L)								
Potassium-40	**1,490**	**3,780**	**5,960**	**6,450**	NA	NA	**1,760**	**1,970**
Cesium-134	NA	NA	NA	NA	NA	**118,000**	NA	NA
Cesium-137	NA	NA	NA	NA	NA	**320,000**	NA	NA

Notes:

mg/L	Milligrams per liter
pCi/L	Picocuries per liter
NA	Constituent not analyzed
	Bold values exceed the laboratory detection limit.
1	Corresponds with sample locations shown on Figure 10.

Table 03. Groundwater Analytical Results, Phase II Investigation, December 2002, PSEG Salem Generating Station, Hancock's Bridge, New Jersey.

Sample Identification[1]	Sample Date	Sodium (mg/L)	Chlorine (mg/L)	Boron (mg/L)	Tritium (pCi/L)	Gamma Emmitting Isotopes (pCi/L)											
						Potassium-40	Chromium-51	Manganese-54	Cobalt-58	Cobalt-60	Antimony-125	Iodine-131	Cesium-134	Cesium-137	Radium-Nat	Thorium-234	Uranium-235
Production Wells and Observation Wells																	
HC-1	12/12/2002	NA	NA	NA	<160	**53.3**	<6.64	<0.881	<0.892	<1.25	<2.87	<0.863	<0.614	<1.18	**17.6**	NA	NA
HC-2	12/12/2002	NA	NA	NA	<166	**75.0**	<6.80	<0.822	<1.11	<0.985	<1.99	<0.992	<0.895	<1.86	**51.9**	NA	NA
PW-2	12/12/2002	NA	NA	NA	<167	**66.3**	<6.81	<0.649	<0.747	<1.02	<2.33	<0.936	<0.841	<1.11	**58.0**	NA	NA
PW-5	12/12/2002	NA	NA	NA	<162	**43.7**	<4.01	<1.20	<0.793	<0.681	<1.37	<0.457	<0.803	<1.31	**17.0**	NA	NA
PW-6	12/12/2002	NA	NA	NA	<156	**42.4**	<6.45	<0.902	<0.630	<0.813	<1.45	<0.601	<0.541	<0.850	**18.0**	NA	NA
Obs G	12/13/2002	NA	NA	NA	<169	**64.2**	<6.62	<1.28	<0.988	<1.26	<3.75	<0.842	<1.19	<1.66	**221**	**42.10**	**3.90**
Obs J	12/13/2002	NA	NA	NA	<161	**31.0**	<5.72	<0.424	<0.562	<0.788	<1.95	<0.685	<0.832	<0.780	**19.2**	**53.10**	**1.79**
Direct-Push Discrete Water Samples																	
DP-1	12/19/02 14:37	**14.0**	**5.5**	**1,705**	**137,000,000**	NA	NA	NA	NA	**6,779**	**24,870**	NA	**75,790**	**254,100**	NA	NA	NA
DP-1	12/20/02 9:30	**10.4**	**0.33**	**1,968**	**120,000,000**	NA	NA	**1,057**	**1,025**	**2,107**	**1,776**	**2,591**	**40,570**	**132,600**	NA	NA	NA
DP-2	12/20/02 13:00	**98.0**	**0.39**	**684**	**69,800,000**	NA	NA	**234**	NA	NA	NA	**794**	**23,760**	**72,710**	NA	NA	NA
DP-2	12/20/02 13:25	**40.6**	**0.43**	**1,293**	**121,000,000**	NA	NA	**201**	NA	**316**	NA	**1,595**	**19,650**	**64,930**	NA	NA	NA
DP-2	12/20/02 14:00	**22.6**	**0.50**	**1,725**	**182,000,000**	NA	NA	**697**	NA	**784**	NA	**2,134**	**32,290**	**102,800**	NA	NA	NA
DP-2	12/20/02 14:40	**23.3**	**0.56**	**1,771**	**179,000,000**	NA	NA	**972**	**638**	**3,877**	**3,635**	**2,362**	**40,240**	**133,900**	NA	NA	NA

Notes:

mg/L	Milligrams per liter
pCi/L	Picocuries per liter
14.0	Result was detected above laboratory method detection limit.
<6.64	Laboratory method detection limit.
ND	Analyte was not detected; laboratory detection limit is not known.
NA	Constituent not analyzed.
1	Corresponds with sample locations shown on Figure 10.

Table 04. Well Construction Details, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

Well ID	Installation Date	Purpose	Construction Details	Diameter (inches)	Total Depth (feet bgs)	Monitoring Interval (feet bgs)	Monitored Hydrogeologic Unit	MP Elevation (feet RPD)	MP Elevation (feet amsl)	Northing (NAD 83)	Easting (NAD 83)
Well K	Feb-03	Monitoring	Sch-40 PVC	2	80.0	70.0 - 80.0	Vincentown[1]	102.00	12.08	231,435	199,697
Well L	Jan-03	Monitoring	Sch-40 PVC	2	80.0	70.0 - 80.0	Vincentown[1]	101.46	11.54	230,933	199,263
Well M	May-03	Monitoring	Sch-40 PVC	1	20.0	10.0 - 20.0	Cofferdam[2]	102.17	12.25	230,843	199,546
Well N	Jan-03	Monitoring	Sch-40 PVC	2	20.0	10.0 - 20.0	Cofferdam[2]	101.65	11.73	230,777	199,661
Well O	Jan-03	Monitoring	Sch-40 PVC	2	20.0	10.0 - 20.0	Cofferdam[2]	101.33	11.41	230,804	199,839
Well P	Mar-03	Monitoring	Sch-40 PVC	2	80.0	70.0 - 80.0	Vincentown[1]	101.13	11.21	230,336	200,000
Well Q	Mar-03	Monitoring	Sch-40 PVC	2	80.0	70.0 - 80.0	Vincentown[1]	106.59	16.67	230,645	201,196
Well R	Jun-03	Monitoring	Sch-40 PVC	1	19.0	9.0 - 19.0	Cofferdam[2]	102.35	12.43	230,906	199,640
Well S[4]	May-03	Monitoring	Sch-40 PVC	2	34.7	24.7 - 34.7	Shallow[3]	99.04	9.12	230,711	199,613
Well T	Jun-03	Monitoring	Sch-40 PVC	2	31.2	21.2 - 31.2	Shallow[3]	104.13	14.21	231,575	199,575
Well U[4]	May-03	Monitoring	Sch-40 PVC	2	32.2	27.2 - 32.2	Shallow[3]	98.57	8.65	231,370	199,618
Well V[4]	Jun-03	Monitoring	Sch-40 PVC	2	79.5	69.5 - 79.5	Vincentown[1]	98.74	8.82	231,355	199,548
Well W[4]	Jun-03	Monitoring	Sch-40 PVC	2	35.0	25.0 - 35.0	Shallow[3]	98.69	8.77	230,777	199,450
Well Y	Sep-03	Monitoring	Sch-40 PVC	2	37.0	27.0 - 35.0	Shallow[3]	101.81	11.89	230,771	199,343
Well Z	Sep-03	Monitoring	Sch-40 PVC	2	37.5	27.5 - 37.5	Shallow[3]	101.86	11.94	230,681	199,399
Well AA[4]	Sep-03	Monitoring	Sch-40 PVC	2	36.0	26.0 - 36.0	Shallow[3]	99.07	9.15	230,603	199,541
Well AB[4]	Oct-03	Monitoring	Sch-40 PVC	2	42.0	32.0- 42.0	Shallow[3]	98.93	9.01	230,623	199,677
Well AC[4]	Sep-03	Monitoring	Sch-40 PVC	2	24.0	14.0 - 24.0	Cofferdam[2]	98.77	8.85	230,724	199,725
Well AD[4]	Oct-03	Monitoring	Sch-40 PVC	6	43.0	33.0 - 43.0	Shallow[3]	98.99	9.07	230,684	199,607
Well AE	Oct-03	Monitoring	Sch-40 PVC	2	37.5	27.5 - 37.5	Cofferdam[2]	101.54	11.62	230,829	199,845
Well AF	Oct-03	Monitoring	Sch-40 PVC	2	45.0	35.0 - 45.0	Shallow[3]	101.61	11.69	230,491	199,702
Well AG-Shallow	Feb-04	Monitoring	Sch-40 PVC	1	24.2	14.2 - 24.2	Shallow[3]	99.29	9.37	230,496	199,508
Well AG-Deep	Feb-04	Monitoring	Sch-40 PVC	1	40.0	30.0 - 40.0	Shallow[3]	99.20	9.28	230,496	199,508
Well AH-Shallow	Feb-04	Monitoring	Sch-40 PVC	1	24.5	14.5 - 24.5	Shallow[3]	102.58	12.66	230,450	199,596
Well AH-Deep	Feb-04	Monitoring	Sch-40 PVC	1	40.0	30.0 - 40.0	Shallow[3]	102.70	12.78	230,450	199,596
Well AI	Jan-04	Monitoring	Sch-40 PVC	4	22.0	12.0 - 22.0	Cofferdam[2]	98.79	8.87	230,798	199,521
Well AJ	Jan-04	Monitoring	Sch-40 PVC	4	35.3	15.3 - 35.3	Shallow[3]	98.85	8.93	230,670	199,665
Well AL	Jan-04	Monitoring	Sch-40 PVC	2	25.3	15.3 - 25.3	Shallow[3]	99.13	9.21	230,594	199,806
Well AM	Jan-04	Monitoring	Sch-40 PVC	4	20.9	10.9 - 20.9	Cofferdam[2]	98.55	8.63	230,762	199,680

Notes:

MP	Measuring Point
bgs	Below ground surface
RPD	Relative to plant datum
amsl	Relative to mean sea level (NAVD 1988).

[1] Monitoring well is screened in the Vincentown Formation.

[2] Monitoring well is screened in the shallow, water-bearing unit at a location within the limits of the cofferdam.

[3] Monitoring well is screened in the shallow, water-bearing unit at a location outside the limits of the cofferdam.

[4] The surface completions of Monitoring Wells S, U, V, W, AA, AB, AC, and AD were converted from above-grade to flush-grade in February 2004.

Table 05. Supplemental Groundwater Investigation Details, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

Boring Identification	Comments/Details	Groundwater Sample Interval (ft bgs)				Groundwater Sample Analysis			
		11 to 15[1]	21 to 25[1]	15 to 25[2]	31 to 35[1]	Tritium - Salem[3]	Tritium - Maplewood[4]	Boron	Gamma-Emitting Isotopes[5]
1		X	X	--	X	X	X	X	X
2		--	--	X	X	X	X	X	X
3		--	--	X	X	X	X	X	X
4		--	--	X	X	X	X	X	X
5	Unable to advance boring due to obstruction.	--	--	--	--	--	--	--	--
6	Unable to advance boring due to obstruction.	--	--	--	--	--	--	--	--
7		X	X	--	X	X	X	X	X
8		--	--	X	X	X	--	--	--
9	Equipment refusal encountered at 22 ft bgs.	--	**X(18-22)**	--	--	X	--	--	--
10	Equipment refusal encountered at 21.5 ft bgs.	--	**X(17.5-21.5)**	--	--	X	--	--	--
11	Unable to advance boring due to obstruction.	--	--	--	--	--	--	--	--
12		**X(8-9)**	--	X	--	X	X	--	X

Notes:

ft bgs - Feet below ground surface.

[1] Groundwater samples collected from the 11 to 15, 21 to 25 and 31 to 35 foot below ground surface intervals were collected using the Geoprobe® four-foot SP-15 Screened Point Groundwater Sampler.

[2] Groundwater samples collected from the interval of 15 to 25 foot below ground surface were collected from a temporary one-inch diameter PVC well. The temporary wells were installed to facilitate the collection of groundwater samples in areas/intervals that did not yield sufficient groundwater.

[3] Refers to the PSEG Nuclear, LLC Station Chemistry. Initial analysis of groundwater samples was conducted at the on-site laboratory for screening purposes. If tritium concentrations indicated by the groundwater sample were below the detection limits of Station chemistry, the sample was submitted to Maplewood Testing Services for analysis.

[4] Maplewood Testing Services.

[5] The list of gamma-emitting isotopes included: Potassium-40; Actinium-228; Lead-221; Bismuth-212; Thallium-208; Thorium-234; Lead-214; Bismuth-214; Cesium-137; and, Uranium-235.

-- Indicates that either a sample was attempted and was unsuccessful, the collection of water from the interval was not attempted, and/or the analysis was not performed.

X - Indicates that a groundwater sample was collected from the listed sample interval, unless otherwise indcated (e.g., "18-22), and was subsequently analyzed for the indicated parameters.

Table 05. Supplemental Groundwater Investigation Details, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

Boring Identification	Comments/Details	Groundwater Sample Interval (ft bgs)				Groundwater Sample Analysis			
		11 to 15[1]	21 to 25[1]	15 to 25[2]	31 to 35[1]	Tritium - Salem[3]	Tritium - Maplewood[4]	Boron	Gamma-Emitting Isotopes[5]
13		--	--	X	--	X	X	--	--
14		--	--	X	X	X	X	--	--
15		--	--	X	X	X	X	--	X
16	Unable to advance boring due to obstruction.	--	--	--	--	--	--	--	--
17	Unable to advance boring due to obstruction.	--	--	--	--	--	--	--	--
18		--	--	X	X	X	--	--	--
19		X	--	X(14-18)	--	X	--	--	--
20		--	--	X	X	X	--	--	--
21	Unable to advance boring due to obstruction.	--	--	--	--	--	--	--	--
22	Equipment refusal encountered at 33 ft bgs.	X	X	--	X(29-33)	X	X	--	X
23		--	--	X	X	X	X	--	X
24		--	--	--	X	X	X	--	X

Notes:

ft bgs - Feet below ground surface.

[1] Groundwater samples collected from the 11 to 15, 21 to 25 and 31 to 35 foot below ground surface intervals were collected using the Geoprobe® four-foot SP-15 Screened Point Groundwater Sampler.

[2] Groundwater samples collected from the interval of 15 to 25 foot below ground surface were collected from a temporary one-inch diameter PVC well. The temporary wells were installed to facilitate the collection of groundwater samples in areas/intervals that did not yield sufficient groundwater.

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Table 05. Supplemental Groundwater Investigation Details, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

Boring Identification	Comments/Details	Groundwater Sample Interval (ft bgs)				Groundwater Sample Analysis			
		11 to 15[1]	21 to 25[1]	15 to 25[2]	31 to 35[1]	Tritium - Salem[3]	Tritium - Maplewood[4]	Boron	Gamma-Emitting Isotopes[5]
25	Equipment refusal encountered at 25 ft bgs.	--	--	X	--	X	X	--	X
26	Equipment refusal encountered at 32 ft bgs.	--	--	X	X(28-32)	X	X	--	X
27		X	--	--	X	X	X	--	X
28		X	X	--	X	X	X	--	X
29	Unable to advance boring due to obstruction.	--	--	--	--	--	--	--	--
30		--	--	X	X	X	--	--	--
31		--	--	X	X(34-38)	X	--	--	--
32		--	--	X	X(34-38)	X	--	--	--
33	Equipment refusal encountered at 19 ft bgs.	--	X(9-19)	--	--	X	--	--	--
34	Equipment refusal encountered at 22 ft bgs.	--	X(12-22)	--	--	X	--	--	--
35	Equipment refusal encountered at 24 ft bgs.	--	X(14-24)	--	--	X	--	--	--
36	Equipment refusal encountered at 16 ft bgs.	X	--	--	--	X	--	--	--
37	Boring was not advanced deeper than 25 ft bgs.	--	--	X	--	X	--	--	--

<u>Notes:</u>

ft bgs - Feet below ground surface.

[1] Groundwater samples collected from the 11 to 15, 21 to 25 and 31 to 35 foot below ground surface intervals were collected using the Geoprobe® four-foot SP-15 Screened Point Groundwater Sampler.

[2] Groundwater samples collected from the interval of 15 to 25 foot below ground surface were collected from a temporary one-inch diameter PVC well. The temporary wells were installed to facilitate the collection of groundwater samples in areas/intervals that did not yield sufficient groundwater.

[3] Refers to the PSEG Nuclear, LLC Station Chemistry. Initial analysis of groundwater samples was conducted at the on-site laboratory for screening purposes. If tritium concentrations indicated by the groundwater sample were below the detection limits of Station chemistry, the sample was submitted to Maplewood Testing Services for analysis.

[4] Maplewood Testing Services.

[5] The list of gamma-emitting isotopes included: Potassium-40; Actinium-228; Lead-221; Bismuth-212; Thallium-208; Thorium-234; Lead-214; Bismuth-214; Cesium-137; and, Uranium-235.

-- Indicates that either a sample was attempted and was unsuccessful, the collection of water from the interval was not attempted, and/or the analysis was not performed.

X - Indicates that a groundwater sample was collected from the listed sample interval, unless otherwise indcated (e.g., "18-22), and was subsequently analyzed for the indicated parameters.

Table 06. Supplemental Groundwater Investigation Results, PSEG Nuclear, LLC, Salem Generating Station, Artificial Island, Hancock's Bridge, New Jersey.

					Gamma-Emitting Isotopes (pCi/L)			
Boring Identification	Sample Interval (ft bgs)	Tritium (pCi/L)		Boron (ug/L)	Potassium - 40	Bismuth - 212 (Thorium - 232)	Thorium - 234 (Uranium - 238)	Uranium - 235
		Salem[1]	Maplewood[2]	Maplewood[2]	Maplewood[2]	Maplewood[2]	Maplewood[2]	Maplewood[2]
1	11 - 15	<6,800	<138	--	--	--	--	--
	21 - 25	<5,960	--	--	--	--	--	--
	31 - 35	<5,740	<139	812	81.5	<4.45	84.7	5.59
2	15 - 25	<5,190	<145	578	<23.5	<6.70	<103	<4.47
	31 - 35	<5,380	206	635	<26.8	<4.35	<69.1	<4.53
3	15 - 25	<4,740	<140	641	97.9	<13.8	<11.0	4.76
	31 - 35	<5,420	986	393	<80.2	<6.33	<50.0	<3.78
4	15 - 25	<5,790	<142	626	65.4	<13.1	175	4.75
	31 - 35	<5,520	271	457	<10.2	<4.99	<50.2	<1.78
7	11 - 15	<5,020	<142	266	51.3	<5.45	<128	<5.05
	21 - 25	<5,020	222	318	75.5	<7.47	<46.0	<3.88
	31 - 35	<5,090	2,545	690	71.9	<4.33	<38.5	<2.63
8	15 - 25	<6,670	1,175	206	57.0	<4.80	<7.91	<3.87
	31 - 35	<14,600	1,731	510	<42.6	<4.78	199	4.53
9	18 - 22	80,800	--	--	--	--	--	--
10	17.5 - 21.5	21,300	--	--	--	--	--	--
12	8 - 9	<4,540	1,941	365	<14.7	<3.68	169	6.00
	15 - 25	<4,380	1,814	291	82.7	<8.57	187	3.90
13	15 - 25	<5,410	579	457	46.6	<10.7	165	6.47
14	15 - 25	5,860	8,674	--	<15.0	<3.68	198	5.27
	31 - 35	<5,590	10,190	--	--	--	--	--
15	15 - 25	<5,210	726	407	96.5	18.5	<119	5.83
	31 - 35	<5,170	756	411	<56.0	<3.94	<144	<4.61
18	15 - 25	<15,500	499	143	50.2	15.2	209	6.17
	31 - 35	<14,600	396	675	99.0	<7.48	<112	<5.31
19	11 - 15	114,000	--	--	--	--	--	--
	14 - 18	591,000	--	--	--	--	--	--
20	15 - 25	461,000	--	--	--	--	--	--
	31 - 35	172,000	--	--	--	--	--	--
22	11 - 15	<4,750	920	408	<34.9	<4.13	<105	<2.98
	21 - 25	<4,700	1,433	268	<22.7	<4.10	150	<1.27
	29 - 33	<6,020	8,449	301	<35.3	<13.5	180	6.59
23	15 - 25	<3,920	567	--	<56.0	<5.09	<40.3	<4.23
	31 - 35	<7,210	474	344	--	--	--	--

Notes:

ft bgs	Feet below ground surface.
pCi/L	Picocuries per liter.
ug/L	micrograms per liter.
<	Less than the laboratory detection limit.
--	Constituent not analyzed.

[1] Refers to PSEG Nuclear, LLC Station Chemistry. If tritium concentrations indicated by a groundwater sample were below the detection limits of Station chemistry, the sample was submitted to Maplewood Testing Services for analysis. Initial analysis of groundwater samples was conducted at the Salem on-site laboratory for screening purposes.

[2] Maplewood Testing Services.

Table 06. Supplemental Groundwater Investigation Results, PSEG Nuclear, LLC, Salem Generating Station, Artificial Island, Hancock's Bridge, New Jersey.

					Gamma-Emitting Isotopes (pCi/L)			
Boring Identification	Sample Interval (ft bgs)	Tritium (pCi/L)		Boron (ug/L)	Potassium - 40	Bismuth - 212 (Thorium - 232)	Thorium - 234 (Uranium - 238)	Uranium - 235
		Salem[1]	Maplewood[2]	Maplewood[2]	Maplewood[2]	Maplewood[2]	Maplewood[2]	Maplewood[2]
24	31 - 35	<4,790	361	188	43.1	<9.04	<130	<3.87
25	15 - 25	<4,610	1,500	409	<48.4	<5.82	<120	<4.52
26	15 - 25	<4,500	4,127	582	97.6	<9.56	<62.6	<5.52
	28 - 32	6,760	--	--	--	--	--	--
27	11 - 15	620,000	--	--	--	--	--	--
	31 - 35	<4,930	1,028	710	67.5	<6.63	<61.7	<3.21
28	11 - 15	45,000	--	--	--	--	--	--
	21 - 25	1,980,000	--	--	--	--	--	--
	31 - 35	<5,140	1,794	660	95.4	<6.55	<109	<4.55
30	15 - 25	<14,900	406	339	70.2	<5.83	152	<1.46
	31 - 35	<15,500	<142	228	<14.4	<4.38	143	3.71
31	15 - 25	<15,500	<140	--	--	--	--	--
	34 - 38	<15,500	<141	--	47.9	<4.61	<63.9	<3.35
32	15 - 25	<15,500	<139	793	197	<13.0	457	<10.0
	34 - 38	<15,700	168	--	<11.6	<6.11	<72.2	<4.38
33	9 - 19	1,080,000	--	--	--	--	--	--
34	12 - 22	698,000	--	--	--	--	--	--
35	14 - 24	1,250,000	--	--	--	--	--	--
36	11 - 16	<15,300	11,404	--	--	--	--	--
37	15 - 25	<15,200	4,550	181	<42.8	16.8	<91.2	<4.15

Notes:

ft bgs	Feet below ground surface.
pCi/L	Picocuries per liter.
ug/L	micrograms per liter.
<	Less than the laboratory detection limit.
--	Constituent not analyzed.
1	Refers to PSEG Nuclear, LLC Station Chemistry. If tritium concentrations indicated by a groundwater sample were below the detection limits of Station chemistry, the sample was submitted to Maplewood Testing Services for analysis. Initial analysis of groundwater samples was conducted at the Salem on-site laboratory for screening purposes.
2	Maplewood Testing Services.

Table 07. Field Parameter Measurements, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

		Parameter					
Observation Well Identification	Date	pH (SU)	Specific Conductance (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation-Reduction Potential (mV)
Well K	04/29/03	7.10	8.58	18.5	0.37	18.23	21
	05/05/03	6.80	7.55	12.0	0.23	14.90	-107
	05/20/03	7.13	7.68	13.2	0.22	16.93	-174
	05/28/03	7.17	7.84	15.1	0.20	15.97	-153
	06/04/03	7.04	7.92	14.4	0.14	14.91	-173
	06/10/03	7.10	7.06	14.4	0.25	17.44	-140
	06/17/03	7.18	7.02	17.8	0.10	16.00	-184
	06/24/03	7.11	8.62	1.8	0.16	17.61	-186
	06/30/03	7.30	8.28	11.1	0.14	18.52	-142
	07/16/03	7.24	8.23	6.5	0.19	18.31	-102
	07/29/03	7.19	8.47	7.0	0.13	18.09	-127
	08/12/03	6.95	8.37	1.6	0.21	19.06	-58
	08/27/03	6.91	8.17	5.6	0.41	19.75	-64
	09/09/03	6.93	8.01	5.5	0.72	18.89	-38
	09/25/03	7.13	8.3	5.8	1.67	18.51	-22
	10/06/03	6.75	8.29	20.0	2.44	17.22	-14
	11/09/03	6.84	8.19	3.1	0.30	15.75	-25
Well L	04/29/03	7.40	14.11	13.3	0.36	16.35	-75
	05/05/03	7.00	13.29	11.0	1.35	12.50	-166
	05/15/03	7.45	13.12	6.3	0.42	15.09	-183
	05/20/03	7.38	12.98	8.8	0.22	15.48	-201
	05/28/03	7.39	13.52	11.0	0.34	15.04	-160
	06/04/03	7.31	13.44	10.0	0.29	14.64	-191
	06/10/03	7.45	11.98	9.4	0.20	16.94	-150
	06/17/03	7.38	12.03	13.2	0.18	15.59	-185
	06/24/03	7.36	14.90	1.2	0.18	16.70	-199
	06/30/03	7.43	14.14	9.7	0.17	17.32	-160
	07/29/03	7.40	14.29	11.0	0.14	16.99	-140
	08/27/03	7.08	14.07	9.4	0.13	17.67	-35
	09/25/03	7.37	14.41	3.9	0.12	17.65	19
	12/16/03	7.09	14.27	8.1	0.11	13.60	52

Notes:

The values presented in the table are stabilized, final readings during purging.

SU	Standard Units
mg/L	Milligrams per liter; equivalent to parts per million
mV	Millivolts
mS/cm	Microsiemens per centimeter
NTU	Nephelometric turbidity units
°C	Degrees Celsius

Table 07. Field Parameter Measurements, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

		Parameter					
Observation Well Identification	Date	pH (SU)	Specific Conductance (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation-Reduction Potential (mV)
Well M	04/30/03	7.17	0.42	16.6	7.64	21.34	35
	07/09/03	6.84	0.43	125.0	0.14	28.42	-27
	07/23/03	6.81	0.43	59.0	0.11	28.89	-39
	08/06/03	6.75	0.44	120.0	0.13	30.08	-19
	08/20/03	6.70	0.43	100.0	0.15	30.53	85
	09/04/03	6.72	0.42	134	0.10	30.71	163
	09/16/03	6.72	0.42	71.5	0.25	32.69	197
	10/03/03	6.77	0.43	150.0	0.13	28.53	24
	10/20/03	6.71	0.44	30.5	0.12	27.55	27
	12/04/03	6.85	0.39	22.3	0.11	19.48	95
Well N	04/30/03	5.70	0.37	3.8	2.18	20.14	484
	05/06/03	5.65	0.31	7.9	3.40	19.60	239
	05/21/03	5.90	0.38	6.7	3.25	19.75	194
	05/27/03	5.80	0.35	38.8	3.29	20.23	283
	06/04/03	5.80	0.31	11.1	2.18	20.11	-58
	06/11/03	5.66	0.28	8.1	1.70	21.83	151
	06/19/03	5.63	0.29	25.1	1.24	22.21	194
	06/25/03	5.61	0.30	1.6	1.24	23.06	165
	07/10/03	5.66	0.29	24.8	1.31	24.88	294
	07/25/03	5.70	0.31	2.0	1.63	26.83	120
	08/20/03	5.53	0.31	10.0	1.65	27.89	188
	09/04/03	5.77	3.65	2.0	2.03	27.45	263
	09/17/03	5.81	0.37	3.2	2.88	28.52	330
	10/03/03	5.95	0.405	13.5	3.19	27.42	190
	11/03/03	6.02	0.39	76.1	1.98	25.61	299
	12/12/03	5.92	0.42	6.1	0.79	22.23	86

Notes:

The values presented in the table are stabilized, final readings during purging.

SU	Standard Units
mg/L	Milligrams per liter; equivalent to parts per million
mV	Millivolts
mS/cm	Microsiemens per centimeter
NTU	Nephelometric turbidity units
°C	Degrees Celsius

Table 07. Field Parameter Measurements, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

		Parameter					
Observation Well Identification	Date	pH (SU)	Specific Conductance (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation-Reduction Potential (mV)
Well O	04/29/03	7.25	0.21	3.5	0.30	16.39	NA
	05/06/03	6.99	0.19	1.8	0.50	16.00	-144
	05/23/03	7.28	0.20	4.9	0.32	18.87	-119
	05/28/03	7.40	0.23	6.5	0.39	17.92	-134
	06/03/03	7.01	0.24	6.1	0.55	18.95	-82
	06/10/03	7.10	0.21	10.6	0.54	20.30	-123
	06/17/03	7.08	0.21	10.2	0.66	20.33	-91
	06/24/03	6.84	0.27	0.0	0.76	22.49	-88
	07/09/03	7.05	0.27	0.0	0.41	23.81	-46
	07/25/03	6.79	0.25	0.0	0.82	25.27	-11
	08/20/03	6.66	0.30	4.6	0.40	27.68	80
	09/03/03	6.96	0.26	0.0	0.74	27.94	42
	09/15/03	7.11	0.26	0.0	0.59	28.50	31
	10/03/03	6.74	0.45	4.9	0.26	26.24	129
	10/20/03	6.58	0.71	0.0	0.28	25.07	-35
	11/17/03	6.68	0.42	3.8	0.21	22.25	-43
	12/18/03	6.20	2.49	2.1	1.40	14.48	290
Well P	04/29/03	6.74	10.39	29.5	0.94	15.16	-40
	05/05/03	6.50	9.94	13.4	0.48	12.90	-175
	05/15/03	6.80	10.50	17.6	0.19	14.68	-166
	05/20/03	6.83	10.38	15.8	0.33	16.22	-178
	05/31/03	6.69	12.30	20.6	0.18	17.00	-137
	06/04/03	6.75	10.84	24.3	0.10	14.25	-181
	06/10/03	6.75	9.78	33.0	0.50	17.43	-165
	06/17/03	6.79	9.98	40.2	0.17	15.72	-176
	06/24/03	6.86	12.29	20.0	0.21	17.44	-181
	07/16/03	6.88	11.91	46.7	0.18	18.44	-120
	08/13/03	6.39	12.29	56.0	0.13	18.38	-105
	09/08/03	6.52	11.78	9.9	0.10	18.29	-76
	10/06/03	6.41	12.38	14.0	0.09	17.22	-96

Notes:

The values presented in the table are stabilized, final readings during purging.

SU	Standard Units
mg/L	Milligrams per liter; equivalent to parts per million
mV	Millivolts
mS/cm	Microsiemens per centimeter
NTU	Nephelometric turbidity units
°C	Degrees Celsius

Table 07. Field Parameter Measurements, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

		Parameter					
Observation Well Identification	Date	pH (SU)	Specific Conductance (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation-Reduction Potential (mV)
Well Q	04/30/03	6.46	13.69	20.0	0.20	14.55	-48
	05/06/03	6.34	12.01	99.6	0.16	15.30	-123
	05/12/03	6.28	12.43	38.9	0.36	16.56	-76
	05/19/03	6.42	12.61	159	0.12	16.19	-170
	05/30/03	6.35	14.80	173.0	0.22	16.88	-113
	06/05/03	6.43	11.80	15.4	0.17	15.31	-157
	06/11/03	6.35	11.74	12.6	0.14	17.64	-145
	06/16/03	6.48	12.00	16.5	0.16	16.64	-152
	06/23/03	6.24	15.10	8.3	0.18	16.99	-99
	07/17/03	6.39	13.87	11.0	0.31	17.10	-86
	08/13/03	6.25	14.11	14.2	0.14	18.98	-85
	09/10/03	6.14	13.75	11.4	0.09	16.58	13
	10/07/03	6.01	14.44	0.0	0.16	16.61	169
	11/09/03	5.98	14.06	4.2	0.17	13.86	102
Well R	04/30/03	6.74	0.54	15.8	8.02	18.72	33
	07/09/03	8.20	0.60	85	0.12	24.33	-189
	07/25/03	7.30	0.57	21.6	0.12	25.52	-99
	08/06/03	8.11	0.60	145	0.10	26.17	-99
	08/20/03	6.76	0.58	280	0.19	27.13	84
	09/17/03	8.32	0.63	27.3	0.16	26.03	-
	10/03/03	6.66	0.64	19.8	0.12	24.48	178
	10/21/03	6.58	0.65	24.9	0.12	22.86	197
	12/05/03	6.31	0.64	24.8	0.13	15.87	279
Well S	07/09/03	6.89	0.72	5.9	0.12	19.20	-128
	07/21/03	7.05	0.69	9.6	0.13	20.80	-107
	08/07/03	6.58	6.70	32.4	0.08	19.85	-73
	08/21/03	6.92	0.62	-65.0	0.15	21.77	0
	09/15/03	6.58	0.62	23.7	0.10	21.63	-23
	10/04/03	6.29	0.63	40.8	0.13	20.75	61
	10/13/03	6.43	0.67	15.0	0.10	21.11	0
	10/20/03	5.98	0.70	39.0	0.10	19.54	145
	11/09/03	6.42	0.63	13.6	0.11	18.40	-42
	11/26/03	6.57	0.62	64.4	0.28	17.67	278

Notes:

The values presented in the table are stabilized, final readings during purging.

SU	Standard Units
mg/L	Milligrams per liter; equivalent to parts per million
mV	Millivolts
mS/cm	Microsiemens per centimeter
NTU	Nephelometric turbidity units
°C	Degrees Celsius

Table 07. Field Parameter Measurements, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

		Parameter					
Observation Well Identification	Date	pH (SU)	Specific Conductance (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation-Reduction Potential (mV)
Well T	07/02/03	NA	NA	NA	NA	NA	NA
	07/10/03	6.86	6.35	3.0	0.10	17.80	-149
	07/15/03	6.81	6.34	4.2	0.18	19.07	-101
	07/30/03	6.88	6.43	4.9	0.19	18.52	-92
	08/12/03	6.83	6.41	0.5	0.10	19.99	-100
	08/28/03	6.61	6.27	59.1	0.13	18.85	12
	09/09/03	6.71	6.18	38.9	0.07	19.23	-55
	09/25/03	7.07	6.33	50.0	0.09	19.53	-84
	10/06/03	6.51	6.08	14.6	0.16	18.31	90
	12/12/03	6.51	6.41	69.9	0.06	15.85	-21
Well U	07/02/03	NA	NA.	NA	NA	NA	NA
	07/10/03	6.91	1.57	6.7	0.13	16.45	-136
	07/16/03	6.85	1.53	5.6	0.09	17.91	-140
	07/29/03	6.96	1.52	20.8	0.09	17.88	-128
	08/12/03	6.81	1.59	0.4	0.10	18.72	-117
	08/27/03	6.75	1.49	21.0	0.09	19.05	-94
	09/08/03	6.54	1.48	14.1	0.09	17.74	-46
	09/25/03	7.07	1.43	24.9	0.12	18.98	-63
	10/06/03	6.45	1.52	23.1	0.06	17.29	-65
	12/12/03	6.38	1.52	11.0	0.06	14.36	0
Well V	07/02/03	NA	NA	NA	NA	NA	NA
	07/21/03	7.14	3.91	14.9	0.16	19.64	-29
	07/29/03	7.06	3.90	7.2	0.11	18.61	-95
	08/12/03	6.80	3.85	0.0	0.11	18.82	-24
	08/22/03	6.81	3.83	3.5	0.15	19.66	-10
	09/09/03	6.72	3.89	0.0	0.08	18.80	-41
	09/25/03	7.30	4.05	0.6	0.20	18.99	12
	10/06/03	6.65	3.69	0.0	0.07	17.94	-85
	12/12/03	6.51	3.68	1.7	0.09	14.07	14

Notes:

The values presented in the table are stabilized, final readings during purging.

SU	Standard Units
mg/L	Milligrams per liter; equivalent to parts per million
mV	Millivolts
mS/cm	Microsiemens per centimeter
NTU	Nephelometric turbidity units
°C	Degrees Celsius

Table 07. Field Parameter Measurements, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

		Parameter					
Observation Well Identification	Date	pH (SU)	Specific Conductance (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation-Reduction Potential (mV)
Well W	07/07/03	6.80	2.29	1.0	0.48	19.78	-108
	07/21/03	6.80	2.36	2.0	0.14	20.74	-104
	08/07/03	5.62	0.35	17.0	1.68	26.89	308
	08/19/03	6.73	2.39	8.0	0.12	20.34	-74
	09/03/03	6.63	2.33	3.3	0.10	19.25	-35
	09/15/03	6.72	2.34	0.5	0.13	20.37	-24
	10/03/03	6.53	2.35	2.3	0.11	19.39	45
	10/20/03	6.24	2.67	0.0	0.13	17.81	125
	11/17/03	6.43	2.46	2.6	0.23	17.72	-24
	12/16/03	6.49	2.16	6.0	0.09	15.11	8
Well Y	10/27/03	6.92	7.42	34.2	0.32	16.29	108
	11/09/03	6.55	7.52	3.7	0.67	15.44	259
	11/24/03	6.92	7.49	5.6	0.11	15.73	255
	12/12/03	6.43	7.46	5.8	0.11	13.53	141
	12/22/03	6.33	7.5	11.5	0.09	14.25	186
Well Z	10/27/03	7.10	3.90	42.0	0.08	17.25	-37
	11/09/03	6.71	3.99	28.2	0.58	16.18	206
	11/24/03	7.06	4.00	19.5	0.07	16.21	120
	12/12/03	6.62	3.98	20.6	0.07	14.41	55
	12/22/03	6.51	3.92	9.9	0.09	15.13	76
Well AA	10/27/03	5.74	2.21	53.0	0.08	18.17	10
	11/10/03	5.73	2.24	49.2	0.15	17.79	80
	11/24/03	6.03	2.21	14.7	0.11	17.72	57
	12/10/03	5.02	2.19	18.3	0.16	18.70	236
	12/22/03	4.96	1.96	10.0	0.26	15.54	76
Well AB	10/28/03	6.41	1.79	58.7	0.12	22.95	29
	11/02/03	6.32	1.82	31.9	0.05	23.28	205
	11/17/03	6.13	1.90	16.2	0.14	22.12	17
	12/04/03	6.45	1.85	24.6	0.11	20.04	87
	12/16/03	6.31	1.89	5.1	0.07	19.22	-27
Well AC	10/28/03	6.68	0.45	50.3	0.24	24.61	-16
	11/03/03	6.65	0.43	25.0	0.30	24.38	0.429
	11/18/03	6.39	0.48	12.9	0.17	23.41	-219
	12/05/03	6.52	0.44	38.0	0.27	21.88	304
	12/18/03	6.49	0.44	14.4	0.05	20.25	101

Notes:

The values presented in the table are stabilized, final readings during purging.

SU	Standard Units
mg/L	Milligrams per liter; equivalent to parts per million
mV	Millivolts
mS/cm	Microsiemens per centimeter
NTU	Nephelometric turbidity units
°C	Degrees Celsius

Table 07. Field Parameter Measurements, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

		Parameter					
Observation Well Identification	Date	pH (SU)	Specific Conductance (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temperature (°C)	Oxidation-Reduction Potential (mV)
Well AD	10/27/03	7.12	1.90	24.0	0.07	20.28	-72
	11/02/03	6.67	1.98	16.3	0.06	21.36	64
	11/17/03	6.52	2.18	21.8	0.22	18.72	15
	12/04/03	6.76	1.60	4.6	0.08	17.69	81
	12/16/03	6.08	1.45	11.1	0.13	17.36	-12
Well AE	10/27/03	6.64	0.27	11.4	0.10	24.98	-60
	11/02/03	6.19	0.25	13.6	0.44	25.18	-60
	11/17/03	6.15	0.25	2.9	0.16	23.64	-25
	12/04/03	6.32	0.23	2.3	0.23	19.83	83
	12/18/03	5.60	0.22	1.6	0.36	17.09	288
Well AF	10/27/03	7.11	4.10	101.0	0.04	20.43	-99
	11/10/03	6.73	3.00	55.4	0.09	19.68	20
	11/24/03	7.01	3.65	9.5	0.07	20.51	-30
	12/13/03	6.39	3.36	21.7	0.11	18.50	238
	12/22/03	6.41	3.36	2.9	0.06	18.19	3
Maximum Measurement		8.32	15.10	280.0	8.02	32.69	484
Minimum Measurement		4.96	0.19	-65.0	0.04	12.50	-219
Average Measurement		6.65	4.73	23.1	0.48	19.58	-4

Notes:

The values presented in the table are stabilized, final readings during purging.

SU	Standard Units
mg/L	Milligrams per liter; equivalent to parts per million
mV	Millivolts
mS/cm	Microsiemens per centimeter
NTU	Nephelometric turbidity units
°C	Degrees Celsius

Table 08. Groundwater Elevations, PSEG Salem Generating Station, Hancock's Bridge, New Jersey.

Screened Interval - Typical (ft bgs)	Monitored Lithologic Unit[1]	Well Identification	Water-Level Elevation (ft rpd) 26-Jun-2003	Water-Level Elevation (ft amsl) 26-Jun-2003	Water-Level Elevation (ft rpd) 28-Jul-2003	Water-Level Elevation (ft amsl) 28-Jul-2003	Water-Level Elevation (ft rpd) 15-Aug-2003	Water-Level Elevation (ft amsl) 15-Aug-2003	Water-Level Elevation (ft rpd) 14-Oct-2003	Water-Level Elevation (ft amsl) 14-Oct-2003	Water-Level Elevation (ft rpd) 6-Nov-2003	Water-Level Elevation (ft amsl) 6-Nov-2003	Water-Level Elevation (ft rpd) 20-Feb-2004	Water-Level Elevation (ft amsl) 20-Feb-2004
10 to 20	Shallow, Water-Bearing Unit (Inside the Limits of Cofferdam)	Well M	95.11	5.19	94.56	4.64	94.74	4.82	93.58	3.66	93.37	3.45	93.51	3.59
		Well N	94.33	4.41	93.55	3.63	93.73	3.81	93.00	3.08	92.76	2.84	92.29	2.37
		Well O	95.17	5.25	94.50	4.58	94.79	4.87	93.45	3.53	93.57	3.65	92.47	2.55
		Well R	96.50	6.58	95.86	5.94	96.04	6.12	94.44	4.52	94.65	4.73	94.84	4.92
		Well AC	–	–	–	–	–	–	93.01	3.09	92.82	2.90	NM	NM
		Well AE	–	–	–	–	–	–	93.15	3.23	94.32	4.40	92.13	2.21
		Well AI	–	–	–	–	–	–	–	–	–	–	92.21	2.29
		Mean	95.28	5.36	94.62	4.70	94.83	4.91	93.44	3.52	93.58	3.66	92.91	2.99
25 to 35	Shallow, Water-Bearing Unit (Outside the Limits of Cofferdam)	Well S	92.95	3.03	92.46	2.54	92.54	2.62	92.44	2.52	92.10	2.18	91.57	1.65
		Well T	92.95	3.03	92.66	2.74	92.62	2.70	92.74	2.82	92.06	2.14	91.76	1.84
		Well U	93.20	3.28	92.85	2.93	92.82	2.90	92.79	2.87	92.14	2.22	91.87	1.95
		Well W	92.86	2.94	92.41	2.49	92.41	2.49	92.29	2.37	91.79	1.87	91.41	1.49
		Well Y	–	–	–	–	–	–	92.09	2.17	91.68	1.76	91.19	1.27
		Well Z	–	–	–	–	–	–	92.07	2.15	91.70	1.78	91.13	1.21
		Well AA	–	–	–	–	–	–	91.97	2.05	91.57	1.65	91.08	1.16
		Well AB	–	–	–	–	–	–	92.31	2.39	92.03	2.11	91.53	1.61
		Well AD	–	–	–	–	–	–	92.17	2.25	91.80	1.88	91.24	1.32
		Well AF	–	–	–	–	–	–	92.18	2.26	91.80	1.88	91.23	1.31
		Well AG (Shallow)	–	–	–	–	–	–	–	–	–	–	90.92	1.00
		Well AG (Deep)	–	–	–	–	–	–	–	–	–	–	90.85	0.93
		Well AH (Shallow)	–	–	–	–	–	–	–	–	–	–	90.45	0.53
		Well AH (Deep)	–	–	–	–	–	–	–	–	–	–	90.71	0.79
		Well AJ	–	–	–	–	–	–	–	–	–	–	91.40	1.48
		Well AL	–	–	–	–	–	–	–	–	–	–	93.11	3.19
		Well AM	–	–	–	–	–	–	–	–	–	–	92.30	2.38
		Mean	92.99	3.07	92.60	2.68	92.60	2.68	92.31	2.39	91.87	1.95	91.40	1.48
70 to 80	Vincentown Formation	Well K	91.36	1.44	90.98	1.06	90.84	0.92	91.90	1.98	90.12	0.20	NM	NM
		Well L	91.35	1.43	90.61	0.69	90.54	0.62	92.42	2.50	91.91	1.99	NM	NM
		Well P	91.32	1.40	90.67	0.75	90.37	0.45	92.55	2.63	93.23	3.31	NM	NM
		Well Q	91.29	1.37	89.90	-0.02	91.08	1.16	91.51	1.59	91.18	1.26	NM	NM
		Well V	91.58	1.66	91.08	1.16	90.92	1.00	92.00	2.08	91.32	1.40	NM	NM
		Mean	91.38	1.46	90.65	0.73	90.75	0.83	92.08	2.16	91.55	1.63	NM	NM

Notes

1	Lithologic units correspond with those outlined on cross sections A-A' through E-E'. The shallow, water-bearing unit consists of the structural and hydraulic fill and the riverbed deposits. *The shallow, water-bearing unit is separated from the Vincentown Formation by the Kirkwood Formation.*
–	Monitoring well not installed at the time of the water level gauging event.
NM	*Water level measurement not collected.*
ft bgs	Feet below ground surface.
ft rpd	Elevation (in feet) relative to plant datum.
ft amsl	Feet above mean sea level (NAVD 1988).
	Mean tide level at Artificial Island is 0.11 feet (NAVD 1988).

Table09. Summary of Field Observations - Aquifer Pumping Tests, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

Well ID	Date of Test	Test No.	Total Depth of Well (ft) [2]	Depth to Static Water Level (ft) [2]	Duration of Pumping Phase of Test (min)	Approximate Discharge Rates (gpm)	Duration of Discharge Rate (min)	Maximum Displacment at Specified Rate (ft)	Radius of well (in)	Volume of Well (gal) [3]	Volume of Water Produced (gal)
AM[1]	2/4/2004	1	20.9	6.74	140	0.25 0.5	80 60	5.4 12.3	0.17	48.5	40
AM[1]	2/4/2004	2	20.9	7.5	62	0.33	62	9.1	0.17	45.9	18
S	2/2/2004	1	37.2	11.83	305	0.25	305	19.9	0.08	74.6	77
AC	2/4/2004	1	27	9.64	283	0.25 0.5 0.75	78 174 31	2.3 6.4 10.3	0.08	51.0	116
AJ[1]	2/2/2004	1	35.3	8.16	275	0.25 0.5	148 127	7.3 23.2	0.17	93.0	75
AI[1]	2/3/2004	1	22	10.63	315	0.25 0.5 0.75	80 175 60	3.3 6.6 11.6	0.17	38.9	145
AD	1/30/2004	1	45.5	10.44	331	0.25 0.5	205 126	8.6 17.0	0.25	148.1	85
AB	1/29/2004	1	44.5	11.1	304	0.25 0.5 1 2	60 70 94 80	1.5 3.3 6.2 16.0	0.08	98.2	280

Notes:

[1] Well not completed, top of well approximately at land surface.

[2] From measuring point, approximately 2.5 feet above land surface.

[3] included volume of gravel pack

ft = feet

gal = gallons

Table 10. Slug Test Results, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

Well Identification	Monitored Lithologic Unit[1]	Test Type	Hydraulic Conductivity Results (ft/day)	Hydraulic Conductivity Results (cm/s)
Well N	Engineered Fill (10 to 20 ft bgs)	Falling Head Rising Head	0.144 0.0928	5.07×10^{-5} 3.28×10^{-5}
Well O	Engineered Fill (10 to 20 ft bgs)	Falling Head Rising Head	3.62 4.26	1.28×10^{-3} 1.50×10^{-3}
Well U	Vincentown formation (70 to 80 ft bgs)	Falling Head Rising Head	2.95 NA	1.04×10^{-3} NA

Notes

1	Lithologic units correspond with those outlined on cross sections A-A' through E-E'.
ft/day	Feet per day.
cm/s	Centimeters per second.
ft bgs	Feet below ground surface.
NA	Data not available. Test not performed

Table 11. Summary of Aquifer Pumping Test Results, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

		Pumping		Recovery	
Well ID	Date of Test	Transmissivity (ft^2/day)	Hydraulic Conductivity (ft/day)	Transmissivity (ft^2/day)	Hydraulic Conductivity (ft/day)
AM[1]	2/4/2004	1.403	0.14	0.572	0.06
AM[2]	2/4/2004	1.079	0.11	0.338	0.03
S	2/2/2004	1.701	0.17	1.096	0.11
AC	2/4/2004	12.63	1.26	1.672	0.17
AJ	2/2/2004	1.73	0.09	0.56	0.03
AI	2/3/2004	7.97	0.80	2.101	0.21
AD	1/30/2004	0.942	0.09	0.937	0.09
AB	1/29/2004	27.67	2.77	22.69	2.27

Notes:

[1] Results of the step drawdown test.

[2] Results of the constant rate test.

ft^2/day = square feet per day.

ft/day - feet per day.

Table 12. Groundwater Analytical Results, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

Well Identification	Sample Date	Tritium (pCi/L)	Major Cations and Anions		Gamma-Emmitting Isotopes (pCi/L)				
			Boron (ug/L)	Sodium (mg/L)	Potassium-40	Radium-Natural	Thorium-232	Thorium-234	Uranium-235
K[1]	02/05/03	**1,120**	**738**	**1,060**	**82.4**	**23.7**	<6.51	<50.4	**4.90**
K[2]	02/05/03	**1,070**	--	--	--	--	--	--	--
K	02/12/03	**506**	**557**	**727**	--	--	--	--	--
K	02/27/03	**1,170**	**803**	**1,210**	<20.4	**9.24**	<9.31	**128**	**5.76**
K	03/14/03	**937**	**1,380**	**1,200**	--	--	--	--	--
K	03/18/03	**875**	**1,190**	**1,060**	--	--	--	--	--
K	03/26/03	**822**	**966**	**1,070**	--	--	--	--	--
K	03/31/03	**677**	**1,150**	**1,190**	--	--	--	--	--
K	04/09/03	**1,010**	**1,290**	**1,290**	--	--	--	--	--
K	04/17/03	**1,170**	**1,160**	**1,370**	--	--	--	--	--
K	04/21/03	**911**	--	**1,240**	--	--	--	--	--
K	04/29/03	**833**	--	**1,240**	--	--	--	--	--
K	05/05/03	**948**	--	**1,210**	--	--	--	--	--
K	05/20/03	**878**	**1,240**	**1,200**	--	--	--	--	--
K	05/28/03	**859**	**1,020**	**1,210**	--	--	--	--	--
K	06/04/03	**921**	**980**	**1,240**	--	--	--	--	--
K	06/10/03	**897**	**1,260**	**1,260**	--	--	--	--	--
K	06/17/03	**894**	**1,040**	**1,220**	--	--	--	--	--
K	06/24/03	**783**	**1,080**	**1,250**	--	--	--	--	--
K	06/30/03	**914**	**1,190**	**1,300**	**61.0**	<1.31	<4.40	**241**	**6.06**
K	07/16/03	**870**	**1,140**	**1,300**	<13.6	**6.24**	<4.81	<59.6	**8.23**
K	07/29/03	**950**	**988**	**1,240**	<18.1	<3.93	<6.81	**166**	**5.57**
K	08/12/03	**845**	**1,130**	**1,190**	**57.4**	<4.62	<3.61	**132**	**5.82**
K	08/27/03	**852**	**1,020**	**1,220**	**41.3**	<2.15	<5.16	**160**	**4.79**
K	09/09/03	**653**	**1,160**	**1,170**	<21.4	<2.69	<6.02	<80.0	<5.50
K	09/25/03	**713**	**816**	**1,280**	**57.6**	<3.13	<4.69	**135**	<4.87
K	10/06/03	**880**	**1,150**	**1,250**	--	--	--	--	--
K	11/09/03	**891**	**919**	**1,330**	--	--	--	--	--

Notes:

ug/L	Micrograms per liter
mg/L	Milligrams per liter
pCi/L	Picocuries per liter
1,120	Constituent was detected above the laboratory method detection limit.
<20.4	Constituent was not detected above the laboratory detection limit.
--	Constituent not analyzed.
[1]	Grab groundwater sample collected during monitoring well installation.
[2]	Samples were re-analyzed to compare results.

Table 12: Groundwater Analytical Results, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

Well Identification	Sample Date	Tritium (pCi/L)	Major Cations and Anions		Gamma-Emmitting Isotopes (pCi/L)				
			Boron (ug/L)	Sodium (mg/L)	Potassium-40	Radium-Natural	Thorium-232	Thorium-234	Uranium-235
L[1]	01/27/03	<151	**533**	**1,900**	--	--	--	--	--
L	03/14/03	<143	--	--	--	--	--	--	--
L	03/18/03	<143	--	--	--	--	--	--	--
L	03/26/03	<141	--	--	--	--	--	--	--
L	04/02/03	<153	**2,170**	**2,260**	--	--	--	--	--
L	04/08/03	<142	--	--	--	--	--	--	--
L	04/15/03	<141	--	--	--	--	--	--	--
L	04/24/03	<139	--	--	--	--	--	--	--
L	04/29/03	<141	--	--	--	--	--	--	--
L	05/05/03	<134	--	--	--	--	--	--	--
L	05/15/03	<144	--	--	--	--	--	--	--
L	05/20/03	<144	--	--	--	--	--	--	--
L	05/28/03	<141	--	--	--	--	--	--	--
L	06/04/03	<140	--	--	--	--	--	--	--
L	06/10/03	<137	--	--	--	--	--	--	--
L	06/17/03	<141	--	--	--	--	--	--	--
L	06/24/03	<141	--	--	--	--	--	--	--
L	06/30/03	<140	**2,080**	**2,490**	<95.3	<5.55	<19.1	**447**	**12.3**
L	07/29/03	<141	**1,860**	**2,360**	<9.99	**6.47**	<5.08	**264**	**9.55**
L	08/27/03	<142	**1,950**	**2,330**	--	--	--	--	--
L	09/25/03	<140	**1,620**	**2,490**	--	--	--	--	--
L	12/16/03	<146	--	--	--	--	--	--	--
M[1]	02/12/03	**18,700**	**252**	**23.0**	**146**	**12.9**	<13.3	<43.2	**7.10**
M	02/28/03	**14,400**	**168**	**27.7**	**64.7**	<2.84	<6.48	**123**	<1.22
M	03/03/03	**9,420**	**164**	**26.6**	**62.7**	<2.44	<4.54	<42.8	<2.90
M	03/10/03	**15,000**	**234**	**23.6**	--	--	--	--	--
M	03/17/03	**10,600**	**207**	**22.2**	--	--	--	--	--
M	03/24/03	**10,100**	**171**	**26.3**	--	--	--	--	--
M	03/31/03	**11,000**	**161**	**23.1**	--	--	--	--	--
M	04/07/03	**9,260**	**177**	**24.3**	--	--	--	--	--
M	04/14/03	**9,600**	**186**	**23.9**	--	--	--	--	--

Notes:

ug/L	Micrograms per liter
mg/L	Milligrams per liter
pCi/L	Picocuries per liter
18,700	Constituent was detected above the laboratory method detection limit.
<141	Constituent was not detected above the laboratory detection limit.
--	Constituent not analyzed.
1	Grab groundwater sample collected during monitoring well installation.

Table 12. Groundwater Analytical Results, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

Well Identification	Sample Date	Tritium (pCi/L)	Major Cations and Anions		Gamma-Emmitting Isotopes (pCi/L)				
			Boron (ug/L)	Sodium (mg/L)	Potassium-40	Radium-Natural	Thorium-232	Thorium-234	Uranium-235
M[3]	04/21/03	**8,880**	--	**22.5**	--	--	--	--	--
M[3]	04/30/03	**8,800**	--	**23.7**	--	--	--	--	--
M[3]	07/09/03	**126,000**	**307**	**20.8**	<23.7	**43.9**	<3.70	<83.2	<4.13
M	07/23/03	**113,000**	**234**	**22.0**	**78.1**	<2.97	<7.30	<82.4	<4.52
M	08/06/03	**73,200**	**242**	**21.9**	**53.1**	**16.1**	<4.38	<38.9	<2.88
M	08/20/03	**62,000**	**274**	**22.5**	**48.1**	<2.17	<4.08	**169**	<4.31
M	09/04/03	**35,300**	**222**	**22.8**	**63.2**	**12.7**	<4.48	**178**	<337
M	09/16/03	**28,400**	**320**	**24.5**	**47.7**	**7.26**	<3.97	<148	<412
M	10/03/03	**25,400**	**266**	**25.0**	**49.0**	**11.8**	<4.46	**116**	<479
M	10/20/03	**16,380**	--	--	--	--	--	--	--
M	12/04/03	**9,010**	--	--	--	--	--	--	--
M	01/06/04	**11,400**	--	--	--	--	--	--	--
N[1]	01/30/03	**69,000**	**339**	**14.3**	<41.2	**32**	<5.25	<38.4	<3.37
N[2]	01/30/03	**58,400**	**370**	**14.4**	--	--	--	--	--
N	02/10/03	**15,600**	**276**	**10.6**	--	--	--	--	--
N	03/04/03	**2,770**	**197**	**34.3**	**62.5**	**43.9**	<7.23	<47.0	**4.99**
N	03/14/03	**2,670**	**408**	**24.0**	--	--	--	--	--
N	03/17/03	**3,830**	**362**	**20.5**	--	--	--	--	--
N	03/25/03	**3,480**	**238**	**18.1**	--	--	--	--	--
N	04/04/03	**3,560**	**210**	**19.6**	--	--	--	--	--
N	04/11/03	**3,730**	**249**	**19.3**	--	--	--	--	--
N	04/16/03	**3,910**	**228**	**22.2**	--	--	--	--	--
N	04/25/03	**4,600**	--	**16.2**	--	--	--	--	--
N	04/30/03	**9,370**	--	**15.8**	--	--	--	--	--
N	05/06/03	**9,830**	--	**19.8**	--	--	--	--	--
N	05/21/03	**7,480**	**299**	**19.2**	--	--	--	--	--
N	05/27/03	**7,130**	**225**	**17.6**	--	--	--	--	--
N	06/04/03	**5,480**	**233**	**20.0**	--	--	--	--	--
N	06/11/03	**4,990**	**304**	**19.8**	--	--	--	--	--

Notes:

ug/L	Micrograms per liter
mg/L	Milligrams per liter
pCi/L	Picocuries per liter
18,700	Constituent was detected above the laboratory method detection limit.
<141	Constituent was not detected above the laboratory detection limit.
--	Constituent not analyzed.
[1]	Grab groundwater sample collected during monitoring well installation.
[2]	Samples were re-analyzed to compare results.
[3]	Well M was replaced in May 2003 with a properly constructed Monitoring Well. Prior to this, Well M was installed as a temporary well constructed with mill-slotted steel

Table 12. Groundwater Analytical Results, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

Well Identification	Sample Date	Tritium (pCi/L)	Major Cations and Anions		Gamma-Emmitting Isotopes (pCi/L)				
			Boron (ug/L)	Sodium (mg/L)	Potassium-40	Radium-Natural	Thorium-232	Thorium-234	Uranium-235
N	06/19/03	**5,680**	**217**	**18.4**	--	--	--	--	--
N	06/25/03	**5,060**	**268**	**17.1**	--	--	--	--	--
N	07/10/03	**5,020**	**268**	**17.5**	<21.1	**5.37**	<4.48	<64.5	**8.10**
N	07/25/03	**5,220**	**217**	**19.6**	<13.0	<2.38	<4.19	**153**	<4.52
N	08/07/03	**5,110**	**210**	**23.5**	<15.4	**14.7**	<4.70	<93.5	**11.0**
N	08/20/03	**5,850**	**247**	**20.4**	<9.32	<2.41	<4.00	<160	<4.06
N	09/04/03	**5,660**	**334**	**22.8**	<16.1	<1.75	<4.54	<52.9	3.96
N	09/17/03	**6,160**	**267**	**22.4**	**67.9**	<2.51	<5.90	<57.1	<4.81
N	10/03/03	**5,740**	**240**	**24.0**	<31.7	**6.37**	<3.87	166	<1.25
N	11/03/03	**5,560**	--	--	--	--	--	--	--
N	12/12/03	**6,010**	--	--	--	--	--	--	--
N	01/20/04	**6,460**	--	--	--	--	--	--	--
O[1]	01/29/03	**1,220**	**156**	**40.5**	**930**	**62.9**	**88.5**	**177**	**16.5**
O[2]	01/29/03	**1,400**	**172**	**40.4**	--	--	--	--	--
O	02/10/03	**10,300**	**97**	**13.2**	--	--	--	--	--
O	02/21/03	**7,370**	**89**	**15.4**	--	--	--	--	--
O	02/28/03	**11,700**	**89**	**17.0**	<14.8	**9.12**	<6.97	**120**	**4.04**
O	03/04/03	**8,800**	**71**	**20.8**	--	--	--	--	--
O	03/13/03	**12,300**	**108**	**15.5**	--	--	--	--	--
O	03/17/03	**11,000**	**83**	**11.9**	--	--	--	--	--
O	03/25/03	**8,660**	**98**	**11.7**	--	--	--	--	--
O	03/31/03	**8,010**	**64**	**13.9**	--	--	--	--	--
O	04/07/03	**7,290**	**77**	**8.8**	--	--	--	--	--
O	04/15/03	**12,400**	**85**	**10.0**	--	--	--	--	--
O	04/21/03	**11,800**	--	**11.5**	--	--	--	--	--
O	04/29/03	**10,500**	--	**12.3**	--	--	--	--	--
O	05/06/03	**10,200**	--	**11.2**	--	--	--	--	--
O	05/21/03	**11,100**	**108**	**10.3**	--	--	--	--	--
O	05/28/03	**12,700**	**183**	**11.9**	--	--	--	--	--

Notes:

ug/L	Micrograms per liter
mg/L	Milligrams per liter
pCi/L	Picocuries per liter
12,400	Constituent was detected above the laboratory method detection limit.
<16.1	Constituent was not detected above the laboratory detection limit.
--	Constituent not analyzed.
1	Grab groundwater sample collected during monitoring well installation.
2	Samples were re-analyzed to compare results.

Table 12. Groundwater Analytical Results, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

Well Identification	Sample Date	Tritium (pCi/L)	Major Cations and Anions		Gamma-Emmitting Isotopes (pCi/L)				
			Boron (ug/L)	Sodium (mg/L)	Potassium-40	Radium-Natural	Thorium-232	Thorium-234	Uranium-235
O	06/08/03	**12,200**	**140**	**13.5**	--	--	--	--	--
O	06/10/03	**12,800**	**183**	**14.3**	--	--	--	--	--
O	06/17/03	**10,300**	**204**	**14.9**	--	--	--	--	--
O	06/24/03	**13,400**	**252**	**14.7**	--	--	--	--	--
O	07/09/03	**9,100**	**272**	**14.6**	<21.2	<2.66	<6.62	<123	<3.43
O	07/25/03	**7,710**	**234**	**13.5**	<37.8	**6.34**	<4.13	<199	**3.95**
O	08/06/03	**8,300**	**240**	**14.4**	**39.2**	**10.8**	<4.26	<148	<4.13
O	08/20/03	**7,440**	**305**	**13.9**	<16.4	<2.58	<3.82	**164**	<4.31
O	09/03/03	**6,400**	**282**	**13.5**	**46.2**	<2.58	<3.82	**164**	<4.31
O	09/15/03	**5,110**	**270**	**12.9**	<2.62	**6.13**	<6.96	**58.2**	<3.52
O	10/03/03	**6,980**	**233**	**23.2**	**4.30**	**10.7**	<3.55	<92.9	<3.45
O	10/20/03	**6,700**	**201**	**47.0**	--	--	--	--	--
O	12/18/03	**7,060**	--	--	--	--	--	--	--
P[1]	02/06/03	<153	--	--	--	--	--	--	--
P	02/21/03	<148	--	--	--	--	--	--	--
P	03/13/03	**303**	**417**	**1,080**	--	--	--	--	--
P	03/18/03	**465**	**199**	**699**	--	--	--	--	--
P	03/26/03	<143	**336**	**698**	--	--	--	--	--
P	04/03/03	<154	**241**	**1,110**	--	--	--	--	--
P	04/24/03	<139	--	--	--	--	--	--	--
P	04/29/03	<144	--	--	--	--	--	--	--
P	05/05/03	<134	--	--	--	--	--	--	--
P	05/20/03	<145	--	--	--	--	--	--	--
P	05/30/03	<142	--	--	--	--	--	--	--
P	06/04/03	<141	--	--	--	--	--	--	--
P	06/10/03	<138	--	--	--	--	--	--	--
P	06/17/03	<141	--	--	--	--	--	--	--
P	06/24/03	<141	--	--	--	--	--	--	--
P	07/16/03	<141	**485**	**1,580**	**60.7**	<3.56	<5.04	**127**	**3.46**
P	08/13/03	<140	**480**	**1,570**	**47.5**	**3.21**	<4.54	<1.98	<4.34
P	09/09/03	<147	**645**	**1,560**	**63.8**	**11.8**	**6.19**	**54.8**	<5.02
P	10/06/03	<143	**481**	**1,610**	--	--	--	--	--

Notes:

ug/L	Micrograms per liter
mg/L	Milligrams per liter
pCi/L	Picocuries per liter
303	Constituent was detected above the laboratory method detection limit.
<3.56	Constituent was not detected above the laboratory detection limit.
--	Constituent not analyzed.
1	Grab groundwater sample collected during monitoring well installation.

Table 12. Groundwater Analytical Results, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

Well Identification	Sample Date	Tritium (pCi/L)	Major Cations and Anions		Gamma-Emmitting Isotopes (pCi/L)				
			Boron (ug/L)	Sodium (mg/L)	Potassium-40	Radium-Natural	Thorium-232	Thorium-234	Uranium-235
Q	03/14/03	<143	--	--	--	--	--	--	--
Q	03/19/03	<143	--	--	--	--	--	--	--
Q	03/24/03	<143	--	--	--	--	--	--	--
Q	04/23/03	<139	--	--	--	--	--	--	--
Q	04/30/03	<142	--	--	--	--	--	--	--
Q	05/06/03	<135	--	--	--	--	--	--	--
Q	05/12/03	<144	--	--	--	--	--	--	--
Q	05/19/03	<144	--	--	--	--	--	--	--
Q	05/30/03	<140	--	--	--	--	--	--	--
Q	06/05/03	<139	--	--	--	--	--	--	--
Q	06/11/03	<138	--	--	--	--	--	--	--
Q	06/16/03	<141	--	--	--	--	--	--	--
Q	06/23/03	<143	--	--	--	--	--	--	--
Q	07/17/03	<141	**340**	**2,100**	**151**	<5.78	<13.9	<88.4	**8.99**
Q	08/13/03	<142	**315**	**1,830**	85.7	5.63	<4.09	<7.45	<3.06
Q	09/10/03	<148	**247**	**1,790**	86.8	30.2	<5.42	98.1	5.53
Q	10/07/03	<144	**331**	**1,920**	--	--	--	--	--
Q	11/09/03	<142	**317**	**1,930**	--	--	--	--	--
R [1,2]	02/26/03	**13,900**	**288**	**42.6**	**258**	**15.0**	<8.58	**122**	**7.49**
R [2]	03/03/03	**7,490**	**229**	**37.3**	**80.5**	**7.37**	<8.73	**144**	**5.75**
R [2]	03/10/03	**6,170**	**270**	**28.7**	--	--	--	--	--
R [2]	03/17/03	**7,270**	**269**	**33.4**	--	--	--	--	--
R [2]	03/25/03	**6,810**	**248**	**32.4**	--	--	--	--	--
R [2]	04/01/03	**6,740**	**216**	**34.8**	--	--	--	--	--
R [2]	04/08/03	**5,940**	**251**	**33.3**	--	--	--	--	--
R [2]	04/14/03	**5,890**	**255**	**33.4**	--	--	--	--	--
R [2]	04/22/03	**5,800**	--	**32.6**	--	--	--	--	--
R [2]	04/30/03	**5,260**	--	**31.8**	--	--	--	--	--
R	07/09/03	**3,270**	**511**	**57.4**	**58.2**	**33.4**	<4.73	<36.6	<3.18

Notes:

ug/L	Micrograms per liter
mg/L	Milligrams per liter
pCi/L	Picocuries per liter
6,740	Constituent was detected above the laboratory method detection limit.
<4.73	Constituent was not detected above the laboratory detection limit.
--	Constituent not analyzed.
1	Grab groundwater sample collected during monitoring well installation.
2	Well R was replaced in May 2003 with a properly constructed Monitoring Well. Prior to this, Well R was installed as a temporary well constructed with mill-slotted steel

Table 12. Groundwater Analytical Results, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

Well Identification	Sample Date	Tritium (pCi/L)	Major Cations and Anions		Gamma-Emmitting Isotopes (pCi/L)				
			Boron (ug/L)	Sodium (mg/L)	Potassium-40	Radium-Natural	Thorium-232	Thorium-234	Uranium-235
R	07/25/03	**2,940**	**403**	**48.7**	<14.2	<2.40	<4.91	**226**	<3.98
R	08/06/03	**2,860**	**457**	**53.6**	**52.2**	**14.0**	<4.29	**112**	<4.03
R	08/20/03	**2,861**	**505**	**48.1**	**92.1**	<2.46	<5.91	<78.0	<3.43
R	09/04/03	**2,987**	**567**	**45.6**	<18.0	**6.2**	<4.20	<78.7	<2.61
R	09/17/03	**2,797**	**472**	**49.6**	**59.3**	**5.8**	<4.48	**139**	<4.35
R	10/03/03	**2,740**	**402**	**51.8**	**61.6**	**11.8**	<4.51	<49.7	<2.92
R	10/21/03	**2,650**	--	--	--	--	--	--	--
R	12/05/03	**2,550**	**367**	**49.9**	--	--	--	--	--
S	07/09/03	**3,530,000**	**57,400**	**67.0**	<19.4	**52.0**	<5.06	<50.6	<9.62
S^2	07/09/03	**3,450,000**	--	--	--	--	--	--	--
S	08/07/03	**2,920,000**	--	--	--	--	--	--	--
S	08/21/03	**2,570,000**	--	--	--	--	--	--	--
S	09/03/03	**2,390,000**	--	--	--	--	--	--	--
S	09/15/03	**2,340,000**	--	--	--	--	--	--	--
S	10/04/03	**2,180,000**	--	--	--	--	--	--	--
S	10/13/03	**2,030,000**	--	--	--	--	--	--	--
S	10/20/03	**2,060,000**	--	--	--	--	--	--	--
S	11/09/03	**1,960,000**	--	--	--	--	--	--	--
S	11/26/03	**2,660,000**	--	--	--	--	--	--	--
S	01/20/04	**1,420,000**	--	--	--	--	--	--	--
T	07/10/03	<147	**680**	**1,040**	**51.0**	**87.7**	<4.67	**111**	<1.53
T	07/15/03	<140	**645**	**1,150**	**63.4**	**43.2**	<7.56	<114	<3.85
T	07/30/03	<141	**601**	**969**	**72.3**	<3.41	<4.49	<49.8	<3.33
T	08/12/03	<140	**637**	**931**	**59.7**	**3.67**	<4.38	<91.2	<3.01
T	08/28/03	<141	**660**	**896**	**73.3**	**11.4**	<4.31	**121**	**6.17**
T	09/09/03	<147	**633**	**899**	**75.5**	**18.7**	<4.40	**184**	<3.61
T	09/25/03	<142	**633**	**912**	<3.94	**7.35**	<5.87	<68.3	<5.08
T	10/06/03	<146	**650**	**966**	--	--	--	--	--
T	12/12/03	<149	--	--	--	--	--	--	--

Notes:

ug/L	Micrograms per liter
mg/L	Milligrams per liter
pCi/L	Picocuries per liter
680	Constituent was detected above the laboratory method detection limit.
<3.41	Constituent was not detected above the laboratory detection limit.
--	Constituent not analyzed.
^{2}	Samples were re-analyzed to compare results.

Table 12. Groundwater Analytical Results, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

Well Identification	Sample Date	Tritium (pCi/L)	Major Cations and Anions		Gamma-Emmitting Isotopes (pCi/L)				
			Boron (ug/L)	Sodium (mg/L)	Potassium-40	Radium-Natural	Thorium-232	Thorium-234	Uranium-235
U	07/10/03	<136	**389**	**178**	**88.4**	**13.6**	<7.18	<48.6	<4.55
U	07/16/03	**146**	**380**	**175**	**77.4**	**14.5**	<4.56	<35.2	<4.01
U	07/29/03	<141	**421**	**146**	**53.2**	<3.09	<4.05	**153**	<3.90
U	08/12/03	<139	**341**	**139**	**64.6**	<2.13	<4.65	**201**	<1.16
U	08/27/03	<143	**347**	**144**	<43.3	**4.20**	<4.55	<136	<3.62
U	09/09/03	**148**	**376**	**139**	<36.8	<3.97	<4.60	**107**	**5.30**
U	09/25/03	<139	**335**	**155**	<23.3	<1.79	<4.58	<46.9	<3.59
U	10/06/03	**203**	**354**	**140**	--	--	--	--	--
U	12/12/03	<148	--	--	--	--	--	--	--
V	07/21/03	**334**	**489**	**609**	**43.0**	<1.86	<4.01	<5.68	<2.78
V	07/29/03	**285**	**431**	**592**	**47.4**	<3.26	<4.71	**164**	<4.63
V	08/12/03	**278**	**495**	**568**	**39.0**	<1.60	<3.95	<143	<2.47
V	08/27/03	**338**	**607**	**584**	<16.8	<1.81	<3.97	<53.3	<3.21
V	09/09/03	**337**	**571**	**582**	<15.7	<4.35	<4.06	**116**	**5.23**
V	09/25/03	**261**	**472**	**670**	<43.5	<1.79	<4.30	**171**	**4.65**
V	10/06/03	**185**	**463**	**543**	--	--	--	--	--
V	11/19/03	**549**	--	--	--	--	--	--	--
V	12/12/03	**207**	--	--	--	--	--	--	--
W	07/07/03	**10,500**	**490**	**220**	<15.9	**9.51**	<3.36	**98.2**	<4.56
W	07/21/03	**11,100**	**491**	**227**	**67.7**	<1.73	<3.11	<59.0	<2.65
W	08/06/03	**11,500**	**464**	**211**	**74.2**	<2.78	<7.46	<94.1	<4.62
W	08/07/03	**6,010**	--	--	--	--	--	--	--
W	08/19/03	**7,660**	**591**	**215**	60.1	<2.43	<5.86	<135	<5.29
W	09/03/03	**8,110**	**533**	**222**	<45.1	<1.76	<3.82	111	5.80
W	09/15/03	**8,710**	**566**	**237**	55.2	<2.43	<4.33	158	<1.23
W	10/03/03	**11,100**	**455**	**240**	<68.1	<3.82	<6.46	<51.9	<5.91
W	10/21/03	**8,260**	--	--	--	--	--	--	--
W	11/17/03	**12,200**	--	--	--	--	--	--	--
W	11/19/03	**13,200**	--	--	--	--	--	--	--
W	12/16/03	**15,500**	--	--	--	--	--	--	--
W	01/14/04	**11,400**	--	--	--	--	--	--	--

Notes:

mg/L	Milligrams per liter
pCi/L	Picocuries per liter
10,500	Constituent was detected above the laboratory method detection limit.
<148	Constituent was not detected above the laboratory detection limit.
--	Constituent not analyzed.

Table 12. Groundwater Analytical Results, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey.

Well Identification	Sample Date	Tritium (pCi/L)	Major Cations and Anions		Gamma-Emmitting Isotopes (pCi/L)				
			Boron (ug/L)	Sodium (mg/L)	Potassium-40	Radium-Natural	Thorium-232	Thorium-234	Uranium-235
Y	10/27/03	<142	--	--	--	--	--	--	--
Y	11/09/03	<143	--	--	--	--	--	--	--
Y	11/19/03	<3,750	--	--	--	--	--	--	--
Y	11/25/03	<141	**822**	**1,070**	--	--	--	--	--
Y	12/12/03	<148	--	--	--	--	--	--	--
Y	12/22/03	<147	--	--	--	--	--	--	--
Z	10/27/03	**573**	--	--	--	--	--	--	--
Z	11/09/03	<140	--	--	--	--	--	--	--
Z	11/19/03	**729**	--	--	--	--	--	--	--
Z	11/24/03	**583**	**498**	**519**	--	--	--	--	--
Z	12/12/03	**621**	--	--	--	--	--	--	--
Z	12/22/03	**659**	--	--	--	--	--	--	--
AA	10/27/03	**613**	--	--	--	--	--	--	--
AA	11/10/03	**645**	--	--	--	--	--	--	--
AA	11/19/03	**734**	--	--	--	--	--	--	--
AA	11/24/03	**639**	**247**	**253**	--	--	--	--	--
AA	12/10/03	**785**	--	--	--	--	--	--	--
AA	12/22/03	**682**	--	--	--	--	--	--	--
AA	01/06/04	**713**	--	--	--	--	--	--	--
AB	10/28/03	**292,000**	--	--	--	--	--	--	--
AB	11/02/03	**280,000**	--	--	--	--	--	--	--
AB	11/19/03	**321,000**	--	--	--	--	--	--	--
AB	12/04/03	**409,000**	--	--	--	--	--	--	--
AB	12/16/03	**396,000**	--	--	--	--	--	--	--
AB	01/14/03	**281,000**	--	--	--	--	--	--	--

Notes:

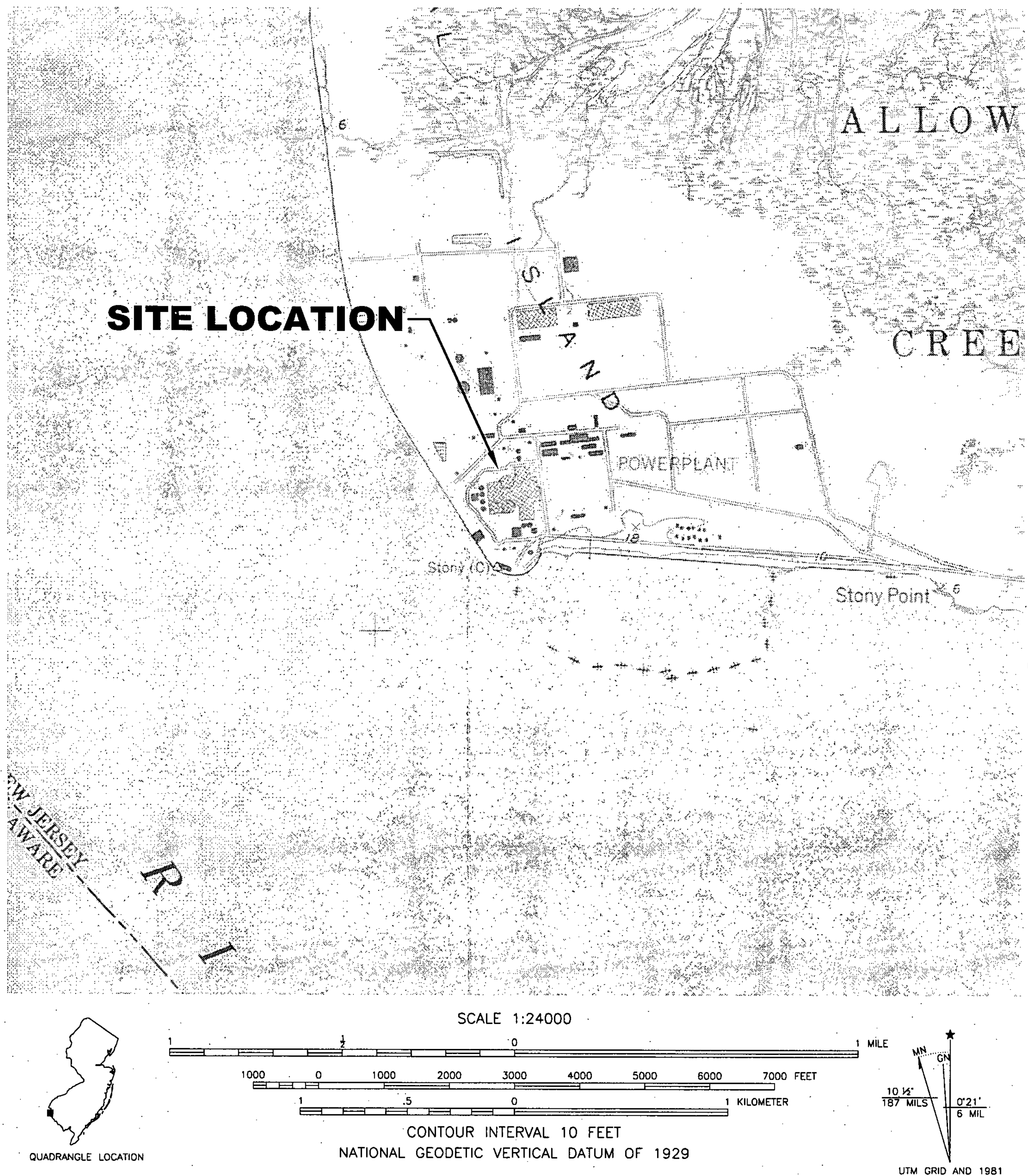
mg/L	Milligrams per liter
pCi/L	Picocuries per liter
613	Constituent was detected above the laboratory method detection limit.
<140	Constituent was not detected above the laboratory detection limit.
--	Constituent not analyzed.

Table 12. Groundwater Analytical Results, PSEG Nuclear, LLC, Salem Generating Station, Hancock's Bridge, New Jersey

Well Identification	Sample Date	Tritium (pCi/L)	Major Cations and Anions		Gamma-Emmitting Isotopes (pCi/L)				
			Boron (ug/L)	Sodium (mg/L)	Potassium-40	Radium-Natural	Thorium-232	Thorium-234	Uranium-235
AC	10/28/03	**10,900,000**	**253,000**	**30.8**	--	--	--	--	--
AC	11/03/03	**14,200,000**	**332,000**	**30.4**	--	--	--	--	--
AC	11/18/03	**14,200,000**	--	--	--	--	--	--	--
AC	12/18/03	**15,000,000**	--	--	--	--	--	--	--
AC	01/20/04	**10,700,000**	--	--	--	--	--	--	--
AD	10/27/03	**244,000**	--	--	--	--	--	--	--
AD	11/02/03	**242,000**	--	--	--	--	--	--	--
AD	11/17/03	**225,000**	--	--	--	--	--	--	--
AD	12/04/03	**392,000**	--	--	--	--	--	--	--
AD	12/16/03	**487,000**	--	--	--	--	--	--	--
AD	01/14/04	**220,000**	--	--	--	--	--	--	--
AE	10/27/03	**5,990**	--	--	--	--	--	--	--
AE	11/02/03	**5,710**	--	--	--	--	--	--	--
AE	11/19/03	**6,910**	**234**	**14.2**	--	--	--	--	--
AE	12/04/03	**6,310**	--	--	--	--	--	--	--
AE	12/18/03	**16,100**	--	--	--	--	--	--	--
AE	01/14/04	**12,600**	--	--	--	--	--	--	--
AF	10/07/03	<142	**380**	**227**	--	--	--	--	--
AF	10/27/03	**242**	--	--	--	--	--	--	--
AF	11/10/03	**330**	--	--	--	--	--	--	--
AF	11/19/03	**256**	--	--	--	--	--	--	--
AF	11/24/03	**245**	**429**	**545**	--	--	--	--	--
AF	12/10/03	**343**	--	--	--	--	--	--	--
AF	12/22/03	**302**	--	--	--	--	--	--	--

Notes:

mg/L	Milligrams per liter
pCi/L	Picocuries per liter
242	Constituent was detected above the laboratory method detection limit.
<142	Constituent was not detected above the laboratory detection limit.
--	Constituent not analyzed.



SOURCE: USGS 7.5 MIN. TOPOGRAPHICAL QUADRANGLE TAYLORS BRIDGE, DEL-N.J. 1948, PHOTOREVISED 1981.

ARCADIS

DRAWN: M. WASILEWSKI
DATE: 2/27/04
PROJECT MANAGER: P. MILIONIS
DEPARTMENT MANAGER: D. FULTON

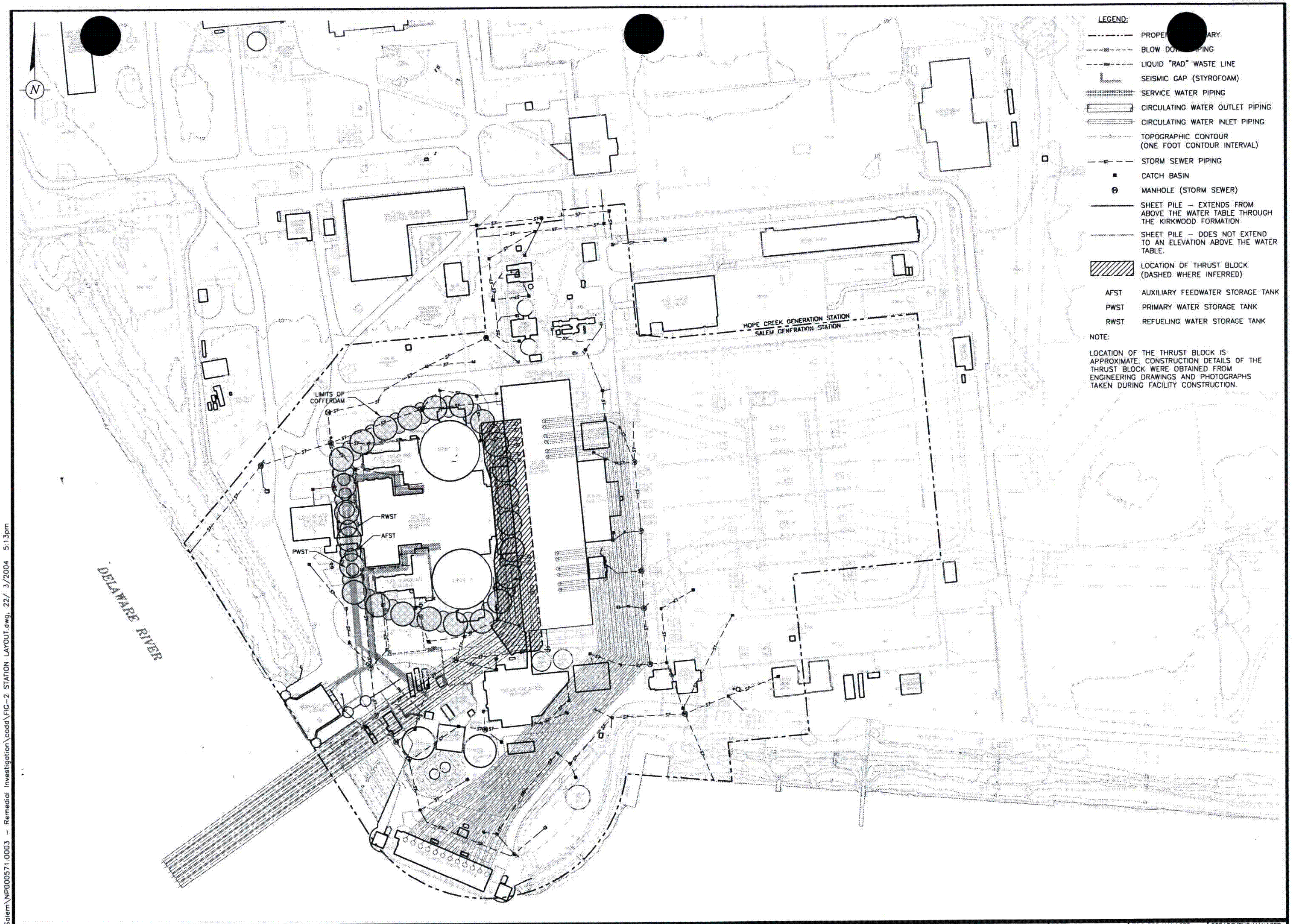
SITE LOCATION

LEAD DESIGN PROF.: S. POTTER
CHECKED: B. PIERCE

PSEG NUCLEAR, LLC
SALEM GENERATING STATION
ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

PROJECT NUMBER: NP000571.0003
DRAWING NUMBER: 1

G:\APROJECT\PSE&G\Salem\NP000571.0003 - Remedial Investigation\cadd\FIG-1 STATION LOCATION.DWG 2/27/2004 - 2:30:44 PM Layout: 8.5x11 H



LEGEND:

PROPE[illegible]ARY
BLOW DO[illegible]PING
LIQUID "RAD" WASTE LINE
SEISMIC GAP (STYROFOAM)
SERVICE WATER PIPING
CIRCULATING WATER OUTLET PIPING
CIRCULATING WATER INLET PIPING
TOPOGRAPHIC CONTOUR (ONE FOOT CONTOUR INTERVAL)
STORM SEWER PIPING
CATCH BASIN
MANHOLE (STORM SEWER)
SHEET PILE – EXTENDS FROM ABOVE THE WATER TABLE THROUGH THE KIRKWOOD FORMATION
SHEET PILE – DOES NOT EXTEND TO AN ELEVATION ABOVE THE WATER TABLE.
LOCATION OF THRUST BLOCK (DASHED WHERE INFERRED)

AFST	AUXILIARY FEEDWATER STORAGE TANK
PWST	PRIMARY WATER STORAGE TANK
RWST	REFUELING WATER STORAGE TANK

NOTE:

LOCATION OF THE THRUST BLOCK IS APPROXIMATE. CONSTRUCTION DETAILS OF THE THRUST BLOCK WERE OBTAINED FROM ENGINEERING DRAWINGS AND PHOTOGRAPHS TAKEN DURING FACILITY CONSTRUCTION.

G:\APROJECT\PSE&G\Salem\NP000571.0003 - Remedial Investigation\cadd\FIG-2 STATION LAYOUT.dwg, 22/ 3/2004 5:13pm

0 150 300
SCALE: 1"=150'

NO.	DATE	REVISION DESCRIPTION	BY / CKD

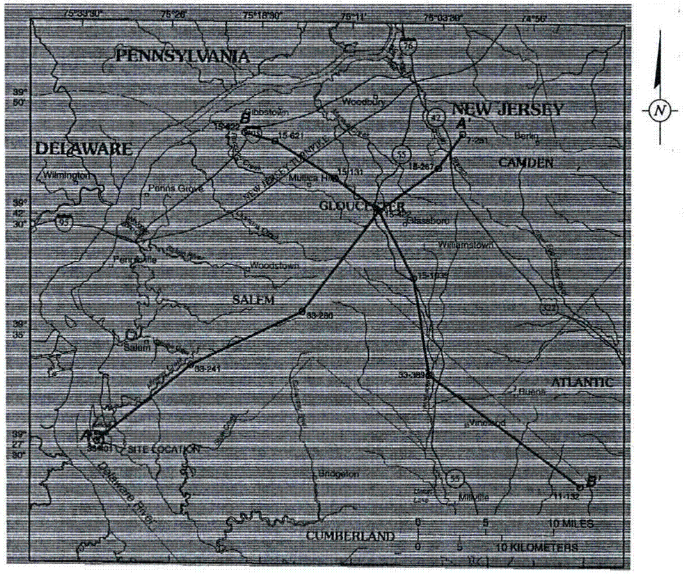
ARCADIS
6 Terry Drive
Suite 300 , Newtown, PA 18940
Tel: 267/685-1800 Fax: 267/685-1801

PSEG NUCLEAR, LLC
SALEM GENERATING STATION

ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

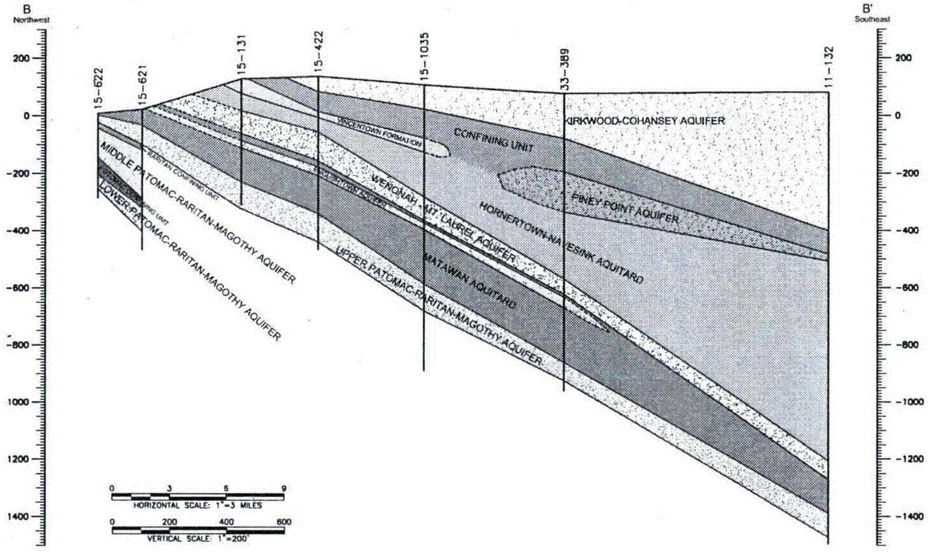
DRAWN M. WASILEWSKI
DATE 2/27/04
STATION LAYOUT

PROJECT MANAGER P. MILIONIS
DEPARTMENT MANAGER D. FULTON
LEAD DESIGN PROF. S. POTTER
CHECKED B. PIERCE
PROJECT NUMBER NP000571.0003
DRAWING NUMBER 2



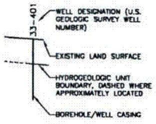
SOURCE:

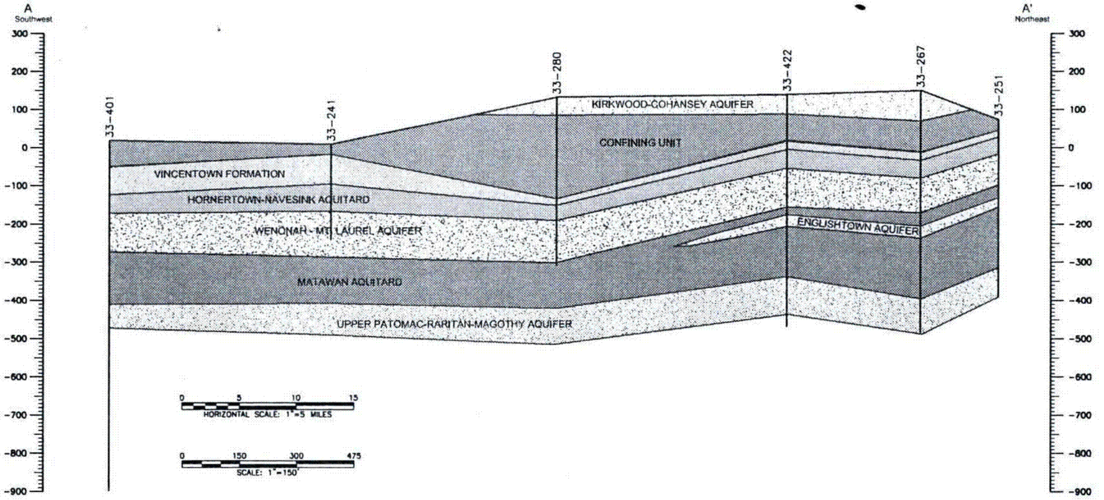
CAULLER, STEPHEN J., GLEN B. CARLETON, MELISSA J. STORCK; HYDROGEOLOGY OF, WATER WITHDRAWAL FROM, AND WATER LEVELS AND CHLORIDE CONCENTRATIONS IN THE MAJOR COASTAL PLAIN AQUIFERS OF GLOUCESTER AND SALEM COUNTIES, NEW JERSEY; UNITED STATES GEOLOGIC SURVEY WATER-RESOURCES INVESTIGATION REPORT 98-4136, 1999.



LEGEND:

- ░ KIRKWOOD-COHANSEY AQUIFER
- ▒ CONFINING UNIT
- ▒ PINEY POINT AQUIFER
- ░ VINCENTOWN FORMATION
- ▒ HORNERTOWN-NAVESINK AQUITARD
- ░ WENONAH - MT. LAUREL AQUIFER
- ▓ MATAWAN AQUITARD
- ░ ENGLISHTOWN AQUIFER
- ░ UPPER PATOMAC-RARITAN-MAGOTHY AQUIFER
- ▒ RARITAN CONFINING UNIT
- ░ MIDDLE PATOMAC-RARITAN-MAGOTHY AQUIFER
- ▓ POTOMAC CONFINING UNIT
- ░ LOWER PATOMAC-RARITAN-MAGOTHY AQUIFER





NO.	DATE	REVISION DESCRIPTION	BY / CKD

PSEG NUCLEAR, LLC
SALEM GENERATING STATION

ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

REGIONAL CROSS SECTIONS

ARCADIS
8 Terry Drive
Suite 300 , Newtown, PA 18940
Tel: 267/885-1800 Fax: 267/885-1801

PROJECT MANAGER
P. MILIONIS

DEPARTMENT MANAGER
D. FULTON

LEAD DESIGN PROF.
S. POTTER

CHECKED
B. PIERCE

DRAWN
M. WASILEWSKI

DATE
2/27/04

PROJECT NUMBER
NP000571.0003

DRAWING NUMBER
3

LEGEND:

WELL S ⊗	MONITORIN [illegible] SCREENED IN THE SHALLOW, WATER TABLE AQUIFER (RI-2003)
WELL L ◎	MONITORING WELL SCREENED IN THE VINCENTOWN FORMATION (RI-2003)
68 ⊕	SOIL BORING LOCATION (PREFACILITY CONSTRUCTION)
63.00	ELEVATION OF CLAY UNIT (PLANT DATUM)
—67.50	CONTOUR (2.5 FOOT INTERVAL) DASHED WHERE INFERRED
—··—··—	PROPERTY BOUNDARY
	BLOW DOWN PIPING
	LIQUID "RAD" WASTE LINE
	SERVICE WATER PIPING
	CIRCULATING WATER OUTLET PIPING
	CIRCULATING WATER INLET PIPING
	STORM SEWER PIPING
	CATCH BASIN
	MANHOLE (STORM SEWER)
———	SHEET PILE – EXTENDS FROM ABOVE THE WATER TABLE THROUGH THE KIRKWOOD FORMATION
———	SHEET PILE – DOES NOT EXTEND TO AN ELEVATION ABOVE THE WATER TABLE.
AFST	AUXILIARY FEEDWATER STORAGE TANK
PWST	PRIMARY WATER STORAGE TANK
RWST	REFUELING WATER STORAGE TANK

G:\APROJECT\PSE&G\Salem\NP000571.0003 – Remedial Investigation\cadd\FIG-4 SURFACE ELEVATION OF THE KIRKWOOD FORMATION.dwg, 27/ 2/2004 2:56pm

0 150 300
SCALE: 1"=150'

NO.	DATE	REVISION DESCRIPTION	BY / CKD

ARCADIS
6 Terry Drive
Suite 300 , Newtown, PA 18940
Tel: 267/685-1800 Fax: 267/685-1801

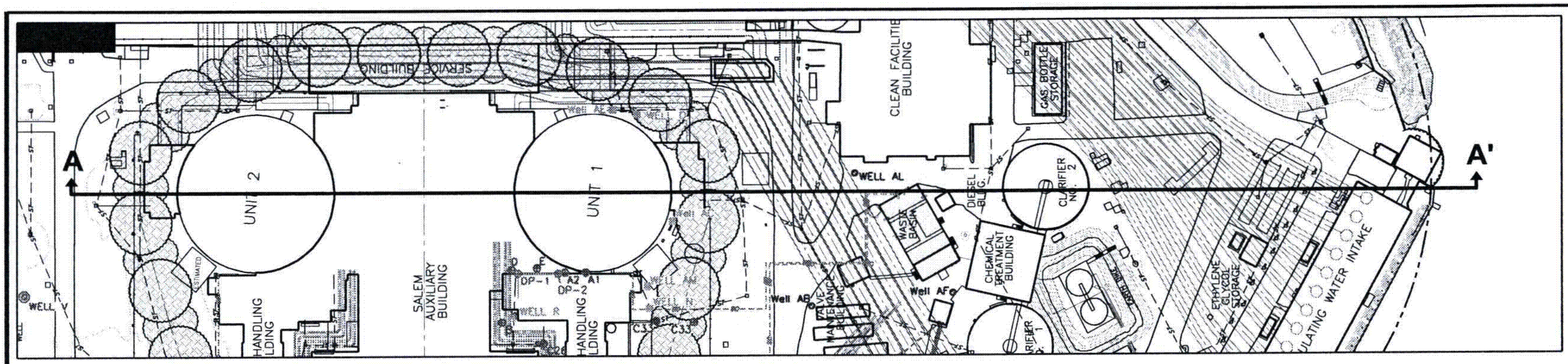
PSEG NUCLEAR, LLC
SALEM GENERATING STATION

ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

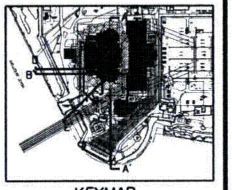
DRAWN M. WASILEWSKI
DATE 2/27/04
PROJECT MANAGER P. MILIONIS
DEPARTMENT MANAGER D. FULTON
LEAD DESIGN PROF S. POTTER
CHECKED B. PIERCE

SURFACE ELEVATION OF THE KIRKWOOD FORMATION

PROJECT NUMBER NP000571.0003
DRAWING NUMBER 4

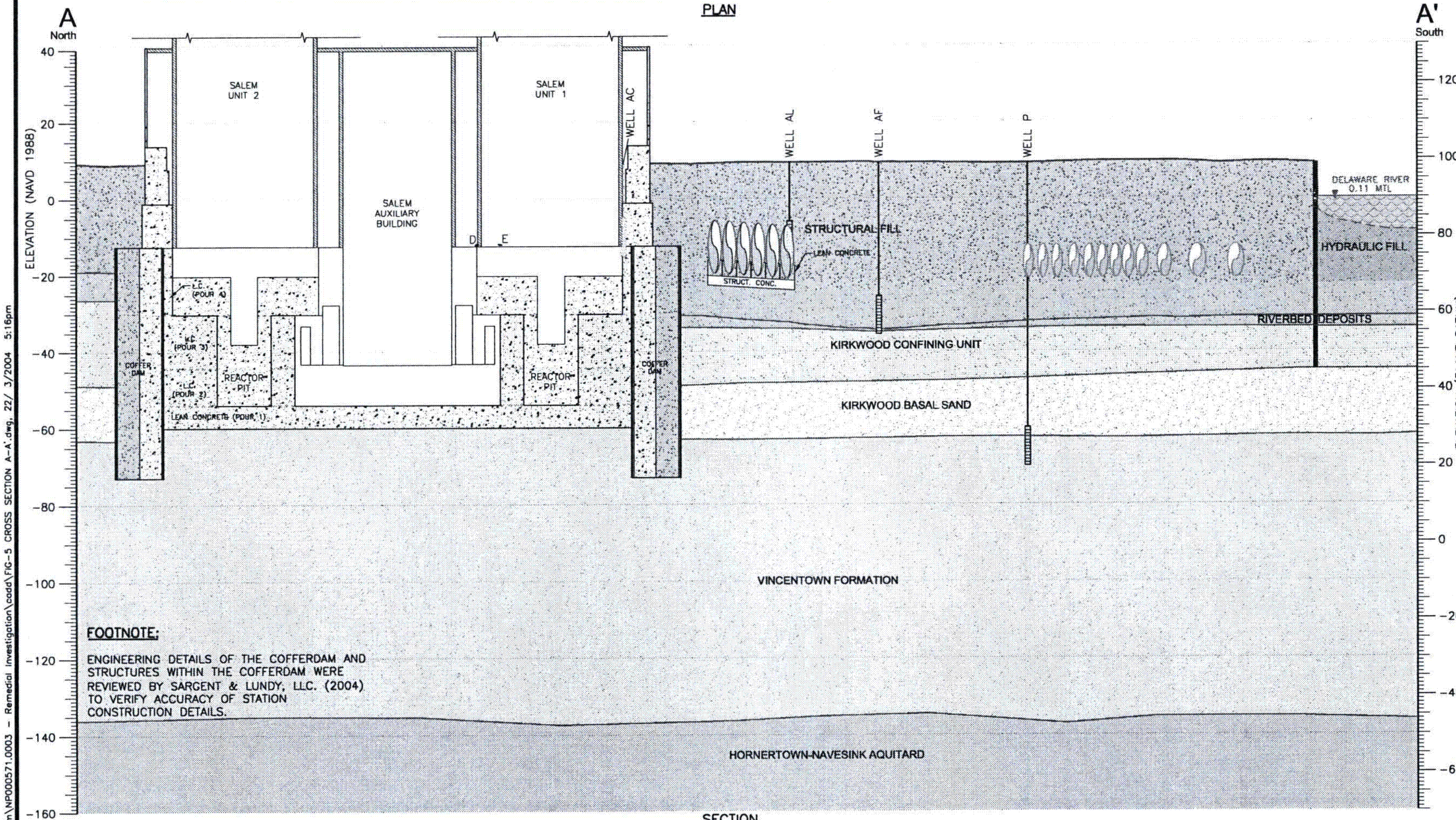


PLAN



KEYMAP

0 800 SCALE: 1"=800'



SECTION

FOOTNOTE:

ENGINEERING DETAILS OF THE COFFERDAM AND STRUCTURES WITHIN THE COFFERDAM WERE REVIEWED BY SARGENT & LUNDY, LLC. (2004) TO VERIFY ACCURACY OF STATION CONSTRUCTION DETAILS.

LEGEND:

▨	HYDRAULIC FILL
▨	STRUCTURAL FILL
▨	RIVERBED DEPOSITS
▨	KIRKWOOD CONFINING UNIT
▨	KIRKWOOD BASAL SAND
▨	VINCENTOWN FORMATION
▨	HORNERTOWN-NAVESINK AQUITARD
▨	LEAN CONCRETE WITH CONSTRUCTION JOINT
▨	STRUCTURAL CONCRETE
▨	SEISMIC GAP (STYROFOAM)
---RW---	BLOW DOWN PIPING
---RW---	LIQUID "RAD" WASTE LINE
∿∿∿∿	SHEET PILE
▨	SERVICE WATER PIPING
▭	CIRCULATING WATER OUTLET PIPING
▭	CIRCULATING WATER INLET PIPING
---ST---	STORM SEWER PIPING
□	CATCH BASIN
⊗	MANHOLE (STORM SEWER)
RCP	REINFORCED CONCRETE PIPE
MTL	MEAN TIDE LEVEL
▨	BUILDING WALL
WELL R ▨	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT WITHIN THE LIMITS OF THE COFFERDAM, 20 FEET DEEP-TYPICAL (WELLS M, N, O, R, AC, AE, AI AND AM).
WELL S ●	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT OUTSIDE THE LIMITS OF THE COFFERDAM, 35 FEET DEEP- TYPICAL (WELLS S, T, U, W, Y, Z, AA, AB, AD, AF, AG(SHALLOW & DEEP), AH(SHALLOW & DEEP), AJ AND AL).
WELL L ◎	MONITORING WELL SCREENED IN THE VINCENTOWN FORMATION, 80 FEET DEEP-TYPICAL (WELLS K, L, P, Q AND V).
B8 ■	PHASE I SAMPLE LOCATION
DP-1 ●	PHASE II SAMPLE LOCATION
▨	SEISMIC GAP
—·—·—	PROPERTY BOUNDARY

WELL O — WELL DESIGNATION
EXISTING LAND SURFACE
BOREHOLE/WELL CASING
SCREENED INTERVAL

G:\APROJECT\PSE&G\Salem\NP000571.0003 - Remedial Investigation\cadd\FIG-5 CROSS SECTION A-A'.dwg, 22/ 3/2004 5:16pm

0 20 VERTICAL SCALE: 1"=20'
0 80 HORIZONTAL SCALE: 1"=80'

NO.	DATE	REVISION DESCRIPTION	BY / CKD
1	9/8/03	CLIENT SUBMITTAL	MCW / BP

ARCADIS
6 Terry Drive
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Tel: 267/685-1800 Fax: 267/685-1801

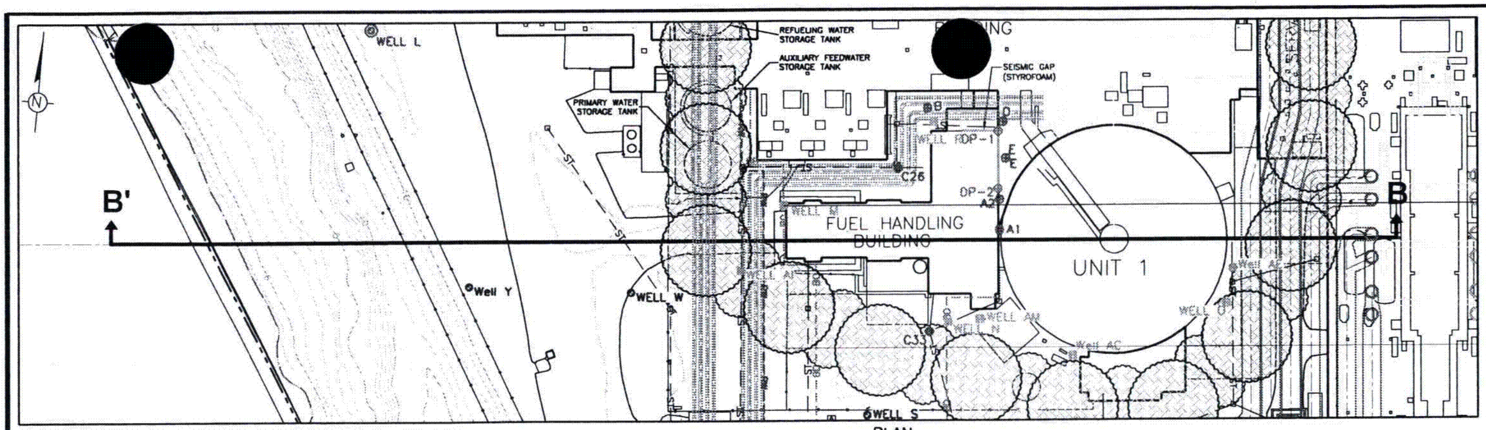
PSEG NUCLEAR, LLC
SALEM GENERATING STATION

ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

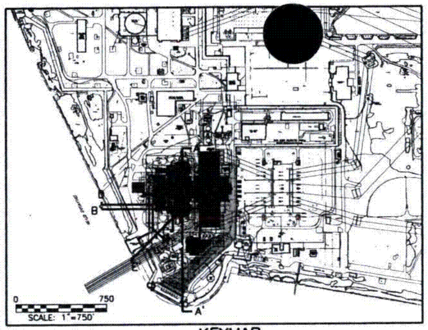
DRAWN: M. WASILEWSKI
DATE: 2/27/04

CROSS SECTION A-A'

PROJECT MANAGER: P. MILIONIS
DEPARTMENT MANAGER: D. FULTON
LEAD DESIGN PROF.: S. POTTER
CHECKED: B. PIERCE
PROJECT NUMBER: NP00057[illegible]003
DRAWING NUMBER: 5



PLAN



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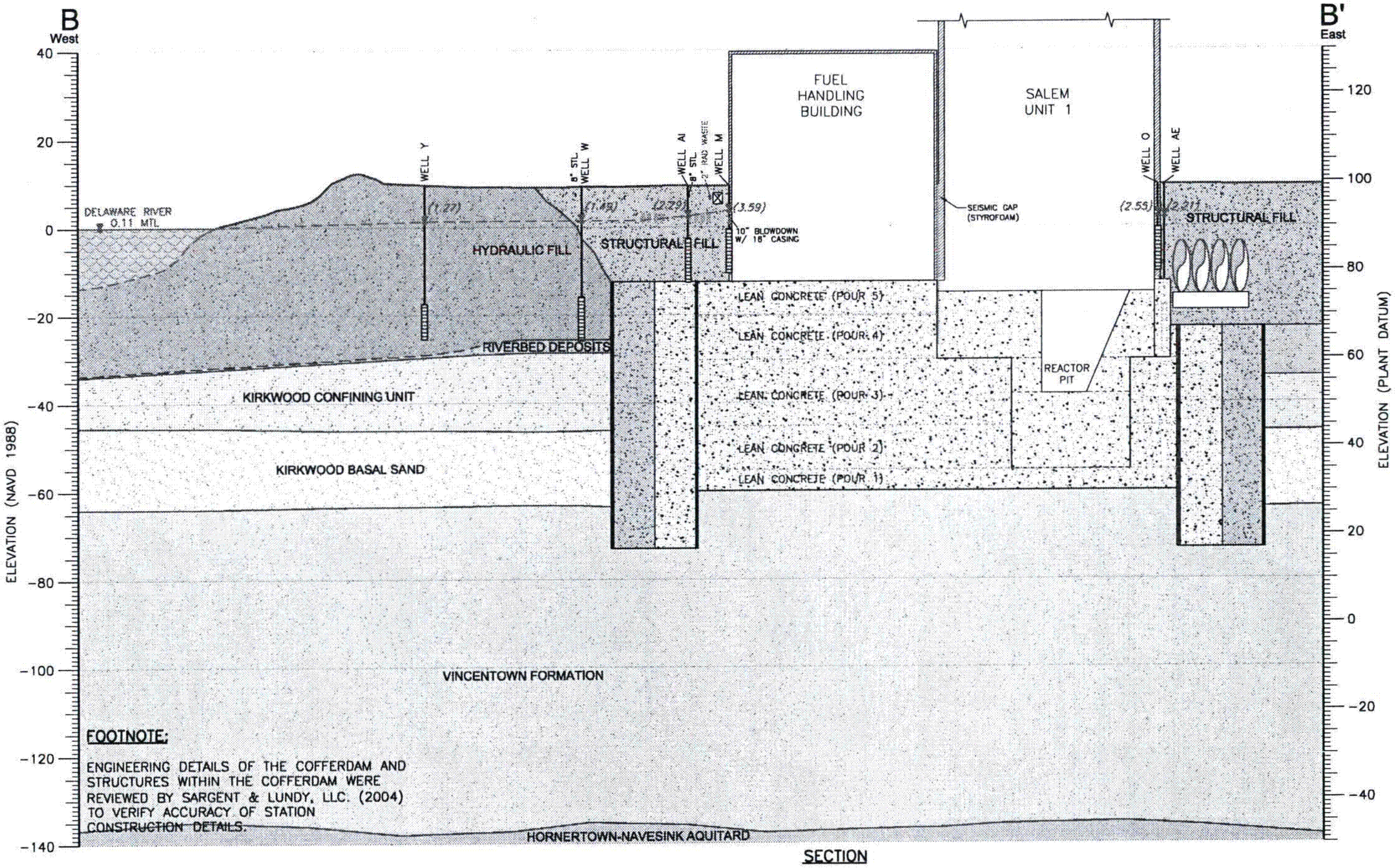


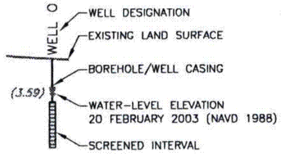
FOOTNOTE:

ENGINEERING DETAILS OF THE COFFERDAM AND STRUCTURES WITHIN THE COFFERDAM WERE REVIEWED BY SARGENT & LUNDY, LLC. (2004) TO VERIFY ACCURACY OF STATION CONSTRUCTION DETAILS.

SECTION

LEGEND:

▨	HYDRAULIC FILL
▨	STRUCTURAL FILL
▨	RIVERBED DEPOSITS
▨	KIRKWOOD CONFINING UNIT
▨	KIRKWOOD BASAL SAND
▨	VINCENTOWN FORMATION
▨	HORNERTOWN-NAVESINK AQUITARD
▨	LEAN CONCRETE WITH CONSTRUCTION JOINT
▨	STRUCTURAL CONCRETE WITH CONSTRUCTION JOINT
▨	SEISMIC GAP (STYROFOAM)
--BD---	BLOW DOWN PIPING
--RW---	LIQUID "RAD" WASTE LINE
∿∿∿	SHEET PILE
	SERVICE WATER PIPING
	CIRCULATING WATER OUTLET PIPING
	CIRCULATING WATER INLET PIPING
--ST--	STORM SEWER PIPING
□	CATCH BASIN
⊗	MANHOLE (STORM SEWER)
RCP	REINFORCED CONCRETE PIPE
MTL	MEAN TIDE LEVEL
	BUILDING WALL
WELL R	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT WITHIN THE LIMITS OF THE COFFERDAM, 20 FEET DEEP- TYPICAL (WELLS M, N, O, R, AC, AE, AI AND AM).
WELL S	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT OUTSIDE THE LIMITS OF THE COFFERDAM, 35 FEET DEEP- TYPICAL (WELLS S, T, U, W, Y, Z, AA, AB, AD, AF, AG(SHALLOW & DEEP), AH(SHALLOW & DEEP), AJ AND AL).
WELL L	MONITORING WELL SCREENED IN THE VINCENTOWN FORMATION, 80 FEET DEEP- TYPICAL (WELLS K, L, P, Q AND V).
B ■	PHASE I SAMPLE LOCATION
DP-1	PHASE II SAMPLE LOCATION
······	SEISMIC GAP
—··—	PROPERTY BOUNDARY



G:\APROJECT\PSE&G\Salem\NP000571.0003 – Remedial Investigation\cadd\FIG-6-9 CROSS SECTIONS B-E.dwg, 22/ 3/2004 5:21pm

0 60
HORIZONTAL SCALE: 1"=60'

0 20
VERTICAL SCALE: 1"=20'

NO.	DATE	REVISION DESCRIPTION	BY / CKD
1	9/8/03	CLIENT SUBMITTAL	MGW / BP

ARCADIS
6 Terry Drive
Suite 300 , Newtown, PA 18940
Tel: 267/685-1800 Fax: 267/685-1801

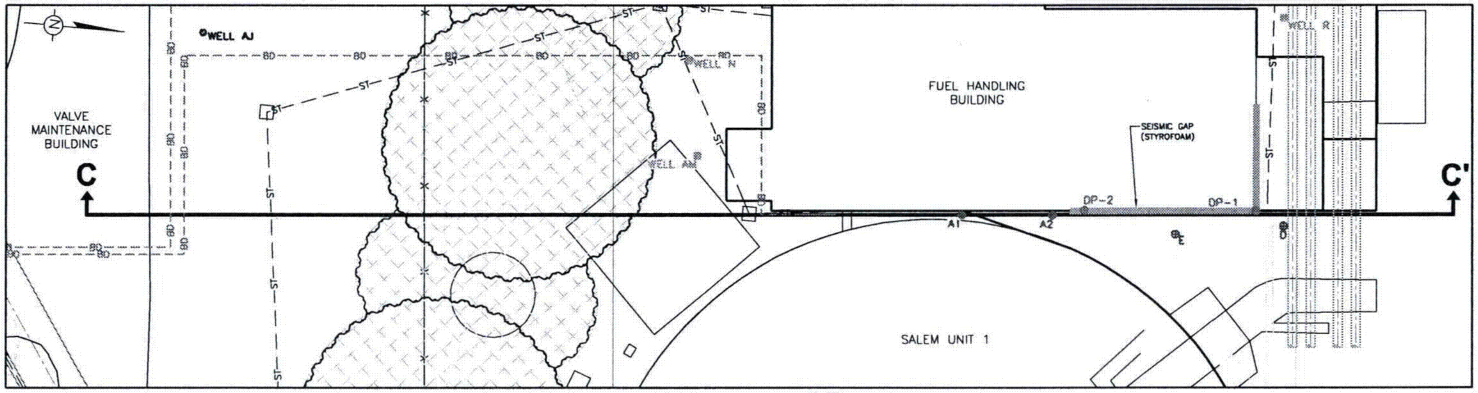
PSEG NUCLEAR, LLC
SALEM GENERATING STATION

ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

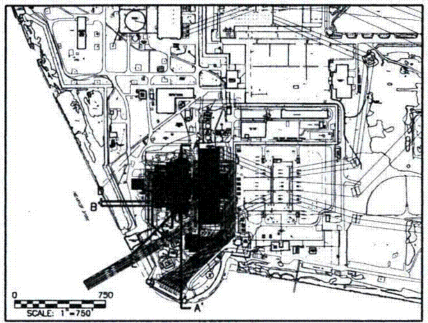
DRAWN: M. WASILEWSKI
DATE: 4/27/04
PROJECT MANAGER: P. MILIONIS
DEPARTMENT MANAGER: D. FULTON
LEAD DESIGN PROF.: S. POTTER
CHECKED: B. PIERCE

CROSS SECTION B-B'

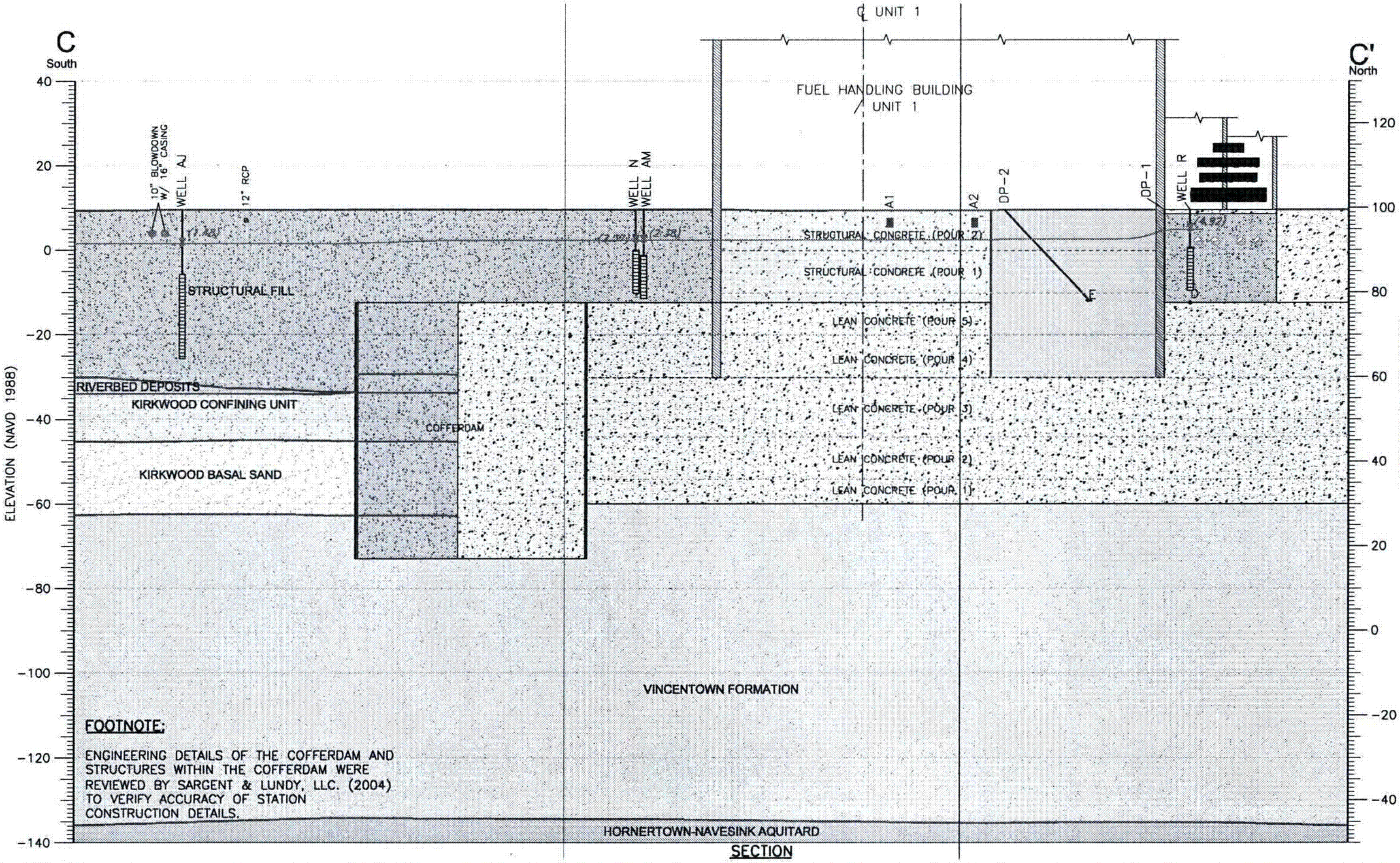
PROJECT NUMBER: NP000571.0003
DRAWING NUMBER: 6



PLAN



KEYMAP



FOOTNOTE:

ENGINEERING DETAILS OF THE COFFERDAM AND STRUCTURES WITHIN THE COFFERDAM WERE REVIEWED BY SARGENT & LUNDY, LLC. (2004) TO VERIFY ACCURACY OF STATION CONSTRUCTION DETAILS.

SECTION

LEGEND:

▨	HYDRAULIC FILL
▨	STRUCTURAL FILL
▨	STRUCTURAL FILL WITH CONCRETE BEYOND
▨	RIVERBED DEPOSITS
▨	KIRKWOOD CONFINING UNIT
▨	KIRKWOOD BASAL SAND
▨	VINCENTOWN FORMATION
▨	HORNERTOWN-NAVESINK AQUITARD
▨	LEAN CONCRETE WITH CONSTRUCTION JOINT
▨	STRUCTURAL CONCRETE WITH CONSTRUCTION JOINT
▨	SEISMIC GAP (STYROFOAM)
--BW--	BLOW DOWN PIPING
--RW--	LIQUID "RAD" WASTE LINE
∿∿∿	SHEET PILE
═══	SERVICE WATER PIPING
▭	CIRCULATING WATER OUTLET PIPING
▭	CIRCULATING WATER INLET PIPING
--ST--	STORM SEWER PIPING
☐	CATCH BASIN
⊗	MANHOLE (STORM SEWER)
RCP	REINFORCED CONCRETE PIPE
MTL	MEAN TIDE LEVEL
▬	BUILDING WALL
WELL R ●	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT WITHIN THE LIMITS OF THE COFFERDAM, 20 FEET DEEP- TYPICAL (WELLS M, N, O, R, AC, AE, AI AND AM).
WELL S ●	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT OUTSIDE THE LIMITS OF THE COFFERDAM, 35 FEET DEEP- TYPICAL (WELLS S, T, U, W, Y, Z, AA, AB, AD, AF, AG(SHALLOW & DEEP, AH(SHALLOW & DEEP), AJ AND AL).
WELL L ◉	MONITORING WELL SCREENED IN THE VINCENTOWN FORMATION, 80 FEET DEEP- TYPICAL (WELLS K, L, P, Q AND V).
B● ▮	PHASE I SAMPLE LOCATION
DP-1●	PHASE II SAMPLE LOCATION
┈┈┈	SEISMIC GAP
—·—·—	PROPERTY BOUNDARY

WELL O
(4.41)
- WELL DESIGNATION
- EXISTING LAND SURFACE
- BOREHOLE/WELL CASING
- WATER-LEVEL ELEVATION 20 FEBRUARY 2003 (NAVD 1988)
- SCREENED INTERVAL

G:\APROJECT\PSE&G\Salem\NP000571.0003 - Remedial Investigation\cadd\FIG-6-9 CROSS SECTIONS B-E.dwg, 22/ 3/2004 5:22pm

0 20
HORIZONTAL SCALE: 1"=20'

0 20
VERTICAL SCALE: 1"=20'

NO.	DATE	REVISION DESCRIPTION	BY / CKD
1	9/8/03	CLIENT SUBMITTAL	MGW / BP

ARCADIS
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Tel: 267/685-1800 Fax: 267/685-1801

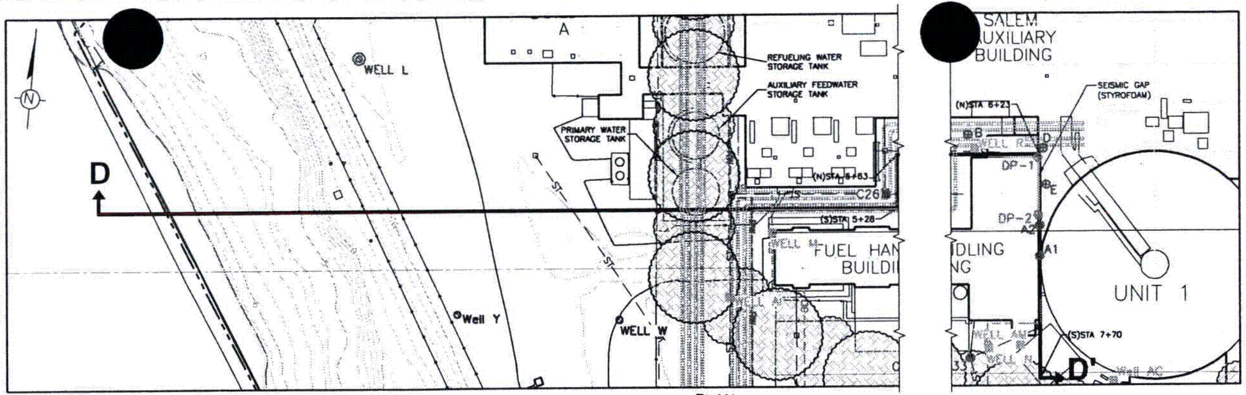
PSEG NUCLEAR, LLC
SALEM GENERATING STATION

ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

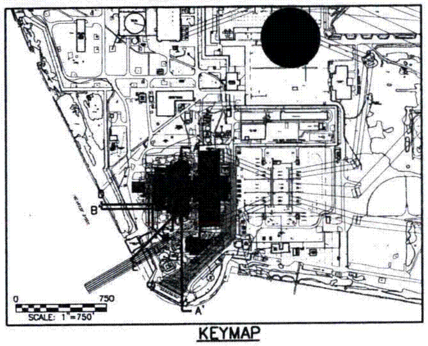
DRAWN: M. WASILEWSKI
DATE: 4/27/04
PROJECT MANAGER: P. MILIONIS
DEPARTMENT MANAGER: D. FULTON
LEAD DESIGN PROF.: S. POTTER
CHECKED: B. PIERCE

FACILITY CROSS SECTION C-C'

PROJECT NUMBER: NP000571 [illegible]
DRAWING NUMBER: 7



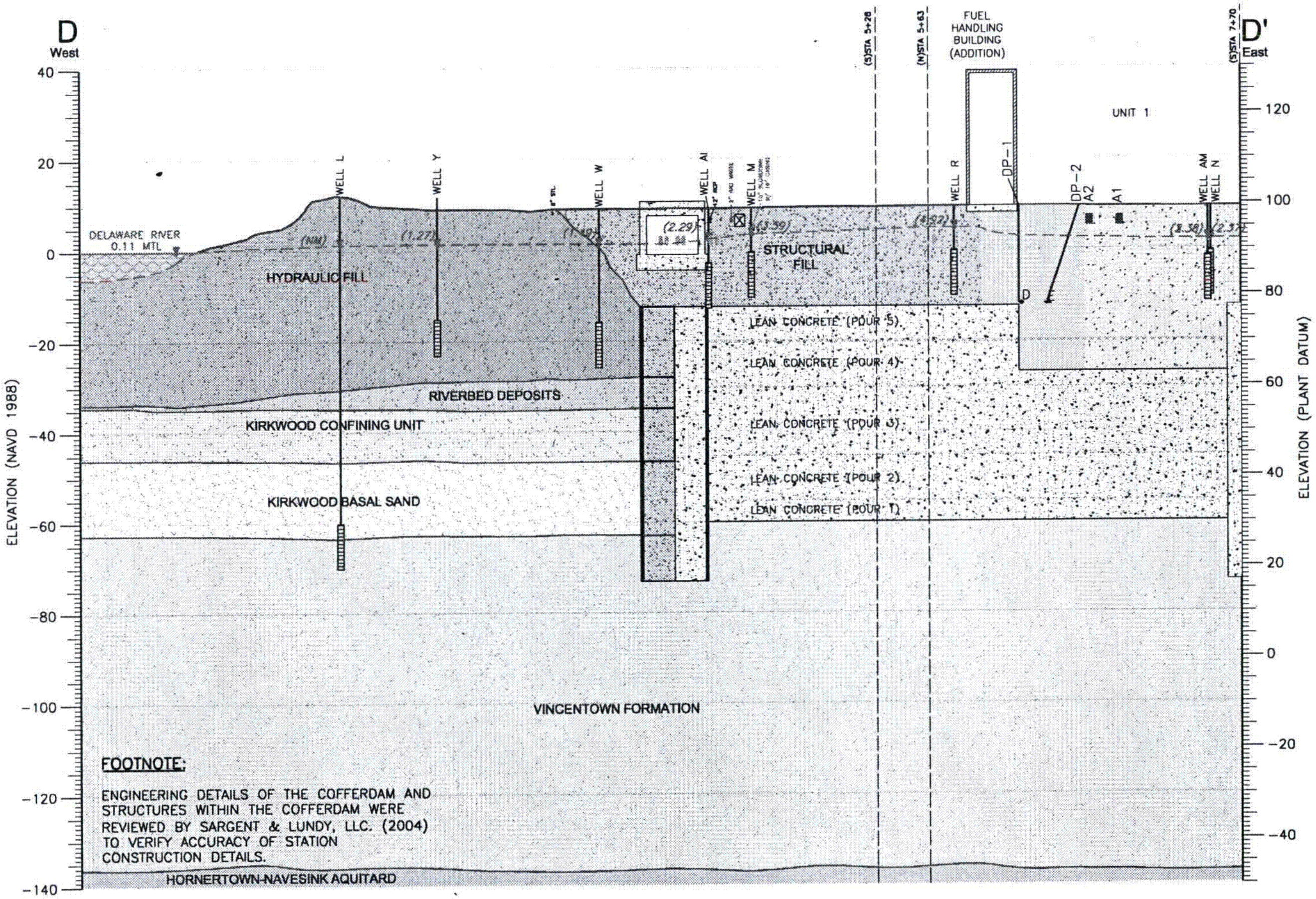
PLAN



KEYMAP

LEGEND:

▨ HYDRAULIC FILL
▨ STRUCTURAL FILL
▨ STRUCTURAL FILL WITH CONCRETE BEYOND
▨ RIVERBED DEPOSITS
▨ KIRKWOOD CONFINING UNIT
▨ VINCENTOWN FORMATION
▨ HORNERTOWN–NAVESINK AQUITARD
▨ LEAN CONCRETE WITH CONSTRUCTION JOINT
▨ STRUCTURAL CONCRETE WITH CONSTRUCTION JOINT
▨ SEISMIC GAP (STYROFOAM)
BLOW DOWN PIPING
LIQUID "RAD" WASTE LINE
SHEET PILE
SERVICE WATER PIPING
CIRCULATING WATER OUTLET PIPING
CIRCULATING WATER INLET PIPING
— —ST— — STORM SEWER PIPING
☐ CATCH BASIN
⊗ MANHOLE (STORM SEWER)
RCP REINFORCED CONCRETE PIPE
MTL MEAN TIDE LEVEL
BUILDING WALL
WELL R● MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT WITHIN THE LIMITS OF THE COFFERDAM, 20 FEET DEEP– TYPICAL (WELLS M, N, O, R, AC, AE, AI AND AM).
WELL S● MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT OUTSIDE THE LIMITS OF THE COFFERDAM, 35 FEET DEEP– TYPICAL (WELLS S, T, U, W, Y, Z, AA, AB, AD, AF, AG(SHALLOW & DEEP, AH(SHALLOW & DEEP), AJ AND AL).
WELL L● MONITORING WELL SCREENED IN THE VINCENTOWN FORMATION, 80 FEET DEEP– TYPICAL (WELLS K, L, P, Q AND V).
B● ■ PHASE I SAMPLE LOCATION
DP-1● PHASE II SAMPLE LOCATION
SEISMIC GAP
—··— PROPERTY BOUNDARY
WELL O — WELL DESIGNATION
EXISTING LAND SURFACE
BOREHOLE/WELL CASING
(4.41) WATER-LEVEL ELEVATION 20 FEBRUARY 2003 (NAVD 1988)
SCREENED INTERVAL



FOOTNOTE:

ENGINEERING DETAILS OF THE COFFERDAM AND STRUCTURES WITHIN THE COFFERDAM WERE REVIEWED BY SARGENT & LUNDY, LLC. (2004) TO VERIFY ACCURACY OF STATION CONSTRUCTION DETAILS.

SECTION

Z:\APROJECT\PSE&G\Salem\NP000571.0003 – Remedial Investigation\cadd\FIG-6-9 CROSS SECTIONS B-E.dwg, 22/ 3/2004 5:22pm

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0 60
HORIZONTAL SCALE: 1"=60'

0 20
VERTICAL SCALE: 1"=20'

NO.	DATE	REVISION DESCRIPTION	BY / CKD
1	9/8/03	CLIENT SUBMITTAL	MGW / BP

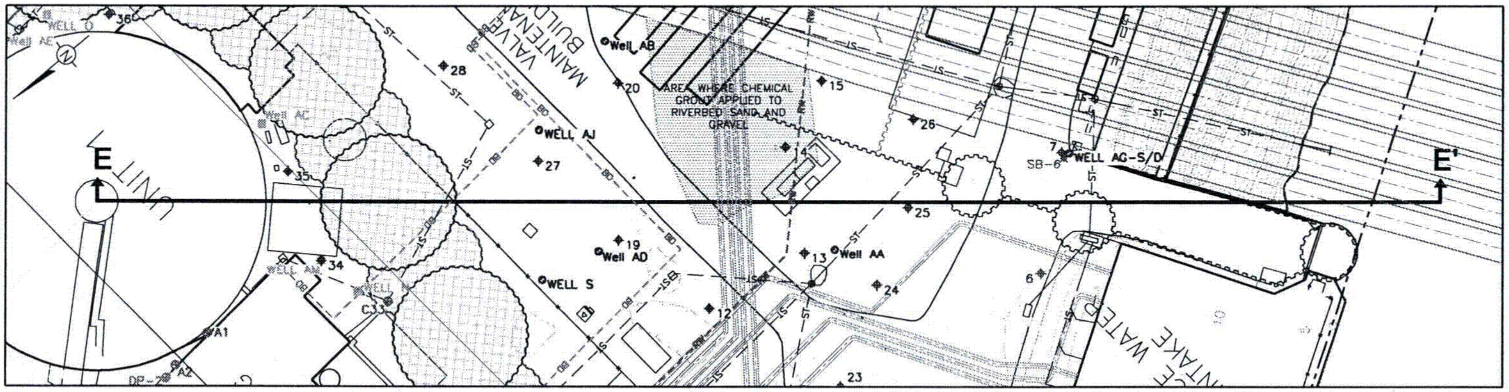
ARCADIS
6 Terry Drive
Suite 300, Newtown, PA 18940
Tel: 267/685-1800 Fax: 267/685-1801

PSEG NUCLEAR, LLC
SALEM GENERATING STATION

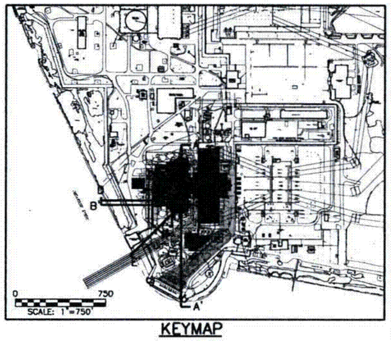
ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

FACILITY CROSS SECTION D-D'

DRAWN: M. WASILEWSKI
DATE: 4/27/04
PROJECT MANAGER: P. MILIONIS
DEPARTMENT MANAGER: D. FULTON
LEAD DESIGN PROF.: S. POTTER
CHECKED: B. PIERCE
PROJECT NUMBER: NP000571.0003
DRAWING NUMBER: 8



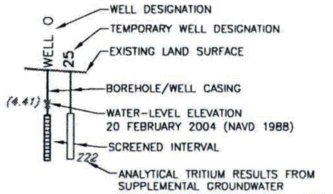
PLAN

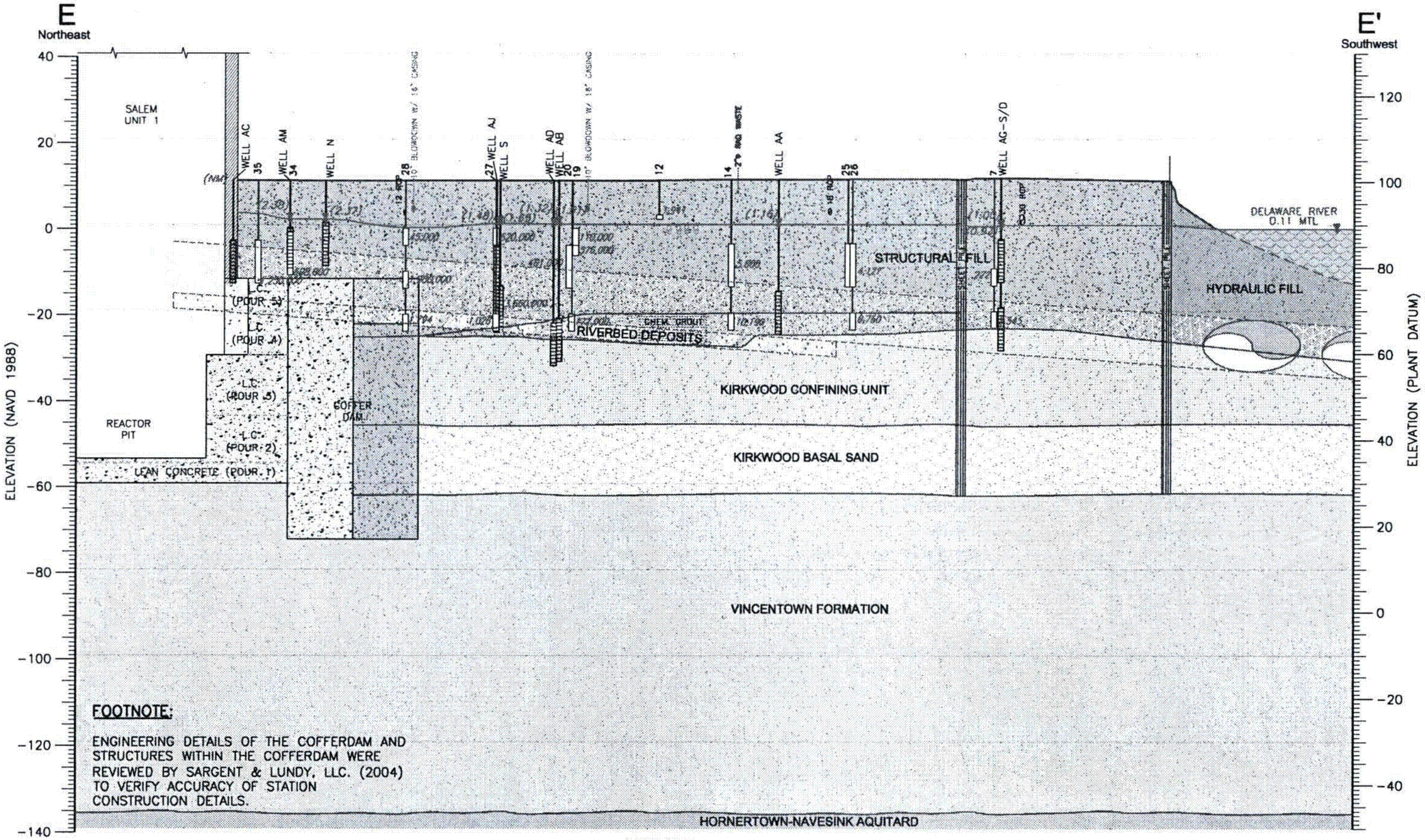


KEYMAP

LEGEND:

- ▨ HYDRAULIC FILL
- ▨ STRUCTURAL FILL
- ▨ RIVERBED DEPOSITS
- ▨ KIRKWOOD CONFINING UNIT
- KIRKWOOD BASAL SAND
- ▨ VINCENTOWN FORMATION
- ▨ HORNERTOWN–NAVESINK AQUITARD
- ▨ LEAN CONCRETE WITH CONSTRUCTION JOINT
- ▨ STRUCTURAL CONCRETE WITH CONSTRUCTION JOINT
- ▨ SEISMIC GAP (STYROFOAM)
- --RR--- BLOW DOWN PIPING
- ------ LIQUID "RAD" WASTE LINE
- ⌇⌇⌇ SHEET PILE
- SERVICE WATER PIPING
- CIRCULATING WATER OUTLET PIPING
- CIRCULATING WATER INLET PIPING
- — —ST— — STORM SEWER PIPING
- ☐ CATCH BASIN
- ⊕ MANHOLE (STORM SEWER)
- RCP REINFORCED CONCRETE PIPE
- MTL MEAN TIDE LEVEL
- ▭ BUILDING WALL
- WELL R● MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT WITHIN THE LIMITS OF THE COFFERDAM, 20 FEET DEEP- TYPICAL (WELLS M, N, O, R, AC, AE, AI AND AM).
- WELL S● MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT OUTSIDE THE LIMITS OF THE COFFERDAM, 35 FEET DEEP- TYPICAL (WELLS S, T, U, W, Y, Z, AA, AB, AD, AF, AG(SHALLOW & DEEP, AH(SHALLOW & DEEP), AJ AND AL).
- WELL L● MONITORING WELL SCREENED IN THE VINCENTOWN FORMATION, 80 FEET DEEP- TYPICAL (WELLS K, L, P, Q AND V).
- B● ■ PHASE I SAMPLE LOCATION
- DP-1● PHASE II SAMPLE LOCATION
- ········ SEISMIC GAP
- —··— PROPERTY BOUNDARY





FOOTNOTE:

ENGINEERING DETAILS OF THE COFFERDAM AND STRUCTURES WITHIN THE COFFERDAM WERE REVIEWED BY SARGENT & LUNDY, LLC. (2004) TO VERIFY ACCURACY OF STATION CONSTRUCTION DETAILS.

SECTION

0 40
HORIZONTAL SCALE: 1"=40'

0 20
VERTICAL SCALE: 1"=20'

NO.	DATE	REVISION DESCRIPTION	BY / CKD
1	9/8/03	CLIENT SUBMITTAL	MGW / BP

ARCADIS

6 Terry Drive
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Tel: 267/685-1800 Fax: 267/685-1801

PSEG NUCLEAR, LLC
SALEM GENERATING STATION

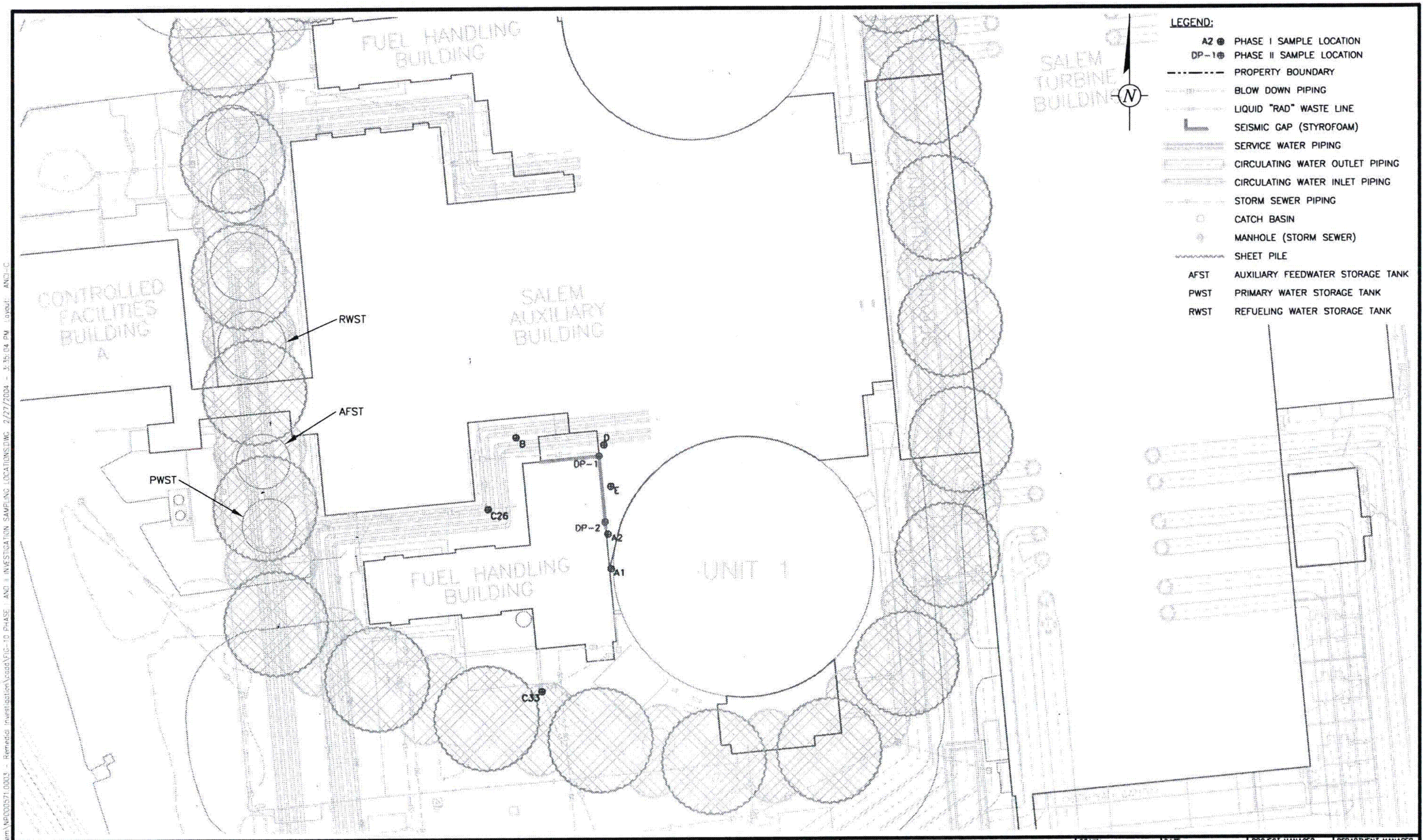
ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

DRAWN: M. WASILEWSKI
DATE: 4/27/04

FACILITY CROSS SECTION E-E'

PROJECT MANAGER: P. MILIONIS
DEPARTMENT MANAGER: D. FULTON
LEAD DESIGN PROF.: S. POTTER
CHECKED: B. PIERCE
PROJECT NUMBER: NP000571.0003
DRAWING NUMBER: 9

G:\APROJECT\PSE&G\Salem\NP000571.0003 - Remedial Investigation\cadd\FIG-10 PHASE I AND II INVESTIGATION SAMPLING LOCATIONS.DWG 2/27/2004 - 3:35:04 PM Layout: ANCI-C



0 50
SCALE: 1"=50'

NO.	DATE	REVISION DESCRIPTION	BY/CKD

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6 Terry Drive
Suite 300, Newtown, Pa 18940
Tel: 267/685-1800 Fax: 267/685-1801

PSEG NUCLEAR, LLC
SALEM GENERATING STATION

ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

DRAWN
M. WASILEWSKI

DATE
2/27/04

PHASE I AND II
INVESTIGATION
SAMPLING LOCATIONS

PROJECT MANAGER
P. MILIONIS

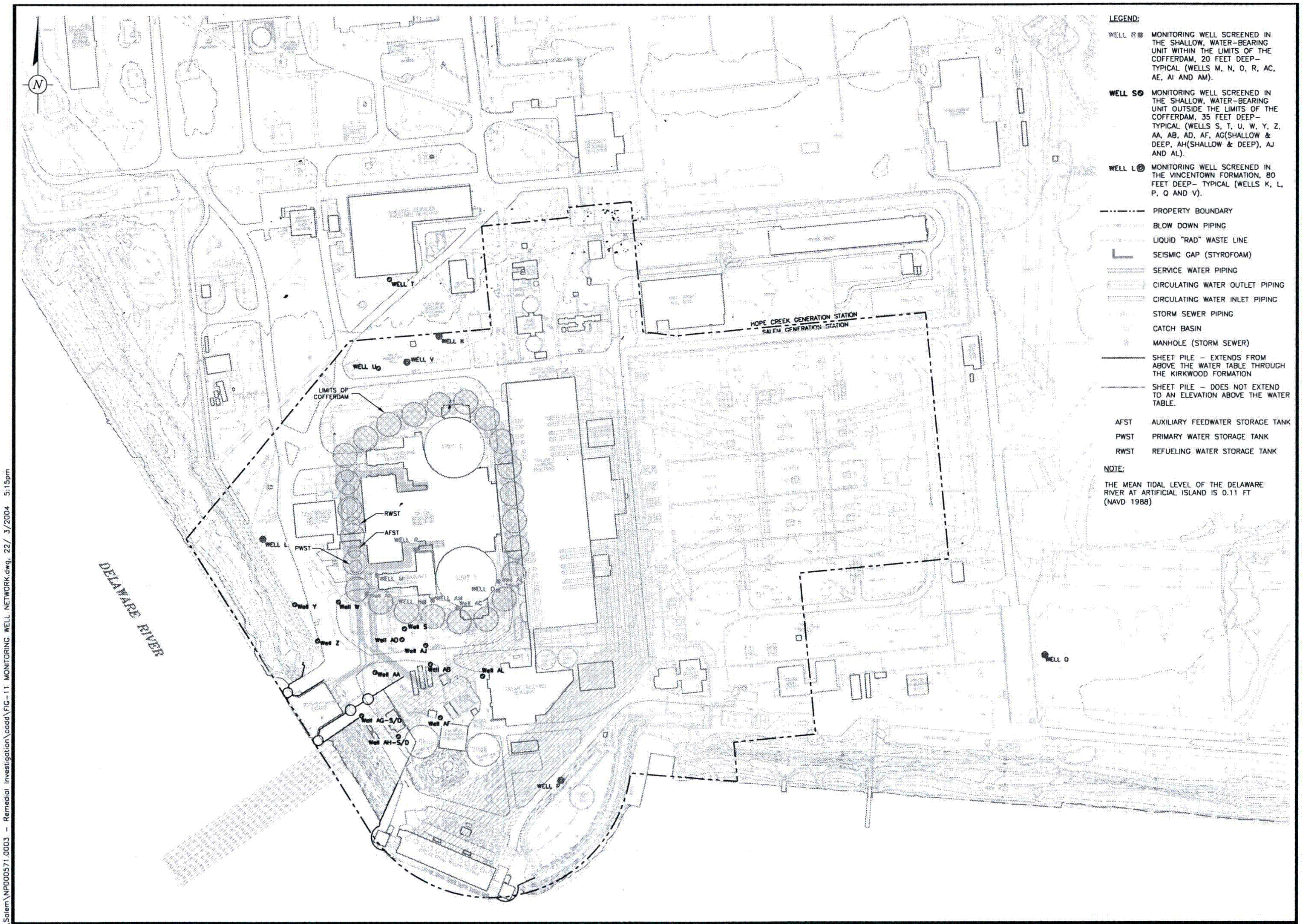
DEPARTMENT MANAGER
D. FULTON

LEAD DESIGN PROF.
S. POTTER

CHECKED
B. PIERCE

PROJECT NUMBER
NP000571.0003

DRAWING NUMBER
10



LEGEND:

WELL R ▨	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT WITHIN THE LIMITS OF THE COFFERDAM, 20 FEET DEEP-TYPICAL (WELLS M, N, O, R, AC, AE, AI AND AM).
WELL S○	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT OUTSIDE THE LIMITS OF THE COFFERDAM, 35 FEET DEEP-TYPICAL (WELLS S, T, U, W, Y, Z, AA, AB, AD, AF, AG(SHALLOW & DEEP, AH(SHALLOW & DEEP), AJ AND AL).
WELL L◎	MONITORING WELL SCREENED IN THE VINCENTOWN FORMATION, 80 FEET DEEP- TYPICAL (WELLS K, L, P, Q AND V).
—··—··—	PROPERTY BOUNDARY
	BLOW DOWN PIPING
	LIQUID "RAD" WASTE LINE
L	SEISMIC GAP (STYROFOAM)
	SERVICE WATER PIPING
	CIRCULATING WATER OUTLET PIPING
	CIRCULATING WATER INLET PIPING
	STORM SEWER PIPING
	CATCH BASIN
	MANHOLE (STORM SEWER)
———	SHEET PILE – EXTENDS FROM ABOVE THE WATER TABLE THROUGH THE KIRKWOOD FORMATION
———	SHEET PILE – DOES NOT EXTEND TO AN ELEVATION ABOVE THE WATER TABLE.
AFST	AUXILIARY FEEDWATER STORAGE TANK
PWST	PRIMARY WATER STORAGE TANK
RWST	REFUELING WATER STORAGE TANK

NOTE:

THE MEAN TIDAL LEVEL OF THE DELAWARE RIVER AT ARTIFICIAL ISLAND IS 0.11 FT (NAVD 1988)

G:\APROJECT\PSE&G\Salem\NP000571.0003 - Remedial Investigation\cadd\FIG-11 MONITORING WELL NETWORK.dwg, 22/ 3/2004 5:15pm

0 150 300
SCALE: 1"=150'

NO.	DATE	REVISION DESCRIPTION	BY / CKD

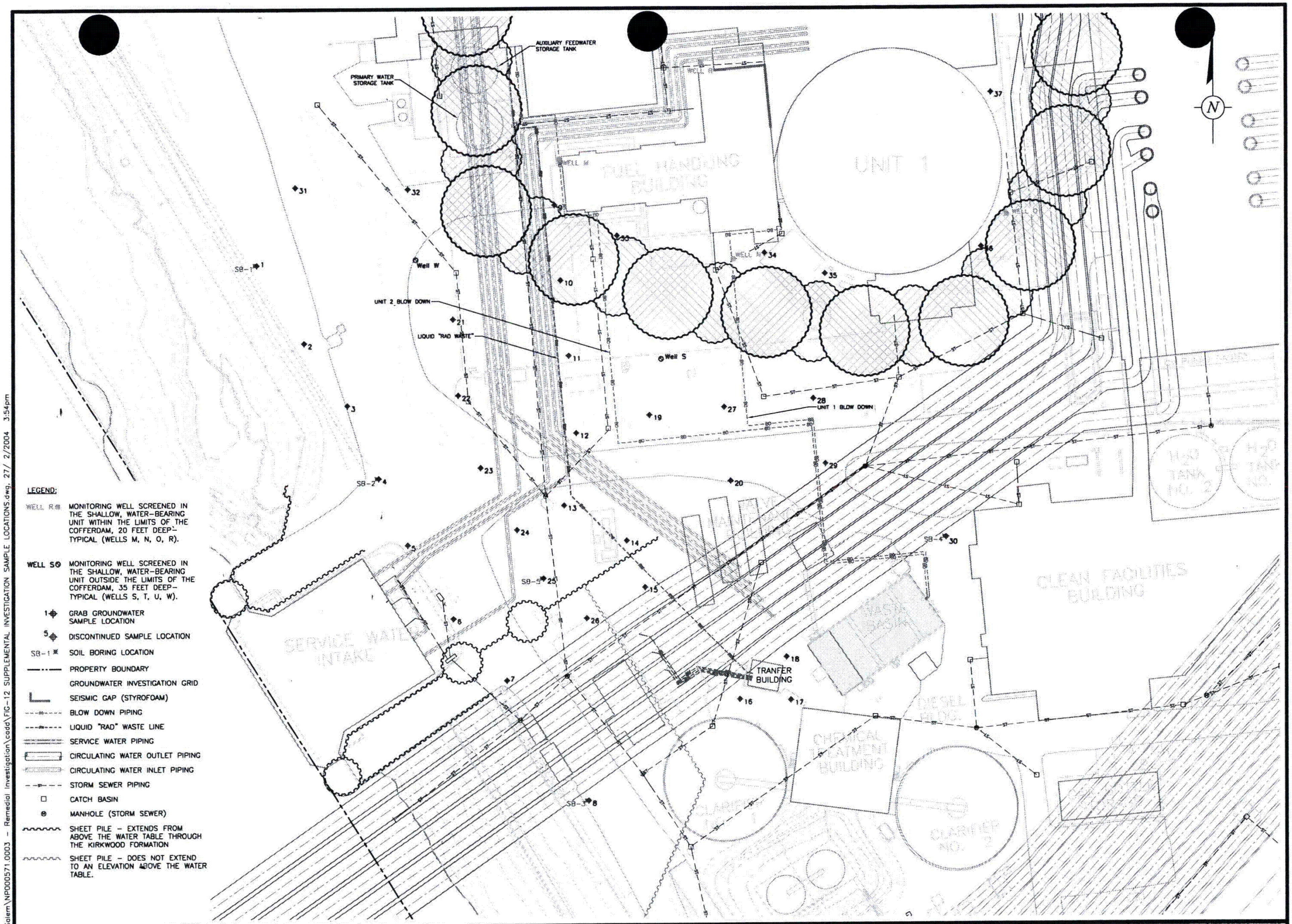
ARCADIS
6 Terry Drive
Suite 300 , Newtown, PA 18940
Tel: 267/685-1800 Fax: 267/685-1801

PSEG NUCLEAR, LLC
SALEM GENERATING STATION

ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

MONITORING WELL NETWORK

DRAWN M. WASILEWSKI	DATE 2/27/04	PROJECT MANAGER P. MILIONIS	DEPARTMENT MANAGER D. FULTON
		LEAD DESIGN PROF. S. POTTER	CHECKED B. PIERCE
		PROJECT NUMBER NP000571.0003	DRAWING NUMBER 11



LEGEND:

WELL R ▨	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT WITHIN THE LIMITS OF THE COFFERDAM, 20 FEET DEEP-TYPICAL (WELLS M, N, O, R).
WELL S ⊗	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT OUTSIDE THE LIMITS OF THE COFFERDAM, 35 FEET DEEP-TYPICAL (WELLS S, T, U, W).
1 ◆	GRAB GROUNDWATER SAMPLE LOCATION
5 ◆	DISCONTINUED SAMPLE LOCATION
SB-1 ▨	SOIL BORING LOCATION
—·—·—	PROPERTY BOUNDARY
	GROUNDWATER INVESTIGATION GRID
└	SEISMIC GAP (STYROFOAM)
---BD---	BLOW DOWN PIPING
---RW---	LIQUID "RAD" WASTE LINE
═══	SERVICE WATER PIPING
▭	CIRCULATING WATER OUTLET PIPING
▭	CIRCULATING WATER INLET PIPING
---ST---	STORM SEWER PIPING
□	CATCH BASIN
⊗	MANHOLE (STORM SEWER)
∿∿∿	SHEET PILE - EXTENDS FROM ABOVE THE WATER TABLE THROUGH THE KIRKWOOD FORMATION
∿∿∿	SHEET PILE - DOES NOT EXTEND TO AN ELEVATION ABOVE THE WATER TABLE.

G:\APROJECT\PSE&G\Salem\NP000571.0003 - Remedial Investigation\cadd\FIG-12 SUPPLEMENTAL INVESTIGATION SAMPLE LOCATIONS.dwg, 27/ 2/2004 3:54pm

0 40 80
SCALE: 1"=40'

NO.	DATE	REVISION DESCRIPTION	BY / CKD

ARCADIS
6 Terry Drive
Suite 300 , Newtown, PA 18940
Tel: 267/685-1800 Fax: 267/685-1801

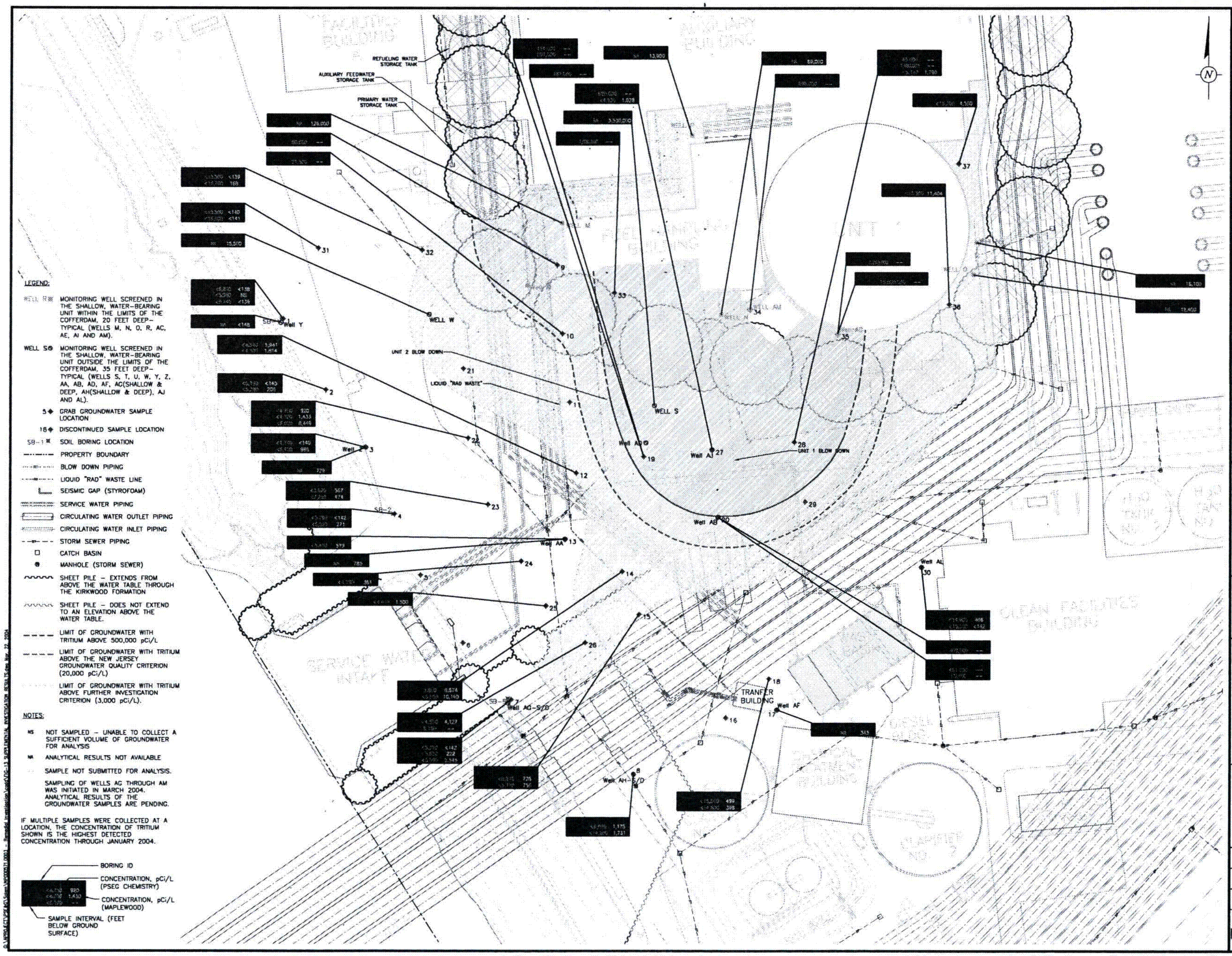
PSEG NUCLEAR, LLC
SALEM GENERATING STATION

ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

DRAWN: M. WASILEWSKI
DATE: 2/27/04
PROJECT MANAGER: P. MILIONIS
DEPARTMENT MANAGER: D. FULTON
LEAD DESIGN PROF.: S. POTTER
CHECKED: B. PIERCE

SUPPLEMENTAL INVESTIGATION
SAMPLE LOCATIONS

PROJECT NUMBER: NP000571.0003
DRAWING NUMBER: 12



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[redacted]

[redacted]

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[redacted]

[redacted]

[redacted]

[redacted]

[redacted]

LEGEND:

WELL R ⊠	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT WITHIN THE LIMITS OF THE COFFERDAM, 20 FEET DEEP-TYPICAL (WELLS M, N, O, R, AC, AE, AI AND AM).
WELL S⊚	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT OUTSIDE THE LIMITS OF THE COFFERDAM, 35 FEET DEEP-TYPICAL (WELLS S, T, U, W, Y, Z, AA, AB, AD, AF, AG(SHALLOW & DEEP, AH(SHALLOW & DEEP), AJ AND AL).
5◆	GRAB GROUNDWATER SAMPLE LOCATION
18◆	DISCONTINUED SAMPLE LOCATION
SB-1 ⊠	SOIL BORING LOCATION
—·—·—	PROPERTY BOUNDARY
···········	BLOW DOWN PIPING
···········	LIQUID "RAD" WASTE LINE
	SEISMIC GAP (STYROFOAM)
	SERVICE WATER PIPING
	CIRCULATING WATER OUTLET PIPING
	CIRCULATING WATER INLET PIPING
— — —	STORM SEWER PIPING
☐	CATCH BASIN
●	MANHOLE (STORM SEWER)
	SHEET PILE – EXTENDS FROM ABOVE THE WATER TABLE THROUGH THE KIRKWOOD FORMATION
	SHEET PILE – DOES NOT EXTEND TO AN ELEVATION ABOVE THE WATER TABLE.
— — — —	LIMIT OF GROUNDWATER WITH TRITIUM ABOVE 500,000 pCi/L
— — — —	LIMIT OF GROUNDWATER WITH TRITIUM ABOVE THE NEW JERSEY GROUNDWATER QUALITY CRITERION (20,000 pCi/L)
· · · · ·	LIMIT OF GROUNDWATER WITH TRITIUM ABOVE FURTHER INVESTIGATION CRITERION (3,000 pCi/L).

NOTES:

NS	NOT SAMPLED – UNABLE TO COLLECT A SUFFICIENT VOLUME OF GROUNDWATER FOR ANALYSIS
NA	ANALYTICAL RESULTS NOT AVAILABLE
--	SAMPLE NOT SUBMITTED FOR ANALYSIS.
	SAMPLING OF WELLS AG THROUGH AM WAS INITIATED IN MARCH 2004. ANALYTICAL RESULTS OF THE GROUNDWATER SAMPLES ARE PENDING.

IF MULTIPLE SAMPLES WERE COLLECTED AT A LOCATION, THE CONCENTRATION OF TRITIUM SHOWN IS THE HIGHEST DETECTED CONCENTRATION THROUGH JANUARY 2004.

[redacted]

BORING ID

CONCENTRATION, pCi/L (PSEG CHEMISTRY)

CONCENTRATION, pCi/L (MAPLEWOOD)

SAMPLE INTERVAL (FEET BELOW GROUND SURFACE)

NO.	DATE	REVISION DESCRIPTION	BY / CKD

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PSEG NUCLEAR, LLC
SALEM GENERATING STATION

ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

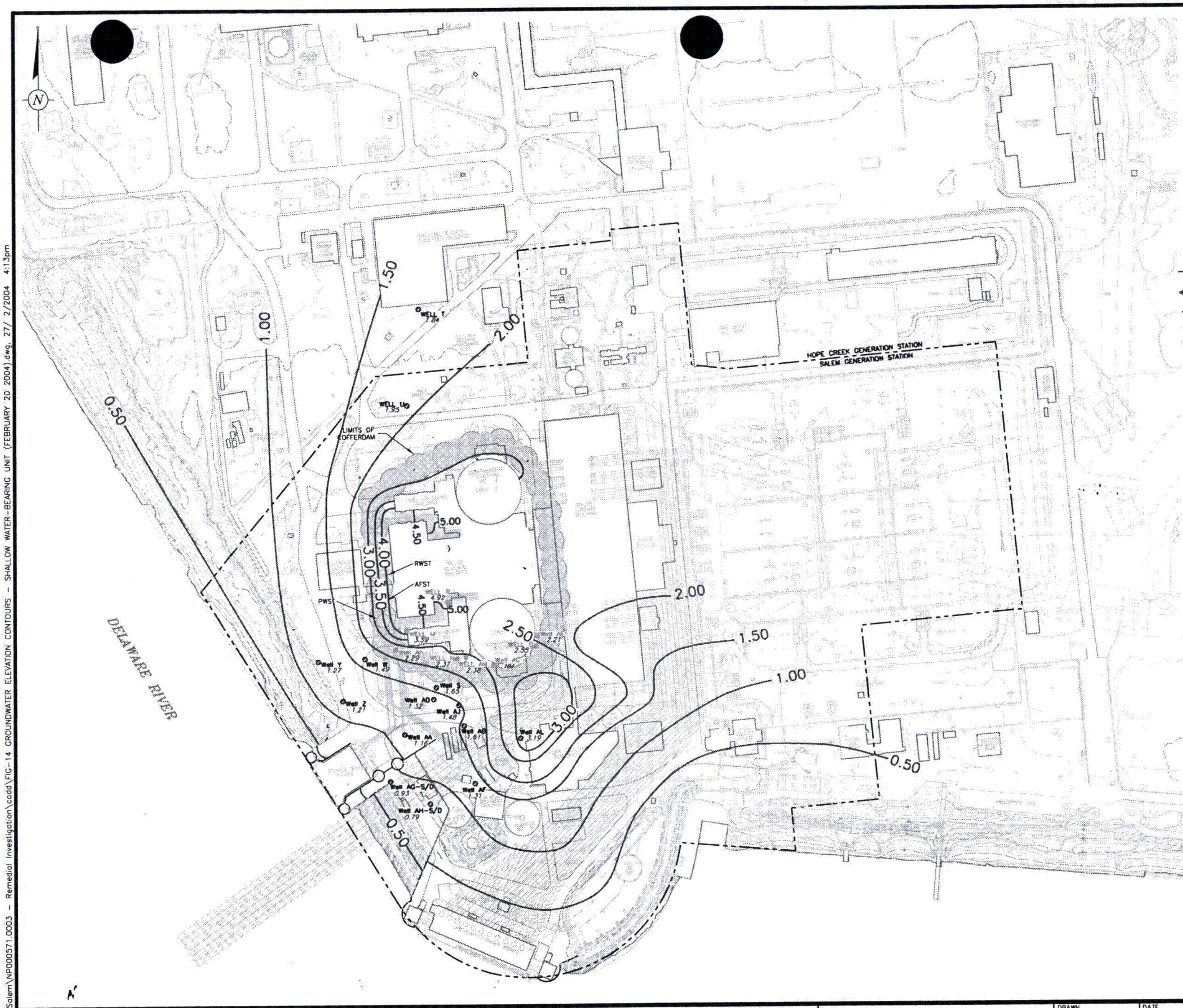
GROUNDWATER TRITIUM RESULTS

ARCADIS

3000 Cabot Blvd West
Suite 3004, Langhorne, Pa 19047
Tel: 215/752-6840 Fax: 215/752-6879

0 30 60 90
SCALE: 1"=30'

PROJECT MANAGER P. MILIONIS	DEPARTMENT MANAGER D. FULTON
LEAD DESIGN PROF. S. POTTER	CHECKED B. PIERCE
DRAWN M. WASILEWSKI	DATE 2/27/03
PROJECT NUMBER NP000571.0003	DRAWING NUMBER 13



LEGEND:

WELL R	MONITOR[illegible] SCREENED IN THE SHA[illegible]TER-BEARING UNIT WITHIN THE LIMITS OF THE COFFERDAM, 20 FEET DEEP-TYPICAL (WELLS M, N, O, R, AC, AE, AI AND AM).
WELL S	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT OUTSIDE THE LIMITS OF THE COFFERDAM, 35 FEET DEEP-TYPICAL (WELLS S, T, U, W, Y, Z, AA, AB, AD, AF, AG(SHALLOW & DEEP, AH(SHALLOW & DEEP), AJ AND AL).
	MONITORING WELL SCREENED IN THE VINCENTOWN FORMATION, 80 FEET DEEP- TYPICAL (WELLS K, L, P, Q AND V).
3.19	GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL - NAVD 1988)
—1.00	GROUNDWATER ELEVATION CONTOUR (0.5 FOOT INTERVAL)
←	GROUNDWATER FLOW DIRECTION
—··—··—	PROPERTY BOUNDARY
	BLOW DOWN PIPING
	LIQUID "RAD" WASTE LINE
	SERVICE WATER PIPING
	CIRCULATING WATER OUTLET PIPING
	CIRCULATING WATER INLET PIPING
	STORM SEWER PIPING
	CATCH BASIN
	MANHOLE (STORM SEWER)
———	SHEET PILE - EXTENDS FROM ABOVE THE WATER TABLE THROUGH THE KIRKWOOD FORMATION
	SHEET PILE - DOES NOT EXTEND TO AN ELEVATION ABOVE THE WATER TABLE.
AFST	AUXILIARY FEEDWATER STORAGE TANK
PWST	PRIMARY WATER STORAGE TANK
RWST	REFUELING WATER STORAGE TANK

NOTE:

THE MEAN TIDE LEVEL OF THE DELAWARE RIVER AT ARTIFICIAL ISLAND IS 0.11 FT (NAVD 1988)

G:\APROJECT\PSE&G\Salem\NP000571.0003 - Remedial Investigation\cadd\FIG-14 GROUNDWATER ELEVATION CONTOURS - SHALLOW WATER-BEARING UNIT (FEBRUARY 20 2004).dwg, 27/ 2/2004 4:13pm

0 150 300
SCALE: 1"=150'

NO.	DATE	REVISION DESCRIPTION	BY CKD

ARCADIS
6 Terry Drive
Suite 300 , Newtown, PA 18940
Tel: 267/685-1800 Fax: 267/685-1801

PSEG NUCLEAR, LLC
SALEM GENERATING STATION

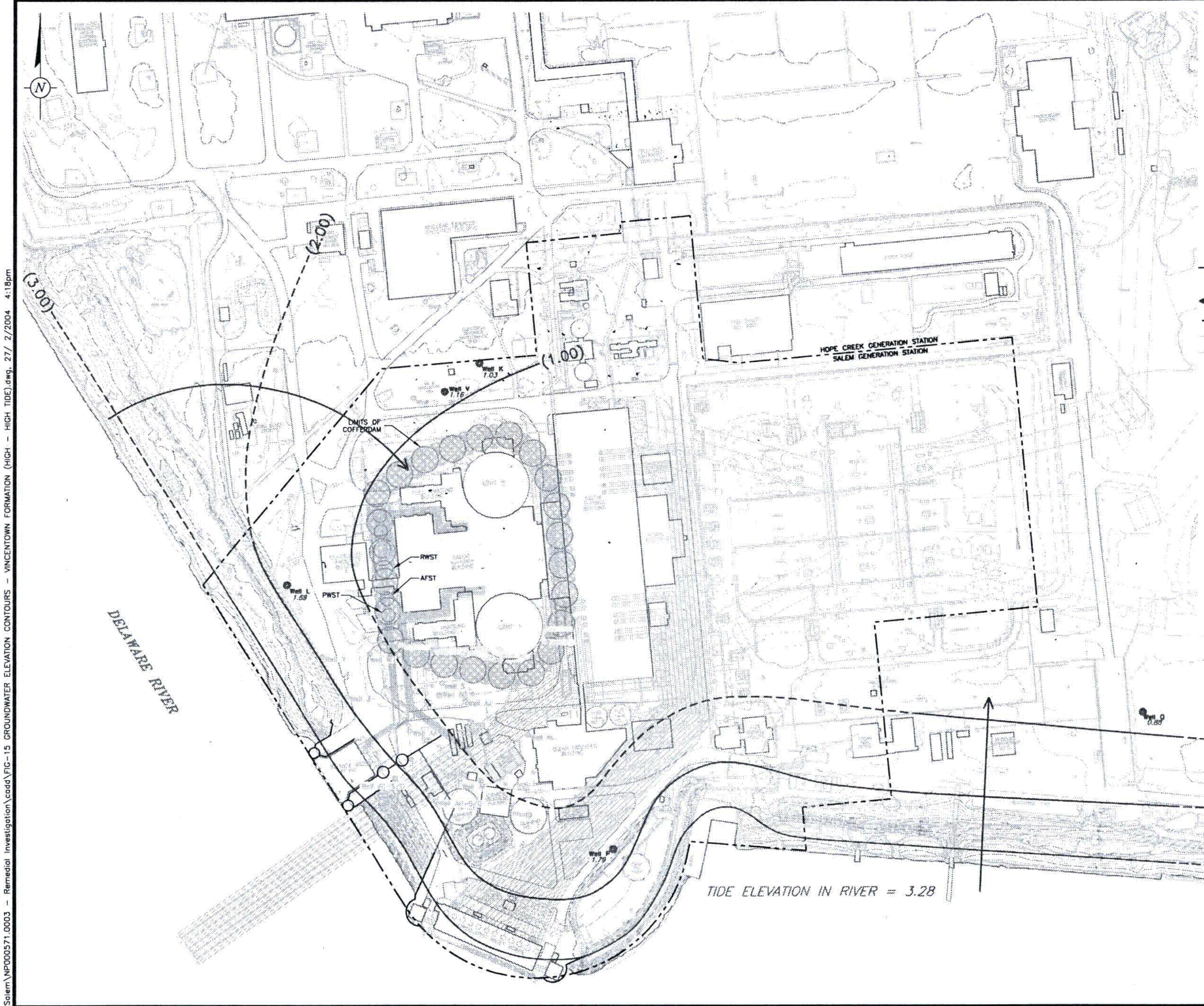
ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

DRAWN: M. WASILEWSKI
DATE: 2/27/04
PROJECT MANAGER: P. MILIONIS
DEPARTMENT MANAGER: D. FULTON

GROUNDWATER ELEVATION CONTOURS
SHALLOW WATER-BEARING UNIT
(FEBRUARY 20, 2004)

LEAD DESIGN PROF.: S. POTTER
CHECKED: B. PIERCE
PROJECT NUMBER: NP000571.0003
DRAWING NUMBER: 14

G:\APROJECT\PSE&G\Salem\NP000571.0003 - Remedial Investigation\cadd\FIG-15 GROUNDWATER ELEVATION CONTOURS - VINCENTOWN FORMATION (HIGH - HIGH TIDE).dwg, 27/ 2/2004 4:18pm



LEGEND:

	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT WITHIN THE LIMITS OF THE COFFERDAM, 20 FEET DEEP-TYPICAL (WELLS M, N, O, R, AC, AE, AI AND AM).
	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT OUTSIDE THE LIMITS OF THE COFFERDAM, 35 FEET DEEP-TYPICAL (WELLS S, T, U, W, Y, Z, AA, AB, AD, AF, AG(SHALLOW & DEEP, AH(SHALLOW & DEEP), AJ AND AL).
WELL L ●	MONITORING WELL SCREENED IN THE VINCENTOWN FORMATION, 80 FEET DEEP- TYPICAL (WELLS K, L, P, Q AND V).
1.03	GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL - NAVD 1988)
—1.00	GROUNDWATER ELEVATION CONTOUR (1.0 FOOT INTERVAL) DASHED WHERE INFERRED
←	GROUNDWATER FLOW DIRECTION
—··—··—	PROPERTY BOUNDARY
	BLOW DOWN PIPING
	LIQUID "RAD" WASTE LINE
	SERVICE WATER PIPING
	CIRCULATING WATER OUTLET PIPING
	CIRCULATING WATER INLET PIPING
	STORM SEWER PIPING
□	CATCH BASIN
●	MANHOLE (STORM SEWER)
——	SHEET PILE - EXTENDS FROM ABOVE THE WATER TABLE THROUGH THE KIRKWOOD FORMATION
——	SHEET PILE - DOES NOT EXTEND TO AN ELEVATION ABOVE THE WATER TABLE.
AFST	AUXILIARY FEEDWATER STORAGE TANK
PWST	PRIMARY WATER STORAGE TANK
RWST	REFUELING WATER STORAGE TANK

NOTE:

THE MEAN TIDE LEVEL OF THE DELAWARE RIVER AT ARTIFICIAL ISLAND IS 0.11 FT (NAVD 1988)

0 150 300
SCALE: 1"=150'

NO.	DATE	REVISION DESCRIPTION	BY / CKD

ARCADIS
6 Terry Drive
Suite 300 , Newtown, PA 18940
Tel: 267/685-1800 Fax: 267/685-1801

PSEG NUCLEAR, LLC
SALEM GENERATING STATION

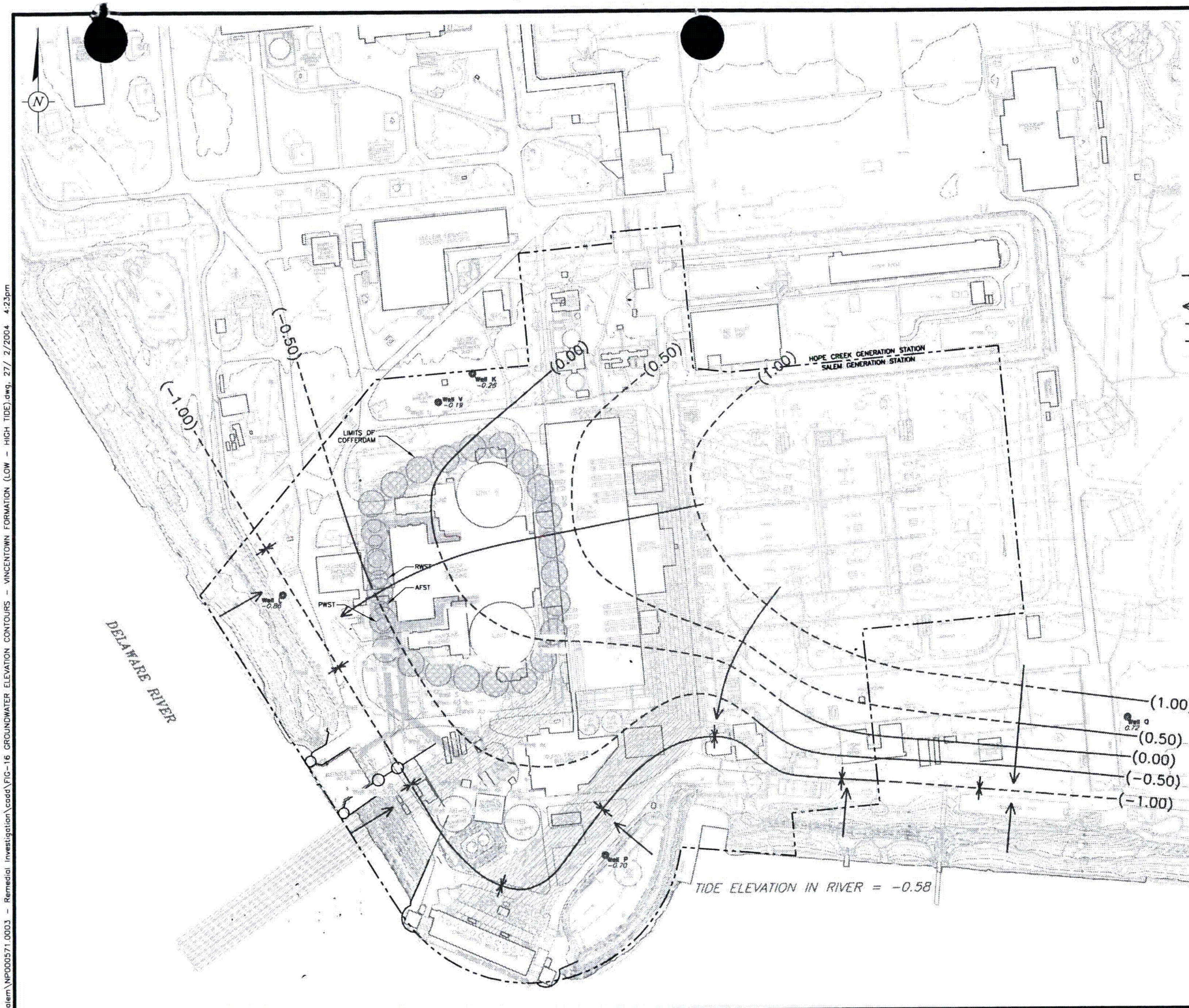
ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

DRAWN M. WASILEWSKI
DATE 2/27/04

GROUNDWATER ELEVATION CONTOURS
VINCENTOWN FORMATION
(HIGH - HIGH TIDE)

PROJECT MANAGER P. MILIONIS
DEPARTMENT MANAGER D. FULTON
LEAD DESIGN PROF. S. POTTER
CHECKED B. PIERCE
PROJECT NUMBER NP000571.0003
DRAWING NUMBER 15

G:\APROJECT\PSE&G\Salem\NP000571.0003 - Remedial Investigation\cadd\FIG-16 GROUNDWATER ELEVATION CONTOURS - VINCENTOWN FORMATION (LOW - HIGH TIDE).dwg, 27/ 2/2004 4:23pm



LEGEND:

	MONITORI SCREENED IN THE SHALL TER-BEARING UNIT WITHIN THE LIMITS OF THE COFFERDAM, 20 FEET DEEP-TYPICAL (WELLS M, N, O, R, AC, AE, AI AND AM).
WELL S	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT OUTSIDE THE LIMITS OF THE COFFERDAM, 35 FEET DEEP-TYPICAL (WELLS S, T, U, W, Y, Z, AA, AB, AD, AF, AG(SHALLOW & DEEP, AH(SHALLOW & DEEP), AJ AND AL).
WELL L ◎	MONITORING WELL SCREENED IN THE VINCENTOWN FORMATION, 80 FEET DEEP- TYPICAL (WELLS K, L, P, Q AND V).
-0.26	GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL - NAVD 1988)
—1.00	GROUNDWATER ELEVATION CONTOUR (0.5 FOOT INTERVAL) DASHED WHERE INFERRED
←	GROUNDWATER FLOW DIRECTION
	GROUNDWATER SADDLE
—··—··—	PROPERTY BOUNDARY
	BLOW DOWN PIPING
	LIQUID "RAD" WASTE LINE
	SERVICE WATER PIPING
	CIRCULATING WATER OUTLET PIPING
	CIRCULATING WATER INLET PIPING
	STORM SEWER PIPING
	CATCH BASIN
	MANHOLE (STORM SEWER)
——	SHEET PILE - EXTENDS FROM ABOVE THE WATER TABLE THROUGH THE KIRKWOOD FORMATION
	SHEET PILE - DOES NOT EXTEND TO AN ELEVATION ABOVE THE WATER TABLE.
AFST	AUXILIARY FEEDWATER STORAGE TANK
PWST	PRIMARY WATER STORAGE TANK
RWST	REFUELING WATER STORAGE TANK

NOTE:

THE MEAN TIDE LEVEL OF THE DELAWARE RIVER AT ARTIFICIAL ISLAND IS 0.11 FT (NAVD 1988)

0 150 300
SCALE: 1"=150'

NO.	DATE	REVISION DESCRIPTION	BY CKD

ARCADIS
6 Terry Drive
Suite 300 , Newtown, PA 18940
Tel: 267/685-1800 Fax: 267/685-1801

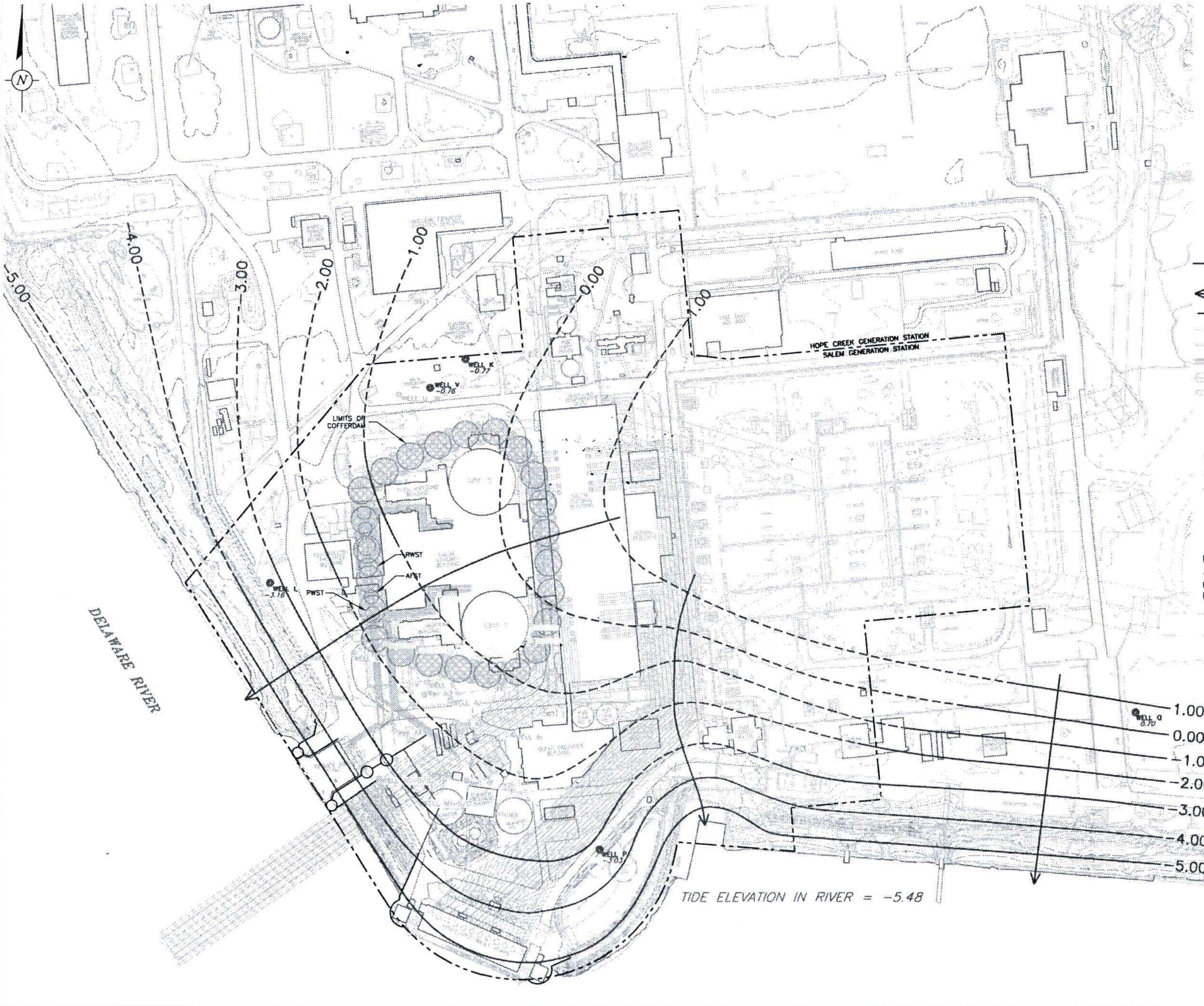
PSEG NUCLEAR, LLC
SALEM GENERATING STATION

ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

DRAWN M. WASILEWSKI
DATE 2/27/04

GROUNDWATER ELEVATION CONTOURS
VINCENTOWN FORMATION
(LOW - HIGH TIDE)

PROJECT MANAGER P. MILIONIS
DEPARTMENT MANAGER D. FULTON
LEAD DESIGN PROF. S. POTTER
CHECKED B. PIERCE
PROJECT NUMBER NP000571.0003
DRAWING NUMBER 16



LEGEND:

	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT WITHIN THE LIMITS OF THE COFFERDAM, 20 FEET DEEP-TYPICAL (WELLS M, N, O, R, AC, AE, AI AND AM).
WELL SO	MONITORING WELL SCREENED IN THE SHALLOW, WATER-BEARING UNIT OUTSIDE THE LIMITS OF THE COFFERDAM, 35 FEET DEEP-TYPICAL (WELLS S, T, U, W, Y, Z, AA, AB, AD, AF, AG(SHALLOW & DEEP), AH(SHALLOW & DEEP), AJ AND AL).
WELL L◉	MONITORING WELL SCREENED IN THE VINCENTOWN FORMATION, 80 FEET DEEP- TYPICAL (WELLS K, L, P, Q AND V).
0.76	GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL - NAVD 1988)
—1.00	GROUNDWATER ELEVATION CONTOUR (1.0 FOOT INTERVAL) DASHED WHERE INFERRED
←	GROUNDWATER FLOW DIRECTION
— · — · —	PROPERTY BOUNDARY
	BLOW DOWN PIPING
	LIQUID "RAD" WASTE LINE
	SERVICE WATER PIPING
	CIRCULATING WATER OUTLET PIPING
	CIRCULATING WATER INLET PIPING
	STORM SEWER PIPING
□	CATCH BASIN
●	MANHOLE (STORM SEWER)
	SERVICE WATER PIPING
	CIRCULATING WATER OUTLET PIPING
	CIRCULATING WATER INLET PIPING
AFST	AUXILIARY FEEDWATER STORAGE TANK
PWST	PRIMARY WATER STORAGE TANK
RWST	REFUELING WATER STORAGE TANK

NOTE:

THE MEAN TIDE LEVEL OF THE DELAWARE RIVER AT ARTIFICIAL ISLAND IS 0.11 FT (NAVD 1988)

G:\APROJECT\PSE&G\Salem\NP000571.0003 - Remedial Investigation\cadd\FIG-17 GROUNDWATER ELEVATION CONTOURS - VINCENTOWN FORMATION (LOW - LOW TIDE).dwg, 27/ 2/2004 4:29pm

0 150 300
SCALE: 1"=150'

NO.	DATE	REVISION DESCRIPTION	BY	CKD

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PSEG NUCLEAR, LLC
SALEM GENERATING STATION

ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

DRAWN
M. WASILEWSKI

DATE
4/11/04

GROUNDWATER CONTOUR MAP
VINCENTOWN FORMATION
(LOW - LOW TIDE)

PROJECT MANAGER
P. MILIONIS

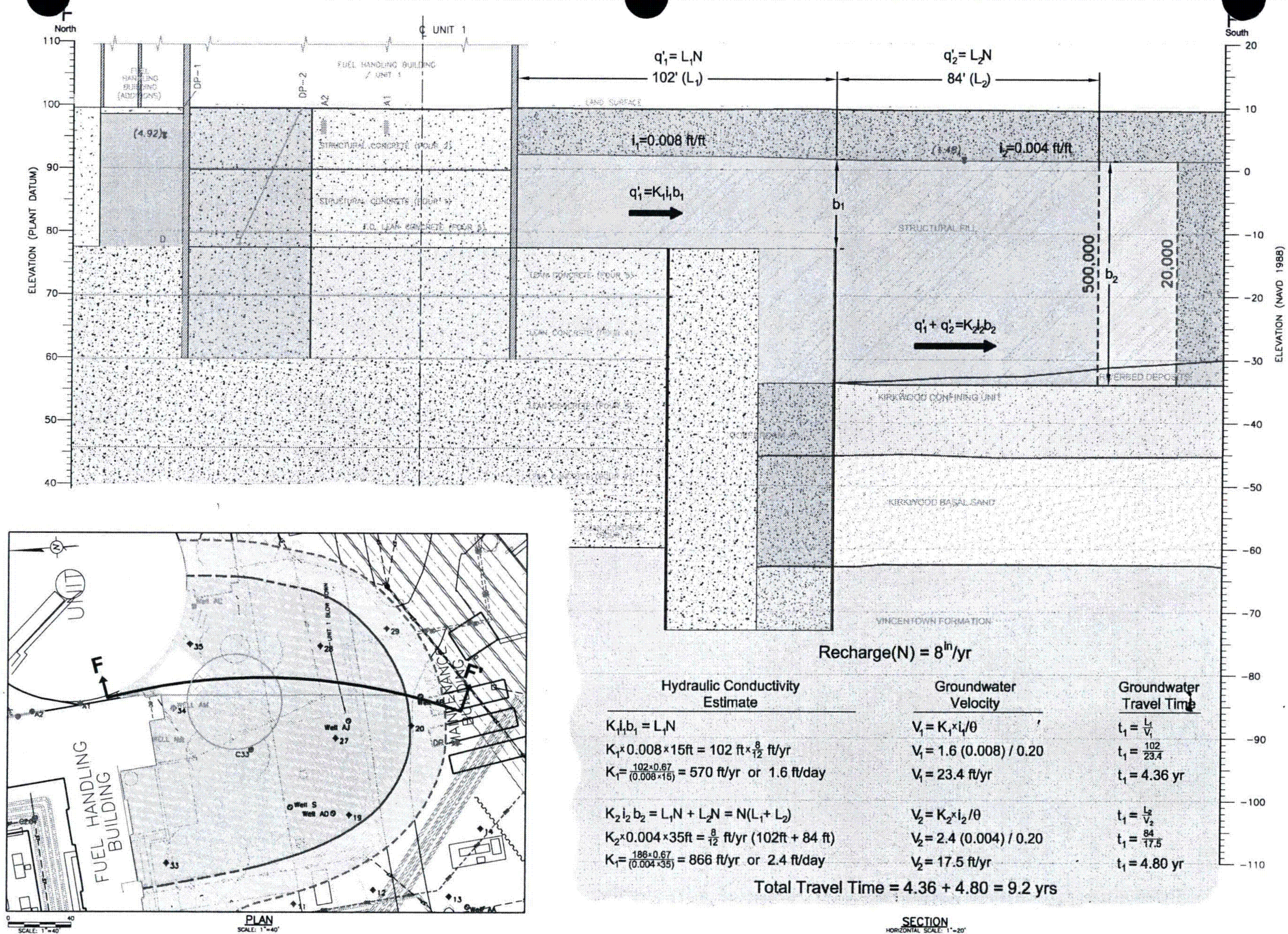
DEPARTMENT MANAGER
D. FULTON

LEAD DESIGN PROF.
S. POTTER

CHECKED
B. PIERCE

PROJECT NUMBER
NP000571.0003

DRAWING NUMBER
17



Recharge(N) = 8^{in}/yr

Hydraulic Conductivity Estimate	Groundwater Velocity	Groundwater Travel Time
$K_1i_1b_1 = L_1N$	$V_1 = K_1 \times i_1/\theta$	$t_1 = \frac{L_1}{V_1}$
$K_1 \times 0.008 \times 15ft = 102\ ft \times \frac{8}{12}$ ft/yr	V_1 = 1.6 (0.008) / 0.20	$t_1 = \frac{102}{23.4}$
$K_1 = \frac{102 \times 0.67}{(0.008 \times 15)}$ = 570 ft/yr or 1.6 ft/day	V_1 = 23.4 ft/yr	t_1 = 4.36 yr
$K_2 i_2 b_2 = L_1N + L_2N = N(L_1 + L_2)$	$V_2 = K_2 \times i_2/\theta$	$t_1 = \frac{L_2}{V_2}$
$K_2 \times 0.004 \times 35ft = \frac{8}{12}$ ft/yr (102ft + 84 ft)	V_2 = 2.4 (0.004) / 0.20	$t_1 = \frac{84}{17.5}$
$K_1 = \frac{186 \times 0.67}{(0.004 \times 35)}$ = 866 ft/yr or 2.4 ft/day	V_2 = 17.5 ft/yr	t_1 = 4.80 yr

Total Travel Time = 4.36 + 4.80 = 9.2 yrs

PLAN
SCALE: 1"=40'

SECTION
HORIZONTAL SCALE: 1"=20'
VERTICAL SCALE: 1"=10'

G:\APROJECT\PSE&G\Salem\NP000571.0003 - Remedial Investigation\cadd\FIG-18 HYDRAULIC CONDUCTIVITY AND TRAVEL TIME CALCULATIONS.dwg, 22/ 3/2004 5:20pm

0 10
HORIZONTAL SCALE: 1"=10'
0 20
VERTICAL SCALE: 1"=10'

NO.	DATE	REVISION DESCRIPTION	BY / CKD

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PSEG NUCLEAR, LLC
SALEM GENERATING STATION

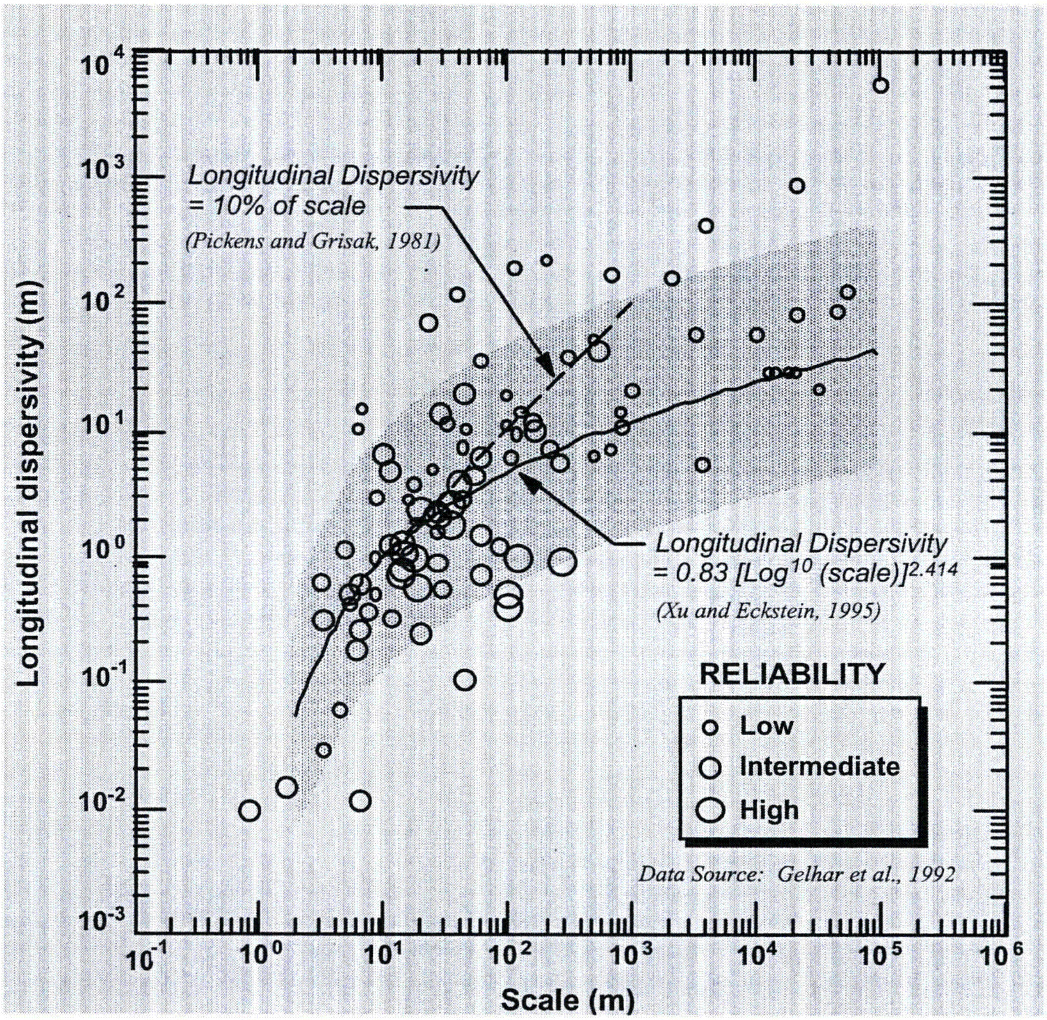
ARTIFICIAL ISLAND
HANCOCK'S BRIDGE, NEW JERSEY

DRAWN M. WASILEWSKI
DATE 3/04/04
PROJECT MANAGER P. MILIONIS
DEPARTMENT MANAGER D. FULTON
LEAD DESIGN PROF. S. POTTER
CHECKED B. PIERCE

HYDRAULIC CONDUCTIVITY AND TRAVEL TIME CALCULATIONS

PROJECT NUMBER NP000571.0003
DRAWING NUMBER 18

DWG DATE: 3/04/04 PRJCT NO.: NP000571.0003 FILE NO.: Fig18.srf CHECKED: B.Pierce APPROVED: P.Millionis DRAFTER: S.Potter



Longitudinal Dispersivity = 10% of scale
(Pickens and Grisak, 1981)

Longitudinal Dispersivity $= 0.83\ [\mathrm{Log}^{10}\ (\mathrm{scale})]^{2.414}$
(Xu and Eckstein, 1995)

Data Source: Gelhar et al., 1992

ARCADIS

Relationship Between Dispersivity and Travel Distance

PSEG Nuclear, LLC Salem Generating Station
Hancock's Bridge, New Jersey

FIGURE
19

Appendix A

Investigations of Salem Unit 1 Fuel Pool Leakage – Final Report Summary

INVESTIGATIONS OF SALEM UNIT 1 FUEL POOL LEAKAGE

FINAL REPORT SUMMARY

FEBRUARY 23, 2004

PSEG NUCLEAR LLC
RADIATION PROTECTION/CHEMISTRY SUPPORT
P.O. BOX 236
HANCOCKS BRIDGE, NEW JERSEY 08038

ABSTRACT

On September 18, 2002 radioactive contamination in the 78-Foot Mechanical Penetration Room in the Unit 1 Auxiliary Building had characteristics of Spent Fuel Pool (SFP) water. Preliminary conclusions from sample results during the initial Phase I investigations prompted an extensive investigation to characterize the source of activity and leakage paths. This evaluation documents the pathway for leakage from the SFP to the liner surrounding the SFP; blockage in the telltale drains; seepage through construction joints in the liner into the Styrofoam Seismic Gap between the Auxiliary Building and the Fuel Handling Building. The seepage is confirmed by monitoring the 78-Foot Mechanical Penetration Room wall, the Spent Fuel Pool cooling line at the interface between the Auxiliary and Fuel Handling Building, the water stop (boot) at the penetration between the Auxiliary Building and the Fuel Handling Building, and two drill points in the Styrofoam. The testing results indicate that build-up of SFP water behind the liner has been ongoing for at least five years on the basis of cesium activity ratios, and that water from the sampling points is consistent with boron and tritium levels in the Unit 1 Spent Fuel Pool. The telltale drains were snaked on January 29, 2003 and following days. Water then freely drained from the telltales, thereby reducing both the amount of water and the time that SFP water stayed in the leakage collection system (i.e. the space between the liner and the concrete enclosure). Water from the telltales (after snaking) drained at about 100 gpd and had characteristics that more closely resembled SFP water with less indication of interactions with the concrete enclosure. By February 7th, "cleared" telltales had reduced the hydraulic pressure and effectively stopped the seepage around the Auxillary and Fuel Handling Building. In February 2003, 45 gallons of water were pumped from Drill Pont No. 1, thereby significantly reducing the amount of water in the Styrofoam Seismic Gap. Further investigation during 2003 indicated that the composition of the water that migrated back into the gap was most likely a mixture of SFP water (3%) that had migrated beyond the gap and groundwater (97%). Again, boron and tritium confirm the link to the SFP, whereas cesium and cobalt activity are at very low or non-detectable levels because of interactions with concrete and soil surfaces. Water from the SFP continues to drain through the telltales at the rate of about 130 gpd (as of January 29th 2004). Most of the water drips through Telltale No. 2 with tritium levels that reflect the changes in the SFP tritium (50% increase during 2003). Cesium activity ratios in the telltales do not change in response to introduction of SFP demineralizers, again reflecting the strong role that concrete surfaces play in controlling cesium levels.

Background for Investigation

The Spent Fuel Pool (hereafter referred to as SFP) liner drains (telltale drains) are a leakage detection system designed to collect water from the SFP that migrates through the stainless steel liner into the concrete enclosure surrounding the SFP. Work orders, interim reports and discussions with Salem personnel have indicated that the Unit 1 telltale drains have performed this function since early in the operation of the plant. At some unknown point in the past, chemical deposits (originally assumed to be boric acid- now shown to be a mix of boric acid and other crystals such as calcium carbonate) began to interfere with the drainage system. The space between the stainless steel liner and concrete enclosure of the SFP began to collect water with characteristics of the SFP. On September 18, 2002, Radiation Protection reported the detection of low-level radioactivity on several technicians' shoes. Investigations indicated a "calcium-like" substance adhering to the west wall in the 78-Foot Mechanical Penetration Room had measurable radionuclide contamination (Notification No. 20114071). These deposits were removed and an active flow of water into the room was then noted. Phase I investigations indicted that the leak had characteristics of Spent Fuel Pool water (see Table 1) and more samples were collected to characterize the source of activity and possible leakage paths. Another leak was subsequently discovered around the Unit 1 Spent Fuel Pool cooling line return on the 92-Foot Elevation (relative to a plant surface elevation of 100 feet). This leak was separated into the return line at the interface between the Auxiliary Building and Fuel Handling Building and the water stop (boot) at the penetration between the Auxiliary Building and the Fuel Handling Building. The following sample points were routinely monitored for radioactivity and compared with activity in the SFP and the telltale drains:

- A drip bag was constructed on the 78-Foot Mechanical Penetration Room wall to collect water. This is the "Drip Bag" sample.
- A catch tray with a sample tube was placed under the Spent Fuel Pool cooling line at the interface between the Auxiliary and Fuel Handling Building on December 17, 2002. This sample was designated as the "Short" sample because of the length of the sample line.
- A sample tube was inserted in the water stop (boot) located at the penetration between the Auxiliary Building and the Fuel Handling Building. This sample was designated as the "Long" sample because of the length of the sample line.
- Two drill points (Drill Point No. 1 and Drill Point No. 2) were inserted into the Styrofoam between the Auxiliary Building and the Fuel Handling Building (often referred to as the Seismic Gap).
- Water that accumulated between the Unit 1 Containment and the Auxiliary Building (1BD41).

Because of low flow from the leakage collection system of about 6 gallons/day (as well as other factors), the telltale drains were snaked on January 29 and following days. Water then freely drained from the telltales, thereby reducing both the amount of water and the time that SFP water stayed in the leakage collection system. Water from the telltales (after snaking) drained at about 100 gpd and had characteristics that more closely resembled SFP water with less indication of interactions with the concrete enclosure. Fiber optic examinations of the telltale drains on January 31st showed blockage in No. 4 and 5 drains beneath the welds, creating a dam effect. The probe inserted beyond this point indicated chemical deposits (originally assumed to be boric acid crystals) had formed. Flow from leakage of the SS liner was forced between the liner plate and concrete providing water to other channels. Rather than draining out, the blockage diverted the water along the space between the SS liner and the concrete, eventually seeping out at the 78-Foot Elevation in the Mechanical Penetration Room. Water also seeped out of the gap where the Spent Fuel Pool cooling return line intersects the wall at the 92-Foot Elevation. Over time, the water apparently migrated and reached the void space between the Auxiliary Building and Containment. ***Figure 4*** shows these locations.

By February 7, 2003, "cleared" telltales had reduced the hydraulic pressure in the leakage collection system and samples from the Drip Bag, "Short," and "Long" sample points could not be obtained because the flow had stopped (or nearly so). Minor amounts of water could be obtained from the sampling points at infrequent intervals in 2003. In February 2003, 45 gallons of water were pumped from Drill Point No. 1, thereby significantly reducing the amount of water in the Styrofoam Seismic Gap. Some water migrated back into the gap and samples were collected when sufficient water was present or about every two months). All radionuclide characteristics from the sampling program waters supported the scenario described above.

Summary of Evaluation Methodology

Characteristics of SFP Water

Radioactive water from the SFP of a PWR (Pressurized Water Reactor) will contain approximately constant levels of boron, tritium, cesium, and cobalt activities (subject to radioactive decay). To detect and quantify leakage from the Spent Fuel Pool, the results are interpreted using the assumptions that the Spent Fuel Pool water typically contains a distinctive radionuclide fingerprint and that interaction with solid surfaces (e.g. concrete) can alter the activity levels dramatically:

- Boron at approximately 2300 ppm and tritium at 0.2 μCi/mL (increasing during 2003 to 0.3 μCi/mL – see Figure 1, Tables 1 and 5). These two tracers are relatively inert and typically migrate with minimal reactivity to concrete or soil (termed "conservative" behavior in the literature).

- Cesium-134 (^{134}Cs has a 2.062 year half-life) and ^{137}Cs (30.17 year half-life) activity in the SFP results from refueling operations and leaching from rods stored in the pool. The activity levels and ratio can change during the course of a fuel cycle. Demineralizers effectively remove cesium from the SFP and change the activity by more than a factor of ten (see Figure 1). Because of difference in half-lives but similar chemical behavior the ratio of cesium activity can provide some qualitative measure of the approximate timing of any release and migration of SFP water. However, cesium interacts strongly with both concrete and soil to retard the migration away from the SFP (i.e. most of the cesium remains sorbed on the concrete enclosure of the SFP. This strong interaction with soil and concrete surfaces also complicates the straightforward use of cesium activity ratios.

- Cobalt Activity: ^{58}Co (70.80 day half-life) and ^{60}Co (5.271 year half-life) will have a characteristic activity ratio after refueling operations that will drop rapidly as the ^{58}Co decays.

Cobalt also interacts strongly with soil and concrete with typically a lower mobility than cesium.

- The presence of short-lived radionuclides such as ^{131}I (a nuclide that does not adsorb to solid surfaces) would be indicative of rapid transport of SFP water from pool to sample point. Only during an October 21,2002 fuel movement (Mode 6) were any shorter-lived radionuclides (i.e., ^{131}I) detected.

Although assumed to have a constant radionuclide inventory, activity levels in the SFP do change in response to the use of a mixed-bed resin demineralizer (to reduce radioactive cations and anions in the SFP water) and to operational events such as refueling . After an interval of time, the levels return to an approximately "steady state" condition (where production and removal rates are equivalent and levels remain constant). However, water analyzed many years after migration from the SFP (or other source) may be difficult to trace to a particular event because of non-unique activity ratios and chemical interactions with concrete and soil. Both cesium and cobalt activity levels (relative to tritium or boron) from SFP leakage will be different than activity in the Spent Fuel Pool because of these chemical and physical interactions (plus decay of short-lived cesium and cobalt). Activity ratios of a given element (i.e., cesium or cobalt) may provide an indication of the age of the leak and/or the extent of the interaction with solid surfaces because of the very different half-lives of the two isotopes. As seen in Tables 1 and 2, the cesium and cobalt activity ratios are much lower for the sampling points vs. the SFP and strongly point to both age of the leak and chemical/physical interactions with the surrounding concrete and soil. Because demineralizers reduce all reactive cations (and anions) in the SFP water, any measurable cation concentration (such as sodium) could indicate introduction of groundwater and/or leaching of sodium from the concrete. Boron and tritium levels showed a "qualitative" inverse relationship with sodium (higher sodium in some samples- e.g. 1BD41- that have lower tritium) that may indicate mixing with groundwater, although the correlation is far from exact.

Conclusions from Radionuclide Evaluation

The results from the radionuclide investigations produce the following conclusions about the leakage collection system (telltale drains). This system was designed to collect and drain the water that migrated through the stainless steel liner of the SFP. All available reports and data indicated that the Unit 1 telltale drains had performed this function since early in the operation of the plant. At some unknown point in the past, the precipitation of chemical deposits (originally assumed to be boric acid; calcium carbonate has also been detected) began to interfere with the drainage system. The space between the stainless steel liner and concrete enclosure of the SFP began to collect SFP water. In October 2002, a number of seepage points appeared in the Auxiliary Building and were collected for radionuclide analysis. They indicated that water from the leakage collection system had seeped/migrated to several sampling sites (see Figure 4 for locations and background investigation for description). Table I summarized the average results for samples collected for the Phase II investigation (prior to snaking of the telltales drains) (Figures 5 through 10 graph the time series of the data and discussion of the individual sampling points follows this section). The following major conclusions result from the Phase II samples in January 2003 (prior to snaking):

- The samples from the Spent Fuel Pool telltale drains, the 78-Foot Elevation Drip Bag, and the water in the Styrofoam between the Fuel Handling Building and the Auxiliary Building had common isotopic characteristics. Boron and tritium levels are equivalent to SFP water (90 to 100% of SFP level). Sodium was between 2 and 15 ppm indicating minimal groundwater input and/or leaching of structural material. Cesium and cobalt absolute activities were more than a factor of five lower than the SFP (8 to 20% of SFP) and the activity ratios were indicative of extensive interaction with the concrete and structural materials.

- The samples from the canal telltale drains and the water stop (boot) located at the penetration between the Auxiliary Building and the Fuel Handling Building ("Long" sample) had common characteristics. Boron and tritium were at 60% to 70% of SFP water; elevated sodium suggested that groundwater mixed with these two sources (although the potential pathway for groundwater ingress was unclear). The canal telltales and "Long" sample also had very low ^{60}Co activity, suggesting a strong interaction with structural materials or soil.

- Water in the space between the Unit 1 Containment and the Auxiliary Building (1BD41 sample) had characteristics of Spent Fuel Pool water that left the pool more than five-years ago and was subject to extensive interaction with structural materials. Cesium-137 activity is nearly 70 times lower than SFP and cobalt activity is at or near ND (non-detectable) levels. Higher sodium with some chloride indicated a groundwater component and/or interaction with solid surfaces. Most likely, SFP water had migrated from the leakage collection system over time through a six-inch gap between buildings and mixed with groundwater (70% SFP-30% groundwater) (although the pathway is not clear).

- The whole question surrounding the seepage of groundwater into the various sampling points is problematic. The pathways are not defined but average water table elevations are about 5 feet bgs (95 feet plant datum) vs. sampling points between 78 and 92 feet (plant datum). Thus for most of the past twenty years there has been a hydrostatic head driving water through cracks and construction joints into the Auxiliary and Fuel Handling Building. In the absence of any radionuclide contamination, this small amount of water that seeps into the building would not be noticed (most or all would evaporate rather than pool). The presence of sodium in a sample does not automatically "fingerprint" groundwater as the source of the sodium. If sodium and chloride are not "balanced" and the levels of tritium and boron are near or at SFP values (e.g. Drip Bag samples), then most likely the sodium has been released from leaching of the concrete/structural materials. On the other hand if tritium and boron are at some % of SFP values (e.g. Canal Telltales and 78' Long –Table 1) and sodium is elevated, then the sodium may come from seepage of groundwater into the facility or mixing with periodic precipitation and structural concrete. A complete structural analysis of potential seepage paths is not required for analysis of the source of the SFP water.

- Iodine-131 in selected samples was related to Mode 6 operation (part of 1R15 refueling) during October 2002. ^{131}I leached from rods stored in the fuel racks during the refueling operations. This water, containing ^{131}I, leaked and mixed with existing water (^{131}I–free) in the space between the SS liner and the concrete enclosure of the SFP. Cesium activity ratios for the sampling points reflect water that has interacted with the concrete as opposed to "zero-age" SFP water. The ^{131}I activity suggests a relatively rapid migration of small amounts of SFP water to the sampling points. Iodine-131 activity has not been detected in samples after January 2003, supporting the link to the refueling operation and not some other leakage path.

TABLE 1: AVERAGE COMPOSITION AND ACTIVITY LEVELS DURING STABLE PERIODS FOR PHASE II SAMPLE POINTS (January 2003)

Constituent	**AVERAGE RESULT DURING STABLE PERIODS**							
	1 SFP	**Pool Telltales***	**Canal Telltales***	**78 "Short"**	**Drip Bag**	**78 "Long"**	**Drill Points**	**1BD41**
Na, ppm		6.2	122	2.8	14.7	26.8	6.02	59.7
Cl, ppm	0.0012			0.09	0.52	10.6	0.41	12.1
Iron, ppm				0.03	0.10	0.47	5.15	0.04
Boron, ppm	2316	2257	1465	2292	2605	1365	2119	1208
H-3	1.93E-01	1.78E-01	1.31E-01	1.91E-01	1.81E-01	1.18E-01	1.88E-01	1.19E-01
H-3 **Ratio to SFP**		92%	68%	99%	94%	61%	97%	62%
^{131}I, Mode 6**	5.96E-04	4.25E-04	ND	4.24E-04	4.05E-04	3.12E-04	3.84E-04	1.28E-04
^{134}Cs	2.18E-03	5.34E-05	5.11E-05	3.01E-04	5.84E-05	8.62E-05	4.01E-05	6.22E-06
^{137}Cs	2.17E-03	1.67E-04	1.87E-04	4.52E-04	1.73E-04	2.02E-04	1.31E-04	3.06E-05
137Cs Ratio to SFP		7.7%	8.6%	20.8%	8.0%	9.3%	6.0%	1.4%
^{54}Mn	4.10E-05	2.38E-06	ND	9.07E-06	1.39E-06	1.87E-06	1.22E-06	ND
^{58}Co, Mode 6**	8.02E-03	2.46E-05	2.72E-05	9.00E-04	ND	1.05E-04	8.43E-07	ND
^{60}Co	9.82E-04	5.88E-05	8.06E-06	2.12E-04	3.56E-07	2.86E-05	1.02E-06	9.99E-08
^{125}Sb	1.07E-05	2.59E-05	2.12E-06	9.40E-06	ND	3.62E-06	1.82E-06	ND
^{134}Cs/^{137}Cs	1.02	0.33	0.22	0.67	0.34	0.42	0.31	0.20
^{58}Co/^{60}Co	8.27	0.83	2.74	4.21	0.0	3.59	0.53	-

ND = Not detected in samples analyzed.

Units for concentrations of radionuclides are presented in microcuries per milliliter (?Ci/mL)

*Before snaking telltale drains.

**Shorter-lived activities were decay-corrected to October 21, 2002 22:42 when Mode 6 (fuel movement) was established.

"Snaking " of the Telltale Drains

Because of low flow from the leakage collection system (as well as other factors), the telltale drains were snaked on January 29 and following days. Fiber optic inspection confirmed that the drains had been generally cleared. Water then freely drained from the telltales, thereby reducing both the amount of water and the time that SFP water stayed in the leakage collection system. Water from the telltales (after snaking) drained at about 100 gpd and this rate has continued to the present, as measured by the building sump pump (February, 2004). Most of the water (about 500 ml/min) drained through Telltale No.2. By February 7, 2003, "cleared" telltales had reduced the hydraulic pressure and samples from the Drip Bag, "Short," and "Long" sample points could not be obtained at regular intervals because the flow had stopped (or nearly so). The results obtained during 2003 (after snaking) are summarized in Table 2:

- After the "snaking" operation, the telltale (TT) samples closely resembled the SFP water (see time series in Figures 1 and 2). In boron and tritium, the match is almost exact, reflecting the fact that neither constituent reacts with the concrete materials in the SFP. Cesium-137 activity was 75% of SFP at No. 1 TT and 16% at No. 8 TT; the cesium activity ratios (0.89 - 0.64) and the ^{60}Co activity (64% to 2%) also decrease in a similar fashion reflecting an increase in flow path and time for chemical interactions from No. 1 TT to No. 8 TT.

- Water from the SFP continues to drain through the telltales at the rate of about 130 gpd (as of January 29th 2004). Most of the water drips through No. 2 TT and has tritium levels that reflect the changes in the SFP during 2003 (from 0.2 μCi/ml to 0.3 μCi/ml). Cesium ratios in the telltales did not change dramatically in response to introduction of SFP demineralizers in October 2003, again reflecting the strong role that concrete surfaces play in controlling cesium levels. Figure 2 does show a consistent drop in Cesium-137 activity for Telltale No.2 during 2003 as the cesium on the surface of the concrete exchanges with low cesium in the demineralized SFP water to "buffer" the activity level.

- After "snaking of the telltales", sampling points outside the concrete enclosure had a lower overall yield as well as a lower contribution of water from the leakage collection system. Tritium dropped to 14% (of SFP) at BD41 to 31% at the Drip Bag (Table 2). The tritium level in the Styrofoam Seismic Gap dropped to 3% of SFP levels from about 70% prior to "snaking" the drains. The low tritium level at Drill Point No. 1 resulted from inflow of groundwater or precipitation into the Seismic Gap, driven by the change in hydrostatic head when water was pumped from the Seismic Gap. Cesium-activity levels were 2 to 8% of SFP (with the exception of a single Drip Bag sample that was not replicated). Cesium activity ratios were comparable to pre-snaking ratios and reflect long-term interaction with the concrete enclosure of the SFP. Cobalt activity is at or near non-detectable (ND) and <1% of SFP because of strong adsorption to structural material.

- The interpretation and results from the individual sampling locations during 2002 and 2003 are presented in the sections that follow and are used to support the above conclusions. The time series is typically divided into "pre and post – snaking", pre and post refueling operation.

Table 2. Activity in Selected Samples (Averages after Snaking) Ratios to Unit 1 Spent Fuel Pool.

Sample	Date/Time	Boron, ppm	Na, ppm	^{3}H, µCi/mL	^{137}Cs, µCi/mL	^{134}Cs/^{137}Cs Ratio	^{60}Co, µCi/mL	^{58}Co/^{60}Co Ratio
1 SFP	12-Jun-03	2395	~0	2.36E-01	3.08E-03	0.75	2.42E-03	0.36
	10-Jul-03	2354	~0	2.67E-01	3.48E-03	0.71	2.46E-03	0.28
	17-Jul-03	-	~0		3.65E-03	0.71	2.40E-03	0.29
	24-Jul-03	2359	~0		3.73E-03	0.69	2.60E-03	0.24
	7-Aug-03	2349	~0		4.32E-03	0.67	2.86E-03	0.21
1SFP Average		***2364***		***2.52E-01***	***3.65E-03***	***0.71***	***2.55E-03***	***0.28***
Drill Pt	12-Jun-03	234**	38	7.71E-03	1.34E-04	0.28	2.40E-07	-
No. 1	30-Jul-03	-	-	6.77E-03	1.25E-04	0.26	2.14E-07	-
Ratio to-SFP		0.10		***0.029***	***0.035***	***0.38***	***0.000089***	
1 BD 41	24-Sep-03	-	-	-	5.49E-05	0.20	ND	-
	23-Oct-03	317*	178	3.45E-02	6.99E-05	0.19	ND	-
Ratio to-SFP		0.13		***0.14***	***0.019***	***0.27***		
"Long"	1-Jul-03	332	60	5.19E-02				
	3-Jul-03				3.34E-04	0.36	1.72E-05	-
Ratio to-SFP		***0.14***		***0.21***	***0.091***	***0.51***	***0.007***	
78 Drip Bag	1-Jul-03	-	2.45	7.87E-02				-
	3-Jul-03				5.86E-03	0.30	-	
Ratio to-SFP				***0.31***	***1.61***	***0.43***		
No. 1 TT	27-Aug-03	2393	1.50	2.90E-01	2.84E-03	0.65	1.42E-03	0.19
	24-Sep-03	2371	5.60	*	2.64E-03	0.63	1.65E-03	0.14
	22-Oct-03	2364	0.94	2.61E-01	2.78E-03	0.60	1.79E-03	0.11
Ratio to-SFP		***1.01***		***1.10***	***0.75***	***0.89***	***0.64***	***0.53***
Sample	**Date/Time**	**Boron, ppm**	**Na, ppm**	**^{3}H, µCi/mL**	**^{137}Cs, µCi/mL**	**^{134}Cs/^{137}Cs Ratio**	**^{60}Co, µCi/mL**	**^{58}Co/^{60}Co Ratio**
No. 2 TT	27-Aug-03	2264	4.52	3.06E-01	1.64E-03	0.62	6.99E-04	0.18
	24-Sep-03	2278	14.7	*	9.59E-04	0.64	3.35E-04	0.15
	22-Oct-03	2310	2.70	3.26E-01	1.33E-03	0.61	6.54E-04	0.09
Ratio to-SFP		***0.97***		***1.26***	***0.36***	***0.88***	***0.22***	***0.51***
No. 3 TT	2-Jul-03	2140	1.00	***	3.78E-04	0.61	8.72E-05	-
	26-Sep-03	2282	-	*	5.62E-04	0.53	3.48E-05	-
	23-Oct-03	2294	2.40	2.67E-01	1.01E-03	0.53	3.89E-05	-
Ratio to-SFP		0.95		1.06	0.18	0.79	0.021	
No. 5 TT	27-Aug-03	2296	4.01	2.93E-01	8.52E-04	0.56	6.55E-05	-
	26-Sep-03	2260	24.5	*	5.95E-04	0.52	7.92E-05	-
	23-Oct-03	2054**	6.40	2.25E-01	5.26E-04	0.48	8.78E-05	-
Ratio to-SFP		***0.93***		***1.03***	***0.18***	***0.74***	***0.030***	
No. 8 TT	27-Aug-03	2279	5.56	2.89E-01	6.63E-04	0.509	1.00E-04	
	26-Sep-03	2263	-	2.97E-01	5.20E-04	0.46	1.51E-04	0.09
	23-Oct-03	2159*	4.90	2.68E-01	5.19E-04	0.51	2.12E-04	0.10
Ratio to-SFP		***0.94***		***1.13***	***0.16***	***0.68***	***0.061***	***0.34***

* Suspect Value

**Re-analysis

***Insufficient sample

FIGURE 1a: SALEM UNIT 1 SPENT FUEL POOL/TELLTALE NO. 1 BORON, CESIUM, AND IODINE ACTIVITY

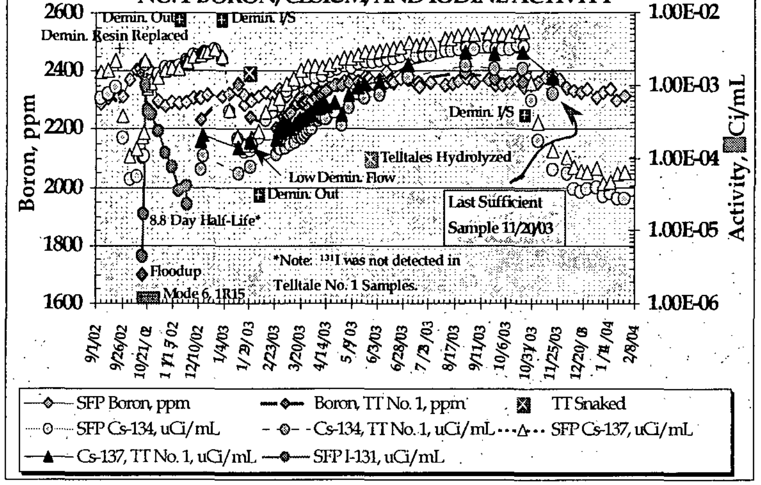


FIGURE 1b: SALEM UNIT 1 SPENT FUEL POOL/ TELLTALE NO. 1 BORON AND COBALT ACTIVITY

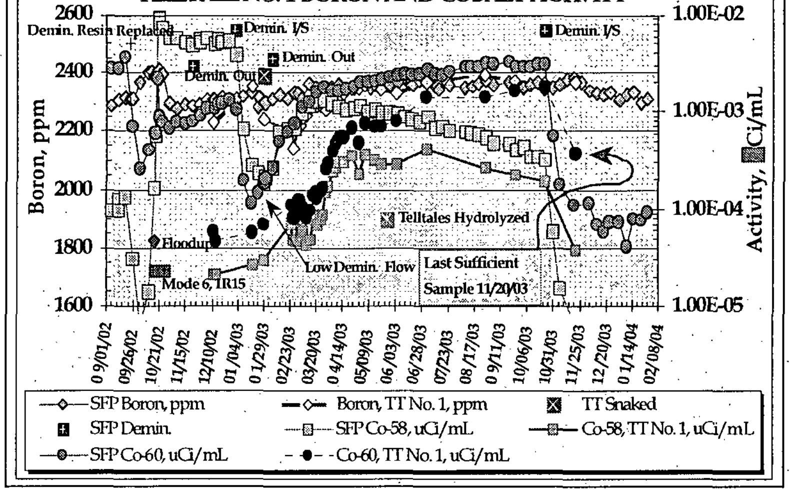


FIGURE 1c: SALEM UNIT 1 SPENT FUEL POOL/ TELLTALE NO. 1 BORON, TRITIUM, AND SODIUM

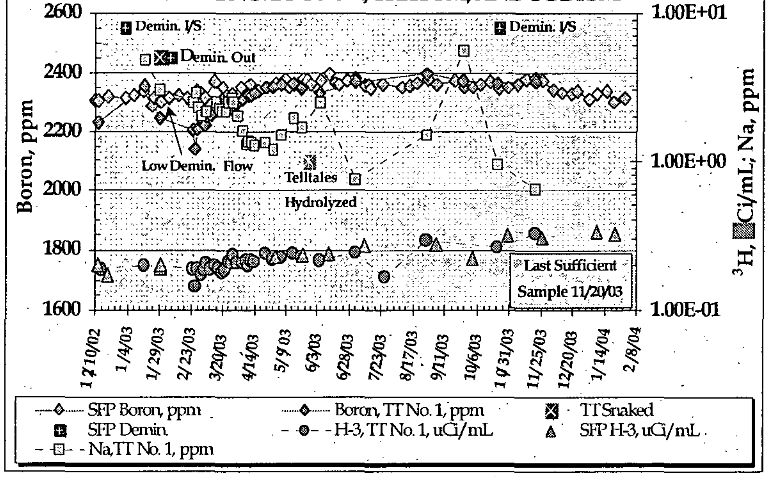


FIGURE 1d: SALEM UNIT 1 TELLTALE NO. 1 METALS AND COBALT ACTIVITY

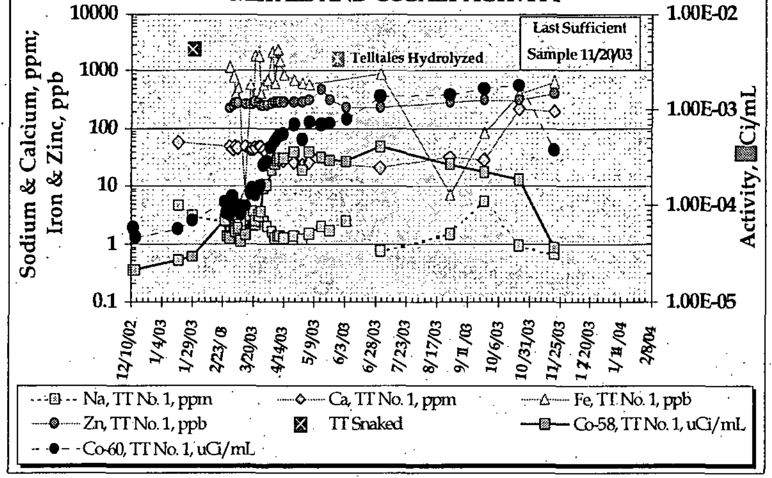


FIGURE 2a: SALEM UNIT 1 SPENT FUEL POOL/TELLTALE NO. 2 BORON, CESIUM, AND IODINE ACTIVITY

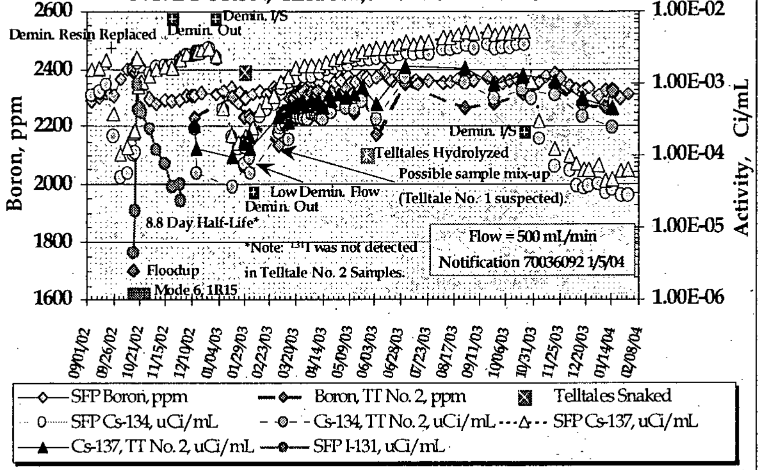


FIGURE 2b: SALEM UNIT 1 SPENT FUEL POOL/ TELLTALE NO. 2 BORON AND COBALT ACTIVITY

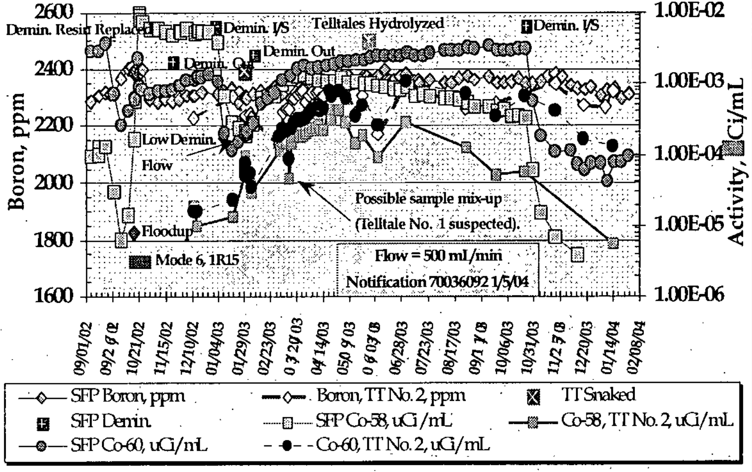


FIGURE 2c: SALEM UNIT 1 SPENT FUEL POOL/ TELLTALE NO. 2 BORON, TRITIUM, AND SODIUM

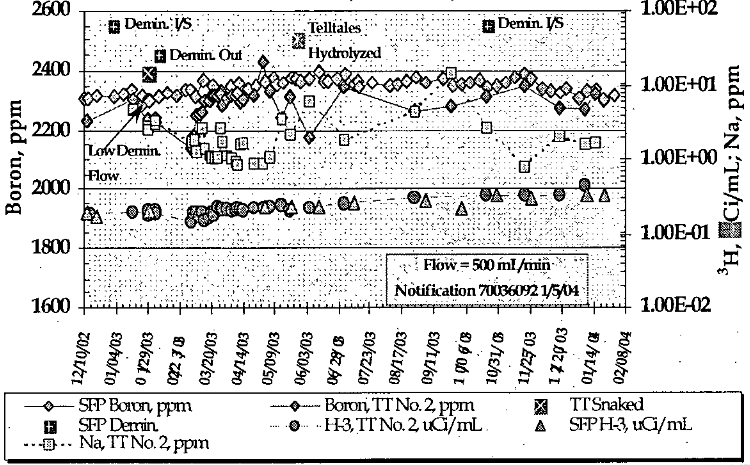


FIGURE 2d: SALEM UNIT 1 TELLTALE NO. 2 METALS AND COBALT ACTIVITY

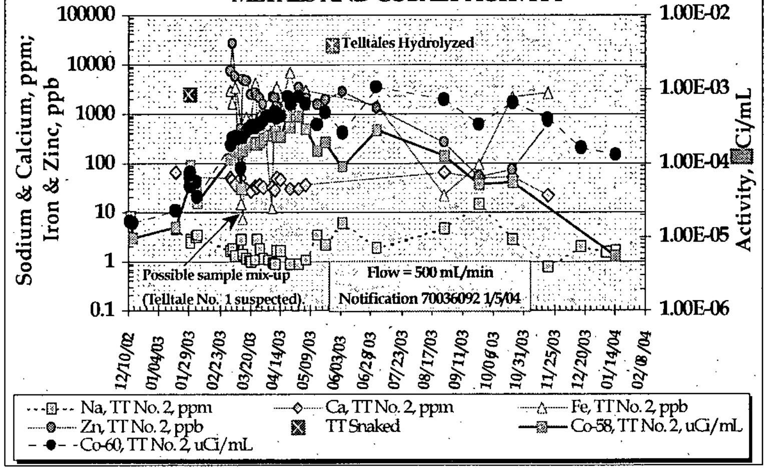


FIGURE 3A: SALEM UNIT 1 SPENT FUEL BORON, CESIUM, AND IODINE

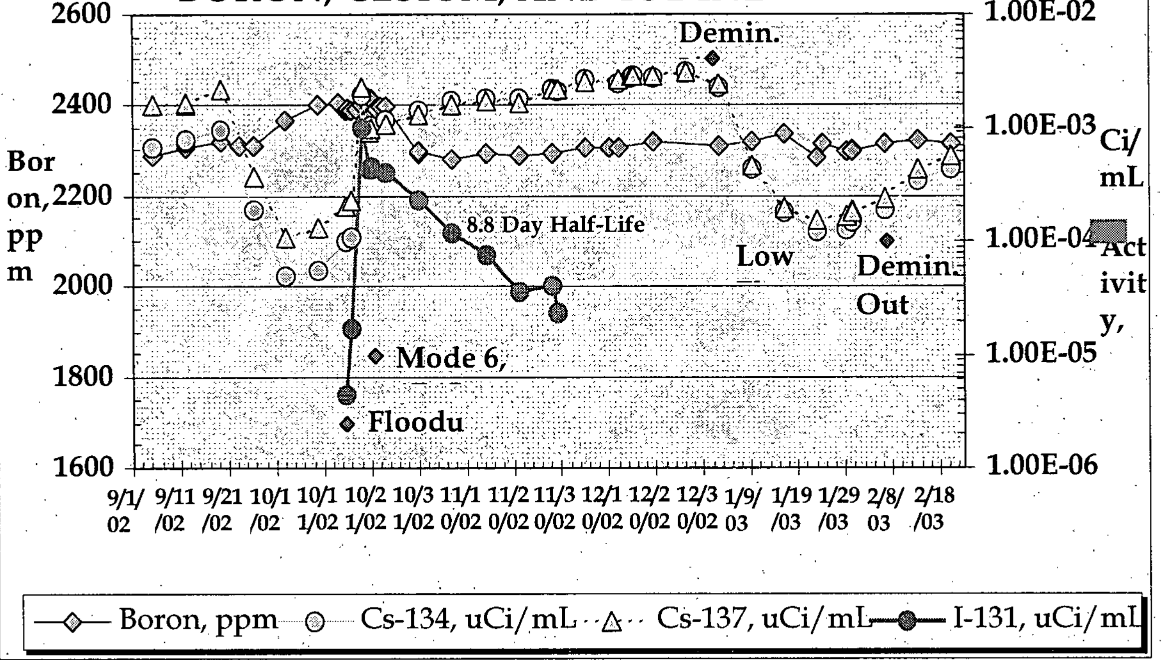
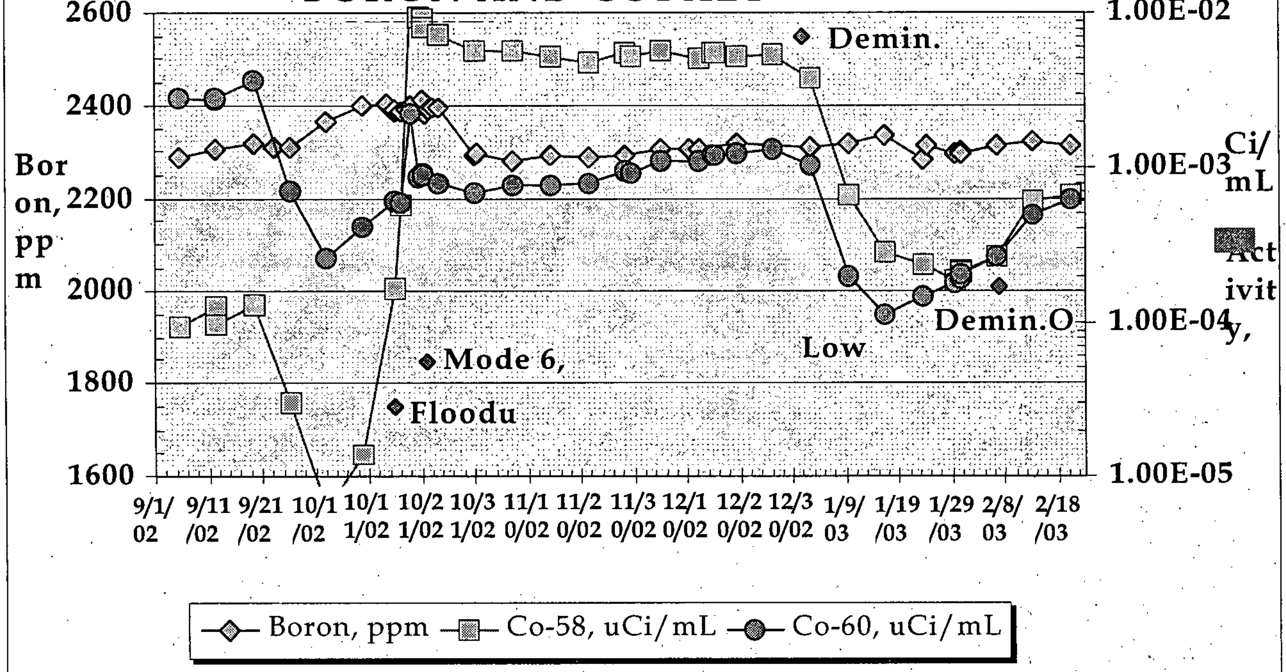


FIGURE 3B: SALEM UNIT 1 SPENT FUEL BORON AND COBALT



Time Series of Individual Sampling Locations

SALEM UNIT 1 SPENT FUEL POOL - (Recent History)

Salem performs weekly boron and gamma isotopic analyses and monthly impurity (e.g., chloride, fluoride, and sulfate) analyses of the Spent Fuel Pool water. The normal sample point is the Spent Fuel Pump discharge pressure tap and is representative of water re-circulated in the Spent Fuel Pool through the unit's heat exchanger (note that water beneath the fuel racks could be relatively stagnant and only mix with the rest of the SFP by thermal convection). Figures 3A and 3B show historic boron levels in the Salem Spent Fuel Pools based on routine analyses. Salem Unit 1 prepared for a scheduled refueling outage in October 2002. Salem Chemistry personnel have noticed a faint "bathtub" ring of white crystals at the wall interface of the pool surface that suggests decreasing water level and deposition of trace levels of boric acid. Boron levels in the Unit 1 Spent Fuel Pool decreased prior to the refueling outage ; the result of a combination of evaporation, leakage of SFP water through the SS liner and makeup with de-mineralized (boron-free) water. Mass balance calculations are not sufficiently sensitive to estimate leakage rates because the evaporation term is a number of times greater than the leakage rate through the SS liner (which by October 2002 had slowed considerably (< 10gpd) as the water level in the concrete enclosure reached the level of the SFP, thereby eliminating the hydrostatic driving force).

Salem Unit 1 entered Mode 3 for 1R15 (refueling operation) on October 10, 2002. The cavity was flooded on October 15th and Mode 6 was established on October 21st. During refueling, the water in the canal is connected to the Spent Fuel Pool when the gate is open, but re-circulation between the Spent Fuel Pool and the canal is limited. The significance of flooding was that reactor coolant was mixed with refueling water and activity levels in the Spent Fuel Pool increased.

Iodine-131 and ^{58}Co activity reported after October 21st was decayed-corrected to October 21st when Mode 6 was established to enable comparisons of isotopes with different half-lives. Iodine-131 was not detected in the bulk Spent Fuel Pool water after November 29th (Figure 3A); sample size and the counting interval were not optimized to detect ^{131}I prior to the recent investigation. The average decay-corrected level of ^{131}I was 5.96 x 10^{-4} µCi/mL. Several samples (see Table 3) detected ^{131}I activity after October 21, suggesting a relatively short pathway from the SFP to sampling points such as the Styrofoam Seismic Gap.

The Spent Fuel Pool de-mineralizer was placed in service January 1, 2003. Activity levels decreased by approximately a factor of ten as the resin effectively reduced radioactive cesium and cobalt (Figures 3A and 3B). Antimony-125 could now be detected because spectral interferences were reduced. Cobalt and cesium activities had begun to increase because of low flow in the demineralizer and continued to increase after removal of the demineralizer on February 6th. Prior to placing the demineralizer in service, the average ^{134}Cs/^{137}Cs activity ratio was 1.02, whereas the average decay-corrected (to Mode 6 on October 21, 2002) ^{58}Co/^{60}Co activity ratio was 8.27. After the demineralizer was placed in service, the cesium activity ratio decreased from 1.02 to 0.80 and the cobalt activity ratio decreased from a decay-corrected value of approximately 8.27 to

2.9. This is explained by isotopic equilibration with accumulated cesium on the demineralizer resin and differences in removal efficiency for ^{58}Co relative to ^{60}Co with the purification media used in the demineralizer vessel.

On January 30, 2003 special sampling techniques were used to safely sample water underneath the fuel racks in the Unit 1 Spent Fuel Pool and water at the bottom of the canal. For comparison a separate sample was collected near the surface of the Spent Fuel Pool. These sample results are summarized in Table 3 and provide important conclusions:

- Water in the Unit 1 Spent Fuel Pool at the normal sampling point, near the pool surface, and beneath the fuel racks was homogeneous with little temperature gradient.
- The special sample analysis results do not indicate that a difference exists in the water chemistry beneath the fuel racks and the circulating water; after the demineralizer was placed in service January 1, 2003, the pool water was homogeneous by January 30th.
- The special sampling did not establish that ^{131}I levels were higher in the bottom of the pool prior to placing the demineralizer in service. With an 8.04 day half-life, insufficient ^{131}I activity remained by January 30th to provide confirmation.
- The demineralizers were taken out of service in late January 2003. Cesium and cobalt activity levels gradually increased throughout 2003 (Figure 1). Tritium also showed a slight increase throughout 2003. Cesium and cobalt activity dropped again when the de-mineralizers were placed into service in late October 2003.

In conclusion, activity in the Unit 1 Spent Fuel Pool increased during refueling operations as expected and decreased when the demineralizer was placed in service on January 1, 2003. The expectation is that samples from leakage paths from the Spent Fuel Pool would eventually show decreasing activity levels and changing activity ratios, providing a means to estimate the migration time (however, the strong interaction of cesium and cobalt with concrete surfaces obscured any simple correlation). Temperature, boron, tritium, cesium and cobalt activity indicate homogeneity in the SFP. Activity levels from the bottom of the pool, where assemblies with defective rods are stored, were equivalent to surface SFP water at 29 days after the demineralizer was placed in service. During 2003, nuclear operations continued in a normal mode and activity levels in the SFP stabilized over the course of the year (slight increase in activity from February to October). In October, the demineralizer was returned to service and cesium and cobalt activity levels dropped dramatically in the SFP. Because of the strong interaction of cesium and cobalt with the concrete surfaces, the telltale drain samples did not show a dramatic change because the large amount of cesium present on the surfaces of structural material "buffered" the cesium activity.

SPENT FUEL POOL LINER DRAINS

The Salem Unit 1 Spent Fuel Pool liner drains (e.g., telltale drains) are a leak detection/collection system designed to collect leakage beneath the stainless steel liner. Telltale drains No. 1 through 10 receive the leakage from the Spent Fuel Pool, whereas drains No. 11 through 17 receive the leakage from the refueling canal, which is deeper than the Spent Fuel Pool (Tables 3 and 4). Three sets of samples were collected from the telltale drains (prior to the "snaking" operation. The first set was taken December 11 – 12, 2002 and the second set was taken December 14, 2002 by collecting water dripping from each drain. The average leakage was equivalent to approximately 5.8 gpd. Drains No. 1, 2, 4, and 6 of the Spent Fuel Pool and No. 14 of the canal had the highest leakage; no leakage was noted for No. 7, 10, 11, and 12. Caps were placed on the drains and removed January 17, 2003 for the third set of samples.

Tables 2-4 summarize boron, impurities, tritium, and gamma activity from the samples collected. Time series are graphed in Figures 1 and 2. Boron and tritium levels in the telltale drain samples provided a direct correlation with the Spent Fuel Pool, whereas cesium and cobalt activities (and ratios) were expected to provide a possible indication of sample age and extent of interaction with structural material. Sodium levels may provide an indication of groundwater intrusion and/or leaching from structural materials. Chloride should balance sodium if groundwater is present. pH changes may indicate interactions of the boric acid with structural materials. On January 29, 2003 the telltale drains were individually snaked; the water collected, analyzed, and reported in Tables 2-4. Collectively, the telltale drain data indicate the following:

- Boron and tritium data from the Unit 1 Spent Fuel Pool telltale drains indicate that the pool water was the source (Figures 1 and 2), whereas the canal telltale drains indicate possible mixing with groundwater (10 to 20%). Sodium levels for the SFP drains were reasonably consistent at <1ppm. In Telltale No. 14 and No. 16 (from the canal liner), sodium was 69.7 ppm and 329 ppm, respectively. Boron and tritium in the canal telltale drains were lower than typical levels in the pool drains, and sodium was also much higher, suggesting dilution by groundwater (although the sodium was not balanced by chloride ion) and/or release of sodium from the interactions with structural materials.
- Iodine-131 (8.04 day half-life), when detected, was present in selected samples from telltale samples from the Spent Fuel Pool but not present in the telltale samples from the canal area. When decay-corrected to Mode 6 (the time of fuel movement), the average level was 71% of the average SFP decay-corrected activity of ^{131}I. This comparison strongly suggests that the Spent Fuel Pool was the source of the ^{131}I activity. The lack of detected ^{131}I activity in the telltale drain samples after December 14, 2002 also points to the refueling operation as the source of the activity which became too low to measure after two months of decay.
- Cobalt-58 was not detected in all samples in which ^{131}I was detected, suggesting interactions of cobalt with structural materials (e.g., concrete) that does not adsorb iodine. The ^{131}I-to-^{137}Cs activity ratio corrected to Mode 6 for drains No. 3, 4, 5, and 6 was 5.2, compared to 0.36 for the Spent Fuel Pool. Substantial uptake of cesium by structural materials had occurred, to reduce cesium activity by about 90%. Cesium and cobalt activity levels in the telltale drain samples were small fractions of levels in the Spent Fuel Pool water analyzed, most likely as a result of interactions with structural materials. The ^{134}Cs-to-^{137}Cs activity ratio (0.19 – 0.85) and ^{58}Co-to-^{60}Co activity ratio (0.20 – 2.01) in the telltale drain samples were also lower than average ratios for the Spent Fuel Pool (1.02 and 8.27, respectively). The cesium and cobalt in telltale drain water had exchanged (to isotopic equilibration) with "old" cesium and cobalt (low ^{58}Co and ^{134}Cs activity), adsorbed to the structural concrete. Thus, even if the path is short (from SFP to telltale) the cesium and cobalt exchange rapidly with the large amount of cesium and cobalt on the concrete and will reflect the activity ratio of the adsorbed fraction (i.e. "old") rather than the activity ratio of the SFP (i.e., "young").

Because ^{131}I only weakly adsorbs to concrete and migrates at the rate of water flow, levels of ^{131}I activity are present soon after the refueling operation was completed.

- Antimony-125 was detected in only one telltale drain sample from the canal and in several of the pool telltale drain samples. Antimony-125 (2.77 year half-life) is a decay product of ^{125}Sn (9.64 day half-life), an activation product of ^{124}Sn (5.79% in nature), which is in the zirconium alloy cladding. Leakage from water in the pool in contact with fuel rods would explain the ^{125}Sb in the samples.
- The average pH of pool drains No. 1, 3, 4, 5, and 6 sampled January 17th was 7.10 compared to an expected pH for approximately 2,257 ppm boron of 4.56. The average pH of canal drains No. 13 and 14 was 7.79 compared to an expected pH of approximately 4.80 for 1465 ppm boron. The neutral to basic pH indicates interactions with structural materials and/or mixing with groundwater. The calcium carbonate in concrete would neutralize the hydrogen ions in boric acid to increase the pH to neutral without changing the borate content of the water. Cation exchange of hydrogen ion for sodium and potassium in the concrete would cause both an increase in the pH and in the sodium and potassium concentration.

After snaking on January 29th significant tan or brown debris, characteristic of rust deposits, flushed from drains No. 2, No. 3, No. 6, and No.14. The debris was not magnetic. The water initially flowed from drain No. 2 at approximately 1 gpm after snaking, decreasing to about 1 liter per minute. Telltale No. 2 continued to drain at about 0.5 liters/min through 2003. The other drains had at least a factor of ten lower flow. The data in Table 3 suggest that the operation allowed accumulated water to drain, and resulted in an increase in both the ^{58}Co level and ^{58}Co-to-^{60}Co activity ratio [1.5 to approximately 3.2 (decay-corrected to Mode 6)] . Fiber optic inspections on January 31, 2003 indicated deposits (originally thought to be boric acid) behind the telltale drains.. The restriction of flow forced leaking water to the build up in the leakage collection system. The formation of deposits suggests that the leakage had occurred over many years, which helps to explain the age characteristics of cesium and cobalt activity in the telltale drain samples. The drip rate from telltale drains was approximately 5.8 gpd prior to snaking. After snaking, initially water freely flowed from the telltale drains, diminishing to steady drips; however, the rate was not accurately measured for an extended period. Snaking was repeated February 21, 2003 and the flow was measured at 22 liters per hour (139 gpd) from the sump pump. This rate continued throughout 2003.

Deposits on the wall area above the pitchdown trench, which receives the drips from the telltale drains, had an average ^{134}Cs-to-^{137}Cs- activity ratio of 0.13. Decay of an initial source with an activity ratio of 1.02 (SFP water) would require 6.5 years to decrease to an activity ratio of 0.13; an upper limit age of the activity on the wall. The calculated "age" was about three years if one used an activity ratio typical of the telltale drains (0.3 to 0.4). Cobalt activity was not detected in the white deposits, confirming the slow migration rate of cobalt in contact with concrete.

In summary, water beneath the fuel racks is postulated to be leaking into the telltale drains beneath the Unit 1 Spent Fuel Pool, and water beneath the canal is postulated to be leaking into the telltale drains beneath the canal area. Groundwater may be mixing with the water in the drains beneath the canal based on lower tritium and higher sodium levels (although the pathway is not clear) and/or interactions with the structural concrete is occurring. Very limited mixing with groundwater in the drains beneath the Spent Fuel Pool has occurred.

- Cesium activity ratios suggested a "history" equivalent to approximately five years based on an initial ^{134}Cs-to-^{137}Cs activity of 1.02 (SFP) that decayed to 0.22 (telltales). Most of the reduction in activity has taken place through a process of isotopic exchange between cesium in the water and cesium on concrete surfaces. The chemical behavior of cesium strongly favored adsorption to solid surfaces. [Cesium-134 decays with a 2.062 year half-life and ^{137}Cs decays with a 30.17 year half-life.]
- Iodine-131 was detected in selected samples after a refueling operation (only) and demonstrates that a radioisotope that only weakly adsorbs to solid surfaces can migrate rapidly in this environment from source to sampling point.
- Snaking initially increased the flow rate, allowing the accumulated water to be purged from the leakage collection system. After snaking the cobalt activity level also increased in the No. 2 drain with an increase in the ^{58}Co-to-^{60}Co activity ratio, indicating a more recent history and a better comparison to cobalt activity in the Spent Fuel Pool.
- Figures 1 and 2 show the activity levels in the Telltale drains Nos.1 and 2 through 2003. Of particular importance was the fact that during the interval that the demineralizers were in service (January and October through December 2003) the cesium activity dropped by more than a factor of ten in the SFP; the telltale drains did not show a similar drop. This supports the hypothesis of a strong adsorbtion coefficient for cesium and that the cesium activity is buffered by interaction between the water in the leakage collection system and the concrete surfaces.
- Tritium in the SFP increased by about 50% during 2003 and Telltale No.2 displayed a similar trend to the SFP that confirmed the direct connection between the SFP and Telltale No. 2.

78-Foot Mechanical Penetration Area Drip Bag

Sampling of the 78-Foot Elevation Mechanical Penetration wall began on December 11, 2002. Tables 2 and 3 summarize results and compare average levels in the Drip Bag to the Unit 1 Spent Fuel Pool and telltale drains. The boron, tritium, iodine (two samples), and cesium activity for the Drip Bag is equivalent to the average telltale activity. Figures 5A through 5D show boron, activity levels, and sodium as a function of time. Boron and tritium gradually increased with time, whereas cesium activity was relatively constant; ^{58}Co activity was not detected and ^{60}Co levels were low and only detected when the sample size and counting intervals were increased. By February 7, 2003, the snaking of the telltales had reduced the hydraulic pressure and the seepage stopped. Tables 2 and 3 and Figures 5A-D show the following:

- Boron and tritium suggest Spent Fuel Pool water migrated through the SFP leakage collection system. Boron and tritium levels in samples collected in the drip bag increased over time as indicated in Figure 5A, possibly as a result of source water displacing groundwater. The boron was 2735 ppm in the most recent sample; levels that are higher than the Spent Fuel Pool; evaporation (and possible dissolution of previously deposited boric acid) may explains the elevated boron level . The increase in boron and tritium corresponds to a decrease in sodium (Figure 5D), suggesting less dilution by groundwater and/or less chemical interaction with structural material over time (chloride was less than 1 ppm, a level that would support the latter conclusion).

- The extremely low cesium and cobalt activity levels compared to the Unit 1 Spent Fuel Pool levels (but similar to telltale drain samples) may be explained by interactions with structural materials; the cesium activity ratio also linked the Drip Bag samples to the telltale drain. Low sodium and chloride levels also indicate a low level of groundwater dilution (chloride was less than 1 ppm). Relatively constant cesium levels indicate equilibrium with construction materials/concrete.
- The relatively low ^{134}Cs-to-^{137}Cs activity ratio in the Drip Bag samples (0.34 average) indicates "old" cesium that has adsorbed to the walls of the leakage collection system and matches the cesium ratio in the telltale drain samples (0.33 average prior to snaking). This conclusion is supported by non-detectable ^{58}Co (70.80 day half-life) and detectable ^{60}Co (5.27 year half-life) only in counting large samples.
- Iodine-131 (8.04 day half-life) was detected in two samples after the drip bag was established. When decay-corrected to the time Mode 6 was established for 1R15, the activity levels match levels in the Unit 1 Spent Fuel Pool. This fact and the lack of detected ^{131}I activity in later samples point to the refueling operation as the source of ^{131}I. Iodine does not adsorb strongly to surfaces, as cesium and cobalt do, and may explain why the iodine signal reflects "young" water while the cesium activity reflects "old" water.
- Iron was measured in selected samples and present at 0.09 to 0.48 ppm. The source of iron is uncertain and two scenarios are most plausible. The concern is boric acid corrosion of rebar in the concrete. If iron rebar corrodes under reducing conditions (Fe metal would oxidize to Fe(II)aqueous; although the rate is certainly much lower than under oxidizing conditions – i.e. when oxygen is present), soluble Fe(II) is formed. Groundwater also contains high levels of mobile Fe(II). Groundwater Fe(II) occurs when bacteria reduce FeO(OH) in soils to soluble Fe(II). The Fe acts as an electron acceptor bacterial oxidation of organic matter. Soluble Fe in groundwater can be as high as 5ppm in organic rich sediments of coastal marshes. In either scenario, when soluble Fe(II) is exposed to air (oxygen), insoluble Fe(III) hydroxides form, leading to the familiar yellow to orange to red staining patterns from $Fe(OH)_3$, FeOOH, and Fe_2O_3. An extensive structural review is underway by plant personnel to understand the source of the iron.
- The pH of the Drip Bag sample collected January 28, 2003 was 7.16 rather than an expected pH of 4.45 for 2735 ppm boron as boric acid. The concrete can neutralize the hydrogen ions via exchange of sodium and potassium in the concrete for hydrogen ion.

In conclusion, the 78-Foot Mechanical Penetration Area Drip Bag samples match reasonably well with the Unit 1 Spent Fuel Pool telltale drains. The water in the SFP leakage collection system has been modified from the original SFP activity ratios via interaction with structural material. Possible minor dilution with groundwater may occur for the Drip Bag sample (although chloride was less than 1 ppm). The cesium activity ratio and levels match, but cobalt activity levels in the drip bag are lower as explained by additional uptake (interaction) with structural materials. Cesium and cobalt activity levels through January 28, 2003 did not decrease when the Unit 1 Spent Fuel Pool demineralizer was placed in service January 1st, suggesting that the cesium and cobalt activity in the leakage collection system are controlled by surface interactions between the concrete and the water.

FIGURE 4: LOCATION OF SAMPLES TO CHARACTERIZE SALEM UNIT 1 SPENT FUEL POOL LEAKAGE
(Not to Scale)

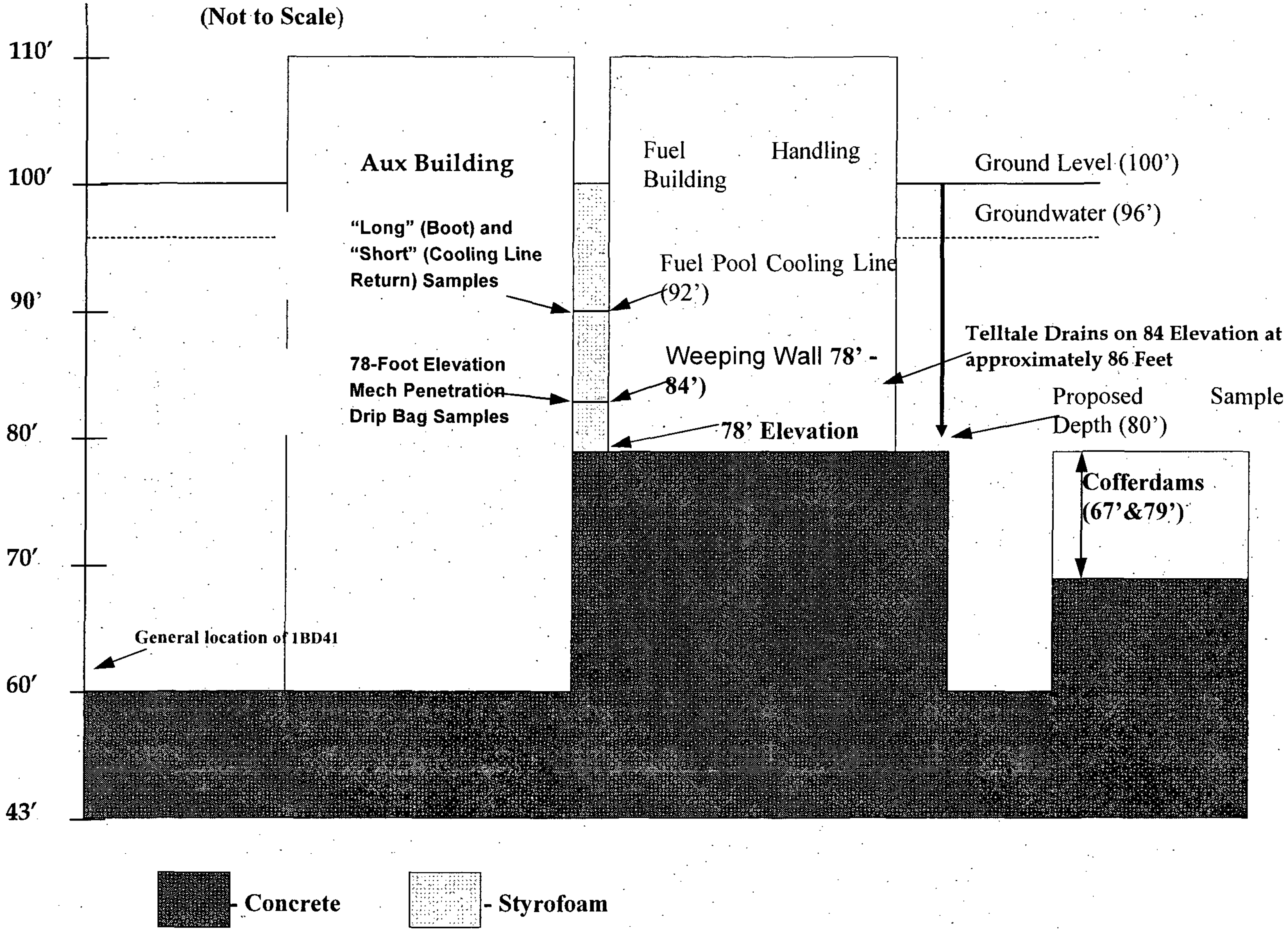


FIGURE 5A: 78 DRIP BAG BORON AND TRITIUM

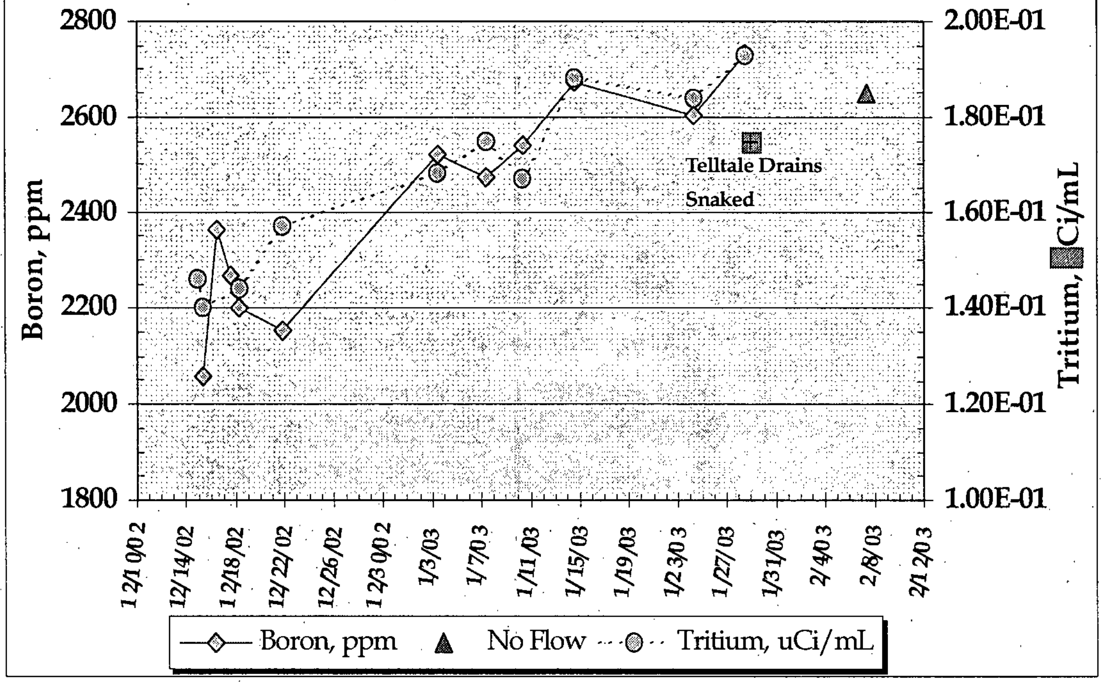


FIGURE 5B: 78 DRIP BAG BORON, CESIUM, AND IODINE ACTIVITY

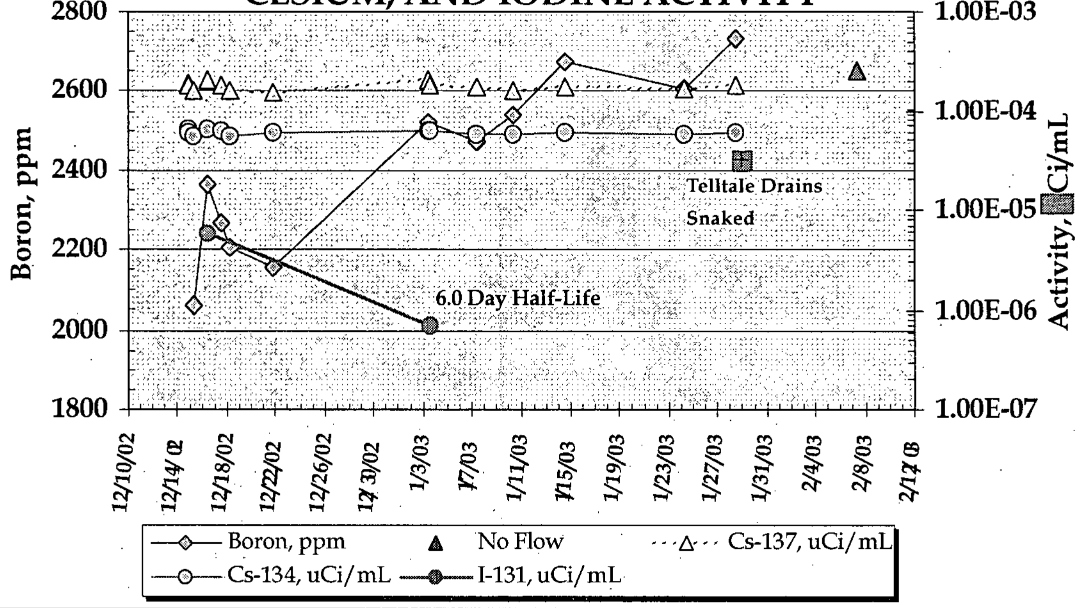


FIGURE 5D: 78 DRIP BAG BORON AND SODIUM

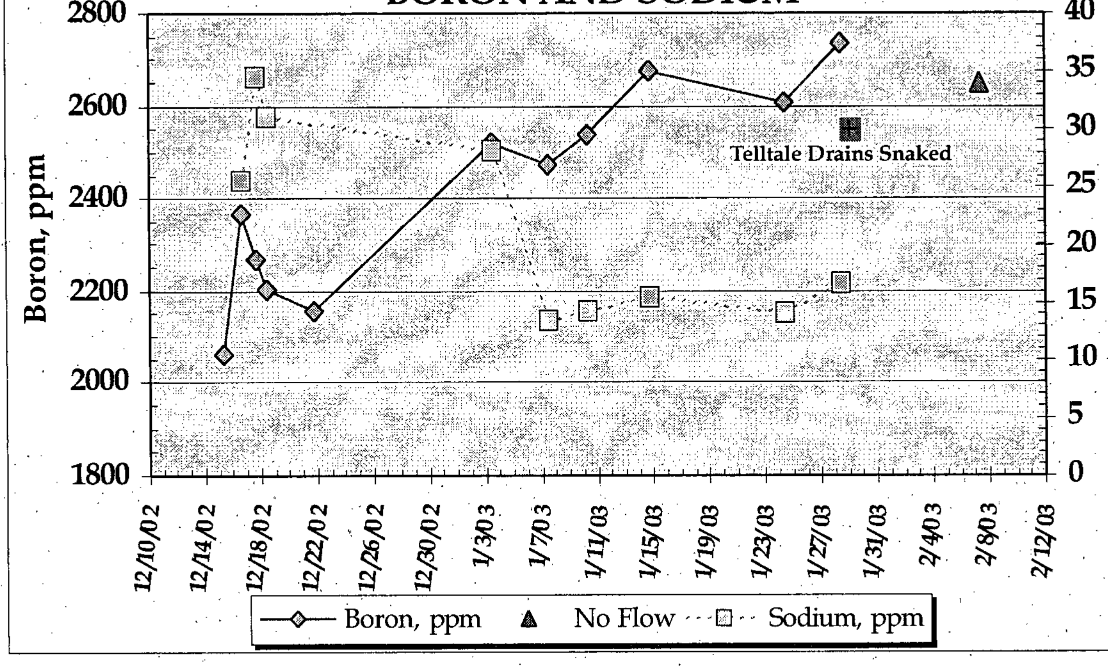


FIGURE 6A: 92 "SHORT" BORON AND TRITIUM

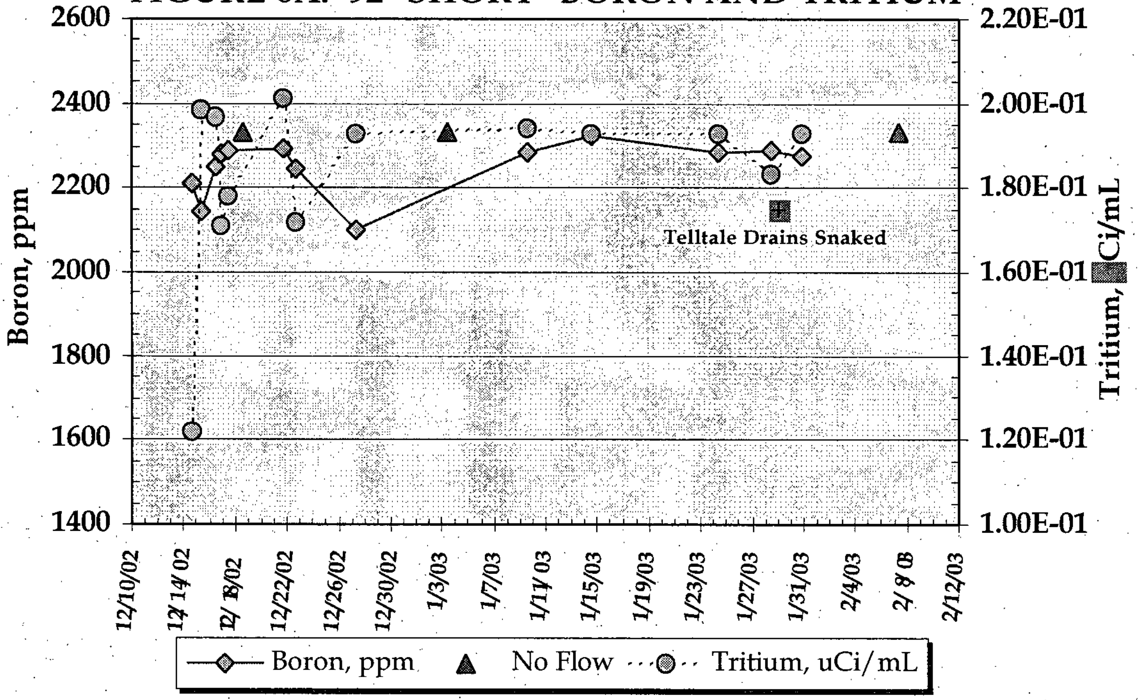


FIGURE 6B: 92 "SHORT" BORON, CESIUM, AND IODINE ACTIVITY

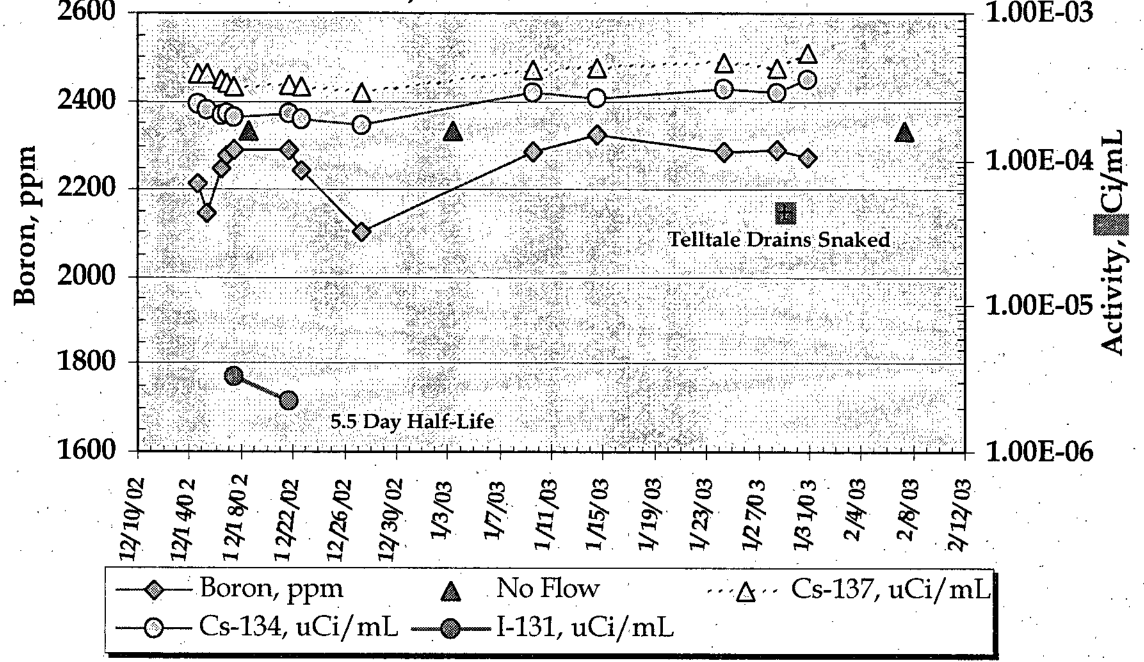


FIGURE 6C: 92 "SHORT" BORON AND COBALT ACTIVITY

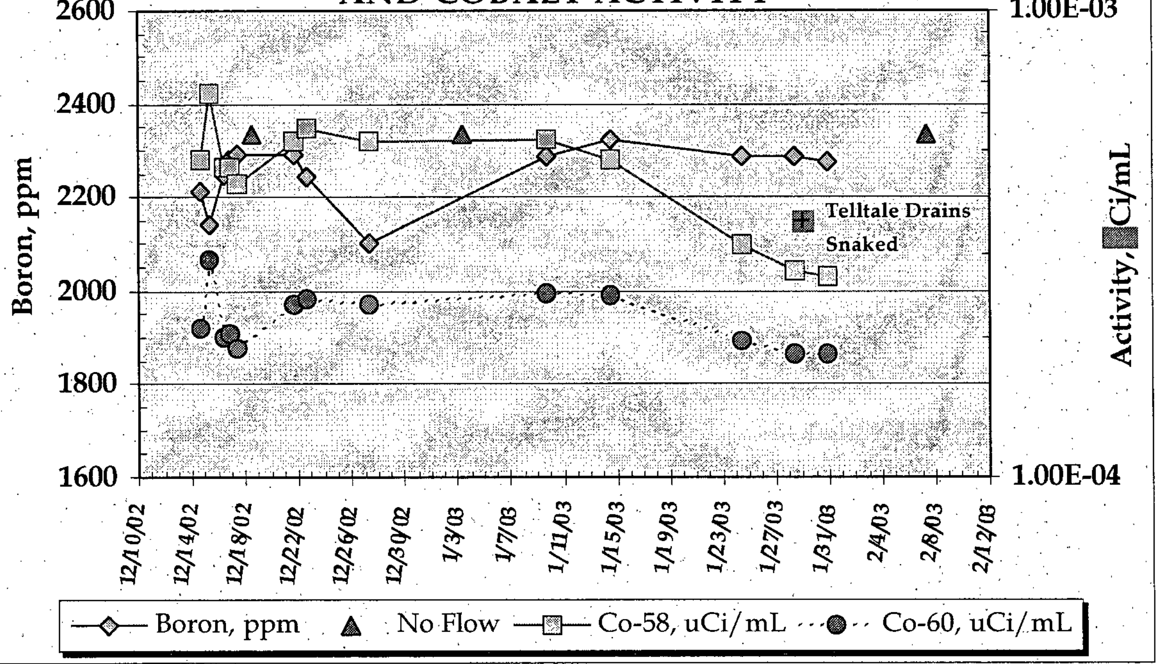
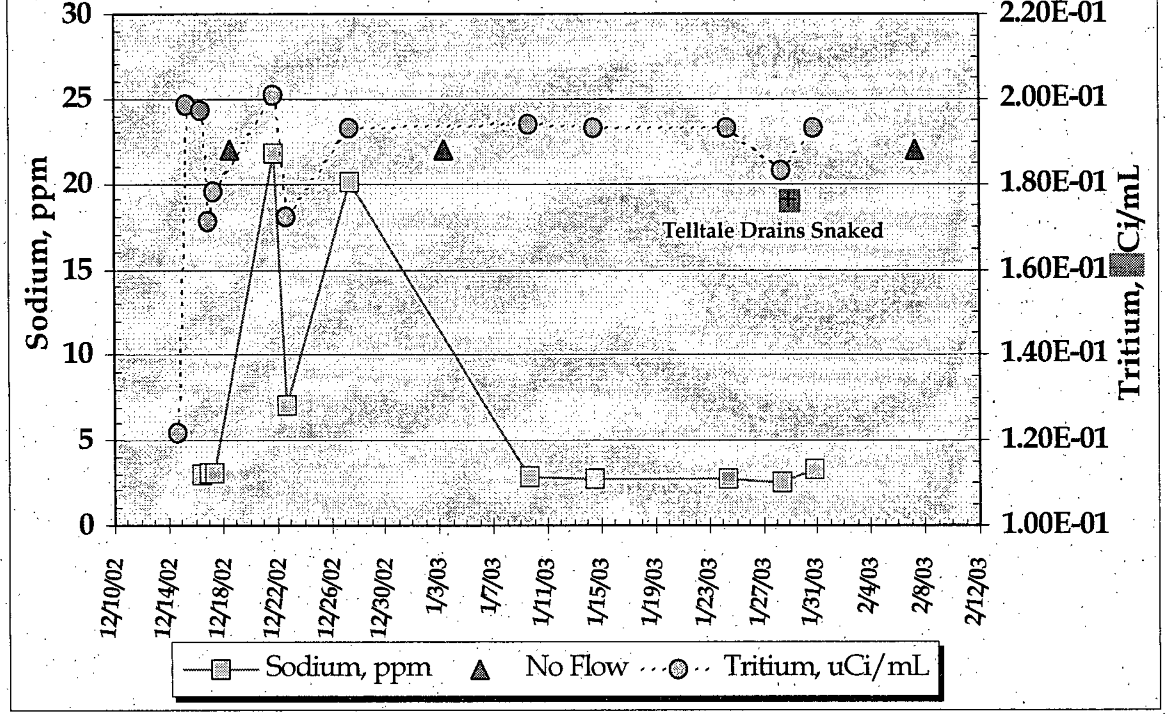


FIGURE 6D: 92 "SHORT" SODIUM AND TRITIUM



Spent Fuel Pool Cooling Line Return at the Auxiliary and Fuel Handling Building Interface ("Short" Sample)

Water was dripping from the annular space around the Spent Fuel Pool cooling return line at the interface between the Auxiliary Building and Fuel Handling Building. A catch tray with a sample tube was installed on December 17, 2002 to divert and collect the water, which ranged from 0 to 0.039 gpm (14.5 gpd average) between December 22, 2002 and January 7, 2003. Because of the length of the sample tube, the sample point was designated as the "Short" sample. Tables 2 and 3 summarize analysis results from this sample and Figures 6A through 6D show trends over time. The analysis results indicate the following:

- The "Short" sample was not water currently re-circulating in the Unit 1 Spent Fuel Pool (i.e., a leak in the cooling return line is not indicated).
- Once the sample source was separated, the boron and tritium levels were relatively constant and indicate Spent Fuel Pool water modified by interaction with structural material (e.g. concrete). Most likely this water originated in the leakage collection system of the SFP.
- Sodium levels initially were erratic, but became stable and relatively low. Sodium levels were much higher than levels expected in the Spent Fuel Pool but comparable to water in the leakage collection system. This suggested that interactions with structural materials released sodium to water in the leakage collection system (also explains the increase in pH) and this water migrated to the "Short" sample. Chloride levels were less than 0.1 ppm and suggest minimal involvement of groundwater.
- Cesium and cobalt activity levels were relatively stable and intermediate between levels in the Unit 1 Spent Fuel Pool and the telltale drains. The ^{134}Cs-to-^{137}Cs activity ratio averaged 0.67 (compared to 1.02 for the Spent Fuel Pool and 0.33 for the average telltale), and the decay-corrected ^{58}Co-to-^{60}Co activity averaged 4.21 compared to 8.27 for the Spent Fuel Pool. This suggests a more recent history and/or less interaction with structural concrete than the Drip Bag or telltale samples. The higher activity ratios suggest a shorter and quicker pathway for migration from the SFP to the "Short" sampler. Because both cesium and cobalt activity levels were lower than corresponding levels in the Spent Fuel Pool, both dilution and interaction with structural materials was indicated,
- Iodine-131 (8.04 day half-life) was detected in two samples. When decay-corrected to the time Mode 6 was established for 1R15, the activity levels match levels in the Unit 1 Spent Fuel Pool (and the telltale drains for the pool and 78-foot elevation Drip Bag) reasonably well. This linked the iodine activity to the refueling operation and a postulated leak from areas in the Spent Fuel Pool that contained defective rods from 1R15.
- Iron levels were low, indicating relatively little contact with corroding ferrous materials or iron in groundwater.
- The pH of the "Short" sample collected January 28, 2003 was 6.47 rather than an expected pH of 4.55 for 2290 ppm boron as boric acid. It is not as basic as the Drip Bag sample perhaps indicative of a shorter travel time or direct mixing of SFP water with water from the leakage collection system.

After the telltale drains were snaked on January 29, 2003, the flow from the "Short" sample decreased. When the caps were placed on the drains, the flow resumed. Radiation Protection

personnel noted this correlation on three occasions. By February 7, 2003, flow was insufficient to obtain a sample. This behavior supported a hypothesis that water from leakage from the pool liner was restricted and being forced into the region between the concrete and the liner, eventually issuing through the opening where the cooling line return pipe intersects the wall.
In conclusion, the "Short" sample indicated a more recent history and less interaction with the structural material than other samples (such as the Drip Bag or telltale drains) as compared with water in the Unit 1 Spent Fuel Pool after 1R15. Interactions with structural materials and dilution with an "older" source (e.g. water from the leakage collection system) can explain cesium and cobalt activity levels being lower than corresponding levels in the Spent Fuel Pool. Cesium and cobalt activity levels in the "Short" sample were higher than corresponding levels in the telltale drain samples or the 78-Foot Elevation Drip Bag sample, suggesting less opportunity for interactions with structural materials. Cesium and cobalt activity levels in the "Short" sample were higher than corresponding levels in other samples, but below levels in the Spent Fuel Pool. After snaking, the telltale drains showed more common characteristics with the "Short" sample (before it dried up).

Water Stop (Boot) Around the Fuel Handling Building Concrete Plug at 92-Foot Elevation ("Long" Sample)

A rupture in the boot occurred on December 14, 2002 and the flow eventually stabilized. A long tube was inserted to divert the water, hence the designation of "Long" sample. The flow rate ranged from 0 to 1 gpm, averaging approximately 51.4 gpd between December 21, 2002 and January 7, 2003. The flow appeared to be affected by rainfall (as noted by Radiation Protection personnel) because leakage from the roof between the Auxiliary Building and the Fuel Handling Building near the service water pit, resulted in rainwater in the penetrations area in the 12 Service Water Valve Room; repairs were completed January 10, 2003. Precipitation data showed a direct correlation between the daily rainfall and increasing the "Long" sample flow rate, which was not indicated for the "Short" sample. Results for the "Long" sample are summarized in Tables 2 and 3 and plotted in Figures 7A through 7D. Boron, tritium, gamma activity, and sodium levels were more variable than for other sample points, suggesting mixing with other sources (such as rainfall). Boron generally followed tritium, suggesting a common source. The following conclusions result from evaluating Table 3 data and Figures 7A through 7D:

- After the "long" tube was inserted into the "boot" on December 14th boron, tritium, and sodium increased for about three weeks. This suggests that the initial samples contained higher levels of groundwater .In early January 2003, chloride concentrations increased and tritium and boron decreased, suggesting a quick response of this sampling point to changing environmental variables.
- Cesium activity levels were relatively stable (^{137}Cs <10% of SFP water) until January 6, 2003, after which time levels increased as tritium and boron decreased. The average ^{134}Cs-to-^{137}Cs activity ratio prior to January 6, 2003 was 0.36, similar to "old" cesium activity present in the leakage collection system.
- Cobalt activity was more variable and was not detected in several samples. The average ^{58}Co-to-^{60}Co activity ratio based on ^{58}Co activity (decay-corrected to Mode 6) was 3.59, suggesting that a small fraction of the water came from the previous refueling operation.

- Iodine-131 was detected in four sample and related (in time) to the Mode 6 refueling operation, contributing "recent" radioisotopes to the SFP inventory.

On the average, the "Long" sample showed similar characteristics to the water in the telltale drains. A mixture of groundwater and/or rainfall reduced activity of tritium to about 70 to 90% of the level in the leakage collection system. ^{131}I and ^{58}Co activity in some samples, linked in time to Mode 6 refueling, suggested that at least a small fraction of recent SFP or canal water could migrate (through the SS liner of the SFP- most likely) to the "Long" sample at 92-foot elevation. After January 24th the sample point dried up because of limited groundwater ingress with lack of precipitation and eventually from the "snaking" of the telltales that drained the water from the leakage collection system of the SFP.

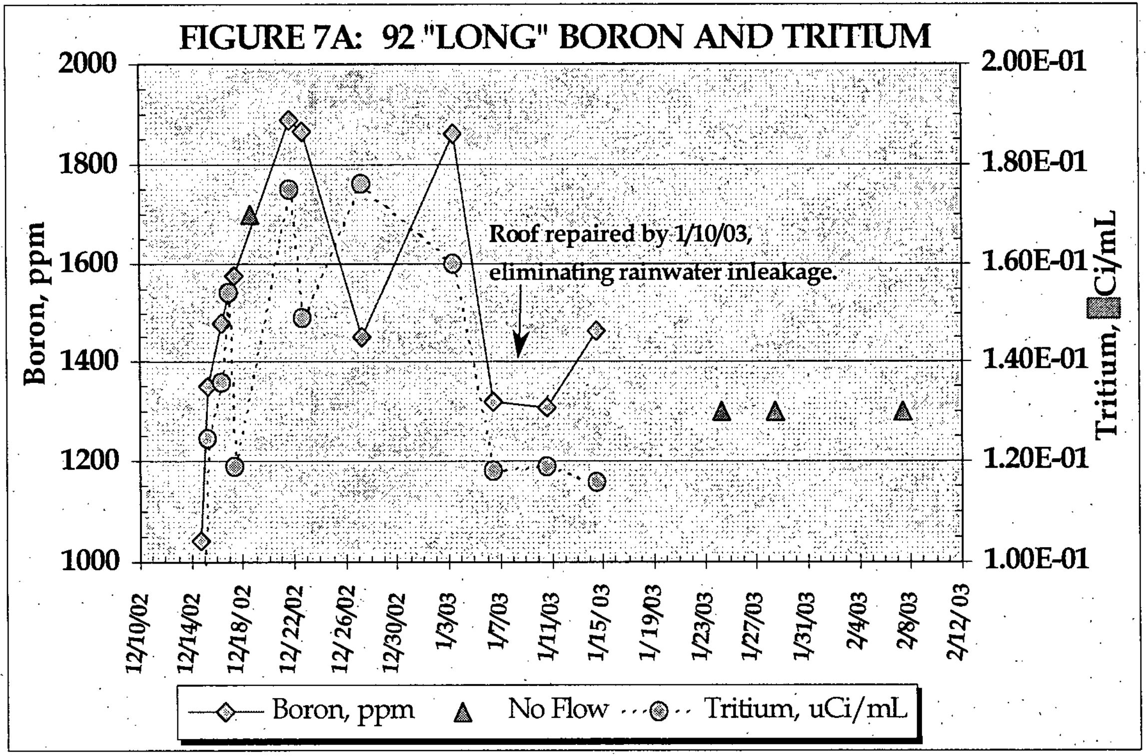


FIGURE 7A: 92 "LONG" BORON AND TRITIUM
Boron, ppm
2000
1800
1600
1400
1200
1000
Tritium, ▨Ci/mL
2.00E-01
1.80E-01
1.60E-01
1.40E-01
1.20E-01
1.00E-01
Roof repaired by 1/10/03, eliminating rainwater inleakage.
12/10/02
12/14/02
12/18/02
12/22/02
12/26/02
12/30/02
1/3/03
1/7/03
1/11/03
1/15/03
1/19/03
1/23/03
1/27/03
1/31/03
2/4/03
2/8/03
2/12/03
Boron, ppm
No Flow
Tritium, uCi/mL

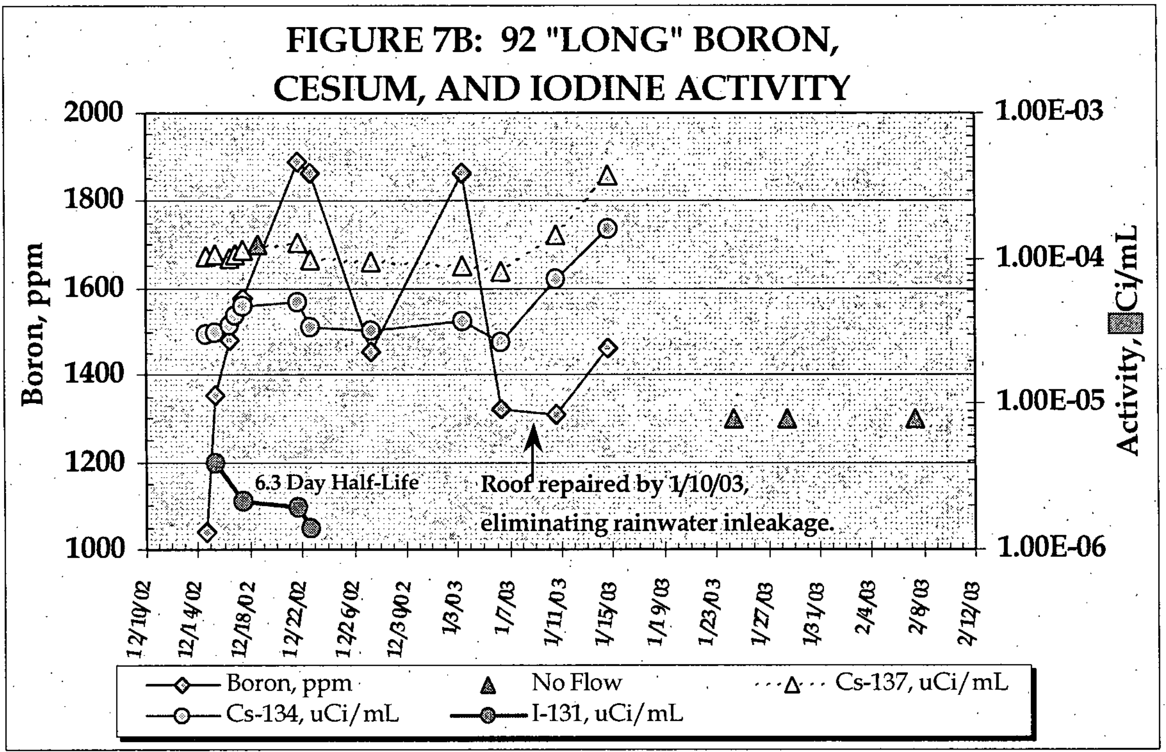


FIGURE 7B: 92 "LONG" BORON, CESIUM, AND IODINE ACTIVITY
Boron, ppm
2000
1800
1600
1400
1200
1000
Activity, ▨Ci/mL
1.00E-03
1.00E-04
1.00E-05
1.00E-06
6.3 Day Half-Life
Roof repaired by 1/10/03, eliminating rainwater inleakage.
12/10/02
12/14/02
12/18/02
12/22/02
12/26/02
12/30/02
1/3/03
1/7/03
1/11/03
1/15/03
1/19/03
1/23/03
1/27/03
1/31/03
2/4/03
2/8/03
2/12/03
Boron, ppm
No Flow
Cs-137, uCi/mL
Cs-134, uCi/mL
I-131, uCi/mL

STYROFOAM SEISMIC GAP- AUXILARY BUILDING AND THE FUEL HANDLING BUILDING

Two drill points were installed in the Styrofoam between the Salem Auxiliary Building and the Fuel Handling Building on December 19 and 20, 2002. The drill points consisted of a 1-¼-inch direct push sampler with a 2-foot mill-slotted well point. The samples were obtained using ¼-inch tubing and a pump. Drill Point No. 1 was installed vertically along the northeast exterior wall of the Fuel Handling Building as shown in Figure 8. Drill Point No. 2 was installed on a 45-degree angle into the Styrofoam from the "Door to Nowhere" (100-Foot Elevation of Auxiliary Building, opening to the outside of the Fuel Handling Building on the right and Containment on the left) near the area for the 78 Drip Bag sample in the Auxiliary Building. Tables 2 and 3 summarize results through February 21, 2003. Figures 9A through 9D showed Drill Point No. 1 trends and Figures 10A through 10D showed Drill Point No. 2 trends. The Table 3 data and plots showed the following:

- The initial samples indicated groundwater mixed with water containing activity levels similar to the leakage collection system. Once purged of the groundwater component, boron, tritium, and cesium activity levels were stable and identical to water from the SFP telltales (or the 78-Foot Drip Bag sample). After stable conditions were attained, Drill Point No. 1 and Drill Point No. 2 were essentially equivalent.
- The average ^{134}Cs-to-^{137}Cs activity ratio of 0.31 and the average decay-corrected ^{58}Co-to-^{60}Co activity ratio of 0.90 suggested "old" activity that resulted from isotopic equilibration with the concrete enclosure of the SFP.
- Iodine-131 was detected in selected samples up to January 9, 2003. Decay-corrected ^{131}I activity supports the link between ^{131}I and the Mode 6 refueling operation.
- Activity levels through January 28, 2003 were reasonably stable, with no effect from use of the demineralizer after January 1, 2003. The water in the Styrofoam Seismic Gap was not directly related to the water in the Spent Fuel Pool (based on cesium and cobalt activity) but rather had flowed through the SS liner of the SFP and into the leakage collection system. Interaction with the walls of the concrete enclosure reduced the cesium and cobalt activity.

Water in the seismic gap was a cause of concern because of its elevated tritium activity and its ability to migrate away from the Containment building and to contaminate groundwater. On February 6 through 13, 2003 , 45 gallons of water were extracted from the Styrofoam at Drill Point No. 1. As shown in Figures 9A and 10A, boron and tritium decreased and sodium increased as shown in Figures 9D and 10D. Cesium activity remained constant and ^{60}Co decreased (^{58}Co had not been detected since January 16th). Cesium adsorbs strongly onto surfaces and the cesium activity reflects an isotopic exchange between the water and structural material near the Seismic Gap. The snaking the telltale drains eliminated the source of SFP water to the Seismic Gap and removal of the water in the Seismic Gap allowed ambient groundwater to flow into the region. Boron and tritium levels dramatically dropped from SFP levels to less than 50% of SFP activity in one week. The important conclusion was that the chemical and radionuclide characteristics for both drill points were identifiable to the Spent Fuel Pool telltale drains, and the combined effects of snaking telltale drains and pumping the water out of the Styrofoam was effective in dramatically reducing boron, tritium, and cobalt activity. Samples collected during the summer of 2003 (Table 2) at Drill Point No. 1 had decreased levels of tritium (3% of SFP) , consistent with the stoppage of the leak to the Styrofoam Seismic Gap and the subsequent inflow of groundwater to the Styrofoam. Cesium and cobalt activity are also very low, near ND levels.

FIGURE 8: LOCATION OF DRILL POINTS DECEMBER 19 – 20, 2002

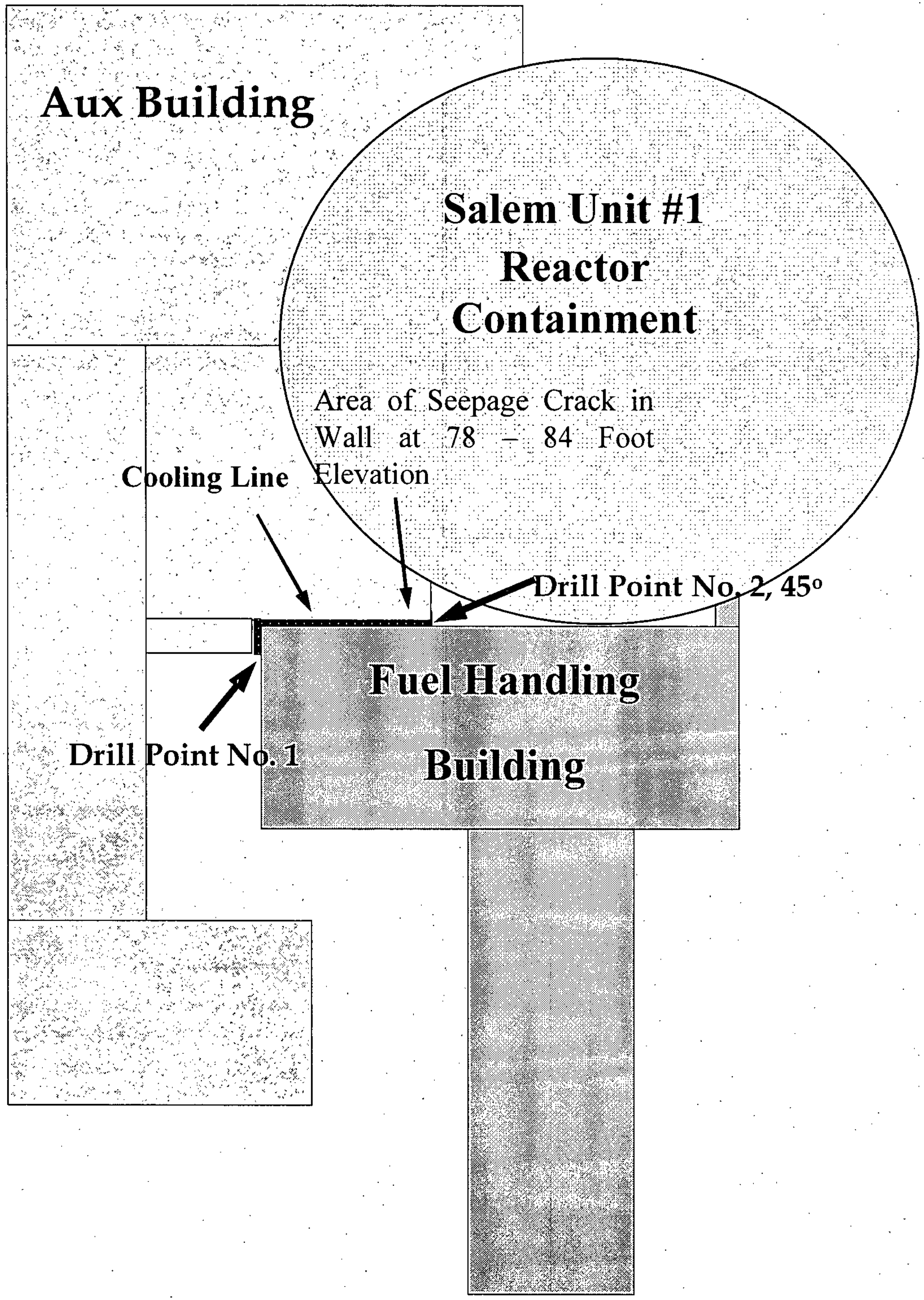


FIGURE 9A: PHASE II DRILL POINT NO. 1 AT 20 - 21 FEET--BORON AND TRITIUM

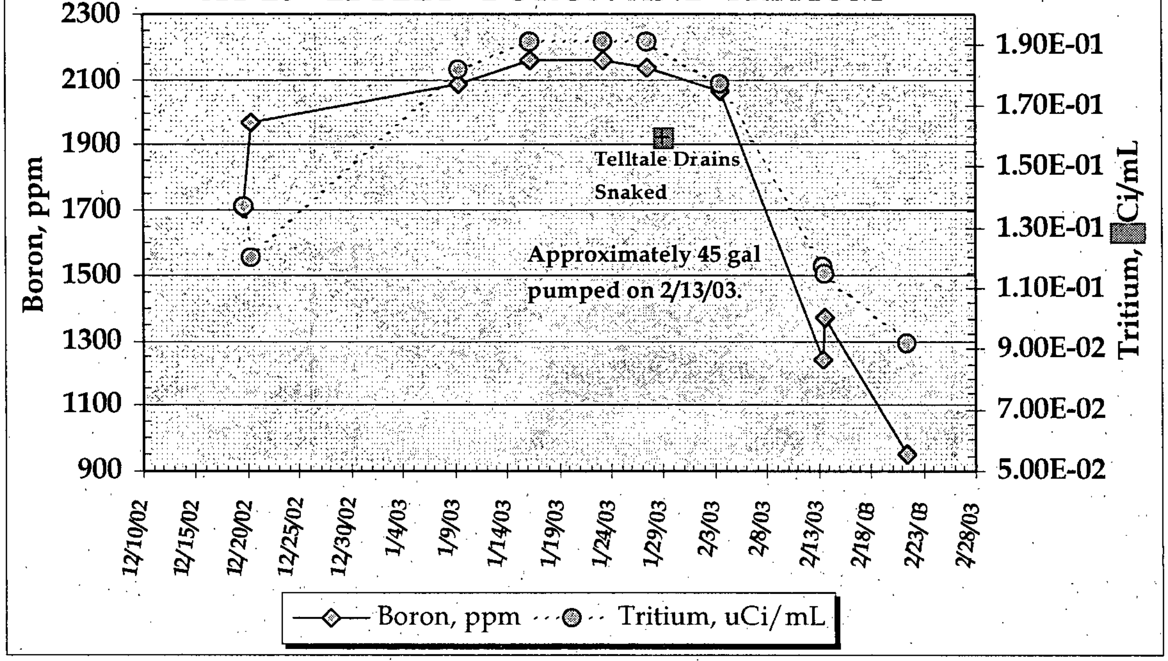
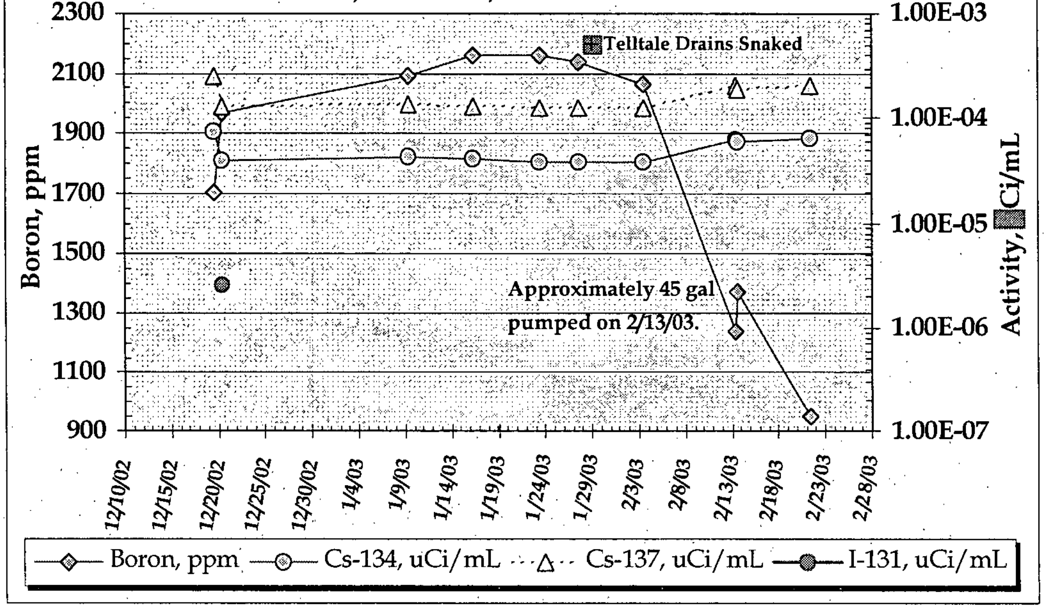


FIGURE 9B: PHASE II DRILL POINT NO. 1 AT 20 - 21 FEET-- BORON, CESIUM, AND IODINE ACTIVITY



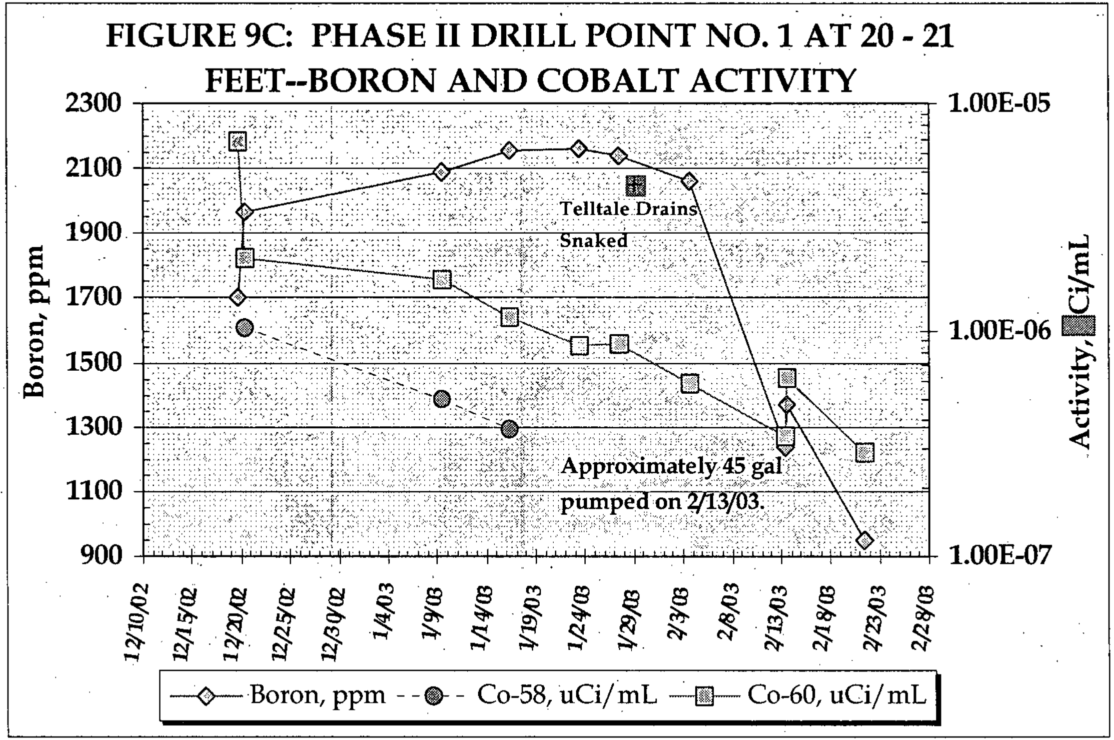


FIGURE 9C: PHASE II DRILL POINT NO. 1 AT 20 - 21 FEET--BORON AND COBALT ACTIVITY
Boron, ppm
2300
2100
1900
1700
1500
1300
1100
900
Activity, Ci/mL
1.00E-05
1.00E-06
1.00E-07
Telltale Drains Snaked
Approximately 45 gal pumped on 2/13/03.
12/10/02
12/15/02
12/20/02
12/25/02
12/30/02
1/4/03
1/9/03
1/14/03
1/19/03
1/24/03
1/29/03
2/3/03
2/8/03
2/13/03
2/18/03
2/23/03
2/28/03
Boron, ppm
Co-58, uCi/mL
Co-60, uCi/mL

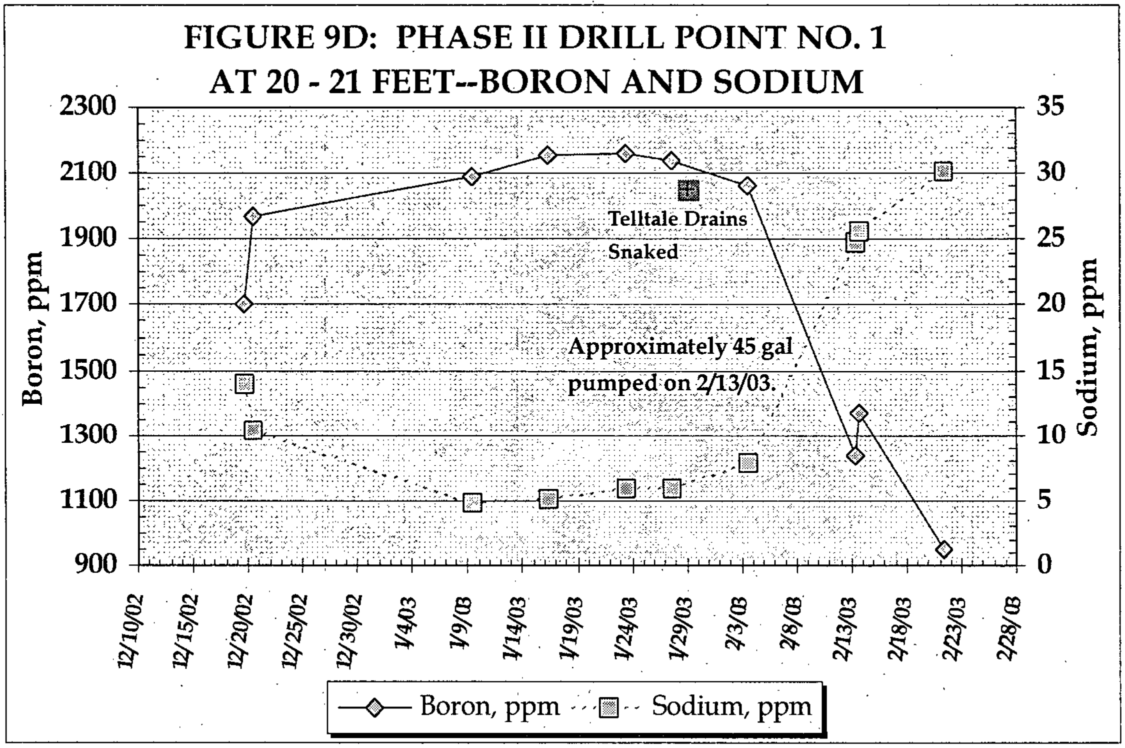


FIGURE 9D: PHASE II DRILL POINT NO. 1 AT 20 - 21 FEET--BORON AND SODIUM
Boron, ppm
2300
2100
1900
1700
1500
1300
1100
900
Sodium, ppm
35
30
25
20
15
10
5
0
Telltale Drains Snaked
Approximately 45 gal pumped on 2/13/03.
12/10/02
12/15/02
12/20/02
12/25/02
12/30/02
1/4/03
1/9/03
1/14/03
1/19/03
1/24/03
1/29/03
2/3/03
2/8/03
2/13/03
2/18/03
2/23/03
2/28/03
Boron, ppm
Sodium, ppm

FIGURE 10A: PHASE II DRILL POINT NO. 2 AT 27 FEET--BORON AND TRITIUM

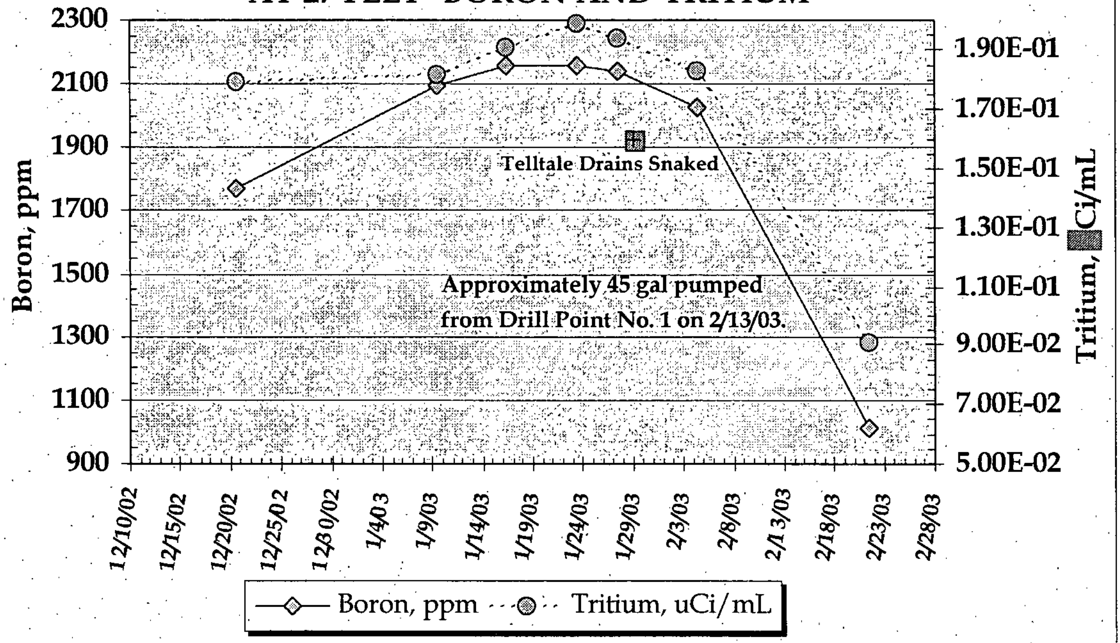


FIGURE 10C: PHASE II DRILL POINT NO. 2 AT 27 FEET-- BORON AND COBALT ACTIVITY

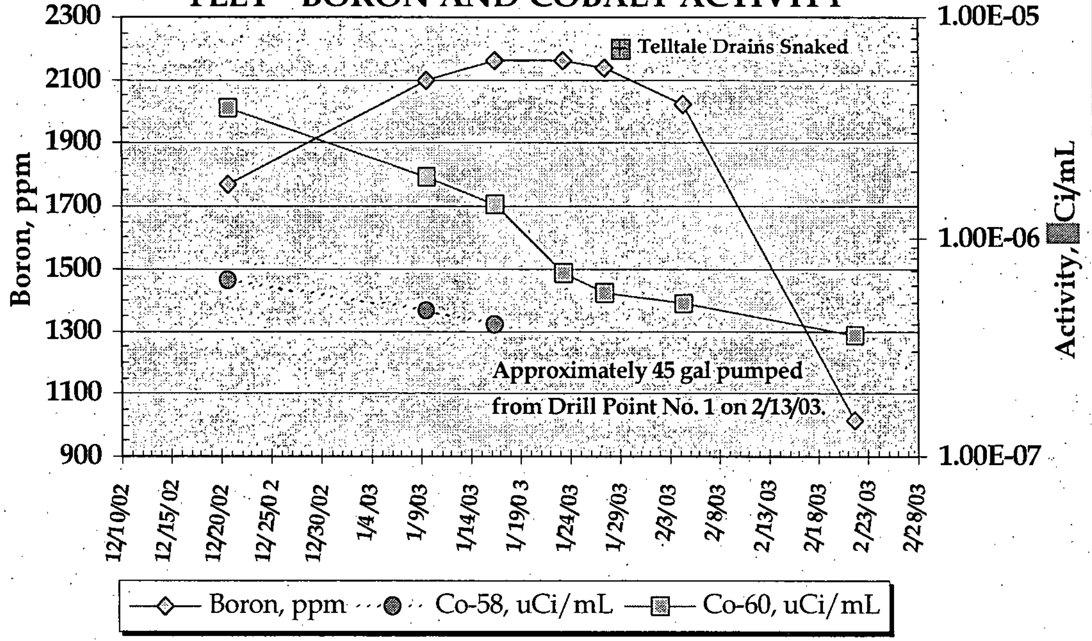
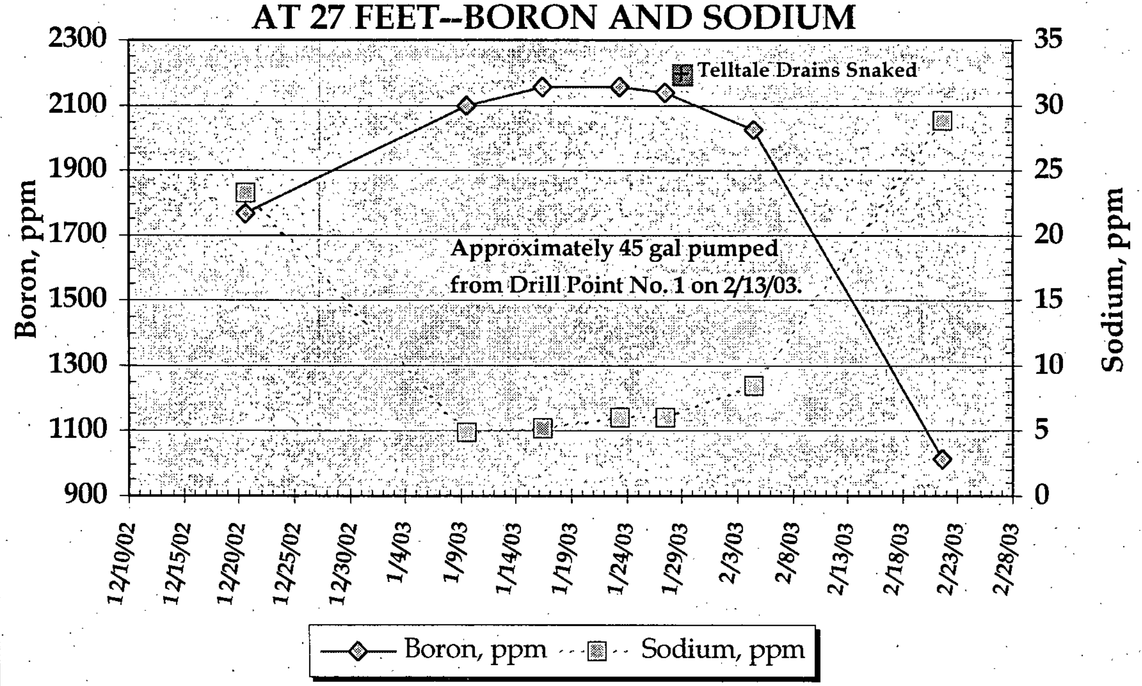


FIGURE 10D: PHASE II DRILL POINT NO. 2 AT 27 FEET--BORON AND SODIUM



OTHER SAMPLE LOCATIONS

Table 4 summarizes analysis results for miscellaneous samples withdrawn at various Salem Unit 1 and Unit 2 locations. Evaluation of these data indicate the following:

- The Unit 1 RWST after 1R15 was not the source of contamination on the basis of tritium level (1.26 E-1 μCi/mL versus 1.91 E-1 μCi/mL average in the "Short" sample) and average ^{58}Co-to-^{60}Co activity ratio (1.51 versus 4.21 average in the "Short" sample, decay corrected to Mode 6).
- Although the 12 RHR floor drain indicated cesium and cobalt contamination, boron was not detected in deposits collected in the area.
- The stalactites in the RAP tank area (this the R̲WST, A̲FST, and P̲WST) did not contain boron; leakage from the RWST to this area was eliminated on this basis.
- Three samples of seepage water between the Unit 1 Containment and Auxiliary Building (1BD41) suggest a link to the leakage collection system on the basis of boron (1208 ppm average) and tritium (1.19E-1 μCi/mL average). Water from the leakage collection system could possibly migrate in the void between buildings and accumulate over time. The ^{134}Cs-to-^{137}Cs activity ratio of 0.20 indicates "old" activity, consistent with the telltale samples. A low ^{60}Co level was detected, but interactions with structural materials will reduce cobalt in liquid samples. The 59.7-ppm sodium (average) and 12.1-ppm chloride level indicates some groundwater, and/or leaching from structural materials. The source of ^{131}I, seen in many of the telltale, drill point and seepage samples most likely related to the refueling in October 2002.

TABLE 6. SUMMMARY OF SPECIAL ANALYSIS RESULTS OF SALEM UNIT 1 FUEL POOL INVESTIGATIONS--MISCELLANEOUS SAMPLES

	Sample	Concentration, ppm			Activity at Sample Time, µCi/mL						Mode 6 µCi/mL		Cs-134/	Co-58/
Sample Location	**Date/Time**	**Na**	**Cl**	**Boron**	**H-3**	**I-131**	**Cs-134**	**Cs-137**	**Co-58**	**Co-60**	**Sb-125**	**I-131**	**Co-58**	**Cs-137**	**Co-60**
1 RWST	12/17/02 8:10			2367	1.26E-01		3.89E-04	3.61E-04	3.29E-03	1.77E-04			5.72E-03	1.08	32.3
Puddle Around U1 RWST	9/27/02 9:00						2.94E-05	5.56E-05	6.08E-05	5.41E-05	2.99E-05			0.53	
Rainwater Puddle Around U1/U2 RWSTs	9/27/02 9:00						2.90E-05	5.05E-05	1.04E-06	9.78E-07				0.57	
Puddle Around U1 RWST	12/15/02 8:30			0	7.81E-06										
Rainwater Puddle Around U1 RWST	12/21/02 17:50			0	4.45E-05										
Puddle Around U1 RWST	12/22/02 16:30			0	3.25E-04										
Water from Void Between Aux Bldg and Unit 1 Containment (1BD41)	12/24/02 10:00				1.11E-01	5.39E-07	4.66E-06	2.31E-05				1.28E-04		0.20	

Units for concentrations of radionuclides are presented in microcuries per milliliter (?Ci/mL)

TABLE 6 (continued). SUMMMARY OF SPECIAL ANALYSIS RESULTS OF SALEM UNIT 1 FUEL POOL INVESTIGATIONS--MISCELLANEOUS SAMPLES

Sample Location	Sample Date/Time	Concentration, ppm			Activity at Sample Time, µCi/mL							Mode 6 µCi/mL		Cs-134/	Co-58/
		Na	Cl	Boron	H-3	I-131	Cs-134	Cs-137	Co-58	Co-60	Sb-125	I-131	Co-58	Cs-137	Co-60
Water from Void Between Aux Bldg and Unit 1 Containment (1BD41)	1/16/03 9:05	72.3	12.1	1159	1.12E-01		7.54E-06	3.72E-05		9.29E-08				0.20	
Water from Void Between Aux Bldg and Unit 1 Containment (1BD41)	2/19/03 9:50	47.0		1256	1.34E-01		6.47E-06	3.16E-05		1.07E-07				0.21	
Water from Void Between Aux Bldg and Unit 2 Containment (2BD41)	1/17/03 8:35			<3.3	2.41E-05										
Unit 2 Cable Tunnels Under South RAP Tank	1/9/03 10:50			0			5.49E-08	1.92E-07		1.68E-07				0.29	
U1 12 RHR-Wall Across from Ladder	1/2/03 10:00			0											
U1 12 RHR--Floor Drain	1/2/03 10:02			0				1.42E-04		2.81E-03					
U1 12 RHR--12SJ147	1/2/03 10:05			0					7.83E-05	8.18E-05			1.59E-04		1.94
Pipe Trench North RAP Tanks Overhead Stalactites	1/15/03 13:12			0											

Units for concentrations of radionuclides are presented in microcuries per milliliter (?Ci/mL)

Summary

The Salem Unit 1 Spent Fuel Pool has experienced leakage through the SS liner into the leakage collection system that surrounded the SFP. Over time chemical deposits in the telltale drains restricted flow and caused a buildup of water in the concrete enclosure surrounding the SFP. This water has seeped through the enclosure and migrated to several unexpected locations: the area behind the 78-Foot Mechanical Penetration Room wall in the Auxiliary Building, the Spent Fuel Pool cooling line at the interface between the Auxiliary and Fuel Handling Building, the water stop (boot) located at the penetration between the Auxiliary Building and the Fuel Handling Building, and Styrofoam Seismic Gap between the Fuel Handling Building and the Auxiliary Building. The water in question had many characteristics of Spent Fuel Pool water (e.g., boron and tritium levels), but low cesium and cobalt activity levels and activity ratios suggested extensive interactions with structural materials (e.g. concrete). Iodine-131 in selected samples when decay corrected to Mode 6 during 1R15 refueling, were comparable to levels in the Spent Fuel Pool. This finding for ^{131}I, which does not interact with concrete, suggests relatively rapid migration of SFP water through the SS liner and ultimately seeping through construction joints and/or cracks in the concrete enclosure of the SFP. Iodine-131 activity was not detected at other times, suggesting that the refueling operations were the source. None of the samples points showed the effects of placing the Spent Fuel Pool demineralizer in service January 1, 2003 because cesium and cobalt activity levels and ratios are controlled by exchange with solid surfaces (e.g. concrete). Flow rates at seepage points dropped dramatically (or stopped) after the telltale drains were snaked and normal flow in the leakage collection system resumed (at about 100 gpd). Because of more rapid throughput of water to the telltales after snaking, the activity levels in the telltales more closely resembled SFP water (e.g. Telltale No.2 tritium level increased by about 50% through 2003 in response to a similar increase in the SFP). In October 2003, the use of demineralizers reduced SFP cesium and cobalt by more than a factor of ten; a similar decrease was not observed in the Telltale No. 2 because of the buffering effect of the cesium that strongly sorbed to the surfaces of the SFP concrete enclosure. Removal of the water in the Styrofoam Seismic Gap on February 13,2003 reduced activity levels of tritium to 3% of SFP levels in the Gap via groundwater inflow. Less than 5 gallons of water could be withdrawn from the gap on two occasions and the activity levels were at about 3% of SFP for tritium and <<1% for cobalt and cesium activity.

TABLE 3. SUMMMARY OF SPECIAL ANALYSIS RESULTS OF SALEM UNIT 1 SPENT FUEL POOL LINER DRAINS PRIOR TO SNAKING (TELLTALE DRAINS)

	Concentration, ppm				Activity at Sample Time, µCi/mL							Mode 6 µCi/mL		Cs-134/	Co-58/
Sample Location	Fe	Na	Cl	Boron	H-3	I-131	Cs-134	Cs-137	Co-58	Co-60	Sb-125	I-131	Co-58	Cs-137	Co-60
					€	€	€	€	€	€	€	€			
Average SFP 1- water				2316	1.93E-01		2.18E-03	2.17E-03	5.53E-03	9.82E-04	9.44E-06	**5.96E-04**	8.02E-03	1.02	8.27
Bottom of Canal				2314	2.09E-01		2.02E-03	2.04E-03	2.72E-03	8.88E-04	3.20E-05		7.28E-03	0.99	8.2
AVERAGE POOL DRAINS		6.24		2257	1.74E-01	4.74E-06	5.34E-05	1.67E-04	1.29E-05	5.88E-05	2.59E-05	4.25E-04	2.46E-05	0.33	0.83
AVERAGE CANAL DRAINS		122		1465	1.31E-01		5.11E-05	1.87E-04	1.31E-05	8.06E-06	2.12E-06		2.72E-05	0.22	2.74
Ratio Pool Drains:1 SFP				0.97	0.92		0.025	0.077		0.06	2.74	0.71	0.0031	0.33	0.1
Ratio Canal Drains:1 SFP				0.63	0.68		0.023	0.086		0.008	0.22	0.00	0.0034	0.21	0.33
AVERAGE 78 MECH DRIP BAG	0.10	14.7	0.52	2605	1.81E-01	7.04E-07	5.84E-05	1.73E-04		3.56E-07		4.05E-04	0.34		
Ratio 78 Drip Bag:Pool Telltale Drains		2.36		1.15	1.02		1.09	1.04		0.006		0.95	1.02		
Ratio 78 Drip Bag:1 SFP				1.12	0.98		0.027	0.08		0.00036		0.68	0.33		
AVERAGE "SHORT" SAMPLE	<0.03	2.82	0.09	2292	1.91E-01	2.76E-06	3.01E-04	4.52E-04	3.74E-04	2.12E-04	9.40E-06	4.24E-04	9.00E-04	0.67	4.21
Ratio to Pool Telltales		0.45		1.02	1.07		5.63	2.71		3.60	0.36	1.00	36.5	2.01	5.08

Units for concentrations of radionuclides are presented in microcuries per milliliter (?Ci/mL)

February 24, 2003

TABLE 3 (continued). SUMMMARY OF SPECIAL ANALYSIS RESULTS OF SALEM UNIT 1 SPENT FUEL POOL LINER DRAINS PRIOR TO SNAKING (TELLTALE DRAINS)

	Concentration, ppm					Activity at Sample Time, µCi/mL						Mode 6 µCi/mL			
Sample Location	**Fe**	**Na**	**Cl**	**Boron**	**H-3**	**I-131**	**Cs-134**	**Cs-137**	**Co-58**	**Co-60**	**Sb-125**	**I-131**	**Co-58**	**Cs-134/ Cs-137**	**Co-58/ Co-60**
Ratio to No. 2 Telltales		1.05		1.03	0.99		3.86	2.84		3.59	0.82		4.61	1.37	1.31
Ratio to 78 Drip Bag	>0.33	0.19	0.18	0.88	1.05		5.15	2.62		595		1.05		1.97	
Ratio to 1 SFP				0.99	0.99		0.14	0.21		0.22	1.00	0.71	0.11	0.66	0.51
AVERAGE "LONG"	0.47	26.8	10.6	1365	1.18E-01	1.84E-06	8.62E-05	2.02E-04	4.69E-05	2.86E-05	3.62E-06	3.12E-04	1.05E-04	0.42	3.59
Ratio to "Short"	14.4	9.9	113.2	0.60	0.62		0.29	0.45		0.13	0.39	0.74	0.12	0.63	0.85
Ratio to Canal		0.22		0.93	0.90		1.69	1.08		3.54	1.71		3.85	1.93	1.31
Ratio to 1 SFP				0.59	0.61		0.04	0.093		0.029	0.38	0.52	0.013	0.41	0.43
Ave. Well No. 1 (21 Ft), No. 2 (27 Ft)	5.15	6.02	0.41	2119	1.88E-01	1.86E-06	4.01E-05	1.31E-04	4.29E-07	1.02E-06	1.82E-06	3.84E-04	8.43E-07	0.31	0.53
Ratio to 78 Drip Bag	51.2	0.41	0.79	0.81	1.04		0.69	0.76		2.87		0.95		0.91	
Ratio to "Short"	156	2.13	4.36	0.92	0.98		0.13	0.29		0.0048	0.19	0.91	0.00094	0.46	0.13
Ratio to "Long"	10.9	0.22	0.039	1.55	1.60		0.47	0.65		0.036	0.50	1.23	0.008	0.74	0.15
Ratio to Pool Telltales		0.97		0.94	1.06		0.75	0.78		0.017	0.07	0.90	0.034	0.93	0.64
Ratio to 1 SFP				0.91	0.97		0.018	0.06		0.001		0.64	0.000105	0.30	0.064

Units for concentrations of radionuclides are presented in microcuries per milliliter (?Ci/mL)

TABLE 3 (continued). SUMMMARY OF SPECIAL ANALYSIS RESULTS OF SALEM UNIT 1 SPENT FUEL POOL LINER DRAINS PRIOR TO SNAKING (TELLTALE DRAINS)

	Sample	Concentration, ppm				Activity at Sample Time, µCi/mL							Mode 6 µCi/mL		Cs-134/	Co-58/
Sample Location	Date/Time	Fe	Na	Cl	Boron	H-3	I-131	Cs-134	Cs-137	Co-58	Co-60	Sb-125	I-131	Co-58	Cs-137	Co-60
Trench Below Drains	9/30/02 10:35							2.34E-04	7.23E-04		1.00E-03	2.51E-04			0.32	
Telltale No. 1 (Pool)	12/11/02 16:30				2232			7.01E-05	1.72E-04	2.14E-05	5.90E-05			3.52E-05	0.41	0.60
Telltale No. 1 (Pool)	12/14/02 6:00					1.86E-01		1.08E-04	2.07E-04	2.11E-05	4.65E-05			3.56E-05	0.52	0.77
Telltale No. 1 (Pool)	1/17/03 13:05		4.76		2355	1.95E-01		6.01E-05	1.40E-04	2.63E-05	5.66E-05	9.32E-06		6.21E-05	0.43	1.10
Telltale No. 2 (Pool)	12/11/02 16:45				2229			2.27E-04	2.68E-04	1.92E-05	1.57E-05			3.16E-05	0.85	2.01
Telltale No. 2 (Pool)	12/14/02 6:00					1.85E-01		5.71E-05	1.24E-04	9.71E-06	1.56E-05	1.83E-05		1.64E-05	0.46	1.05
Telltale No. 2 (Pool)	1/17/03 13:07		4.74		2301			3.69E-05	9.59E-05	1.33E-05	2.23E-05	1.78E-05		3.13E-05	0.38	1.40
Telltale No. 3 (Pool)	12/12/02 17:30				2263		4.83E-06	1.27E-05	4.82E-05		2.81E-05		4.20E-04		0.26	
Telltale No. 3 (Pool)	12/14/02 11:45					1.64E-01	2.35E-06	1.17E-05	5.12E-05		2.42E-05		2.37E-04		0.23	
Telltale No. 3 (Pool)	1/17/03 13:09		3.44		2259	1.94E-01		1.02E-05	4.32E-05		3.22E-05				0.24	
Telltale No. 4 (Pool)	12/11/02 16:45				2230		7.43E-06	2.93E-05	8.52E-05	4.32E-06	2.41E-05	2.33E-05	5.91E-04	7.10E-06	0.34	0.29
Telltale No. 4 (Pool)	12/14/02 6:00					1.65E-01	3.20E-06	5.04E-05	1.12E-04	5.79E-06	1.93E-05	2.54E-05	3.17E-04	9.76E-06	0.45	0.51

Units for concentrations of radionuclides are presented in microcuries per milliliter (?Ci/mL)

TABLE 3 (continued). SUMMMARY OF SPECIAL ANALYSIS RESULTS OF SALEM UNIT 1 SPENT FUEL POOL LINER DRAINS PRIOR TO SNAKING (TELLTALE DRAINS)

Sample Location	Sample Date/Time	Concentration, ppm				Activity at Sample Time, µCi/mL							Mode 6 µCi/mL		Cs-134/ Cs-137	Co-58/ Co-60
		Fe	Na	Cl	Boron	H-3	I-131	Cs-134	Cs-137	Co-58	Co-60	Sb-125	I-131	Co-58		
Telltale No. 4 (Pool)	1/17/03 13:12		4.56		2301	1.85E-01		2.93E-05	8.09E-05	5.00E-06	3.19E-05	1.50E-05		1.18E-05	0.36	0.37
Telltale No. 5 (Pool)	12/12/02 17:30				2357		2.93E-06	2.25E-05	7.38E-05		3.78E-05		2.54E-04		0.30	
Telltale No. 5 (Pool)	12/14/02 11:45					1.34E-01	2.92E-06	2.40E-05	8.25E-05		4.15E-05		2.95E-04		0.29	
Telltale No. 5 (Pool)	1/17/03 13:15		3.34		2232	1.90E-01		2.09E-05	6.43E-05		4.59E-05				0.33	
Telltale No. 6 (Pool)	12/11/02 16:45				2221		8.80E-06	2.86E-05	1.07E-04		2.54E-05	1.48E-05	7.00E-04		0.27	
Telltale No. 6 (Pool)	12/14/02 6:00					1.35E-01		4.98E-05	1.39E-04	3.29E-06	2.80E-05	1.50E-05		5.54E-06	0.36	0.20
Telltale No. 6 (Pool)	1/17/03 13:19		7.84		2402	1.91E-01		2.62E-05	1.05E-04		1.76E-04	4.73E-05			0.25	
Telltale No. 8 (Pool)	12/12/02 17:30				2290		5.27E-06	8.05E-05	3.88E-04		2.87E-05	1.25E-05	4.58E-04		0.21	
Telltale No. 8 (Pool)	12/14/02 11:45					1.71E-01	5.48E-06	7.00E-05	3.38E-04		2.61E-05		5.54E-04		0.21	
Telltale No. 8 (Pool)	1/17/03 13:21		12.1		2304			7.07E-05	3.48E-04		4.52E-04	1.05E-04			0.20	
Telltale No. 9 (Pool)	12/12/02 17:30				2271			6.95E-05	3.31E-04		3.22E-05				0.21	
Telltale No. 9 (Pool)	12/14/02 11:45					1.72E-01	4.24E-06	6.49E-05	3.49E-04		3.14E-05		4.29E-04		0.19	
Telltale No. 9 (Pool)	1/17/03 13:23		9.16		1861			5.12E-05	2.55E-04		1.12E-04	6.62E-06			0.20	
AVERAGE POOL DRAINS:			6.24		2257	1.74E-01	4.74E-06	5.34E-05	1.67E-04	1.29E-05	5.88E-05	2.59E-05	4.25E-04	2.46E-05	0.33	0.83

Units for concentrations of radionuclides are presented in microcuries per milliliter (?Ci/mL)

TABLE 3 (continued). SUMMMARY OF SPECIAL ANALYSIS RESULTS OF SALEM UNIT 1 SPENT FUEL POOL LINER DRAINS PRIOR TO SNAKING (TELLTALE DRAINS)

	Sample	Concentration, ppm				Activity at Sample Time, µCi/mL							Mode 6 µCi/mL		Cs-134/	Co-58/
Sample Location	**Date/Time**	**Fe**	**Na**	**Cl**	**Boron**	**H-3**	**I-131**	**Cs-134**	**Cs-137**	**Co-58**	**Co-60**	**Sb-125**	**I-131**	**Co-58**	**Cs-137**	**Co-60**
Telltale No. 11 (Canal)	1/17/03 13:26							**3.03E-06**	**1.76E-05**	**1.66E-06**	**3.48E-06**			**3.91E-06**	0.17	1.12
Telltale No. 13 (Canal)	12/12/02 17:30				**2085**			**8.54E-05**	**4.10E-04**						0.21	
Telltale No. 13 (Canal)	12/14/02 11:45					**1.49E-01**		**8.63E-05**	**3.68E-04**						0.23	
Telltale No. 13 (Canal)	1/17/03 13:28		**48.4**			**1.92E-01**		**5.77E-05**	**2.66E-04**		**9.90E-07**	**2.12E-06**			0.22	
Telltale No. 14 (Canal)	12/11/02 16:50				**1703**			**5.18E-05**	**2.12E-04**	**1.11E-05**				**1.82E-05**	0.24	
Telltale No. 14 (Canal)	12/14/02 6:00					**1.12E-01**		**7.11E-05**	**2.12E-04**	**9.92E-06**	**4.05E-06**			**1.67E-05**	0.34	4.13
Telltale No. 14 (Canal)	1/17/03 13:30		**69.7**		**1665**	**1.59E-01**		**5.02E-05**	**1.82E-04**	**2.97E-05**	**2.37E-05**			**7.01E-05**	0.28	2.95
Telltale No. 15 (Canal)	1/17/03 13:30		**40.7**						**7.34E-06**						0.00	
Telltale No. 16 (Canal)	1/17/03 13:34		**329**		**408**	**4.40E-02**		**3.31E-06**	**1.29E-05**						0.26	
AVERAGE CANAL DRAINS			122		1465	1.31E-01		5.11E-05	1.87E-04	1.31E-05	8.06E-06	2.12E-06		2.72E-05	0.22	2.74
Ratio Pool Drains:1 SFP					0.97	0.92		0.025	0.077		0.060	2.74	0.71	0.0031	0.33	0.10
Ratio Canal Drains:1 SFP					0.63	0.68		0.023	0.086		0.008	0.22	0.00	0.0034	0.21	0.33

Note: Bolded values were used in averages. Mode 6 for 1R15 was established 10/21/02 22:42.
Units for concentrations of radionuclides are presented in microcuries per milliliter (?Ci/mL)

TABLE 3B: SUMMMARY OF SPECIAL ANALYSIS RESULTS OF SALEM UNIT 1 SPENT FUEL POOL LINER DRAINS AFTER SNAKING (TELLTALE DRAINS)

Sample Location	Sample Date/Time	Concentration, ppm				Activity at Sample Time, µCi/mL							Mode 6 µCi/mL		Cs-134/ Cs-137	Co-58/ Co-60
		Fe	Na	Cl	Boron	H-3	I-131	Cs-134	Cs-137	Co-58	Co-60	Sb-125	I-131	Co-58		
Telltale No. 1																
Ave Before Snaking			**4.76**		**2294**	**1.91E-01**		**7.95E-05**	**1.73E-04**	**2.30E-05**	**5.40E-05**	**9.32E-06**		**4.43E-05**	**0.45**	**0.82**
After Snaking	1/29/03 10:30		3.04		2242			7.65E-05	1.70E-04	2.91E-05	6.90E-05	2.63E-05		7.71E-05	0.45	1.12
Telltale No. 2																
Ave Before Snaking			**4.74**		**2265**	**1.89E-01**		**1.07E-04**	**1.63E-04**	**1.41E-05**	**1.79E-05**	**1.80E-05**		**2.64E-05**	**0.56**	**1.49**
After Snaking	1/29/03 10:25		2.84		2229	1.97E-01		7.04E-05	1.50E-04	5.51E-05	4.85E-05	1.26E-05		1.46E-04	0.47	3.01
	1/29/03 10:50		2.84		2230	1.76E-01		7.23E-05	1.49E-04	9.24E-05	7.31E-05	1.27E-05		2.45E-04	0.48	3.35
	1/29/03 14:00		2.42		2237	2.01E-01		7.60E-05	1.50E-04	7.36E-05	5.97E-05	1.24E-05		1.95E-04	0.51	3.27
	2/3/03 14:30		3.10		2241	2.00E-01		9.33E-05	1.87E-04	4.03E-05	5.46E-05	8.27E-06		1.12E-04	0.50	2.05
Telltale No 3																
Ave Before Snaking			**3.44**		**2261**	**1.79E-01**	**3.59E-06**	**1.15E-05**	**4.75E-05**		**2.82E-05**		**3.29E-04**		**0.24**	
After Snaking	1/29/03 9:45		5.42		2217			3.36E-05	9.70E-05	8.44E-06	6.12E-05	1.46E-05		2.23E-05	0.35	0.36
Telltale No 5																
Ave Before Snaking			**3.34**		**2295**	**1.62E-01**	**2.92E-06**	**2.25E-05**	**7.35E-05**		**4.17E-05**		**2.75E-04**		**0.31**	
After Snaking	1/29/03 10:15		8.08		2349			4.26E-05	1.48E-04		1.00E-04				0.29	

Units for concentrations of radionuclides are presented in microcuries per milliliter (?Ci/mL)

TABLE 3B (continued): SUMMMARY OF SPECIAL ANALYSIS RESULTS OF SALEM UNIT 1 SPENT FUEL POOL LINER DRAINS AFTER SNAKING (TELLTALE DRAINS)

	Sample	Concentration, ppm				Activity at Sample Time, µCi/mL							Mode 6 µCi/mL		Cs-134/	Co-58/
Sample Location	**Date/Time**	**Fe**	**Na**	**Cl**	**Boron**	**H-3**	**I-131**	**Cs-134**	**Cs-137**	**Co-58**	**Co-60**	**Sb-125**	**I-131**	**Co-58**	**Cs-137**	**Co-60**
Telltale No 6																
Ave Before Snaking			**7.84**		**2312**	**1.63E-01**		**3.48E-05**	**1.17E-04**	**3.29E-06**	**7.65E-05**	**2.57E-05**	**7.00E-04**	**5.54E-06**	**0.29**	**0.20**
After Snaking	1/29/03 12:00		5.40		2206			3.98E-05	2.72E-04	8.48E-07	7.43E-05	7.23E-06		2.25E-06	0.15	0.03
Telltale No 8																
Ave Before Snaking			**12.1**		**2297**	**1.71E-01**	**5.37E-06**	**7.37E-05**	**3.58E-04**		**1.69E-04**	**5.89E-05**	**5.06E-04**		**0.21**	
After Snaking	1/29/03 10:25		12.4		2123			6.28E-05	2.91E-04		3.25E-05	7.74E-06			0.22	
Telltale No 9																
Ave Before Snaking			**9.16**		**2066**	**1.92E-01**	**4.24E-06**	**6.19E-05**	**3.11E-04**		**5.86E-05**	**6.62E-06**	**4.29E-04**		**0.20**	
After Snaking	1/29/03 10:35				2145			5.53E-05	3.23E-04		1.01E-04				0.17	
Telltale No 13																
Ave Before Snaking			**48.4**		**2085**	**1.71E-01**		**7.65E-05**	**3.48E-04**		**9.90E-07**	**2.12E-06**			**0.22**	
After Snaking	1/29/03 13:35				1806	1.93E-01		5.19E-05	2.44E-04		2.22E-06	4.30E-06			0.21	
Telltale No 14																
Ave Before Snaking			**69.7**		**1684**	**1.35E-01**		**5.77E-05**	**2.02E-04**	**1.69E-05**	**1.39E-05**			**3.50E-05**	**0.29**	**3.54**
After Snaking	1/29/03 9:08		66.0		1637	1.79E-01		3.78E-05	1.74E-04	2.18E-05	9.02E-05	2.52E-05		5.76E-05	0.22	0.64

Units for concentrations of radionuclides are presented in microcuries per milliliter (?Ci/mL)

TABLE 4: UNIT 1 TELLTALE ANALYSIS SUMMARY (August 2003 to January 2004)

Telltale No.	Date/Time	LR, mL/min	pH	Na, ppm	K, ppm	Ca, ppm	Mg, ppm	Zn, ppb	Cr, ppb	Ni, ppb	Fe, ppb	Boron, ppm	Activity: μCi/mL					^{134}Cs/ ^{137}Cs	^{58}Co/ ^{60}Co
													^{3}H	^{134}Cs	^{137}Cs	^{58}Co	^{60}Co		
No. 1	8/27/03 8:30		6.18	1.50	15.4	32.3	0.689	288	≤8.06	98.9	≤7.15	2393	2.90E-01	1.86E-03	2.84E-03	2.68E-04	1.42E-03	0.65	0.19
	9/24/03 9:19			5.60	4.06	28.2	0.574	312	≤8.06	113	84.7	2371		1.67E-03	2.64E-03	2.24E-04	1.65E-03	0.63	0.14
	10/22/03 2:20		6.19	0.94	1.55	220	0.548	316	12.2	139	395	2364	2.61E-01	1.67E-03	2.78E-03	1.88E-04	1.79E-03	0.60	0.11
	11/20/03 10:30		6.06	0.65	1.34	205	0.510	414	10.6	36.7	657	2367	3.27E-01	7.51E-04	1.26E-03	3.67E-05	3.70E-04	0.59	0.10
	12/22/03 9:00		No sample																
	1/14/04 8:45	<1	No sample																
No. 2	8/27/03 8:30		6.84	4.52	9.35	62.1	1.70	266	9.66	45.5	21.5	2264	3.06E-01	1.02E-03	1.64E-03	1.23E-04	6.99E-04	0.62	0.18
	9/24/03 9:19			14.7	8.38	48.8	1.81	53.6	≤8.06	26.0	94.3	2278		6.17E-04	9.59E-04	5.12E-05	3.35E-04	0.64	0.15
	10/22/03 2:20		6.74	2.70	8.25	53.6	1.50	71.0	11.8	53.7	2155	2310	3.26E-01	8.19E-04	1.33E-03	5.60E-05	6.54E-04	0.61	0.09
	11/20/03 10:30		6.19	0.79	7.34	21.3	0.60	626	13.5	33.7	2668	2347	3.20E-01	6.72E-04	1.12E-03	ND	4.00E-04	0.60	-
	12/17/03 9:00		6.77	2.08								2274	3.21E-01	3.46E-04	6.16E-04	ND	1.62E-04	0.56	-
	1/6/04 12:20		6.67	1.60								2268	4.36E-01	ND	ND	ND	ND	ND	-
	1/6/04 13:00	500																	
	1/14/04 8:00	500	6.66	1.70								2319		2.45E-04	4.60E-04	5.50E-06	1.29E-04	0.53	0.04
No. 3	8/27/03 8:45		No sample																
	9/26/03 10:40				59.6	57.2	1.95	6196	≤8.06	10.8	≤7.15	2282		3.00E-04	5.62E-04	ND	3.48E-05	0.53	-
	10/23/03 0:50		6.94	2.40	102	55.0	1.82	11,900	10.1	≤10.0	53.5	2294	2.67E-01	5.33E-04	1.01E-03	ND	3.89E-05	0.53	-
	11/20/03 10:30		6.78	3.39	18.3	70.5	2.08	534	11.4	≤10.0	1132	2463	2.93E-01	5.37E-04	8.86E-04	ND	8.68E-05	0.61	-
	12/17/03 9:00		7.14	5.33								2210		2.38E-04	4.67E-04	ND	8.93E-05	0.51	-
	1/14/04 8:05	0.14																	
No. 4	8/13/03 13:00		Insufficient sample																
	9/26/03 10:40				250	61.9	2.30	113	≤8.06	≤10.0	90.3	2279		4.05E-04	6.69E-04	ND	6.17E-05	0.61	-
	10/23/03 0:50		7.05	4.30	15.0	83.8	2.91	954	9.91	≤10.0	271	2378	2.80E-01	6.09E-04	1.03E-03	ND	9.27E-05	0.59	-
	11/20/03 10:30		7.16	6.20	21.0	115	4.00	861	11.3	≤10.0	13.5	2254	3.12E-01	2.57E-04	5.32E-04	ND	4.41E-05	0.48	-
	12/17/03 9:00		7.33	5.73								2224	3.21E-01	2.15E-04	4.62E-04	ND	5.85E-05	0.46	-
	1/14/04 8:10	0.23																	

Units for concentrations of radionuclides are presented in microcuries per milliliter (?Ci/mL)

TABLE 4: UNIT 1 TELLTALE ANALYSIS SUMMARY, Continued

Telltale No.	Date/Time	LR, mL/min	pH	Na, ppm	K, ppm	Ca, ppm	Mg, ppm	Zn, ppb	Cr, ppb	Ni, ppb	Fe, ppb	Boron, ppm	Activity: µCi/mL					^{134}Cs/ ^{137}Cs	^{58}Co/ ^{60}Co
													^{3}H	^{134}Cs	^{137}Cs	^{58}Co	^{60}Co		
No. 5	8/27/03 8:30		6.90	4.01	11.7	67.5	2.36	52.8	8.71	≤10.0	26.7	2296	2.93E-01	4.74E-04	8.52E-04	ND	6.55E-05	0.56	-
	9/26/03 10:40.			24.5	15.7	108	3.35	573	≤8.06	≤10.0	≤7.15	2260		3.07E-04	5.95E-04	ND	7.92E-05	0.52	-
	10/23/03 0:50		7.16	6.40	17.4	119	4.02	1253	10.1	≤10.0	24.6	2054	2.25E-01	2.52E-04	5.26E-04	ND	8.78E-05	0.48	-
	11/20/03 10:30		7.17	6.00	13.3	119	3.92	1514	9.62	12.2	16.4	2246	3.16E-01	2.18E-04	4.88E-04	ND	6.44E-05	0.45	-
	12/17/03 9:00		7.64	6.70								2203	3.18E-01						
	1/14/04 8:15	0.18																	
No. 6	8/27/03 8:30		7.16	7.03	15.3	99.0	3.72	≤11.3	≤8.06	16.7	19.3	2231	2.87E-01	2.83E-04	6.17E-04	2.14E-05	1.15E-04	0.46	0.19
	9/26/03 10:40			30.8	223	220	3.82	31.6	≤8.06	≤10.0	≤7.15	2236		2.05E-04	5.23E-04	ND	6.02E-05	0.39	-
	10/23/03 0:50		7.21	6.40	19.6	130	3.73	59.4	11.8	10.1	19.8	2124	2.17E-01	1.69E-04	4.18E-04	ND	6.30E-05	0.40	-
	11/20/03 10:30		7.24	7.21	21.0	130	3.81	55.2	11.3	≤10.0	22.0	2250	3.05E-01	2.13E-04	5.46E-04	ND	7.49E-05	0.39	-
	12/17/03 9:00		7.59	6.68								2190	3.21E-01	1.86E-04	4.20E-04	ND	5.80E-05	0.44	-
	1/14/04 8:20	0.27																	
No. 8	8/27/03 8:30			5.56	13.6	108	3.27	534	8.28	15.5	170	2279	2.89E-01	3.33E-04	6.63E-04	ND	1.00E-04	0.50	-
	9/26/03 10:35				8.05	135	2.99	453	≤8.06	≤10.0	16.6	2263	2.97E-01	2.41E-04	5.20E-04	1.43E-05	1.51E-04	0.46	0.09
	10/23/03 0:50		7.16	4.90	9.47	108	3.06	330	11.4	21.3	2114	2159	2.68E-01	2.66E-04	5.19E-04	2.22E-05	2.12E-04	0.51	0.10
	11/20/03 10:30		7.18	5.98	21.2	118	3.64	309	11.6	19.0	2561	2264	3.17E-01	2.96E-04	6.49E-04	ND	1.52E-04	0.46	-
	12/17/03 9:00		7.40	5.30								2110	3.37E-01	2.65E-04	5.54E-04	ND	1.62E-04	0.48	-
	1/14/04 8:25	0.68																	
No. 9	8/27/03 8:30				15.2	185	3.70	13,390	9.97	109	≤7.15		1.19E-01	7.58E-05	2.95E-04	ND	2.18E-04	0.26	-
	9/26/03 10:35				15.6	145	4.02	16,400	≤8.06	91.9	19.2	2445							
	10/23/03 0:50		No sample																
	11/20/03 10:30		No sample																
	12/17/03 9:00		No sample																
	1/14/04 8:45	<1	No sample																
No. 10	1/14/04 8:45	<1	No sample																
No. 11	1/14/04 8:45	<1	No sample																
No. 12	1/14/04 8:45	<1	No sample																
No.13	1/14/04 8:30	<1	No sample																
No. 14	1/14/03 8:35	<1	No sample																
No. 15	1/14/04 8:45	<1	No sample																
No. 16	1/14/04 8:45	<1	No sample																
No. 17	1/14/04 8:45	<1	No sample																

TABLE 5: SALEM UNIT 1 SPENT FUEL POOL ANALYSIS SUMMARY

Date/Time	Boron, ppm	Activity, µCi/mL					^{134}Cs/ ^{137}Cs	^{58}Co/ ^{60}Co
		^{3}H	^{137}Cs	^{60}Co	^{58}Co	^{60}Co		
08/07/03 14:40	2349		2.90E-03	4.32E-03	6.12E-04	2.86E-03	0.67	0.21
08/13/03 13:13			2.88E-03	4.40E-03	6.08E-04	2.85E-03	0.66	0.21
08/14/03 9:15	2353							
08/20/03 8:00	2364		3.10E-03	4.80E-03	5.71E-04	2.86E-03	0.65	0.20
08/28/03 9:20	2374		3.28E-03	5.07E-03	5.36E-04	3.19E-03	0.65	0.17
09/04/03 8:00	2359	2.73E-01	3.07E-03	4.91E-03	4.75E-04	3.05E-03	0.63	0.16
09/18/03 8:45	2370		3.39E-03	5.29E-03	4.68E-04	3.28E-03	0.64	0.14
09/25/03 10:30	2350		3.08E-03	4.75E-03	4.04E-04	2.89E-03	0.65	0.14
10/02/03 9:55	2351	2.23E-01	3.12E-03	4.92E-03	4.26E-04	2.92E-03	0.64	0.15
10/09/03 0:55	2358		3.11E-03	4.83E-03	3.41E-04	2.92E-03	0.64	0.12
10/16/03 8:55	2366		3.53E-03	5.45E-03	3.48E-04	3.08E-03	0.65	0.11
10/22/03 22:15	2345							
10/23/03 0:05			3.39E-03	5.45E-03	3.22E-04	3.10E-03	0.62	0.10
10/30/03 0:30	2348	3.20E-01	6.05E-04	1.06E-03	5.83E-05	5.69E-04	0.57	0.10
11/06/03 5:35	2357		1.69E-04	3.06E-04	1.52E-05	1.79E-04	0.55	0.085
11/12/03 23:00	2375							
11/20/03 8:15	2383		6.94E-05	1.26E-04	6.94E-06	1.09E-04	0.55	0.063
11/26/03 12:50	2370	3.02E-01						
12/04/03 8:45	2339		6.01E-05	1.01E-04	ND	1.11E-04	0.60	-
12/11/03 9:15	2329		3.83E-05	7.53E-05	3.83E-06	6.94E-05	0.51	0.055
12/18/03 8:50	2325		3.50E-05	6.49E-05	ND	5.81E-05	0.54	-
12/23/03 8:10	2336		3.74E-05	6.33E-05	ND	7.37E-05	0.59	-
01/01/04 8:30	2307		3.87E-05	7.34E-05	ND	7.44E-05	0.53	-
01/08/04 8:05	2327	3.32E-01	2.97E-05	4.49E-05	ND	4.06E-05	0.66	-
01/15/04 8:05	2333		3.28E-05	4.74E-05	ND	7.89E-05	0.69	-
01/21/04 13:15	2298							
01/21/04 17:10	2299							
01/22/04 8:15		3.25E-01	2.76E-05	6.13E-05	ND	7.68E-05	0.45	-
01/29/04 8:10	2313		2.82E-05	6.36E-05	ND	9.14E-05	0.44	-

Appendix B

Section C – ISRA Non-Applicability Application (Station Operational History)

Exhibit C
Salem and Hope Creek Generating Station Assessments

Salem Generating Station Assessment

Table of Contents

Figures

Tables

Appendix to Exhibit C

Salem Generating Station

1. Introduction

Public Service Electric and Gas Company ("PSE&G") is making an application to the New Jersey Department of Environmental Protection ("NJDEP") for a determination of the applicability of the requirements of the Industrial Site Recovery Act ("ISRA") with respect to PSE&G's transfer of generation-related assets to an affiliate. This application contains detailed information on PSE&G's generation-related assets, identifies potential environmental liabilities related to these assets, calculates the expected value of these liabilities, and presents relevant financial information concerning the affiliate.

PSE&G's generation-related assets include steam electric generating units and combustion turbine electric generating units. The steam electric generating units use both fossil and nuclear fuels. The Salem Generating Station ("Salem") consists of two nuclear-fueled steam electric generating units and one combustion turbine unit fueled by distillate oil. Nuclear-fueled steam electric generating units present a potential for radioactivity to impact the environment. Because of this and other potential impacts, the United States Nuclear Regulatory Commission ("USNRC") has been empowered to strictly regulate all aspects of Salem related to radiological controls. The Appendix to this Exhibit describes this strict regulatory program and how it applies to the design, construction, licensing, operation, monitoring, and decommissioning of Salem so as to ensure that potential radiological impacts are minimized and addressed in the unlikely event that this becomes necessary. This Exhibit describes all major aspects of Salem's electric generating processes, including those associated with radioactivity. This Exhibit presents the expected value of potential environmental liabilities associated with the non-radiological aspects of Salem's electric generating process. However, the expected value of any potential environmental liabilities associated with radioactivity is not calculated for the reasons discussed in the Appendix to this Exhibit.

Although unique features exist, steam electric generating stations that use nuclear fuel employ the same basic processes as are employed by steam electric generating stations that use fossil fuels. Since many of the processes conducted at Salem are the same as those conducted at PSE&G's other steam electric generating stations, the information set forth in Exhibit B to the Memorandum in Support of Applicability Determination provides a useful reference for understanding certain processes present at Salem. Based on the station-specific information as supplemented by Exhibit B, Exhibit C to the Memorandum in Support of Applicability Determination identifies potential environmental liabilities for the processes not associated with releases of radioactivity and calculates their expected value using the methodology and approach described in Exhibit A to the Memorandum in Support of Applicability Determination.

2. Salem Generating Station Characteristics

2.1. Station Description and Setting

PSE&G operates and is a part owner of Salem which is located on Artificial Island in Lower Alloways Creek Township, Salem County, New Jersey (see Figure 2-1). Salem is jointly owned as follows: PSE&G (42.59 percent), Philadelphia Electric Company ("PECO") (42.59 percent), Atlantic Electric Company (7.41 percent), and DELMARVA Power and Light Company (7.41 percent). Salem is situated adjacent to the Hope Creek Generating Station ("Hope Creek" and together with Salem, the "Stations"), which is also located on Artificial Island. The Stations are located on the eastern bank of the Delaware River. Salem is approximately 26 acres in size. At any one time during the operational history of Salem, the electric generation and ancillary facilities occupied only a portion of the property.

PSE&G owns and controls an approximately 600-acre area of Artificial Island that is situated adjacent to and surrounds Salem and Hope Creek. This area contains certain administrative and support facilities that are used by both Salem and Hope Creek, the Hope Creek Switchyard, the Salem Switchyard, and certain undeveloped vacant land. With the exception of the Salem Switchyard, this area is evaluated as part of the Hope Creek Generating Station.

The zoning classification for the Salem property is industrial. The land adjacent to Salem is zoned for industrial and residential or agricultural use, but falls under statutes that restrict development.

2.2. Station Processes and Operations

Salem is composed of two nuclear generating units and one combustion turbine unit fueled by distillate oil. Commercial operations of Unit 1 commenced in 1976 and commercial operations of Unit 2 commenced in 1981. The combustion turbine unit commenced operations in 1972. The nuclear generating units operate as base load units and the combustion turbine unit is a peaking unit. Salem has a combined generating capacity of approximately 2,250 MW. Over its operational life Salem has experienced no significant changes in its operation. Figure 2-2 is a site plan showing the major operational features associated with Salem.

Section 2.2.1 describes the nuclear electric generating process, while Section 2.2.2 describes the support processes and operations, including those associated with electric generation and those that support electric generation.

2.2.1. Nuclear Electric Generating Process

The primary difference between nuclear fuel electric generation and fossil-fueled electric generation is that a nuclear reactor replaces the boiler to generate heat for the production of steam to drive the turbine generator. Salem's reactors are Pressurized

Water Reactors ("PWR"), with a generating capacity of 1,106 MW each (see Figure 2-3).

Water used as reactor coolant in the production of electricity is obtained from on-site wells and demineralized using resins to remove impurities prior to introduction to the system. Reactor coolant is pumped at high pressure through the reactor core in a closed loop system called the Reactor Coolant System ("RCS"), described in further detail below. The reactor coolant is heated by the reactor core and is then pumped under high pressure from the reactor core to the steam generators, where it heats the water in the steam generator to produce steam in a second closed loop system, referred to as the secondary cooling system. The reactor coolant recirculates from the steam generators back to the reactor core to continue the cycle. Once the steam is produced in the steam generators, the nuclear generating unit processes are essentially the same as the fossil-fueled steam electric generating processes. The steam produced in the steam generators is transferred to the turbine generator to generate electricity. Exhaust steam from the turbine passes into the condensers where it is cooled and condensed using Delaware River water as non-contact cooling water in the Circulating Water System ("CWS"). The condensate is returned to the steam generators as feed to continue the cycle. After passing once through the condenser, the non-contact cooling water is returned to the River.

Gases are removed from the condenser to improve steam cycle efficiency. There are stationary radiological monitors at the condenser, which continuously monitor the removed gases for radioactivity. This monitoring is described in the Appendix to this Exhibit.

Reactor coolant becomes radioactive during this process as a result of fission products from fuel rods, activation of corrosion products, and radiolytic decomposition of the reactor coolant. Salem is designed to control this radioactivity and to provide for its appropriate management. A portion of the reactor coolant is continuously let down and treated in demineralizers to remove both radioactivity and impurities in order to maintain reactor coolant quality. Most of this reactor coolant is returned to the system, but the letdown process does generate certain liquid, solid, and gaseous radioactive wastes. Radioactive and other gases accumulate in the reactor coolant and are removed by degassing during the letdown process. These gases are managed as gaseous radioactive wastes. Small amounts of the reactor coolant are also periodically removed from the system to maintain equilibrium and are managed as a liquid radioactive waste. The management of these and other solid, liquid, and gaseous radioactive wastes is discussed below.

Nuclear generating stations are designed and constructed to incorporate a series of overlapping physical barriers and boundaries to contain radioactivity to protect public safety and the environment. This overlapping system of barriers and boundaries embodies the "defense in depth" principle that constitutes the foundation for the USNRC licensing requirements for nuclear generating stations. Barriers are physical containments. These physical containments include various components of the Nuclear

Steam Supply System ("NSSS"), including but not limited to the fuel rods and the RCS; the reactor containment; and the Radiologically Controlled Area ("RCA"). The boundaries, which are defined areas within which specified radiological controls are required, are the Protected Area and the Owner Controlled Area ("OCA").
These barriers and boundaries are discussed below.

2.2.1.1. Nuclear Steam Supply System

The NSSS is the system by which steam is generated at Salem to produce electricity. It consists of the fuel rods and the RCS, and is designed to function as a barrier to contain radioactivity, and thereby prevent any unplanned releases. The function of the fuel rods and the RCS and associated systems as barriers is described below.

2.2.1.1.1. Fuel Rods

The PWR uses uranium dioxide as fuel. Pellets of uranium dioxide in a ceramic matrix are sealed inside 12-foot-long zirconium-alloy tubes called fuel rods, which are arranged in bundles called fuel assemblies. The fuel assemblies are inserted vertically into the reactor vessel (which is a large carbon steel tank approximately seven inches thick with a stainless steel liner, filled with water) in a precise grid pattern known as the reactor core.

The ceramic matrix provides voids that allow for thermal and gaseous expansion within the fuel rods during the fission process without deforming the fuel rods. The zirconium alloy is used for the fuel rods due to its strength and corrosion resistance. The fuel rods are designed to contain fission gasses generated during the fission process and, therefore, most of the radioactivity. The fuel rods prevent the contact of the reactor coolant water with the fuel and limit the release of fission products to the reactor coolant water. The small amounts of radioactivity released to the reactor coolant are managed as described below in connection with the letdown process for maintaining reactor coolant quality and RCS equilibrium. Thus, the fuel rods provide the first barrier for the control of radioactivity.

2.2.1.1.2. Reactor Coolant System

The RCS includes: the reactor vessel; four coolant loops connected in parallel to the reactor vessel, each of which contains a circulating pump and a steam generator; and a pressurizer. The pressurizer includes relief valves and a relief tank and appurtenant piping. These elements compose the closed loop system, in which heat is transferred from the reactor to the reactor coolant for the steam generation process. Thus, this system contains or transports all fluids coming from, or going to, the reactor core. All components of this system are constructed of or lined with corrosion-resistant stainless steel and are designed to contain the pressure of the system. The RCS is designed to accommodate water volume, temperature, and pressure changes. Protection from overpressure of the RCS is provided by the pressurizer relief system. The pressurizer relief system releases steam from the top of the pressurizer, which is quenched and directed to the pressurizer relief tank. The resultant liquid in the pressurizer relief tank is managed in the radioactive liquid waste system.

The RCS is a closed loop system, located entirely within the Reactor Containment Building, and constitutes the Reactor Coolant Pressure Boundary ("RCPB"), the second barrier for the control of radioactivity.

2.2.1.2. Reactor Containment Building

The Reactor Containment Building contains the NSSS, which as indicated above includes the fuel rods and the RCS. It is a domed, reinforced concrete structure and extends about 190 feet above grade. The Reactor Containment Building has a 16-foot-thick concrete base, which is constructed atop a 30-foot-thick concrete foundation. The containment building is constructed of reinforced concrete; the walls are 4.5 feet thick and the hemispherical dome is 3.5 feet thick. A steel liner, ranging from 0.25 to 0.75 inches thick, is attached to the interior wall of the containment building for impact protection. The underground portion of the containment building is waterproofed with an impervious membrane to prevent seepage of groundwater.

The Reactor Containment Building, its access openings and penetrations, and related safety systems are virtually air-tight. The Reactor Containment Building is designed, consistent with applicable USNRC regulatory requirements, to contain the energy released and the resultant pressure build-up following a loss-of-coolant accident ("LOCA") as well as to contain the atmosphere of the building under normal operating conditions. Under operating conditions, it is isolated from the ambient atmosphere, and there are no gaseous releases from the Reactor Containment Building. Periodic grab samples of the air within the Reactor Containment Building are collected and analyzed. The Reactor Containment Building contains systems to filter the air, if necessary, and then to purge the air through the Plant Vent. Releases from the Plant Vent are continuously monitored by Salem's Radiation Monitoring System, and periodic grab samples are collected and analyzed pursuant to Salem's radiological effluent release program, as described in the Appendix to this Exhibit.

The Reactor Containment Building is specially controlled and monitored to ensure the integrity of the equipment, processes, and structures it contains, to control exposure to radioactivity, and to prevent unplanned releases of radioactivity. It has secured ingress and egress points to help achieve these objectives. Prior to leaving, personnel and equipment are monitored for radioactive contamination. This monitoring is conducted using portable survey meters. In the event of an elevated reading, the source of the contamination would be identified and the individual or equipment would be decontaminated prior to leaving the Reactor Containment Building.

The Reactor Containment Building constitutes the third barrier for the control of radioactivity.

2.2.1.3. Radiologically Controlled Area

The Radiologically Controlled Area ("RCA") is an area at Salem that is specially designed, controlled, and monitored to ensure the integrity of the equipment, processes, and structures it contains; to control exposure to radioactivity; and to prevent transfer of radioactivity beyond the RCA. While all areas of the RCA are subject to control, most areas within the RCA do not have elevated levels of radioactivity. Those areas within the RCA that have elevated levels of radioactivity are subject to special controls related to access, as discussed below. Radiation monitoring conducted in the RCA is discussed in the Appendix to this Exhibit.

All of the equipment, processes, and structures discussed above in Sections in 2.2.1.1 and 2.2.1.2 are located within the RCA. The RCA also contains other equipment, processes, and structures. In addition to the Reactor Containment Building, the structures within the RCA include the auxiliary buildings and the fuel handling buildings. These buildings are constructed of reinforced concrete. The auxiliary buildings house radioactive waste handling and management systems and certain safety systems, which are discussed below. The RCA also houses other auxiliary systems such as fire protection systems, component cooling systems, and ventilation systems. The auxiliary and fuel handling buildings' ventilation systems are designed to maintain a slight negative pressure within these buildings to ensure that no unmonitored releases of airborne radioactivity will occur.

All areas within the auxiliary and fuel handling buildings that potentially have radioactivity have ventilation systems that route ambient air to the Plant Vent (located at the top of the containment building) for controlled and monitored release to the environment. There are stationary radiological monitors at the Plant Vent that continuously monitor for radioactivity. Periodic grab samples are also collected from the Plant Vent and analyzed for radioactivity. These monitoring programs are described in the Appendix to this Exhibit.

The fuel handling buildings contain the new fuel storage areas and the spent fuel pools. New fuel is stored in strategically located, separate dry concrete storage vaults in specially designed fuel storage racks. The concrete storage vaults protect the fuel from any design basis accidents. The storage racks are configured to prevent a fission chain reaction of the stored fuel. As stored, the new fuel has very low levels of natural radioactivity.

Similar to new fuel, spent fuel is stored in the strategically located pool with concrete walls that protect the spent fuel from any design basis accidents. The spent fuel is stored in a pool of borated water in specially designed storage racks configured to prevent a fission chain reaction of the stored fuel. Boron is added to the water as an additional means to absorb neutrons, further reducing the potential for fission to occur in the spent fuel pool. The borated water is recirculated to cool the spent fuel. The water from the spent fuel pool is routed to demineralizers and heat exchangers and then returned to the pool. Fuel is placed in and removed from the reactor in accordance with the operating license Technical Specifications and Station operating procedures.

Approximately every 18 months, 30 to 50 percent of fuel rods are removed from each reactor vessel and transported within enclosed structures within the RCA for storage in the spent fuel pool. Following safe shutdown of the reactors, the removal process involves the following steps: (1) the reactor vessel head is removed and stored inside the Reactor Containment Building using a specially designed, in-situ crane; (2) the reactor vessel cavity is filled with borated water; (3) the spent fuel rods are removed from the reactor vessel using the in-situ crane and placed in borated water in a specially designed canal, which is equipped with rails; (4) the spent fuel rods are directed via rail through the canal to the spent fuel pool in the fuel handling building; and (5) the spent fuel rods are removed from the canal in the fuel handling building using a specially designed in-situ crane, which places them in the spent fuel pool. A similar process is used to move new fuel from the new fuel storage area to the reactor vessel.

Once the refueling process is complete, excess water from the reactor vessel cavity and the water from the canal are drained and stored for reuse in the fuel handling process. Enhanced radiological controls, including enhanced radiation monitoring, are implemented throughout the refueling process pursuant to USNRC requirements.

The RCA has a single, monitored ingress and egress point (the control point) to control normal access to the RCA and to prevent the transfer of radioactivity beyond the RCA. Controls on the ingress are discussed below. Prior to leaving, personnel and equipment are monitored for radioactive contamination. This monitoring is conducted by both radiation protection personnel and stationary electronic monitoring devices. In the event of an elevated reading, the source of the contamination would be identified and the individual or equipment would be decontaminated prior to leaving the RCA. This monitoring is discussed in the Appendix to this Exhibit.

The RCA constitutes an additional barrier for the control of radioactivity from Salem.

2.2.1.4. Protected Area

The Protected Area is an area, common to both Salem and Hope Creek, inside the established security fence line. It encompasses the entire RCAs for both Salem and Hope Creek, as well as a designated area surrounding the RCAs. The security fence line consists of two separate fences: an inner fence and an outer fence. Each fence is constructed of seven-foot-high steel chain link fencing topped with one foot of barbed wire. The two fences are separated by a 25-foot area known as the "Isolation Zone." No personnel or equipment is permitted in the Isolation Zone. There are motion sensitive detectors located in the Isolation Zone to provide a continuous alarm function.

The entire Protected Area, including the Isolation Zone, is monitored by roving security patrols and a continuously operating closed-circuit television system, which provide information on movements of individuals and vehicles to the security force, which is on duty 24 hours a day. Stationary radiation monitoring devices are located throughout the Protected Area. These are discussed in the Appendix to this Exhibit.

The Protected Area has a single, secured ingress point, the primary purpose of which is to prevent unauthorized access to the Stations. This single ingress point also serves as the sole egress point to prevent the transfer of radioactivity beyond the Protected Area. Controls on ingress are discussed below. Prior to leaving, personnel and equipment are monitored for radioactive contamination. This monitoring is conducted by stationary electronic monitoring devices. In the unlikely event of an elevated reading, the source of the contamination would be identified, appropriate corrective action taken, and the incident reported to the USNRC.

2.2.1.4.1. Protected Area Access

As indicated above, the Protected Area is the area inside an established security fenceline, which encompasses the entire RCAs for both Salem and Hope Creek, as well as a designated area surrounding the RCAs, and which has a single, secured ingress and egress point. Personnel and vehicle access for the Stations is provided through a common point, the Security Center. Access is limited and strictly controlled in accordance with USNRC requirements. Personnel granted access to the Protected Area must be specially trained and have a security clearance or must be escorted by personnel with the required training and clearance. Escorts must remain with visitors at all times. All personnel entering the Protected Area must pass through a metal detector, an explosives detector, and sensitive radiation monitors. These devices ensure that no unauthorized materials are brought into the Protected Area. Drivers of vehicles seeking access to the Protected Area must pass through the same security systems as visitors on foot after which their vehicles are appropriately processed for entry and escorted to their destination by security personnel. As indicated above, movements of individuals and vehicles within the Protected Area are monitored by security cameras and roving patrols.

As also discussed above, ingress to the RCA is through a single point of entry (the "Control Point"). Individuals seeking access to the RCA must have first passed through the controls associated with entry to the Protected Area, discussed above. Radiation Protection Personnel are stationed at the entrance to the RCA and ensure that only authorized individuals gain access.

Individuals seeking access to the RCA must have been issued a Radiation Work Permit by Salem's Radiation Protection Department. Radiation Work Permits are issued only for specific tasks and activities and limit access to specified areas, all of which are indicated on the Permit.

Each individual entering the RCA must be equipped with a personal radiation monitoring device, the sophistication of which is dependent upon the work being performed and the areas being accessed. These monitors measure, record, and indicate a total radiation dose to which an individual is exposed while in the RCA. Certain of these monitors are equipped with an alarm function that activates when predetermined dose limits are approached.

2.2.1.5. Owner Controlled Area

The area owned and controlled by the Company outside the Protected Area is known as the Owner Controlled Area ("OCA"). The OCA contains a number of support operations, including the Stations' administrative support building, employee and visitor parking areas, contractor trailer facilities, and a network of roads. The area of the OCA immediately outside of and adjacent to the outer security fence is maintained as an "exclusion zone" by security personnel and is continuously monitored by security cameras. The OCA is also monitored by roving security patrols. This area provides an additional buffer between the Stations and the public at large.

2.2.1.6. *Station Safety Systems*

Salem has several systems that are designed to safely shut down the reactor, maintain adequate reactor cooling after shutdown, and contain radioactivity primarily for the purpose of ensuring the protection of the public and the environment in the event of a design basis accident. Salem has never experienced a design basis accident. Certain of these systems may be used to support safe, normal, shutdown operations.

2.2.1.7. *Radioactive Waste Management Systems*

Gaseous, liquid, and solid wastes are generated within the RCA. These wastes are managed as radioactive unless and until measurements demonstrate otherwise. Salem's radioactive waste management systems, typically referred to as "radwaste systems," provide for the collection, processing, monitoring, and release or disposal of radioactive material in liquid, gaseous, and solid form from Salem. Salem's Operating License requires that the radwaste systems be operated and maintained to ensure that the release of radioactivity is kept as low as reasonably achievable ("ALARA"). Salem's Operating License imposes limitations on all radiological effluents, compliance with which will ensure that the ALARA standard is met. Salem's effluents are managed, monitored, released, and documented in accordance with Salem's operating procedures and the USNRC's requirements, as discussed in the Appendix to this Exhibit. A report of the monitoring results is filed with the USNRC and the BNE semi-annually. The radiological waste management system, in concert with Salem's radiation monitoring programs, ensures that any release of radioactivity is protective of public safety and the environment.

2.2.1.7.1. Gaseous Waste

Gases accumulate in the reactor coolant, are removed in the letdown process, as discussed above, and are then managed as a gaseous radioactive waste via the radioactive gaseous waste system. This system consists primarily of piping, waste gas compressors, and waste gas decay tanks. The gases removed in the letdown process are compressed and directed to the decay tanks, where they are stored for a discrete period of time to allow for decay of radionuclides. The gases in the decay tanks are sampled and analyzed pursuant to the radiological effluent release program to determine when appropriate radioactive decay has occurred. Once appropriate decay has occurred and requisite Station approvals have been received, the gases are released to the Plant Vent. Gaseous releases from the tank are monitored continuously, and an automatic shutoff valve will activate to terminate the release if predetermined setpoints are reached. All gaseous releases are also continuously monitored at the Plant Vent for gross radioactivity pursuant to Salem's Radiation Monitoring System. Salem's radiological effluent monitoring program and Radiation Monitoring System are described in the Appendix to this Exhibit.

As previously discussed, the Reactor Containment Building purge system, and the auxiliary building and the fuel handling building ventilation systems, route and manage exhaust air (which may contain radioactivity) for release through the Plant Vent. These purge and ventilation systems include HEPA (high-efficiency particulate air) and charcoal filtration, as necessary, to remove airborne particulates and certain gases prior to release of any gaseous effluent to the atmosphere. The management of the exhaust air through the Reactor Containment Building purge system and the auxiliary building and fuel handling building ventilation systems includes radiation monitoring which is described in the Appendix to this Exhibit.

2.2.1.7.2. Liquid Waste

Salem generates liquid radioactive wastes in the course of ordinary operations. These wastes are generated by leakage from equipment, system water sampling, intentional system bleeds, drainage, and dewatering of solid radioactive wastes. All liquid wastes generated within the RCA are handled as radioactive and managed through the Radioactive Liquid Waste System ("RLWS"). This system collects liquid wastes through a network of drains and pipes which direct the wastes to stainless steel holding tanks for management prior to reuse or discharge.

The liquid wastes in these RLWS tanks are sampled and analyzed for levels of radioactivity. If appropriate, the liquid wastes are treated to reduce radioactivity, using primarily filtration and/or demineralization. When treatment is complete, the wastes are transferred to stainless steel monitor tanks. The monitor tanks are isolated (to prevent the addition of more wastes), recirculated to mix the contents, and sampled to measure for radioactivity. The radioactivity level is evaluated against the radioactive effluent limitations contained in the Technical Specifications. If the radioactive effluent limitations are met and requisite Station approvals are received, the radioactive liquid waste may be manually released in a controlled manner from the monitor tanks to Salem's cooling water for discharge to the Delaware River. If the effluent limitations are not met, the wastes are subjected to further treatment. The RLWS discharge piping contains radiation monitors that will activate automatic isolation valves to terminate the discharge if predetermined setpoints are reached. As discussed in the Appendix to this Exhibit, the results of this liquid effluent sampling are reported to the USNRC and the BNE semi-annually.

2.2.1.7.3. Solid Waste

Solid radioactive wastes are generated from either dry or wet processes. Dry, solid radioactive wastes include materials such as removed components, anti-contamination clothing, ventilation filters, rags, and debris. These materials are collected throughout the RCA and accumulated in the radioactive waste handling area in the auxiliary building. These materials are then placed in USDOT-specification shipping containers (e.g., 55-gallon drums) that have been approved by the USNRC. Solid radioactive wastes generated from wet processes (e.g., demineralizer resins, water filters) are dewatered and placed in special USNRC and USDOT-specification shipping containers (e.g., casks). The area in which solid radiological waste is packaged and stored on site contains stationary instrumentation installed as part of the Radiation Monitoring System area-wide monitors that continuously measure ambient radioactivity levels. The results of this monitoring are displayed, recorded, and alarmed in Salem's Control Room. Documentation of these results is made available for USNRC inspection.

The outside of the solid radioactive waste shipping containers is surveyed for radioactive materials and radiation levels before transfer to a licensed radioactive material transporter for delivery to the USNRC-licensed disposal site (e.g., Barnwell, S.C.). As discussed in the Appendix to this Exhibit, the volume of, and the quantity of radioactivity in, the radioactive solid waste sent off site for disposal are reported to the USNRC and the BNE semi-annually.

2.2.2. Support Processes and Operations

There are a number of processes and operations that support the nuclear electric generating process in addition to those described above. These additional processes and operations, for the most part, are located outside the RCA. Salem is designed and operated so that these additional processes and operations are not exposed to radioactive materials.

Support processes and operations began at Salem circa 1970 in connection with construction activities. The function of these operations shifted from construction support to operations support when the nuclear units began commercial operation. Other support processes and operations that were not required for construction support became operational in 1976. There have been relatively few modifications to these processes and operations since 1976.

Sections 2.2.2.1 through 2.2.2.7 of this Exhibit describe the various auxiliary and support processes and operations employed at Salem. Exhibit B to the Memorandum in Support of Applicability Determination contains a more detailed review of certain aspects of these processes and operations.

Representative inventories of hazardous waste generated at Salem and Hope Creek are presented in Table 2-1 (PSE&G jointly manages hazardous wastes from both Stations). The current inventory of hazardous substances at Salem is presented in Table 2-2. Table 2-3 describes relevant information regarding Station facilities and their historic operations for each relevant potential candidate liability issue identified in Exhibit A to the Memorandum in Support of Applicability Determination. Table 2-4 provides information regarding the various pollution prevention plans developed and implemented at Salem. Figure 2-4 summarizes major operating components of Salem relative to fossil fuel use and wastewater effluents. Radioactive wastes are managed separately, as discussed above and in the Appendix to this Exhibit.

2.2.2.1. Auxiliary Boilers (1972–Present)

Salem has two auxiliary boilers that commenced operations circa 1972. Distillate oil has been the only fuel source for the boilers for the life of Salem. The auxiliary boilers are located in the house heating boiler building north of the turbine building. The boilers have been used as a general steam source and for building heating.

2.2.2.2. Emergency Generators (1976–Present)

Salem has six emergency generators that were made available for operations in 1976. Distillate oil has been the only fuel used in the generators. The generators are located in the auxiliary building. Generally, the electricity needed for normal operations of Salem is generated by the Station itself. When Salem is not generating electricity, it obtains power from off-site sources. In the unlikely event that off-site power were not available when Salem was not generating electricity, the emergency generators would provide electricity to Salem to maintain safe shutdown conditions. These units have not been operated other than for periodic testing to ensure operability.

2.2.2.3. Combustion Turbine Unit (1972–Present)

There is one combustion turbine unit at Salem to provide peaking capabilities during periods of high demand. The unit was installed in a metal housing on a concrete foundation. Distillate oil is the only fuel source for the combustion turbine unit. The fuel is stored in the 840,000-gallon above ground, diked storage tank that was installed in 1970, as discussed below.

The combustion turbine unit has a purge oil collection system to collect unburned fuel that remains in the engine each time a unit is shut down. The system typically collected less than five gallons of fuel each time the unit shut down. As originally constructed, the purge oil tanks for this unit were underground. The system consisted of two 55-gallon tanks and associated valves and piping. In the early 1990s, these purge oil tanks were replaced with sumps that are routed to the high-volume oil/water separator system. Separated oil is managed in accordance with applicable regulations.

2.2.2.4. Distillate Oil Storage and Handling

The primary fossil fuel used at Salem has been distillate oil. This fuel is used to generate electricity at the Unit 3 combustion turbine, to power the emergency diesel generators, and in the auxiliary boilers. The distillate oil is stored in an 840,000-gallon above ground, diked storage tank, which was constructed in 1970 and remains in use. This tank was constructed consistent with the design criteria for distillate oil tanks described in Exhibit B to the Memorandum in Support of Applicability Determination.

Distillate oil was initially delivered to Salem by barge. Since circa 1972, distillate oil has been delivered by tank truck. Distillate oil is unloaded from tank trucks at a designated area and is pumped via underground pipeline to the storage tank. The designated tank truck unloading area is currently curbed and has secondary containment. Piping from the storage tanks to the emergency generators, the boilers, and the combustion turbine unit is also underground.

2.2.2.5. Electric Transmission and Distribution Equipment

Salem uses a switchyard that is located on property immediately adjacent to Salem property. It became operational in 1976 when Salem began commercial operation. The switchyard occupies approximately eight acres, as shown in Figure 2-1. These facilities contain mineral oil-filled transformers and other miscellaneous mineral oil-filled equipment. The switchyard has been expanded and upgraded over the life of Salem; specifically, eight of its 16 transformers were added in 1992. There are also a number of mineral oil-filled transformers located outside the switchyard, some of which are located adjacent to Salem's electric generating units. The design and operation of the electrical equipment is consistent with that discussed in Exhibit B to the Memorandum in Support of Applicability Determination.

There are approximately 70 pieces of mineral oil-filled electrical equipment (e.g., transformers) at Salem. PSE&G implemented a survey of certain mineral oil-filled equipment at Salem in the late 1980s. This survey indicated that some of the mineral oil-filled equipment was PCB-contaminated. Based upon the results of this survey, in 1990, Salem initiated a comprehensive program to retrofill any mineral oil-filled electrical equipment that contained mineral oil with PCB concentrations in excess of 50 ppm, and to label the mineral oil-filled equipment pursuant to applicable regulatory requirements. This program was completed circa 1993, and currently there is no mineral oil-filled electrical equipment at Salem containing mineral oil with measured PCB concentrations in excess of 50 ppm.

Mineral oil in the electrical equipment is maintained using mobile filtering equipment, as described in Exhibit B to the Memorandum in Support of Applicability Determination.

2.2.2.6. Wastewater Effluents

Liquid radiological waste management is discussed above and in the Appendix to this Exhibit. Management of liquid radiological effluent releases including monitoring is discussed in the Appendix to the Exhibit.

The primary wastewater effluent generated at Salem has been and remains non-contact cooling water. Non-contact cooling water is discharged to the Delaware River in accordance with Salem's National or New Jersey Pollutant Discharge Elimination System ("NJPDES") permit. Other wastewater effluents at Salem include non-radioactive liquid waste, discharges from the high-volume oil/water separator system, and stormwater. The volumes of these other effluents are significantly lower than those of the non-contact cooling water flow. All wastewater discharges from Salem have been authorized by Salem's NJPDES permit since 1975, before Salem began commercial operation.

Wastewater treatment systems for the effluents discussed in this section were constructed at different times during the life of Salem to enable Salem to comply with the effluent limitations contained in applicable NJPDES permits. Non-radioactive liquid wastewaters include those from demineralizers, condensate polishers, the non-radioactive wastewater treatment system laboratory, building sumps, and roof drains. Non-radioactive liquid wastewaters have always been treated in a wastewater treatment plant prior to discharge to the river in accordance with Salem's NJPDES permit. Prior to 1988, the non-radioactive liquid waste was routed to an equalization basin where the pH was increased with caustic to facilitate precipitation. Decant water from this basin was discharged with the non-contact cooling water to the river in compliance with Salem's NJPDES permit. In 1988, the non-radioactive wastewater treatment plant was upgraded and expanded. The wastewater is collected in an equalization basin where sodium hypochlorite may be added to reduce total organic carbon. The effluent from the equalization basin is routed to clarifiers for settling. If necessary, caustic may be added to promote settling. The final effluent is discharged with the non-contact cooling water to the river in compliance with Salem's NJPDES permit. The wastewater treatment plant is operated by a licensed operator.

Prior to 1994, process water with the potential to contain oil was treated in three skim tanks. In 1994, the oil/water separator was installed. Treated water from the skim tanks and, subsequently, from the oil/water separator has been discharged to the river in accordance with Salem's NJPDES permit.

Stormwater is managed in accordance with Salem's NJPDES permit and Stormwater Pollution Prevention Plan. Stormwater is collected in storm drains and routed to the river for discharge in accordance with Salem's NJPDES permit. Stormwater from the major petroleum storage and handling areas is routed to the oil/water separator prior to discharge.

Prior to 1990, Salem sanitary wastewater was treated in a 10,500-gallon extended aeration tank and a 20,000-gallon rotating biological contactor. In 1990, a sewage treatment plant was constructed at Hope Creek, which began receiving Salem's sanitary wastewater. All solids were removed from the sanitary treatment system and disposed in accordance with applicable regulations. The treatment system structures were removed, soil samples were collected and analyzed, and the area was graded. Closure documentation was submitted to the NJDEP in accordance with applicable regulations.

2.2.2.7. Auxiliary and Maintenance Processes

The auxiliary and maintenance processes associated with Station operations and conducted outside the RCA are generally the same as those processes described in Exhibit B to the Memorandum in Support of Applicability Determination for steam generating units. For the nuclear electric generating unit, these processes include water conditioning, non-contact cooling, equipment cleanings, and equipment lubrication. For the combustion turbine unit, these processes include engine cleanings, purge oil collection, and equipment lubrication.

2.3. Environmental Setting

2.3.1. Surrounding Land Use and Surface Waters

Salem is located on the Delaware Estuary. The Estuary, in the location of Salem, is a tidal, brackish river, located in an area designated as Zone 5 by the Delaware River Basin Commission.

Artificial Island was created by the U.S. Army Corps of Engineers, beginning early in the twentieth century. Hydraulic dredging spoils were deposited within a diked area established around a natural bar that projected into the river. Prior to construction of Salem, the property was vacant, undeveloped, low-lying land.

The zoning classification of the property is industrial. The land adjacent to the property on which Salem is located is zoned for industrial and residential or agricultural use, but falls under statutes that restrict development. The nearest resident in New Jersey is three miles away.

2.3.2. Topography and Surface Drainage

The topography at Salem is nearly flat. Stormwater management is as described above. There are no permanent bodies of surface water on the property.

2.3.3. Geology

Salem and Hope Creek are underlain by approximately 25 feet of engineered fill composed mainly of dredge spoils (PSE&G, 1987; PSE&G, 1999). The engineered fill consists of silt, silty clay, sand, and gravel (Dames & Moore, 1974). Due to the composition of the engineered fill, the hydraulic conductivity of this material is very low, severely limiting the extent and rate of vertical movement of liquids through the medium. Below the engineered fill there is five feet of tidal marsh deposits, consisting of silty peat and organic silt and meadow mat (Thor, 1982; Warren George, 1970). The tidal marsh deposits are semi-confining. Beneath the tidal marsh deposits are approximately ten feet of discontinuous Quaternary Age riverbed deposits of sand and gravel (Davisson, 1979; Thor, 1982). The discontinuous riverbed deposits occur from 30 to 40 feet below ground surface ("bgs"). Below the ten-foot-thick discontinuous riverbed deposits is the Miocene Kirkwood Formation. The Kirkwood Formation is dark gray clay with some silt and layers of fine-grained micaceous quartz sand. The Kirkwood Formation is approximately 15 feet thick at the property and occurs from approximately 40 to 55 feet bgs (Dames & Moore, 1970; Rosenau and others, 1969; PSE&G 1987).

Below the Kirkwood Formation, the Paleocene-Eocene Vincentown Formation is encountered at 55 feet bgs to a depth of approximately 135 feet bgs (Dames & Moore, 1970; Dames & Moore, 1974). The Vincentown Formation is a competent, greenish-gray, fine to medium sand with some silt and shell fragments and some feldspar and glauconite (Dames & Moore, 1970; PSE&G, 1987). Beneath the Vincentown Formation lies the Paleocene Hornerstown Formation. The Hornerstown Formation is primarily a glauconitic sand and occurs from 135 feet bgs to approximately 145 feet bgs (Davisson, 1979).

Beneath the Hornerstown Formation lies the Upper Cretaceous Navesink Formation, which consists of glauconitic sand. The Navesink Formation is encountered from approximately 145 to 170 feet bgs. Beneath the Navesink Formation lies the Upper Cretaceous Mount Laurel-Wenonah Formation, which is clayey medium sand with some gravel, feldspar, and glauconite (PSE&G, 1987). At the property and regionally, the Mount Laurel-Wenonah Formation is approximately 100 feet thick and occurs from approximately 170 to 270 feet bgs (Rosenau, 1969; Dames & Moore, 1974).

Regionally, over 1,000 feet of Upper Cretaceous sediments lie beneath the Mount Laurel-Wenonah Formation. These formations collectively overlie crystalline bedrock and include in descending order: the Marshalltown Formation (gray fine sand), the Englishtown Formation (yellow-brown fine sand), the Woodbury Clay (dark gray, stiff, silty clay), the Merchantville Formation (dark green clay), the Magothy Formation (coarse to fine silt with little, fine sand), and the Raritan and Potomac Formations (interbedded sand, gravelly sand, and clay) (Dames & Moore, 1974; Rosenau, 1969).

Bedrock at the property is the Late Precambrian Wissahickon Schist, which underlies the entire Upper Cretaceous sedimentary package in the region. The Wissahickon Schist is encountered at depths up to 1,500 feet bgs at the property (Rosenau, 1969).

2.3.4. Hydrogeology

There are four aquifers directly beneath the property: a shallow aquifer and three deep aquifers. The shallow aquifer occurs from 10 to 40 feet bgs. The shallow aquifer is within the engineered fill, tidal marsh sediments, and discontinuous Quaternary riverbed deposits (Dames & Moore, 1974). In general, the engineered fill and tidal marsh deposits have low permeabilities (Dames & Moore, 1974; PSE&G, 1987). Occasional lenses of sand within the engineered fill may contain perched water within a few feet of the ground surface (Dames & Moore, 1974). The groundwater in the shallow aquifer is generally brackish, with flow to the southeast and a gradient of approximately 0.007ft/ft (Rosenau, 1969; Dames & Moore, 1974). The Kirkwood Formation, which is composed of Miocene clays, occurs from 40 to 55 feet bgs and is considered a confining layer which separates the shallow aquifer above from the first deep aquifer (PSE&G, 1984).

The first of the deep aquifers beneath the property occurs from 55 to 135 feet bgs and is the Paleocene-Eocene Vincentown Formation. The Vincentown Formation is a semi-confined to confined aquifer under artesian conditions (Dames & Moore, 1974) and is underlain by the leaky confining units in the Hornerstown and Navesink Formations. The confining units of the Hornerstown and Navesink Formations occur from 135 to 170 feet bgs (Dames & Moore, 1974). Groundwater in the Vincentown aquifer generally flows from north to south with a gradient of approximately 0.003 ft/ft (Dames & Moore, 1974). Regionally, the Vincentown aquifer is a water-producing aquifer, which supplies some of the domestic wells within Salem County (PSE&G, 1984; Rosenau, 1969). Groundwater in this aquifer is moderately hard with a high iron content (Rosenau, 1969; Dames & Moore, 1974). However, salt-water intrusions occur within this aquifer near the Delaware River, where water quality is brackish and non-potable (Rosenau, 1969).

The second deep aquifer is confined and occurs in the Upper Cretaceous Mount Laurel-Wenonah Formations at depths from 170 to 270 ft bgs. The Mount Laurel-Wenonah aquifer is bounded above by the confining units of the Hornerstown and Navesink Formations. Two potable and fire-water supply wells at the property can produce from this aquifer, although these wells are not typically used. Below the Mount Laurel-Wenonah aquifer lies the Marshaltown Formation (Rosenau, 1969).

The third deep aquifer is confined and is the Cretaceous Potomac-Raritan-Magothy (PRM) Aquifer System, which is the primary water-producing aquifer in the State of New Jersey. In Salem County, the PRM Aquifer System occurs at depths in excess of

500 feet bgs. At the property, four potable and fire-water supply wells produce from this aquifer system at depths ranging from 800 to 1,100 feet bgs. This aquifer system is bounded above by the Merchantville Formation and below by the crystalline basement of the Wissahickon Schist.

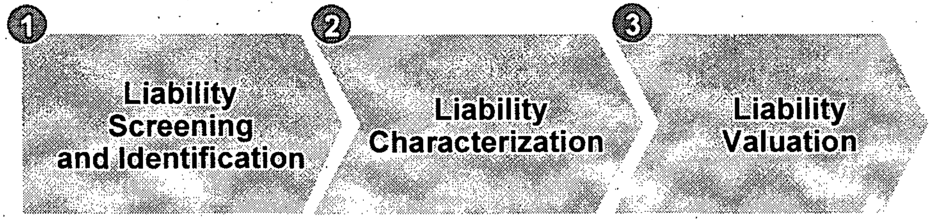
The crystalline basement rock of the Wissahickon Schist is not considered a productive aquifer and only locally transmits water along fractures and faults (Rosenau, 1969). Salem County has no known wells that produce water from this formation (Rosenau, 1969).

2.4. Environmental Characterization and Remedial Activities

Table 2-5 summarizes the nature of and results from environmental characterization and remedial activities conducted at the property.

3. Liability Screening, Characterization, and Valuation

The liability estimation process applied at each generation-related asset followed a step-wise procedure, as shown schematically below. This process is discussed in detail in Exhibit A to the Memorandum in Support of Applicability Determination.



The liability estimation process produces a quantitative estimate of the expected value for Salem's potential remediation liabilities. This section presents the results of the liability screening, characterization, and valuation for this Station.

3.1. Candidate Liability Screening and Identification

Candidate Liability Issues and associated Liability Elements that are potentially applicable to all generation-related assets were developed as discussed in Exhibit A to the Memorandum in Support of Applicability Determination. Each Candidate Liability Issue and Liability Element was evaluated based on the asset-specific data collected pursuant to the data collection protocol described in Exhibit A to the Memorandum in Support of Applicability Determination to determine:

1. Whether the activity or source existed at this generation-related asset;
2. Whether an environmental investigation has been conducted or chemical data were collected that demonstrate that contamination is not present at this generation-related asset with respect to a particular activity or source; or
3. Whether structural or engineering systems, such as full secondary containment, could have prevented a liability from arising at this generation-related asset.

Liabilities were screened out for this generation-related asset if: (1) an activity never existed at the property; (2) there is convincing documentation that issues never existed or have been eliminated through remediation or other corrective action; or (3) there have been structural or engineering systems that would have prevented a liability issue from arising. If any of a Candidate Liability Issue's Liability Elements was determined to be applicable to this generation-related asset, it was retained for characterization and valuation.

Table 3-1 provides the results of the liability screening for this generation-related asset and the rationale for the screening decisions.

3.2. Liability Characterization

For each retained Liability Issue and Liability Element, pertinent information collected using the data collection protocol was used to determine the number of Liability Units ("Liability Enumeration"), the aggressiveness of remedial effort (i.e., high, medium, or low intensity) ("Remedy Intensity"), and the physical extent of remedial effort ("Remedy Scale"). These were each determined employing the standard decision rules set forth in Exhibit A to the Memorandum in Support of Applicability Determination.

The results of the liability characterization are presented in Table 3-2.

3.3. Liability Valuation

As described in Exhibit A to the Memorandum in Support of Applicability Determination, the Liability Valuation step consists of three activities: decision tree configuration, liability evaluation, and expected value computation. This step produced a quantitative estimate of this generation-related asset's potential remediation liabilities.

3.3.1. Decision Tree

Table 3-3 is the remediation decision tree for this generation-related asset. This decision tree incorporates all Candidate Liability Issues retained for this generation-related asset as well as the investigation and monitoring activities. The decision tree is composed of a series of columns, each of which represents a Candidate Liability Issue. Remedy scenarios available to address each Issue are arrayed vertically in each column.

Remedy scenarios consist of a number of remedial technologies. The remedy scenarios included in the decision tree for each Liability Issue are those that we determined, based on our professional judgment, to best reflect the feasible choices available to remedy that particular Liability Issue. Remedial scenarios were considered for each Liability Issue retained to address all media of concern through either institutional controls, engineering controls, or active treatment. The selection of remedy scenarios and remediation technologies is detailed in Exhibit A to the Memorandum in Support of Applicability Determination.

3.3.2. Remedy Probability Assignments and Remedy Cost Calculations

For each retained Liability Issue, a probability was assigned to each remedy scenario that represents the probability that, following a site investigation, the remedy scenario would be selected and approved by the NJDEP. These probabilities were determined employing the standard decision rules set forth in Exhibit A to the Memorandum in Support of Applicability Determination. The decision rules identify the probability allocation for each Liability Issue first by reference to investigation effort, remedial alternative, or monitoring effort, as appropriate, and then by reference to Remedy Intensity. The remedy probability allocations for this generation-related asset are presented in the decision tree, Table 3-3.

The capital and operating costs of each remedy scenario in the decision tree were determined following the procedures outlined in Exhibit A to the Memorandum in Support of Applicability Determination. The remedy scenario costs were calculated using the scale inputs set forth in Table 3-2 and Arthur D. Little's in-house remediation cost database, which is based on standard remediation engineering cost assumptions. The present value of each remedy was calculated using accepted financial analysis principles and incorporating assumptions about the timing of remedial actions as well as discount and inflation rates. Key assumptions incorporated into the cost calculations are set forth in Exhibit A to the Memorandum in Support of Applicability Determination.

3.3.3. Liability Expected Value Computation

The liability valuation expected value computation was performed using a Microsoft® Excel spreadsheet-based cost-estimating model for the decision tree shown in Table 3-3. The model calculated the expected value for this generation-related asset by multiplying the probability assigned to each remedy alternative by the cost of that alternative and adding the calculated probability-weighted cost of all the remedy alternatives for that Liability Issue. The total expected value for this generation-related asset is the sum of the expected values for each Liability Issue.

The summary spreadsheet tabulating the remedy scenarios in the decision tree, present value costs, probabilities, and expected values is shown in Table 3-4. The total expected value cost estimate for this generation-related asset is $1,901,055.

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3. Citation from USCG for spill discharge violations, November 1988.
4. Citation from NJDEPE for water discharge violations, March 1989.
5. Citation from USEPA for water discharge violations, June 1989.
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18. Citation from USCG for spill violations, May 24, 1995.
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Salem Generating Station

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2. Aerial Viewpoint. Photograph, February 18, 1951. (1":1667').
3. Aerial Viewpoint. Photograph, March 1, 1962. (1":1500').
4. Aerial Viewpoint. Photograph, March 14, 1974. (1":1500').
5. Aerial Viewpoint. Photograph, March 6, 1987. (Scale not available.)
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Other

1. PSE&G database of underground storage tanks and related files of registrations and/or removal.

Figure 2-1: Map Showing the Salem and Hope Creek Generating Station

Figure 2-2: Major Operational Features Associated with the Salem Generating Station

Figure 2-3: Pressurized Water Reactor

Salem Generating Station

Figure 2-4: Salem Generating Station Operations

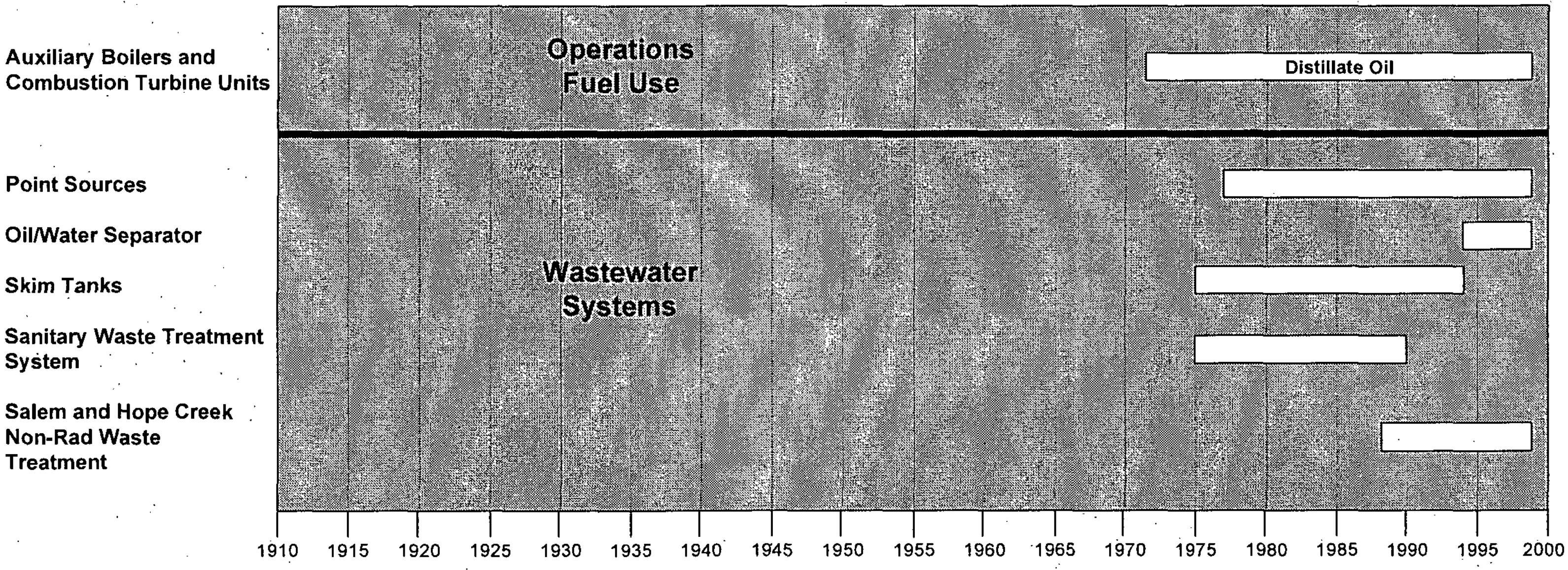


Table 2-1: Representative Hazardous Wastes for Salem and Hope Creek Generating Stations

Waste Stream	Amount (1997)
Contaminated solids and debris (toxic) containing benzene (D018)	413 lbs.
Contaminated solids and debris (toxic) containing chromium (D007)	1,614 lbs.
Contaminated water (toxic), containing chromium (D007)	5,572 lbs.
Oil and other liquid hydrocarbon waste (toxic), containing 1,1,1-trichloroethane (F001)	434 lbs.
Oil and other liquid hydrocarbon waste (toxic), containing oil, benzene, and tetrachloroethylene (D018, D029, D039, D040, F001)	20,627 lbs.
Paint-related waste (ignitable) containing petroleum hydrocarbons (D001)	739 lbs.
Paint-related waste (ignitable) debris, containing petroleum hydrocarbons (D001)	11,169 lbs.
Paint-related waste (ignitable) labpack, containing petroleum hydrocarbons (D001)	1,485 lbs.
Paint-related waste (ignitable, toxic), containing mineral spirits and methyl ethyl ketone (D001, D035)	9,025 lbs.
Photography development (reactive) waste, containing reactive sulfides (D003)	3,869 lbs.
Process chemicals (corrosive) in labpacks containing acid and amine solutions (D002)	208 lbs.
Process chemicals (corrosive) in labpacks containing hydroxides or various acids and bases (D002)	304 lbs.
Process chemicals (corrosive, ignitable) containing methanol and potassium hydroxide (D001, D002, F003)	125 lbs.
Process chemicals (corrosive, ignitable) in labpacks containing amine solutions or petroleum acids and acid (D001, D002)	134 lbs.
Process chemicals (corrosive, ignitable, toxic) containing acetic acid and formic acid (D001, D002, U123)	125 lbs.
Process chemicals (corrosive, ignitable, toxic) containing sulfuric acid, nitric acid, and silver (D001, D002, D011)	175 lbs.
Process chemicals (corrosive, ignitable, toxic) in labpacks containing sodium dichromate and sulfuric acid (D001, D002, D007)	40 lbs.
Process chemicals (corrosive, toxic) containing mercuric nitrate and sodium hydroxide (D002, D009)	8 lbs.
Process chemicals (corrosive, toxic) containing organic acids, inorganic acids, and chromium (D002, D007)	58 lbs.
Process chemicals (ignitable) containing ammonium persulfate (D001)	2 lbs.
Process chemicals (ignitable) containing benzyl peroxide (D001)	18 lbs.
Process chemicals (ignitable) containing iron and copper (D001)	25 lbs.

Table 2-1: Representative Hazardous Wastes for Salem and Hope Creek Generating Stations *(continued)*

Waste Stream	Amount (1997)
Process chemicals (ignitable) containing permanganates (D001)	1 lbs.
Process chemicals (ignitable) containing peroxides (D001)	15 lbs.
Process chemicals (ignitable) containing petroleum distillates (D001)	1,237 lbs.
Process chemicals (ignitable) containing sodium nitrite (D001)	20 lbs.
Process chemicals (ignitable, toxic) containing acetone and benzene (D001, D018, F003)	70 lbs.
Process chemicals (ignitable, toxic) containing mercuric nitrate (D001, D009)	7 lbs.
Process chemicals (ignitable, toxic) containing sodium hypochlorite and silver (D001)	8 lbs.
Process chemicals (toxic) containing arsenic (D004)	125 lbs.
Process chemicals (toxic) containing barium, chromium, and silver (D005, D007, D011)	41 lbs.
Process chemicals (toxic) containing mercuric acetate (D009)	5 lbs.
Process chemicals (toxic) containing mercury (D009)	16 lbs.
Process chemicals (toxic) in labpacks containing silver (D011)	5 lbs.
Solvent waste (ignitable) from cleaning and degreasing, containing mineral spirits (D001)	2,758 lbs.
Solvent waste (ignitable) from laboratory samples; containing isopropanol (D001)	826 lbs.
Solvent waste (toxic) from cleaning and degreasing in labpacks containing 1,1,1-trichloroethane (F002)	8 lbs.

Note: Hazardous wastes reported in this table are the total types and quantities of hazardous waste generated on Artificial Island. Data were obtained from the annual hazardous waste report submitted in February 1998 to the NJDEP for calendar year 1997.

Table 2-2: Current Hazardous Substances and Related Pollution Prevention Systems

Source	Container Type	Hazardous Substance	Product Quantity	Containment Type
Hydrocarbon Sources				
Main fuel oil storage tank and truck unloading area	Steel tank	Distillate oil	840,000 gallons	Gravel dike with impermeable membrane liner
70 pieces of (active) outside mineral oil-filled electrical equipment	Steel housing	Mineral oil	172,647 gallons total	Housekeeping; concrete pad and curbed with crushed rock bottom; diversion to oil/water separator
4 storage tanks	Steel tank	Distillate oil	120,000 gallons total	Concrete room encloses each tank
13 lube oil storage tanks and associated truck unloading areas	Steel tank	Petroleum lube oil	101,800 gallons total	Housekeeping; concrete floor; diversion to oil/water separator
2 oil/water separators	Steel tank	Oil/water mix	80,000 gallons total	Concrete containment
3 tanks	Concrete tank	Oil/water mixtures	30,000 gallons	Housekeeping
2 pieces of (inactive) spare mineral oil-filled transformers	Steel housing	Mineral oil	22,500 gallons total	Housekeeping; concrete pad
Sludge storage tank and transfer area	Steel tank	Oily sludge	5,000 gallons	Concrete containment
2 storage tanks and associated transfer area	Steel tank	Waste oil	4,000 gallons total	Integral steel inside concrete
6 smaller day tanks	Steel tank	Distillate oil	3,300 gallons total	Concrete curb/floor

Table 2-2: Current Hazardous Substances and Related Pollution Prevention Systems *(continued)*

Source	Container Type	Hazardous Substance	Product Quantity	Containment Type
5 smaller storage tanks located in the boiler building and the pump house	Steel tank	Distillate oil	1,600 gallons total	Concrete curbing; pad diversion to oil/water skimmer
Chemical Sources				
Clarifier No. 1 and 2	Coated carbon steel tank	Process wastewater	880,000 gallons	Housekeeping; concrete floor
Waste equalization basin	Fiberglass-lined concrete tank	Process wastewater	240,000 gallons	Housekeeping; concrete floor
4 waste tanks (low and high conductivity)	Coated concrete tank	Process wastewater	195,000 gallons total	Housekeeping; concrete floor; diversion to chemical waste tank
2 storage tanks (Unit Nos. 1 and 2) and truck unloading areas	Durakane fiberglass-lined steel tank	Sodium hypochlorite (15%) solution	176,000 gallons	Earth dike (sand, gravel, and clay); asphalt sprayed; concrete/asphalt floor
5 caustic storage tanks and associated truck unloading areas	Durakane fiberglass-lined steel tank, epoxy enamel-coated steel tank	Sodium hydroxide (50%) solution	17,500 gallons	Caustic-resistant concrete dike/floor; diversion to chemical waste tank
4 storage tanks and truck unloading areas	Lined or resin-coated steel tank	Sulfuric acid (98%)	12,500 gallons total	Acid-resistant dike/ flooring; diversion to chemical waste tank
4 smaller tanks	Fiberglass tank, coated concrete tank, lined steel tank	Process wastewater	12,250 gallons total	Housekeeping; concrete flooring diverted to larger process waste tanks
2 spray additive tanks and truck unloading areas	Steel tank	Sodium hydroxide	8,000 gallons total	Housekeeping; concrete building and floor

Table 2-2: Current Hazardous Substances and Related Pollution Prevention Systems *(continued)*

Source	Container Type	Hazardous Substance	Product Quantity	Containment Type
1 ethylene glycol storage tank	Steel tank	Ethylene glycol (antifreeze)	5,200 gallons	Steel
3 storage tanks at Unit No. 1 turbine, and truck unloading areas	Steel tank	Ammonia hydroxide (<28%) solution	4,000 gallons total	Concrete curbing; diversion to chemical waste tank
2 component coolant system surge/mix tanks (Unit Nos. 1 and 2)	Steel tank	Potassium chromate	4,000 gallons total	Housekeeping; concrete floor
4 storage tanks for the Unit No. 1 turbine	Steel tank	Hydrazine (5-35%) solution	850 gallons total	Housekeeping; concrete floor; diversion to chemical waste tank

Salem Generating Station

Table 2-3: Historic Operations and Related Pollution Prevention Systems

Operation	Description (Type, Use, Activity, Materials, etc.)	Size	Dates of Operation	Original Pollution Prevention Controls and Systems	Upgrades (Items and Dates)
Hydrocarbon Sources					
USTs	One removed fiberglass distillate oil storage tank, located at the TSC	2,000 gallons	Unknown–1989	None	N/A
ASTs	Salem Main Fuel Tank: Distillate Oil	840,000 gallons	1970–Present	Concrete dike on Delaware River side of containment, gravel dike; periodic integrity testing	Impermeable liner on gravel dike added in 1990.
Transfer Pipelines	All fuel oil piping from distillate oil tank to day tanks, generators, and combustion turbine unit is underground, single-walled and has no leak detection.	N/A	1971–Present	None	None
Combustion Turbine Units	Unit No. 3 combustion turbine has underground purge oil collection tank that collects unburned oil when engines are shut down.	55 gallons	1971–Present	Two underground 55-gallon steel tanks	Tanks replaced in 1991 with sump directed to high-volume oil/water separator.

Table 2-3: Historic Operations and Related Pollution Prevention Systems *(continued)*

Operation	Description (Type, Use, Activity, Materials, etc.)	Size	Dates of Operation	Original Pollution Prevention Controls and Systems	Upgrades (Items and Dates)
Oil-Containing Electric T&D Equipment	One 500kv switchyard at each generating station; mineral oil-filled containers that require regular mineral oil changeouts via mobile filtering equipment.	7.5–8 acres	1976–Present	Traprock; inspection/ housekeeping; generally concrete containment, drain to treatment system	None

Salem Generating Station

Table 2-4: Pollution Prevention Plans

Plan	Coverage	Original Date	Status/ Last Update
Discharge Prevention, Containment, and Countermeasures Plan Discharge Cleanup and Removal Plan (DPCC/SPCC/DCR)	Management of petroleum and other hazardous substances. The plans include provisions for spill prevention, spill response, inspection of storage and containment areas, training of personnel, etc.	1978	July 1999
Spill Prevention Control and Countermeasures Plan		Approximately 1978	
Best Management Practices (BMP) Plan	Management of hazardous substances to prevent unauthorized discharges to ground and surface waters.	1985	1999
Stormwater Pollution Prevention Plan	Management of stormwater runoff to prevent contamination.		September 1998
Facility Response Plan	Management of major sources of oil storage and transfer on navigable waters.	February 1993	February 1998
Underground Storage Tank Release Response Plan	Management of response to releases from underground storage tanks.		No underground storage tanks on site
RCRA Contingency Plan	Management of releases of hazardous waste. This information is shared with Local Emergency Planning Committees.		February 1998
Non-Radioactive Waste Operations and Maintenance Manual	Procedures for operations and maintenance of the treatment facility under routine and emergency conditions.	1985	July 1996
Low-Volume Oily Waste Operations and Maintenance Manual	Procedures for operations and maintenance of the treatment facility under routine and emergency conditions.	1985	July 1996
Cooling Tower Manual Operations and Maintenance Manual	Procedures for operations and maintenance of the treatment facility under routine and emergency conditions.	1985	July 1996
Sewage Treatment Plant Operations and Maintenance Manual	Procedures for operations and maintenance of the treatment facility under routine and emergency conditions.	1985	March 1999
Emergency Response Guide ND.FP-EO.ZZ-0002(Z)	Substance-specific procedures for responding to releases and spills of hazardous substances.		November 1992

Table 2-4: Pollution Prevention Plans *(continued)*

Plan	Coverage	Original Date	Status/ Last Update
Regulatory Reporting Guide ECG Att. 16	Reference guidelines for reporting and documenting environmental incidents.		January 1997
Operations Manual for Fuel Transfer Operations By Barge	Management of fuel transfer operations from barges.		N/A

Table 2-5: Summary of Discharge Investigations and Remediation Cases

Location	Case Number	Issue	Outcome
Unit No. 3 Gas Turbine	91-01-23-1549-05	• Discharge discovered during removal of two 55-gallon oil collection USTs. • Investigation concluded that soil contamination was result of historic discharges from Gas Turbine Unit.	• MOA executed 4/93. • Soil remediation and RAR completed. • NJDEP issued No Further Action letter 11/5/94.
Auxiliary Building	95-11-15-1210-31	• Historic leaks of No. 2 fuel oil line to the Auxiliary Building between 1978 and 1980.	• Determination that none of the impacted area had a concentration of TPH exceeding the 10,000 ppm cleanup level. • Groundwater was tested in the area of the leak and no VOCs or SVOCs were detected. • Based on TPH concentrations and the absence of impacted water, no soil was removed from the area. • Results were submitted to the NJDEP in December 1996 and the NJDEP determined that N.J.A.C. requirements were satisfied.

Table 3-1: Liability Screening—Salem Generating Station

Candidate Liability Issue	Issue Retained	Element Retained	Rationale for Screening Decision
Investigation	**Yes**		✓ **Investigation is retained as an issue at all sites where any candidate liability issue is retained.**
Ash Ponds	**No**		X **Issue does not exist at Salem.**
Coal Pile	**No**		X **Issue does not exist at Salem.**
Hydrocarbon Sources	**Yes**		✓ **One or more elements were retained.**
USTs		Yes	✓ One UST was removed from Salem in 1989. There are insufficient data to warrant exclusion as an element.
ASTs—distillate oil		Yes	✓ Salem has one distillate oil AST. There are no site-specific data to warrant exclusion as an element.
ASTs—heavy oil		No	X Element does not exist at Salem.
Transmission pipelines		No	X Element does not exist at Salem.
Transfer pipelines		Yes	✓ Underground transfer pipelines exist at Salem. There are no site-specific data to warrant exclusion as an element.
Combustion turbine units		No	X One combustion turbine unit exists at Salem. Two former underground purge oil collection tanks were removed in 1990. Soil remediation related to purge oil tanks occurred in the area of the former tanks. In November 1994, the NJDEP issued an NFA letter for soil and groundwater at the combustion turbine unit. The existing purge oil collection tanks are contained inside a concrete vault. Therefore, the element is not retained.
Oil-containing electric T&D equipment		Yes	✓ Element exists at Salem. There are no site-specific data to warrant exclusion as an element.
Miscellaneous spills		Yes	✓ Spill records date back to 1986. There are no records of spills prior to 1986 to warrant exclusion as an element.

Table 3-1: Liability Screening—Salem Generating Station *(continued)*

Candidate Liability Issue	Issue Retained	Element Retained	Rationale for Screening Decision
Chemical Sources	**Yes**		✓ **One or more elements were retained.**
Boiler operations and maintenance processes		No	X The auxiliary boiler building foundation is poured concrete that provides containment for operations and maintenance processes.
Bulk storage and handling areas		Yes	✓ Element exists at Salem. There are no site-specific data to warrant exclusion as an element.
Waste disposal		Yes	✓ There are no site-specific data to warrant exclusion as an element.
Miscellaneous spills		Yes	✓ Spill records date back to 1986. There are no records of spills prior to 1986 to warrant exclusion as an element.
PCB Sources	**Yes**		✓ **One or more elements were retained.**
Oil-containing electric T&D equipment		Yes	✓ Salem has oil-filled equipment that was in service when PCBs were in use. There are insufficient site-specific data to warrant exclusion as an element.
Gas condensate blowdown		No	X Element does not exist at Salem.
On-Site Fill	**No**		X **No elements were retained.**
Historic fill		No	X The property was made by deposition of hydraulic fill from USACOE dredging at depth of the Delaware River channel. The majority of the filling occurred prior to 1940. Therefore, it is not retained as an element.
Ash fill		No	X Element does not exist at Salem.
Dredge spoils		No	X Element does not exist at Salem.
On-Site Surface Water, Drainages, and Wetlands	**Yes**		✓ **Element exists at Salem and there are potential upgradient sources associated with Station operations.**
Monitoring	**Yes**		✓ **Monitoring is retained as an issue at all sites where any candidate liability issue is retained.**

Table 3-2: Liability Characterization—Salem Generating Station

			Remedy Intensity			Remedy Scale		
Issue	**Element**	**Number of Units**	**Impact Potential**	**Mitigating Factors**	**Intensity**	**Scale per Unit**	**Volume (c.y.)**	**Area (s.f.)**
Investigation		**N/A**	N/A	N/A	**M** (16 liability units)	N/A	**N/A**	**N/A**
Ash Ponds		**N/A**	N/A	N/A	**N/A**	N/A	**N/A**	**N/A**
Coal Pile		**N/A**	N/A	N/A	**N/A**	N/A	**N/A**	**N/A**
Hydrocarbon Sources								
	USTs	1	Potential pathway to groundwater and Delaware River and wetlands	• UST removed in 1989 in accordance with applicable regulations. Total: 1	M	Default scale of 200 cy/tank. Assume depth of 9 feet and surface area of 600 sf/ tank.	200	600
	ASTs—distillate oil	1	Potential pathway to groundwater and Delaware River and wetlands	• The AST has had an earthen dike or other containment throughout its history, has been upgraded to meet API requirements, and an impermeable liner has been installed. Total: 1	M	Default scale of 400 cy/unit. Assume depth of 3 feet and surface area of 3,600 sf/ unit.	400	3,600
	ASTs—heavy oil	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Transmission Pipelines	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 3-2: Liability Characterization—Salem Generating Station *(continued)*

			Remedy Intensity			Remedy Scale		
Issue	**Element**	**Number of Units**	**Impact Potential**	**Mitigating Factors**	**Intensity**	**Scale per Unit**	**Volume (c.y.)**	**Area (s.f.)**
	Transfer Pipelines	1	Potential pathway to groundwater and Delaware River	None	M	Default scale of 400 cy/unit. Assume depth of 3 feet and surface area of 3,600 sf/ unit.	400	3,600
	Combustion Turbine Units	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Oil-Containing Electric T&D Equipment	1	Potential pathway to groundwater and Delaware River	• Presence of traprock or containment limits impact to soil. Total: 1	M	Default scale of 200 cy/ unit. Assume depth of 3 feet and surface area of 1,800 sf/unit.	200	1,800
	Miscellaneous Spills	1	Potential pathway to groundwater and Delaware River	None	M	Default scale of 200 cy/ station. Assume depth of 3 feet and surface area of 1,800 sf/ station.	200	1,800
Total		**5**			**M**		**1,400**	**11,400**

Table 3-2: Liability Characterization—Salem Generating Station *(continued)*

			Remedy Intensity			Remedy Scale		
Issue	**Element**	**Number of Units**	**Impact Potential**	**Mitigating Factors**	**Intensity**	**Scale per Unit**	**Volume (c.y.)**	**Area (s.f.)**
Chemical Sources								
	Boiler Operations and Maintenance Processes	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Bulk Storage and Handling Areas	1	Potential pathway to groundwater and Delaware River	• Areas have been contained since circa 1990. Total: 1	M	Default scale of 100 cy/ station. Assume depth of 3 feet and surface area of 900 sf/ station.	100	900
	Waste Disposal	1	Potential pathway to groundwater and Delaware River	None	M	Default scale of 100 cy/ station. Assume depth of 3 feet and surface area of 900 sf/ station.	100	900

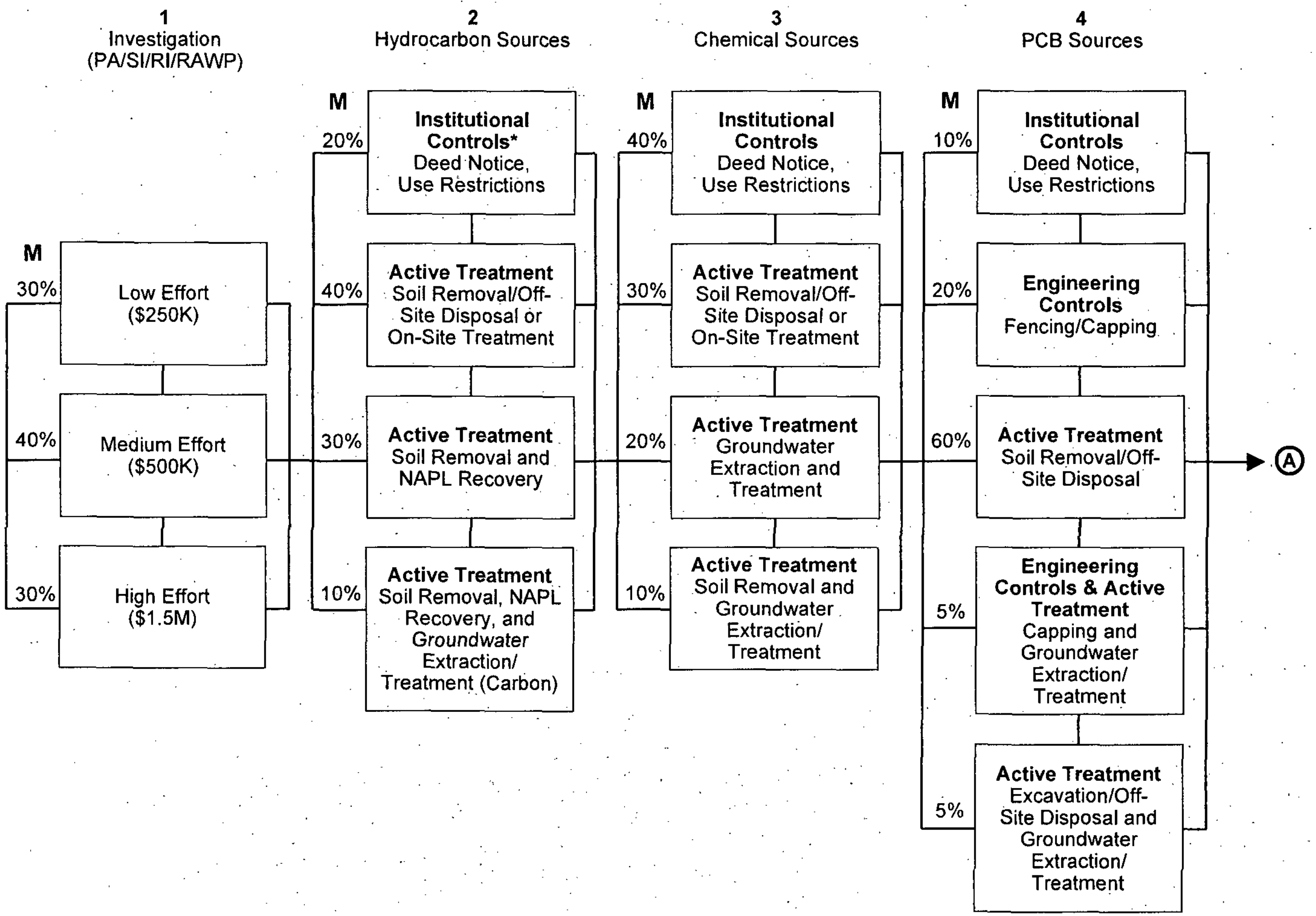
Table 3-2: Liability Characterization—Salem Generating Station *(continued)*

			Remedy Intensity			Remedy Scale		
Issue	**Element**	**Number of Units**	**Impact Potential**	**Mitigating Factors**	**Intensity**	**Scale per Unit**	**Volume (c.y.)**	**Area (s.f.)**
	Miscellaneous Spills	1	Potential pathway to groundwater and Delaware River	None	M	Default scale of 100 cy/ station. Assume depth of 3 feet and surface area of 900 sf/ station.	100	900
Total		**3**			**M**		**300**	**2,700**
PCB Sources								
	Oil-Containing Electric T&D Equipment	7	Potential pathway to groundwater and Delaware River and to Station personnel	• Presence of traprock or containment limits impact to soil. Total: 1	M	Default scale of 60 cy/ station. Assume depth of 3 feet and surface area of 540 sf/ station.	420	3,780
	Gas Condensate Blowdown	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total		**7**			**M**		**420**	**3,780**

Table 3-2: Liability Characterization—Salem Generating Station *(continued)*

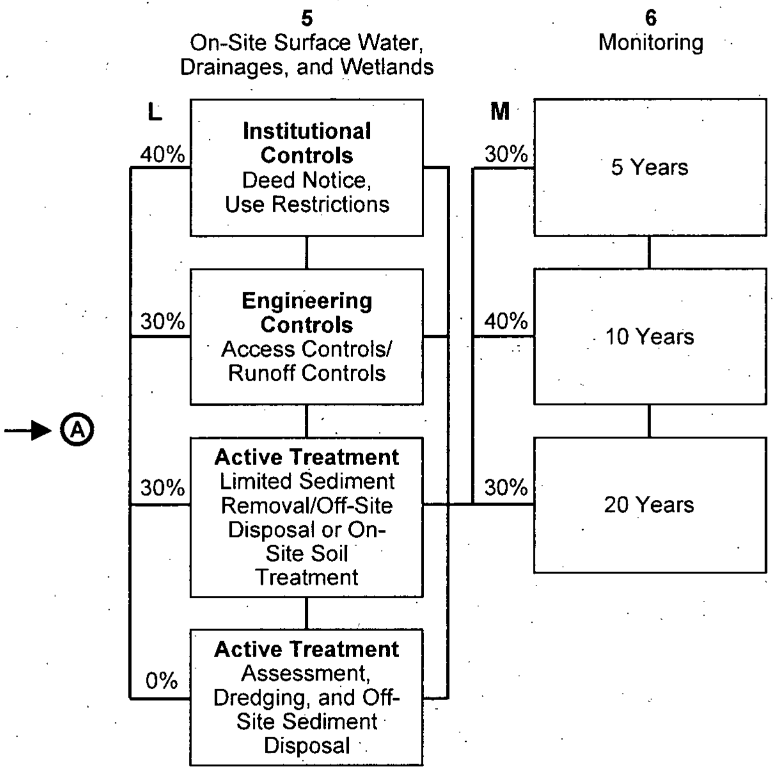
			Remedy Intensity			Remedy Scale		
Issue	**Element**	**Number of Units**	**Impact Potential**	**Mitigating Factors**	**Intensity**	**Scale per Unit**	**Volume (c.y.)**	**Area (s.f.)**
On-Site Fill								
	Historic Fill	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Ash Fill	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Dredge Spoils	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total		**N/A**			**N/A**		**N/A**	**N/A**
On-Site Surface Water, Drainages, and Wetlands		**1**	Potential pathway to wetland ecological communities	• No visual indication of stress or impact. • Receives tidal flushing. Total: 2	**L**	100% of on-site water, drainage, and wetlands area downgradient from potential sources. Assume depth of 2 feet and 10% of total volume for remediation.	**32**	**4,375**
Monitoring		**N/A**	N/A	N/A	**M** Average remedy intensity is medium.	12 wells (4 liability issues)	**N/A**	**N/A**

Table 3-3: Liability Decision Tree—Salem Generating Station



*Institutional controls are also assumed as a component of all engineering controls and active treatment remedies.

Table 3-3: Liability Decision Tree—Salem Generating Station *(continued)*



*Institutional controls are also assumed as a component of all engineering controls and active treatment remedies.

Table 3-4: Liability Valuation—Salem Generating Station

Item 1 - Investigation				Item 4 - Hydrocarbon Sources			
Scenario	Cost U.S. $	Prob. M	Expected Value U.S. $	Scenario	Cost U.S. $	Prob. M	Expected Value U.S. $
Low Effort	$ 238,318	0.30	$ 71,495	Institutional Controls	$ 11,396	0.20	$ 2,279
Medium Effort	$ 476,636	0.40	$ 190,654	Soil Removal/Off-Site Disposal or On-Site Treatment	$ 214,070	0.40	$ 85,628
High Effort	$ 1,429,907	0.30	$ 428,972	Soil Removal and NAPL Recovery	$ 270,362	0.30	$ 81,109
				Soil Removal, NAPL Recovery, and Groundwater Extraction /Treatment (Carbon)	$ 1,556,661	0.10	$ 155,666
		1.00	$ 691,121			1.00	$ 324,682

Item 5 - Chemical Sources				Item 6 - PCB Sources			
Scenario	Cost U.S. $	Prob. M	Expected Value U.S. $	Scenario	Cost U.S. $	Prob. M	Expected Value U.S. $
Institutional Controls	$ 11,396	0.40	$ 4,558	Institutional Controls	$ 11,396	0.10	$ 1,140
Soil Removal/Off-Site Disposal or On-Site Treatment	$ 173,164	0.30	$ 51,949	Fencing/Capping	$ 41,025	0.20	$ 8,205
Groundwater Extraction and Treatment	$ 1,276,755	0.20	$ 255,351	Soil Removal/Off-Site Disposal	$ 115,278	0.60	$ 69,167
Soil Removal and Groundwater Extraction/Treatment	$ 1,450,085	0.10	$ 145,008	Capping and Groundwater Extraction/Treatment	$ 1,317,781	0.05	$ 65,889
				Excavation/Off-Site Disposal and Groundwater Extraction/Treatment	$ 1,392,198	0.05	$ 69,610
		1.00	$ 456,867			1.00	$ 214,010

Item 8 - On-Site Surface Water, Drainages, and Wetlands				Item 9 - Monitoring				Total Expected Value
Scenario	Cost U.S. $	Prob. L	Expected Value U.S. $	Scenario	Cost U.S. $	Prob. M	Expected Value U.S. $	
Institutional Controls	$ 7,517	0.40	$ 3,007	Monitoring - 5 years	$ 97,580	0.30	$ 29,274	
Access Controls/ Runoff Controls	$ 127,006	0.30	$ 38,102	Monitoring - 10 years	$ 147,096	0.40	$ 58,838	
Limited Sediment Removal/Off-Site Disposal or On-Site Soil Treatment	$ 67,086	0.30	$ 20,126	Monitoring - 20 years	$ 216,759	0.30	$ 65,028	
Assessment, Dredging, and Off-Site Sediment Disposal	$ 341,780	0.00						
		1.00	$ 61,235			1.00	$ 153,140	$ 1,901,055

Discount Rate	**7%**
Inflation Rate	**2%**
Start Year of Remediation	**4**

Appendix C

Well Details (Boring Logs, Well Completion Details, Well Completion Details, Well Completion Records, and Survey Form Bs)

ARCADIS

Sample/Core Log

Boring/Well Well M

Project/No. PSEG Nuclear, LLC Salem Generrating Station/NP000571.0002 Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 5/3/2003

Drilling Completed 5/3/2003

Total Depth Drilled 20.0 Feet

Hole Diameter 5.25 inches

Type of Sample/ Coring Device NA

Length and Diameter of Coring Device 5.25 inches by 5.0 feet hollow-stem augers

Sampling Interval NA feet

Land-Surface Elev. 99.26 feet ☒ Surveyed ☐ Estimated

Datum Plant Datum

Drilling Fluid Used None

Drilling Method Hollow Stem Auger

Drilling Contractor CT&E Environmental Services, Inc.

Driller Nick

Helper Larry

Prepared By Jon Rutledge

Hammer Weight NA

Hammer Drop NA inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
0.0	10.0	--	--	--	Borehole advanced to 10.0 feet below ground surface using vacuum excavation.
11.5	20.0	--	--	--	SAND, medium, brown, some silt, wet, slight hydrocarbon odor.
					Description from cuttings.
20.0					End of boring. Boring completed as Monitoring Well M.

ARCADIS

Sample/Core Log

Boring/Well Well R

Project/No. PSEG Nuclear, LLC Salem Generrating Station / NP000571.0002 Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 6/3/2003

Drilling Completed 6/3/2003

Total Depth Drilled 19.0 Feet

Hole Diameter 3.25 inches

Type of Sample/ Coring Device NA

Length and Diameter of Coring Device 3.25 inches by 4.0 feet

Sampling Interval NA feet

Land-Surface Elev. 99.82 feet ☒ Surveyed ☐ Estimated

Datum Plant Datum

Drilling Fluid Used None

Drilling Method Direct Push

Drilling Contractor CT&E Environmental Services, Inc.

Driller Jeff

Helper Steve

Prepared By Jon Rutledge

Hammer Weight NA

Hammer Drop NA inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
0.0	3.0	--	--	--	Description from cuttings: SAND, reddish to yellowish orange, some silt, clay and
					gravel.
3.0	12.0	--	--	--	Description from cuttings: CLAY, yellowish orange, some sand (fine to medium).
					Borehole advanced to 12.0 feet below ground surface using vacuum excavation.
12.0	19.0	--	--	--	Boring advanced from 12.0 feet to 19.0 feet using direct push process.
					A sample/core desription was unable to be observed between 12.0 and
					19.0' due to the nature of the direct push process.
19.0					End of boring. Boring completed as Monitoring Well R.

ARCADIS

Sample/Core Log

Boring/Well Well S

Project/No. PSEG Nuclear, LLC Salem Generrating Station/NP000571.0002 Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 5/29/2003

Drilling Completed 5/29/2003

Total Depth Drilled 36.0 Feet

Hole Diameter 2 inches

Type of Sample/ Coring Device Split-Spoon

Length and Diameter of Coring Device 2 feet by 2 inches

Sampling Interval 5 feet

Land-Surface Elev. 99.61 feet ☒ Surveyed ☐ Estimated

Datum Plant Datum

Drilling Fluid Used None

Drilling Method Hollow Stem Auger

Drilling Contractor CT&E Environmental Services, Inc.

Driller Marc

Helper Steve

Prepared By Jon Rutledge

Hammer Weight 140 pounds

Hammer Drop 36 inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
					0.0 - 9.5' Vacuum excavation to identify subsurface utilities
9.5	11.5	2.0	7-9-11-15	0.0	9.5 - 14.0' orange, silty medium SAND with gravel
14.0	16.0	1.9	12-15-16-17	0.0	14.0 - 19.0' tan, clayey medium SAND with gravel
19.0	21.0	2.0	8-9-13-15	0.0	19.0 - 20.7' light brown, medium SAND with gravel
					20.7 - 24.0' gray, medium SAND with gravel
24.0	26.0	2.0	140 lbs/0.9'-2-3	0.0	24.0 - 25.7' gray, CLAY with trace fine sand and mica
					25.7 - 26.0' gray, fine sandy CLAY with trace mica
29.0	31.0	2.0	140 lbs/0.5'-2-1-2	1.0	26.0 - 34.4' gray, CLAY with trace fine sand and mica
34.0	36.0	2.0	2-2-8-14	0.0	34.4 - 36.0' gray, medium SAND with gravel and trace mica
					36.0' End of Boring

ARCADIS

Sample/Core Log

Boring/Well Well T

Project/No. PSEG Nuclear, LLC Salem Generrating Station/NP000571.0002 Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 6/5/2003

Drilling Completed 6/5/2003

Total Depth Drilled 35.5 Feet

Hole Diameter 2 inches

Type of Sample/ Coring Device Split-Spoon

Length and Diameter of Coring Device 2 feet by 2 inches

Sampling Interval 5 feet

Land-Surface Elev. 100.97 feet ☒ Surveyed ☐ Estimated

Datum Plant Datum

Drilling Fluid Used None

Drilling Method Hollow Stem Auger

Drilling Contractor CT&E Environmental Services, Inc.

Driller Marc

Helper Steve

Prepared By Jon Rutledge

Hammer Weight 140 pounds

Hammer Drop 36 inches

Sample/Core Depth (feet below land surface)		Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
From	To				
					0.0 - 9.5' Vacuum excavation to identify subsurface utilities
9.5	11.5	2.0	2-2-2-2	0.0	9.5 - 14.9' gray, CLAY with trace fine sand and mica
14.5	16.5	2.0	5-4-3-3	0.0	14.9 - 15.4' gray, medium SAND with trace clay and mica
19.5	21.5	2.0	1-2-2-3	0.0	15.4 - 26.0' gray, CLAY with trace fine sand and mica
24.5	26.5	2.0	1-2-2-4	0.0	26.0 - 26.5' gray, fine sandy CLAY with trace mica
29.5	31.5	2.0	3-3-21-50	0.0	
31.5	33.5	2.0	25-30-20-15	0.0	26.5 - 33.2' gray, medium SAND with gravel and trace mica
33.5	35.5	0.0	140 lbs/2.0'	NA	33.2 - 33.5' gray, CLAY with trace mica
					35.5' End of Boring

ARCADIS

Sample/Core Log

Boring/Well Well U

Project/No. PSEG Nuclear, LLC Salem Generrating Station/NP000571.0002 Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 5/28/2003

Drilling Completed 5/28/2003

Total Depth Drilled 36.0 Feet

Hole Diameter 2 inches

Type of Sample/ Coring Device Split-Spoon

Length and Diameter of Coring Device 2 feet by 2 inches

Sampling Interval 5 feet

Land-Surface Elev. 99.54 feet ☒ Surveyed ☐ Estimated

Datum Plant Datum

Drilling Fluid Used None

Drilling Method Hollow Stem Auger

Drilling Contractor CT&E Environmental Services, Inc.

Driller Marc

Helper Steve

Prepared By Jon Rutledge

Hammer Weight 140 pounds

Hammer Drop 36 inches

Sample/Core Depth (feet below land surface)		Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
From	To				
					0.0 - 9.0' Vacuum excavation to identify subsurface utilities
9.0	11.0	2.0	7-3-4-4	78.1	9.0 - 9.7 black, fine sandy SILT with trace mica; hydrocarbon odor
					9.7 - 14.0' gray, silty fine SAND with trace mica; hydrocarbon odor
14.0	16.0	2.0	5-4-3-3	38.5	14.0 - 20.0' gray, fine SAND with trace silt and mica; hydrocarbon odor
19.0	21.0	2.0	1-2-1-2	7.6	20.0 - 29.0' gray, fine sandy CLAY with trace mica
24.0	26.0	2.0	2-2-1-2	7.2	
29.0	31.0	2.0	16-20-28-30	20.2	29.0 - 32.0' gray, medium SAND with gravel
34.0	36.0	1.7	11-7-6-8	8.6	32.0 - 36.0' gray, CLAY with trace fine sand and mica
					36.0' End of Boring

ARCADIS

Sample/Core Log

Boring/Well Well V

Project/No. PSEG Nuclear, LLC Salem Generrating Station/NP000571.0002 Page 1 of 2

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 6/6/2003

Drilling Completed 6/12/2003

Total Depth Drilled 80.0 Feet

Hole Diameter 2 inches

Type of Sample/ Coring Device Split-Spoon

Length and Diameter of Coring Device 2 feet by 2 inches

Sampling Interval Continous

Land-Surface Elev. 99.16 feet ☒ Surveyed ☐ Estimated

Datum Plant Datum

Drilling Fluid Used None

Drilling Method Mud Rotary

Drilling Contractor CT&E Environmental Services, Inc.

Driller Marc

Helper Steve

Prepared By Jon Rutledge

Hammer Weight 140 pounds

Hammer Drop 36 inches

Sample/Core Depth (feet below land surface)		Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
From	To				
					0.0 - 10.0' Vacuum excavation to identify subsurface utilities
10.0	12.0	2.0	1-1-3-2	0.0	10.0 - 12.0' gray, fine sandy CLAY with trace mica
12.0	14.0	2.0	3-1-1-2	0.0	12.0 - 14.0' gray, fine sandy CLAY with trace mica
14.0	16.0	2.0	3-3-1/1.0'	0.0	14.0 - 16.0' gray, CLAY with trace medium sand and mica
16.0	18.0	2.0	3-1-1-3	0.0	16.0 - 18.0' gray, CLAY with trace fine sand and mica
18.0	20.0	2.0	140 lbs./1.0'-2-1	0.0	18.0 - 20.0' gray, CLAY with trace fine sand and mica
20.0	22.0	2.0	1-2-2-2	0.0	20.0 - 22.0' gray, CLAY with trace fine sand and mica
22.0	24.0	2.0	140 lbs./1.0'-3-3	0.0	22.0 - 24.0' gray, CLAY with trace fine sand and mica
24.0	26.0	2.0	3-2-3-2	0.0	24.0 - 26.0' gray, CLAY with trace fine sand and mica
26.0	28.0	2.0	140 lbs./1.0'-3-3	0.0	26.0 - 28.0' gray, fine sandy CLAY with trace mica
28.0	30.0	2.0	3-2-2-3	0.0	28.0 - 30.0' gray, fine sandy CLAY with trace mica
30.0	32.0	2.0	8-9-11-15	0.0	30.0 - 31.3' gray, fine sandy CLAY with organic material
					31.3 - 32.0' gray, medium SAND
32.0	34.0	2.0	15-20-25-23	0.0	32.0 - 33.5' gray, silty medium SAND
					33.5 - 33.6' purple, fine SAND with gravel
					33.6 - 34.0' brown, medium to coarse SAND with gravel
34.0	36.0	1.0	20-18-15-9	0.0	34.0 - 36.0' gray, medium to coarse SAND with gravel
36.0	38.0	2.0	6-6-8-15	0.0	36.0 - 36.8' gray, medium to coarse SAND with gravel
					36.8 - 38.0' gray, CLAY
38.0	40.0	0.5	7-8-8-10	0.0	38.0 - 40.0' gray, GRAVEL with trace clay

ARCADIS GERAGHTY & MILLER

Sample/Core Log (Cont.d)

Boring/Well Well V

Page 2 of 2

Prepared by Jon Rutledge

Sample/Core Depth (feet below land surface)		Core Recovery (feet)		PID Reading (ppm)	Sample/Core Description
From	To				
40.0	42.0	2.0	7-7-8-12	0.0	40.0 - 42.0' gray, CLAY with trace silt and gravel
42.0	44.0	2.0	5-7-9-12	0.0	42.0 - 44.0' gray, CLAY with trace silt
44.0	46.0	2.0	7-9-12-12	0.0	44.0 - 44.6' gray, GRAVEL (cave-in)
					44.6 - 46.0' gray, CLAY with trace silt
46.0	48.0	2.0	9-9-10-13	0.0	46.0 - 46.2' gray, GRAVEL (cave-in)
					46.2 - 48.0' gray, CLAY with trace silt
48.0	50.0	2.0	6-8-9-10	0.0	48.0 - 50.0' gray, CLAY with trace silt
50.0	52.0	2.0	5-5-6-10	0.0	50.0 - 52.0' gray, CLAY with trace silt
52.0	54.0	2.0	10-11-12-13	0.0	52.0 - 53.6' gray, CLAY
					53.6 - 54.0' dark purple, silty sandy CLAY with trace mica
54.0	56.0	2.0	10-13-17-17	0.0	54.0 - 56.0' red, clayey fine SAND with trace mica
56.0	58.0	2.0	8-11-25-22	0.0	56.0 - 57.5' reddish gray, clayey fine SAND with trace mica
					57.5 - 58.0' reddish gray, fine SAND with trace mica
58.0	60.0	2.0	12-12-9-9	0.0	58.0 - 60.0' gray, fine SAND with trace mica
60.0	62.0	1.7	8-11-20-21	0.0	60.0 - 62.0' gray, fine SAND with trace mica
62.0	64.0	2.0	8-10-15-25	0.0	62.0 - 64.0' gray, fine SAND with trace silt and mica
64.0	66.0	0.9	24-24-18-10	0.0	64.0 - 66.0' gray, medium to coarse SAND with gravel
66.0	68.0	1.4	4-4-6-12	0.0	66.0 - 67.2' gray, medium to coarse SAND with gravel
					67.2 - 68.0' green, fine SAND with trace silt
68.0	70.0	1.5	15-15-13-23	0.0	68.0 - 70.0' grayish green, fine SAND with trace silt
70.0	72.0	2.0	16-16-20-22	0.0	70.0 - 72.0' green, fine SAND with trace silt and gravel
72.0	74.0	2.0	20-20-31-20	0.0	72.0 - 74.0' greenish black, fine to medium SAND with fragments of seashells
74.0	76.0	1.5	48-50/0.3'	0.0	74.0 - 76.0' dark green, fine SAND with trace fragments of seashells
76.0	78.0	2.0	30-18-23-30	0.0	76.0 - 78.0' olive green, fine SAND with trace silt
78.0	80.0	1.0	30-70-50/0.2'	0.0	78.0 - 80.0' olive green, fine SAND with trace silt
					80.0' End of Boring

ARCADIS

Sample/Core Log

Boring/Well Well W

Project/No. PSEG Nuclear, LLC Salem Generrating Station/NP000571.0002 Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 6/2/2003

Drilling Completed 6/3/2003

Total Depth Drilled 36.0 Feet

Hole Diameter 2 inches

Type of Sample/ Coring Device Split-Spoon

Length and Diameter of Coring Device 2 feet by 2 inches

Sampling Interval 5 feet

Land-Surface Elev. 99.36 feet ☒ Surveyed ☐ Estimated

Datum Plant Datum

Drilling Fluid Used None

Drilling Method Hollow Stem Auger

Drilling Contractor CT&E Environmental Services, Inc.

Driller Marc

Helper Steve

Prepared By Jon Rutledge

Hammer Weight 140 pounds

Hammer Drop 36 inches

Sample/Core Depth (feet below land surface)		Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
From	To				
					0.0 - 9.5' Vacuum excavation to identify subsurface utilities
9.5	11.5	1.6	15-20-22-22	0.0	9.5 - 16.2' brown, medium to coarse SAND with gravel
14.5	16.5	0.3	1/0.9'-2-2	0.0	16.2 - 18.0' gray, medum sandy CLAY
18.0	20.0	2.0	1/1.5'-2	0.0	
24.0	26.0	2.0	140 lbs/0.5-1-1-2	0.0	
29.0	31.0	1.9	140 lbs/2.0'	0.0	18.0 - 34.3' gray, CLAY with trace fine sand and mica
34.0	36.0	2.0	6-8-3-4	0.0	34.3 - 36.0' gray, clayey fine SAND
					36.0' End of Boring

ARCADIS

Sample/Core Log

Boring/Well Well Y

Project/No. PSEG Nuclear, LLC Salem Generating Station / NP000571.000

Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 9/27/2003

Drilling Completed 9/27/2003

Total Depth Drilled 40.0 Feet

Hole Diameter 9.0 inches

Type of Sample/ Coring Device Split-spoon (2-inches by 2-feet)

Length and Diameter of Coring Device 9.0-inch by 5.0-feet hollow-stem augers.

Sampling Interval 5.0 feet

Land-Surface Elev. 99.20 feet ☒ Surveyed ☐ Estimated

Datum NAVD 1988

Drilling Fluid Used None

Drilling Method Hollow-Stem Auger

Drilling Contractor A.C. Schultes, Inc.

Driller C. Warren

Helper W. Powers

Prepared By Christopher Sharpe

Hammer Weight 140 lbs

Hammer Drop 30 inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
0.0	10.0	--	--	--	Borehole advanced to 10 feet below ground surface using vacuum excavation.
14.0	16.0	2.0	1/0/1/0	--	SILT, dark gray, trace sand, fining with depth, wet.
19.0	21.0	2.0	0/0/1/1	--	SILT, dark gray, trace sand, stiffening with depth, wet.
24.0	26.0	1.5	1/3/4/5	--	SILT, dark gray, trace sand.
29.0	31.0	2.0	1/2/1/2	--	First 1.0 feet: SILT, dark gray; Next 1.0 feet: SILT, with clay and some sand,
--	--	--	--	--	sand increasing with depth.
34.0	36.0	2.0	2/3/5/6	--	First 1.0 feet: SILT, dark gray; Next 1.0 feet: CLAY, gray, stiff.
37.0	39.0	1.5	3/1/0/1	--	First 1.0 feet: SILT, dark gray; Next 0.5 feet: CLAY, gray and tan, stiff.
40.0	--	--	--	--	End of boring. Boring completed as Monitoring Well Y.

ARCADIS

Sample/Core Log

Boring/Well Well Z

Project/No. PSEG Nuclear, LLC Salem Generating Station / NP000571.0003 Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 9/30/2003

Drilling Completed 9/30/2003

Total Depth Drilled 38 Feet

Hole Diameter 9.0 inches

Type of Sample/ Coring Device Split-spoon (2-inches by 2-feet)

Length and Diameter of Coring Device 9.0-inch by 5.0-feet hollow-stem augers.

Sampling Interval 5.0 feet

Land-Surface Elev. 99.3 feet ☒ Surveyed ☐ Estimated

Datum NAVD 1988

Drilling Fluid Used None

Drilling Method Hollow-Stem Auger

Drilling Contractor A.C. Schultes, Inc.

Driller C. Warren Helper W. Powers

Prepared By Christopher Sharpe

Hammer Weight 140 lbs Hammer Drop 30 inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
0	10	--	--	--	Borehole advanced to 10 feet below ground surface using vacuum excavation.
15	17	2	2/1/1/1	--	SILT, dark gray with trace fine sand (diesel odor).
20	22	2	0/1/0/1	--	SILT, dark gray with trace fine sand.
25	27	2	0/0/2/1	--	CLAY, dark gray with some silt and trace fine sand.
27	29	2	1/2/2/2	--	SILT, dark gray with some clay and fine to medium sand,
--	--	--	--	--	coarsening with depth.
29	31	2	2/1/1/1	--	SILT, dark gray with some clay and trace sand.
--	--	--	--	--	(Distict 0.05 to 0.1 foot organic horizon @ 1.2 ft)
31	33	2	15/20/44/33	--	First 1.5 feet: SILT, dark gray with some clay and trace sand.
--	--	--	--	--	Next 0.25 foot: SAND with gravel.
--	--	--	--	--	Next 0.25 foot: SAND, brown, medium-fine.
33	35	2	10/11/29/44	--	First 0.25 foot: SAND, cemented gray
--	--	--	--	--	Next 1.75 feet: SAND, dark gray with gravel.
35	37	2	2/9/15/25	--	First 1.2 feet: SAND, dark gray silty.
--	--	--	--	--	Next 0.8 foot: SAND, brown with gravel.
37	--	--	--	--	End of boring. Boring completed as Monitoring Well Z.

ARCADIS

Sample/Core Log

Boring/Well Well AA Project/No. PSEG Nuclear, LLC Salem Generating Station / NP000571.000 Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 9/30/2003 Drilling Completed 9/30/2003

Total Depth Drilled 36.5 Feet Hole Diameter 9.0 inches Type of Sample/Coring Device Split-spoon (2-inches by 2-feet)

Length and Diameter of Coring Device 9.0-inch by 5.0-feet hollow-stem augers. Sampling Interval 5.0 feet

Land-Surface Elev. 99.20 feet ☒ Surveyed ☐ Estimated Datum NAVD 1988

Drilling Fluid Used None Drilling Method Hollow-Stem Auger

Drilling Contractor A.C. Schultes, Inc. Driller C. Warren Helper W. Powers

Prepared By Christopher Sharpe Hammer Weight 140 lbs Hammer Drop 30 inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
0	10	--	--	--	Borehole advanced to 10 feet below ground surface using vacuum excavation.
15	17	1.5	4/8/12/19	--	SAND, tan, with gravel and silt.
20	22	1.9	3/7/14/22	--	SAND, tan, with gravel and silt.
25	27	2	5/12/16/33	--	SAND, tan, with gravel and silt.
30	32	1.8	1/2/6/14	--	SAND, tan, with gravel and silt.
35	37	2	8/6/7/8	--	First 1.0 foot: SAND, tan, with gravel and silt.
--	--	--	--	--	Next 1 foot: CLAY, stiff gray (Kirkwood).
36.5	--	--	--	--	End of boring. Boring completed as Monitoring Well AA.

ARCADIS

Sample/Core Log

Boring/Well Well AB

Project/No. PSEG Nuclear, LLC Salem Generating Station / NP000571.000

Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 10/2/2003

Drilling Completed 10/2/2003

Total Depth Drilled 43 Feet

Hole Diameter 9.0 inches

Type of Sample/ Coring Device Split-spoon (2-inches by 2-feet)

Length and Diameter of Coring Device 9.0-inch by 5.0-feet hollow-stem augers.

Sampling Interval 5.0 feet

Land-Surface Elev. 99.10 feet

☒ Surveyed ☐ Estimated

Datum NAVD 1988

Drilling Fluid Used None

Drilling Method Hollow-Stem Auger

Drilling Contractor A.C. Schultes, Inc.

Driller C. Warren

Helper W. Powers

Prepared By Christopher Sharpe

Hammer Weight 140 lbs

Hammer Drop 30 inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
0	10	--	--	--	Borehole advanced to 10 feet below ground surface using vacuum excavation.
15	17	1.2	3/4/4/5	--	SAND, tan, with gravel and silt.
20	22	2	7/7/12/24	--	SAND, tan, with gravel and silt.
25	27	2	4/12/5/7	--	SAND, tan, with gravel and silt.
30	32	1.2	5/4/5/3	--	SAND, tan, with gravel and silt.
35	37	2	5/7/7/13	--	First 1.8 feeet: SAND, tan, with gravel and silt .
--	--	--	--	--	Next 0.4 foot: SAND, dark gray, medium (petroleum odor).
37	39	2	13/27/13/15	--	First 1.6 feet: SAND, tan, with gravel and silt .
--	--	--	--	--	Next 0.4 foot: SAND, dark gray, clayey.
39	41	2	8/8/8/11	--	First 0.3 foot: SAND, gray.
--	--	--	--	--	Next 1.4 feet: SAND, tan, with gravel and silt .
--	--	--	--	--	Next 0.3 foot: SAND, gray.
41	43	2	7/5/3/5	--	First 1 foot: SLOUGH.
--	--	--	--	--	Next 0.6 foot: SAND, gray, medium.
--	--	--	--	--	Next 0.3 foot: CLAY, gray, stiff.
43.0	--	--	--	--	End of boring. Boring completed as Monitoring Well AB.

ARCADIS

Sample/Core Log

Boring/Well Well AC

Project/No. PSEG Nuclear, LLC Salem Generating Station / NP000571.0003

Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 9/26/2003

Drilling Completed 9/26/2003

Total Depth Drilled 24.5 Feet

Hole Diameter 9.0 inches

Type of Sample/Coring Device Split-spoon (2-inches by 2-feet)

Length and Diameter of Coring Device 13.0-inch by 5.0-feet hollow-stem augers.

Sampling Interval 5.0 feet

Land-Surface Elev. 99.00 feet ☒ Surveyed ☐ Estimated

Datum NAVD 1988

Drilling Fluid Used None

Drilling Method Hollow-Stem Auger

Drilling Contractor A.C. Schultes, Inc.

Driller C. Warren

Helper W. Powers

Prepared By Christopher Sharpe

Hammer Weight 140 lbs

Hammer Drop 30 inches

Sample/Core Depth (feet below land surface)		Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
From	To				
0	10	--	--	--	Borehole advanced to 10 feet below ground surface using vacuum excavation.
10	12	1.6	5/7/6/6	--	SAND, tan, with gravel and silt.
15	17	1.6	4/13/10/17	--	SAND, tan, with gravel and silt.
20	22	2	3/5/8/10	--	First 1.8 feet: SAND, tan, with gravel and silt .
--	--	--	--	--	Next 0.2 foot: SAND, gray, coarse-medium with red-brown clay.
22	24	2	4/3/5/6	--	First 1.5 feet: SAND, tan, with gravel and silt.
--	--	--	--	--	Next 0.5 feet: SAND, gray to brown, with gravel and silt.
24	24.5	0.2	NA	--	First 0.2 foot: Tan silt & sand w/ gravel.
--	--	--	--	--	Refusal.
24.5	--	--	--	--	End of boring. Boring completed as Monitoring Well AC.

ARCADIS

Sample/Core Log

Boring/Well Well AD

Project/No. PSEG Nuclear, LLC Salem Generating Station / NP000571.000

Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 10/3/2003

Drilling Completed 10/3/2003

Total Depth Drilled 44 Feet

Hole Diameter 9.0 inches

Type of Sample/ Coring Device Split-spoon (2-inches by 2-feet)

Length and Diameter of Coring Device 9.0-inch by 5.0-feet hollow-stem augers.

Sampling Interval 5.0 feet

Land-Surface Elev. 99.10 feet ☒ Surveyed ☐ Estimated

Datum NAVD 1988

Drilling Fluid Used None

Drilling Method Hollow-Stem Auger

Drilling Contractor A.C. Schultes, Inc.

Driller C. Warren

Helper W. Powers

Prepared By Christopher Sharpe

Hammer Weight 140 lbs

Hammer Drop 30 inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
0	10	--	--	--	Borehole advanced to 10 feet below ground surface using vacuum excavation.
15	17	2	1/0/0/1	--	CLAY, dark gray with silt and organic material.
20	22	2	0/0/0/0	--	CLAY, dark gray with silt and organic material.
25	27	2	1/0/1/1	--	First 1 foot: CLAY, dark gray with silt and organic material.
--	--	--	--	--	Next 1 foot: SAND, dark gray with silt.
30	32	2	0/1/2/1	--	CLAY, dark gray with silt and organic material (phragmites).
--	--	--	--	--	First 1 foot: SILT, dark gray with sand.
--	--	--	--	--	Next 1 foot: SAND, dark gray, with silt.
37	39	2	3/7/8/5	--	First 1 foot: CLAY, dark gray, sandy.
--	--	--	--	--	Next 1 foot: SAND, gray to brown with gravel.
39	41	2	9/12/6/5	--	First 0.5 foot: SLOUGH.
--	--	--	--	--	Next 0.5 foot: SAND, gray, interbedded with dark gray organic material
--	--	--	--	--	(rhythmites).
--	--	--	--	--	Next 0.5 foot: CLAY, dark gray.
--	--	--	--	--	Next 0.5 foot: SAND, tan, medium.
41	43	2	3/5/5/5	--	First 1 foot: SAND, gray to brown with gravel.
--	--	--	--	--	Next 1 foot: CLAY, dark gray, stiff.
44.0	--	--	--	--	End of boring. Boring completed as Monitoring Well AD.

ARCADIS

Sample/Core Log

Boring/Well Well AE

Project/No. PSEG Nuclear, LLC Salem Generating Station / NP000571.0003

Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 10/2/2003

Drilling Completed 10/2/2003

Total Depth Drilled 28 Feet

Hole Diameter 9.0 inches

Type of Sample/ Coring Device Split-spoon (2-inches by 2-feet)

Length and Diameter of Coring Device 9.0-inch by 5.0-feet hollow-stem augers.

Sampling Interval 5.0 feet

Land-Surface Elev. 99.30 feet ☒ Surveyed ☐ Estimated

Datum NAVD 1988

Drilling Fluid Used None

Drilling Method Hollow-Stem Auger

Drilling Contractor A.C. Schultes, Inc.

Driller C. Warren

Helper W. Powers

Prepared By Christopher Sharpe

Hammer Weight 140 lbs

Hammer Drop 30 inches

Sample/Core Depth (feet below land surface)		Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
From	To				
0	10	--	--	--	Borehole advanced to 10 feet below ground surface using vacuum excavation.
15	17	2	8/9/18/20	--	SAND, tan, with gravel and silt.
20	22	2	14/14/25/32	--	SAND, tan, with gravel and silt.
22	24	2	10/7/13/18	--	SAND, tan, with gravel and silt.
24	26	2	6/13/21/20	--	SAND, tan, with gravel and silt.
26	28	1.5	15/16/34/30	--	First 1.6 feet: SAND, tan, with gravel and silt.
--	--	--	--	--	Next 0.1 foot: CONCRETE chips, w gravel.
28.0	--	--	--	--	End of boring. Boring completed as Monitoring Well AE.

ARCADIS

Sample/Core Log

Boring/Well Well AF

Project/No. PSEG Nuclear, LLC Salem Generating Station / NP000571.0003

Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 10/1/2003

Drilling Completed 10/1/2003

Total Depth Drilled 49.0 Feet

Hole Diameter 9.0 inches

Type of Sample/ Coring Device Split-spoon (2-inches by 2-feet)

Length and Diameter of Coring Device 9.0-inch by 5.0-feet hollow-stem augers.

Sampling Interval 5.0 feet

Land-Surface Elev. 99.20 feet ☒ Surveyed ☐ Estimated

Datum NAVD 1988

Drilling Fluid Used None

Drilling Method Hollow-Stem Auger

Drilling Contractor A.C. Schultes, Inc.

Driller C. Warren

Helper W. Powers

Prepared By Christopher Sharpe

Hammer Weight 140 lbs

Hammer Drop 30 inches

Sample/Core Depth (feet below land surface)		Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
From	To				
0	10	--	--	--	Borehole advanced to 10 feet below ground surface using vacuum excavation.
15	17	1.4	0/4/4/2	--	SAND, tan, with gravel and silt.
20	22	1.5	4/3/8/14	--	SAND, tan, with gravel and silt.
25	27	2	3/6/10/9	--	First 0.6 foot: SAND, tan, with gravel and silt.
--	--	--	--	--	Next 0.6 foot: SAND, gray, with gravel and clay.
--	--	--	--	--	Next 0.6 foot: SAND, tan, with gravel and silt.
30	32	2	2/1/2/2	--	First 0.33 foot: Tan silt & sand w/ gravel. Next1 foot gray clay,
--	--	--	--	--	Next 0.66 foot gray silty sand.
32	34	2	4/9/13/13	--	First 0.66 foot: CLAY, gray with sand.
--	--	--	--	--	Next 0.6 foot: SAND, dark gray, clayey.
--	--	--	--	--	Next 0.6 foot: SAND, gray.
34	36	2	5/6/5/37	--	SAND, gray with red gravel at the tip.
36	38	2	16/16/13/22	--	SAND, gray, medium.
38	40	2	7/6/9/20	--	SAND, gray with greenish sand at tip.
40	42	2	10/13/24/24	--	SAND, gray with greenish sand at tip.
43	45	2	8/8/8/6	--	SAND, dark gray with gravel.
45	47	2	3/5/5/7	--	First 1.5 feet: SAND, silty with some gravel.
--	--	--	--	--	Next 0.25 foot: SAND, greenish.
--	--	--	--	--	Next 0.25 foot: CLAY, gray.
47	49	2	5/4/5/6	--	First 1 foot: SLOUGH (loose sand, silt & clay). Next 1 foot: CLAY dark gray.
49.0	--	--	--	--	End of boring. Boring completed as Monitoring Well AF.

ARCADIS

Sample/Core Log

Boring/Well Well AG-Shallow and Deep Project/No. PSEG Nuclear, Salem Generating Station/NP000571.0003 Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey Drilling Started 2/9/2004 Drilling Completed 02/09/04

Total Depth Drilled 40.0 Feet Hole Diameter 7 inches Type of Sample/ Coring Device Split-Spoon

Length and Diameter of Coring Device 2 feet by 2 inches Sampling Interval 5 feet

Land-Surface Elev. feet ☒ Surveyed ☐ Estimated Datum NAD 83

Drilling Fluid Used None Drilling Method Hollow Stem Auger

Drilling Contractor Talon Drilling Company Driller Joe A. Helper Bill B.

Prepared By Jon Rutledge Hammer Weight 140 pounds Hammer Drop 36 inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
					0.0 - 10.0' Vacuum excavation to identify subsurface utilities
10.0	12.0	NR	4-2-3-3	NA	10.0 - 18.0' Tan, fine to medium SAND, well sorted, wet
13.0	15.0	1.2	4-3-3-3	0.0	
18.0	20.0	1.0	7-5-4-3	0.0	18.0 - 24.7' Tan, fine to medium SAND, well sorted, trace silt, wet
23.0	25.0	0.8	3-2-1-2	0.0	24.7 - 28.0' Black, silty fine SAND, well sorted, wet
28.0	30.0	2.0	1-2-1-2	0.0	28.0 - 29.1' Grey, fine SAND, well sorted, trace silt, wet
					29.1 - 33.0' Black to grey, fine sandy, well sorted, SILT with gravel, wet,
					organic odor
33.0	35.0	NR	5-5-6-5	NA	33.0 - 38.0' Black, fine SAND and SILT with GRAVEL, wet
38.0	40.0	1.5	6-6-5-5	0.0	38.0 - 39.2' Dark grey, fine SAND, well sorted, trace silt, wet
					39.2 - 39.6' Grey, silty fine to coarse SAND, poorly sorted, with gravel, wet
					39.6 - 40.0' Grey, silty fine sandy CLAY with gravel, wet
					40.0' End of boring

ARCADIS

Sample/Core Log

Boring/Well Well AH-Shallow and Deep Project/No. PSEG Nuclear, Salem Generating Station/NP000571.0003 Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 2/4/2004 Drilling Completed 02/04/04

Total Depth Drilled 40.0 Feet Hole Diameter 7 inches Type of Sample/ Coring Device Split-Spoon

Length and Diameter of Coring Device 2 feet by 2 inches Sampling Interval 5 feet

Land-Surface Elev. ______ feet ☒ Surveyed ☐ Estimated Datum NAD 83

Drilling Fluid Used None Drilling Method Hollow Stem Auger

Drilling Contractor Talon Drilling Company Driller Joe A. Helper Bill B.

Prepared By Jon Rutledge Hammer Weight 140 pounds Hammer Drop 36 inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
					0.0 - 10.0' Vacuum excavation to identify subsurface utilities
10.0	12.0	0.9	2-2-2-2	0.0	10.0 - 15.0' Tan, medium SAND, well sorted, trace silt, wet
15.0	17.0	1.5	3-2-1-2	0.0	15.0 - 25.0' Tan, medium SAND, well sorted, wet
20.0	22.0	0.8	2-2-2-140 lbs./0.5'	0.0	25.0 - 30.0' Light grey to tan, fine to medium SAND, well sorted, trace gravel,
25.0	27.0	0.7	3-2-140 lbs./1.0'	0.0	wet
30.0	32.0	2.0	Rods/0.5'-8-11-20	0.0	30.0 - 32.7' Grey, fine to medium SAND, well sorted, trace silt, wet
					32.7 - 33.0' Black, GRAVEL, trace fine sand and silt, wet
33.0	35.0	0.2	4-1-2-1	0.0	33.0 - 39.5' Black, fine sandy SILT with gravel, wet
35.0	37.0	NR	Rods/2.0'	0.0	
38.0	40.0	1.5	3-5-6-6	0.0	39.5 - 40.0' Grey to black, medium to coarse SAND, poorly sorted, with gravel,
					trace silt, wet
					40.0' End of boring

ARCADIS

Sample/Core Log

Boring/Well Well AI

Project/No. PSEG Nuclear, Salem Generating Station/NP000571.0003

Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 1/20/2004

Drilling Completed 1/20/2004

Total Depth Drilled 22.0 Feet

Hole Diameter 10 inches

Type of Sample/ Coring Device Split-Spoon

Length and Diameter of Coring Device 2 feet by 2 inches

Sampling Interval 5 feet

Land-Surface Elev. ______ feet ☒ Surveyed ☐ Estimated

Datum NAD 83

Drilling Fluid Used None

Drilling Method Hollow Stem Auger

Drilling Contractor Talon Drilling Company

Driller Joe A.

Helper Joe K.

Prepared By Jon Rutledge

Hammer Weight 140 pounds

Hammer Drop 30 inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
					0.0 - 10.0' Vacuum excavation to identify subsurface utilities
10.0	12.0	1.2	9-16-19-18	0.0	10.0 - 15.0' Brown, fine to medium SAND, poorly sorted, with gravel and
					trace silt, wet
15.0	17.0	1.0	4-9-12-12	88.2	15.0 - 20.0' Brown, silty fine to medium SAND, poorly sorted, wet,
20.0	22.0	1.3	7-8-9-15	5.1	diesel fuel odor, sheen from 16.5 - 17.0'
					20.0 - 22.0' Brown, fine to medium SAND, poorly sorted, with trace silt, wet
					diesel fuel odor, sheen from 20.9 - 21.1'
					22.0' Auger refusal on lean concrete

ARCADIS

Sample/Core Log

Boring/Well Well AJ

Project/No. PSEG Nuclear, Salem Generating Station/NP000571.0003

Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 1/22/2004

Drilling Completed 1/22/2004

Total Depth Drilled 38.0 Feet

Hole Diameter 10 inches

Type of Sample/ Coring Device Split-Spoon

Length and Diameter of Coring Device 2 feet by 2 inches

Sampling Interval 5 feet

Land-Surface Elev. feet ☒ Surveyed ☐ Estimated

Datum NAD 83

Drilling Fluid Used None

Drilling Method Hollow Stem Auger

Drilling Contractor Talon Drilling Company

Driller Joe A.

Helper Not Applicable

Prepared By Jon Rutledge

Hammer Weight 140 pounds

Hammer Drop 30 inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
					0.0 - 10.0' Vacuum excavation to identify subsurface utilities
10.0	12.0	1.1	6-9-12-12	0.0	10.0 - 15.8' Orange to tan, fine to medium SAND, poorly sorted, with gravel
					and trace silt, wet
15.0	17.0	1.5	2-2-2-3	0.0	15.8 - 25.0' Black to grey, clayey fine sandy SILT with trace mica,
20.0	22.0	1.0	5-5-7-4	0.0	organic odor, wet
25.0	27.0	2.0	1-1-2-2	0.0	25.0 - 28.0' Black to grey, fine sandy clayey SILT with trace mica,
27.0	29.0	2.0	3-4-4-5	0.0	organic odor, wet
28.0	30.0	2.0	1-1-2-2	0.0	28.0 - 28.4' Brown, silty fine to medium SAND, poorly sorted, with gravel, wet
30.0	32.0	2.0	6-6-7-6	0.0	28.4 - 32.0' Grey, fine sandy silty CLAY with trace mica, wet
32.0	34.0	1.1	5-5-3-3	0.0	32.0 - 34.0' Grey, fine sandy silty CLAY with trace mica and gravel, wet
34.0	36.0	2.0	6-7-8-7	0.0	34.0 - 34.9' Grey, fine sandy silty CLAY, wet
36.0	38.0	2.0	7-7-8-10	0.0	34.9 - 35.2' Grey, silty clayey fine to medium SAND, poorly sorted, with gravel,
					wet
					35.2 - 38.0' Grey to brown, very stiff CLAY with trace mica,
					(Kirkwood Formation), wet
					38.0' End of boring

ARCADIS

Sample/Core Log

Boring/Well Well AL

Project/No. PSEG Nuclear, Salem Generating Station/NP000571.0003

Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 1/21/2004

Drilling Completed 1/21/2004

Total Depth Drilled 26.0 Feet

Hole Diameter 7 inches

Type of Sample/ Coring Device Split-Spoon

Length and Diameter of Coring Device 2 feet by 2 inches

Sampling Interval 5 feet

Land-Surface Elev. feet ☒ Surveyed ☐ Estimated

Datum NAD 83

Drilling Fluid Used None

Drilling Method Hollow Stem Auger

Drilling Contractor Talon Drilling Company

Driller Joe A.

Helper Not Applicable

Prepared By Jon Rutledge

Hammer Weight 140 pounds

Hammer Drop 30 inches

Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
					0.0 - 10.0' Vacuum excavation to identify subsurface utilities
9.0	11.0	0.5	2-2-4-5	0.0	11.0 - 21.0' Orange to brown, fine to medium SAND, poorly sorted, with gravel
15.0	17.0	1.2	9-7-6-5	0.0	and trace silt, wet
17.0	19.0	0.4	5-5-4-3	0.0	
19.0	21.0	0.8	7-8-9-11	0.0	
24.0	26.0	1.4	9-13-23-24	0.0	21.0 - 26.0' Orange to brown, silty fine to medium SAND, poorly sorted, with
					gravel, wet
					26.0' End of boring

ARCADIS

Sample/Core Log

Boring/Well Well AM

Project/No. PSEG Nuclear, Salem Generating Station/NP000571.0003

Page 1 of 1

Site Location Artificial Island, Hancock's Bridge, New Jersey

Drilling Started 1/152004

Drilling Completed 1/15/2004

Total Depth Drilled 20.9 Feet

Hole Diameter 10 inches

Type of Sample/ Coring Device Split-Spoon

Length and Diameter of Coring Device 2 feet by 2 inches

Sampling Interval 5 feet

Land-Surface Elev. ______ feet ☒ Surveyed ☐ Estimated

Datum NAD 83

Drilling Fluid Used None

Drilling Method Hollow Stem Auger

Drilling Contractor Talon Drilling Company

Driller Joe A.

Helper Joe K.

Prepared By Jon Rutledge

Hammer Weight 140 pounds

Hammer Drop 30 inches

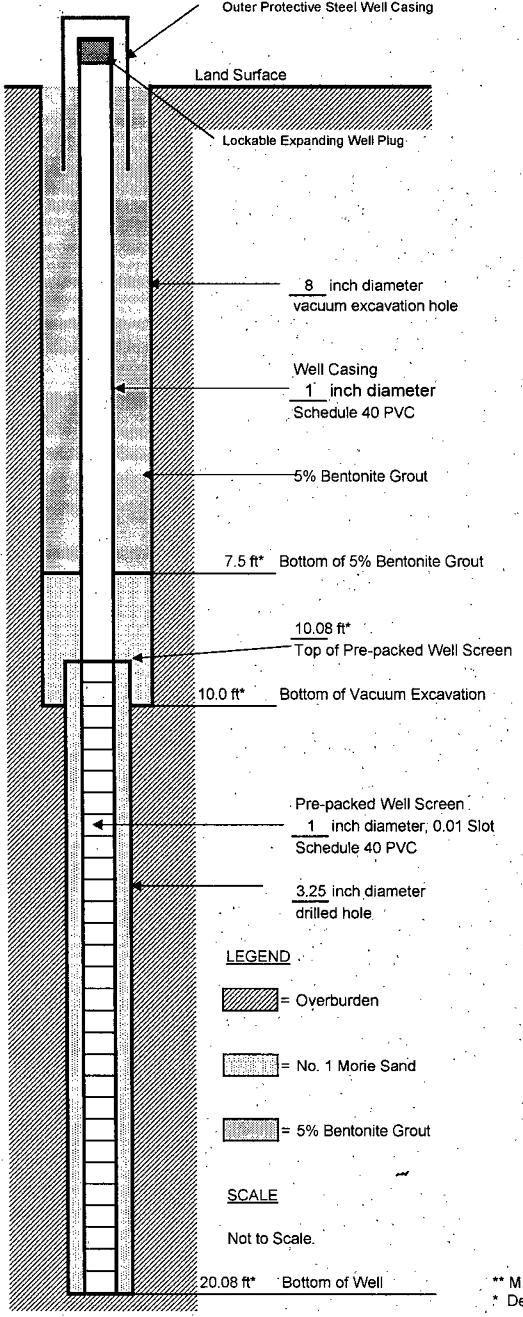
Sample/Core Depth (feet below land surface) From	To	Core Recovery (feet)	Blow Counts	PID Reading (ppm)	Sample/Core Description
					0.0 - 10.0' Vacuum excavation to identify subsurface utilities
10.0	12.0	1.2	9-13-12-8	0.0	10.0 - 16.5' Tan to orange, medium to coarse SAND, poorly sorted, with
15.0	17.0	1.1	4-16-17-34	0.0	gravel, wet
20.0	20.8	0.5	9-50/0.3'	0.0	16.5 - 20.0' Tan fine to medium sandy, poorly sorted, SILT, wet
					20.0 - 20.9' Grey, silty medium to coarse SAND, poorly sorted, wet
					20.9' Auger refusal on lean concrete

ARCADIS

Well Construction Log

(Unconsolidated)

Well Identification Well M



Project/No. PSEG Nuclear, LLC - Salem Generating Station/NP000571.0002

Site Location Salem Generating Station - Artificial Island

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 3400006990

Land-Surface Elevation 99.26 feet ☒ Surveyed

Top-of-Casing Elevation 102.17 feet ☐ Estimated

Datum New Jersey State Plane Coordinates NAD 83

Installation Date(s) May 5, 2003

Drilling Method Hollow Stem Auger

Drilling Contractor CT&E Environmental Services, Inc

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): Peristaltic pump on May 5, 2003. Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: 0 gallons

Water Removed During Development: 10 gallons

Static Depth to Water: NA feet below M.P.**

Pumping Depth to Water: NA feet below M.P.**

Pumping Duration: 0.75 hours

Yield: NA gpm Date: NA

Specific Capacity: NA gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Jon Rutledge

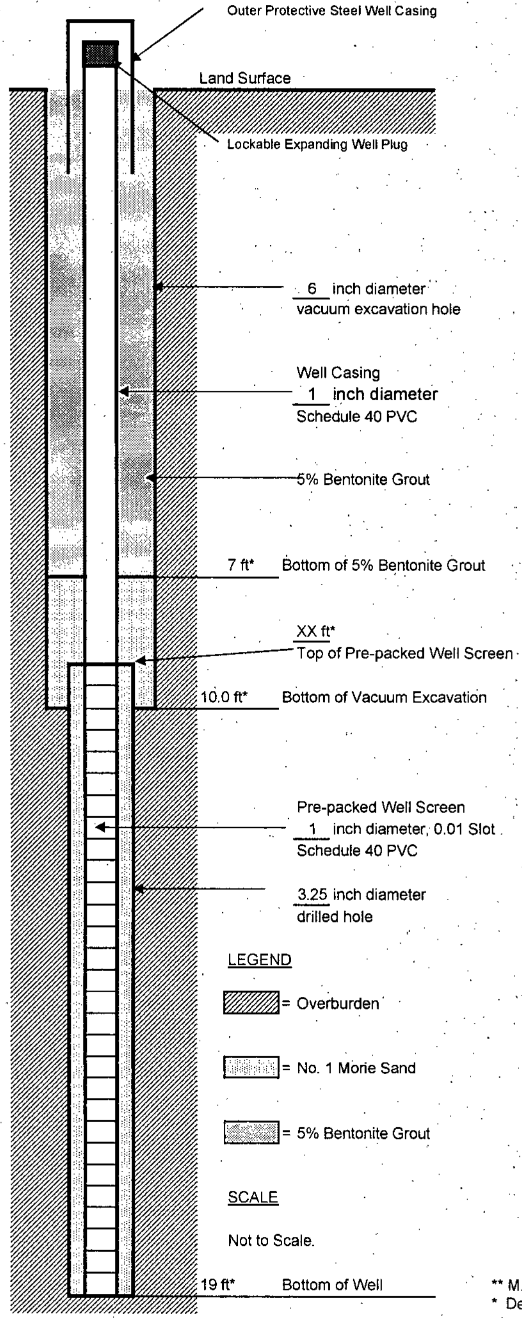
** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.
* Depth Below Land Surface

ARCADIS

Well Construction Log

(Unconsolidated)

Well Identification Well R



Project/No. PSEG Nuclear, LLC - Salem Generating Station/NP000571.0002

Site Location Salem Generating Station - Artificial Island

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 3400006991

Land-Surface Elevation 99.82 feet ☒ Surveyed

Top-of-Casing Elevation 102.35 feet ☐ Estimated

Datum New Jersey State Plane Coordinates NAD 83

Installation Date(s) June 6, 2003

Drilling Method Hollow Stem Auger

Drilling Contractor CT&E Environmental Services, Inc

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): Peristaltic pump on June 6, 2003. Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: 0 gallons

Water Removed During Development: 10 gallons

Static Depth to Water: 6.91 feet below M.P.**

Pumping Depth to Water: NA feet below M.P.**

Pumping Duration: 0.5 hours

Yield: NA gpm Date: NA

Specific Capacity: NA gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Jon Rutledge

** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.
* Depth Below Land Surface

ARCADIS

Well Construction Log

(Unconsolidated)

Well Identification Well S

Project/No. PSEG Nuclear, LLC - Salem Generating Station/NP000571.0002

Site Location Salem Generating Station - Artificial Island

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 3400006999

Land-Surface Elevation 99.61 feet ☒ Surveyed

Top-of-Casing Elevation 102.5 feet ☐ Estimated

Datum New Jersey State Plane Coordinates NAD 83

Installation Date(s) May 29 and 30, 2003

Drilling Method Hollow Stem Auger

Drilling Contractor CT&E Environmental Services, Inc

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): Peristaltic pump on June XX, 2003. Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: 0 gallons

Water Removed During Development: 22 gallons

Static Depth to Water: NA feet below M.P.**

Pumping Depth to Water: 9.77 feet below M.P.**

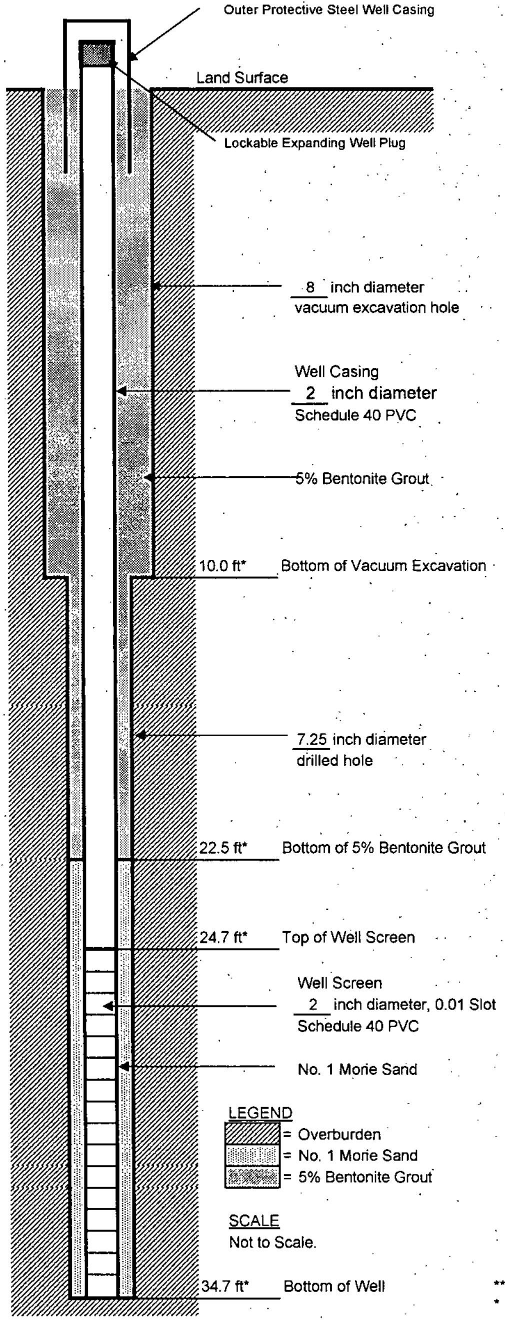
Pumping Duration: 0.9 hours

Yield: NA gpm Date: NA

Specific Capacity: NA gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.



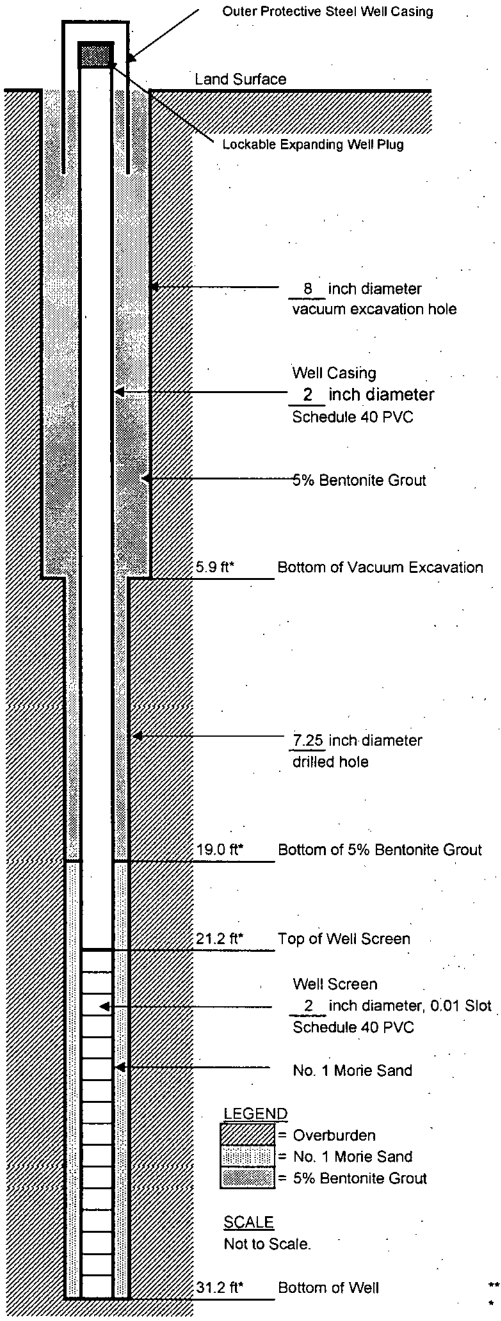
Prepared by: Jon Rutledge

** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.
* Depth Below Land Surface

ARCADIS

Well Construction Log
(Unconsolidated)

Well Identification: Well T



Project/No. PSEG Nuclear, LLC - Salem Generating Station/NP000571.0002

Site Location: Salem Generating Station - Artificial Island

Town/City: Hancock's Bridge

County: Salem State: New Jersey

Permit No. 3400006992

Land-Surface Elevation: 100.97 feet ☒ Surveyed

Top-of-Casing Elevation: 104.13 feet ☐ Estimated

Datum: New Jersey State Plane Coordinates NAD 83

Installation Date(s): June 5, 2003

Drilling Method: Hollow Stem Auger

Drilling Contractor: CT&E Environmental Services, Inc

Drilling Fluid: Not Applicable (NA)

Development Technique(s) and Date(s): Whale pump on June 13, 2003. Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: 0 gallons

Water Removed During Development: 35 gallons

Static Depth to Water: 11.33 feet below M.P.**

Pumping Depth to Water: NA feet below M.P.**

Pumping Duration: 0.5 hours

Yield: NA gpm Date: NA

Specific Capacity: NA gpm/ft

Well Purpose: Well installed to monitor groundwater quality.

Remarks: Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

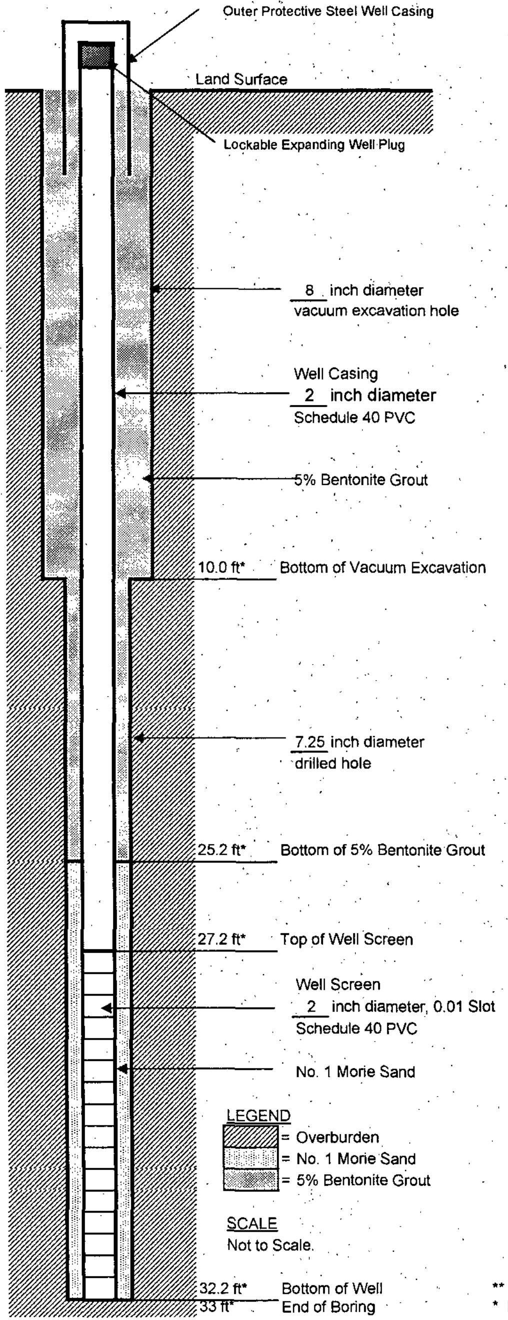
Prepared by: Jon Rutledge

** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.
* Depth Below Land Surface

ARCADIS

Well Construction Log
(Unconsolidated)

Well Identification Well U



Project/No. PSEG Nuclear, LLC - Salem Generating Station/NP000571.0002

Site Location Salem Generating Station - Artificial Island

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 3400006994

Land-Surface Elevation 99.54 feet ☒ Surveyed

Top-of-Casing Elevation 101.54 feet ☐ Estimated

Datum New Jersey State Plane Coordinates NAD 83

Installation Date(s) May 28 and 29, 2003

Drilling Method Hollow Stem Auger

Drilling Contractor CT&E Environmental Services, Inc

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): Whale pump on June 10, 2003. Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: 0 gallons

Water Removed During Development: 55 gallons

Static Depth to Water: 8.53 feet below M.P.**

Pumping Depth to Water: NA feet below M.P.**

Pumping Duration: 1 hours

Yield: NA gpm Date: NA

Specific Capacity: NA gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Jon Rutledge

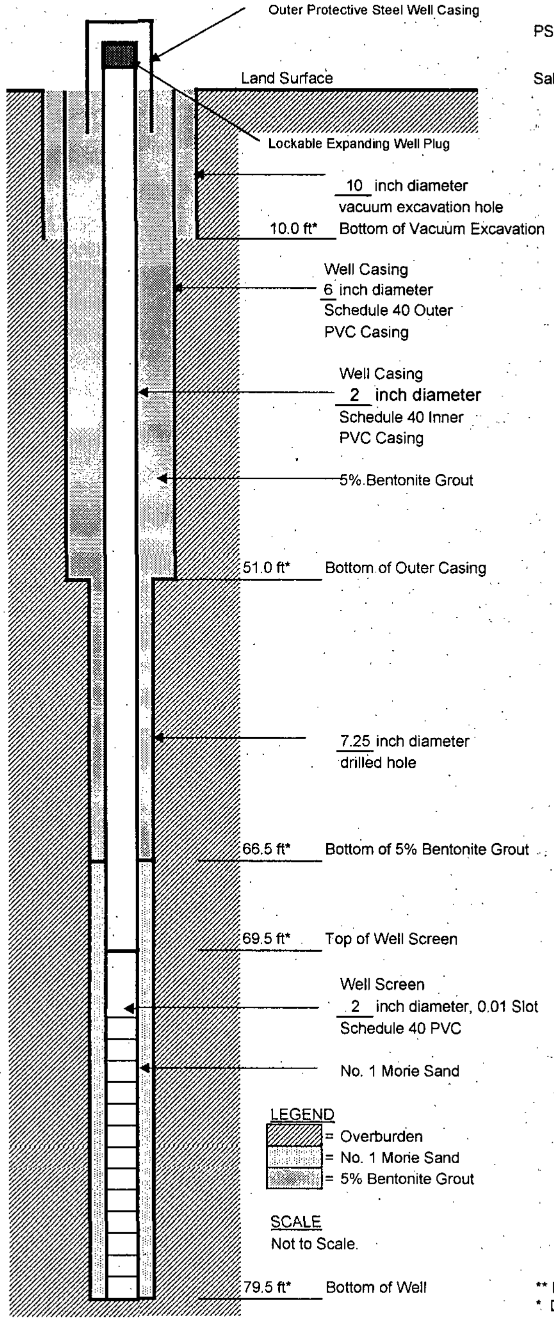
** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.
* Depth Below Land Surface

ARCADIS

Well Construction Log

(Unconsolidated)

Well Identification: Well V



PSEG N Project/No. PSEG Services Corporation

Salem G Site Location: Artificial Island

Town/City: Hancock's Bridge

County: Salem State: New Jersey

Permit No.: 3400006993

Land-Surface Elevation: 99.16 feet ☒ Surveyed

Top-of-Casing Elevation: 102.48 feet ☐ Estimated

Datum: New Jersey State Plane Coordinates NAD 83

Installation Date(s): June 6 through June 12, 2003

Drilling Method: Mud Rotary

Drilling Contractor: CT&E Environmental Services, Inc

Drilling Fluid: Not Applicable (NA)

Development Technique(s) and Date(s): 2-inch Grundfos submersible pump on June 13, 2003. Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: 0 gallons

Water Removed During Development: 40 gallons

Static Depth to Water: 11.47 feet below M.P.**

Pumping Depth to Water: NA feet below M.P.**

Pumping Duration: 0.75 hours

Yield: NA gpm Date: NA

Specific Capacity: NA gpm/ft

Well Purpose: Well installed to monitor groundwater quality.

Remarks: Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Jon Rutledge

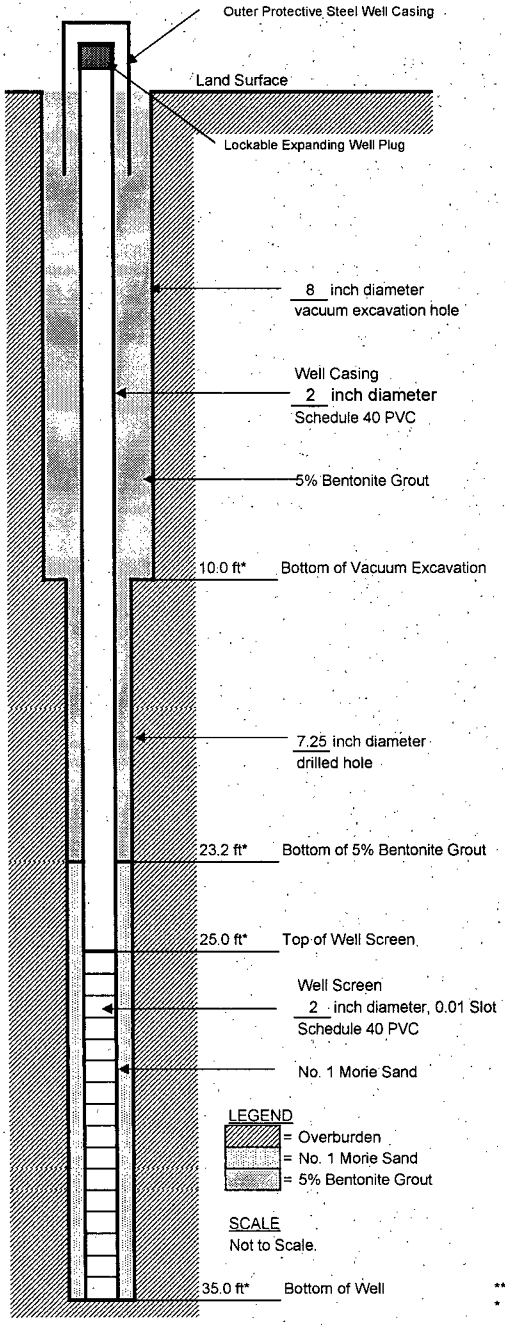
** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.
* Depth Below Land Surface

ARCADIS

Well Construction Log

(Unconsolidated)

Well Identification: Well W



Project/No.: PSEG Nuclear, LLC - Salem Generating Station/NP000571.0002

Site Location: Salem Generating Station - Artificial Island

Town/City: Hancock's Bridge

County: Salem State: New Jersey

Permit No.: 3400006995

Land-Surface Elevation: 99.36 feet ☒ Surveyed

Top-of-Casing Elevation: 101.67 feet ☐ Estimated

Datum: New Jersey State Plane Coordinates NAD 83

Installation Date(s): June 2 and 3, 2003

Drilling Method: Hollow Stem Auger

Drilling Contractor: CT&E Environmental Services, Inc

Drilling Fluid: Not Applicable (NA)

Development Technique(s) and Date(s): Whale pump on June 11, 2003. Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: 0 gallons

Water Removed During Development: 15 gallons

Static Depth to Water: 9.03 feet below M.P.**

Pumping Depth to Water: NA feet below M.P.**

Pumping Duration: 0.2 hours

Yield: NA gpm Date: NA

Specific Capacity: NA gpm/ft

Well Purpose: Well installed to monitor groundwater quality.

Remarks: Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Jon Rutledge

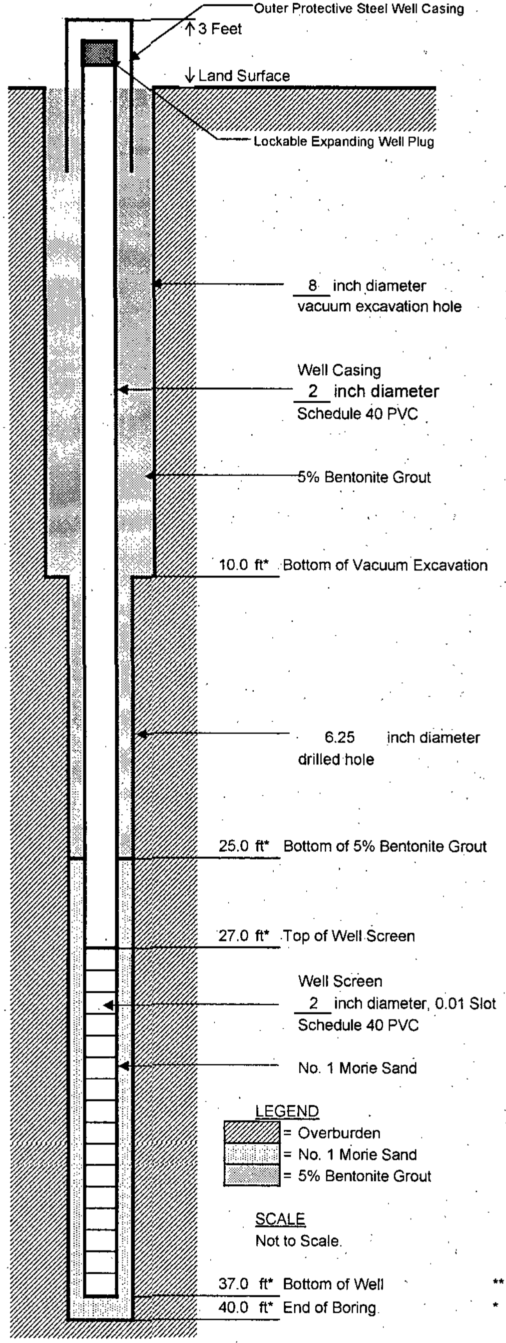
** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.
* Depth Below Land Surface

ARCADIS

Well Construction Log

(Unconsolidated)

Well Identification Well Y



Project/No. PSEG Nuclear, LLC - Salem Generating Station / NP000571.0003

Site Location Artificial Island, Hancock's Bridge, New Jersey

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 340007078

Land-Surface Elevation 99.20 feet ☒ Surveyed

Top-of-Casing Elevation 101.81 feet ☐ Estimated

Datum NAVD 1988

Installation Date(s) September 27, 2003

Drilling Method Hollow-Stem Auger

Drilling Contractor A.C. Schultes, Inc.

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): Submersible pump on October 7, 2003. Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: 0 gallons

Water Removed During Development: 50 gallons

Static Depth to Water: 10 feet below M.P.**

Pumping Depth to Water: 27 feet below M.P.**

Pumping Duration: 2.9 hours

Yield: 1 gpm Date: October 7, 2003

Specific Capacity: 0.06 gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Christopher Sharpe

** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.

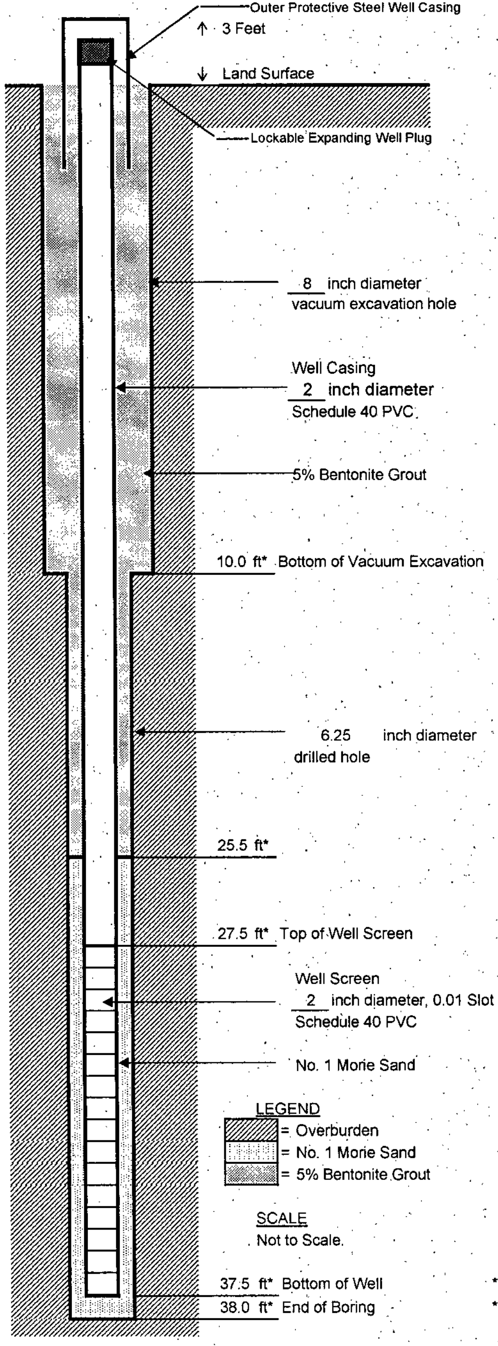
* Depth Below Land Surface

ARCADIS

Well Construction Log

(Unconsolidated)

Well Identification Well Z



Project/No. PSEG Nuclear, LLC - Salem Generating Station / NP000571.0003

Site Location Artificial Island, Hancock's Bridge, New Jersey

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 340007079

Land-Surface Elevation 99.30 feet ☒ Surveyed

Top-of-Casing Elevation 101.86 feet ☐ Estimated

Datum NAVD 1988

Installation Date(s) September 30, 2003

Drilling Method Hollow-Stem Auger

Drilling Contractor A.C. Schultes, Inc.

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): Submersible pump on October 7, 2003. Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: 0 gallons

Water Removed During Development: 50 gallons

Static Depth to Water: 10.5 feet below M.P.**

Pumping Depth to Water: 24.5 feet below M.P.**

Pumping Duration: 1 hours

Yield: 2 gpm Date: October 7, 2003

Specific Capacity: 0.14 gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Christopher Sharpe

** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.

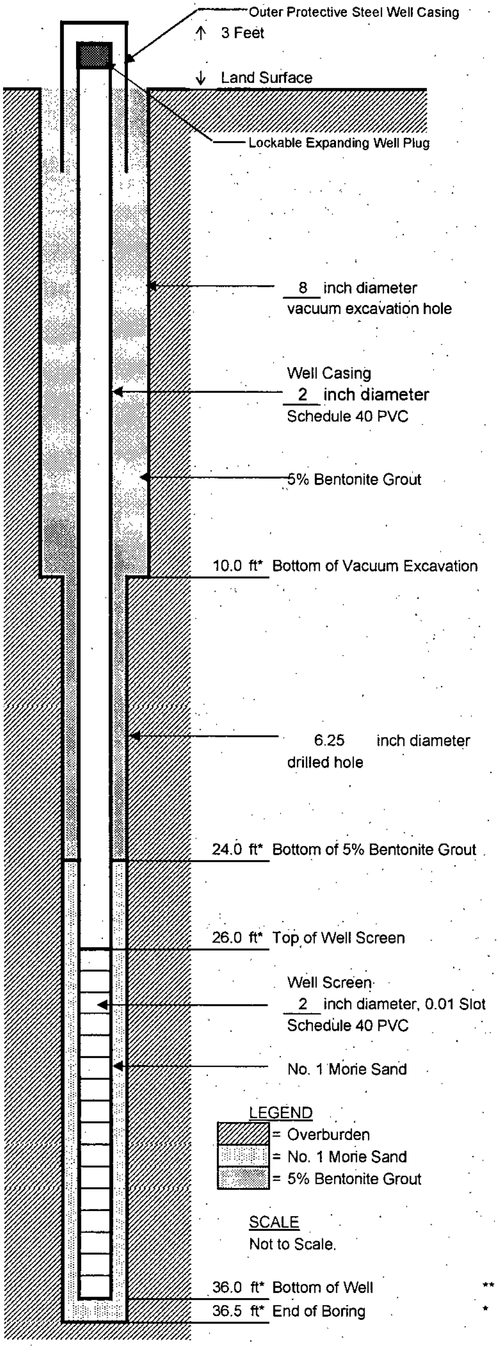
* Depth Below Land Surface

ARCADIS

Well Construction Log

(Unconsolidated)

Well Identification: Well AA



Project/No.: PSEG Nuclear, LLC - Salem Generating Station / NP000571.0003

Site Location: Artificial Island, Hancock's Bridge, New Jersey

Town/City: Hancock's Bridge

County: Salem State: New Jersey

Permit No.: 340007080

Land-Surface Elevation: 99.20 feet ☒ Surveyed

Top-of-Casing Elevation: 101.56 feet ☐ Estimated

Datum: NAVD 1988

Installation Date(s): September 30, 2003

Drilling Method: Hollow-Stem Auger

Drilling Contractor: A.C. Schultes, Inc.

Drilling Fluid: Not Applicable (NA)

Development Technique(s) and Date(s): Submersible pump on October 7, 2003. Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: 0 gallons

Water Removed During Development: 50 gallons

Static Depth to Water: 10 feet below M.P.**

Pumping Depth to Water: 21.5 feet below M.P.**

Pumping Duration: 1 hours

Yield: 1.8 gpm Date: October 7, 2003

Specific Capacity: 0.16 gpm/ft

Well Purpose: Well installed to monitor groundwater quality.

Remarks: Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Christopher Sharpe

** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.

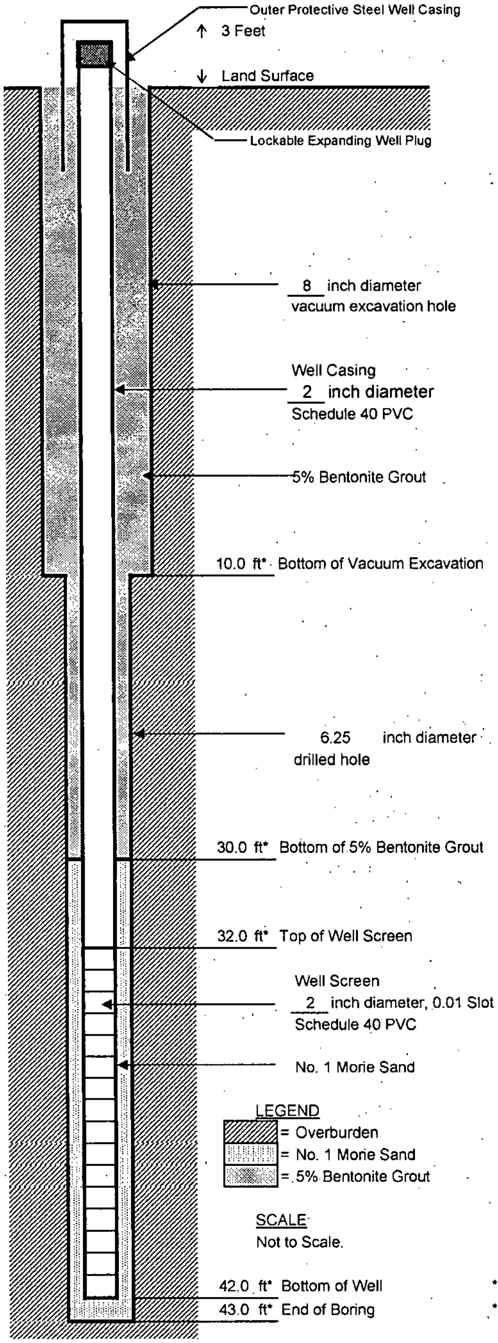
* Depth Below Land Surface

ARCADIS

Well Construction Log

(Unconsolidated)

Well Identification: Well AB



Project/No. PSEG Nuclear, LLC - Salem Generating Station / NP000571.0003

Site Location: Artificial Island, Hancock's Bridge, New Jersey

Town/City: Hancock's Bridge

County: Salem State: New Jersey

Permit No. 340007081

Land-Surface Elevation 99.10 feet ☒ Surveyed

Top-of-Casing Elevation 101.83 feet ☐ Estimated

Datum: NAVD 1988

Installation Date(s): October 2, 2003

Drilling Method: Hollow-Stem Auger

Drilling Contractor: A.C. Schultes, Inc.

Drilling Fluid: Not Applicable (NA)

Development Technique(s) and Date(s): Submersible pump on October 7, 2003. Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: 0 gallons

Water Removed During Development: 50 gallons

Static Depth to Water: 9.5 feet below M.P.**

Pumping Depth to Water: 19.7 feet below M.P.**

Pumping Duration: 1.3 hours

Yield: 1.25 gpm Date: October 7, 2003

Specific Capacity: 0.12 gpm/ft

Well Purpose: Well installed to monitor groundwater quality.

Remarks: Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Christopher Sharpe

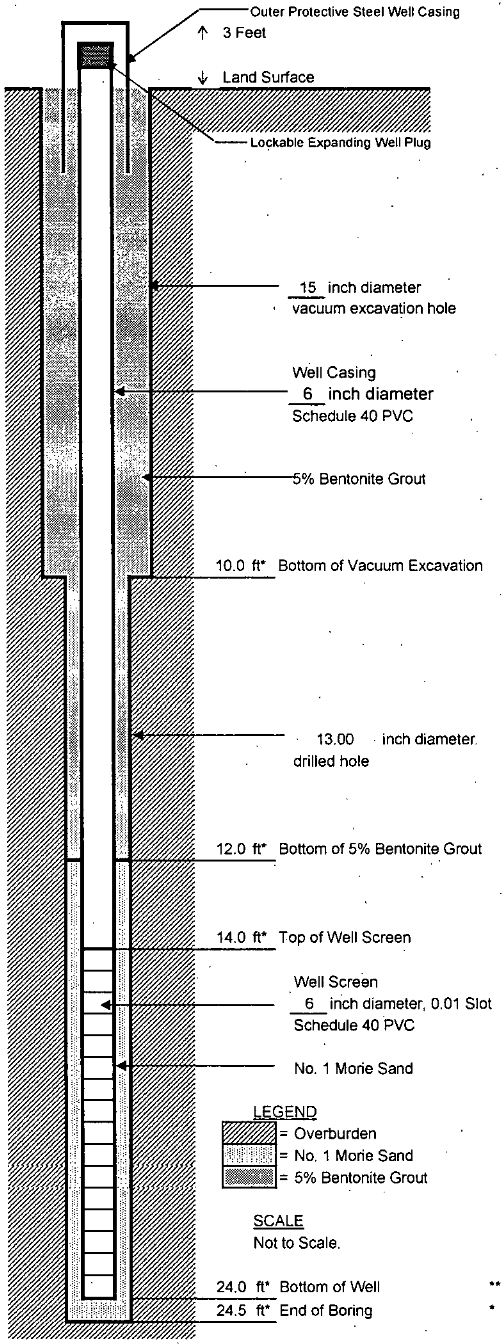
** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.

* Depth Below Land Surface

ARCADIS

Well Construction Log
(Unconsolidated)

Well Identification Well AC



Project/No. PSEG Nuclear, LLC - Salem Generating Station / NP000571.0003

Site Location Artificial Island, Hancock's Bridge, New Jersey

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 340007082

Land-Surface Elevation 99.00 feet ☒ Surveyed

Top-of-Casing Elevation 101.25 feet ☐ Estimated

Datum NAVD 1988

Installation Date(s) September 26, 2003

Drilling Method Hollow-Stem Auger

Drilling Contractor A.C. Schultes, Inc.

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): Submersible pump on October 7, 2003. Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: 0 gallons

Water Removed During Development: 50 gallons

Static Depth to Water: 8.2 feet below M.P.**

Pumping Depth to Water: 19.8 feet below M.P.**

Pumping Duration: 1 hours

Yield: 1 gpm Date: October 7, 2003

Specific Capacity: 0.09 gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Christopher Sharpe

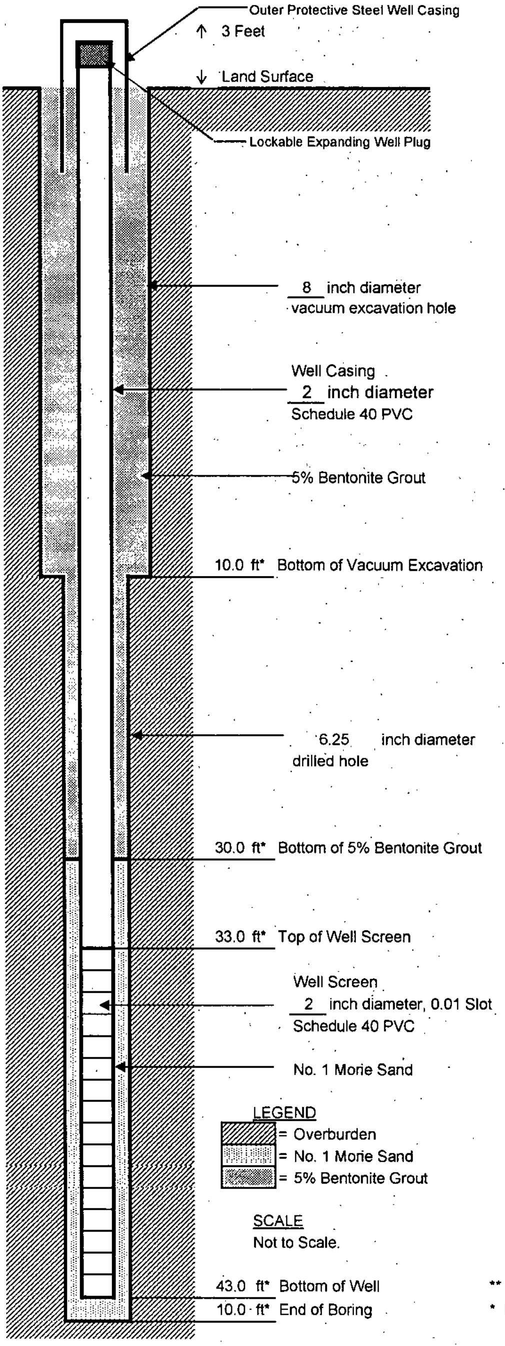
** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.
* Depth Below Land Surface

ARCADIS

Well Construction Log

(Unconsolidated)

Well Identification Well AD



Project/No. PSEG Nuclear, LLC - Salem Generating Station / NP000571.0003

Site Location Artificial Island, Hancock's Bridge, New Jersey

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 340007083

Land-Surface Elevation 99.10 feet ☒ Surveyed

Top-of-Casing Elevation 101.35 feet ☐ Estimated

Datum NAVD 1988

Installation Date(s) October 3, 2003

Drilling Method Hollow-Stem Auger

Drilling Contractor A.C. Schultes, Inc.

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): Submersible pump on October 7, 2003. Development was considered complete when turbidity in discharge was reduced/eliminated. Development was halted several times as a result of a lack of water in the well.

Fluid Loss During Drilling: 0 gallons

Water Removed During Development: 64 gallons

Static Depth to Water: 7.5 feet below M.P.**

Pumping Depth to Water: 35.5 feet below M.P.**

Pumping Duration: 5.15 hours

Yield: NA gpm Date: October 7, 2003

Specific Capacity: NA gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Christopher Sharpe

** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.

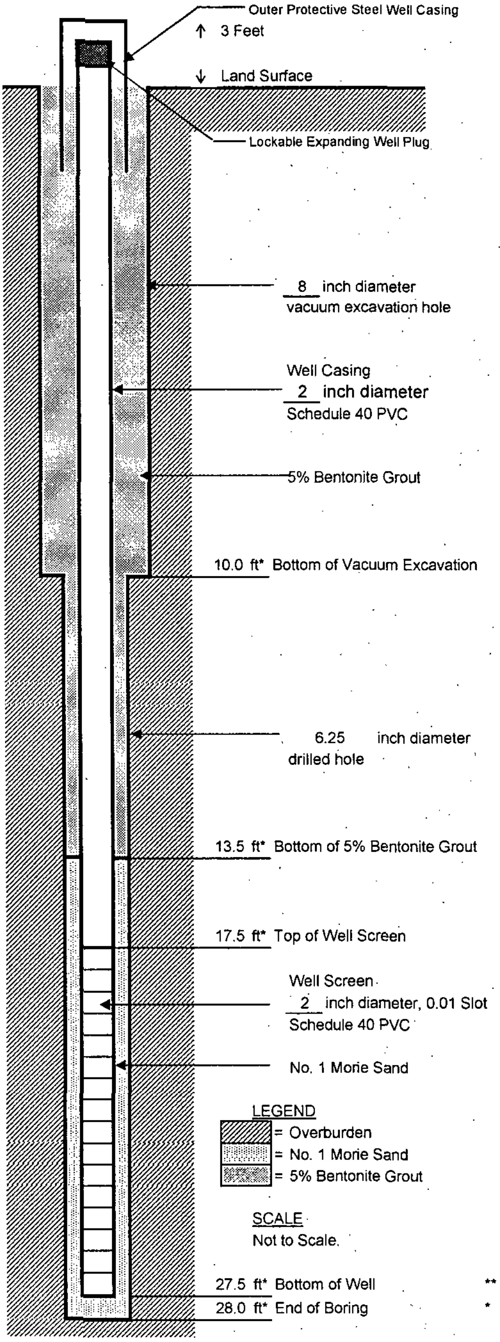
* Depth Below Land Surface

ARCADIS

Well Construction Log

(Unconsolidated)

Well Identification Well AE



Project/No. PSEG Nuclear, LLC - Salem Generating Station / NP000571.0003

Site Location Artificial Island, Hancock's Bridge, New Jersey

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 340007083

Land-Surface Elevation 99.30 feet ☒ Surveyed

Top-of-Casing Elevation 101.54 feet ☐ Estimated

Datum NAVD 1988

Installation Date(s) October 2, 2003

Drilling Method Hollow-Stem Auger

Drilling Contractor A.C. Schultes, Inc.

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): Submersible pump on October 7, 2003. Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: 0 gallons

Water Removed During Development: 25 gallons

Static Depth to Water: 7.5 feet below M.P.**

Pumping Depth to Water: 22.5 feet below M.P.**

Pumping Duration: 1 hours

Yield: 0.8 gpm Date: October 7, 2003

Specific Capacity: 0.05 gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Christopher Sharpe

** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.

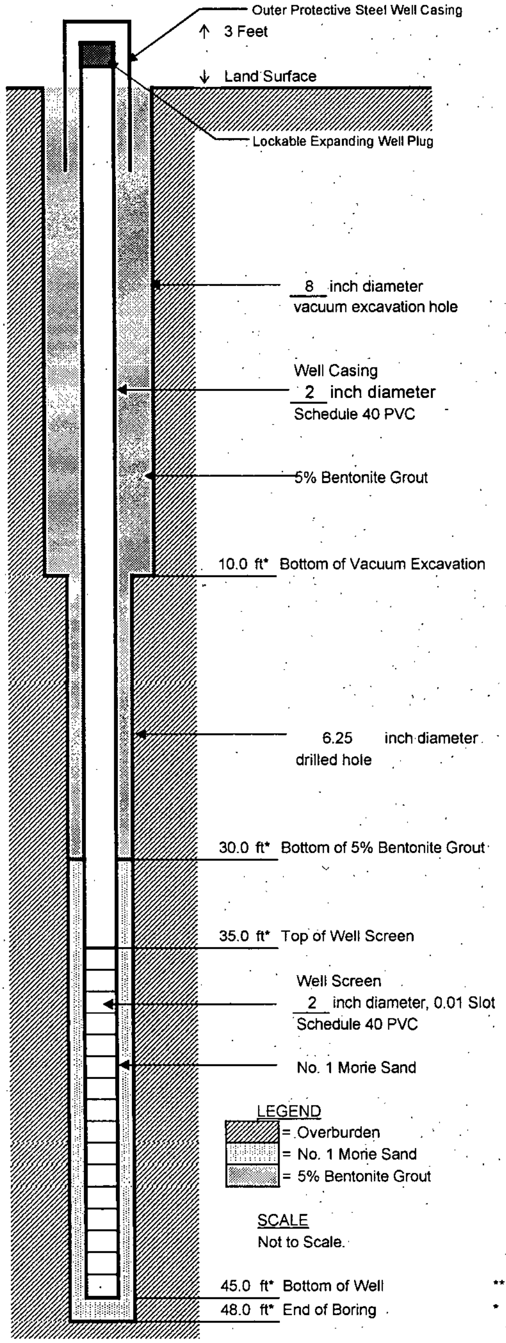
* Depth Below Land Surface

ARCADIS

Well Construction Log

(Unconsolidated)

Well Identification Well AF



Project/No. PSEG Nuclear, LLC - Salem Generating Station / NP000571.0003

Site Location Artificial Island, Hancock's Bridge, New Jersey

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 340007085

Land-Surface Elevation 99.20 feet ☒ Surveyed

Top-of-Casing Elevation 101.61 feet ☐ Estimated

Datum NAVD 1988

Installation Date(s) October 1, 2003

Drilling Method Hollow-Stem Auger

Drilling Contractor A.C. Schultes, Inc.

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): Submersible pump on October 7, 2003. Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: 0 gallons

Water Removed During Development: 50 gallons

Static Depth to Water: 10 feet below M.P.**

Pumping Depth to Water: 13.5 feet below M.P.**

Pumping Duration: 0.75 hours

Yield: 2.5 gpm Date: October 7, 2003

Specific Capacity: 0.71 gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Christopher Sharpe

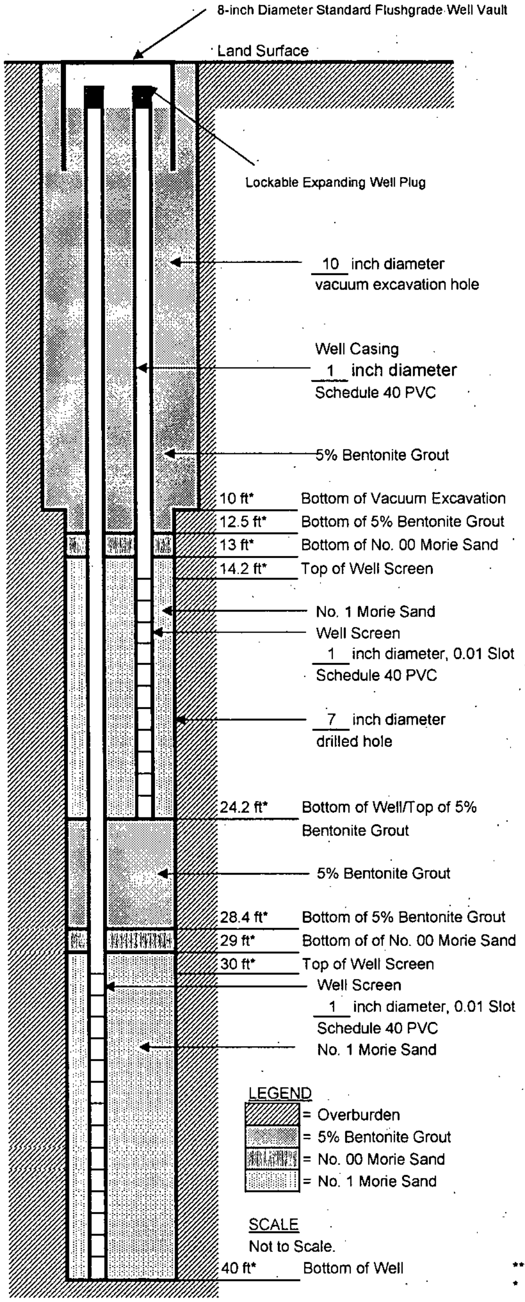
** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.

* Depth Below Land Surface

ARCADIS

Well Construction Log
(Unconsolidated)

Well Identification Well AG Shallow and Deep



Project/No. PSEG Nuclear, LLC - Salem Generating Station/NP000571.0003

Site Location Salem Generating Station - Artificial Island

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 3400007135 (Shallow) and 3400007153 (Deep)

Land-Surface Elevation ______ feet ☒ Surveyed

Top-of-Casing Elevation ______ feet ☐ Estimated

Datum New Jersey State Plane Coordinates NAD 83

Installation Date(s) February 9 and 10, 2004

Drilling Method Hollow Stem Auger

Drilling Contractor Talon Drilling Company

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): February 11, 2004
Surging with 0.75-inch surge block and pumping with peristaltic pump.
Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: Not Applicable gallons

Water Removed During Development: 16 gallons

Static Depth to Water: 9.52 (shallow) and 9.71 (deep) feet below M.P.**

Pumping Depth to Water: Not Applicable feet below M.P.**

Pumping Duration: 0.75 hours

Yield: Not Applicable gpm Date: February 10, 2004

Specific Capacity: Not Applicable gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Jon Rutledge

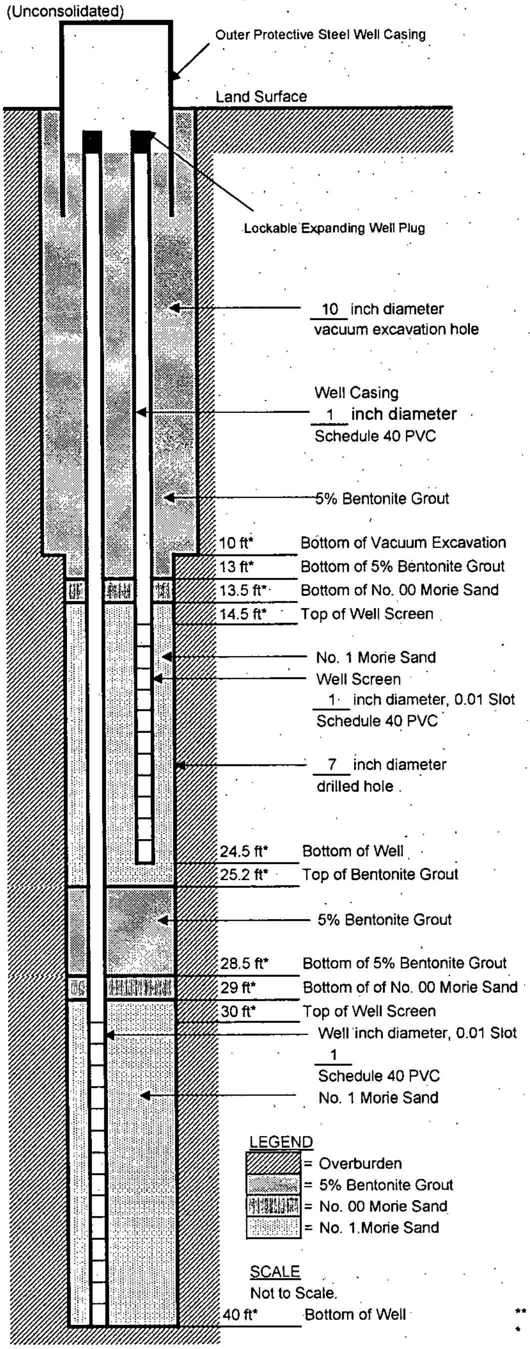
** M.P. Measuring Point. Top of 1-inch PVC well casing unless otherwise noted.
* Depth Below Land Surface

ARCADIS

Well Construction Log

(Unconsolidated)

Well Identification Well AH Shallow and Deep



Project/No. PSEG Nuclear, LLC - Salem Generating Station/NP000571.0003

Site Location Salem Generating Station - Artificial Island

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 3400007136 (Shallow) and 3400007154 (Deep)

Land-Surface Elevation ______ feet ☒ Surveyed

Top-of-Casing Elevation ______ feet ☐ Estimated

Datum New Jersey State Plane Coordinates NAD 83

Installation Date(s) February 4 and 5, 2004

Drilling Method Hollow Stem Auger

Drilling Contractor Talon Drilling Company

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): February 11, 2004
Surging with 0.75-inch surge block and pumping with peristaltic pump.
Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: Not Applicable gallons

Water Removed During Development: 20 gallons

Static Depth to Water: 13.58 (shallow) and 12.92 (deep) feet below M.P.**

Pumping Depth to Water: Not Applicable feet below M.P.**

Pumping Duration: 1 hours

Yield: Not Applicable gpm Date: February 10, 2004

Specific Capacity: Not Applicable gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

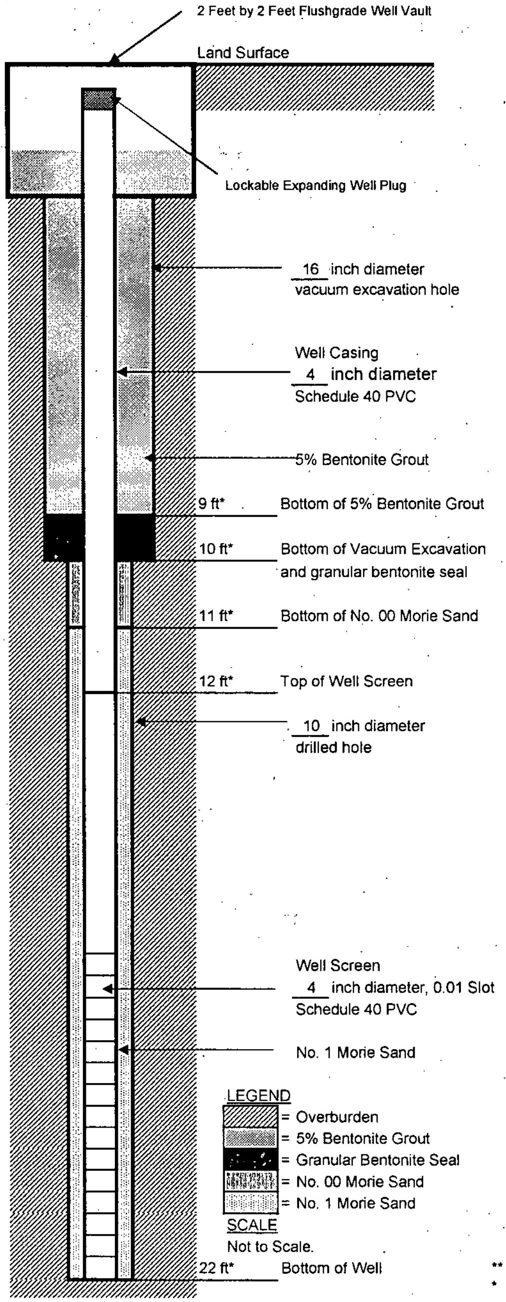
Prepared by: Jon Rutledge

** M.P. Measuring Point. Top of 1-inch PVC well casing unless otherwise noted.
* Depth Below Land Surface

ARCADIS

Well Construction Log
(Unconsolidated)

Well Identification Well AI



Project/No. PSEG Nuclear, LLC - Salem Generating Station/NP000571.0003

Site Location Salem Generating Station - Artificial Island

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 3400007137

Land-Surface Elevation ______ feet ☒ Surveyed

Top-of-Casing Elevation ______ feet ☐ Estimated

Datum New Jersey State Plane Coordinates NAD 83

Installation Date(s) January 20, 2004

Drilling Method Hollow Stem Auger

Drilling Contractor Talon Drilling Company

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): February 2 and 3, 2004
Surging with 4-inch surge block and pumping with 4-inch submersible.
Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: Not Applicable gallons

Water Removed During Development: 90 gallons

Static Depth to Water: 7.61 feet below M.P.**

Pumping Depth to Water: Not Applicable feet below M.P.**

Pumping Duration: 2 hours

Yield: 0.5 gpm Date: February 3, 2004

Specific Capacity: Not Applicable gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Jon Rutledge

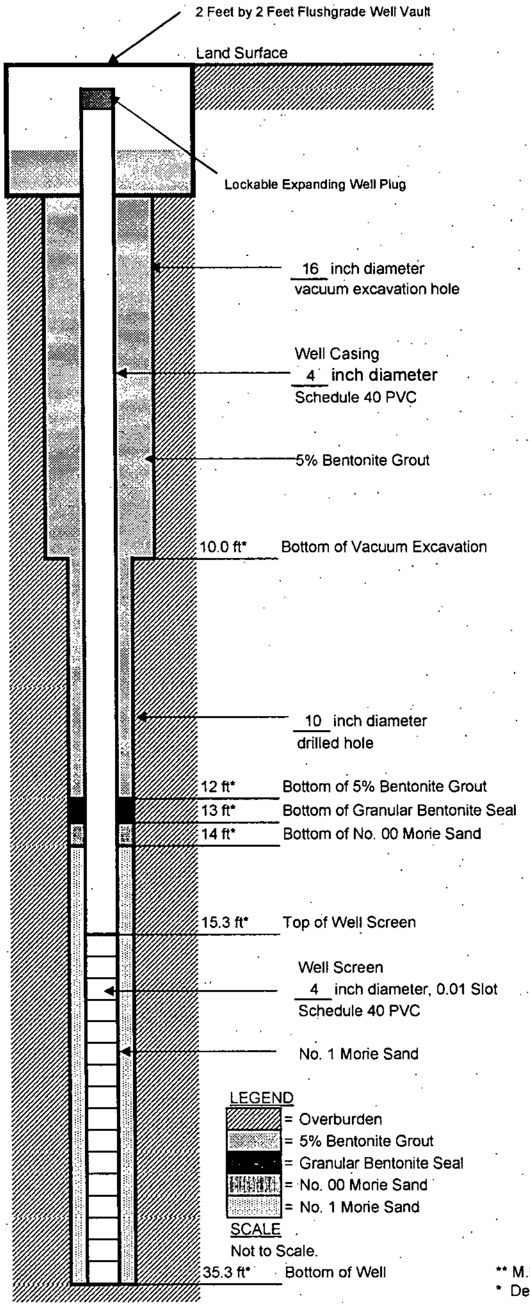
** M.P. Measuring Point. Top of 4-inch PVC well casing unless otherwise noted.

* Depth Below Land Surface

ARCADIS

Well Construction Log
(Unconsolidated)

Well Identification Well AJ



Project/No. PSEG Nuclear, LLC - Salem Generating Station/NP000571.0003

Site Location Salem Generating Station - Artificial Island

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 3400007138

Land-Surface Elevation ______ feet ☒ Surveyed

Top-of-Casing Elevation ______ feet ☐ Estimated

Datum New Jersey State Plane Coordinates NAD 83

Installation Date(s) January 23, 2004

Drilling Method Hollow Stem Auger

Drilling Contractor Talon Drilling Company

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): January 29 and 30, 2004
Surging with 4-inch surge block and pumping with 4-inch submersible.
Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: Not Applicable gallons

Water Removed During Development: 130 gallons

Static Depth to Water: 8.14 feet below M.P.**

Pumping Depth to Water: Not Applicable feet below M.P.**

Pumping Duration: 3.5 hours

Yield: 0.25 gpm Date: Janauary 30, 2004

Specific Capacity: Not Applicable gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

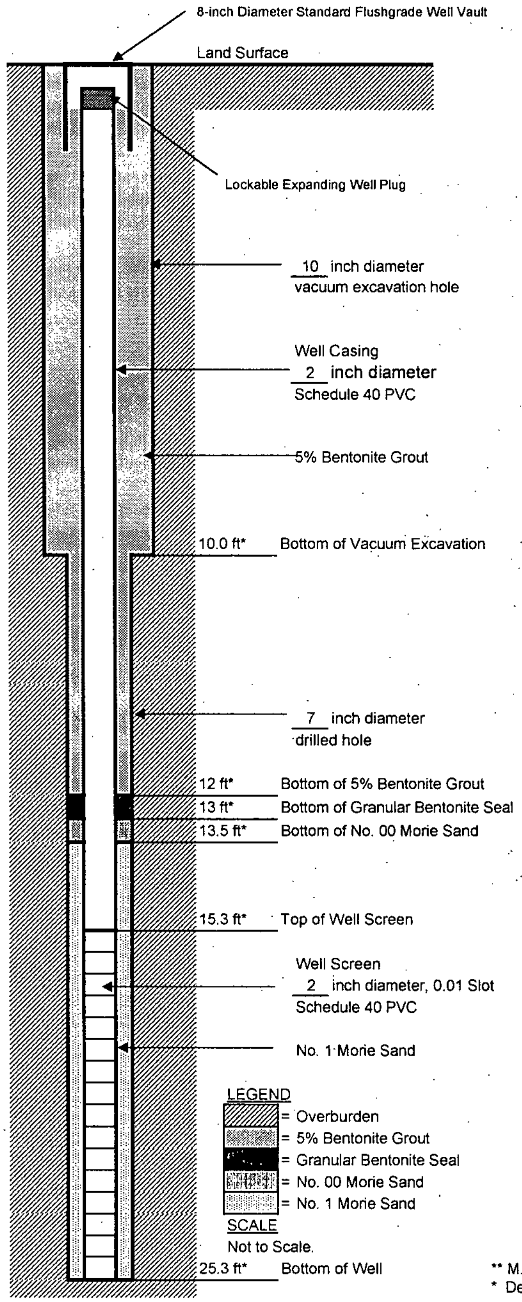
Prepared by: Jon Rutledge

** M.P. Measuring Point. Top of 4-inch PVC well casing unless otherwise noted.
* Depth Below Land Surface

ARCADIS

Well Construction Log
(Unconsolidated)

Well Identification Well AL



Project/No. PSEG Nuclear, LLC - Salem Generating Station/NP000571.0003

Site Location Salem Generating Station - Artificial Island

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 3400007140

Land-Surface Elevation ____ feet ☒ Surveyed

Top-of-Casing Elevation ____ feet ☐ Estimated

Datum New Jersey State Plane Coordinates NAD 83

Installation Date(s) January 21, 2004

Drilling Method Hollow Stem Auger

Drilling Contractor Talon Drilling Company

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): February 3 and 4, 2004
Surging with 2-inch surge block and pumping with 2-inch submersible.
Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: Not Applicable gallons

Water Removed During Development: 80 gallons

Static Depth to Water: 7.09 feet below M.P.**

Pumping Depth to Water: Not Applicable feet below M.P.**

Pumping Duration: 1.5 hours

Yield: 1 gpm Date: February 3, 2004

Specific Capacity: Not Applicable gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

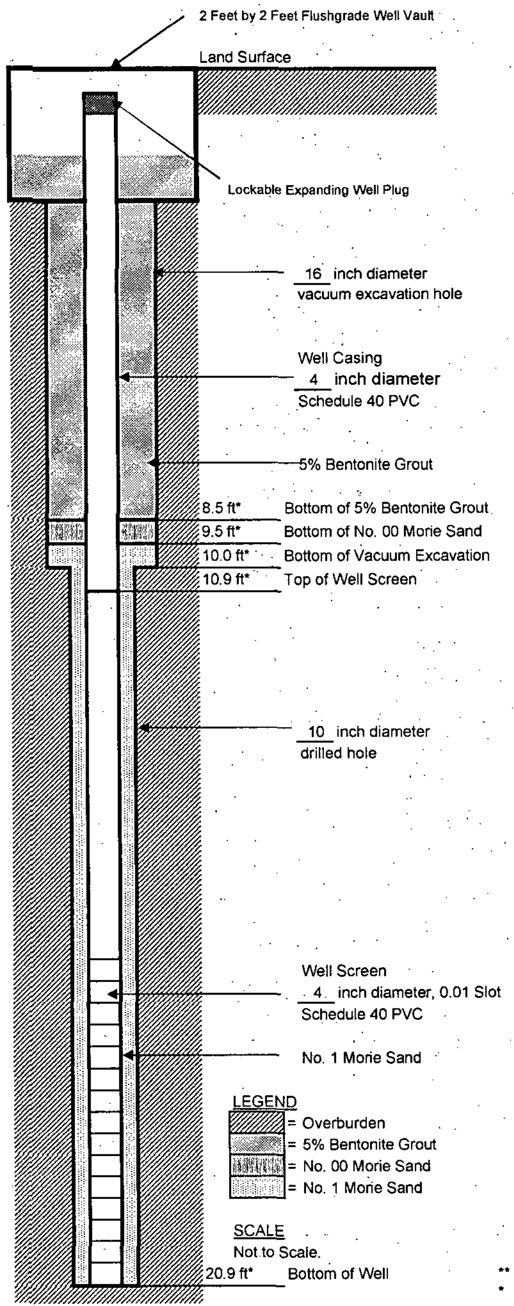
Prepared by: Jon Rutledge

** M.P. Measuring Point. Top of 2-inch PVC well casing unless otherwise noted.
* Depth Below Land Surface

ARCADIS

Well Construction Log
(Unconsolidated)

Well Identification Well AM



Project/No. PSEG Nuclear, LLC - Salem Generating Station/NP000571.0003

Site Location Salem Generating Station - Artificial Island

Town/City Hancock's Bridge

County Salem State New Jersey

Permit No. 3400007141

Land-Surface Elevation ____ feet ☒ Surveyed

Top-of-Casing Elevation ____ feet ☐ Estimated

Datum New Jersey State Plane Coordinates NAD 83

Installation Date(s) January 15, 2004

Drilling Method Hollow Stem Auger

Drilling Contractor Talon Drilling Company

Drilling Fluid Not Applicable (NA)

Development Technique(s) and Date(s): February 2 and 3, 2004
Surging with 4-inch surge block and pumping with 4-inch submersible.
Development was considered complete when turbidity in discharge was reduced/eliminated.

Fluid Loss During Drilling: Not Applicable gallons

Water Removed During Development: 60 gallons

Static Depth to Water: 6.91 feet below M.P.**

Pumping Depth to Water: Not Applicable feet below M.P.**

Pumping Duration: 2 hours

Yield: 0.25 gpm Date: February 4, 2004

Specific Capacity: Not Applicable gpm/ft

Well Purpose Well installed to monitor groundwater quality.

Remarks Vacuum excavation was performed to a depth of 10 feet below ground surface at the location of the monitoring well to help identify potential utilities.

Prepared by: Jon Rutledge

** M.P. Measuring Point. Top of 4-inch PVC well casing unless otherwise noted.
* Depth Below Land Surface

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ____________ SRP Case No.: ____________

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) Well K

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 08.95" Latitude: North 39° 27' 51.08"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 231,435 East 199,697

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) Rim 102.36 PVC 102.00 ground 99.71

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation

Significant observations and notes: ____________

AUTHENTICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false, inaccurate, and incomplete information and that I am committing a crime in the fourth degree if I make a false statement that I do not believe to be true. I am also aware that if I knowingly direct or authorize the violation of any statute, I am personally liable for the penalties.

SEAL

Rhl C Mathews

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

6/16/2003

DATE

RICHARD C. MATHEWS GS29353

PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230

PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ______ SRP Case No.: ______

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) Well L

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 14.41" Latitude: North 39° 27' 46.07"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,933 East 199,263

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) Rim 101.74 PVC 101.46 ground 99.34

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ______

AUTHENTICATION

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SEAL

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

6/16/2003
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ______ SRP Case No.: ______

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW-M

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 10.79" Latitude: North 39° 27' 45.20"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,843 East 199,546

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) Rim 102.37 PVC 102.17 ground 99.26

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ______

AUTHENTICATION

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SEAL

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

7/08/2003
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ____________ SRP Case No.: ____________

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) Well N

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 09.31" Latitude: North 39° 27' 44.57"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,777 East 199,661

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) Rim 102.00 PVC 101.65 ground 99.41

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ____________

AUTHENTICATION

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SEAL

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

6/16/2003
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: SRP Case No.:

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) Well O

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 07.05" Latitude: North 39° 27' 44.85"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,804 East 199,839

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) Rim 101.76 PVC 101.33 ground 99.20

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes:

AUTHENTICATION

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SEAL

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

6/16/2003
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: SRP Case No.:

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) Well P

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 04.93" Latitude: North 39° 27' 40.25"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,336 East 200,000

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) Rim 101.56 PVC 101.13 ground 99.00

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes:

AUTHENTICATION

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SEAL

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

6/16/2003
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ____________ SRP Case No.: ____________

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) Well Q

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 31' 49.72" Latitude: North 39° 27' 43.45"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,645 East 201,196

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) Rim 107.03 PVC 106.59 ground 104.45

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ____________

AUTHENTICATION

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SEAL

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

7/1/2003
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ________ SRP Case No.: ________

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW-R

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 09.60" Latitude: North 39° 27' 45.84"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,906 East 199,640

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) Rim 102.42 PVC 102.35 ground 99.82

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ________

AUTHENTICATION

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SEAL

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

7/08/2003
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ____ SRP Case No.: ____

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW S

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 09.92" Latitude: North 39° 27' 43.92"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,711 East 199,613

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) PVC 99.04

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ____

AUTHENTICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false, inaccurate, and incomplete information and that I am committing a crime in the fourth degree if I make a false statement that I do not believe to be true. I am also aware that if I knowingly direct or authorize the violation of any statute, I am personally liable for the penalties.

SEAL

Richard C Mathews

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

2/23/04

DATE

RICHARD C. MATHEWS GS29353

PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230

PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ______ SRP Case No.: ______

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) Well T

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 10.53" Latitude: North 39° 27' 52.45"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 231,575 East 199,575

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) Rim 104.39 PVC 104.13 ground 100.97

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ______

AUTHENTICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false, inaccurate, and incomplete information and that I am committing a crime in the fourth degree if I make a false statement that I do not believe to be true. I am also aware that if I knowingly direct or authorize the violation of any statute, I am personally liable for the penalties.

SEAL

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

6/16/2003
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ______ SRP Case No.: ______

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:
This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW U
Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 09.95" Latitude: North 39° 27' 50.43"
New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 231,370 East 199,618
Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) RIM 99.19 PVC 98.57

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)
Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ______

AUTHENTICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false, inaccurate, and incomplete information and that I am committing a crime in the fourth degree if I make a false statement that I do not believe to be true. I am also aware that if I knowingly direct or authorize the violation of any statute, I am personally liable for the penalties.

SEAL

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

2/23/04
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ______ SRP Case No.: ______

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:
This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW V
Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 10.83" Latitude: North 39° 27' 50.27"
New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 231,355 East 199,548
Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) RIM 99.03 PVC 98.74

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)
Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ______

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PROFESSIONAL LAND SURVEYOR'S SIGNATURE

2/23/04
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ______ SRP Case No.: ______

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:
This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW W

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 12.01" Latitude: North 39° 27' 44.55"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,777 East 199,450

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) RIM 98.99 PVC 98.69

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ______

AUTHENTICATION

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PROFESSIONAL LAND SURVEYOR'S SIGNATURE

2/23/04
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: SRP Case No.:

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:
This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW-Y
Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 13.36" Latitude: North 39° 27' 44.47"
New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,771 East 199,343
Elevation of Top of Inner Casing (Cap off) at
Reference mark (to nearest 0.01' in relation to permanent
on-site datum) Casing 102.31 PVC 101.81 Ground 99.2

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)
Site Monument N 5 + 0, E 2 + 0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes:

AUTHENTICATION

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SEAL

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

10/22/03
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ____________ SRP Case No.: ____________

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW-Z

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 12.64" Latitude: North 39° 27' 44.59"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,681 East 199,399

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) Casing 102.39 PVC 101.86 Ground 99.3

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5 + 0, E 2 + 0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ____________

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PROFESSIONAL LAND SURVEYOR'S SIGNATURE

10/22/03
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: SRP Case No.:

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:
This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW AA
Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 10.81" Latitude: North 39° 27' 42.83"
New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,603 East 199,541
Elevation of Top of Inner Casing (Cap off) at
Reference mark (to nearest 0.01' in relation to permanent
on-site datum) RIM 99.30 PVC 99.07

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)
Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes:

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PROFESSIONAL LAND SURVEYOR'S SIGNATURE

2/23/04
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ________ SRP Case No.: ________

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW AB

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 09.08" Latitude: North 39° 27' 43.05"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,623 East 199,677

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) PVC 98.93

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ________

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PROFESSIONAL LAND SURVEYOR'S SIGNATURE

2/23/04
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ____________ SRP Case No.: ____________

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW AC

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 08.49" Latitude: North 39° 27' 44.05"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,724 East 199,725

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) PVC 98.77

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ____________

AUTHENTICATION

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SEAL

Rich C Mathews

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

2/23/04

DATE

RICHARD C. MATHEWS GS29353

PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230

PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ____________ SRP Case No.: ____________

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW AD

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 09.99" Latitude: North 39° 27' 43.64"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,684 East 199,607

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) PVC 98.99

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ____________

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PROFESSIONAL LAND SURVEYOR'S SIGNATURE

2/23/04
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ______ SRP Case No.: ______

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:
This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW-AE
Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 06.97" Latitude: North 39° 27' 45.11"
New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,829 East 199,845
Elevation of Top of Inner Casing (Cap off) at
Reference mark (to nearest 0.01' in relation to permanent
on-site datum) Casing 102.07 PVC 101.54 Ground 99.3

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5 + 0, E 2 + 0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ______

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SEAL

PROFESSIONAL LAND SURVEYOR'S SIGNATURE 10/22/03 DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: SRP Case No.:

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW-AF

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 08.75" Latitude: North 39° 27' 41.74"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,491 East 199,702

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) Casing 102.00 PVC 101.61 Ground 99.2

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5 + 0, E 2 + 0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes:

AUTHENTICATION

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PROFESSIONAL LAND SURVEYOR'S SIGNATURE

10/22/03
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: SRP Case No.:

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW AG-S

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 11.23" Latitude: North 39° 27' 41.77"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,496 East 199,508

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) PVC 99.29

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes:

AUTHENTICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false, inaccurate, and incomplete information and that I am committing a crime in the fourth degree if I make a false statement that I do not believe to be true. I am also aware that if I knowingly direct or authorize the violation of any statute, I am personally liable for the penalties.

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PROFESSIONAL LAND SURVEYOR'S SIGNATURE

2/23/04
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ____________ SRP Case No.: ____________

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:
This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW AG-D
Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 11.23" Latitude: North 39° 27' 41.77"
New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,496 East 199,508
Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) PVC 99.20

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)
Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ____________

AUTHENTICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false, inaccurate, and incomplete information and that I am committing a crime in the fourth degree if I make a false statement that I do not believe to be true. I am also aware that if I knowingly direct or authorize the violation of any statute, I am personally liable for the penalties.

SEAL

PROFESSIONAL LAND SURVEYOR'S SIGNATURE

2/23/04
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: SRP Case No.:

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW AH-S

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 10.10" Latitude: North 39° 27' 41.33"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,450 East 199,596

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) PVC 102.58

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes:

AUTHENTICATION

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2/23/04
DATE

RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ____________ SRP Case No.: ____________

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW AH-D

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 10.10" Latitude: North 39° 27' 41.33"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,450 East 199,596

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) PVC 102.70

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ____________

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2/23/04
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PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: SRP Case No.:

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW AI

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 11.11" Latitude: North 39° 27' 44.76"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,798 East 199,521

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) PVC 98.79

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes:

AUTHENTICATION

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PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ______ SRP Case No.: ______

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:
This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW AJ
Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 09.24" Latitude: North 39° 27' 43.51"
New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,670 East 199,665

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) PVC 98.85

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ______

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2/23/04
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RICHARD C. MATHEWS GS29353
PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ____________ SRP Case No.: ____________

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW AL

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 07.44" Latitude: North 39° 27' 42.78"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,594 East 199,806

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) RIM 99.42 PVC 99.13

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ____________

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PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

MONITORING WELL CERTIFICATION FORM B
LOCATION CERTIFICATION

Name of Owner PSE&G Salem Generating Facility

Name of Facility PSE&G Salem Generating Facility

Location Lower Alloways Creek, Salem County

UST Number: ____________ SRP Case No.: ____________

LAND SURVEYOR'S CERTIFICATION

Well Permit Number:

This number must be permanently affixed to the well casing.

Owners Well Number (As shown on application or plans) MW AM

Geographic Coordinates NAD 83 (to the nearest 1/10 of second)

Longitude: West 75° 32' 09.07" Latitude: North 39° 27' 44.42"

New Jersey State Plane Coordinates NAD 83 to nearest 10 feet:

North 230,762 East 199,680

Elevation of Top of Inner Casing (Cap off) at Reference mark (to nearest 0.01' in relation to permanent on-site datum) PVC 98.55

Source of elevation datum (benchmark, number/description and elevation/datum. If an on-site datum is used, identify here, assume datum of 100', and give approximate actual elevation. Please note that, if information from the well is to be submitted electronically, the EDSA manual specifies the well elevation to be reported according to NAVD 1988 to an accuracy of 0.2'.)

Site Monument N 5+0, E 2+0 Elevation 102.78 scaled actual elevation 10

Significant observations and notes: ____________

AUTHENTICATION

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe the submitted information is true, accurate and complete. I am aware that there are significant penalties for submitting false, inaccurate, and incomplete information and that I am committing a crime in the fourth degree if I make a false statement that I do not believe to be true. I am also aware that if I knowingly direct or authorize the violation of any statute, I am personally liable for the penalties.

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PROFESSIONAL LAND SURVEYOR'S NAME AND LICENSE NUMBER

43 WEST HIGH STREET, SOMERVILLE, NEW JERSEY 908 725 0230
PROFESSIONAL LAND SURVEYOR'S ADDRESS AND PHONE NUMBER

WR-138 M
00

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit No. 34 - 26931

Atlas Sheet Coordinates 31 : 01 : 235

OWNER IDENTIFICATION - Owner PSEG NUCLEAR LLC
Address PO BOX 236
City HANCOCKS BRIDGE State NJ Zip Code

WELL LOCATION - If not the same as owner please give address. Owner's Well No. MW4 (Well K)
County SALEM Municipality LOWER ALLOWAYS Lot No. 4.01 Block No. 26
Address END OF ALLOWAY CREEK NECK RD
DATE WELL STARTED 1/22/03
DATE WELL COMPLETED 3/3/03
TYPE OF WELL (as per Well Permit Categories) MONITORING
Regulatory Program Requiring Well — Case I.D.# —

CONSULTING FIRM/FIELD SUPERVISOR (If applicable) — Tele. # —

WELL CONSTRUCTION

Total depth drilled 80 ft.
Well finished to 80 ft.

Borehole diameter:
Top 6 in.
Bottom 6 in.

Well was finished: ☒ above grade
☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2 ft.

Was steel protective casing installed?
☒ Yes ☐ No

Static water level after drilling 16 ft.
Water level was measured using M Scope
Well was developed for 1 hours
at 2 gpm

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/ech no.)
Single/Inner Casing	+2	70	2	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	70	80	2	PVC	.020
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	68	80	6	Morie	#1
Grout	0	68	6	Neat Cement Bentonite	lbs. 100 lbs.

Grouting Method Tremmie
Drilling Method Auger

Method of development Pump
Was permanent pumping equipment installed? ☐ Yes ☒ No
Pump capacity — gpm
Pump type: —
Drilling Fluid — Type of Rig CME 75
Health and Safety Plan submitted? ☐ Yes ☒ No
Level of Protection used on site (circle one) None [✓ D] C B A

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A.C. SCHULTES INC.
Well Driller (Print) CHRIS WARREN
Driller's Signature Chris Warren
Registration No. MD 1546 Date 4/1/03

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations.

0-18	Med-Fine silty gray sand
18-36	Fine silty gray sand
36-62	Fine Med gray silty sand
62-80	Med gray SILTY SAND w/ Clay Streaks

AS-BUILT WELL LOCATION
(NAD 83 HORIZONTAL DATUM)
NJ STATE PLANE COORDINATE IN US SURVEY FEET

NORTHING: EASTING:
OR
LATITUDE: ° ' . " LONGITUDE: ° ' . "

COPIES: White - DEP Canary - Driller Pink - Owner Goldenrod - Health Dept.

DWR-138 M
8/00

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit No. 31 - 06332

Atlas Sheet Coordinates 34 : 01 : 325

OWNER IDENTIFICATION - Owner PSEG NUCLEAR LLC
Address PO BOX 236
City HANCOCKS BRIDGE State NJ Zip Code

WELL LOCATION - If not the same as owner please give address. Owner's Well No. MW 5 (Well 2)
County SALEM Municipality LOWER ALLOWAYS Lot No. 4.01 Block No. 20
Address END OF ALLOWAY CREEK NECK RD

DATE WELL STARTED 1 / 22 / 03
DATE WELL COMPLETED 1 / 28 / 03

TYPE OF WELL (as per Well Permit Categories) MONITORING
Regulatory Program Requiring Well — Case I.D.# —

CONSULTING FIRM/FIELD SUPERVISOR (if applicable) — Tele. # —

WELL CONSTRUCTION

Total depth drilled 80 ft.
Well finished to 80 ft.

Borehole diameter:
Top 6 in.
Bottom 6 in.

Well was finished: ☒ above grade
☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2 ft.

Was steel protective casing installed?
☒ Yes ☐ No

Static water level after drilling 16 ft.

Water level was measured using M Scope

Well was developed for 1 hours
at 7 gpm

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/ach no.)
Single/Inner Casing	+2	70	2	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	70	80	2	PVC	.020
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	68	80	6	Morie	#1
Grout	0	68	6	Neat Cement Bentonite	___ lbs. 100 lbs.

Grouting Method Tremie
Drilling Method Auger

Method of development Pump

Was permanent pumping equipment installed? ☐ Yes ☒ No

Pump capacity — gpm

Pump type: —

Drilling Fluid — Type of Rig CME 75

Health and Safety Plan submitted? ☐ Yes ☒ No

Level of Protection used on site (circle one) None [✓ D] C B A

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A.C. SCHULTES INC.
Well Driller (Print) CHRIS WARREN
Driller's Signature Chris [illegible]
Registration No. MD1546 Date 4 / 1 / 03

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations.

0-18 Med - Fine silty gray sand
18-36 Fine silty gray sand
36-62 Fine Med gray silty sand
62-80 Med gray silty sand w/ clay streaks

AS-BUILT WELL LOCATION
(NAD 83 HORIZONTAL DATUM)
NJ STATE PLANE COORDINATE IN US SURVEY FEET

NORTHING: ______ EASTING: ______
OR
LATITUDE: ___° ___' ___.__" LONGITUDE: ___° ___' ___.__"

COPIES: White - DEP Canary - Driller Pink - Owner Goldenrod - Health Dept.

R-138 M

New sey Department of Environmental Pro ion
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit No. 34 - 06020

Atlas Sheet Coordinates 31 : 01 : 035

OWNER IDENTIFICATION - Owner PSEG NUCLEAR LLC
Address PO BOX 236
City HANCOCKS BRIDGE State NJ Zip Code

WELL LOCATION - If not the same as owner please give address. Owner's Well No. MW 1 (Well M)
County SALEM Municipality LOWER ALLOWAYS Lot No. 4.01 Block No. 26
Address END OF ALLOWAY CREEK NECK RD
DATE WELL STARTED 2/24/03
DATE WELL COMPLETED 2/24/03

TYPE OF WELL (as per Well Permit Categories) MONITORING
Regulatory Program Requiring Well — Case I.D.# —

CONSULTING FIRM/FIELD SUPERVISOR (if applicable) — Tele. # —

WELL CONSTRUCTION

Total depth drilled 20 ft.
Well finished to 20 ft.

Borehole diameter:
Top 6 in.
Bottom 6 in.

Well was finished: ☒ above grade
☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2 ft.

Was steel protective casing installed?
☒ Yes ☐ No

Static water level after drilling 6 ft.

Water level was measured using M Scope

Well was developed for 1/2 hours at 3 gpm

Method of development pumping by airlifting

Was permanent pumping equipment installed? ☐ Yes ☒ No

Pump capacity — gpm

Pump type: —

Drilling Fluid — Type of Rig CME 75

Health and Safety Plan submitted? ☐ Yes ☒ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch./No.)
Single/Inner Casing	+2	10	1	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	10	20	1	SS	.010
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	8	20	6	Morie	#1
Grout	0	8	6	Neat Cement Bentonite	lbs. 50 lbs.

Grouting Method Tremie
Drilling Method Auger

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations.

0-20' Fine tan/orange sand

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A.C. SCHULTES INC
Well Driller (Print) CHRIS WARREN
Driller's Signature Chris Warren
Registration No. MD 1546 Date 4/1/03

AS-BUILT WELL LOCATION
(NAD 83 HORIZONTAL DATUM)
NJ STATE PLANE COORDINATE IN US SURVEY FEET

NORTHING: ____ EASTING: ____
OR
LATITUDE: ___° ___' ___.__" LONGITUDE: ___° ___' ___.__"

COPIES: White - DEP : Canary - Driller Pink - Owner Goldenrod - Health Dept.

8/97

Water Supply Element - Bureau of Water Allocation

WELL ABANDONMENT REPORT

MAIL TO: Bureau of Water Allocation
PO Box 426
Trenton, NJ 08625-0426

WELL PERMIT # 34-06028 of well sealed

DATE WELL SEALED 5/6/03

PROPERTY OWNER PSE&G Services Corp

ADDRESS 80 Park Place Newark, NJ 07102

WELL LOCATION Artificial Island Lower Alloway Twp., NJ Salem
Street & No., Township, County

Well No. Well M
Lot No. 4.01
Block No. 26

USE OF WELL PRIOR TO ABANDONMENT: Monitoring

REASON FOR ABANDONMENT: Decommission

WAS A NEW WELL DRILLED? ☒ YES ☐ NO PERMIT # OF NEW WELL 3400006990

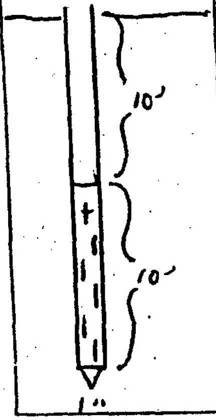
TOTAL DEPTH OF WELL 20'
DIAMETER 1"
CASING LENGTH 10'
SCREEN LENGTH 10'
NUMBER OF CASINGS 1

MATERIAL USED TO DECOMMISSION WELL:

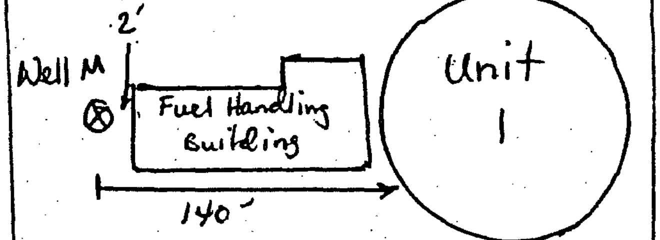
* NA	Gallons of Water
NA	Lbs. of Cement
NA	Lbs. of Bentonite
NA	Lbs. of Sand/Gravel (none if well is contaminated)

FORMATION:
___ Consolidated
X Unconsolidated

Cross-section of sealed well



Draw a sketch showing distance and relations of well site to nearest roads, buildings, etc.



* Probe rods + millslot screen overdrilled with 3¼ HSA to depth. Wellpoint was removed and a new prepack well was installed

N

To permit adequate grouting, the casing should remain in place, but ungrouted liner pipes or any other obstructions must be removed. Pressure grouting is the only accepted method.

WAS CASING LEFT IN PLACE? ☐ YES ☒ NO CASING MATERIAL:

WERE OTHER OBSTRUCTIONS LEFT IN WELL? ☐ YES ☒ NO WHAT WERE THE OBSTRUCTIONS:

IF "YES", AUTHORIZATION GRANTED BY ___ (NJDEP Official) ON ___ (Date)

Was an alternative decommissioning method used? ☐ YES ☒ NO

IF "YES", authorization granted by ___ (NJDEP Official) ON ___ (Date)

I certify that this well was sealed in accordance with N.J.A.C. 7:9-9.1 et seq.

Nicholas A. Fallucca
Performing Work (Print or Type) Name of NJ Certified Well Sealer

PO Box 423 West Creek, NJ
Address

Nicholas A. Fallucca
Signature of NJ Certified Well Sealer Performing Work

6/26/03
Mailing Date

J1526
Registration #

COPIES: *White - Water Allocation* *Yellow - Owner* *Pink - Health Dept.* *Goldenrod - Driller*

Bureau of Water Allocation

MONITORING WELL RECORD

3400006990

Atlas Sheet Coordinates 3401635

OWNER IDENTIFICATION PSE&G Services Corp

[illegible]ess 80 Park Place

[illegible] Newark State New Jersey Zip Code 07102

WELL LOCATION - If not the same as owner please give address Owner's Well No. Well M

County Salem Municipality Lower Alloway Twp. Lot No. 4.01 Block No. 26

Address Artificial Island

WELL USE Monitoring

DATE WELL STARTED 5/6/03

DATE WELL COMPLETED 5/6/03

WELL CONSTRUCTION

Total Depth Drilled 20 ft.

Finished Well Depth 20 ft.

Borehole Diameter:

Top 6 in.

Bottom 6 in.

Well was finished: ☒ above grade ☐ flush mounted

If finished above grade, casing height (stick up) above land surface 3 ft.

Steel protective casing installed?

☒ Yes ☐ No

[illegible]atic Water Level after drilling 6 ft.

Water Level was Measured Using Tape

Well was developed for 1 hours at 3/4 gpm

Method of development Peristoltic Pump

Pump Capacity ——— gpm

Pump Type ———

Drilling Fluid ——— Type of Rig Geoprobe 66DT

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+3	10	1	PVC	sch 40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used .010)	10	20	1	* PVC/s.s.	sch 40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	** 7.5'	20	6	# 1 well gravel	**200 lbs
Grout	0	7.5	6	cement/bentonite	126 lbs 7 lbs

Grouting Method Tremie

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-20' fine to med orange sand, trace gravel

* 1" PVC w/stainless steel mesh wrap (2.5" OD sand pack)

** install sand pack around pre-packed screen

I certify that I have constructed the above referenced well in accordance with all wellpermit requirements and applicable State rules and regulations.

Drilling Company C T & E ENVIRONMENTAL SERVICES

Well Driller (Print) Nicholas A. Fallucca

Driller's Signature Nick A. Fallucca

[illegible]egistration No. J1526 Date 6/26/03

3550

ORIGINAL: DEP *COPIES: DRILLER* *OWNER* *HEALTH DEPARTMENT*

DWR-138 M
8/00

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit No. 34 - 06020

Atlas Sheet Coordinates 31 : 91 : 735

OWNER IDENTIFICATION - Owner PSE&G NUCLEAR LLC
Address PO BOX 236
City HANCOCK'S BRIDGE State NJ Zip Code

WELL LOCATION - If not the same as owner please give address. Owner's Well No. MW7 (Well-N)
County SALEM Municipality LOWER ALLOWAYS Lot No. 4.01 Block No. 26
Address END OF ALLOWAY CREEK NECK RD
DATE WELL STARTED 1/29/03
DATE WELL COMPLETED 1/30/03
TYPE OF WELL (as per Well Permit Categories) MONITORING
Regulatory Program Requiring Well — Case I.D.# —

CONSULTING FIRM/FIELD SUPERVISOR (if applicable) — Tele. # —

WELL CONSTRUCTION

Total depth drilled 20 ft.
Well finished to 20 ft.

Borehole diameter:
Top 6 in.
Bottom 6 in.

Well was finished: ☒ above grade
☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2 ft.

Was steel protective casing installed?
☒ Yes ☐ No

Static water level after drilling 6 ft.
Water level was measured using M Scope
Well was developed for 1/2 hours at 3 gpm

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+2	10	2	PVC	.40.
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	10	20	2	PVC	.010
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	8	20	6	Morie	#1
Grout	0	8	6	Neat Cement Bentonite	— lbs. 50 lbs.

Grouting Method Tremie
Drilling Method Auger

Method of development Pump

Was permanent pumping equipment installed? ☐ Yes ☒ No

Pump capacity — gpm

Pump type: —

Drilling Fluid — Type of Rig CME 75

Health and Safety Plan submitted? ☐ Yes ☒ No

Level of Protection used on site (circle one) None [✓ D] C B A

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A.C. SCHULTES INC.

Well Driller (Print) CHRIS WARREN

Driller's Signature Chris Warren

Registration No. MD 1546 Date 4/1/03

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations.

0-20 Fine Tan/Orange Sand

AS-BUILT WELL LOCATION
(NAD 83 HORIZONTAL DATUM)
NJ STATE PLANE COORDINATE IN US SURVEY FEET

NORTHING: ________ EASTING: ________
OR
LATITUDE: ___° ___' ___.___" LONGITUDE: ___° ___' ___.___"

COPIES: White - DEP Canary - Driller Pink - Owner Goldenrod - Health Dept.

WR-138 M
[illegible]/00

New [illegible]sey Department of Environmental Pro[illegible]on
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit No. 31 06930

Atlas Sheet Coordinates 34 : 01 : 935

OWNER IDENTIFICATION - Owner PSE&G NUCLEAR LLC
Address PO BOX 236
City HANCOCKS BRIDGE State NJ Zip Code

WELL LOCATION - If not the same as owner please give address. Owner's Well No. MW 3 (Well O)
County SALEM Municipality LOWER ALLOWAYS Lot No. 4.01 Block No. 26
Address END OF ALLOWAY CREEK NECK RD
DATE WELL STARTED 1 / 29 / 03
DATE WELL COMPLETED 1 / 29 / 03

TYPE OF WELL (as per Well Permit Categories) MONITORING
Regulatory Program Requiring Well — Case I.D.# —

CONSULTING FIRM/FIELD SUPERVISOR (if applicable) — Tele. # —

WELL CONSTRUCTION

Total depth drilled 20 ft.
Well finished to 20 ft.

Borehole diameter:
Top 6 in.
Bottom 1 in.

Well was finished: ☒ above grade
☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2 ft.

Was steel protective casing installed?
☒ Yes ☐ No

Static water level after drilling 6 ft.

Water level was measured using M Scope

Well was developed for 1/2 hours at 3 gpm

Method of development pump

Was permanent pumping equipment installed? ☐ Yes ☒ No

Pump capacity — gpm

Pump type: —

Drilling Fluid — Type of Rig CME 75

Health and Safety Plan submitted? ☐ Yes ☒ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+2	10	2	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	10	20	2	PVC	[illegible].020
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	8	20	6	Morie	#1
Grout	0	8	6	Neat Cement Bentonite	lbs. 50 lbs.

Grouting Method Tremmie
Drilling Method Auger

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations.

0-20 Fine Tan/Gray Sand

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A.C. SCHULTES INC.

Well Driller (Print) CHRIS WARREN

Driller's Signature Chris Warren

Registration No. MD1546 Date 4/1/03

AS-BUILT WELL LOCATION
(NAD 83 HORIZONTAL DATUM)
NJ STATE PLANE COORDINATE IN US SURVEY FEET

NORTHING: ________ EASTING: ________
OR
LATITUDE: ___° ___' ___.__" LONGITUDE: ___° ___' ___.__"

COPIES: White - DEP Canary - Driller Pink - Owner Goldenrod - Health Dept.

DWR-138 M
8/00

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit No. 34- 06033

Atlas Sheet Coordinates 34 : 01 : 925

OWNER IDENTIFICATION - Owner PSEG NUCLEAR LLC
Address PO BOX 236
City HANCOCKS BRIDGE State NJ Zip Code

WELL LOCATION - If not the same as owner please give address. Owner's Well No. MW 6 (Well P)
County SALEM Municipality LOWER ALLOWAYS Lot No. 4.01 Block No. 26
Address END OF ALLOWAY CREEK NECK RD
DATE WELL STARTED 1 / 24 / 03
DATE WELL COMPLETED 3 / 25 / 03
TYPE OF WELL (as per Well Permit Categories) MONITORING
Regulatory Program Requiring Well Case I.D.#

CONSULTING FIRM/FIELD SUPERVISOR (if applicable) Tele. #

WELL CONSTRUCTION

Total depth drilled 80 ft.
Well finished to 80 ft.

Borehole diameter:
Top 6 in.
Bottom 6 in.

Well was finished: ☒ above grade
☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2 ft.

Was steel protective casing installed?
☒ Yes ☐ No

Static water level after drilling 16 ft.
Water level was measured using MScope
Well was developed for 1 hours at 2 gpm

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+2	70	2	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	70	80	2	PVC	.020
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	68	80	6	Morie	#1
Grout	0	68	6	Neat Cement Bentonite	lbs. 100 lbs.

Grouting Method Tremmie
Drilling Method Auger

Method of development Pump
Was permanent pumping equipment installed? ☐ Yes ☒ No
Pump capacity — gpm
Pump type: —
Drilling Fluid — Type of Rig CME 75
Health and Safety Plan submitted? ☐ Yes ☒ No
Level of Protection used on site (circle one) None [✓ D] C B A

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A.C. SCHULTES INC.
Well Driller (Print) CHRIS WARREN
Driller's Signature
Registration No. MO 1546 Date 4 / 1 / 03

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations.

0 - 18 Med Fine Silty gray sand
18 - 36 Fine silty gray sand
36 - 67 Fine Med gray silty sand
67 - 80 Med gray silty sand w/ clay streaks

AS-BUILT WELL LOCATION
(NAD 83 HORIZONTAL DATUM)
NJ STATE PLANE COORDINATE IN US SURVEY FEET

NORTHING: ________ EASTING: ________
OR
LATITUDE: __ ° __ ' __ . __ " LONGITUDE: __ ° __ ' __ . __ "

COPIES: White - DEP Canary - Driller Pink - Owner Goldenrod - Health Dept.

[illegible]R-138 M
[illegible]0

New [illegible]sey Department of Environmental Pro[illegible]tion
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit No. M - [illegible]

Atlas Sheet Coordinates [illegible] - 01 - [illegible]

OWNER IDENTIFICATION - Owner PSEG NUCLEAR LLC
Address PO BOX 235
City HANCOCKS BRIDGE State NJ Zip Code

WELL LOCATION - If not the same as owner please give address. Owner's Well No. MW7 (Well Q)
County SALEM Municipality LOWER ALLOWAYS Lot No. 5 Block No. 26
Address ALLOWAY CREEK NECK RD
DATE WELL STARTED 2 / 4 / 03
DATE WELL COMPLETED 2 / 25 / 03
TYPE OF WELL (as per Well Permit Categories) MONITORING
Regulatory Program Requiring Well —
Case I.D.# —

CONSULTING FIRM/FIELD SUPERVISOR (if applicable) — Tele. # —

WELL CONSTRUCTION

Total depth drilled 80 ft.
Well finished to 80 ft.

Borehole diameter:
Top 6 in.
Bottom 6 in.

Well was finished: ☒ above grade
☐ flush mounted

If finished above grade, casing height (stick-up) above land surface 2 ft.

Was steel protective casing installed?
☒ Yes ☐ No

Static water level after drilling 16 ft.
Water level was measured using M Scope
Well was developed for 1 hours at 2 gpm.
Method of development Pump
Was permanent pumping equipment installed? ☐ Yes ☒ No
Pump capacity — gpm
Pump type: —
Drilling Fluid — Type of Rig CME 75
Health and Safety Plan submitted? ☐ Yes ☒ No
Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+2	70	2	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	70	80	2	PVC	.020
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	68	80	6	# Morie	#1
Grout	0	68	6	Neat Cement Bentonite	lbs. 100 lbs.

Grouting Method Tremie
Drilling Method Auger

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations.

0-18 Med - Fine SILTY gray Sand
18-36 Fine SILTY gray Sand
36-62 Fine - Med gray silty Sand
62-80 Med gray SILTY SAND w/clay streaks

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A.C. SCHULTES INC.
Well Driller (Print) CHRIS WARREN
Driller's Signature Chris Warren
Registration No. M1546 Date 4 / 1 / 03

AS-BUILT WELL LOCATION
(NAD 83 HORIZONTAL DATUM)

NJ STATE PLANE COORDINATE IN US SURVEY FEET

NORTHING: ________ EASTING: ________
OR
LATITUDE: ___° ___' ___.__" LONGITUDE: ___° ___' ___.__"

COPIES: White - DEP Canary - Driller Pink - Owner Goldenrod - Health Dept.

DWR-188 M
8/00

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit No. 34 06042

Atlas Sheet Coordinates 34 : 01 : 415

OWNER IDENTIFICATION - Owner PSE&G NUCLEAR LLC
Address PO BOX 236
City HANCOCKS BRIDGE State NJ Zip Code

WELL LOCATION - If not the same as owner please give address. Owner's Well No. MW8 (Well R)
County SALEM Municipality LOWER ALLOWAYS Lot No. 4.01 Block No. 25
Address ALLOWAY CREEK NECK RD
DATE WELL STARTED 3 / 7 / 03
TYPE OF WELL (as per Well Permit Categories) MONITORING DATE WELL COMPLETED 3 / 7 / 03
Regulatory Program Requiring Well — Case I.D.# —

CONSULTING FIRM/FIELD SUPERVISOR (If applicable) — Tele. # —

WELL CONSTRUCTION

Total depth drilled 20 ft.
Well finished to 20 ft.
Borehole diameter:
Top 6 in.
Bottom 6 in.
Well was finished: ☒ above grade ☐ flush mounted
If finished above grade, casing height (stick up) above land surface 2 ft.
Was steel protective casing installed? ☒ Yes ☐ No
Static water level after drilling 6 ft.
Water level was measured using M Scope
Well was developed for 1/2 hours at 3 gpm
Method of development pumping by air lifting
Was permanent pumping equipment installed? ☐ Yes ☒ No
Pump capacity — gpm
Pump type: —
Drilling Fluid — Type of Rig CME 75
Health and Safety Plan submitted? ☐ Yes ☒ No
Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch No.)
Single/Inner Casing	+2	10	1	PVC	40"
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	10	20	1	SS	.010
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	8	20	6	Morie	#1
Grout	0	8	6	Neat Cement Bentonite	___ lbs. 50 lbs.

Grouting Method Tremie
Drilling Method Auger

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations.

0-20' FINE / tan / gray SAND

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A.C. SCHULTES INC.
Well Driller (Print) CHRIS WARREN
Driller's Signature Chris Warren
Registration No. MD 1546 Date 4/1/03

AS-BUILT WELL LOCATION
(NAD 83 HORIZONTAL DATUM)
NJ STATE PLANE COORDINATE IN US SURVEY FEET

NORTHING: ________ EASTING: ________
OR
LATITUDE: ___ ° ___ ' ___ . ___ " LONGITUDE: ___ ° ___ ' ___ . ___ "

COPIES: White - DEP Canary - Driller Pink - Owner Goldenrod - Health Dept.

DWR-020
8/97

New Jersey Department of Environmental Protection
Water Supply Element - Bureau of Water Allocation

WELL ABANDONMENT REPORT

AIL TO: **Bureau of Water Allocation**
PO Box 426
Trenton, NJ 08625-0426

WELL PERMIT # 34-06042 of well sealed

DATE WELL SEALED 6/3/03

PROPERTY OWNER PSE&G Services Corp

ADDRESS 80 Park Place Newark, NJ 07102

WELL LOCATION Artificial Island Lower Alloway Twp., NJ Salem
Street & No., Township, County

Well No. Well R

Lot No. 4.01

Block No. 26

USE OF WELL PRIOR TO ABANDONMENT: Monitoring

REASON FOR ABANDONMENT: Decommission

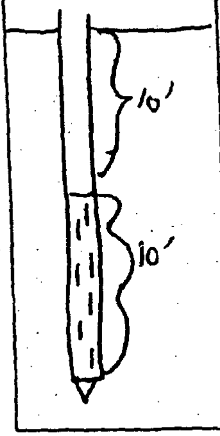
WAS A NEW WELL DRILLED? ☒ YES ☐ NO PERMIT # OF NEW WELL 3400006991

TOTAL DEPTH OF WELL 20'
DIAMETER 1"
CASING LENGTH 10'
SCREEN LENGTH 10'
NUMBER OF CASINGS 1

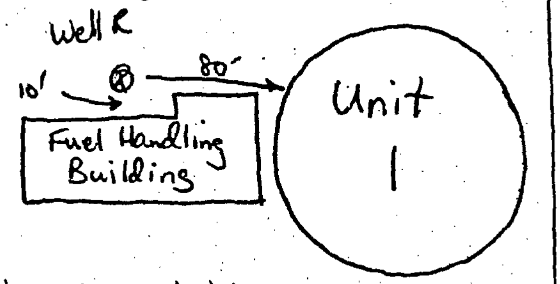
MATERIAL USED TO DECOMMISSION WELL:
* NA Gallons of Water
NA Lbs. of Cement
NA Lbs. of Bentonite
NA Lbs. of Sand/Gravel
(none if well is contaminated)

FORMATION:
___ Consolidated
X Unconsolidated

Cross-section of sealed well



Draw a sketch showing distance and relations of well site to nearest roads, buildings, etc.



* Probe rods + millslot screen overdrilled with 3¼ HSA to depth. Wellpoint was removed and a new prepack well was installed.

↑N

To permit adequate grouting, the casing should remain in place, but ungrouted liner pipes or any other obstructions must be removed. Pressure grouting is the only accepted method.

WAS CASING LEFT IN PLACE? ☐ YES ☒ NO CASING MATERIAL: ______

WERE OTHER OBSTRUCTIONS LEFT IN WELL? ☐ YES ☒ NO WHAT WERE THE OBSTRUCTIONS: ______

IF "YES", AUTHORIZATION GRANTED BY ______ (NJDEP Official) ON ______ (Date)

Was an alternative decommissioning method used? ☐ YES ☒ NO

IF "YES", authorization granted by ______ (NJDEP Official) ON ______ (Date)

I certify that this well was sealed in accordance with N.J.A.C. 7:9-9.1 et seq.

Nicholas A. Fallucca
Performing Work (Print or Type)
Name of NJ Certified Well Sealer

PO Box 423 West Creek, NJ
Address

6/26/03
Mailing Date

Signature of NJ Certified Well Sealer
Performing Work

J1526
Registration #

COPIES: *White - Water Allocation* *Yellow - Owner* *Pink - Health Dept.* *Goldenrod - Driller*

Bureau of Water Allocation

MONITORING WELL RECORD

3400006991

Atlas Sheet Coordinates 3401635

OWNER IDENTIFICATION PSE&G Services Corp

A[illegible]ess 80 Park Place

[illegible] Newark State New Jersey Zip Code 07102

WELL LOCATION - If not the same as owner please give address Owner's Well No. Well R

County Salem Municipality Lower Alloway Twp. Lot No. 4.01 Block No. 26

Address Artificial Island

WELL USE Monitoring **DATE WELL STARTED** 6/3/03

DATE WELL COMPLETED 6/3/03

WELL CONSTRUCTION

Total Depth Drilled 20 ft.

Finished Well Depth 20 ft.

Borehole Diameter:

Top 6 in.

Bottom 6 in.

Well was finished: ☒ above grade ☐ flush mounted

If finished above grade, casing height (stick up) above land surface 3 ft.

Steel protective casing installed? [illegible] Yes ☐ No

[illegible]tic Water Level after drilling 6 ft.

Water Level was Measured Using Tape

Well was developed for 1 hours at 3/4 gpm

Method of development Peristoltic Pump

Pump Capacity ______ gpm

Pump Type ______

Drilling Fluid ______ Type of Rig Geoprobe 66DT

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+3	10	1	PVC	sch 40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used .010)	10	20	1	* PVC/s.s.	sch 40
Blank Casings (No. Used ______)					
Tail Piece					
Gravel Pack	** 7.5'	20	6	# 1 well gravel	**200 lbs
Grout	0	7.5	6	cement/bentonite	126 lbs 7 lbs

Grouting Method Tremie

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-20' fine to med orange sand, trace gravel

* 1" PVC w/stainless steel mesh wrap (2.5" OD sand pack)

** install sand pack around pre-packed screen

I certify that I have constructed the above referenced well in accordance with all wellpermit requirements and applicable State rules and regulations.

Drilling Company C T & E ENVIRONMENTAL SERVICES

Well Driller (Print) Nicholas A. Fallucca

Driller's Signature Nick A. Fallucca

[illegible]gistration No. J1526 Date 6/26/03

3550

ORIGINAL: DEP *COPIES:* *DRILLER* *OWNER* *HEALTH DEPARTMENT*

Bureau of Water Allocation

MONITORING WELL RECORD

3400006995
Atlas Sheet Coordinates
3401635

[illegible]R IDENTIFICATION PSE&G Services Corp
[illegible]s 80 Park Place
City Newark State New Jersey Zip Code 07102

WELL LOCATION - If not the same as owner please give address Owner's Well No. GM-1 (Well S)
County Salem Municipality Lower Alloway Twp. Lot No. 4.01 Block No. 26
Address Artificial Island

WELL USE Monitoring **DATE WELL STARTED** 5/29/03
DATE WELL COMPLETED 5/30/03

WELL CONSTRUCTION
Total Depth Drilled 35 ft.
Finished Well Depth 35 ft.
Borehole Diameter:
Top 8 in in.
Bottom 8 in in.
Well was finished: ☒ above grade ☐ flush mounted
If finished above grade, casing height (stick up) above land surface 2.5 ft.
[illegible]el protective casing installed? [illegible]es ☐ No
Static Water Level after drilling 9 ft.
Water Level was Measured Using Tape
Well was developed for 1/2 hours at 2 gpm
Method of development Pump
Pump Capacity 5 gpm
Pump Type Submersible
Drilling Fluid ---------------- Type of Rig Mobile B-61
Health and Safety Plan Submitted? ☒ Yes ☐ No
Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+2.5	25	2	PVC	sch 40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used .010)	25	35	2	PVC	sch 40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	23	35	8	#1 sand	400 lbs
Grout	0	23	8	Cement/bentonite	400 lbs 10 lbs

Grouting Method Tremie
Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-10' fill
10-34' black silt & sand
34-35' grey med sand

I certify that I have constructed the above referenced well in accordance with all wellpermit requirements and applicable State rules and regulations.

Drilling Company C T & E ENVIRONMENTAL SERVICES
Well Driller (Print) Marc Hauge
Driller's Signature Marc Haug
[illegible]gistration No. J23173 Date 6/26/03

3550

ORIGINAL: DEP *COPIES: DRILLER* *OWNER* *HEALTH DEPARTMENT*

MONITORING WELL RECORD

Atlas Sheet Coordinates 3401635

OWNER IDENTIFICATION PSE&G Services Corp

Address 80 Park Place

City Newark State New Jersey Zip Code 07102

[illegible]L LOCATION - If not the same as owner please give address Owner's Well No. GM-1 (Well S) Revised

County Salem Municipality Lower Alloway Twp. Lot No. 4.01 Block No. 26

Address Artificial Island Changes made 2/6/04

WELL USE Monitoring

DATE WELL STARTED 5/29/03

DATE WELL COMPLETED 5/30/03

WELL CONSTRUCTION

Total Depth Drilled 35 ft.

Finished Well Depth 35 ft.

Borehole Diameter:

Top 8 in in.

Bottom 8 in in.

Well was finished: ☒ above grade ☒ flush mounted

If finished above grade, casing height (stick up) above land surface ~~2.5~~ ft.

Steel protective casing installed?

☒ Yes ☒ No

Static Water Level after drilling 9 ft.

Water Level was Measured Using Tape

[illegible] was developed for 1/2 hours

[illegible] 2 gpm

Method of development Pump

Pump Capacity 5 gpm

Pump Type Submersible

Drilling Fluid ______ Type of Rig Mobile B-61

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+~~2.5~~	25	2	PVC	sch 40
Middle Casing (for triple cased wells only)	-3"				
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used .010)	25	35	2	PVC	sch 40
Blank Casings (No. Used ______)					
Tail Piece					
Gravel Pack	23	35	8	#1 sand	400 lbs
Grout	0	23	8	Cement/bentonite	400 lbs 10 lbs

Grouting Method Tremie

Drilling Method HSA

GEOLOGIC LOG
Note each depth where water was encountered in consolidated formations
0-10' fill
10-34' black silt & sand
34-35' grey med sand

I certify that I have constructed the above referenced well in accordance with all wellpermit requirements and applicable State rules and regulations.

Drilling Company C T & E ENVIRONMENTAL SERVICES

Well Driller (Print) Marc Hauge

Driller's Signature Marc Hauge

Registration No. J23173 Date 6/26/03

3550

[illegible]RIGINAL: DEP *COPIES: DRILLER* *OWNER* *HEALTH DEPARTMENT*

Bureau of Water Allocation

3400006992

MONITORING WELL RECORD

Atlas Sheet Coordinates 3401635

[illegible]ER IDENTIFICATION PSE&G Services Corp

[illegible]ss 80 Park Place

[illegible] Newark State New Jersey Zip Code 07102

WELL LOCATION - If not the same as owner please give address Owner's Well No. GM-3 (Well T)

County Salem Municipality Lower Alloway Twp. Lot No. 4.01 Block No. 26

Address Artificial Island

WELL USE Monitoring **DATE WELL STARTED** 6/5/03

DATE WELL COMPLETED 6/5/03

WELL CONSTRUCTION

Total Depth Drilled 35 ft.

Finished Well Depth 35 ft.

Borehole Diameter:

Top 8 in m.

Bottom 8 in M.

Well was finished: ☒ above grade ☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2.5 ft.

[illegible]eel protective casing installed? [illegible] Yes ☐ No

[illegible]atic Water Level after drilling 9 ft.

Water Level was Measured Using Tape

Well was developed for 1/2 hours at 2 gpm

Method of development Pump

Pump Capacity 5 gpm

Pump Type Submersible

Drilling Fluid ____________ Type of Rig Mobile B-61

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+2.5	25	2	PVC	sch 40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used .010)	25	35	2	PVC	sch 40
Blank Casings (No. Used ______)					
Tail Piece					
Gravel Pack	23	35	8	#1 sand	450 lbs
Grout	0	23	8	Cement/bentonite	400 lbs 10 lbs

Grouting Method Tremie

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-10' fill

10-33' black silt & sand

33-35' grey med sand

I certify that I have constructed the above referenced well in accordance with all wellpermit requirements and applicable State rules and regulations.

Drilling Company C T & E ENVIRONMENTAL SERVICES

Well Driller (Print) Marc Hauge

Driller's Signature Marc Hauge

[illegible]gistration No. J23173 Date 6/26/03

3550

ORIGINAL: DEP *COPIES: DRILLER* *OWNER* *HEALTH DEPARTMENT*

Bureau of Water Allocation

3400006994

MONITORING WELL RECORD

Atlas Sheet Coordinates 3401635

OWNER IDENTIFICATION PSE&G Services Corp

[illegible]ess 80 Park Place

[illegible] Newark State New Jersey Zip Code 07102

WELL LOCATION - If not the same as owner please give address Owner's Well No. GM-2 (Well U)

County Salem Municipality Lower Alloway Twp. Lot No. 4.01 Block No. 26

Address Artificial Island

WELL USE Monitoring **DATE WELL STARTED** 5/28/03

DATE WELL COMPLETED 5/29/03

WELL CONSTRUCTION

Total Depth Drilled 32 ft.

Finished Well Depth 32 ft.

Borehole Diameter:

Top 8 in m.

Bottom 8 in M.

Well was finished: ☒ above grade ☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2.5 ft.

Steel protective casing installed? [illegible]Yes ☐ No

[illegible]tatic Water Level after drilling 8 ft.

Water Level was Measured Using Tape

Well was developed for 1/2 hours at 2 gpm

Method of development Pump

Pump Capacity 5 gpm

Pump Type Submersible

Drilling Fluid ____________ Type of Rig Mobile B-61

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+2.5	27	2	PVC	sch 40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used .010)	27	32	2	PVC	sch 40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	25	32	8	#1 sand	200 lbs
Grout	0	25	8	Cement/bentonite	400 lbs 10 lbs

Grouting Method Tremie

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-10' fill

10-28' black silt & sand

28-32' grey med sand

I certify that I have constructed the above referenced well in accordance with all wellpermit requirements and applicable State rules and regulations.

Drilling Company C T & E ENVIRONMENTAL SERVICES

Well Driller (Print) Marc Hauge

Driller's Signature Marc Hauge

[illegible]gistration No. J23173 Date 6/26/03

3550

ORIGINAL: DEP *COPIES: DRILLER* *OWNER* *HEALTH DEPARTMENT*

MONITORING WELL RECORD

Atlas Sheet Coordinates 3401635

OWNER IDENTIFICATION PSE&G Services Corp

Address 80 Park Place

[illegible] Newark State New Jersey **Zip Code** 07102

[illegible]LL LOCATION - If not the same as owner please give address Owner's Well No. GM-2 (Well U) Revised

[illegible]unty Salem Municipality Lower Alloway Twp. Lot No. 4.01 Block No. 26

Address Artificial Island Changes made 2/11/04

WELL USE Monitoring **DATE WELL STARTED** 5/28/03

DATE WELL COMPLETED 5/29/03

WELL CONSTRUCTION

Total Depth Drilled 32 ft.

Finished Well Depth 32 ft.

Borehole Diameter:

Top 8 in in.

Bottom 8 in M.

Well was finished: ■ above grade

☒ flush mounted

If finished above grade, casing height (stick up) above land surface ~~2.5~~ ft.

Steel protective casing installed?

■ Yes ☒ No

Static Water Level after drilling 8 ft.

Water Level was Measured Using Tape

[illegible]l was developed for 1/2 hours

2 gpm

Method of development Pump

Pump Capacity 5 gpm

Pump Type Submersible

Drilling Fluid ______ Type of Rig Mobile B-61

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	~~+2.5~~ -3"	27	2	PVC	sch 40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used .010)	27	32	2	PVC	sch 40
Blank Casings (No. Used ______)					
Tail Piece					
Gravel Pack	25	32	8	#1 sand	200 lbs
Grout	0	25	8	Cement/bentonite	400 lbs 10 lbs

Grouting Method Tremie

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-10' fill

10-28' black silt & sand

28-32' grey med sand

I certify that I have constructed the above referenced well in accordance with all wellpermit requirements and applicable State rules and regulations.

Drilling Company C T & E ENVIRONMENTAL SERVICES

Well Driller (Print) Marc Hauge

Driller's Signature Marc Hauge

Registration No. J23173 Date 6/26/03

3550

ORIGINAL: DEP *COPIES: DRILLER* *OWNER* *HEALTH DEPARTMENT*

Bureau of Water Allocation

3400006993

MONITORING WELL RECORD

Atlas Sheet Coordinates 3401635

OWNER IDENTIFICATION PSE&G Services Corp

ress 80 Park Plaza

[illegible] Newark State New Jersey Zip Code 07102

WELL LOCATION - If not the same as owner please give address Owner's Well No. GM-2D (Well V)

County Salem Municipality Lower Alloway Twp Lot No. 4.01 Block No. 26

Address Artificial Island

WELL USE Monitoring **DATE WELL STARTED** 6/5/03

DATE WELL COMPLETED 6/12/03

WELL CONSTRUCTION

Total Depth Drilled 80 ft.

Finished Well Depth 80 ft.

Borehole Diameter:

Top 10 in m.

Bottom 6 in M.

Well was finished: ☒ above grade ☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2.5 ft.

Steel protective casing installed? [illegible] Yes ☐ No

atic Water Level after drilling 16 ft.

Water Level was Measured Using Mscope

Well was developed for 1/2 hours at 3 gpm

Method of development Pump

Pump Capacity 5 gpm

Pump Type Submersible Pump

Drilling Fluid Quick Gel Type of Rig Mobile B-61

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+2.5	70	2	PVC	Sch 40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)	0	53	6	PVC	sch 40
Open Hole or Screen (No. Used .010)	70	80	2	PVC	sch 40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	67	80	6	#1 sand	350 lbs
Grout	0/0	53/67	10/6	Cement/bentonite	1400 lbs 49 lbs

Grouting Method Tremie

Drilling Method Mud Rotary

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-10' Fill

10-33' Black silt & sand

33-36' Grey med sand

36-54' Grey clay

54-80' Green & black sand

I certify that I have constructed the above referenced well in accordance with all wellpermit requirements and applicable State rules and regulations.

Drilling Company C T & E ENVIRONMENTAL SERVICES

Well Driller (Print) Marc Hauge

Driller's Signature Marc Hauge

gistration No. J23173 Date 6/26/03

3550

ORIGINAL: DEP *COPIES:* *DRILLER* *OWNER* *HEALTH DEPARTMENT*

MONITORING WELL RECORD

Atlas Sheet Coordinates 3401635

OWNER IDENTIFICATION PSE&G Services Corp

Address 80 Park Plaza

C[illegible] Newark State New Jersey Zip Code 07102

[illegible]L LOCATION - If not the same as owner please give address Owner's Well No. GM-2D (Well V) Revised

[illegible]unty Salem Municipality Lower Alloway Twp Lot No. 4.01 Block No. 26

Address Artificial Island Changes made 2/11/04

WELL USE Monitoring **DATE WELL STARTED** 6/5/03

DATE WELL COMPLETED 6/12/03

WELL CONSTRUCTION

Total Depth Drilled 80 ft.

Finished Well Depth 80 ft.

Borehole Diameter:

Top 10 in in.

Bottom 6 in in.

Well was finished: ☒ above grade ☒ flush mounted

If finished above grade, casing height (stick up) above land surface ~~2.5~~ ft.

Steel protective casing installed? ☒ Yes ☒ No

Static Water Level after drilling 16 ft.

Water Level was Measured Using Mscope

[illegible] was developed for 1/2 hours

3 gpm

Method of development Pump

Pump Capacity 5 gpm

Pump Type Submersible Pump

Drilling Fluid Quick Gel Type of Rig Mobile B-61

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	~~+2.5~~	70	2	PVC	Sch 40
Middle Casing (for triple cased wells only)	-3"				
Outer Casing (largest diameter)	0	53	6	PVC	sch 40
Open Hole or Screen (No. Used .010)	70	80	2	PVC	sch 40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	67	80	6	#1 sand	350 lbs
Grout	0/0	53/67	10/6	Cement/bentonite	1400 lbs 49 lbs

Grouting Method Tremie

Drilling Method Mud Rotary

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-10' Fill

10-33' Black silt & sand

33-36' Grey med sand

36-54' Grey clay

54-80' Green & black sand

I certify that I have constructed the above referenced well in accordance with all wellpermit requirements and applicable State rules and regulations.

Drilling Company C T & E ENVIRONMENTAL SERVICES

Well Driller (Print) Marc Hauge

Driller's Signature Marc Hauge

Registration No. J23173 Date 6/26/03

3550

ORIGINAL: DEP *COPIES: DRILLER OWNER HEALTH DEPARTMENT*

Bureau of Water Allocation

MONITORING WELL RECORD

3400006999

Atlas Sheet Coordinates 3401635

)WNER IDENTIFICATION PSE&G Services Corp

[illegible]s 80 Park Place

[illegible] Newark State New Jersey **Zip Code** 07102

WELL LOCATION - If not the same as owner please give address Owner's Well No. GM-4 (Well W)

County Salem Municipality Lower Alloway Twp. Lot No. 4.01 Block No. 26

Address Artificial Island

WELL USE Monitoring **DATE WELL STARTED** 6/2/03

DATE WELL COMPLETED 6/3/03

WELL CONSTRUCTION

Total Depth Drilled 35 ft.

Finished Well Depth 35 ft.

Borehole Diameter:

Top 8in m.

Bottom 8in M.

Well was finished: ☒ above grade

☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2.5 ft.

[illegible]eel protective casing installed?

[illegible]es ☐No

[illegible]tic Water Level after drilling 8 ft.

Water Level was Measured Using Tape

Well was developed for 1/2 hours

at 2 gpm

Method of development Pump

Pump Capacity 5 gpm

Pump Type Submersible Pump

Drilling Fluid ------------------ Type of Rig Mobile B-61

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+2.5	25	2	PVC	sch 40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used .010)	25	35	2	PVC	sch 40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	23	35	8	# 1 well gravel	450 lbs
Grout	0	23	8	Cement/bentonite	400 lbs 10 lbs

Grouting Method Tremie

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-10' Fill

10-33' Black silt and sand

33-35' Grey sand

I certify that I have constructed the above referenced well in accordance with all wellpermit requirements and applicable State rules and regulations.

Drilling Company C T & E ENVIRONMENTAL SERVICES

Well Driller (Print) Marc Hauge

Driller's Signature Marc Hauge

[illegible]istration No. J23173 Date 6/26/03

3550

ORIGINAL: DEP *COPIES:* *DRILLER* *OWNER* *HEALTH DEPARTMENT*

MONITORING WELL RECORD

Atlas Sheet Coordinates 3401635

OWNER IDENTIFICATION PSE&G Services Corp

Address 80 Park Place

City Newark State New Jersey **Zip Code** 07102

[illegible]L LOCATION - If not the same as owner please give address Owner's Well No. GM-4 (Well W) Revised

[illegible]unty Salem Municipality Lower Alloway Twp. Lot No. 4.01 Block No. 26

Address Artificial Island Changes made 2/5/04

WELL USE Monitoring **DATE WELL STARTED** 6/2/03

DATE WELL COMPLETED 6/3/03

WELL CONSTRUCTION

Total Depth Drilled 35 ft.

Finished Well Depth 35 ft.

Borehole Diameter:

Top 8in in.

Bottom 8in in.

Well was finished: ■ above grade ☒ flush mounted

If finished above grade, casing height (stick up) above land surface ~~25~~ ft.

Steel protective casing installed?

■ Yes ☒ No

Static Water Level after drilling 8 ft.

Water Level was Measured Using Tape

[illegible] was developed for 1/2 hours

[illegible]2 gpm

Method of development Pump

Pump Capacity 5 gpm

Pump Type Submersible Pump

Drilling Fluid ______ Type of Rig Mobile B-61

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	~~35~~	25	2	PVC	sch 40
Middle Casing (for triple cased wells only)	-3"				
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used .010)	25	35	2	PVC	sch 40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	23	35	8	# 1 well gravel	450 lbs
Grout	0	23	8	Cement/bentonite	400 lbs 10 lbs

Grouting Method Tremie

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-10' Fill

10-33' Black silt and sand

33-35' Grey sand

I certify that I have constructed the above referenced well in accordance with all wellpermit requirements and applicable State rules and regulations.

Drilling Company C T & E ENVIRONMENTAL SERVICES

Well Driller (Print) Marc Hauge

Driller's Signature Marc Hauge

Registration No. J23173 Date 6 /26/ 03

3550

ORIGINAL: DEP *COPIES:* *DRILLER* *OWNER* *HEALTH DEPARTMENT*

New Jersey Department of Environmental Protection
Bureau of Water Allocation

Well Permit Number 3400007078

Atlas Sheet Coordinates 3401635

MONITORING WELL RECORD

OWNER IDENTIFICATION PSE&G SERVICES CORP

[illegible]ess 80 PARK PLACE

City Newark State New Jersey Zip Code 07102

WELL LOCATION - If not the same as owner please give address Owner's Well No. Y

County Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26

Address ARTIFICIAL ISLAND SALEM GENERATING STATION

WELL USE Monitoring

DATE WELL STARTED 9/26/03

DATE WELL COMPLETED 10/7/03

WELL CONSTRUCTION

Total Depth Drilled 37 ft.

Finished Well Depth 37 ft.

Borehole Diameter:

Top 6 in.

Bottom 6 in.

Well was finished: ☒ above grade ☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2.5 ft.

[illegible]eel protective casing installed? ☒ Yes ☐ No

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/~~Inner~~ Casing	+2 1/2	27	2	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	27	37	2	PVC	.010" SLOT
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	25	37	6	MORIE	#1
Grout	0	25	6	Neat Cement Bentonite	___ lbs 100 lbs

Static Water Level after drilling 10 ft.

Water Level was Measured Using M-SCOPE

Well was developed for 3 hours at 1 gpm

Method of development Pumping

Pump Capacity 6 gpm

Pump Type GRUNFOS SUB

Drilling Fluid N/A Type of Rig CME-75

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Grouting Method TREMMIE

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-9' F-M GREY SAND
9-14' M-GREY SILTY SAND
14-24' F-M GREY SILTY SAND
24-37' M-GREY SAND W/SILT LAYERS

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A C SCHULTES INC

Well Driller (Print) CHRIS WARREN

[illegible]iller's Signature Chris Warren

Registration No. MD-1540 Date 12/3/03

D24249-06

ORIGINAL: DEP *COPIES: DRILLER OWNER HEALTH DEPARTMENT*

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit Number 3400007079

Atlas Sheet Coordinates 3401635

[illegible]R IDENTIFICATION PSE&G SERVICES CORP

[illegible]ss 80 PARK PLACE

City Newark State New Jersey Zip Code 07102

WELL LOCATION - If not the same as owner please give address Owner's Well No. Z

County Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26

Address ARTIFICIAL ISLAND SALEM GENERATING STATION

WELL USE Monitoring

DATE WELL STARTED 10/1/03

DATE WELL COMPLETED 10/7/03

WELL CONSTRUCTION

Total Depth Drilled 37.5 ft.

Finished Well Depth 37.5 ft.

Borehole Diameter:

Top 6 in.

Bottom 6 in.

Well was finished: ☒ above grade ☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2 1/2 ft.

[illegible]l protective casing installed? ☒ Yes ☐ No

Static Water Level after drilling 10.5 ft.

Water Level was Measured Using M-Scope

Well was developed for 1 hours at 2 gpm

Method of development PUMPING

Pump Capacity 6 gpm

Pump Type GRUNDFOS SUB

Drilling Fluid N/A Type of Rig CME-75

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/~~Inner~~ Casing	+2 1/2	27.5	2	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	27.5	37.5	2	PVC	.010" slot
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	25.5	37.5	6	Morie	#1
Grout	0	25.5	6	Neat Cement Bentonite	lbs 100 lbs

Grouting Method Tremmie

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-11' F-M GREY SAND

11-16' M-GREY SILTY SAND

16'-25' F-M GREY SILTY SAND

25-37.5' F-M GREY SAND W/SILT LAYERS

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A C SCHULTES INC

Well Driller (Print) CHRIS WARREN

[illegible]riller's Signature Chris Warren

Registration No. MD-1576 Date 10/3/03

D24249-04

ORIGINAL: DEP *COPIES: DRILLER* *OWNER* *HEALTH DEPARTMENT*

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit Number 3400007080

Atlas Sheet Coordinates 3401635

OWNER IDENTIFICATION PSE&G SERVICES CORP

[illegible]ss 80 PARK PLACE

City Newark State New Jersey Zip Code 07102

WELL LOCATION - If not the same as owner please give address **Owner's Well No.** AA

County Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26

Address ARTIFICIAL ISLAND SALEM GENERATING STATION

WELL USE Monitoring

DATE WELL STARTED 10-3-03

DATE WELL COMPLETED 10-8-03

WELL CONSTRUCTION

Total Depth Drilled 36 ft.

Finished Well Depth 36 ft.

Borehole Diameter:

Top 6 in.

Bottom 6 in.

Well was finished: ☒ above grade ☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2½ ft.

[illegible]el protective casing installed? ☒ Yes ☐ No

Static Water Level after drilling 10 ft.

Water Level was Measured Using M-SCOPE

Well was developed for 1 hours at 2 gpm

Method of development PUMPING

Pump Capacity 6 gpm

Pump Type GRUNFOS SUB

Drilling Fluid N/A Type of Rig CME-75

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: ~~Measure all depths from land surface~~	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/~~Inner~~ Casing	+2½	26	2	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	26	36	2	PVC	.010" SLOT
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	24	36	6	MORIE	#1
Grout	0	24	6	Neat Cement Bentonite	___ lbs 100 lbs

Grouting Method TREMMIE

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-7' F-M ORANGE SAND

7-15' MED TAN + ORANGE SILTY SAND

15-26' F-M GREY SILTY SAND

26-36' M-GREY SILTY SAND W/SILT LAYERS

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A C SCHULTES INC

Well Driller (Print) CHRIS WARREN

[illegible]iller's Signature Chris Warren

Registration No. MD-1546 Date 10/13/03

D26249-06

ORIGINAL: DEP *COPIES:* *DRILLER* *OWNER* *HEALTH DEPARTMENT*

Bureau of Water Allocation

MONITORING WELL RECORD

3400007080
Atlas Sheet Coordinates
3401635

OWNER IDENTIFICATION PSE&G SERVICES CORP

ddress 80 PARK PLACE

Newark State New Jersey Zip Code 07102

ELL LOCATION - If not the same as owner please give address Owner's Well No. AA Revised

County Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26

Address ARTIFICIAL ISLAND SALEM GENERATING STATION

Changes made 2/5/04

WELL USE Monitoring

DATE WELL STARTED 10-2-03

DATE WELL COMPLETED 10-8-03

WELL CONSTRUCTION

Total Depth Drilled 36 ft.

Finished Well Depth 36 ft.

Borehole Diameter:

Top 6 in.

Bottom 6 in.

Well was finished: ~~☒ above grade~~

☒ flush mounted

If finished above grade, casing height (stick up) above land surface ~~2½~~ ft.

Steel protective casing installed?

~~☒~~ Yes ☒ No

Static Water Level after drilling 10 ft.

ter Level was Measured Using m-scope

ell was developed for 1 hours

at 2 gpm

Method of development pumping

Pump Capacity 6 gpm

Pump Type GRUNFOS SUB

Drilling Fluid N/A Type of Rig CME-75

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/~~Inner~~ Casing	~~+2½~~	26	2	PVC	40
Middle Casing (for triple cased wells only)	-3"				
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	26	36	2	PVC	.010" SLOT
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	24	36	6	MORIE	#1
Grout	0	24	6	Neat Cement Bentonite	___ lbs 100 lbs

Grouting Method TREMMIE

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-7' F-M ORANGE SAND

7-15' MED TAN + ORANGE SILTY SAND

15-26' F-M GREY SILTY SAND

26-36' M-GREY SILTY SAND W/SILT LAYERS

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A C SCHULTES INC

Well Driller (Print) CHRIS WARREN

Driller's Signature Chris Warren

Registration No. MD-1546 Date 10/3/03

D26249-06

GINAL: DEP *COPIES: DRILLER* *OWNER* *HEALTH DEPARTMENT*

New Jersey Department of Environmental Protection
Bureau of Water Allocation

Well Permit Number 3400007081

Atlas Sheet Coordinates 3401635

MONITORING WELL RECORD

OWNER IDENTIFICATION PSE&G SERVICES CORP

[illegible]ss 80 PARK PLACE

City Newark State New Jersey Zip Code 07102

WELL LOCATION - If not the same as owner please give address **Owner's Well No.** AB

County Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26

Address ARTIFICIAL ISLAND SALEM GENERATING STATION

WELL USE Monitoring

DATE WELL STARTED 10-3-03

DATE WELL COMPLETED 10-8-03

WELL CONSTRUCTION

Total Depth Drilled 42 ft.

Finished Well Depth 42 ft.

Borehole Diameter:

Top 6 in.

Bottom 6 in.

Well was finished: ☒ above grade ☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2½ ft.

[illegible]l protective casing installed?

☒ Yes ☐ No

Static Water Level after drilling 10 ft.

Water Level was Measured Using M-SCOPE

Well was developed for 1.5 hours

at 1 gpm

Method of development PUMPING

Pump Capacity 6 gpm

Pump Type GRUNDFOS SUB

Drilling Fluid N/A Type of Rig CME-75

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single~~Inner~~ Casing	42½	32	2	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	37	42	2	PVC	.010 SLOT
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	30	42	6	MORIE	#1
Grout	0	30	6	Neat Cement Bentonite	___ lbs 100 lbs

Grouting Method TREMMIE

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-12' F-M TAN + ORANGE SAND

12-17' M-C TAN SAND

17-22' F-M ORANGE SILTY SAND

22-37 M-C TAN SAND

37-42' F-M GREY SAND

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A C SCHULTES INC

Well Driller (Print) CHRIS WARREN

[illegible]iller's Signature Chris Warren

Registration No. MD-1546 Date 12/3/03

D242490C

ORIGINAL: DEP ***COPIES: DRILLER OWNER HEALTH DEPARTMENT***

3400007081
Atlas Sheet Coordinates
3401635

MONITORING WELL RECORD

OWNER IDENTIFICATION PSE&G SERVICES CORP
ddress 80 PARK PLACE
Newark State New Jersey Zip Code 07102

ELL LOCATION - If not the same as owner please give address Owner's Well No. AB Revised
County Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26
Address ARTIFICIAL ISLAND SALEM GENERATING STATION

Changes Made 2/6/04

WELL USE Monitoring
DATE WELL STARTED 10-3-03
DATE WELL COMPLETED 10-8-03

WELL CONSTRUCTION

Total Depth Drilled 42 ft.
Finished Well Depth 42 ft.
Borehole Diameter:
Top 6 in.
Bottom 6 in.
Well was finished: ☒ above grade
☒ flush mounted
If finished above grade, casing height (stick up) above land surface ~~2½~~ ft.
Steel protective casing installed? ☒ Yes ☒ No
Static Water Level after drilling 10 ft.
ater Level was Measured Using m-scope
ell was developed for 1.5 hours
at 1 gpm
Method of development PUMPING
Pump Capacity 6 gpm
Pump Type GRUNDFOS SUB
Drilling Fluid N/A Type of Rig CME-75
Health and Safety Plan Submitted? ☒ Yes ☐ No
Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	~~+2½~~	32	2	PVC	40
Middle Casing (for triple cased wells only)	-3"				
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	32	42	2	PVC	.010" SLOT
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	30	42	6	MORIE	#1
Grout	0	30	6	Neat Cement Bentonite	___ lbs 100 lbs

Grouting Method TREMMIE
Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-12' F-M TAN + ORANGE SAND
12-17' M-C TAN SAND
17-22' F-M ORANGE SILTY SAND
22-37' M-C TAN SAND
37-42' F-M GREY SAND

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A C SCHULTES INC
Well Driller (Print) CHRIS WARREN
Driller's Signature Chris Warren
Registration No. MD-1546 Date 12/3/03

D24249-00

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New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit Number 3400007082

Atlas Sheet Coordinates 3401635

OWNER IDENTIFICATION PSE&G SERVICES CORP

[illegible]ss 80 PARK PLACE

City Newark State New Jersey Zip Code 07102

WELL LOCATION - If not the same as owner please give address **Owner's Well No.** AC

County Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26

Address ARTIFICIAL ISLAND SALEM GENERATING STATION

WELL USE Monitoring

DATE WELL STARTED 10-7-03

DATE WELL COMPLETED 10-8-03

WELL CONSTRUCTION

Total Depth Drilled 24 ft.

Finished Well Depth 24 ft.

Borehole Diameter:

Top 6 in.

Bottom 6 in.

Well was finished: ☒ above grade
☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2 1/2 ft.

[illegible]el protective casing installed?
☒ Yes ☐ No

Static Water Level after drilling 13 ft.

Water Level was Measured Using m-scope

Well was developed for 1 hours

at 1 gpm

Method of development pumping

Pump Capacity 6 gpm

Pump Type GRUNDFOS SUB

Drilling Fluid N/A Type of Rig CME-7

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/~~Inner~~ Casing	+2 1/2	14	2	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	14	24	2	PVC	.010" SLOT
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	12	24	6	MORIE	#2
Grout	0	12	6	Neat Cement Bentonite	___ lbs 100 lbs

Grouting Method Tremie

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-12' F-M ORANGE SAND

12-19' F+M ORANGE + TAN SILTY SAND

19-24' F-M ORANGE SAND

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A C SCHULTES INC

Well Driller (Print) CHRIS WARREN

[illegible]iller's Signature Chris Warren

Registration No. MD-1576 Date 12/3/03

D26249-06

ORIGINAL: DEP *COPIES:* *DRILLER* *OWNER* *HEALTH DEPARTMENT*

3400007082

MONITORING WELL RECORD

Atlas Sheet Coordinates

3401635

OWNER IDENTIFICATION PSE&G SERVICES CORP

Address 80 PARK PLACE

Newark State New Jersey Zip Code 07102

LL LOCATION - If not the same as owner please give address Owner's Well No. AC Revised

County Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26

Address ARTIFICIAL ISLAND SALEM GENERATING STATION

Changes made 2/6/04

WELL USE Monitoring

DATE WELL STARTED 10-7-03

DATE WELL COMPLETED 10-8-03

WELL CONSTRUCTION

Total Depth Drilled 24 ft.

Finished Well Depth 24 ft.

Borehole Diameter:

Top 6 in.

Bottom 6 in.

Well was finished: ☒ above grade ☒ flush mounted

If finished above grade, casing height (stick up) above land surface ~~[illegible]~~ ft.

Steel protective casing installed? ☒ Yes ☒ No

Static Water Level after drilling 13 ft.

er Level was Measured Using m-scope

ll was developed for 1 hours at 1 gpm

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	~~[illegible]~~	14	2	PVC	40
Middle Casing (for triple cased wells only)	-3"				
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	14	24	2	PVC	.010" Slot
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	12	24	6	MORIE	#2
Grout	0	12	6	Neat Cement Bentonite	____ lbs 100 lbs

Grouting Method TREMIE

Drilling Method HSA

Method of development PUMPING

Pump Capacity 6 gpm

Pump Type GRUNDFOS SUB

Drilling Fluid n/a Type of Rig CME-7

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

GEOLOGIC LOG

Note: each depth where water was encountered in consolidated formations

0-12' F-M ORANGE SAND

12-19' F+M ORANGE + TAN SILTY SAND

19-24' F-M ORANGE SAND

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A C SCHULTES INC

Well Driller (Print) CHRIS WARREN

Driller's Signature Chris Warren

Registration No. MD-1546 Date 12/3/03

D26249-04

GINAL: DEP *COPIES:* *DRILLER* *OWNER* *HEALTH DEPARTMENT*

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit Number 3400007083

Atlas Sheet Coordinates 3401635

OWNER IDENTIFICATION PSE&G SERVICES CORP

[illegible]ss 80 PARK PLACE

City Newark State New Jersey Zip Code 07102

WELL LOCATION - If not the same as owner please give address **Owner's Well No.** AD

County Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26

Address ARTIFICIAL ISLAND SALEM GENERATING STATION

WELL USE Monitoring

DATE WELL STARTED 10/6/03

DATE WELL COMPLETED 10/7/03

WELL CONSTRUCTION

Total Depth Drilled 43 ft.

Finished Well Depth 43 ft.

Borehole Diameter:

Top 13 in.

Bottom 13 in.

Well was finished: ☒ above grade ☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2½ ft.

[illegible]l protective casing installed? ☒ Yes ☐ No

Static Water Level after drilling 8 ft.

Water Level was Measured Using m-scope

Well was developed for 5 hours at 2 gpm

Method of development PUMPING

Pump Capacity 6 gpm

Pump Type GRUNDFOS SUB

Drilling Fluid N/A Type of Rig CME-75

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/~~Inner~~ Casing	+2½	33	6	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	33	43	6	PVC	.010" SLOT
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	30	43	13	Morie	#1
Grout	0	30	13	Neat Cement Bentonite	lbs 135 lbs

Grouting Method Tremmie

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-11' F-M TAN + ORANGE SAND

11-26' F-M ORANGE SAND

26-33' F-M TAN + ORANGE SAND

33-43' F-M GREY SILTY SAND W/MARSH MAT'L

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A C SCHULTES INC

Well Driller (Print) CHRIS WARREN

[illegible]iller's Signature Chris Warren

Registration No. MD-1546 Date 12/3/03

D26249-04

ORIGINAL: DEP *COPIES:* *DRILLER* *OWNER* *HEALTH DEPARTMENT*

Bureau of Water Allocation

3400007083

MONITORING WELL RECORD

Atlas Sheet Coordinates

3401635

OWNER IDENTIFICATION PSE&G SERVICES CORP

ss 80 PARK PLACE

Newark State New Jersey Zip Code 07102

ELL LOCATION - If not the same as owner please give address Owner's Well No. AD Revised

County Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26

Address ARTIFICIAL ISLAND SALEM GENERATING STATION Changes made 2/6/04

WELL USE Monitoring

DATE WELL STARTED 10/6/03

DATE WELL COMPLETED 10/7/03

WELL CONSTRUCTION

Total Depth Drilled 43 ft.

Finished Well Depth 43 ft.

Borehole Diameter:

Top 13 in.

Bottom 13 in.

Well was finished: ☒ above grade

☒ flush mounted

If finished above grade, casing height (stick up) above land surface ~~2½~~ ft.

Steel protective casing installed?

☒ Yes ☒ No

Static Water Level after drilling 8 ft.

r Level was Measured Using M-SCOPE

ell was developed for 5 hours

at 2 gpm

Method of development PUMPING

Pump Capacity 6 gpm

Pump Type GRUNDFOS SUB

Drilling Fluid N/A Type of Rig CME-75

Health and Safety Plan Submitted? ☒ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	~~2½~~	33	6	PVC	40
Middle Casing (for triple cased wells only)	-3"				
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 1)	33	43	6	PVC	.010" slot
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	30	43	13	morie	#1
Grout	0	30	13	Neat Cement Bentonite	lbs 135 lbs

Grouting Method Tremmie

Drilling Method HSA

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-11' F-M TAN + ORANGE SAND

11-26' F-M ORANGE SAND

26-33' F-M TAN + ORANGE SAND

33-43' F-M GREY SILTY SAND W/MARSH MAT'L

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A C SCHULTES INC

Well Driller (Print) CHRIS WARREN

Driller's Signature Chris Warren

Registration No. MD-1546 Date 12/3/03

D26249-06

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New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit Number
3400007084

Atlas Sheet Coordinates
3403535

[illegible]ER IDENTIFICATION PSE&G CORP.

[illegible]ess 80 PARK PLACE

City Newark State New Jersey Zip Code 07102

WELL LOCATION - If not the same as owner please give address **Owner's Well No.** AE (MW-7)

County Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26

Address ARTIFICAL ISLAND SALEM GENERATING STATION

WELL USE Monitoring

DATE WELL STARTED 10/5/03

DATE WELL COMPLETED 10/8/03

WELL CONSTRUCTION

Total Depth Drilled 27.5 ft.

Finished Well Depth 27.5 ft.

Borehole Diameter:

Top 6 in.

Bottom 6 in.

Well was finished: ☒ above grade ☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2 1/2 ft.

[illegible]el protective casing installed?

☒ Yes ☐ No

Static Water Level after drilling 8 ft.

Water Level was Measured Using m-scope

Well was developed for 1 hours at 1 gpm

Method of development Pumping

Pump Capacity 6 gpm

Pump Type Grunfos sub

Drilling Fluid n/a Type of Rig CME-75

Health and Safety Plan Submitted? ☐ Yes ☒ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/~~Inner~~ Casing	+2 1/2	17.5	2	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used .010)	17.5	27.5	2	PVC	40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	14	27.5	6	Morie	#1
Grout	0	14	6	Neat Cement Bentonite	lbs 100 lbs

Grouting Method Tremmie

Drilling Method Auger

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-9 FT F-M tan & orange sand

9-17' M-orange sand

17-27.5' F-M tan & orange silty sand

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A C SCHULTES INC

Well Driller (Print) CHRIS WARREN

[illegible]riller's Signature Chris Warren

Registration No. MD-1546 Date 12/3/03

D2U249-04

ORIGINAL: DEP *COPIES: DRILLER* *OWNER* *HEALTH DEPARTMENT*

New Jersey Department of Environmental Protection
Bureau of Water Allocation

Well Permit Number
3400007085

Atlas Sheet Coordinates
3403535

MONITORING WELL RECORD

ER IDENTIFICATION PSE&G CORP.
ss 80 PARK PLACE
City Newark State New Jersey Zip Code 07102

WELL LOCATION - If not the same as owner please give address **Owner's Well No.** AF(mw-8)
County Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26
Address ARTIFICAL ISLAND SALEM GENERATING STATION

WELL USE Monitoring
DATE WELL STARTED 10/6/03
DATE WELL COMPLETED 10/8/03

WELL CONSTRUCTION
Total Depth Drilled 45 ft.
Finished Well Depth 45 ft.
Borehole Diameter:
Top 6 in.
Bottom 6 in.
Well was finished: ☒ above grade ☐ flush mounted
If finished above grade, casing height (stick up) above land surface 2½ ft.
el protective casing installed? ☑ Yes ☐ No
Static Water Level after drilling 16 ft.
Water Level was Measured Using m-scope
Well was developed for 1 hours at 7 gpm
Method of development pumping
Pump Capacity 25 gpm
Pump Type submersible
Drilling Fluid n/a Type of Rig CME-75
Health and Safety Plan Submitted? ☐ Yes ☒ No
Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	2½	25	*2	PVC	40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
~~Open Hole~~ or Screen (No. Used .010")	25	45	*2	PVC	40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	22	45	6	#2	none
Grout	0	22	6	Neat Cement Bentonite	___ lbs 100 lbs

Grouting Method tremmie
Drilling Method Auger

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-10': F-M TAN + ORANGE SAND
10-21': MED ORANGE SAND
21-34': M-C ORANGE + TAN SAND
34-39': F-M ORANGE SILTY SAND
39-45' F-M YELLOW TAN SAND

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company A C SCHULTES INC
Well Driller (Print) CHRIS WARREN
iller's Signature Chris Warren
Registration No. MD-1576 Date 12/3/03

D24249-06

ORIGINAL: DEP *COPIES: DRILLER* *OWNER* *HEALTH DEPARTMENT*

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit Number 3400007135
Atlas Sheet Coordinates 3401634

OWNER IDENTIFICATION PSE&G SERVICES CORP
Ad[illegible]ss 80 PARK PLACE
[illegible] Newark State New Jersey Zip Code 07102

WELL LOCATION - If not the same as owner please give address Owner's Well No. AG-Shallow
County Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26
Address ALLOWAY CREEK NECK RD SALEM GENERATING STATION AI

WELL USE Monitoring
DATE WELL STARTED 2/10/04
DATE WELL COMPLETED 2/11/04

WELL CONSTRUCTION
Total Depth Drilled 24.5 ft.
Finished Well Depth 24.5 ft.
Borehole Diameter:
Top 7 in.
Bottom 7 in.
Well was finished: ☐ above grade ☑ flush mounted
If finished above grade, casing height (stick up) above land surface ___ ft.
Steel protective casing installed? [illegible] ☐ No
[illegible]c Water Level after drilling 9 ft.
Water Level was Measured Using tape
Well was developed for 1 hours at .5 gpm
Method of development pump
Pump Capacity ___ gpm
Pump Type ___
Drilling Fluid ___ Type of Rig Auger
Health and Safety Plan Submitted? ☑ Yes ☐ No
Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	-3"	14.5	1	PVC	Sch40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 010)	14.5	24.5	1	PVC	Sch40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	13	24	7	morie sand	200lbs
Grout	0	13	7	Neat Cement Bentonite	282 lbs 15 lbs

Grouting Method Tremie
Drilling Method Hollow stem auger

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-10' Sand gravel tan
10-24' black silt sand
water @ 9'

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company TALON DRILLING CO
Well Driller (Print) Joseph Abell
Driller's Signature Joseph Abell
[illegible]ation No. 0C[illegible]31 Date 3/1/04

03329

AS-BUILT WELL LOCATION (NAD 83 HORIZONTAL DATUM)

NJ STATE PLANE COORDINATE IN US SURVEY FEET
NORTHING: ___ EASTING: ___
OR
LATITUDE: ___ ° ___ ' ___ " LONGITUDE: ___ ° ___ ' ___ "

ORIGINAL: DEP *COPIES: DRILLER OWNER HEALTH DEPARTMENT*

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit Number 3400007153

Atlas Sheet Coordinates 3401634

W[redacted] IDENTIFICATION PSE&G SERVICES CORP.

[redacted] 80 PARK PLACE

ity Newark State New Jersey Zip Code 07102

/ELL LOCATION - If not the same as owner please give address Owner's Well No. AG-Deep Formerly known
AGO

ounty Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26

.ddress ALLOWAY CREEK NECK RD SALEM GENERATING STATION

/ELL USE Monitoring

DATE WELL STARTED 2/9/04

DATE WELL COMPLETED 2/9/04

/ELL CONSTRUCTION

'otal Depth Drilled 40 ft.

'inished Well Depth 40 ft.

3orehole Diameter:

Top 7 in.

Bottom 7 in.

Vell was finished: ☑ above grade ☐ flush mounted

f finished above grade, casing height stick up) above land surface 2 ft.

iteel protective casing installed? [redacted] ☐ No

itatic Water Level after drilling 9 ft.

Vater Level was Measured Using tape

Vell was developed for 1 hours

it .5 gpm

Aethod of development Sub pump

'ump Capacity ______ gpm

'ump Type

Drilling Fluid Type of Rig Auger

Iealth and Safety Plan Submitted? ☑ Yes ☐ No

.evel of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+2	30	1	PVC	Sch40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 010)	30	40	1	PVC	Sch40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	28	40	7	morrie	250 lbs.
Grout	0	28	7	Neat Cement Bentonite	94 lbs 5 lbs

Grouting Method Tremie

Drilling Method Hollow stem auger

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-10' sand, gravel, silt, fill

10-30' sand, gravel, silt, black fill

30-40' coarse gravel, sand, silt

Water @ 10'

AS-BUILT WELL LOCATION (NAD 83 HORIZONTAL DATUM)

NJ STATE PLANE COORDINATE IN US SURVEY FEET

NORTHING: ______ EASTING: ______

OR

LATITUDE: ___ ° ___ ' ___ . ___ " LONGITUDE: ___ ° ___ ' ___ . ___ "

certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company TALON DRILLING CO

Vell Driller (Print) Joseph Abell

Driller's Signature Joseph Abell

[redacted]ation No. 0024431 Date 2/20/04

[redacted]
03329

'RIGINAL: DEP *COPIES: DRILLER* *OWNER* *HEALTH DEPARTMENT*

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit Number 3400007136

Atlas Sheet Coordinates 3401634

WNER IDENTIFICATION PSE&G SERVICES CORP

ddress 80 PARK PLACE

[illegible] Newark State New Jersey Zip Code 07102

VELL LOCATION - If not the same as owner please give address Owner's Well No. AH shallow

County Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26

ddress ALLOWAY CREEK NECK RD SALEM GENERATING STATION AI

VELL USE Monitoring

DATE WELL STARTED 2/5/04

DATE WELL COMPLETED 2/5/04

WELL CONSTRUCTION

Total Depth Drilled 25 ft.

Finished Well Depth 25 ft.

Borehole Diameter:
Top 7 in.
Bottom 7 in.

Well was finished: ☑ above grade
☐ flush mounted

If finished above grade, casing height (stick up) above land surface 2 ft.

Steel protective casing installed?
[illegible] ☐ No

[illegible] Water Level after drilling 9 ft.

Water Level was Measured Using tape

Well was developed for 1 hours
at 5 gpm

Method of development sub pump

Pump Capacity ____ gpm

Pump Type ____

Drilling Fluid ____ Type of Rig Auger

Health and Safety Plan Submitted? ☑ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	+2	15	1	PVC	Sch40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 010)	15	25	1	PVC	Sch40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	14	25	7	Sand	200 lbs.
Grout	0	14	7	Neat Cement Bentonite	376 lbs 20 lbs

Grouting Method Tremie

Drilling Method Hollow stem auger

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-10' Sand gravel tan

10-25' Silt sand black

Water @ 10'

AS-BUILT WELL LOCATION (NAD 83 HORIZONTAL DATUM)

NJ STATE PLANE COORDINATE IN US SURVEY FEET

NORTHING: ____ EASTING: ____

OR

LATITUDE: ___° ___' ___.__" LONGITUDE: ___° ___' ___.__"

certify that I have constructed the above referenced well in ccordance with all well permit requirements and applicable State ules and regulations.

rilling Company TALON DRILLING CO

Vell Driller (Print) Joseph Abell

riller's Signature Joseph Abell Jr.

[illegible]tion No. 0024431 Date 3/1/04

D3329

RIGINAL: DEP *COPIES:* *DRILLER* *OWNER* *HEALTH DEPARTMENT*

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit Number 3400007154
Atlas Sheet Coordinates 3401634

IDENTIFICATION PSE&G SERVICES CORP.
80 PARK PLACE
ty Newark State New Jersey Zip Code 07102

'ELL LOCATION - If not the same as owner please give address Owner's Well No. AH Deep Formerly known as AHD
ounty Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26
ddress ALLOWAY CREEK NECK RD SALEM GENERATING STATION

'ELL USE Monitoring
DATE WELL STARTED 2/4/04
DATE WELL COMPLETED 2/4/04

VELL CONSTRUCTION

'otal Depth Drilled 40 ft.
'inished Well Depth 40 ft.
3orehole Diameter:
Top 7 in.
Bottom 7 in.
Well was finished: ☐ above grade ☑ flush mounted
If finished above grade, casing height (stick up) above land surface ____ ft.
protective casing installed?
s ☐ No
Static Water Level after drilling 9.5 ft.
Water Level was Measured Using tape
Well was developed for 1 hours
at .5 gpm
Method of development sub pump
Pump Capacity ____ gpm
Pump Type ____
Drilling Fluid ____ Type of Rig Auger
Health and Safety Plan Submitted? ☑ Yes ☐ No
Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	-3"	30	1	PVC	Sch40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 010)	30	40	1	PVC	Sch40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	28	40	7	morrie	250 lbs.
Grout	0	28	7	Neat Cement Bentonite	94 lbs 5 lbs

Grouting Method Tremie
Drilling Method Hollow stem auger

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-10' sand gravel fill
10-20' sand silt fill
20-30' silt sand gravel gray fill
30-40' silt sand river gravel black
Water @ 10'

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company TALON DRILLING CO
Well Driller (Print) Joseph Abell
iller's Signature Joseph Abell
ation No. 0C24431 Date 2/20/04

03329

AS-BUILT WELL LOCATION (NAD 83 HORIZONTAL DATUM)

NJ STATE PLANE COORDINATE IN US SURVEY FEET
NORTHING: ____ EASTING: ____
OR
LATITUDE: ___° ___' ___.__" LONGITUDE: ___° ___' ___.__"

RIGINAL: DEP *COPIES: DRILLER* *OWNER* *HEALTH DEPARTMENT*

New Jersey Department of Environmental Protection
Bureau of Water Allocation

Well Permit Number
3400007137

MONITORING WELL RECORD

Atlas Sheet Coordinates
3401634

'WNER IDENTIFICATION PSE&G SERVICES CORP

[illegible]s 80 PARK PLACE

Newark State New Jersey Zip Code 07102

VELL LOCATION - If not the same as owner please give address Owner's Well No. AT

:ounty Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26

\ddress ALLOWAY CREEK NECK RD SALEM GENERATING STATION AI

VELL USE Monitoring

DATE WELL STARTED 1/20/04

DATE WELL COMPLETED 1/20/04

WELL CONSTRUCTION

Total Depth Drilled 22 ft.

Finished Well Depth 22 ft.

3orehole Diameter:

Top 10 in.

Bottom 10 in.

Well was finished: ☐ above grade ☑ flush mounted

:f finished above grade, casing height (stick up) above land surface ____ ft.

Steel protective casing installed? [illegible] ☐ No

[illegible]c Water Level after drilling 9 ft.

Water Level was Measured Using tape

Well was developed for 3 hours

it .5 gpm

Method of development sub pump

Pump Capacity ____ gpm

Pump Type ____

Drilling Fluid ____ Type of Rig Auger

Health and Safety Plan Submitted? ☑ Yes ☐ No

Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	-3"	12	4	PVC	Sch40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 010)	12	22	4	PVC	Sch40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	9	22	10	Morie Sand	500 lbs.
Grout	0	9	10	Neat Cement Bentonite	284 lbs 15 lbs

Grouting Method Tremie

Drilling Method Hollow stem auger

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-9' Silt sand, gravel, tan
9-22'

certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company TALON DRILLING CO

Vell Driller (Print) Joseph Abell

Driller's Signature Joseph Abell

[illegible]ation No. 0024431 Date 2/20/04

03339

AS-BUILT WELL LOCATION
(NAD 83 HORIZONTAL DATUM)

NJ STATE PLANE COORDINATE IN US SURVEY FEET

NORTHING: ____ EASTING: ____

OR

LATITUDE: ___ ° ___ ' ___ . ___ " LONGITUDE: ___ ° ___ ' ___ . ___ "

'RIGINAL: DEP *COPIES: DRILLER* *OWNER* *HEALTH DEPARTMENT*

New Jersey Department of Environmental Protection
Bureau of Water Allocation

Well Permit Number 3400007140

Atlas Sheet Coordinates 3401634

MONITORING WELL RECORD

W[illegible]R IDENTIFICATION PSE&G SERVICES CORP
80 PARK PLACE
ity Newark State New Jersey Zip Code 07102

VELL LOCATION - If not the same as owner please give address Owner's Well No. AL
ounty Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26
ddress ALLOWAY CREEK NECK RD SALEM GENERATING STATION AI

VELL USE Monitoring
DATE WELL STARTED 1/21/04
DATE WELL COMPLETED 1/21/04

VELL CONSTRUCTION

otal Depth Drilled 25 ft.
inished Well Depth 25 ft.
Borehole Diameter:
Top 7 in.
Bottom 7 in.
Well was finished: ☐ above grade ☑ flush mounted
If finished above grade, casing height (stick up) above land surface ____ ft.
Ste[illegible]protective casing installed? [illegible] ☐ No
Static Water Level after drilling 9 ft.
Water Level was Measured Using tape
Well was developed for 3 hours
t .5 gpm
Method of development sub pump
Pump Capacity ____ gpm
Pump Type ____
Drilling Fluid ____ Type of Rig Auger
Health and Safety Plan Submitted? ☑ Yes ☐ No
evel of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	-3'	15	2	PVC	Sch40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 010)	15	25	2	PVC	Sch40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	13	25	7	Morie	400lbs
Grout	0	13	7	Neat Cement Bentonite	284 lbs 15 lbs

Grouting Method Tremie
Drilling Method Hollow stem auger

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-10' sand gravel
10-25' sand silt gravel
water @ 9'

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State rules and regulations.

Drilling Company TALON DRILLING CO
Well Driller (Print) Joseph Abell
[illegible]'s Signature Joseph Abell
[illegible]ation No. 0024431 Date 2/20/04

33329

AS-BUILT WELL LOCATION (NAD 83 HORIZONTAL DATUM)

NJ STATE PLANE COORDINATE IN US SURVEY FEET
NORTHING: ____ EASTING: ____
OR
LATITUDE: ___° ___' ___.__" LONGITUDE: ___° ___' ___.__"

RIGINAL: DEP *COPIES: DRILLER* *OWNER* *HEALTH DEPARTMENT*

New Jersey Department of Environmental Protection
Bureau of Water Allocation

MONITORING WELL RECORD

Well Permit Number 3400007141
Atlas Sheet Coordinates 3401634

NER IDENTIFICATION PSE&G SERVICES CORP
80 PARK PLACE
y Newark State New Jersey Zip Code 07102

ELL LOCATION - If not the same as owner please give address **Owner's Well No.** Am
unty Salem Municipality Lower Alloways Creek Lot No. 4.01 Block No. 26
ddress ALLOWAY CREEK NECK RD SALEM GENERATING STATION A

ELL USE Monitoring
DATE WELL STARTED 1/15/04
DATE WELL COMPLETED 1/15/04

ELL CONSTRUCTION
otal Depth Drilled 21 ft.
inished Well Depth 21 ft.
orehole Diameter:
Top 10 in.
Bottom 10 in.
Well was finished: ☐ above grade ☑ flush mounted
If finished above grade, casing height (stick up) above land surface ____ ft.
protective casing installed?
s ☐ No
Static Water Level after drilling 9 ft.
Water Level was Measured Using tape
Well was developed for 3 hours
at .5 gpm
Method of development sub pump
Pump Capacity ____ gpm
Pump Type ____
Drilling Fluid ____ Type of Rig Auger
Health and Safety Plan Submitted? ☑ Yes ☐ No
Level of Protection used on site (circle one) None [✓ D] C B A

Note: Measure all depths from land surface	Depth to Top (ft.)	Depth to Bottom (ft.)	Diameter (inches)	Material	Wgt./Rating (lbs/sch no.)
Single/Inner Casing	-3"	11	4	PVC	Sch 40
Middle Casing (for triple cased wells only)					
Outer Casing (largest diameter)					
Open Hole or Screen (No. Used 010)	11	21	4	PVC	Sch 40
Blank Casings (No. Used)					
Tail Piece					
Gravel Pack	8.5	21	10	Morie sand	500lbs
Grout	0	8.5	10	Neat Cement Bentonite	284 lbs 15 lbs

Grouting Method Tremie
Drilling Method Hollow stem auger

GEOLOGIC LOG

Note each depth where water was encountered in consolidated formations

0-9' Sand, gravel, silt, fill
9-21' Sand, gravel, silt, fill

I certify that I have constructed the above referenced well in accordance with all well permit requirements and applicable State ules and regulations.

rilling Company TALON DRILLING CO
ell Driller (Print) Joseph Abell
iller's Signature Joseph Abell Jr
ation No. 0024431 Date 2/20/04

AS-BUILT WELL LOCATION (NAD 83 HORIZONTAL DATUM)

NJ STATE PLANE COORDINATE IN US SURVEY FEET
NORTHING: ____ EASTING: ____
OR
LATITUDE: ____ ° ____ ' ____ . ____ " LONGITUDE: ____ ° ____ ' ____ . ____ "

03339

RIGINAL: DEP *COPIES: DRILLER* *OWNER* *HEALTH DEPARTMENT*

Appendix D

Tidal Evaluation Results

DRAFTER: V.JAYARAMAN

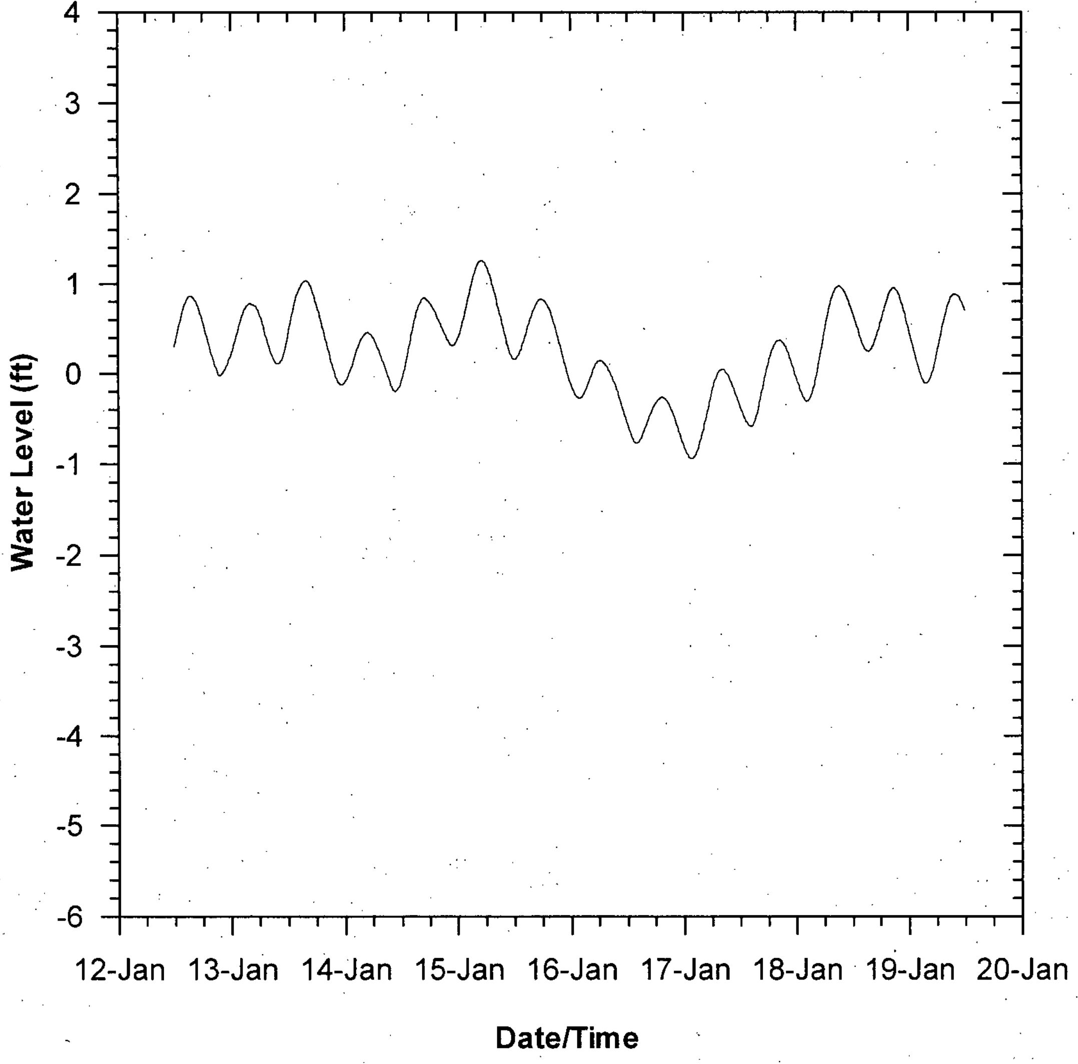
APPROVED: P.MILIONIS

CHECKED: S.POTTER

FILE NO.: Well - K.grf

PRJCT NO.: NP000571.0003

DWG DATE: 2/10/04



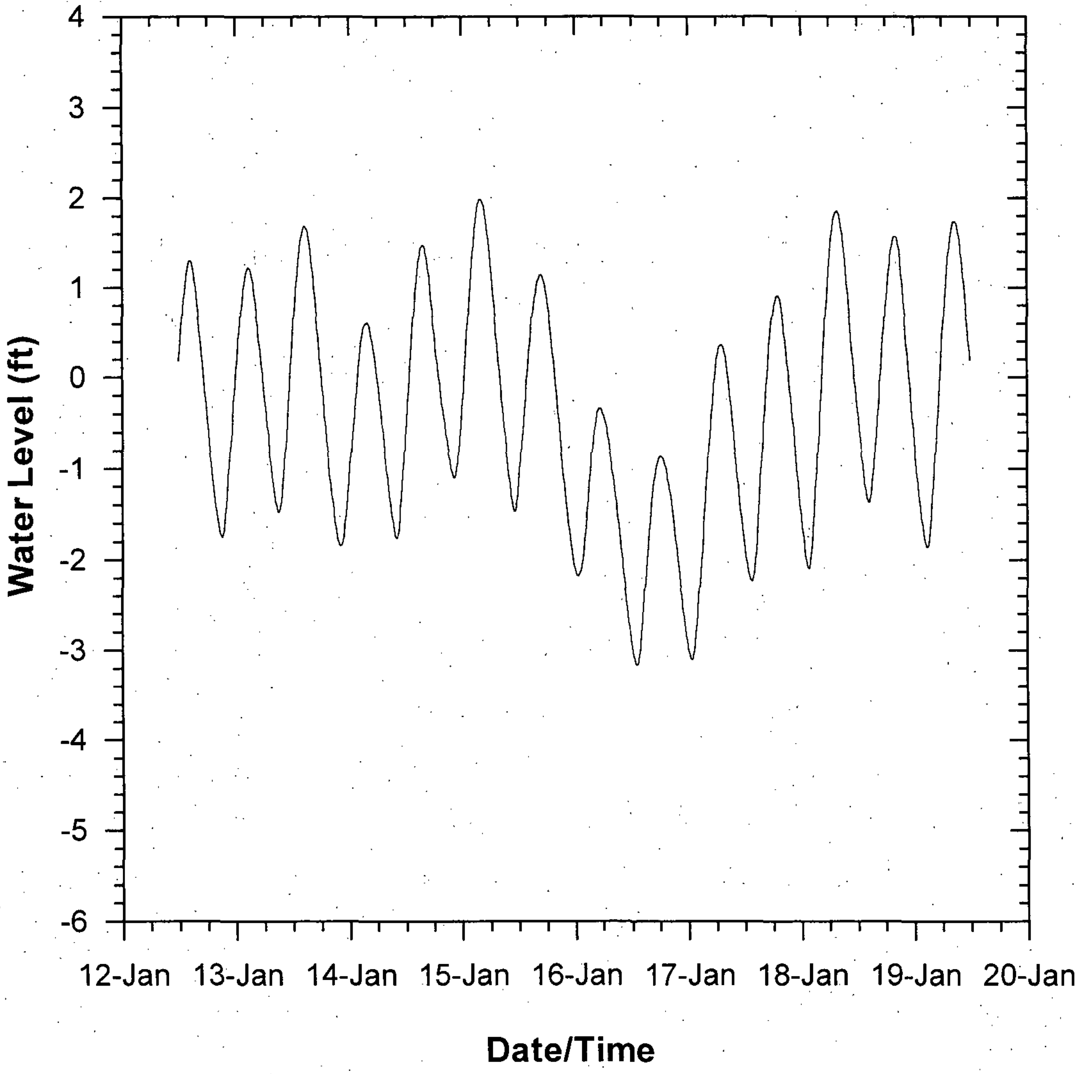
ARCADIS

Water Level In Well K
Tidal Assessment - 1/12 to 1/20

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
D-1

DRAFTER: V.JAYARAMAN
APPROVED: P.MILIONIS
CHECKED: S.POTTER
FILE NO.: Well - L.grf
PRJCT NO.: NP000571.0003
DWG DATE: 02/10/04



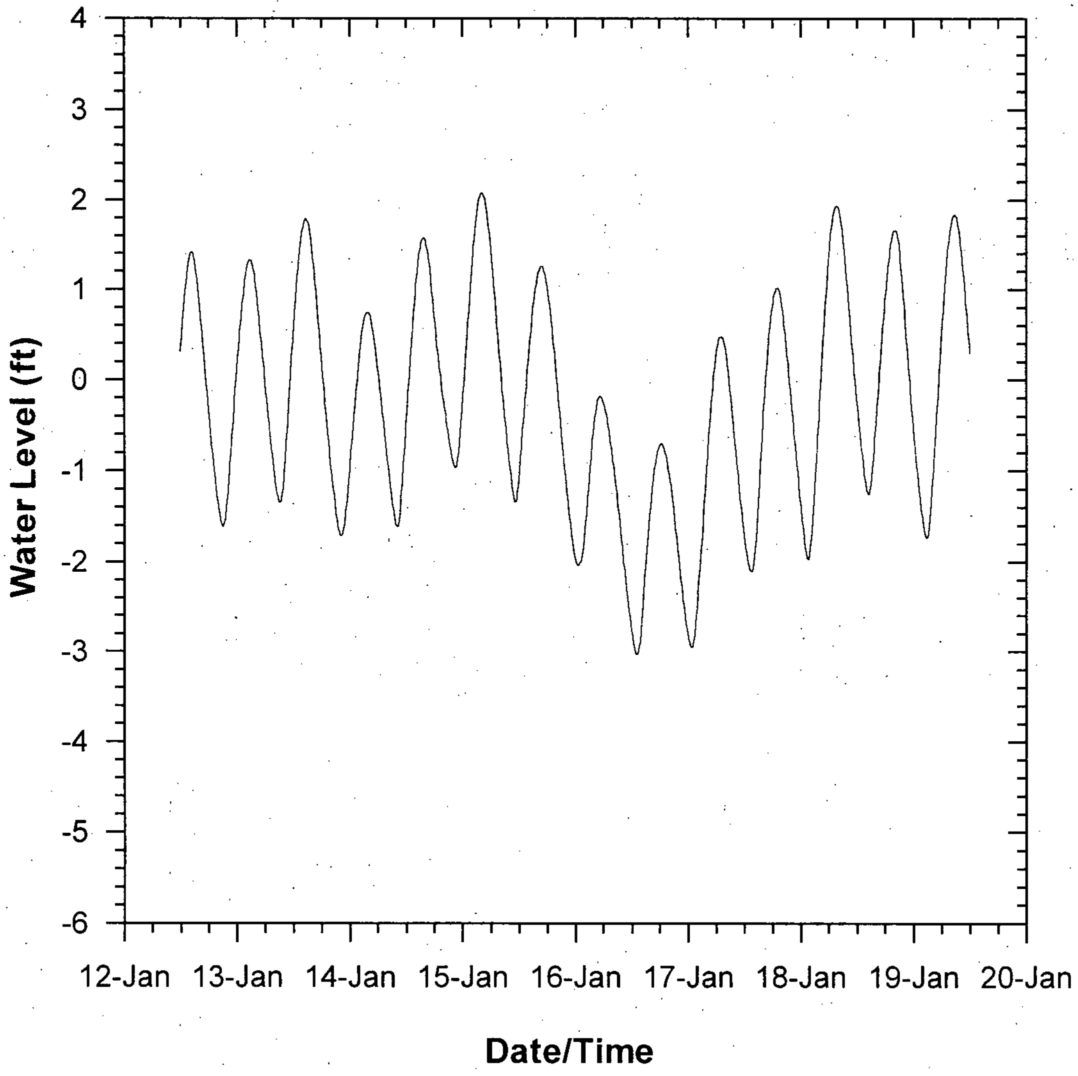
ARCADIS

Water Level In Well L
Tidal Assessment - 1/12 to 1/20

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
D-2

DWG DATE: 02/10/04
PRJCT NO.: NP000571.0003
FILE NO.: Well - P.grf
CHECKED: S.POTTER
APPROVED: P.MILIONIS
DRAFTER: V.JAYARAMAN



ARCADIS

Water Level In Well P
Tidal Assessment - 1/12 to 1/20

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
D-3

DRAFTER: V.JAYARAMAN

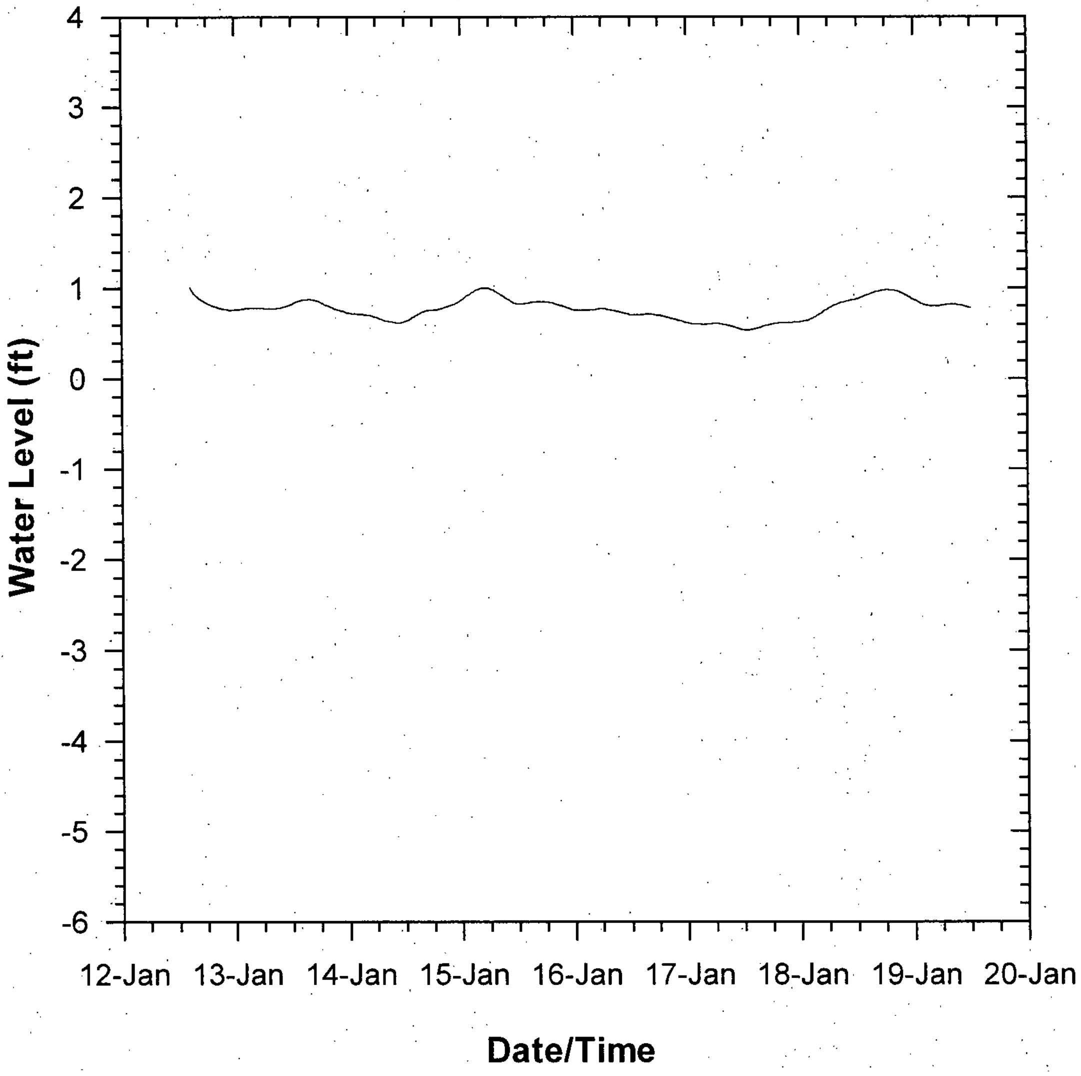
APPROVED: P.MILIONIS

CHECKED: S.POTTER

FILE NO.: Well - Q.grf

PRJCT NO.: NP000571.0003

DWG DATE: 2/10/04



ARCADIS

Water Level In Well Q
Tidal Assessment - 1/12 to 1/20

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
D-4

DRAFTER: V.JAYARAMAN

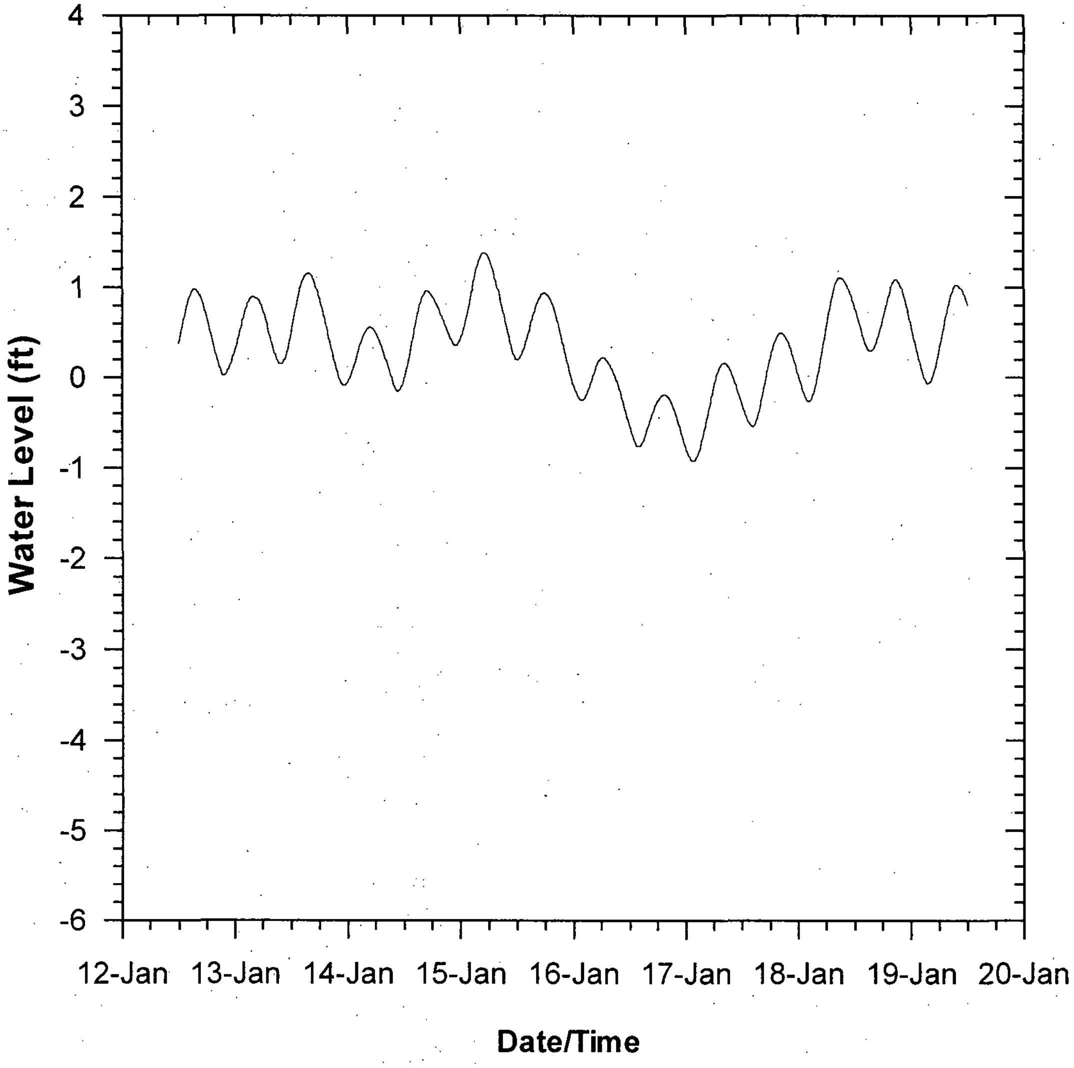
APPROVED: P.MILIONIS

CHECKED: S.POTTER

FILE NO.: Well - V.grf

PRJCT NO.: NP000571.0003

DWG DATE: 02/10/04



ARCADIS

Water Level In Well V
Tidal Assessment - 1/12 to 1/20

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
D-5

DRAFTER: V.JAYARAMAN

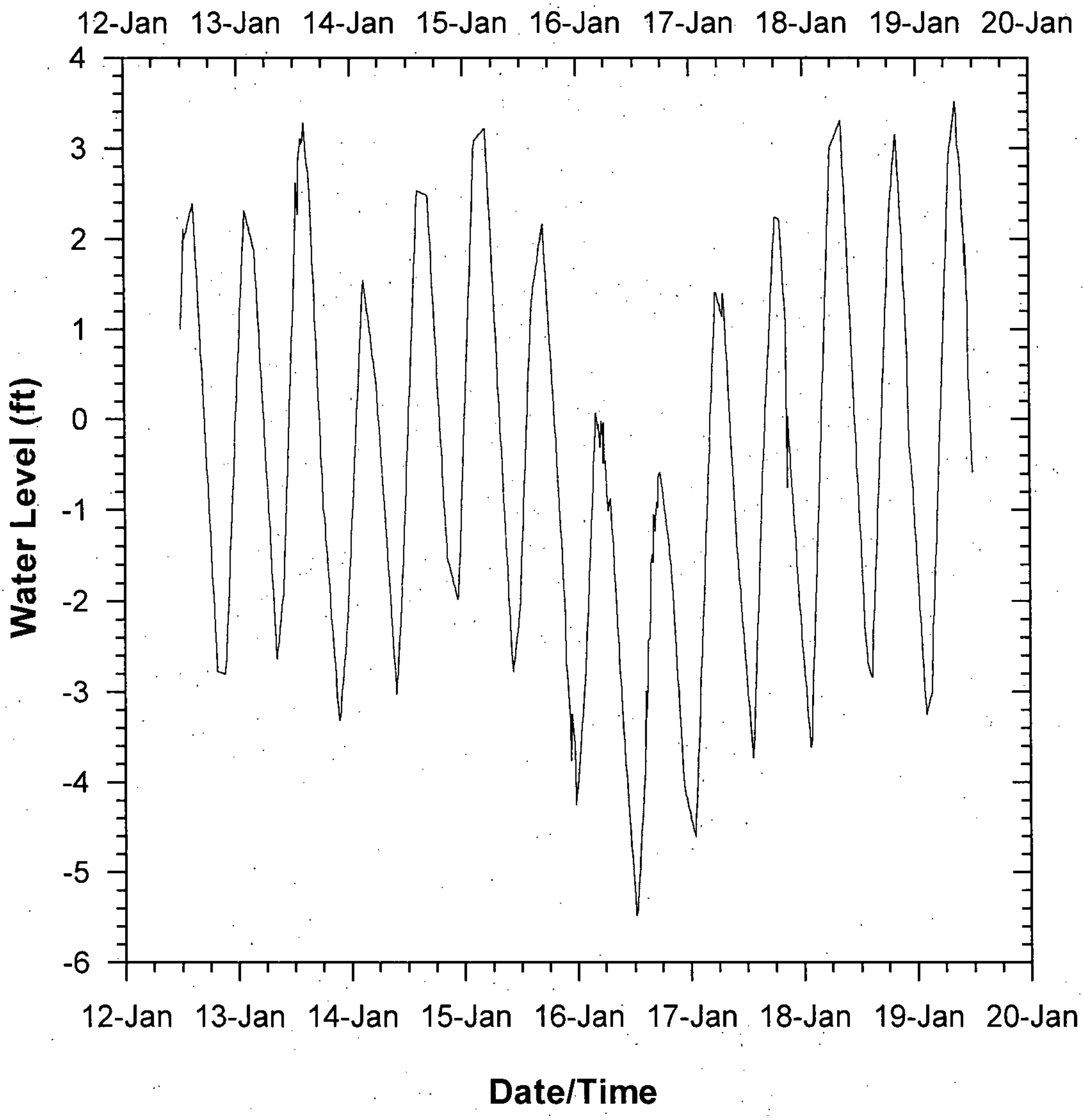
APPROVED: P.MILIONIS

CHECKED: S.POTTER

FILE NO.: Tides.grf

PRJCT NO.: NP000571.0003

DWG DATE: 02/10/04



ARCADIS

Tide Water Level
Tidal Assessment - 1/12 to 1/20

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
D-6

Appendix E

Evaluation of Water Levels in the Vincentown Formation

DRAFTER: DRAFTER

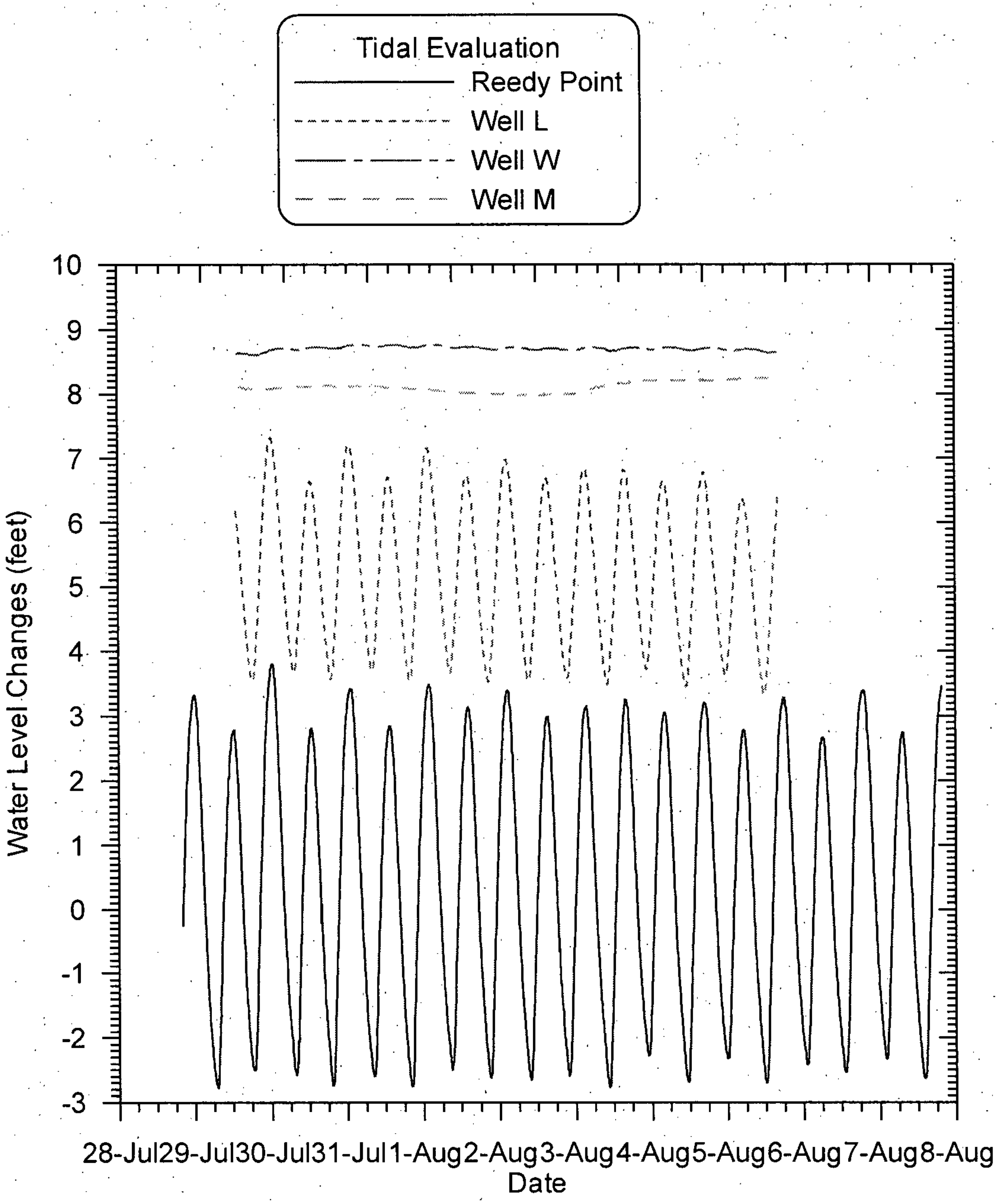
APPROVED: MANAGER

CHECKED: CHECKER

FILE NO.: DRAWING

PRJCT NO.: PRJCT. NO.

DWG DATE: DATE



ARCADIS

Tidal Evaluation

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
E-1

Appendix F

Slug Test Results

DRAFTER: DRAFTER

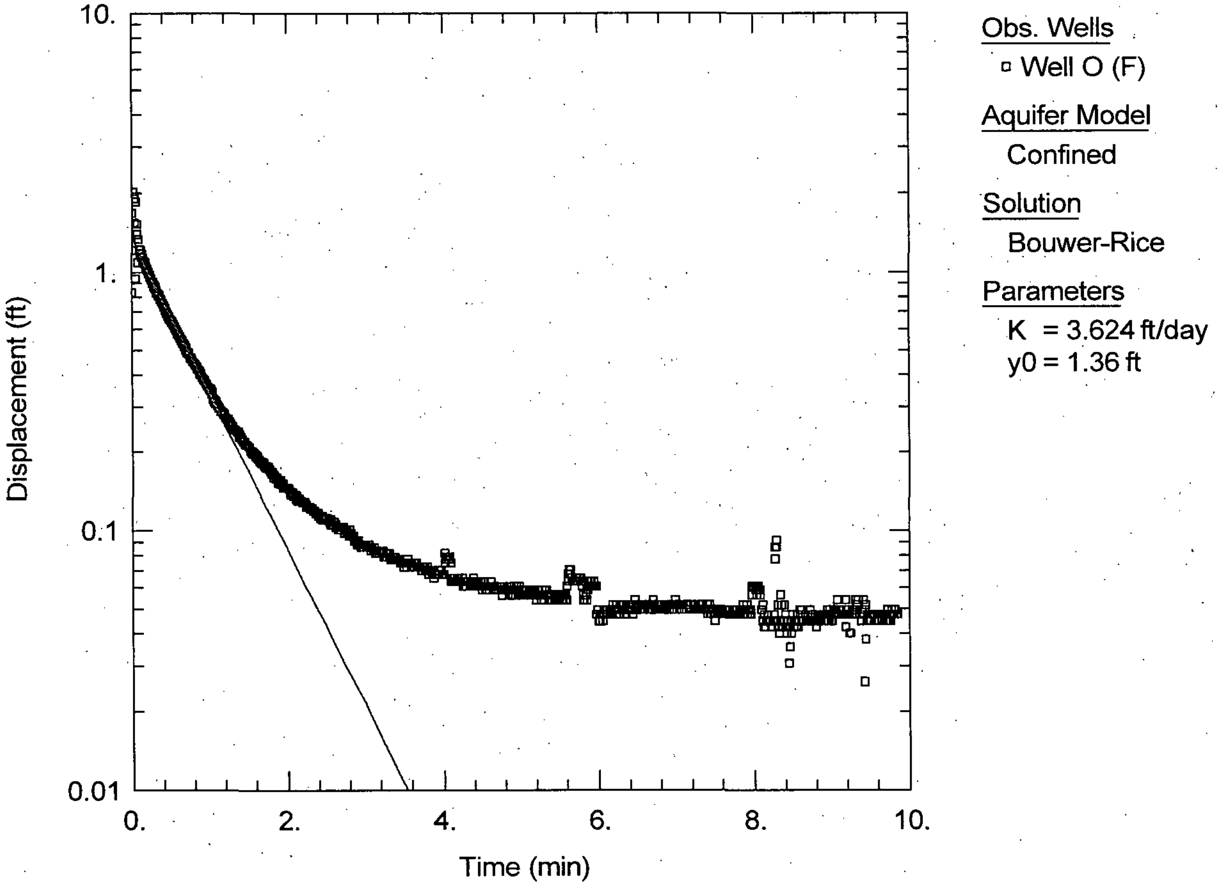
APPROVED: MANAGER

CHECKED: CHECKER

FILE NO.: FILENO

PRJCT NO.: 000000MD.0000

DWG DATE: DWGDATE



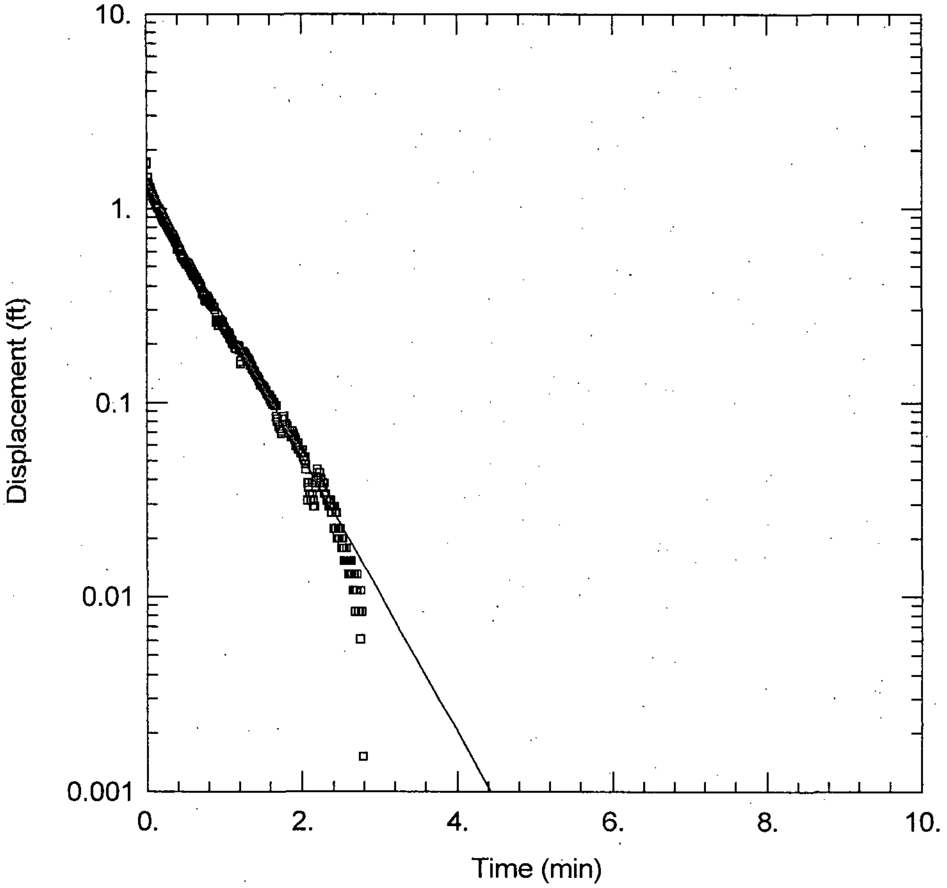
ARCADIS

Slug Test Analysis Well O Falling Test

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

F-1



Obs. Wells
□ Well O (R)

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 4.257 ft/day
y0 = 1.375 ft

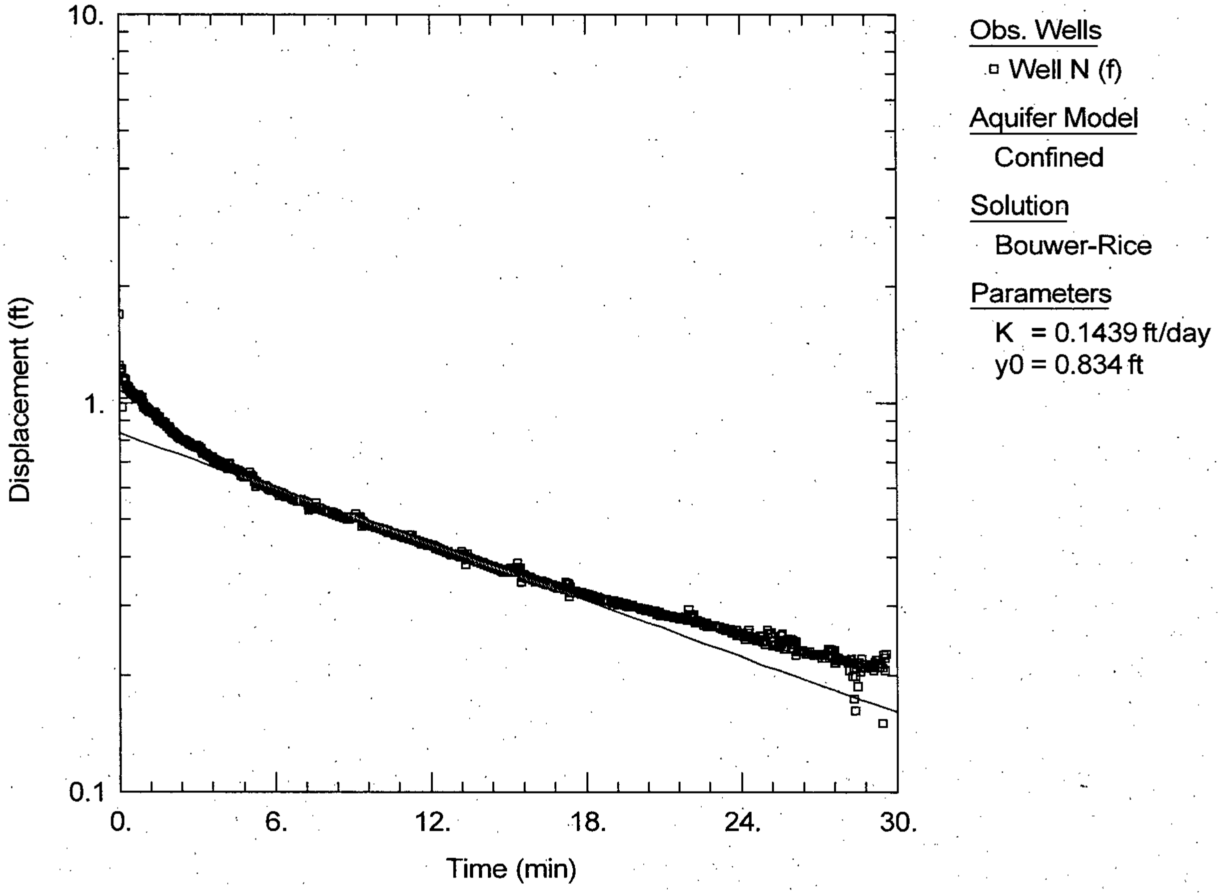
ARCADIS

Slug Test Analysis Well O Rising Test

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
F-2

DRAFTER: DRAFTER
MANAGER
APPROVED:
CHECKER
CHECKED:
FILE NO.: FILENO
PRJCT NO.: 000000MD.0000
DWG DATE: DWGDATE



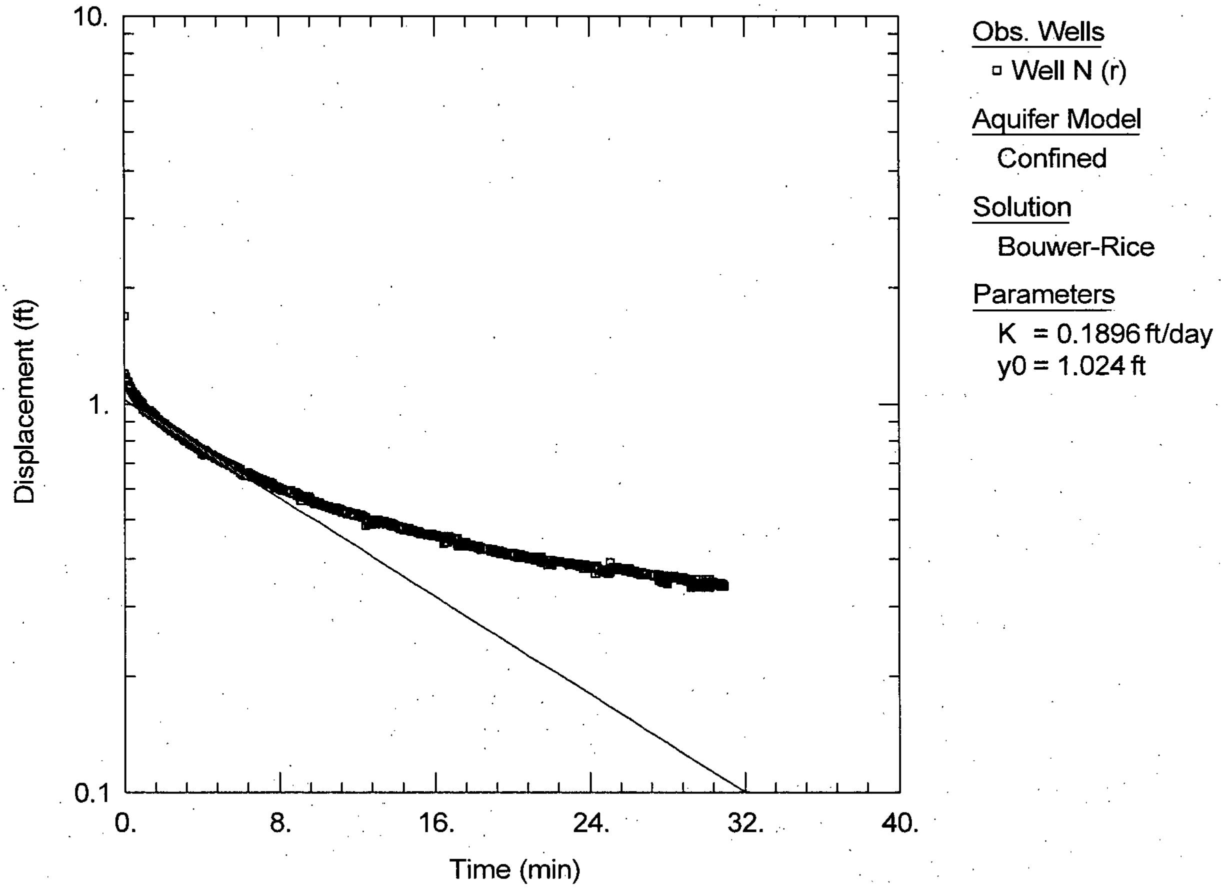
ARCADIS

Slug Test Analysis Well N Falling Test

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
F-3

DRAFTER: DRAFTER
APPROVED: MANAGER
CHECKED: CHECKER
FILE NO.: FILENO
PRJCT NO.: 000000MD.0000
DWG DATE: DWGDATE



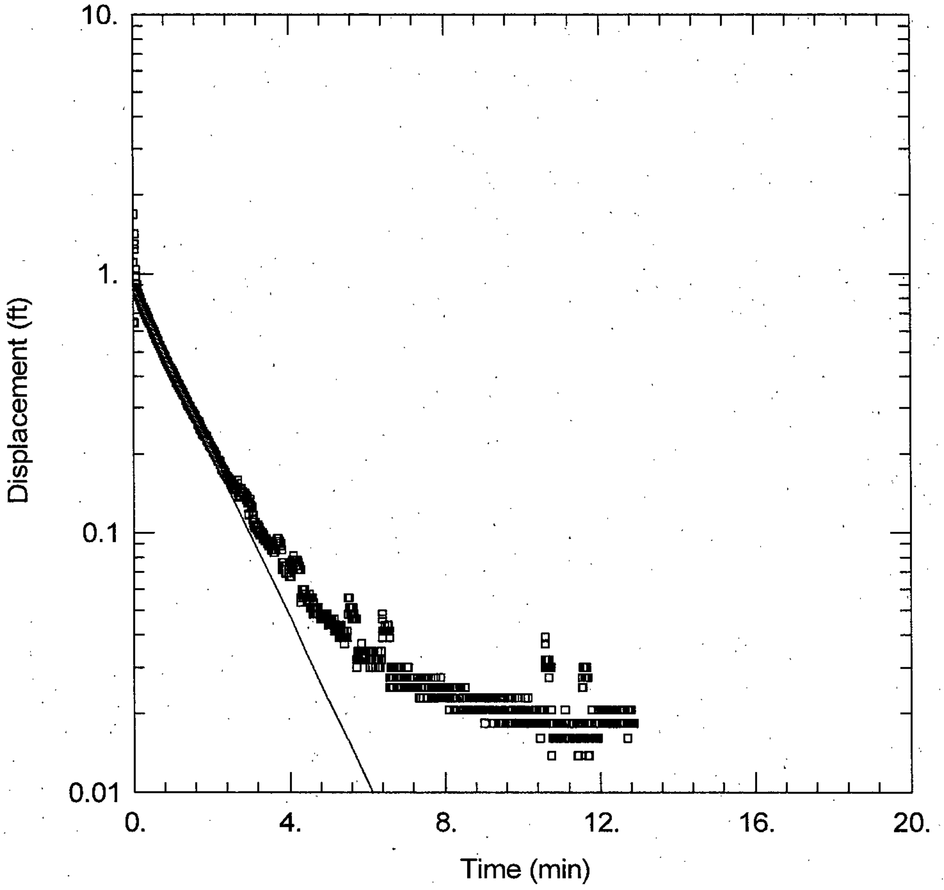
ARCADIS

Slug Test Analysis Well N
Rising Test

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

F-4



Obs. Wells
□ Well U (F)

Aquifer Model
Confined

Solution
Bouwer-Rice

Parameters
K = 2.947 ft/day
y0 = 0.881 ft

ARCADIS

Slug Test Analysis Well U
Falling Test

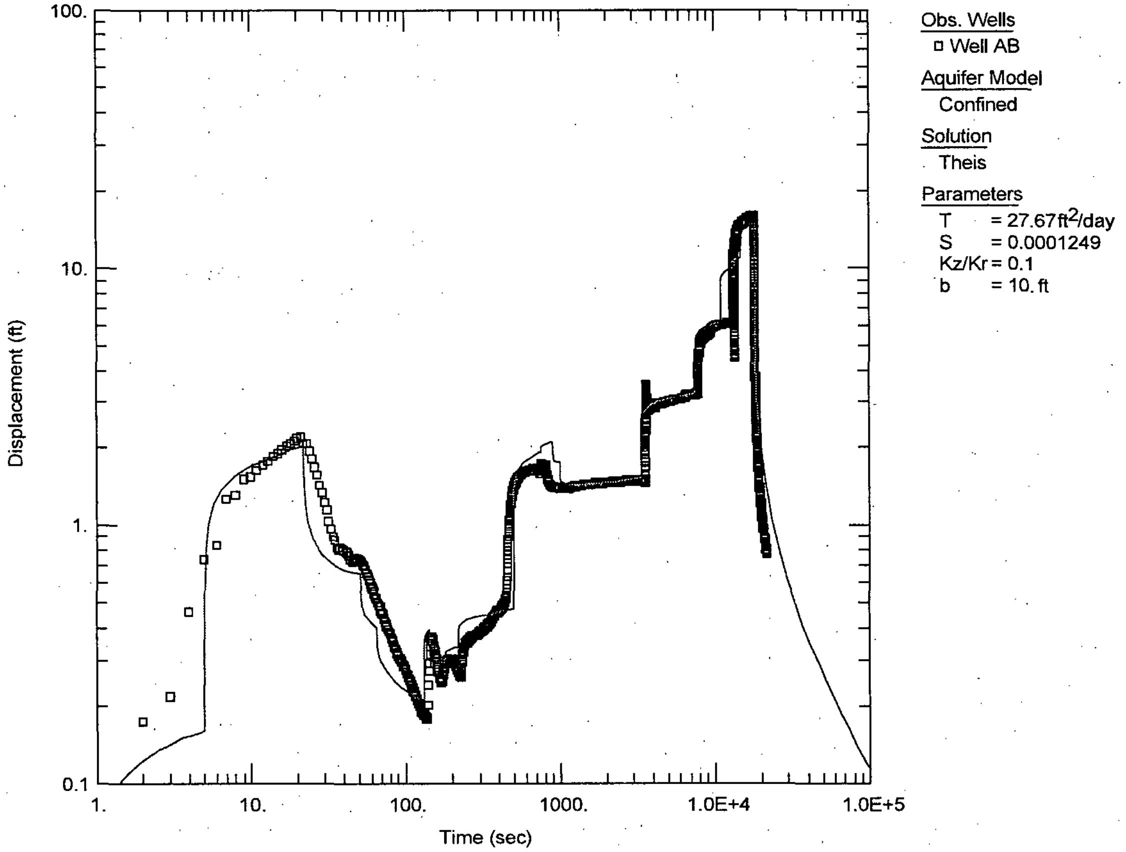
PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

F-5

Appendix G

Pumping Test Results



DRAFTER: CTS
APPROVED: P. MILIONIS
CHECKED: S.Potter
FILE NO.: AB.srf
PRJCT NO.:NP000571.0003.0008
DWG DATE: 02/09/04

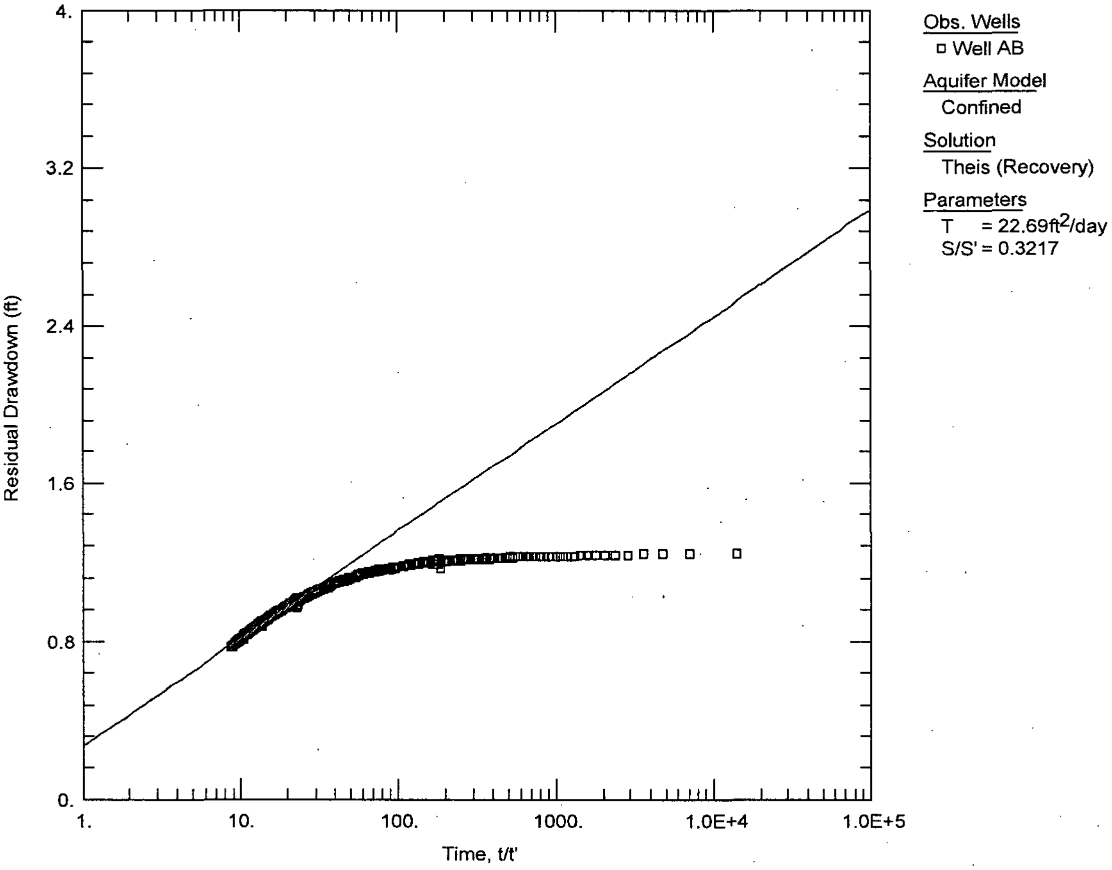
ARCADIS

Aquifer Pumping Test Analysis
Well AB

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
G-1

DRAFTER: CTS
APPROVED: P. MILIONIS
CHECKED: S.Potter
FILE NO.: AB_rec.srf
PRJCT NO.NP000571.00003.0008
DWG DATE: 02/09/04



ARCADIS

Aquifer Recovery Test Analysis
Well AB

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

G-2

DRAFTER: CTS

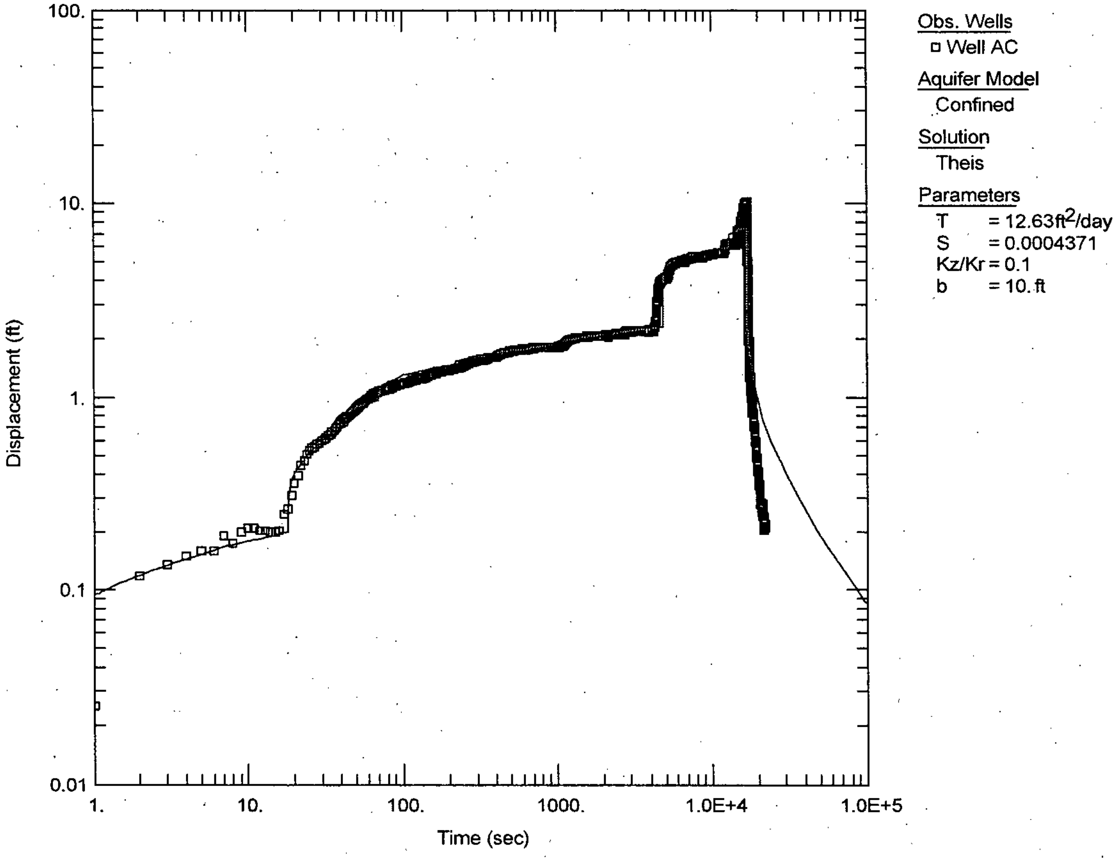
APPROVED: P. MILIONIS

CHECKED: S.Potter

FILE NO.: AC.srf

PRJCT NO.:NP000571.00003.0008

DWG DATE: 02/09/04



ARCADIS

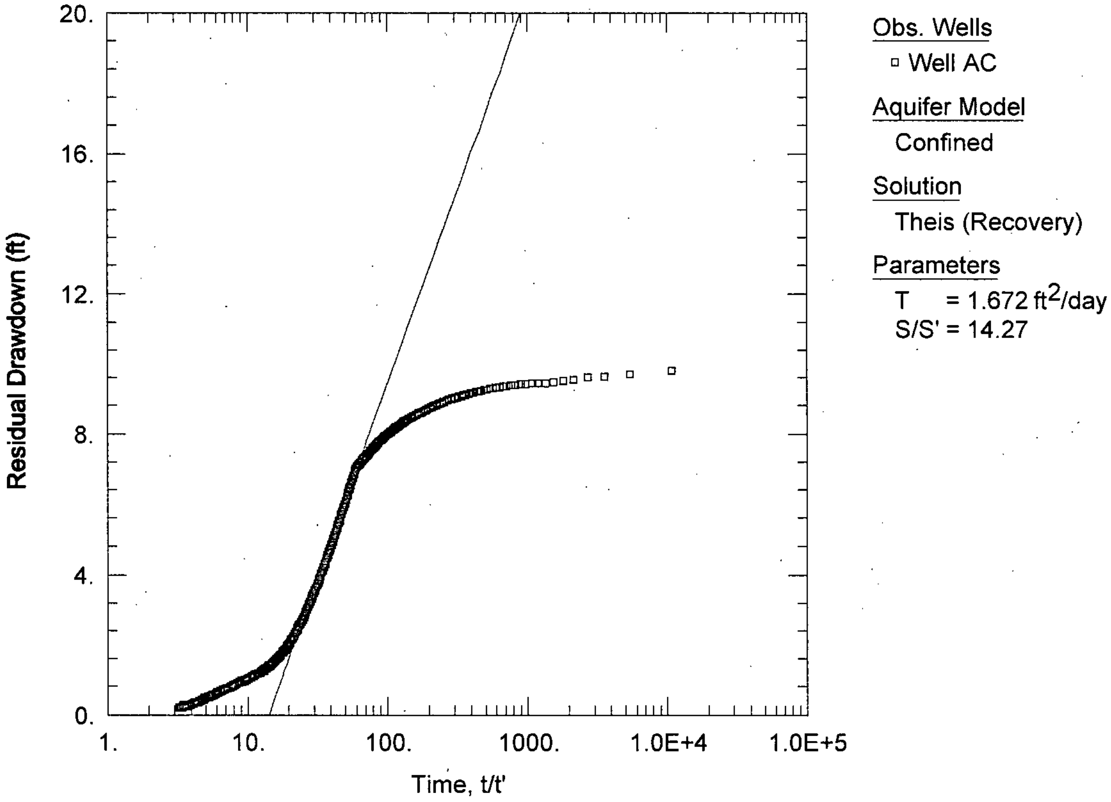
Aquifer Pumping Test Analysis
Well AC

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

G-3

DRAFTER: CTS
APPROVED: P. MILIONIS
CHECKED: S.Potter
FILE NO.: AC_rec.srf
PRJCT NO.NP000571.00003.0008
DWG DATE: 02/09/04



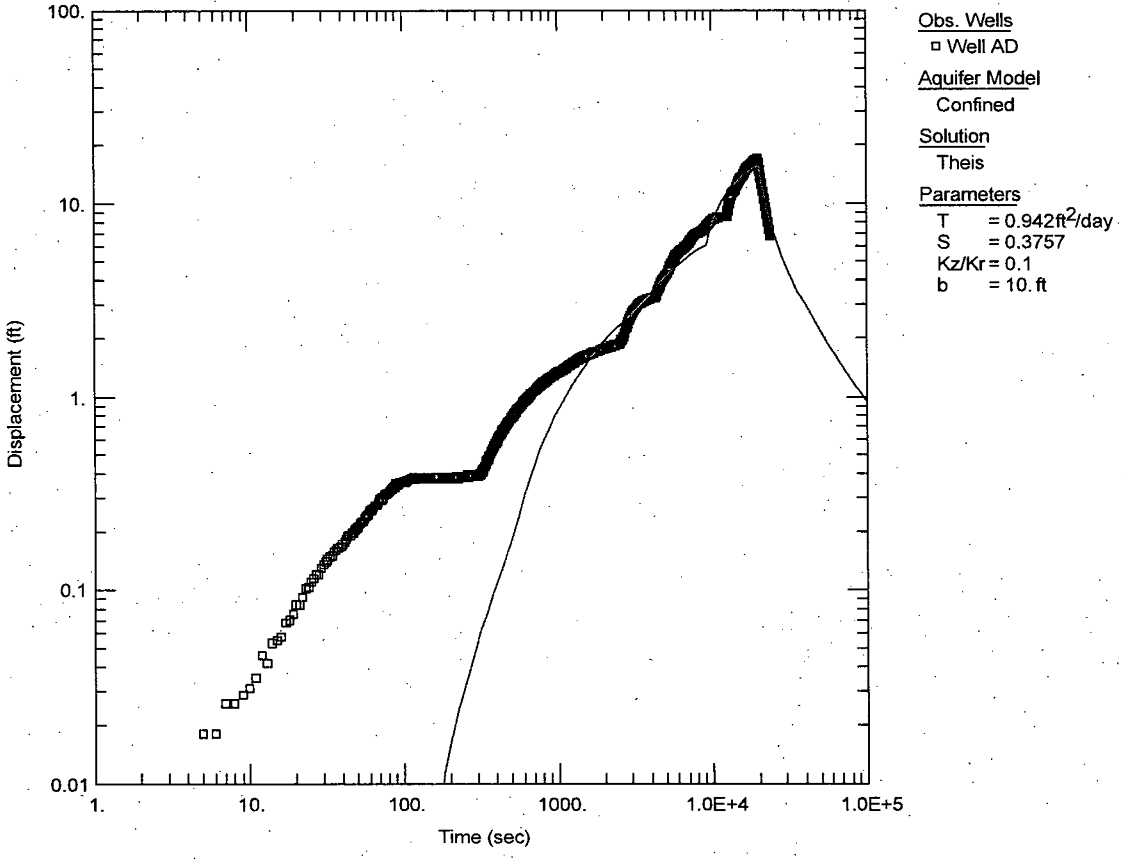
ARCADIS

Aquifer Recovery Test Analysis
Well AC

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

G-4



* EARLY DRAWDOWN WAS EXCESSIVE DUE TO EFFECTS FROM DEVELOPMENT OF WELL AJ DURING AQUIFER PUMPING TEST.

ARCADIS

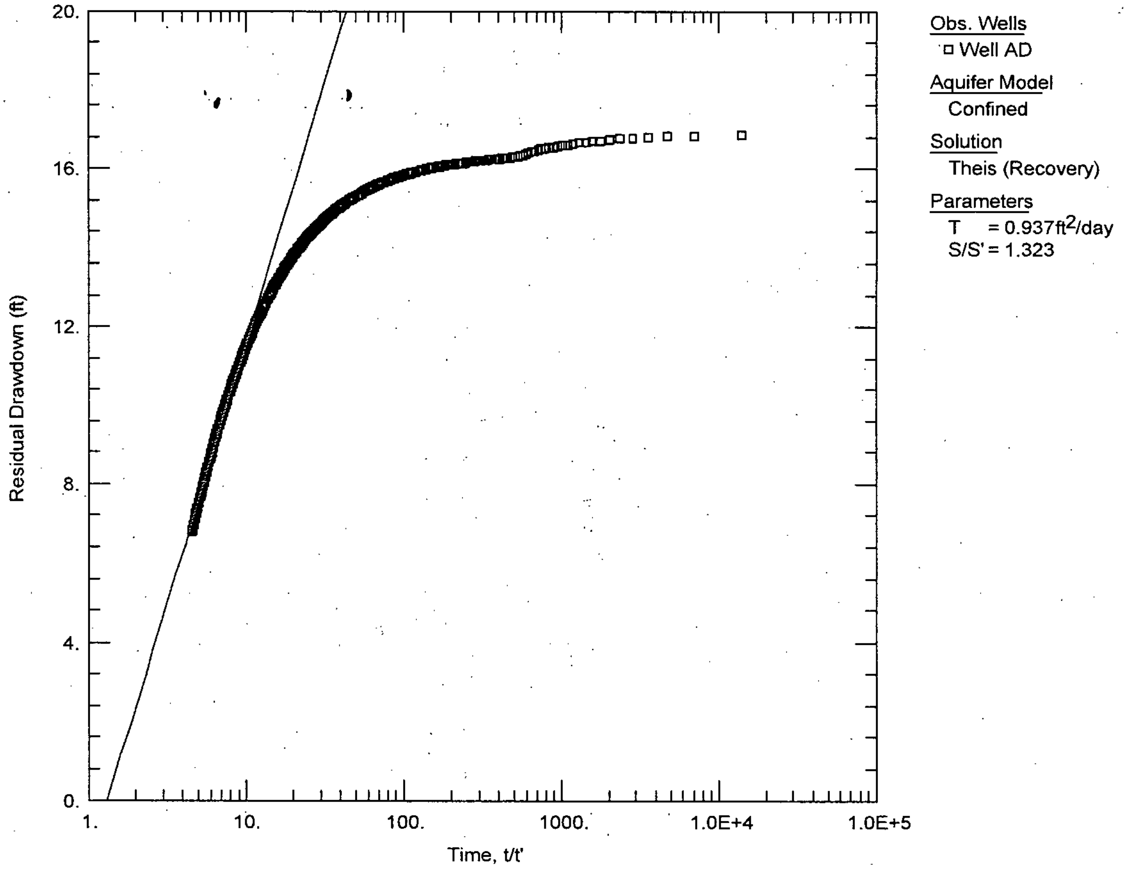
Aquifer Pumping Test Analysis
Well AD

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

G-5

DWG DATE: 02/09/04
PRJCT NO. NP000571.00003.0008
FILE NO.: AD.srf
CHECKED: S.Potter
APPROVED: P. MILIONIS
DRAFTER: CTS



DRAFTER: CTS
APPROVED: P. MILIONIS
CHECKED: S.Potter
FILE NO.: AD_rec.srf
PRJCT NO.NP000571.00003.0008
DWG DATE: 02/09/04

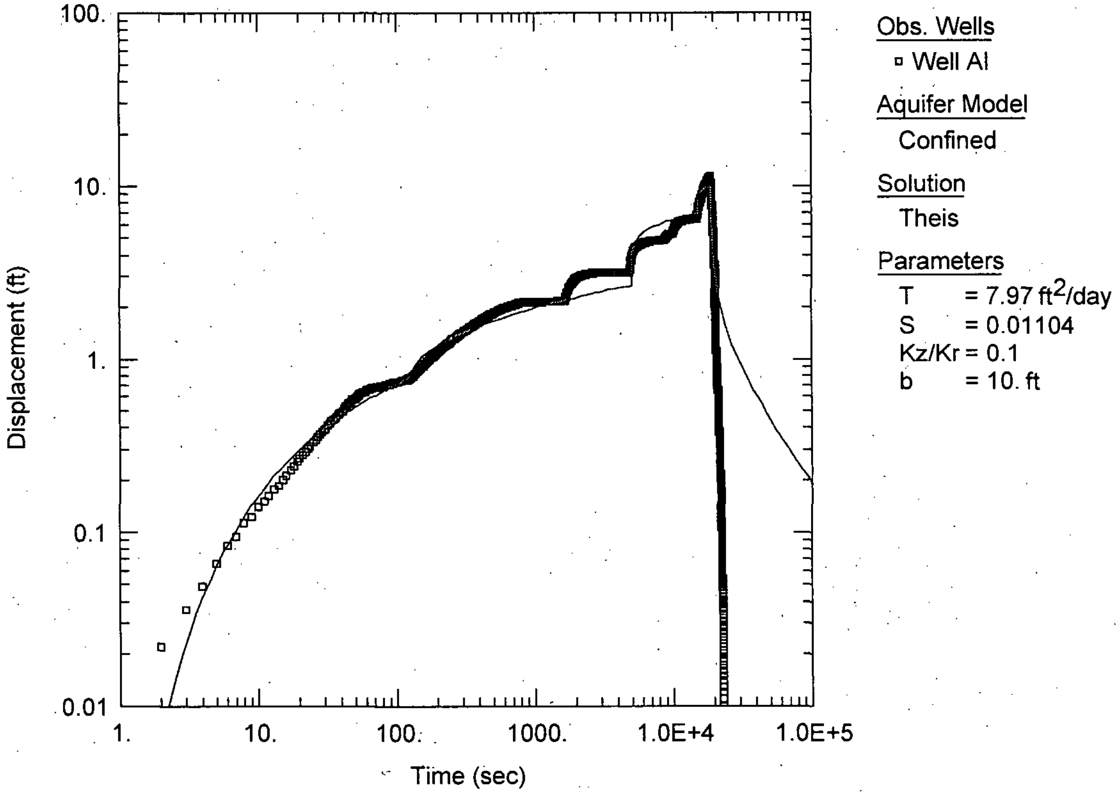
ARCADIS

Aquifer Recovery Test Analysis
Well AD

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
G-6

DRAFTER: CTS
APPROVED: P. MILIONIS
CHECKED: S.Potter
FILE NO.: AI.srf
PRJCT NO.NP000571.00003.0008
DWG DATE: 02/09/04

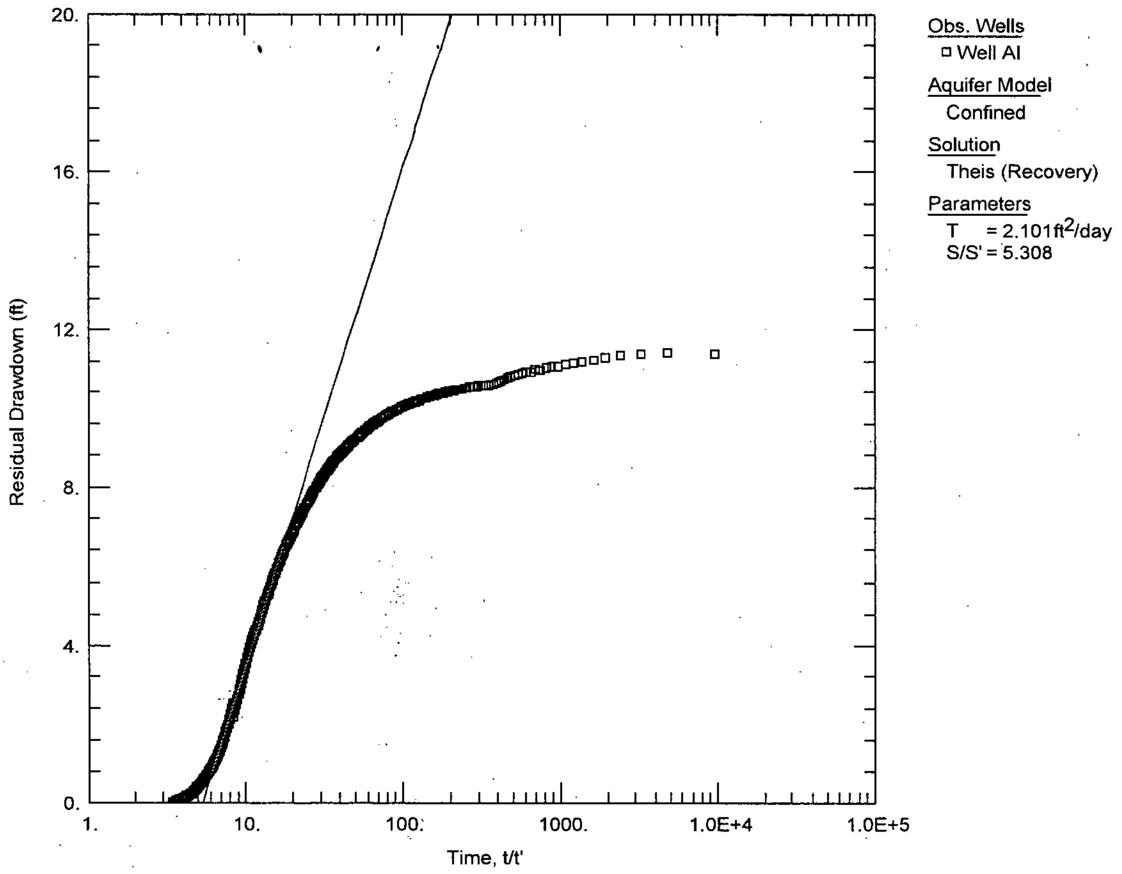


ARCADIS

Aquifer Pumping Test Analysis
Well AI

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
G-7



DRAFTER: CTS

APPROVED: P. MILIONIS

CHECKED: S.Potter

FILE NO.: AI_rec.srf

PRJCT NO.NP000571.00003.0008

DWG DATE: 02/09/04

ARCADIS

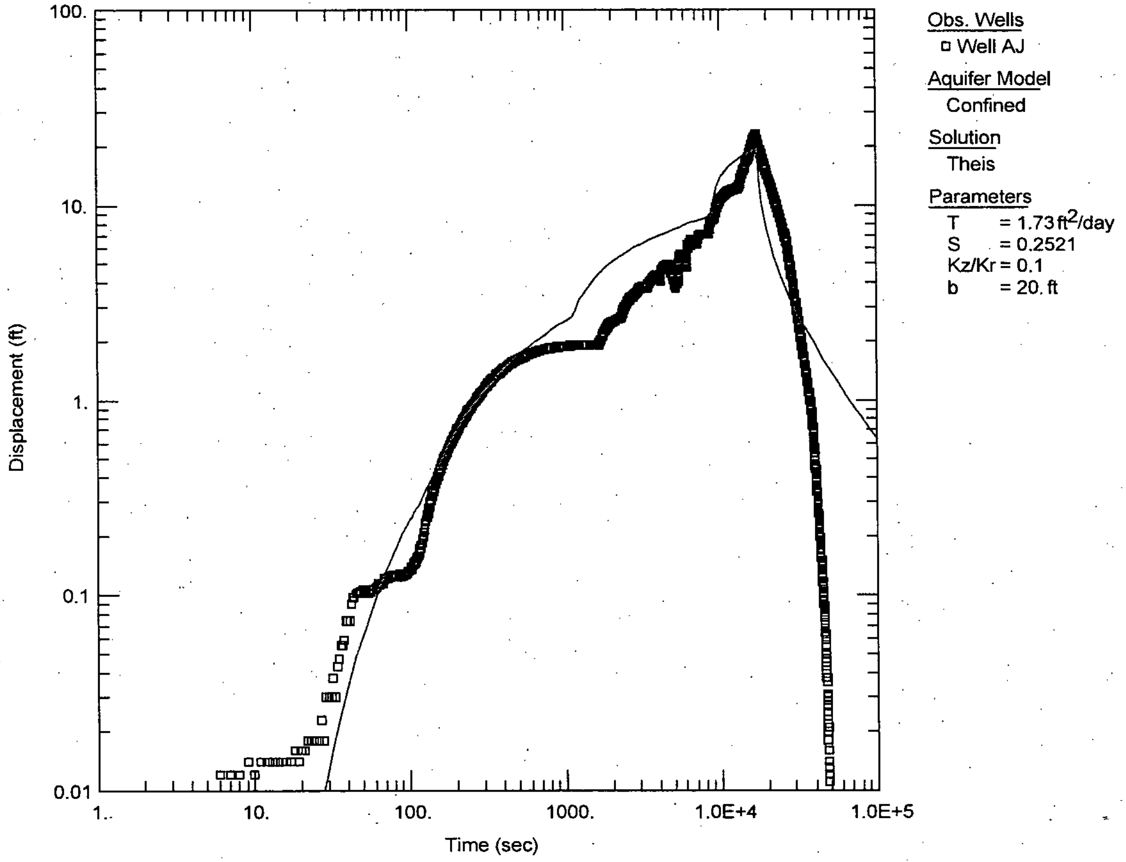
Aquifer Recovery Test Analysis
Well AI

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

G-8

DRAFTER: CTS
APPROVED: P. MILIONIS
CHECKED: S.Potter
FILE NO.: AJ.srf
PRJCT NO.:NP000571.0003.0008
DWG DATE: 02/09/04



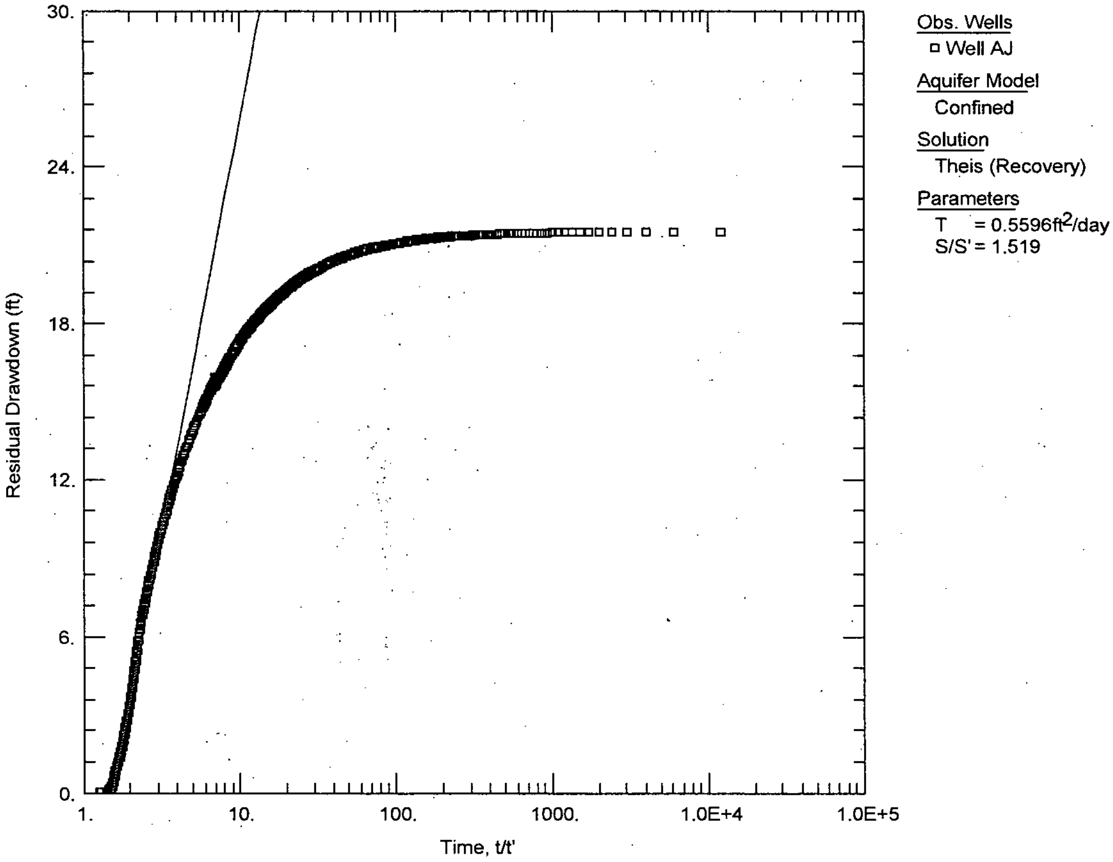
ARCADIS

Aquifer Pumping Test Analysis
Well AJ

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
G-9

DRAFTER: CTS
APPROVED: P. MILIONIS
CHECKED: S.Potter
FILE NO.: AJ_rec.srf
PRJCT NO.:NP000571.00003.0008
DWG DATE: 02/09/04



ARCADIS

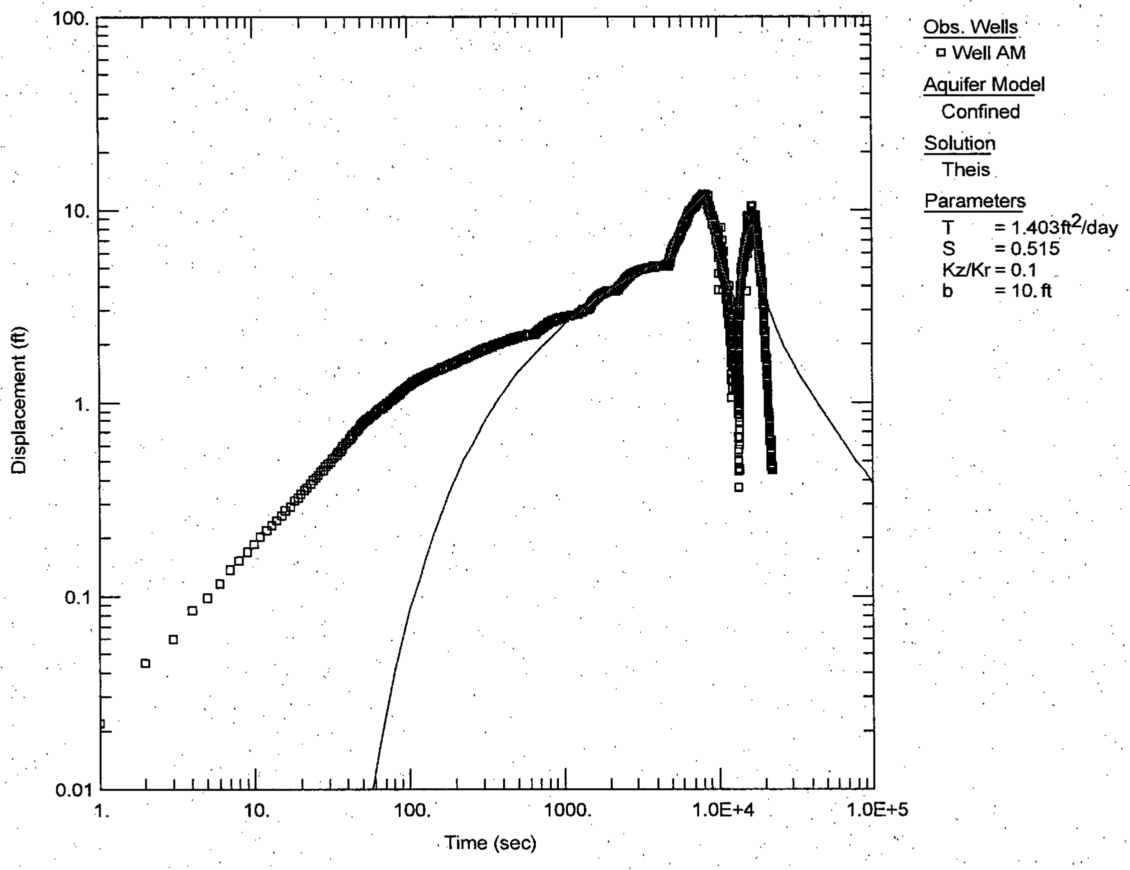
Aquifer Recovery Test Analysis
Well AJ

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

G-10

DRAFTER: CTS
APPROVED: P. Milionis
CHECKED: S.Potter
FILE NO.: AM.srf
PRJCT NO. NP000571.00003.0008
DWG DATE: 02/09/04

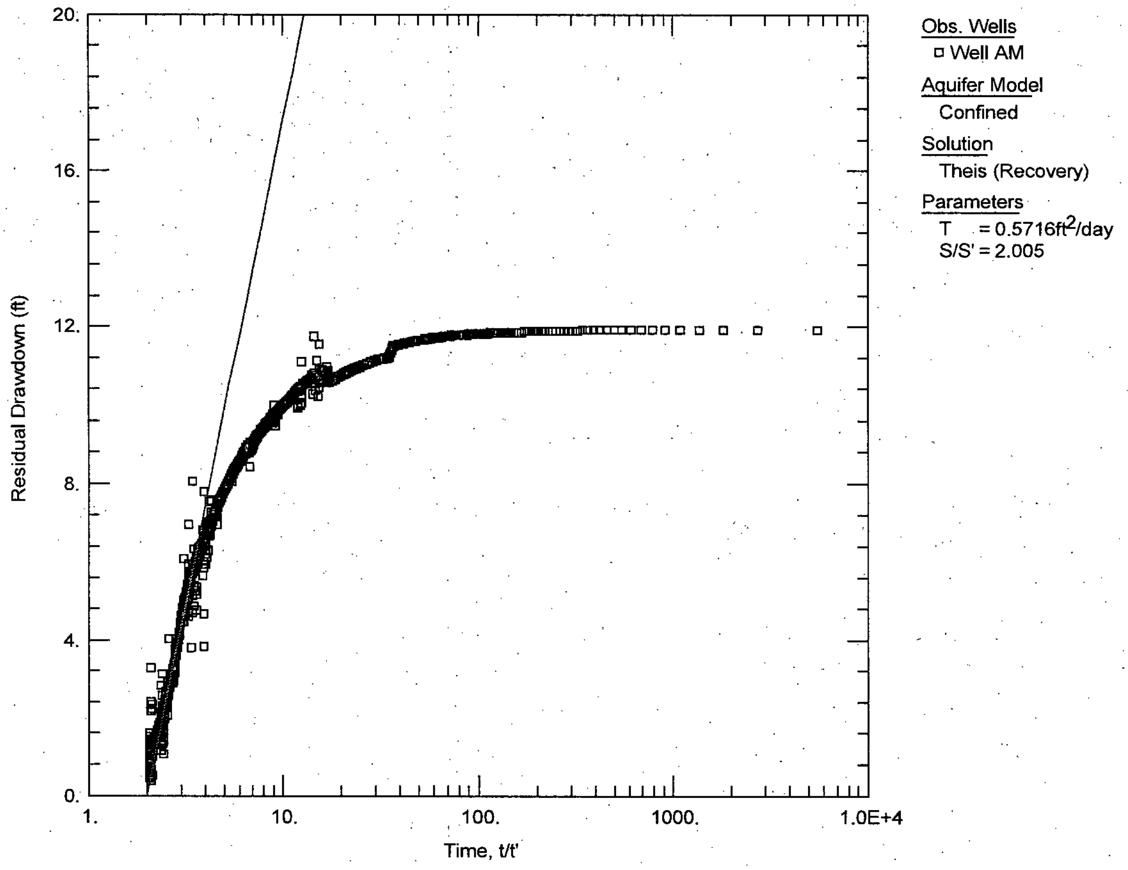


ARCADIS

Aquifer Pumping Test Analysis Well AM - Step Drawdown Test

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
G-11



DRAFTER: CTS

APPROVED: P. Milionis

CHECKED: S.Potter

FILE NO.: AM_rec.srf

PRJCT NO.NP000571.00003.0008

DWG DATE: 02/09/04

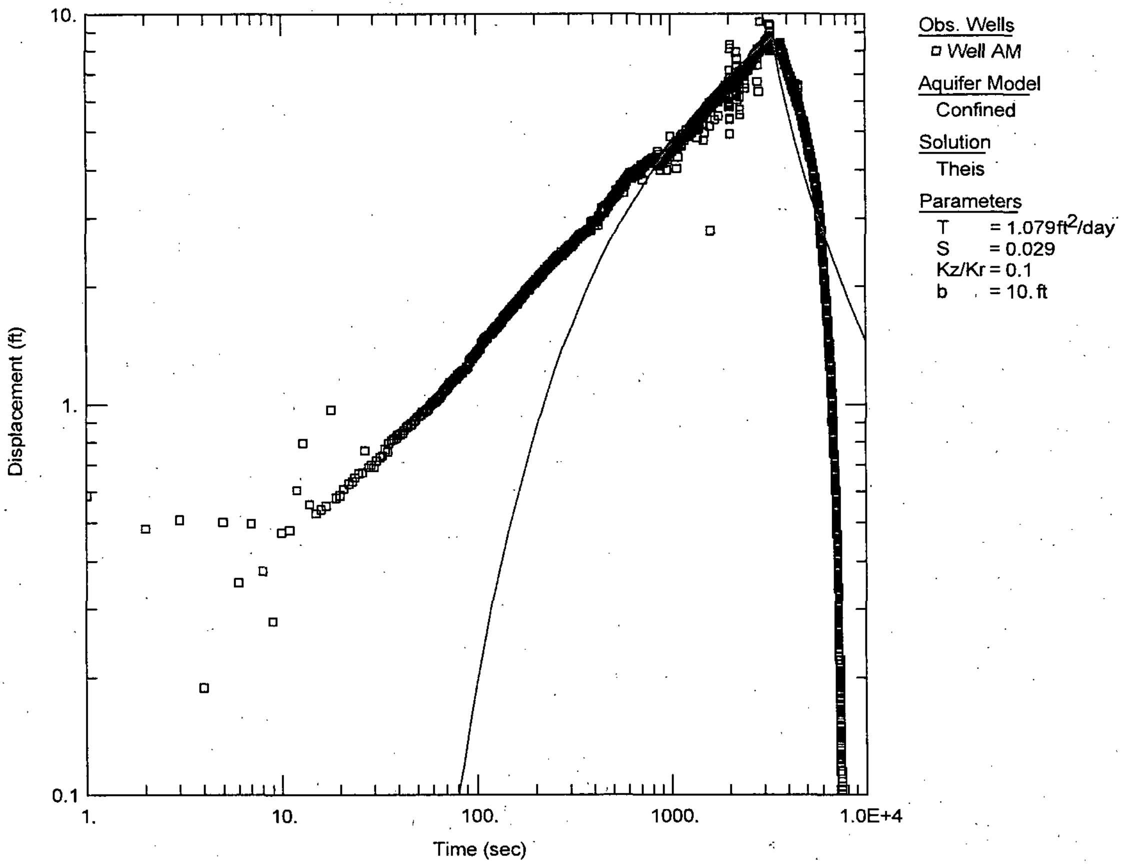
ARCADIS

Aquifer Recovery Test Analysis
Well AM - Step Drawdown Test

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

G-12



* EARLY DRAWDOWN WAS GREATER THAN EXPECTED BECAUSE THE WELL HAD NOT RECOVERED COMPLETELY AT THE START OF THIS TEST.

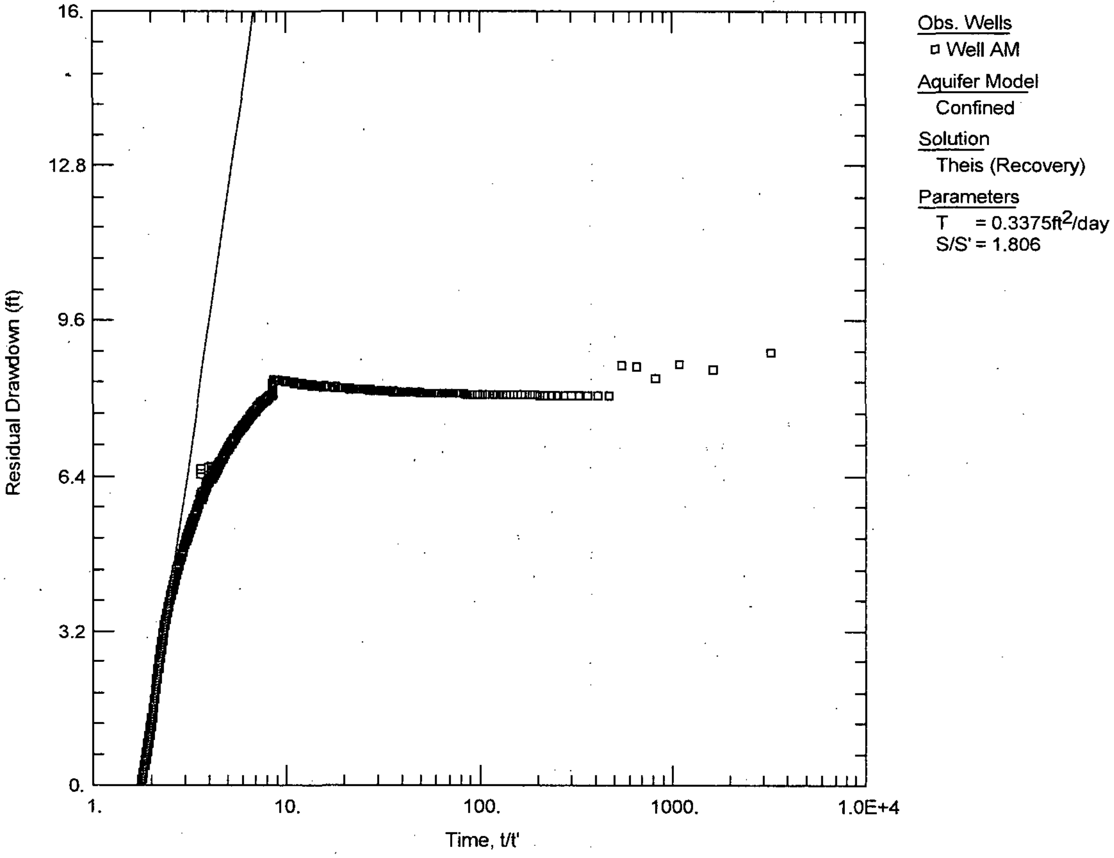
DRAFTER: CTS
APPROVED: P. Milionis
CHECKED: S.Potter
FILE NO.: AM2.srf
PRJCT NO. NP000571.0003.0008
DWG DATE: 02/09/04

ARCADIS

Aquifer Pumping Test Analysis
Well AM - Constant Rate Test

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
G-13



DWG DATE: 02/09/04
PRJCT NO. NP000571.00003.0008
FILE NO.: AM2_rec.srf
CHECKED: S.Potter
APPROVED: P. MILIONIS
DRAFTER: CTS

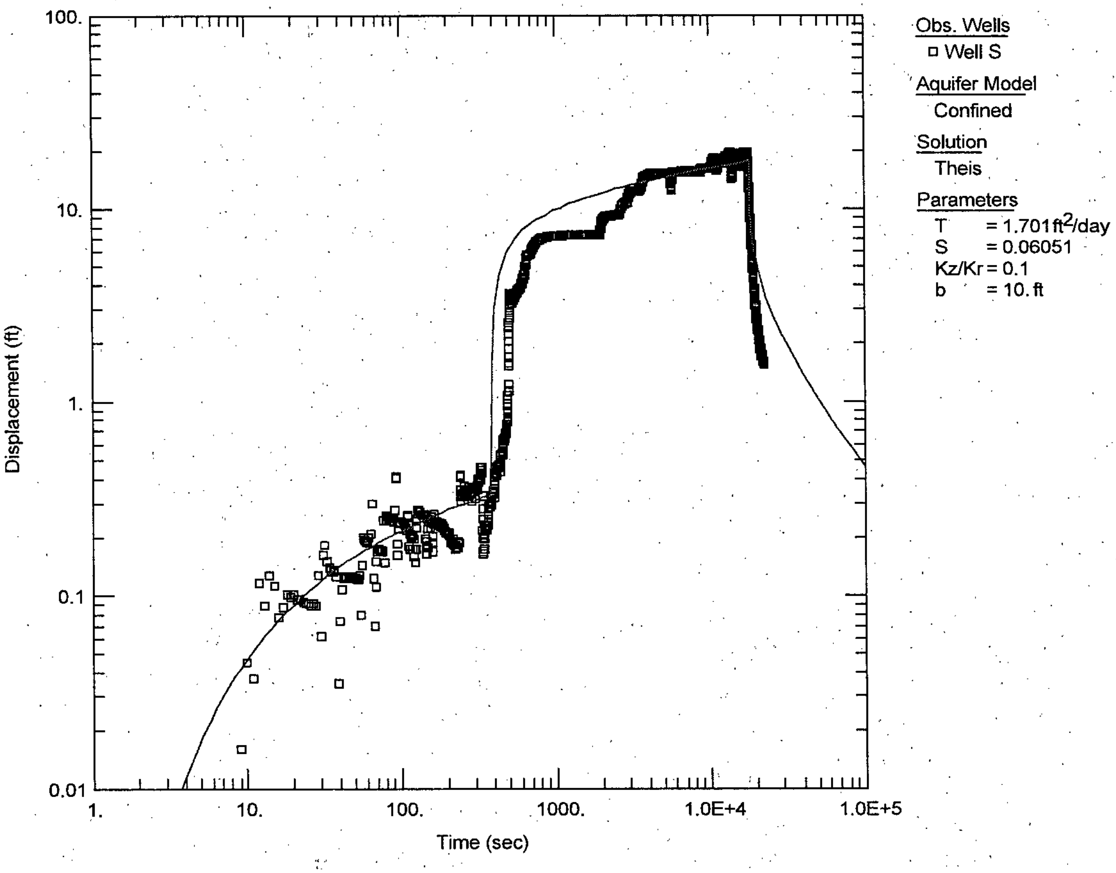
ARCADIS

Aquifer Recovery Test Analysis Well AM - Constant Rate Test

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

G-14



DRAFTER: CTS
APPROVED: P. MILIONIS
CHECKED: S.Potter
FILE NO.: S.srf
PRJCT NO. NP000571.0003.0008
DWG DATE: 02/09/04

ARCADIS

Aquifer Pumping Test Analysis
Well S

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
G-15

DWG DATE: 02/09/04

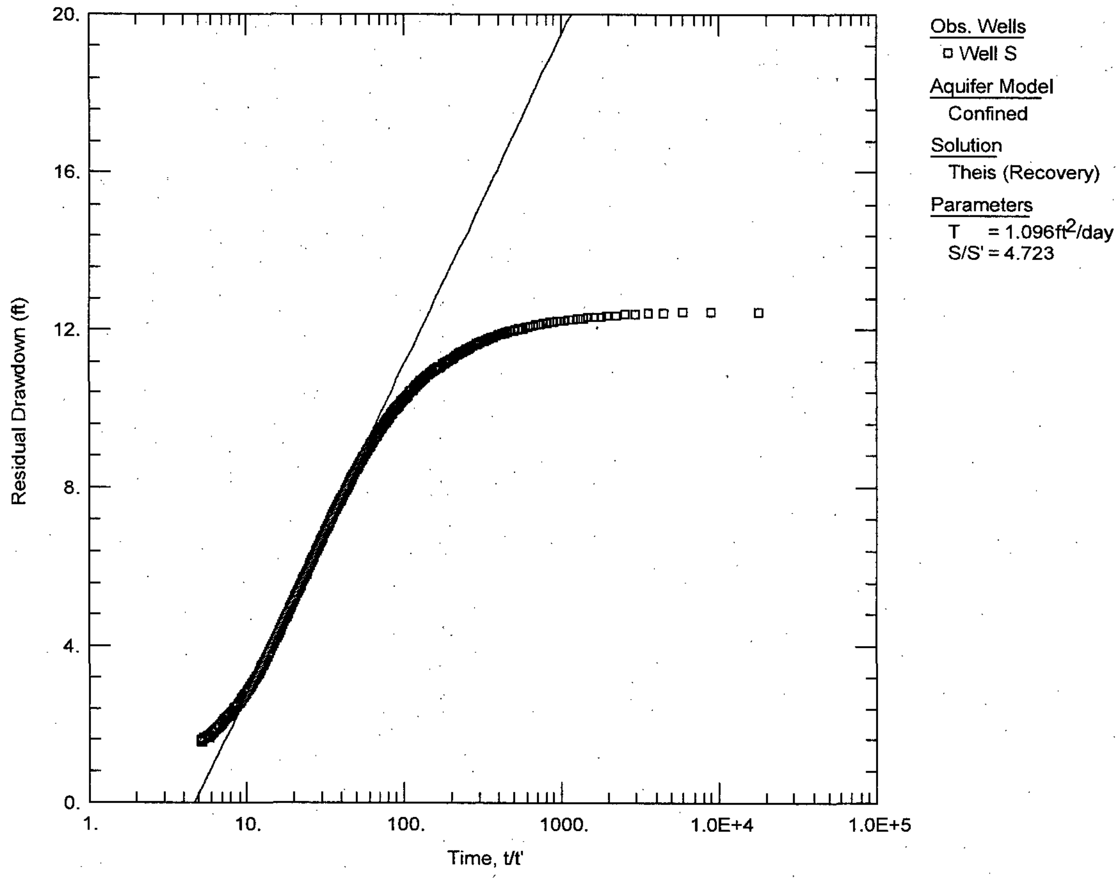
PRJCT NO.NP000571.00003.0008

FILE NO.: S_rec.srf

CHECKED: S.Potter

APPROVED: P. MILIONIS

DRAFTER: CTS



ARCADIS

Aquifer Recovery Test Analysis
Well S

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

G-16

Appendix H

Dissolved Gas, Technetium-99 and Groundwater Age Determination Results for the PSEG Nuclear, LLC Salem Generating Station

Dissolved Gas, Technetium-99 and Groundwater Age Determination Results for the PSEG Nuclear, LLC Salem Generating Station

Prepared by Dr. Robert Poreda, University of Rochester

This report details the results of the dissolved gas, technetium-99 (Tc-99), and groundwater age determination performed on groundwater samples collected through November 2003 from the monitoring well network at the PSEG Nuclear, LLC Salem Generating Station (the "Station"). The analyses were performed in accordance with the attached procedures (Attachment 1 – Groundwater Age Determination and Attachment 2 – Tc-99). Analytical results for the groundwater samples, which are summarized in the attached table, are evaluated based on the water-bearing zone where the monitoring wells are screened. The three primary water-bearing zones investigated beneath the Station are: 1) the Vincentown Formation; 2) the shallow, water-bearing unit within the limits of the cofferdam; and, 3) the shallow, water-bearing unit outside the limits of the cofferdam. Hydrogeologic and geochemical data indicate that the zones of the shallow, water-bearing unit within and outside the limits of the cofferdam are hydraulically connected, but the zones are evaluated as separate units because of their relative proximity to the facility structures.

1. Summary of the Vincentown Formation

- **Well K** –The groundwater age analysis of samples from Well K indicates that tritiated water containing between 3,000 picocuries per liter (pCi/L) to 5,000 pCi/L of tritium recharged approximately 19 years ago and has traveled to the upper part of the Vincentown Formation (70 to 80 feet below ground surface). The upper limit of 5,000 pCi/L is estimated by assuming dispersion of a slug of tritiated water over 20 years and is based on measured dispersion for non-nuclear waters from the 1963 bomb pulse at other sites (Solomon et al 1993). The most likely location for the recharge is east of Well K based on groundwater flow. Tc-99 was detected in the groundwater sample collected from this well at a concentration of 0.8 pCi/L, which is consistent with post-nuclear precipitation (i.e., background) for the eastern United States 25 years ago.

- **Well L** –The groundwater age analysis of Well L indicates that groundwater adjacent to this well recharged approximately 21 years ago with tritium concentrations (measured at 45 pCi/L) equivalent to local precipitation 20 to 25 years ago (based on the Szabo et al measurements at Gloucester). The background tritium concentrations indicated by Well L demonstrate that the release of tritium 20 years ago as indicated by Well K was relatively minor and did not extend over a wide area in the Vincentown Formation. Well L is located to the west and downgradient of the Station near the brackish/fresh water interface. The background concentrations of tritium detected in groundwater samples collected from Well L indicate that the clay confining-unit of the Kirkwood Formation has effectively segregated the Vincentown Formation from the overlying shallow, water-bearing unit.

- **Well P** –The groundwater age analysis of Well P indicates that precipitation with background concentrations of tritium (60 pCi/L - equivalent to local precipitation 20 to 25 years ago, based on the Szabo et al measurements at Gloucester) recharged approximately 13 years ago. The methane concentration indicated by groundwater samples collected from Well P (1 cubic centimeter per kilogram [cc/kg]) suggests that the recharge area for Well P is likely in or near the marshes to the east of the Station or that a small amount of methane has been generated within the Vincentown Formation. As with Well L, the background concentrations of tritium detected in groundwater samples collected from Well P indicate that the clay confining-unit of the Kirkwood Formation has effectively segregated the Vincentown Formation from the overlying shallow, water-bearing unit.

- **Well Q** –The low-level analysis for tritium in the groundwater sample from Well Q indicates a tritium concentration close to the method detection limit (1.5 pCi/L). This low concentration of tritium suggests that groundwater in the vicinity of this well recharged close to the onset of the nuclear era (circa 1950). Dissolved methane concentrations in groundwater samples collected from Well Q (38 cc/kg or 1.7 millimoles/kg [mmol/kg]) and levels of argon and nitrogen below solubility limits indicate that the likely point of recharge is the marshes that border the Station to the east.

- **Well V** –The results of the groundwater age analysis of Well V are consistent with the results of Well K. Groundwater samples collected from Well V indicate a slightly elevated tritium concentration (549 pCi/L) relative to background (local precipitation). The initial tritium level in the recharge water is estimated to be approximately 3,000 pCi/L. The results of the groundwater age analysis for Well V indicate a slightly younger age relative to Well L and Well K, but the age is within the range observed for these wells (13 to 22 years). The relatively high concentration of dissolved methane detected in the groundwater sample collected from Well V indicates that the groundwater either recharged in the marshes to the east of the Station, or is from in situ biological production.

Analytical results of groundwater samples collected from monitoring wells screened in the Vincentown Formation (Wells K, L, P, Q, and V) do not indicate that tritium from the Station has migrated beyond the shallow, water-bearing unit above the Kirkwood Formation and into the deeper Vincentown Formation. Tc-99 concentrations indicated by groundwater samples collected from Well K and Well V (0.5 pCi/L and 0.8 pCi/L, respectively) are consistent with the suspected ambient concentration in precipitation recharged during the 1970s. The Tc-99 concentrations indicated by Well K and Well V are approximately 10 parts per million (100,000 times below) of Spent Fuel Pool water (based on data from Ginna station). At this concentration, Tc-99 is not an effective indicator of Spent Fuel Pool water due to the combined effects of ambient Tc-99 and a concentration of Tc-99 near the method detection limit.

2.0 Summary for the Shallow, Water-Bearing Formation Within the Limits of the Cofferdam.

- **Well M** – The groundwater age analysis of Well M indicates a relatively young age for this groundwater since it became isolated from the atmosphere (less than 0.1 years). The young age suggests that preferential pathways for fluid flow may exist in the subsurface near the plant and/or that elevated dissolved atmospheric helium concentrations have resulted in skewed age determination results. Elevated dissolved atmospheric helium concentrations could be the result of increased gas exchange between the atmosphere and the structural fill within the cofferdam or from the introduction of atmospheric gases during the monitoring well installation activities. The Tc-99 concentration indicated by the groundwater sample collected from this well is at or near the regional background concentration of 0.5 pCi/L. The ratio of tritium/Tc-99 at Well M (280,000) is more than 100 times the estimated ratio of 2000 for the Salem Spent Fuel Pool (based on data from Ginna station). The absence of Tc-99 in groundwater from Well M indicates that the tritium detected in this well may have a source other than the Spent Fuel Pool, or that tritium migrated to Well M by aqueous diffusion. The diffusion coefficient of tritium is approximately 0.04 square meters per year (m^2/yr) (mean diffusion length is about 0.1 m/yr), relative to an approximate Tc-99 diffusion coefficient that may be as much as an order of magnitude lower than tritium (accurate Tc-99 diffusion data does not exist). Diffusion of tritium would be several times more rapid than Tc-99 because of the smaller size of the molecule and the lack of interaction with soil (i.e., sorption).

- **Well N** –The groundwater age determination of the sample from Well N suggests a recharge age of approximately one year. The young age suggests that preferential pathways for fluid flow may exist in the subsurface near the plant and/or that elevated dissolved atmospheric helium concentrations have resulted in skewed age determination results. Elevated dissolved atmospheric helium concentrations could be the result of increased gas exchange between the atmosphere and the structural fill within the cofferdam or from the introduction of atmospheric gases during the monitoring well installation activities. The Tc-99 concentration for this well is at or near the regional background concentration of 0.5 pCi/L or less than 10 ppm of Spent Fuel Pool levels. The absence of Tc-99 in groundwater from Well N indicates that the tritium detected in this well may have a source other than the Spent Fuel Pool, or that tritium migrated to Well N by aqueous diffusion similar to Well M.

- **Well O** –The groundwater age determination of the sample from Well O indicates a relatively young age of approximately 0.22 years. The young age suggests that preferential pathways for fluid flow may exist in the subsurface near the plant and/or that elevated dissolved atmospheric helium concentrations have resulted in skewed age determination results. The Tc-99 concentration for this well is at or near the regional background concentration of 0.5 pCi/L.

- **Well R** – Groundwater age results from Well R suggest an age of approximately 1.2 years. This age is consistent with the location of Well R at the maximum in hydraulic head where the flow path is almost vertical; the age is a lower limit because of loss of He-3 by diffusion and possible exchange with the atmosphere. The Tc-99 concentration for this well is at or near the regional background concentration of 0.5 pCi/L (see discussion for Wells M and N).

- **Well AC** – Groundwater samples from Well AC were not submitted for analysis for dissolved gases, Tc-99, or groundwater age determination at the University of Rochester because of the elevated concentration of tritium detected in this sample by Salem Chemistry. Station protocols prohibited the transport of this sample off site.

- **Well AE** –The analytical result of the groundwater sample collected from Monitoring Well AE indicate a tritium concentration of 8,500 pCi/L. The groundwater age determination of the sample from Well R indicates a relatively young age of approximately 0.33 years. The recent groundwater age again suggests that preferential pathways for fluid flow may exist in the subsurface near the plant and/or that elevated dissolved atmospheric helium concentrations have resulted in skewed age determination results. The Tc-99 concentration for the sample from Well AE is at or near the regional background concentration of 0.5 pCi/L.

Analytical results of groundwater samples collected from monitoring wells screened in the shallow, water-bearing unit within the limits of the cofferdam (Wells M, N, O, R, AC, and AE) indicate groundwater ages of less than 0.1 years to approximately 1.2 years. The recent groundwater age again suggests that preferential pathways for fluid flow may exist in the subsurface near the plant and/or that elevated dissolved atmospheric helium concentrations have resulted in skewed age determination results. Tc-99 concentrations indicated by groundwater samples collected from wells screened in this unit are consistent with the regional background concentration for this constituent. The absence of Tc-99 indicates that the tritium detected in these wells may have a source other than the Spent Fuel Pool, or that tritium migrated to the wells by aqueous diffusion

3.0 Summary for the Shallow, Water-Bearing Formation Outside of the Limits of the Cofferdam.

- **Well S** – The groundwater age determination of the sample from Well S indicates a relatively young age (less than one year). The recent age of this water is consistent with other shallow wells close to the plant and inside of the cofferdam. The Tc-99 concentration for this well is at or near the regional background concentration of 0.5 pCi/L.

- **Well T** – Analytical results of the low-level tritium analysis of the sample from Well T indicate a tritium concentration of 257 pCi/L. The groundwater age analysis for this sample indicates an age of approximately 1.6 years, which is consistent with the ages of other samples collected from this zone. The analytical results of the groundwater sample collected from Well T indicate a methane concentration and low concentrations of dissolved atmospheric gases (15% of solubility) consistent with recharge in the marshes to the east of the Station (similar to Wells Q and U). The Tc-99 concentration for the sample from Well T is at regional background concentration.

- **Well U** – Analytical results of the low-level tritium analysis of the sample from Well U indicate a tritium concentration of 78 pCi/L. The groundwater age analysis for this sample indicates an age of approximately 4.1 years, which is consistent with the ages of other groundwater samples collected from monitoring wells screened in this zone. The analytical results of the groundwater sample collected from Well U indicate a methane concentration and low concentrations of dissolved atmospheric gases (15% of solubility) consistent with recharge in the marshes to the east of the Station (similar to Well T). The Tc-99 concentration for the sample from Well T is at regional background concentration.

- **Well W** –Analytical results of the groundwater sample collected from Monitoring Well W indicate a tritium concentration of 11,300 pCi/L, and the groundwater age determination for this well indicates an age of four years. The analytical results for the groundwater sample from Well W also indicate an elevated concentration of dissolved methane, which suggests that groundwater at Well W is a mixture of groundwater with characteristics similar to groundwater from Well T (or Well Z) with tritiated water from plant activity. Well W is located at or near the boundary between methane-rich water flowing from east to the south and west, and tritiated, methane free water that recharges to the south of Salem Unit #1. The Tc-99 concentration for the sample from Well W is approximately 4 pCi/L, which is above the regional background concentration (0.5 pCi/L). The ratio of tritium to Tc-99 (2700) is very close to the ratio in the Spent Fuel Pool (Tc-99 data from Ginna which has similar tritium and Spent Fuel Pool characteristics to Salem). Although Well W is located X feet from the center of the plume, it is only a few meters outside of the cofferdam.

- **WELL Z** - Analytical results of the groundwater sample collected from Well Z indicate a tritium concentration of 730 pCi/L. Although the tritium concentration indicated by the groundwater sample collected from Well Z is slightly elevated relative to regional precipitation (i.e., background), there is no indication that the release of water from the Spent Fuel Pool has migrated to Well Z. The relatively high concentration of dissolved methane (24 cc/kg or 1.1 mmoles/kg) detected in the groundwater sample from Well Z indicates that the groundwater recharged in the marshes to the east of the Station. Results of the groundwater age determination indicate an age of 3.2 years, which is consistent with the other wells screened in this zone (e.g., Wells U, T, and W). The relatively low concentrations of dissolved methane indicated by monitoring wells installed near the facility and the elevated tritium concentrations indicated by groundwater samples collected from Wells S and AB contrast with the methane-rich, low tritium water indicated by Well Z.

- **WELL AA** - Analytical results of the groundwater sample collected from Well AA indicate a tritium concentration of 734 pCi/L, which is similar to Well Z. A dissolved methane concentration of 0.22 cc/kg indicates that the site of recharge for groundwater at Well AA is likely in the vicinity of the cofferdam on the southwest side of the facility rather than the marshes to the east. Although Well AA is directly downgradient from Well S, it is apparent that groundwater with the characteristics of Spent Fuel Pool water has not migrated this far south (Well AA is located about 50 meters southwest of the cofferdam). The groundwater age analysis of the sample collected from Well AA indicates an age of 2.1 years.

- **WELL AB** - Analytical results of the groundwater sample collected from Well AB indicate a tritium concentration of 321,000 pCi/L. The groundwater age result for this well is 1.4 years.

- **WELL AF** – Analytical results of the groundwater sample collected from Well AF indicate a tritium concentration of 256 pCi/L. Groundwater age estimates for this well are about 10 years, indicating a relatively long/slow flow path (perhaps stagnant conditions) and little or no connection to contaminated waters seen close to the plant (e.g., S or AB). The groundwater at AF is methane-rich, suggesting a recharge location in the marshes to the east of the plant and similar to Wells U, T, and Z.

								Corrected For Excess Air				
Sample #	Tc-99 pCi/liter	^{4}He μcc/kg	Ne μcc/kg	N_2 cc/kg	Ar cc/kg	$\underline{R}$ R_a	Methane cc/kg	^{4}He μcc/kg	$^4He_{rad}$ μcc/kg	He-3* pCi/L	H-3 pCi/L	Age (yr)
Salem L-80		43.11	190.4	13.8	0.351	2.253	0.19	43.11	-1.39	99	45	*21.03*
Salem K-80b	0.8	51.90	204.3	15.2	0.333	22.475	0.46	46.08	2.18	1792	955	*19.23*
Salem Q-80		29.69	90.7	6.6	0.169	0.745	37.91	47.55	6.53		1.6	
Salem P-80		48.10	197.4	13.6	0.316	1.718	1.03	43.30	-0.26	57	58	*12.46*
Salem O-20		59.83	228.6	14.4	0.361	1.321		49.29	3.84	30	6000	*0.09*
Salem K-80		42.55	146.0	14.9	0.329	22.19	0.33	43.3		1662	955	*18.35*
Salem Well 3		337.42	281.3	12.4	0.359	0.175	5.01	309.5	264.9		**<0.5**	*>100*
PSEG Well 6		1920.21	294.6	16.5	0.501	0.062	0.05	1898.0	1849.9		**<0.5**	*>100*
Salem Well T	**0.7**	4.18	14.9	1.7	0.041	1.273	31.92			23	**257**	*1.59*
Salem Well U	**0.5**	7.57	26.7	1.5	0.041	1.226	8.16			20	**78**	*4.10*
Salem Well N	**0.4**	55.48	239.8	13.2	0.329		0.02	37.778	-5.525	24.2	**5194**	*0.08*
Salem Well W	*******4.1**	307.50	1354.7	26.6	0.390	4.225	17.26			263.9	**13062**	*0.36*
Salem Well M	**0.5**	53.69	215.3	15.0	0.368	2.344	0.39	46.788	2.197	132.1	**142696**	*0.02*
Salem Well O	**0.2**	59.06	216.5	14.4	0.310	2.010	0.01	48.627	4.320	109.6	**12963**	*0.15*
Salem Well S	**0.5**	45.00	210.0	14.0	0.340	1564	0.01			126900	3480000	*0.65*
Salem Well R	**0.4**	59.37	253.92	14.5	0.320	3.103		37.38	-6.67	227.6	**3447**	*1.16*
Salem Well V	**0.8**										**549**	
Salem Well Z	**0.4**	**19.18**	**95.65**	**6.18**	**0.133**	**5.08**	**24.06**			**142**	729	***3.24***
Salem Well AA	**0.5**	**86.60**	**393.81**	**21.23**	**0.424**	**1.55**	**0.22**			**88**	734	***2.06***
Salem Well AB	**0.4**	**58.20**	**236.08**	**19.61**	**0.377**	**240.79**	**2.65**			**25261**	321000	***1.38***
Salem Well AE	**0.7**	**62.13**	**253.56**	**15.64**	**0.310**	**2.36**	**0.02**			**155**	8558	***0.33***
Salem Well AF	**0.2**	**25.60**	**97.14**	**7.17**	**0.169**	**4.83**	**20.98**			**178**	256	***9.61***
Salem Well V	**0.5**	**24.75**	**90.60**	**7.57**	**0.166**	**17.25**	**15.36**			**729**	549	***15.37***
Salem Well W	**2.5**	**20.12**	**80.97**	**7.98**	**0.166**	**80.36**	**28.02**			**2891**	11305	***4.14***
Salem Well Y	LOST											

Appendix H

Attachment 1

Research Laboratory Procedures
Remedial Investigation Report
PSEG Nuclear, LLC, Salem Generating Station, Salem, New Jersey

Item	Title
1	Hydrology of the Salem Generating Station, Proposal, 26 February 2003
2	Standard Operating Procedure, Tritium-Helium Dating of Groundwater

In the event of a conflict between the Standard Operating Procedure and the Hydrology of the Salem Generating Station proposal, the Hydrology of the Salem Generating Station proposal will be followed.

Hydrology of the Salem Generating Station

Proposal prepared for
PSEG
by Robert J. Poreda
Professor of Environmental Sciences
University of Rochester
February 26, 2003

The proposed investigation will examine the potential for radionuclide migration in groundwater at the PSEG Salem Power Station. Specifically, the investigation addressed the source of the contamination, the magnitude of the release to the environment and the best methods to address long term monitoring at Salem. Standard monitoring by PSEG scientists had detected tritium at levels above environmental concentrations at several sites surrounding Salem #1. Of particular concern is the possibility that water from the spent fuel pool has leaked or is leaking into the groundwater that surrounds the containment building.

1. Sites that contained elevated tritium levels would also be analyzed for ^{129}I (a long-lived radionuclide produced by uranium fission). The Accelerator Mass Spectrometry method has a detection limit of 10^6 atoms of ^{129}I/liter of water. ^{129}I measurements have several distinct characteristics that make it a suitable tracer for identifying sources of radionuclide release: a) ^{129}I displays "conservative" behavior in groundwater (as I^-) so that it migrates with the flowing water rather than adsorbing on particles (as is the case for ^{137}Cs). b) Because ^{129}I is a long-lived radio-isotope, it can be used to detect any past as well as present leakage of ^{129}I-bearing waters into the environment (the other iodine radio-isotopes decay to background levels in less than one month and hence are only useful in assessing very recent leaks). c) Elevated levels of ^{129}I should be characteristic of water leaking from the spent fuel pool because of the proximity to the large amount of fissionable uranium, Water that leaks from other sources (e.g. the turbine drains or steam releases) should have low ^{129}I because the water that is used to generate the steam has extremely low concentration of dissolved ions.
2. Determine the residence time of groundwater in the vicinity of the containment building and the rate of possible shallow groundwater flow to the southwest (i.e. toward the river). Evaluate flow in the upper Vincetown Formation (50 to 80') to determine: 1. flow direction and recharge estimates; 2. Evidence for or against tritium migration from the surface fill into the Vincetown Formation; 3. the "age" of any tritium release. To accomplish this task, we used the ^{3}He/^{3}H groundwater age dating method. The validity of this method has been established in a series of papers by Poreda, Solomon, and Schlosser (with co-authors) (see references and appended papers). The technique makes use of the

fact that groundwater, once it has been isolated from the atmosphere begins to accumulate ^{3}He from the decay of tritium. Because tritium levels in this region are elevated relative to environmental levels, the technique is extremely sensitive in establishing rates of groundwater flow. We applied this method to the "down gradient" environmental monitoring wells and to the wells that (based on hydraulic heads) flow back to a basement sumps for processing. The goal will be to establish if the rates of groundwater flow away from and toward the facility from the age dating and simple mass balance calculation (residence time = volume of water/flux) .

3. From this preliminary investigation and a review of the initial site survey, we will propose to PSEG an environmental well monitoring program that will provide for rapid and effective detection of the migration of any radionuclides off-site.

Tritium - Helium-3 Age Dating

We can estimate the transit time of the tritium in the subsurface by measuring the amount (%) of the tritium that has decayed to ^{3}He [see the analytical methods section and the attached reference articles for complete procedures]. The tritium levels near the plant are typically 10 to 100 times average rainfall (1.0 vs. 0.1 pCi/g) and the likely source of the tritium is from activities at Salem (a major component is thought to have come from "events" (such as steam release into the system). To calculate a transit time for the tritium, we assume that once the water is isolated from the atmosphere (vadose zone) it begins to accumulate ^{3}He. Thus the ratio of $^3He^*/^3H$ can be used to assess the subsurface transit time by the following equation:

$$\text{time} = (1/\lambda) \ln [(^3He^*/^3H) + 1]$$

$$\text{where } \lambda = 0.0555 yr^{-1}$$

Because a certain percentage of the ^{3}He is from atmospheric solubility, we use the ratio of ^{3}He/Ne in "air-saturated" water to subtract the atmospheric ^{3}He from the total. The tritium values from the University of Rochester Lab will be compared with the estimates made by PSEG's direct counting techniques.

Iodine-129 and the Iodine - Tritium Correlation

To investigate the potential sources of contamination at Salem, we extend the use of radioactive tracers to include the long-lived radioactive isotope of iodine, ^{129}I (15.7 million year half life), a product of U fission. The ratios of ^{129}I / ^3H will help us to identify the release paths for the radionuclides. Iodine and tritium behave as "conservative" (non-reactive) tracers in groundwater. Different sources (secondary water, air-fall, spent fuel pool, natural groundwater) will have distinct ratios of ^{129}I / ^3H. The ^{129}I measurement by Accelerator Mass Spectrometry can detect ^{129}I at levels of 10^6 atoms and a $^{129}I/I$ ratio of 10^{-14}. Thus, this represents an extremely sensitive and long-lived tracer for radionuclide release.

Steam is thought to have extremely low ^{129}I concentrations (1000 atoms/g), presumably because of the procedures used to remove ions from solution to ensure the integrity of the steam generation process. Any leakage of water between the primary and secondary systems leaks mainly tritium (1000 pCi/g) and is not a major release mechanism for other radionuclides. The Turbine Drain sample will serve as an analogue for the water that could leak during any steam release. Only the Spent Fuel Pool contains significant levels of ^{129}I (approximately equivalent to the natural creeks that drain the West Valley, NY facility) although there is no evidence that significant amounts of water have leaked from the pool into the environment. There is a factor of 10000 difference between the ambient ^{129}I concentration in precipitation (1000 atoms/g) and Spent Fuel Pool water (10,000,000 atoms/g). A similar factor of about a million exists for tritium in precipitation (0.05pCi/g) and spent fuel water(50,000 pCi/g). From this simple comparison, one can estimate the percentage of Spent Fuel Pool water finds its way into any of the groundwater monitoring wells. Other sources of significant ^{129}I, may come from the combined effects of "wash down" from the containment building and seepage into the Moat This washdown should be collected by the drainage system that surrounds the plant but must be evaluated as a potential source. A simple model would propose three potential "end-member" compositions for water at Salem : the Spent Fuel Pool water (high in tritium and high in ^{129}I), Turbine Drain Water (relatively high in tritium but very low in ^{129}I) and local precipitation (very low in tritium and ^{129}I .

ANALYTICAL PROCEDURES for IODINE

Water samples were prepared for ^{129}I /I ratio measurement by an adaptation of the method described in Fehn et al., 1992. Approximately 100 mL of water was used as starting material for sample preparation except for the two samples with the highest expected ratios where 1 mL and 0.1 mL were used. Since samples were expected to have high ^{129}I /I ratios and low iodine concentrations, carrier iodine with low ^{129}I content was added to each sample prior to extraction. Addition of carrier serves the dual purpose of increasing sample bulk to facilitate measurement, as well as preventing cross-contamination in the source from "hot" samples, i.e., samples high in ^{129}I, during Accelerator Mass Spectrometry (AMS) measurements. To achieve isotopic equilibrium between the sample and carrier KI which is added, samples and carrier were converted to IO_4^-. Iodine in the samples was then extracted into CCl_4, and back-extracted into the aqueous phase, followed by precipitation as AgI powder, following standard procedures. The silver iodide was pressed into stainless steel sample holders and loaded on a
sample wheel for AMS measurement.

^{129}I -to-stable iodine ratios (^{129}I /I) were determined by AMS at the PRIME lab facility at Purdue University. AMS uses a tandem accelerator in conjunction with an ion source, several magnets and suitable detectors to sensitively measure atoms of choice with detection limits of one atom in 10^{15} stable atoms, with associated removal of interfering atoms (see Elmore et al. (1984a and 1984b), Kubik et al. (1987) for a detailed description of AMS techniques***). (This facility is the only one currently in operation in the U.S that can perform the analysis at the required levels of precision).*** The ^{129}I /I ratios were normalized to a known standard during AMS measurement. AMS has a theoretical detection limit of ^{129}I/I ratio = 1 x 10^{-15} although practical detection limits are about 50 x 10^{-15}, due to the lack of natural materials with lower ^{129}I /I ratios. Chemical blanks and carrier iodine had ^{129}I /I ratios of 80 x 10-15 during that AMS run. I-content in the carrier solution was measured by ion chromatography with errors of +/- 5%.

Analytical Methods for Tritium and Helium

Shallow wells will be sampled using a dedicated "micro-purge" bladder pump to lift the water.. Care will be taken to place the purge tube near the top of the standing water column to ensure that the well was flushed completely and that the well screen is not exposed to air. . Dissolved gas samples were collected in 3/8" o.d. Cu tubing sealed with refrigeration clamps in accordance with standard procedures. Water is collected in 500ml glass bottles fitted with ploy-seal caps.

Gases are extracted from ~25 g of water on a high vacuum line constructed of stainless steel and Corning-1724 glass to minimize helium diffusion. The non-condensable gases (He, Ne, Ar, N_2, CH_4) plus water vapor are transferred into a 1724 glass ampoule for subsequent analysis. The amount of non-condensable gas was measured using a calibrated gas volume fitted with a capacitance manometer. Gas ratios (N_2, Ar, CH_4) were analyzed on a Dycor Quadropole mass spectrometer fitted with a variable leak valve. The results are combined with the capacitance manometer measurement to obtain gas concentrations (cc STP/Kg of water (+ 2%). Prior to helium isotope analyses, N_2 and O_2 are removed by reaction with Zr-Al alloy (SAES-ST707), Ar and Ne are adsorbed on activated charcoal at 77° K and at 40^o K, respectively. SAES-ST-101 Getters (one in the inlet line and 2 in the mass spectrometer) reduce the HD^+ background to ~100 ions/sec.

Helium isotope ratios and concentrations were analyzed on a VG 5400 Rare Gas Mass Spectrometer fitted with a Faraday cup (resolution of 200) and a Johnston electron multiplier (resolution of 600) for sequential analyses of the ^4He (F-cup) and 3He (multiplier) beams. On the axial collector (resolution of 600) $3He^+$ is completely separated from HD+ with a baseline separation of < 2% of the HD^+ peak. The contribution of HD^+ to the ^3He peak if < 0.1 ion/sec at 1,000 ions/sec of HD^+. For 2.0 ucc of He with an air ratio (sensitivity of 2×10^{-4} Amps/torr), the 3He signal averaged 2,000 ions/sec with a background signal of ~15 cps, due to either scattered ^4He ions or the formation of ^4He ions at lower voltage potentials within the source of the mass spectrometer. All $^3He/^4He$ ratios are reported relative to the atmospheric ratio (R_A), using air helium as the absolute standard. Errors in the $^3He/^4He$ ratios result from the precision of the sample measurement (0.2%) and variation in the ratio measurement in air (0.2%) and give a total error of 0.3% at 2σ for the reported helium isotope value. Helium concentrations (cc STP/Kg of water) are derived from comparison of a known split of the total sample to a standard of known size. The value, as measured by peak height comparison, is accurate to 2% (2σ).

Tritium values are analyzed using the 3He "in-growth" technique. 150 g of water are degassed of all He on a high vacuum line and sealed in a 3" O.D. 1724 glass ampoule for a period of 30 to 50 days (because of the high tritium levels , with respect to typical precipitation). Glass ampoules had been baked at 250^{o} C in a helium-free nitrogen gas to minimize the solubility of helium in the glass. After sealing, the ampoules are stored at -20° C to limit diffusion of helium into the bulb during sample storage. During this interval, ^{3}He produced from the decay of tritium accumulates in the flask. Typical sample blanks are ~10^{-9}cc of ^{4}He and 10^{-15}cc of ^{3}He. Blank corrections to ^{3}He are made using the ^{4}He content and assuming that the blank has the air ^{3}He/^{4}He ratio. The ^{3}He content of the storage ampoule is measured on the VG 5400 using the above procedures and compared to the ^{3}He content of air standard. Typical ^{3}He signals for a sample containing 10 T.U. and stored for 90 days are ~$8\text{x}10^{5}$ atoms (± 2%) and a blank of $3 \pm 1\text{x}10^{4}$ atoms of ^{3}He. Errors in the reported tritium value are dependent on the amount of tritium and are 2% (2σ) at 10 T.U. Higher precision can be achieved with larger samples and longer storage times.

Sampling Strategy

1. Determine the age and rate of groundwater flow in the 4 ***existing*** shallow (20 foot) near-field wells O,M,N,R. and 2 to 4 ***proposed*** shallow wells. It is hypothesized that this water should drain toward the containment building (based on hydraulic head distribution). Tritium (by PSEG) / Helium-3 (by U of Rochester) can determine this flow to +/- 20%. The flow will be compared to the tritium inventory estimates for the building sumps (pump rate x tritium level) to evaluate the flow of tritiated water back toward the containment building (cost $1500 – 2000 @$300 per sample)) ***(analysis time 1 month)***
2. Measure tritium and ^{3}He in 4 ***existing*** far field wells that penetrate into the Vincetown Formation Aquifer: K (80) , L (80) , P (,80) , Q(80) (both measurements to be made at Rochester). The goals are to estimate the travel times for natural groundwater in the Vincetown Fromation, determine if any significant tritium release has migrated away from containment and to determine the groundwater age of any discovered tritium release. Possible enhanced pathways for migration may exist along piping or "footings" pounded to depth. The method does not require knowledge of the tritium input function because the ratio of tritium to helium-3 establishes the age. (cost ($2400 @ 4 x$300 for tritium and 4 x $300 for ^{3}He) ***(analysis time 3 months)***
3. Measure trtium and dissolved gases in three to five ***existing*** deep wells (300 to 800 feet) that tap two drinking water aquifers (Mt Laurel-Wenonah at ~ 300 feet and the Upper Raritan at 800 feet). The water at depth is most likely pre-nuclear with tritium at background levels (0.3 pCi/liter). Any potential leakage of surface water can be evaluated at the 1ppm level based on the significant tritium levels found in Turbine steam (1,000,000 pCi/liter) and Spent fuel pool water (100,000,000 pCi/liter) (cost $2000 –3000 at $600/sample) ***(analysis time 3 months)***
4. Measure I-129 in two background samples (precipitation and far field groundwater) and six to eight wells that contain elevated tritium (4-5 shallow (20') and 2-3 wells from 80 feet). The ratio of ^{129}I to ^{3}He will be used to evaluate whether the source is steam (low ^{129}I) or spent fuel pool water (high ^{129}I). (cost $7000 @ $700 per sample) ***(analysis time 6 months)***

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Standard Operating Procedure
Tritium-Helium Dating of Groundwater

Samples of groundwater from the Site will be provided to the noble gas laboratory at the University of Rochester. The helium samples (about 30 grams of water) will be collected in copper tubing according to standard methods (see attached instructions). Tritium samples will be collected in 0.5 liter glass bottles that are sealed with polyethylene caps. The helium and tritium samples will be analyzed at the University of Rochester according to standard methods (see Solomon et al.,1992 and references therein). All contracted work will be performed at University of Rochester facilities. Analytical precision for the measurements are as follows:

1) Tritium: detection limit of 0.1 TU with a maximum uncertainty of +/- 0.1 TU.

2) Helium-4 concentration: Detection limit of 1 cc/kg with a maximum uncertainty of +/- 1 cc/kg.

3) ^{3}He/^{4}He ratios (relative to an air helium standard) with a precision of 0.3% for samples containing 40 grams of water. (Smaller volume samples will have lower precision).

4) Dissolved nitrogen concentrations (detection limit of 1cc/kg) with a maximum uncertainty of +/- 1 cc/kg.

Air standards are used to calibrate the mass spectrometer with the standard procedure of one standard repeated every two samples. High vacuum blanks will be analyzed at a rate of one blank per five samples.

The results of the analyses will be synthesized and provided in tabular format. In addition, groundwater ages based on the tritium and ^{3}He contents of the samples will be calculated and a written report will provide the details of such calculations.

Analytical Methods for Tritium and Helium

Wells are sampled using a Waterra "lift" pump or a “downhole sampler”(a length of Cu tubing fitted with a check valve) to minimize formation of bubbles in the water stream. Each well had been recently purged by extracting more than three well volumes from the standing water in the well prior to sampling. Care was taken to place the purge tube near the top of the standing water column to ensure that the well was flushed completely. During sampling, the Waterra pump was lowered to within 30cm of the bottom of the well. Samples were collected in 3/8" o.d. Cu tubing sealed with refrigeration clamps in accordance with standard oceanographic procedures.

Gases are extracted from ~25 g of water on a high vacuum line constructed of stainless steel and Corning-1724 glass to minimize helium diffusion. The non-condensable gases (He, Ne, Ar, N_2, CH_4) are transferred to a 1724-glass ampoule, filled with activated charcoal, by the use of a "water vapor pump" .Water vapor streams off the sample from the actions of ultrasonic agitation and condenses in the ampoule which is held at –195°C. A 2mm constriction in the sample ampoule limits the "back-streaming" of gases. After removal of H_2O vapor and CO_2 at -90° C and -195° C respectively, the non-condensable gas was measured using a calibrated gas splitter fitted with a capacitance manometer. Gas ratios (N_2, Ar, CH_4) were analyzed on a Dycor Quadropole mass spectrometer fitted with a variable leak valve. The results are combined with the capacitance manometer measurement to obtain gas concentrations (cc STP/Kg of water (+ 2%). Prior to helium isotope analyses, N_2 and O_2 are removed by reaction with Zr-Al alloy (SAES-ST707), Ar and Ne are adsorbed on activated charcoal at 77° K and at 40° K, respectively. SAES-ST-101 Getters (one in the inlet line and 2 in the mass spectrometer) reduce the HD^+ background to ~1,000 ions/sec.

Helium isotope ratios and concentrations were analyzed on a VG 5400 Rare Gas Mass Spectrometer fitted with a Faraday cup (resolution of 200) and a Johnston electron multiplier (resolution of 600) for sequential analyses of the ^4He (F-cup) and 3He (multiplier) beams. On the axial collector (resolution of 600) $3He^+$ is completely separated from HD+ with a baseline separation of < 2% of the HD^+ peak. The contribution of HD^+ to the ^3He peak if < 0.1 ion/sec at 1,000 ions/sec of HD^+. For 2.0 ucc of He with an air ratio (sensitivity of 2×10^{-4} Amps/torr), the 3He signal averaged 2,500 ions/sec with a background signal of ~15 cps, due to either scattered ^4He ions or the formation of ^4He ions at lower voltage potentials within the source of the mass spectrometer. All $^3He/^4He$ ratios are reported relative to the atmospheric ratio (R_A), using air helium as the absolute standard. Errors in the $^3He/^4He$ ratios result from the precision of the sample measurement (0.2%) and variation in the ratio measurement in air (0.2%) and give a total error of 0.3% at 2σ for the reported helium isotope value. Helium concentrations (cc STP/Kg of water) are derived from comparison of a known split of the total sample to a standard of known size. The value, as measured by peak height comparison, is accurate to 2% (2σ).

Tritium values are analyzed using the 3He "in-growth" technique. 150 g of water are degassed of all He on a high vacuum line and sealed in a 3" O.D. 1724 glass ampoule for a period of 60 to 90 days. Glass ampoules had been baked at 250° C in a helium-free nitrogen gas to minimize the solubility of helium in the glass. After sealing, the ampoules are stored at -20° C to limit diffusion of helium into the bulb during sample storage. During this interval, ^3He produced from the decay of tritium accumulates in the flask. Typical sample blanks are ~10^{-9}cc of ^4He and 10^{-15}cc of ^3He. Blank corrections to ^3He are made using the ^4He content and assuming that the blank has the air $^3He/^4He$ ratio. The ^3He content of the storage ampoule is measured on the VG 5400 using the above procedures and compared to the ^3He content of air standard. Typical ^3He signals for a sample containing 10 T.U. and stored for 90 days are ~8×10^5 atoms (± 2%) and a blank of $3 \pm 1 \times 10^4$ atoms of ^3He. Errors in the reported tritium value are dependent on the amount of tritium and are 2% (2σ) at 10 T.U. Higher precision can be achieved with larger samples and longer storage times.

Sampling Procedure for Dissolved Gas (Helium) and ^{3}H (Tritium)

Pre-Sampling Procedures

Purge the well completely prior to sampling. Purging procedures should insure complete purging of the well and allow for minimal agitation of the water column in the well annulus. Do not expose the well screen to air (i.e. do not evacuate low yielding wells to dryness). Pumps utilized for purging and sampling should not introduce gas into the well annulus, preferred are submersible pumps, peristaltic pumps and foot valve (waterra type) pumps.

A slow steady water flow during sampling produces the best results by minimizing cavitation. Cavitation occurs when flow separation forms a partial vacuum on a swiftly moving solid object such as a propeller. The partial vacuum generated strips dissolved gas from the surrounding fluid, generating small bubbles. These bubbles will corrupt the sample by concentrating helium within the bubbles and depleting the water of dissolved helium. Cavitation may occur in both submersible pumps and footvalve pumps, care should be taken for the rate at which the pumps run .

Pumps should <u>not</u> utilize Teflon hosing, helium diffuses very rapidly through Teflon hosing, Teflon in general should be avoided as much as possible, PVC, poly-propylene and tygon are preferred materials.

Care should be taken in purging a deep, low yielding well, purging too quickly causes a rapid pressure change on the deeper water in the well. This may cause the dissolved gas within the deep water to come out of solution and cause bubbles to form within the annulus. These bubbles will strip the water of helium generating a bad sample.

Samples from a residential/ household systems should be taken prior to any treatment system and prior to the pressure tank. If possible it is better to take the sample directly from the well annulus using an external pump. If a sample point is post pressure tank please make note in sample chain of custody.

Procedure for Dissolved Gas Sample (Helium)

Attach two segments of tygon tubing to the ends of the copper sample tube and place the open pinch clamps on the tygon tubes. Select two refrigeration clamps, making sure that they have a suitable "gap" in the fully closed position (1 -2 mm) . Do not use clamps that have no gap (<1mm) or a spacing greater than 2 mm. Lightly tighten the refrigerator clamps to the outside of the copper sampling tube, <u>leaving 1.5 inches of tubing on both ends</u>.

Attach the intake of the sample apparatus to the pumping source (for waterra or submersible pumps) and carefully elevate the sample tube above the pump outlet. (If a peristaltic pump is used, it should be downstream of the Cu tube) Angle the tube at 45 degrees so that the flow of water moves upward through the sampler, carefully chase any air bubbles through the sampler so that no air bubbles are noted within the pump/sampler assembly. Continue pumping, keeping a close eye on the downstream tygon tubing for bubbles, gently tap the copper sample tube, held in the "angled" position, with a metal wrench in order to release any bubbles that may be stuck to the side of the sampler. Continue pumping until several tube volumes have flushed through the copper tube and NO bubbles of gas are noted in the tygon lines and sample tube. A slow steady stream of water works best (about 100 - 400 cc/min)

Note: This step can sometimes be very difficult, be patient, if it doesn't work after numerous attempts just do the best you can and make note of the problem

Continue pumping and slowly close off the upstream pinch clamp on the tygon tubing, then quickly close off the downstream pinch clamp after the upstream is closed. Start to tighten the refrigerator clamps on the copper sample tube by holding the clamp with one hand and tightening the clamp nuts with the other. Tighten the clamp evenly to avoid "scissoring " of the copper tube. The clamp should be tightened to the point where the maximum force is applied to the head of the wrench while holding the clamp tight. Over tightening will breach the sample tube while under tightening will allow the sample to leak. Sometimes there will be a small gap (1-2 mm) in the clamp when it is closed, clamp gaps will vary.

Carefully remove both tygon hoses and check to see if the crimped ends are either wiggly (over tightened) or leak (under tightened), re-sample if necessary. Check that the clamps are secure by giving them a final tightening (torque of about 30 ft.lbs - force applied with a 4 to 6 inch lever arm- e.g. a box end wrench). If the ends are sealed properly, fill the ends of the copper sample tube with water and cap, keep as little headspace in the ends as possible. If possible it is a good idea to take a duplicate sample, just in case. Label the sample tube with the date, time of sampling, and sample number on a sample tag as well as directly on the copper tube with a marking pen.

Procedures For ^{3}H Sample

After taking the dissolved gas sample, simply fill a 500 ml glass sample bottle from the pump discharge and cap with a poly-propylene cap , leaving no headspace within the bottle. Label the bottle with date, time, and sample number. Make sure the sample cap is tight, you can tape the cap to the bottle to prevent loosening with simple electrical tape.

Shipping the Samples Back to the Lab

Store the copper sampling tubes in a horizontal position packed in either foam rubber on their own or encased within piece of aluminum channel stock, packed in foam rubber, pay careful attention to the sample ends, they must be protected from bumps and jars. Either package for shipping very securely or hand carry, bent tubes, mangled ends, and breached tubes are often unextractable back in the lab. As for the tritium sample bottles, pack very tight so that the glass of one bottle cannot contact the glass of another bottle. They should not be able to move or shift within the packing container, usually double boxed sample bottles fair better than single boxed samples. Again some samples have ended up on the floor of UPS due to poor packing, Over Packing Works

Ship samples back with sample identification and sampling dates and times on a separate sheet of paper. Ship to:

Dr. R. J. Poreda
Dept. of Earth and Environmental Sciences
Hutchinson Hall Rm. 227
University of Rochester
Rochester, NY 14627
Phone 716-275-8691 (lab)

Appendix H

Attachment 2

Research Laboratory Procedures
Remedial Investigation Report
PSEG Nuclear, LLC, Salem Generating Station, Salem, New Jersey

Item	Title
1	Technetium-99 Analysis

Technetium-99 Analysis

Prepared for
PSEG
by Robert J. Poreda
Professor of Environmental Sciences
University of Rochester
September 15, 2003

This project will use state-of-the-art methods to determine the abundance and distribution of Technetium-99 in the Salem 1 plant environment. Technetium-99 (^{99}Tc) is a radioactive by-product of nuclear power generation (in addition to other mostly "nuclear" sources). Recent analytical advances in inductively-coupled plasma mass spectrometry (ICP-MS) make it possible to detect sub-picogram (less than 10^{10} atoms) quantities of ^{99}Tc. We will apply these methods to understanding the migration of ^{99}Tc in the environment. ^{99}Tc levels have not been accurately monitored in low-level radioactive settings because of difficulties in detection nor have the pathways of migration in the environment been determined.

One major focus of the research plan is to understand the migration of radionuclides (especially ^{99}Tc and ^{129}I) through the groundwater/soil environment. At Rochester, Professor Udo Fehn and his students have developed and tested the state of the art methods for the determination of ^{129}I. These analyses were successfully used at Ginna to establish the integrity of the containment system that minimized the radionuclide migration from the site. The behavior of Tc in groundwater and its interaction with soils suggests that the mobility of Tc-99 is nearly equivalent to I-129 and tritium. The geochemistry of Tc is such that it exists as an oxyanion, TcO_4^-, and has limited adsorption onto soils. Thus Tc-99 could be readily adopted as a fingerprint for spent fuel pool water with the added benefit of lower analytical costs and more rapid sample throughput than I-129 (only the Purdue accelerator can achieve the LLDs necessary for this investigation).

Technetium (Tc) was detected in 1937 by C. Perrier and E. Segre in a deuteron-irradiated molybdenum sample in the cyclotron of E.O. Lawrence in California. Minute quantities of ^{99}Tc (half life = 2.14 x 10^5yr.) are found to occur naturally as a result of spontaneous fission of uranium in uranium ore bodies. However, the largest source of the weakly radioactive isotope, ^{99}Tc, is from the fission of uranium in nuclear reactors. Technetium from nuclear power generating stations makes up about 6 percent of uranium fission products (Peacock, 1973), and together with ^{129}I, represents the major long-lived radio-isotopes generated in the nuclear industry. Federal regulations (10CFR61...) specify the ^{99}Tc and ^{129}I activity levels for disposal in low-level radioactive burial sites, although most waste shipments over-estimate the activity (by as much as 100x) and simply report the ^{99}Tc and ^{129}I levels as "upper limit values".

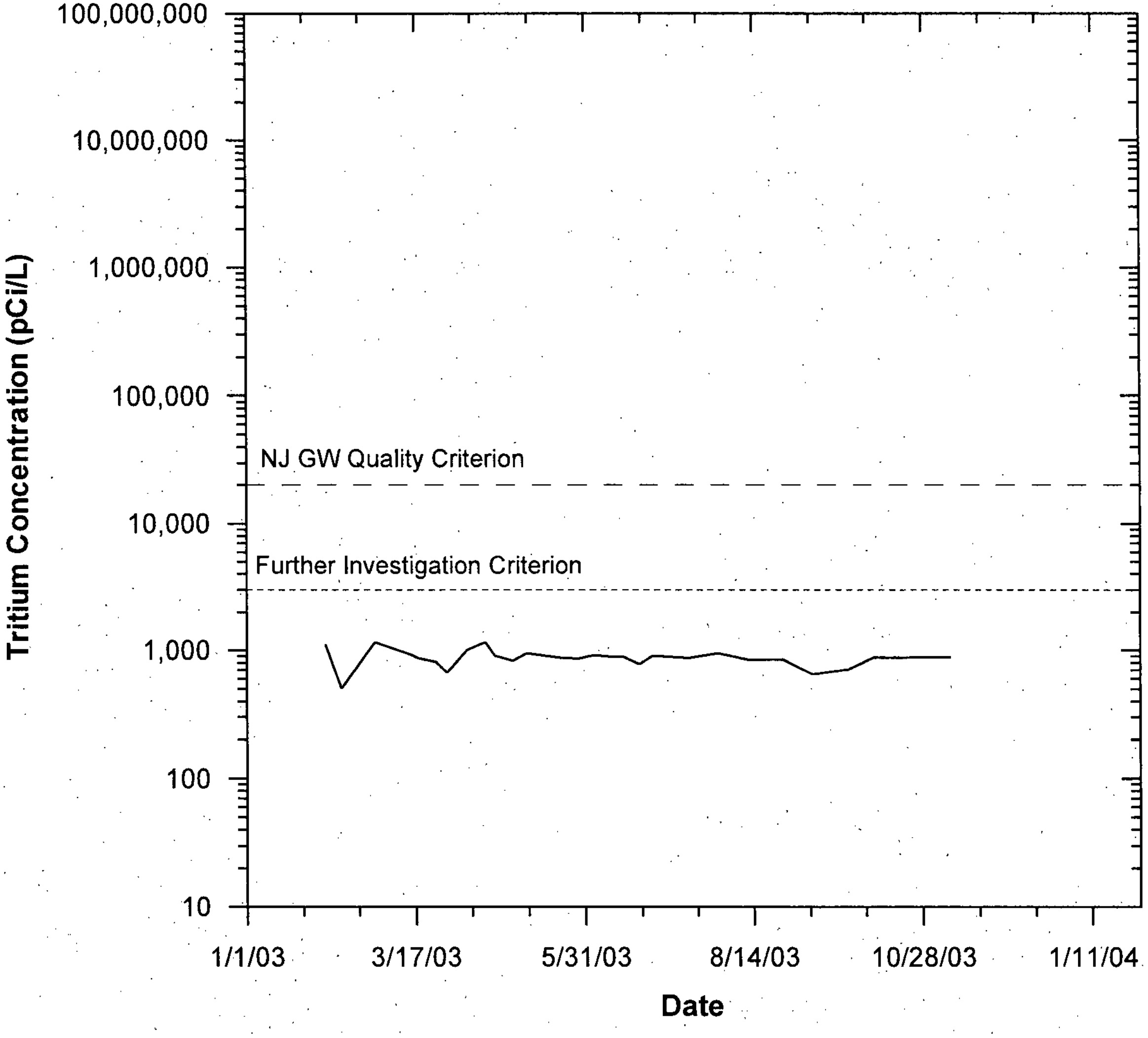
Technetium differs from most of the radionuclides associated with the nuclear industry (^{90}Sr, ^{137}Cs, ^{60}Co, ^{63}Ni) that have half lives of 30 years or less and decay to less than 0.01 percent of their original activity in 300 years (the monitoring/evaluation interval). Because of the long half life, ^{99}Tc in environmental samples is not easily measured by conventional low level counting techniques. Typical detection limit for ^{99}Tc, obtained by counting, is about 20 pCi/L of water (or 10^{13} atoms of ^{99}Tc). ICP-MS techniques should push this limit down by more than 1000x. The technetium from 1000 ml of water is collected on a TEVA disc specifically designed to adsorb Tc. The Tc is eluted from the disc with ultra-pure 2N HCl and 18 MΩ •water to a total volume of 10 ml. At a conservative sensitivity of 100,000 cps/ppb, a signal of 100 cps is equivalent to a concentration in the water of 0.01ppt or about 0.2 pCi/L.

The University of Rochester has established a world-class facility for the detection of extremely low levels of environmental metals, including ^{99}Tc, using plasma source mass spectrometry. In the 1990s, the commercialization of mass spectrometers with ICP sources and quadrupole analyzers has revolutionized the study of trace element geochemistry and environmental chemistry. These instruments have extremely low detection limits (ppt or better) due to the efficiency of the ICP source in ionizing transition metals. In addition, sample preparation is simplified compared to other analytical methods because samples are introduced to the instrument as aqueous solutions. The plasma source mass spectrometry laboratory at the University of Rochester includes a new generation Thermo X-7 instrument, and a VG Plasma 54. The X-7 is a workhorse quadrupole mass spectrometer with exceptional sensitivity and stability for trace metal detection at the ppt level.

Appendix I

Tritium Trend Plots for the Station Monitoring Wells

DRAFTER: VJAYARAMAN
APPROVED: PMILIONIS
CHECKED: SPOTTER
FILE NO.: Well K.grf
PRJCT NO.: NP000571.0003
DWG DATE: 02/23/04



Well Summary:

Installation Date : Feb-2003
Monitored Unit : Vincentown
Top of Screen : 70.0 ft bgs
Bottom of Screen: 80.0 ft bgs

ARCADIS

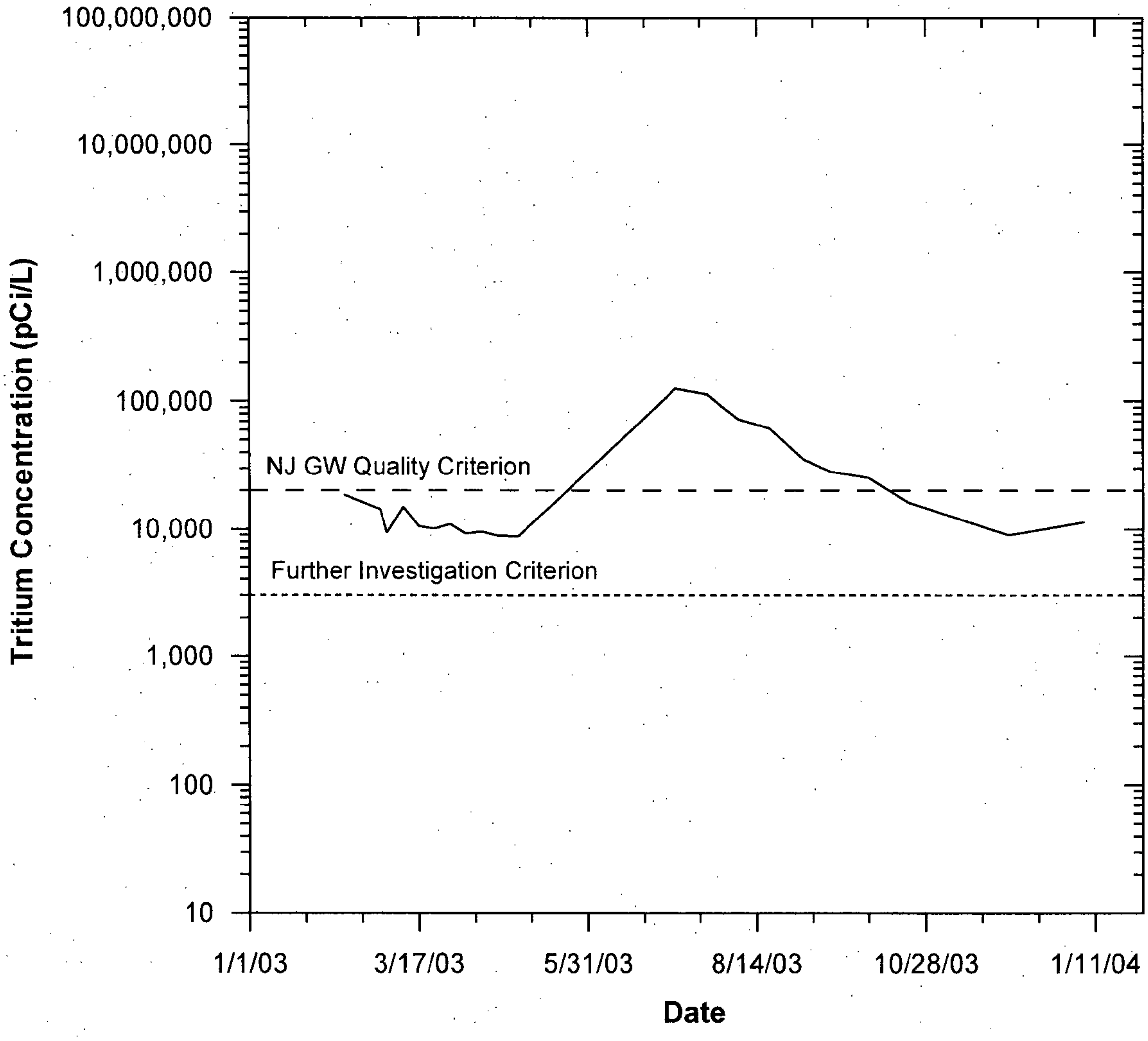
Tritium Concentration in Well K

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

I-1

DRAFTER: VJAYARAMAN
APPROVED: PMILIONIS
CHECKED: SPOTTER
FILE NO.: Well M.grf
PRJCT NO.: NP000571.0003
DWG DATE: 02/23/04



Well Summary:

Installation Date : May-2003
Monitored Unit : Cofferdam
Top of Screen : 10.0 ft bgs
Bottom of Screen: 20.0 ft bgs

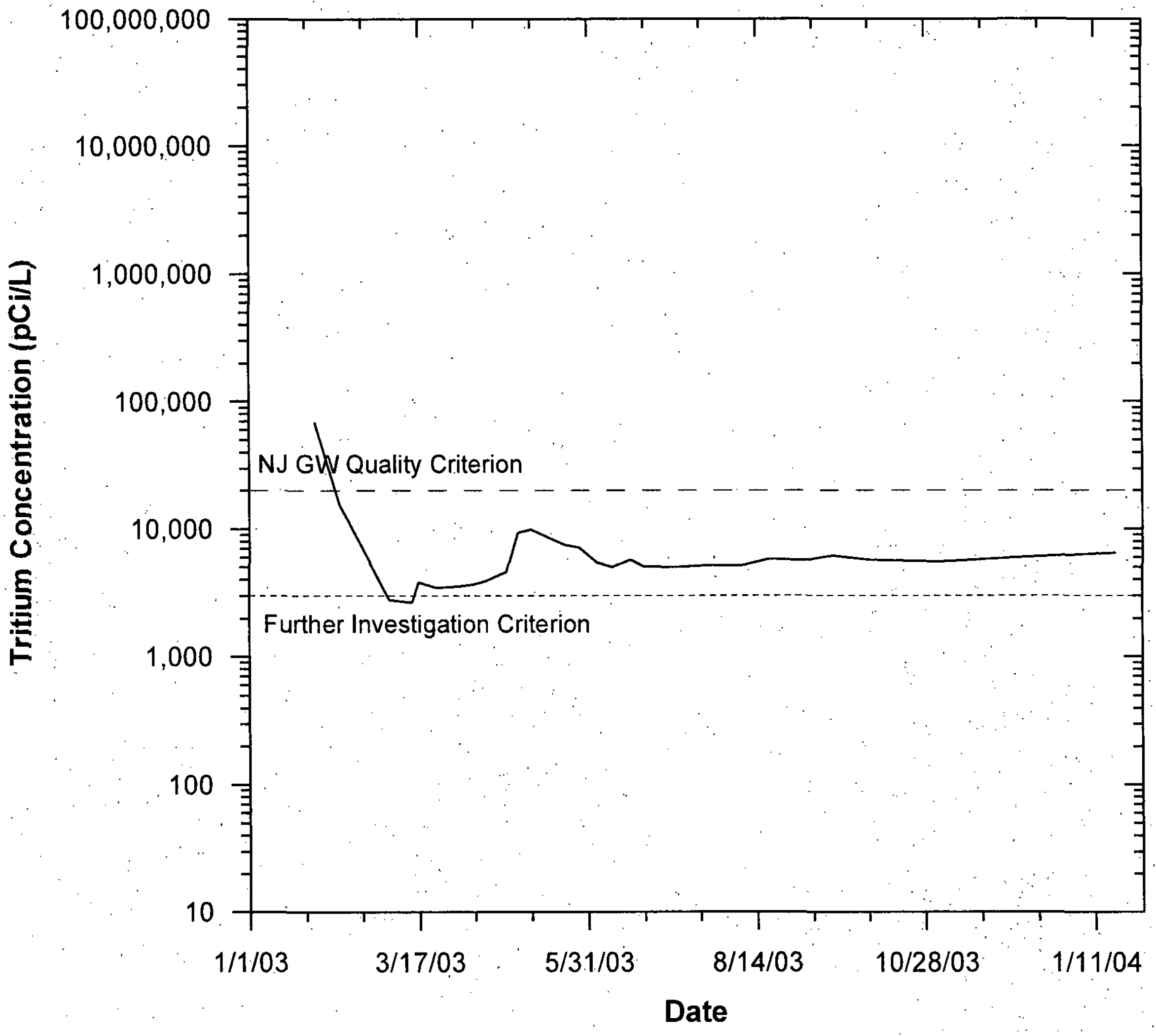
ARCADIS

Tritium Concentration in Well M

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
I-2

DRAFTER: VJAYARAMAN
APPROVED: PMILIONIS
CHECKED: SPOTTER
FILE NO.: Well N.grf
PRJCT NO.: NP000571.0003
DWG DATE: 02/23/04



Well Summary:

Installation Date : Jan-2003
Monitored Unit : Cofferdam
Top of Screen : 10.0 ft bgs
Bottom of Screen: 20.0 ft bgs

ARCADIS

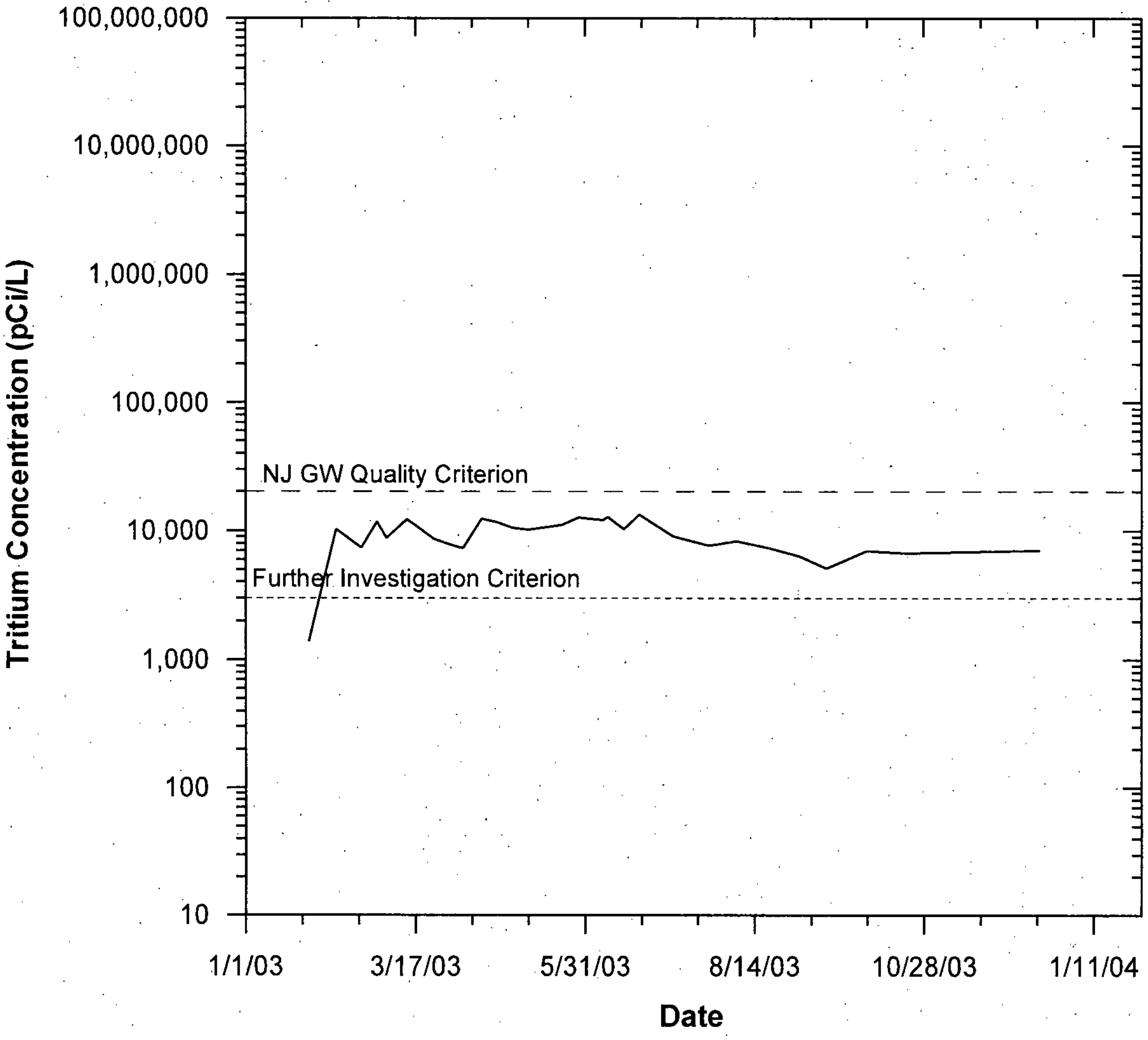
Tritium Concentration in Well N

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

I-3

DRAFTER: VJAYARAMAN
APPROVED: PMILIONIS
CHECKED: SPOTTER
FILE NO.: Well O.grf
PRJCT NO.: NP000571.0003
DWG DATE: 02/23/04



Well Summary:

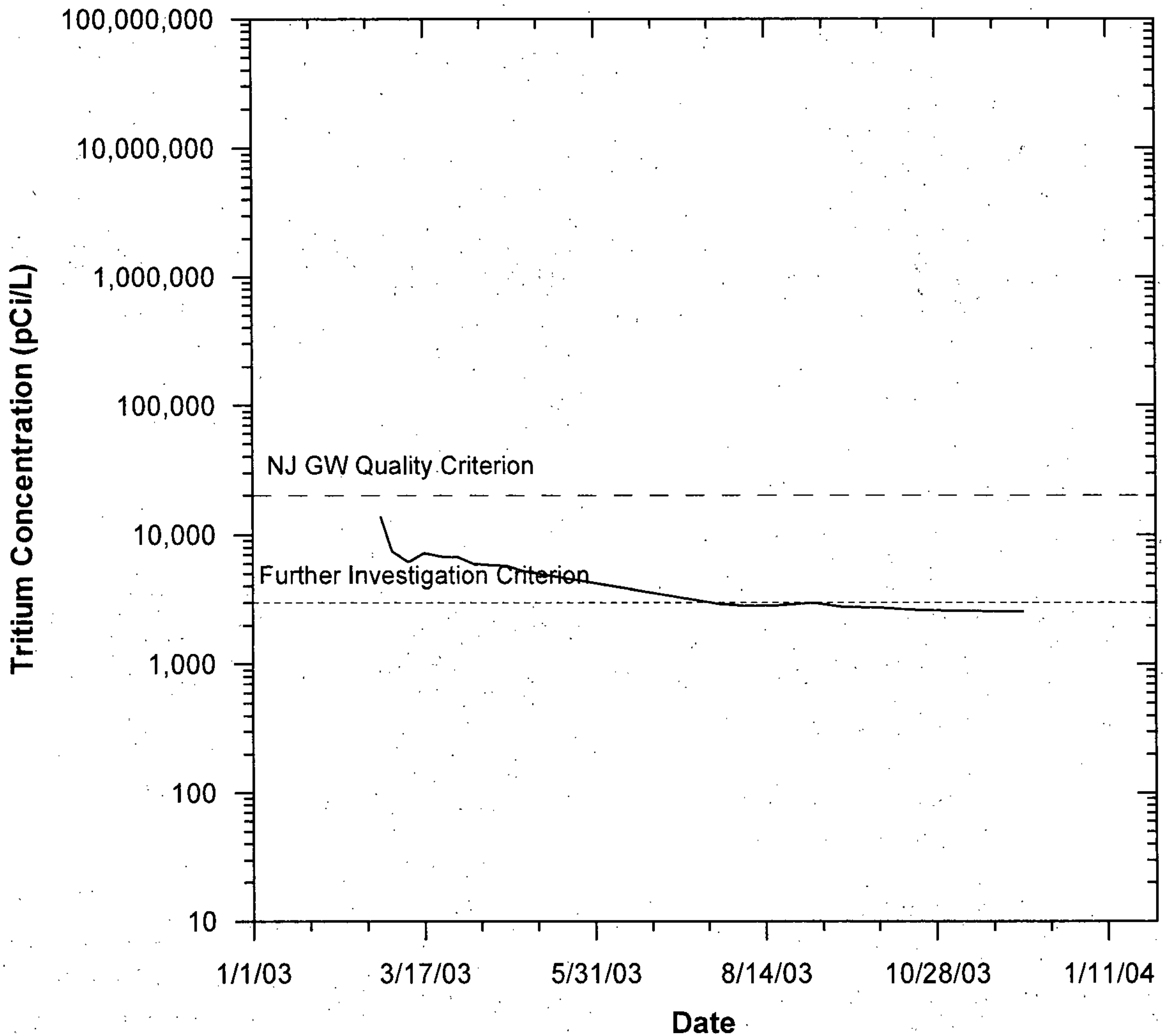
Installation Date : Jan-2003
Monitored Unit : Cofferdam
Top of Screen : 10.0 ft bgs
Bottom of Screen: 20.0 ft bgs

ARCADIS

Tritium Concentration in Well O

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
I-4



Well Summary:

Installation Date : Jun-2003
Monitored Unit : Cofferdam
Top of Screen : 9.0 ft bgs
Bottom of Screen: 19.0 ft bgs

ARCADIS

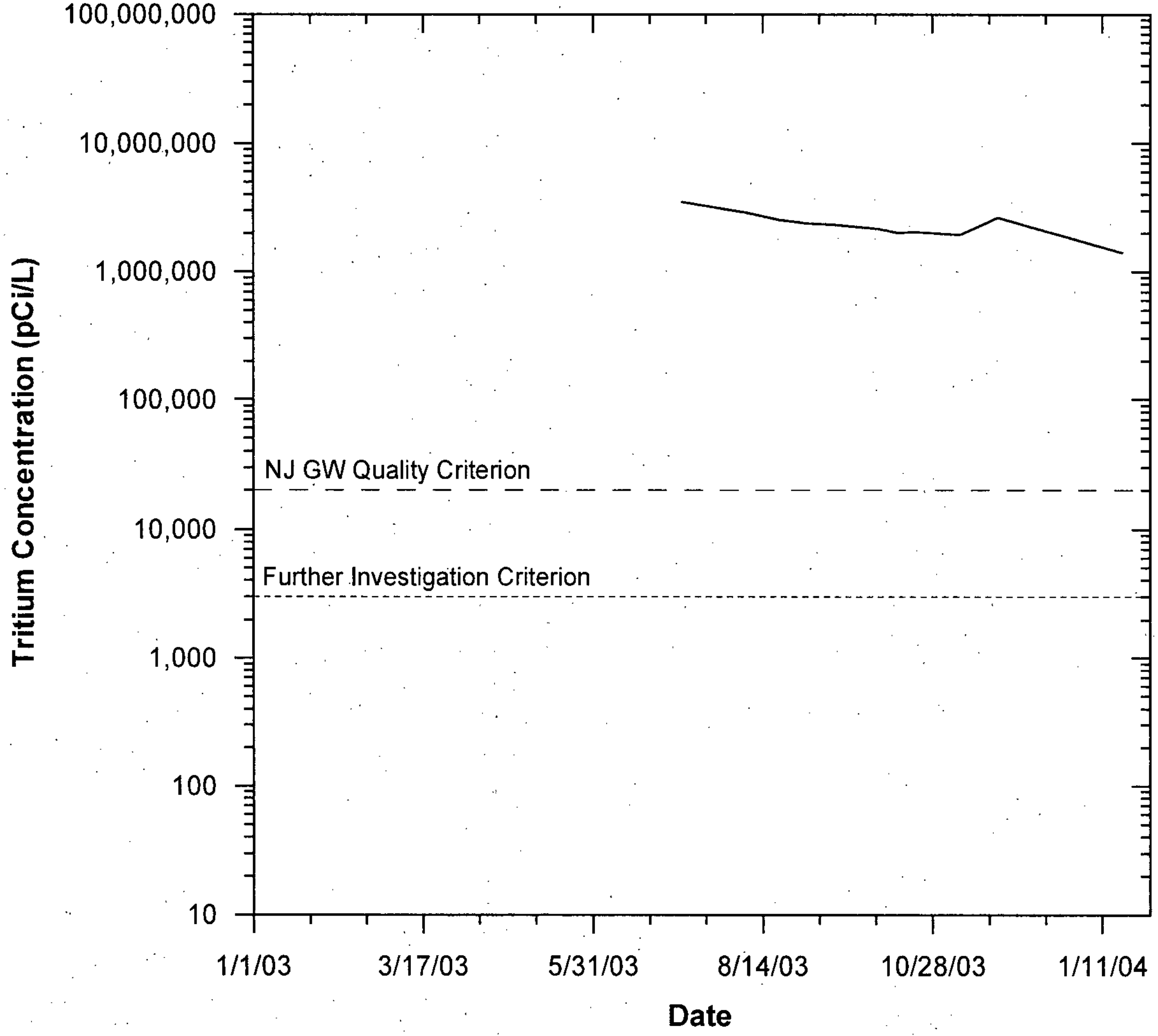
Tritium Concentration in Well R

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
I-5

DRAFTER: VJAYARAMAN
APPROVED: PMILIONIS
CHECKED: SPOTTER
FILE NO.: Well R.grf
PRJCT NO.: NP000571.0003
DWG DATE: 02/23/04

DRAFTER: VJAYARAMAN
APPROVED: PMILIONIS
CHECKED: SPOTTER
FILE NO.: Well S.grf
PRJCT NO.: NP000571.0003
DWG DATE: 02/23/04



Well Summary:

Installation Date : May-2003
Monitored Unit : Shallow, outside Cofferdam
Top of Screen : 24.7 ft bgs
Bottom of Screen: 34.7 ft bgs

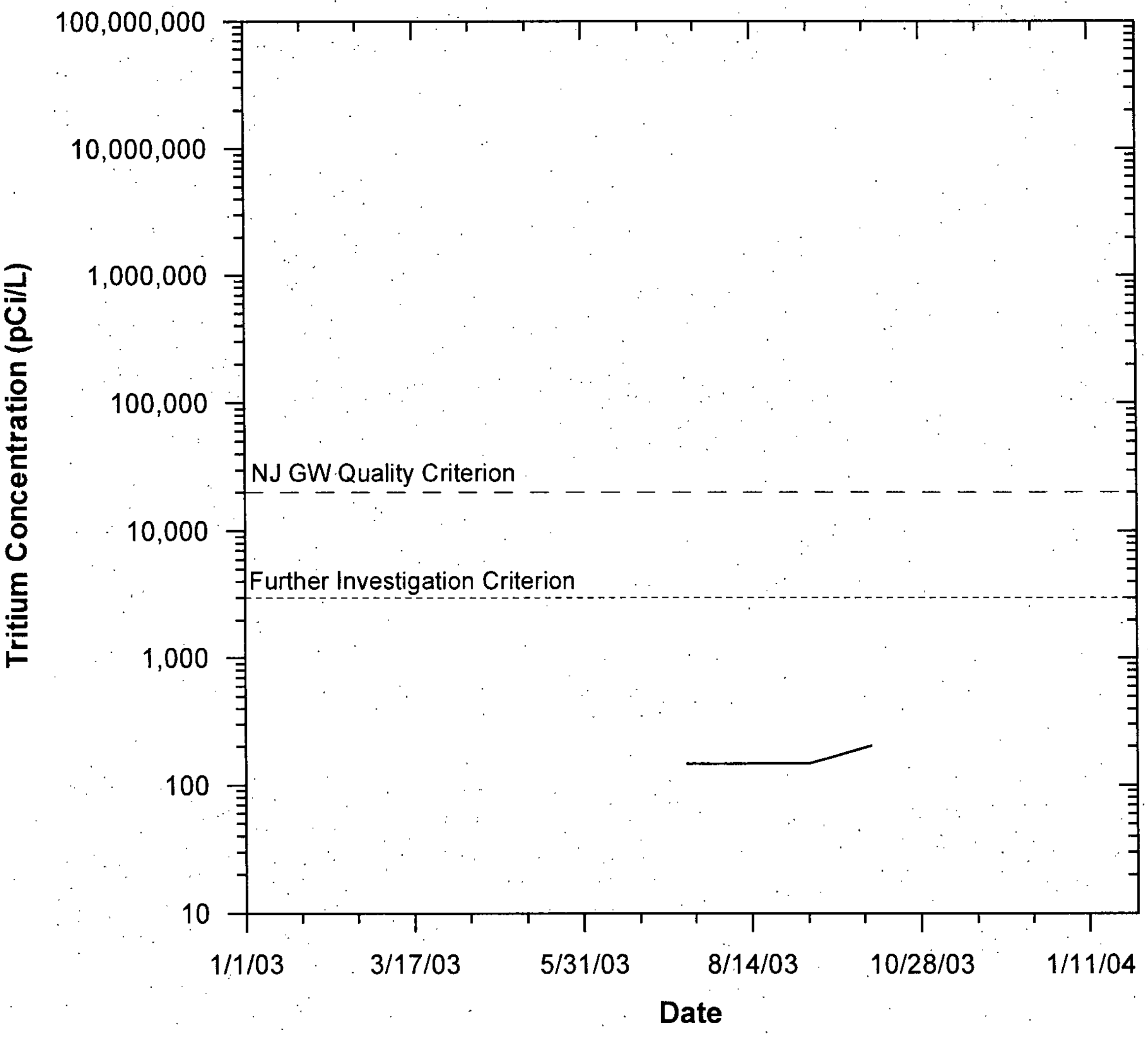
ARCADIS

Tritium Concentration in Well S

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
I-6

DRAFTER: VJAYARAMAN
APPROVED: PMILIONIS
CHECKED: SPOTTER
FILE NO.: Well U.grf
PRJCT NO.: NP000571.0003
DWG DATE: 02/23/04



Well Summary:

Installation Date : May-2003
Monitored Unit : Shallow, outside Cofferdam
Top of Screen : 27.2 ft bgs
Bottom of Screen: 32.2 ft bgs

ARCADIS

Tritium Concentration in Well U

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

I-7

DRAFTER: VJAYARAMAN

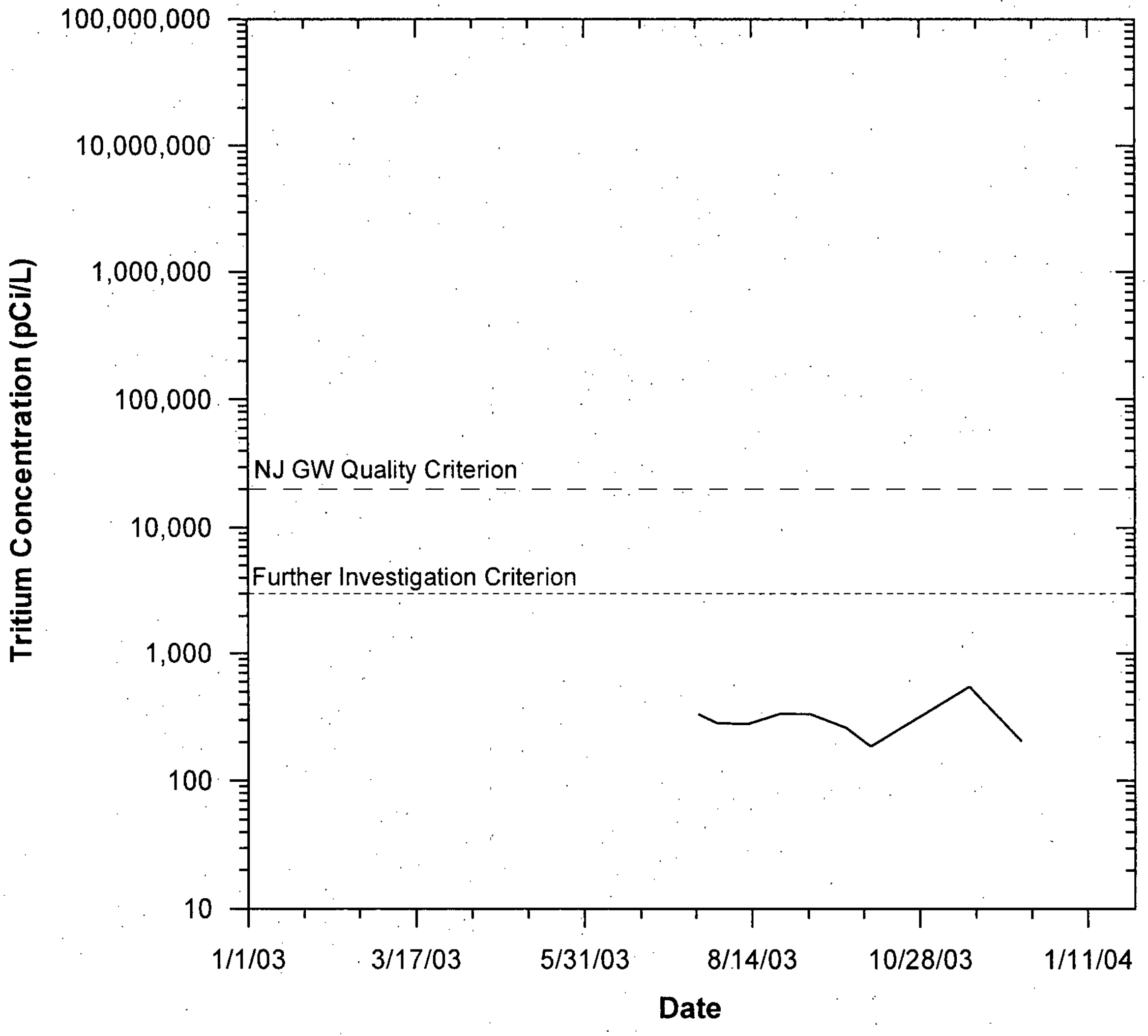
APPROVED: PMILIONIS

CHECKED: SPOTTER

FILE NO.: Well V.grf

PRJCT NO.: NP000571.0003

DWG DATE: 02/23/04



Well Summary:

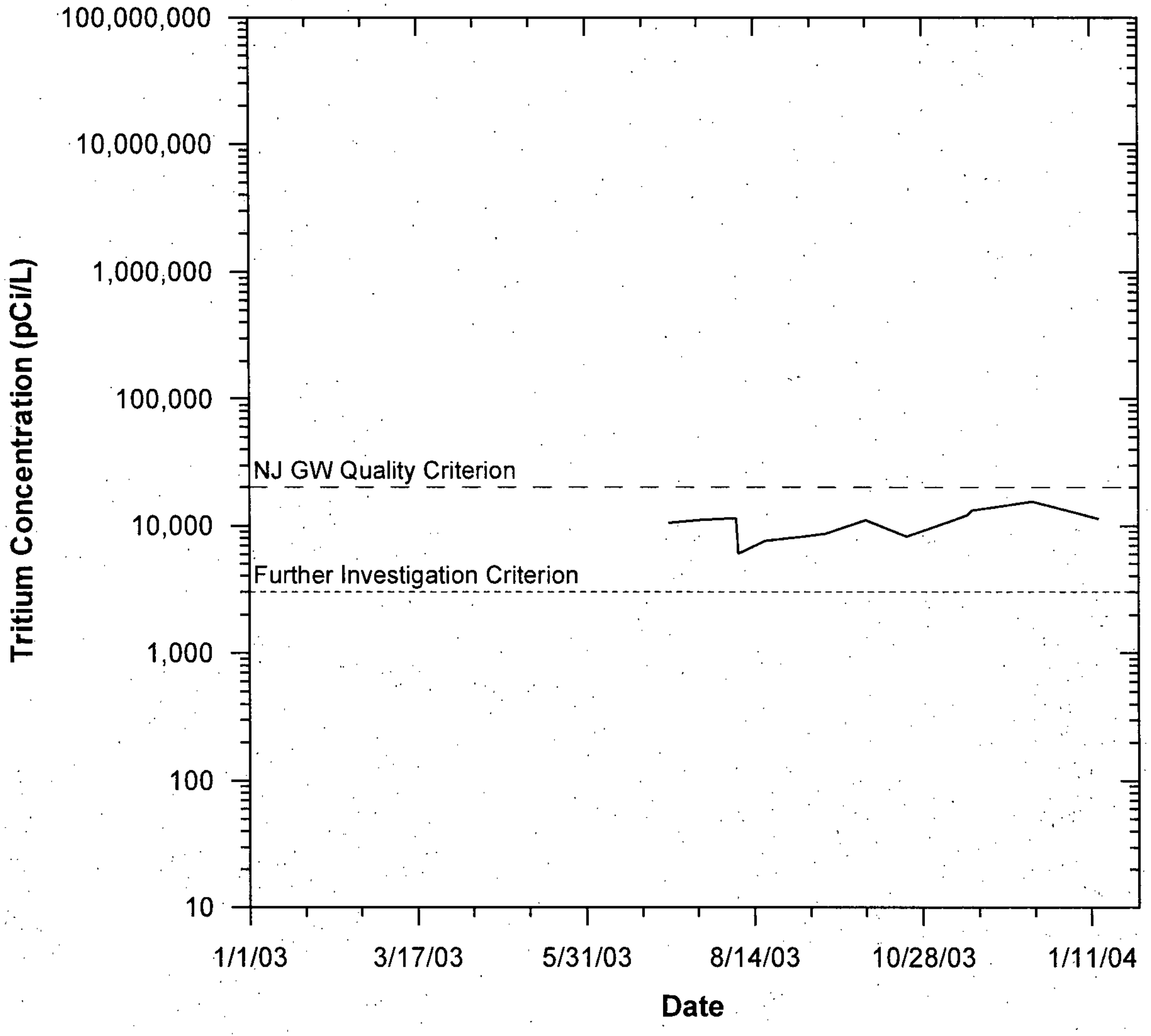
Installation Date : Jun-2003
Monitored Unit : Vincentown
Top of Screen : 69.5 ft bgs
Bottom of Screen: 79.5 ft bgs

ARCADIS

Tritium Concentration in Well V

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
I-8



Well Summary:

Installation Date : Jun-2003
Monitored Unit : Shallow, outside Cofferdam
Top of Screen : 25.0 ft bgs
Bottom of Screen: 35.0 ft bgs

DRAFTER: VJAYARAMAN
APPROVED: PMILIONIS
CHECKED: SPOTTER
FILE NO.: Well W.grf
PRJCT NO.: NP000571.0003
DWG DATE: 02/23/04

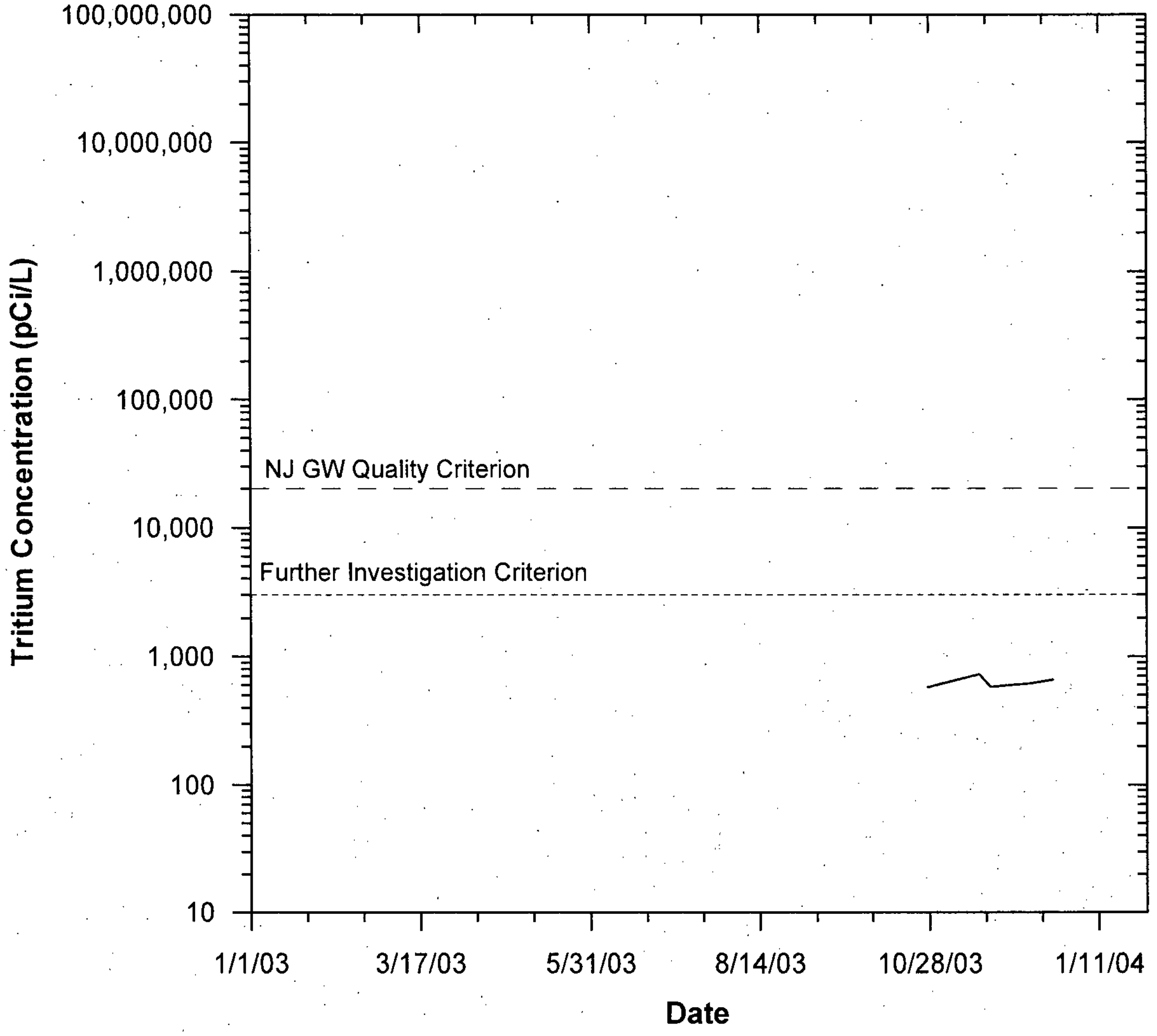
ARCADIS

Tritium Concentration in Well W

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
I-9

DRAFTER: VJAYARAMAN
APPROVED: PMILIONIS
CHECKED: SPOTTER
FILE NO.: Well Z.grf
PRJCT NO.: NP000571.0003
DWG DATE: 02/23/04



Well Summary:

Installation Date : Oct-2003
Monitored Unit : Shallow, outside Cofferdam
Top of Screen : 61.3 ft bgs
Bottom of Screen: 71.3 ft bgs

ARCADIS

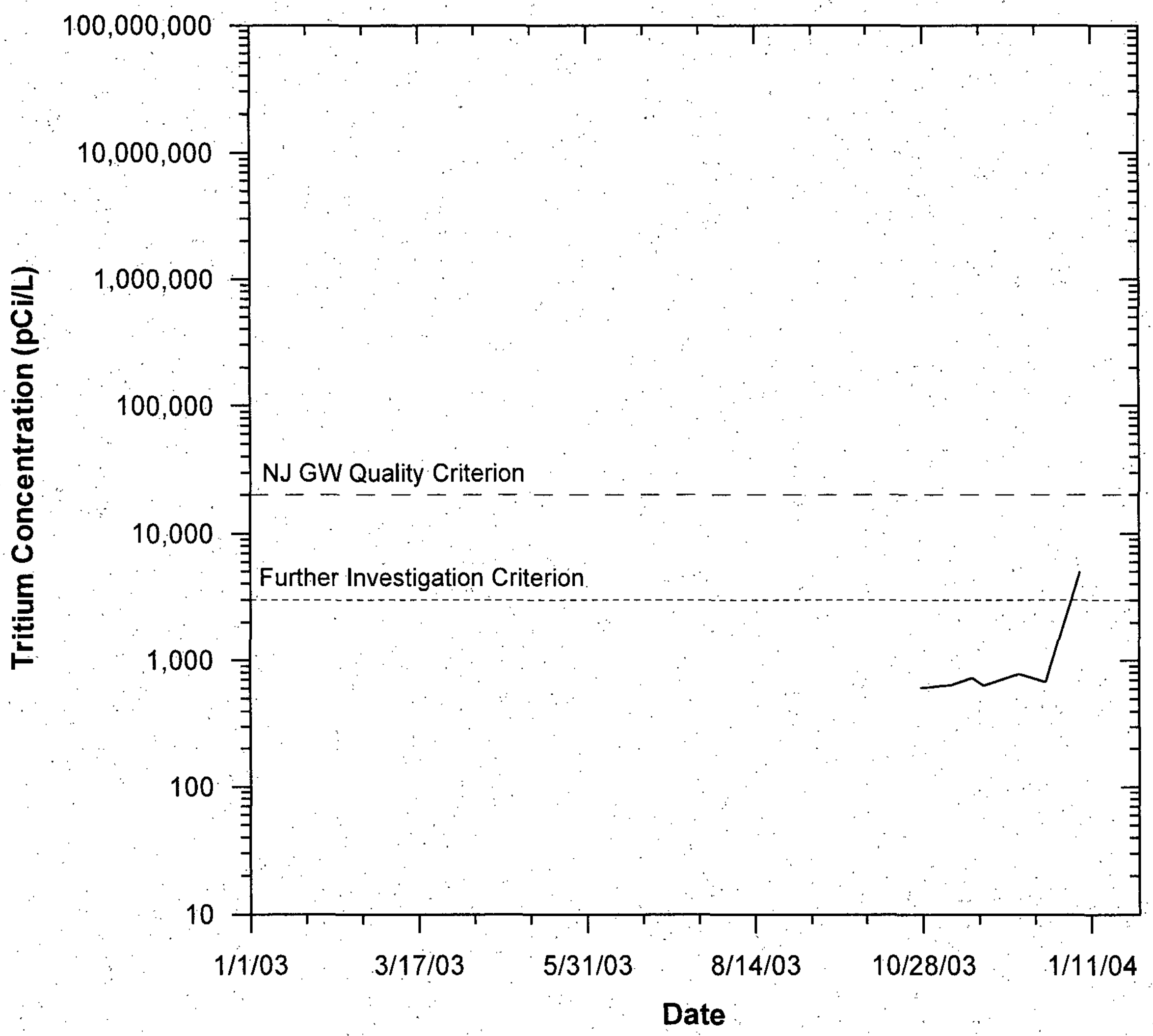
Tritium Concentration in Well Z

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE

I-10

DRAFTER: VJAYARAMAN
APPROVED: PMILIONIS
CHECKED: SPOTTER
FILE NO.: Well AA.grf
PRJCT NO.: NP000571.0003
DWG DATE: 02/23/04



Well Summary:

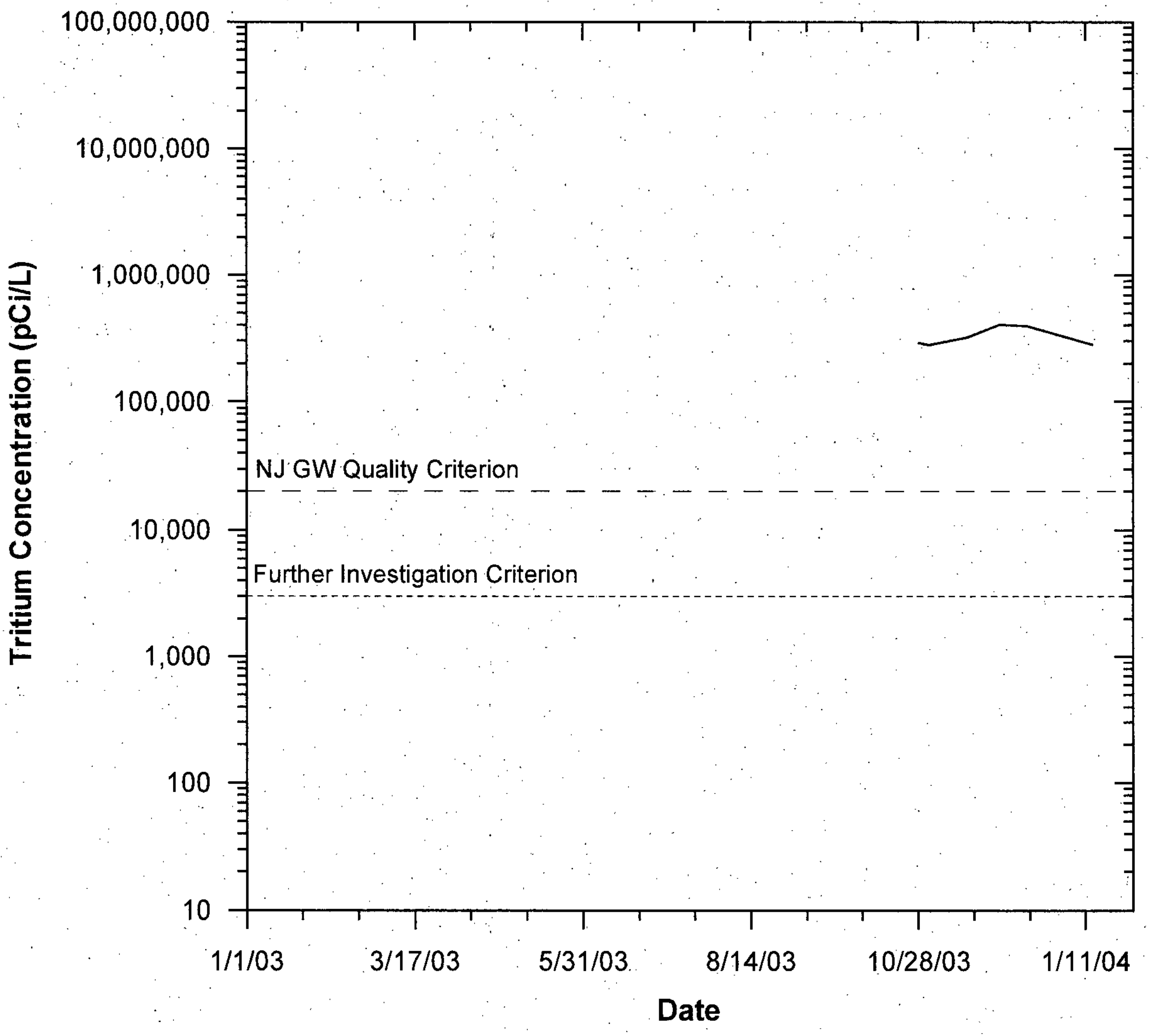
Installation Date : Oct-2003
Monitored Unit : Shallow, outside Cofferdam
Top of Screen : 63.2 ft bgs
Bottom of Screen: 73.2 ft bgs

ARCADIS

Tritium Concentration in Well AA

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
I-11



Well Summary:

Installation Date : Oct-2003
Monitored Unit : Shallow, outside Cofferdam
Top of Screen : 57.1 ft bgs
Bottom of Screen: 67.1 ft bgs

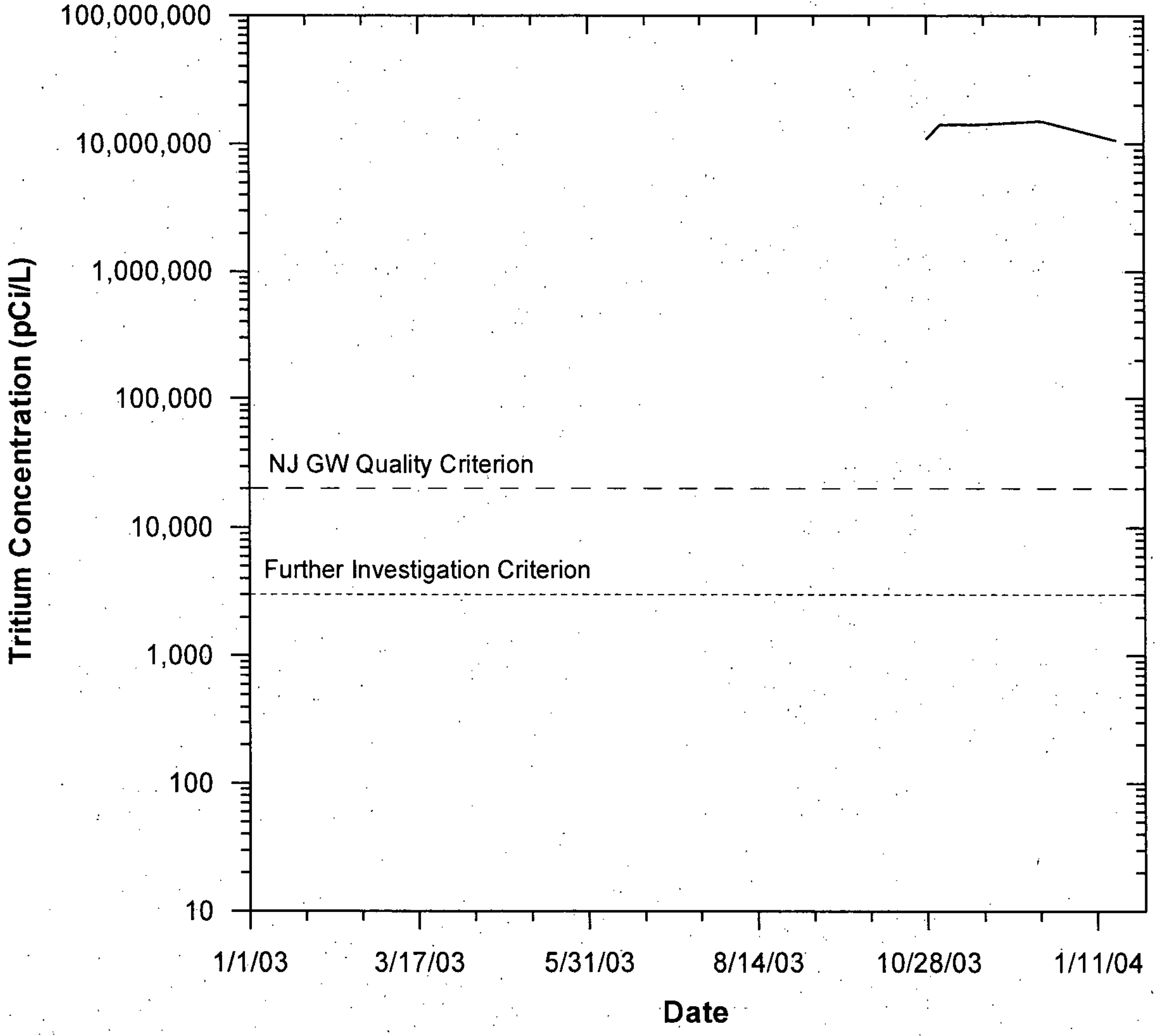
ARCADIS

Tritium Concentration in Well AB

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
I-12

DRAFTER: VJAYARAMAN
APPROVED: PMILIONIS
CHECKED: SPOTTER
FILE NO.: Well AB.grf
PRJCT NO.: NP000571.0003
DWG DATE: 02/23/04



Well Summary:

Installation Date : Oct-2003
Monitored Unit : Cofferdam
Top of Screen : 74.0 ft bgs
Bottom of Screen: 84.0 ft bgs

ARCADIS

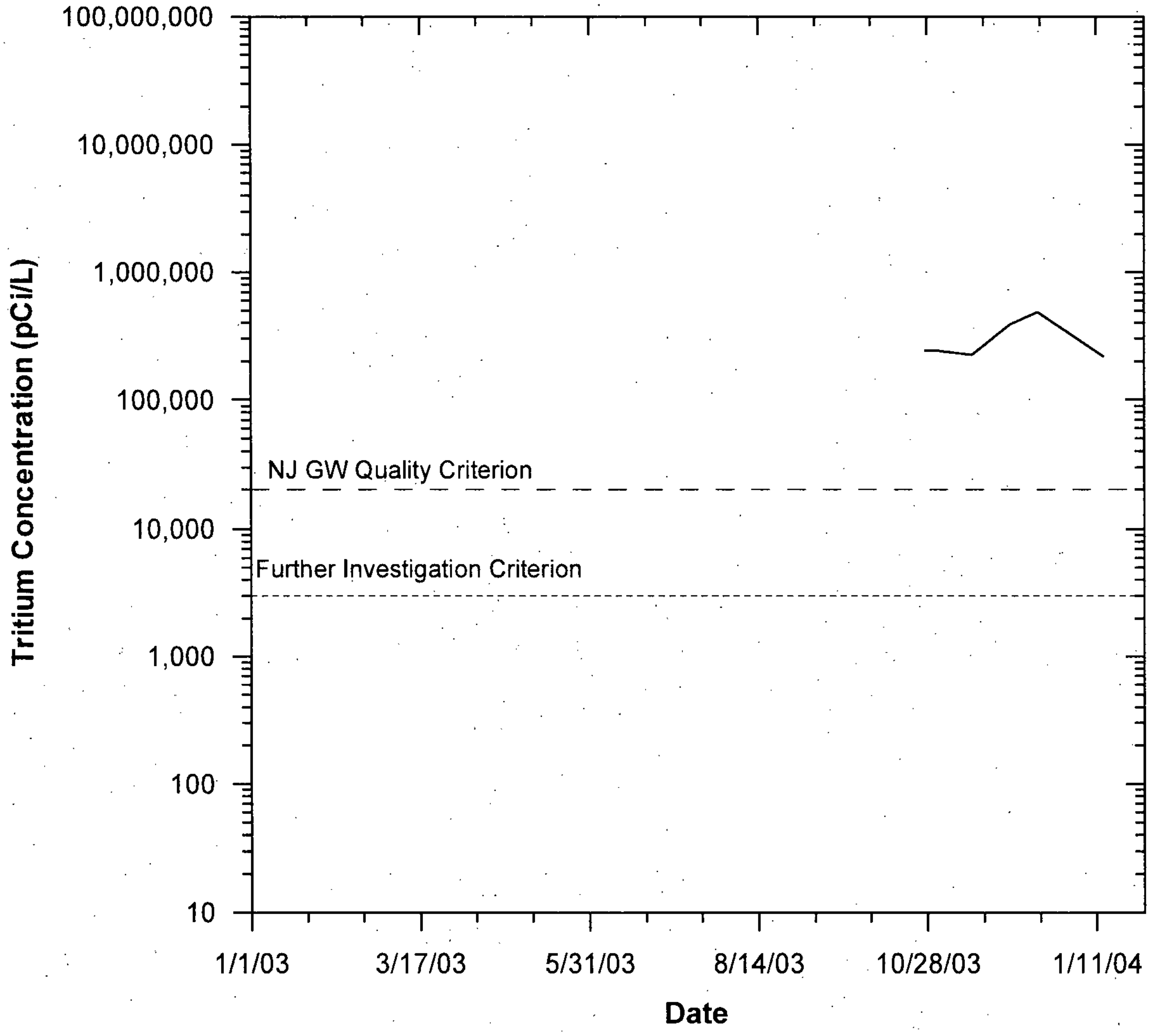
Tritium Concentration in Well AC

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
I-13

DRAFTER: VJAYARAMAN
APPROVED: PMILIONIS
CHECKED: SPOTTER
FILE NO.: Well AC.grf
PRJCT NO.: NP000571.0003
DWG DATE: 02/23/04

DRAFTER: VJAYARAMAN
APPROVED: PMILIONIS
CHECKED: SPOTTER
FILE NO.: Well AD.grf
PRJCT NO.: NP000571.0003
DWG DATE: 02/23/04



Well Summary:

Installation Date : Oct-2003
Monitored Unit : Shallow, outside Cofferdam
Top of Screen : 57.1 ft bgs
Bottom of Screen: 67.1 ft bgs

ARCADIS

Tritium Concentration in Well AD

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
I-14

DRAFTER: VJAYARAMAN

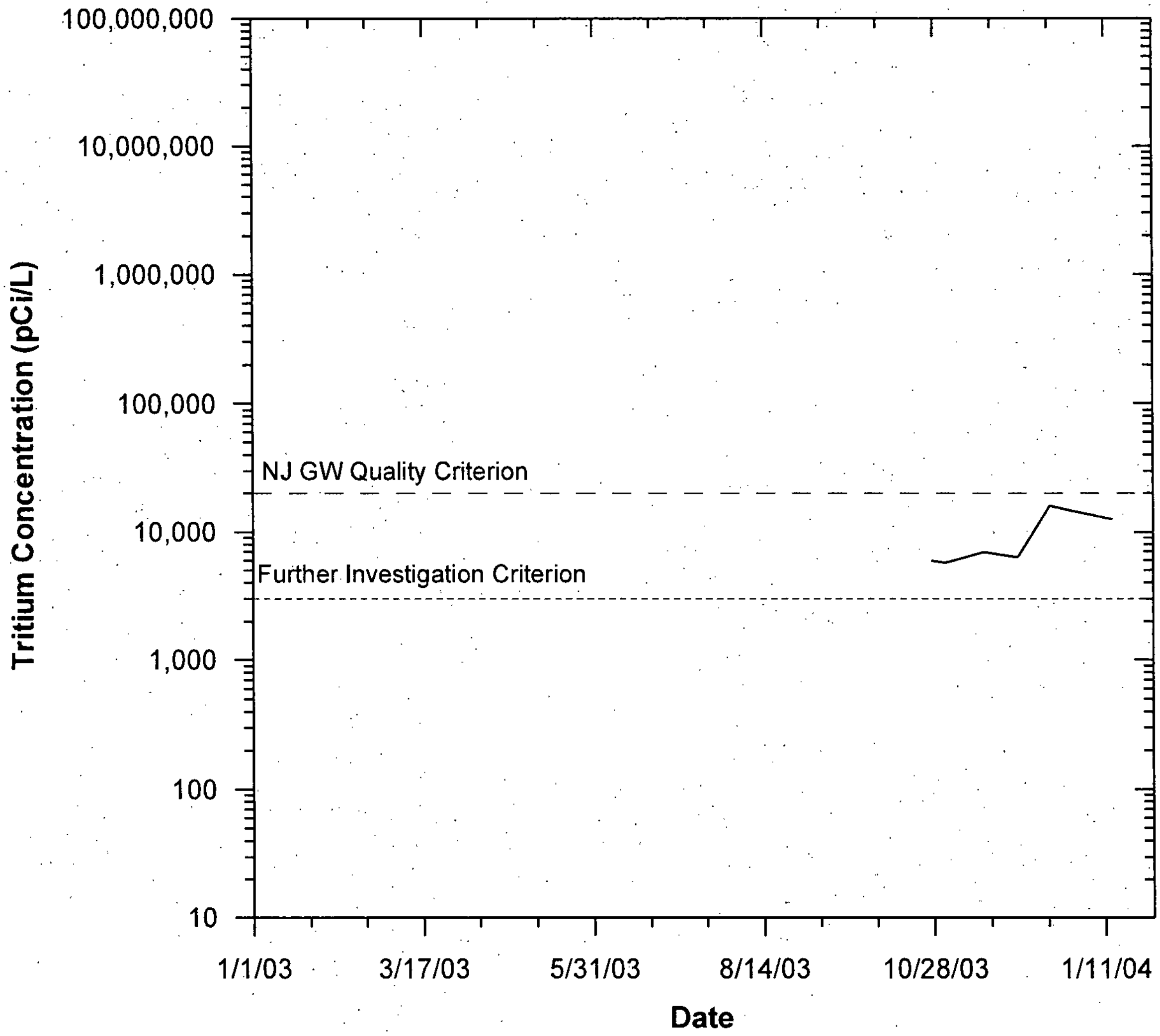
APPROVED: PMILIONIS

CHECKED: SPOTTER

FILE NO.: Well AE.grf

PRJCT NO.: NP000571.0003

DWG DATE: 02/23/04



Well Summary:

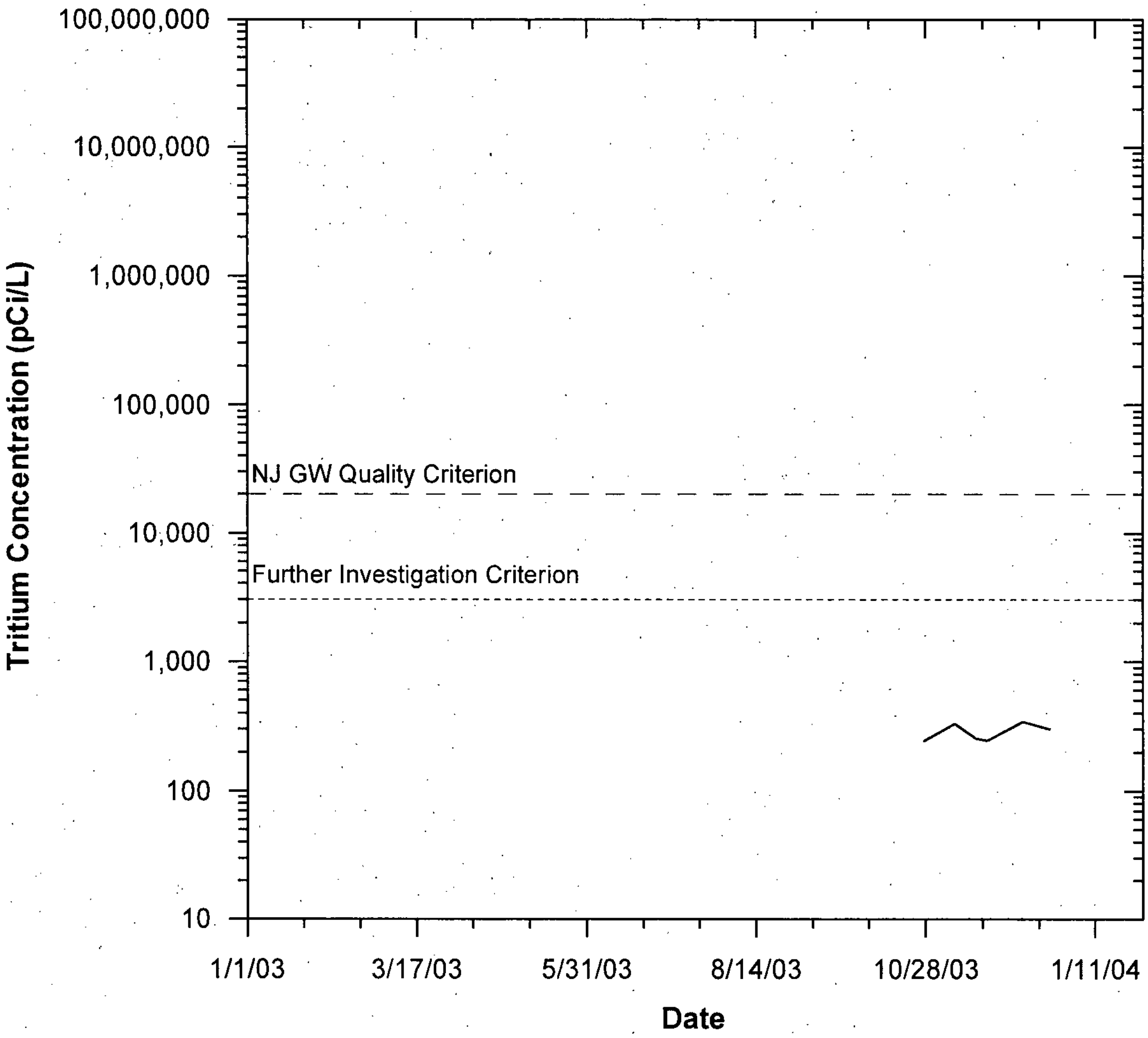
Installation Date : Oct-2003
Monitored Unit : Cofferdam
Top of Screen : 71.8 ft bgs
Bottom of Screen: 81.8 ft bgs

ARCADIS

Tritium Concentration in Well AE

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
I-15



Well Summary:

Installation Date : Oct-2003
Monitored Unit : Shallow, outside Cofferdam
Top of Screen : 54.2 ft bgs
Bottom of Screen: 64.2 ft bgs

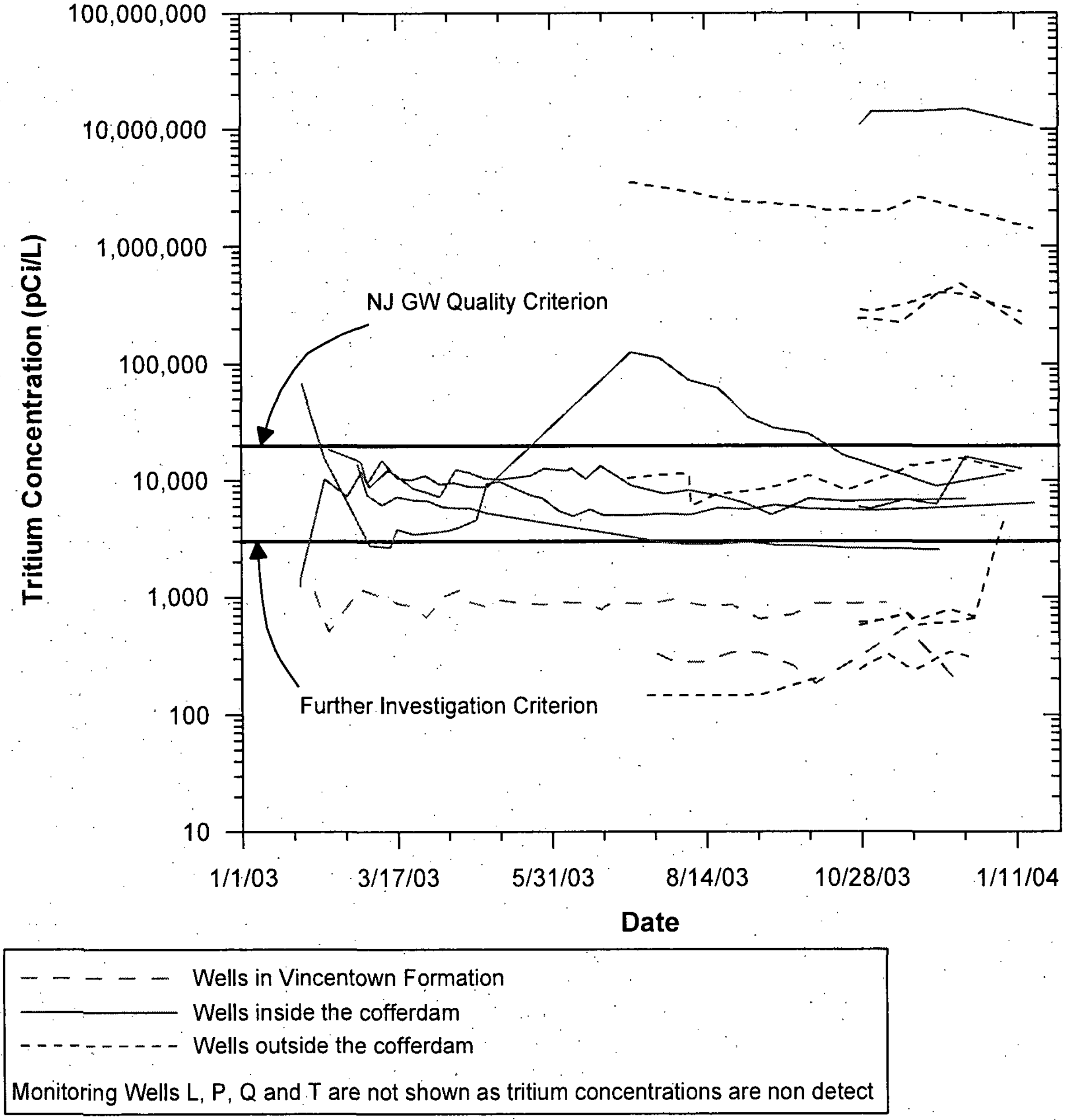
ARCADIS

Tritium Concentration in Well AF

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
I-16

DRAFTER: VJAYARAMAN
APPROVED: PMILIONIS
CHECKED: SPOTTER
FILE NO.: Well ALL.grf
PRJCT NO.: NP000571.0003
DWG DATE: 02/23/04



Monitoring Wells L, P, Q and T are not shown as tritium concentrations are non detect

ARCADIS

Comparison of Tritium Concentration in All Site Monitoring Wells

PSEG NUCLEAR, LLC SALEM GENERATING STATION
HANCOCK'S BRIDGE, NEW JERSEY

FIGURE
I-17

Appendix J

A Perspective on Radiation Doses and Health Risks from Ingestion of Tritium in Drinking Water and Potential Impacts on Aquatic and Terrestrial Biota

A PERSPECTIVE ON RADIATION DOSES AND HEALTH RISKS FROM INGESTION OF TRITIUM IN DRINKING WATER AND POTENTIAL IMPACTS ON AQUATIC AND TERRESTRIAL BIOTA

David C. Kocher
SENES Oak Ridge, Inc.
102 Donner Drive, Oak Ridge, TN 37830

The main purpose of this discussion is to consider radiation doses and health risks to the public resulting from ingestion of tritium in drinking water. We begin by comparing the dose resulting from ingestion of a unit activity of tritium with the dose per unit activity of other radionuclides ingested to provide an indication of the radiotoxicity of tritium. We then present a simple method of estimating doses and cancer risks from ingestion of drinking water containing a known concentration of tritium. This method is illustrated by estimating the dose and risk associated with the current drinking water standard for tritium. This discussion also considers current guidance on radiation dose limits for aquatic and terrestrial biota and levels of tritium in water that would be required to potentially impact populations of species.

Dose Per Unit Activity Intake of Tritium and Other Radionuclides

Of all the radionuclides of potential concern in radiation dose and risk assessments for workers and the public, tritium is among the least radiotoxic, meaning that the dose per unit activity intake by ingestion (or inhalation) is among the lowest of all man-made or naturally occurring radionuclides. This conclusion is illustrated by current estimates of doses to adults per unit activity intake of radionuclides by ingestion given in Table 1.[1] Doses are given in millirem (mrem), or one-thousandth of a rem, and the assumed unit activity is 1 picocurie (pCi), which corresponds to 0.037 disintegrations per second, or approximately 130 per hour.[2]

Doses to adults per unit activity intake of radionuclides by ingestion given in Table 1 are values currently recommended for use in radiation protection of the public by the International Commission on Radiological Protection (ICRP).[3] In addition to tritium, radionuclides listed in Table 1 include several fission and activation products of importance at nuclear reactors, isotopes

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[1] A few radionuclides not listed in Table 1 have estimated doses per unit activity intake by ingestion slightly lower than the value for tritium. However, these radionuclides are rarely, if ever, encountered in significant quantities in the workplace or the environment.

[2] Doses per unit activity intake by an adult in Table 1 represent an effective dose to the whole body over a period of 50 years following an intake. They are based on considerations of doses to different organs and the period of time after an intake over which radionuclides are retained in the body and continue to deliver a dose even with no further intakes; this time is many decades in some cases.

[3] The ICRP has been the leading international authority on radiation protection since the late 1920's, and ICRP recommendations have formed the basis for radiation protection standards and programs throughout the world. However, many current ICRP recommendations, including doses per unit activity intake of radionuclides by ingestion or inhalation, have not yet been formally adopted by regulatory authorities in the U.S., although these authorities may accept their use in many cases.

of uranium found in nuclear fuel, the most important isotopes of plutonium and americium produced in reactors, and naturally occurring isotopes of potassium, radium, and thorium.

The dose per unit activity of a radionuclide ingested depends on several factors including the half-life of the radionuclide, the types and energies of radiations emitted by the radionuclide, the extent of absorption from the GI tract, the organs of the body in which the radionuclide is deposited and the extent of deposition in those organs, and the rate of elimination from the body by biological processes. The low dose per unit activity intake of tritium, compared with values for other radionuclides, is due to two factors. First, most tritium taken into the body in the form of water behaves as normal body water and is rapidly eliminated from the body with a biological half-time of about 10 days in adults, and this biological half-time is much less than values for the other radionuclides listed in Table 1. Second, the beta radiations (electrons) emitted in tritium decay have very low energies and, thus, the energy deposited in tissue, which determines the dose from decay of tritium in the body, is much lower than the energy deposited by radiations emitted by other radionuclides.

Conversely, doses per unit activity intake of isotopes of radium, thorium, uranium, plutonium, and americium listed in Table 1 are relatively high because, first, these radionuclides have relatively long retention half-times in the body, taking into account radioactive decay and biological elimination, and, second, they (or their radioactive decay products) decay by emission of alpha particles, which deposit relatively large amounts of energy per unit mass of tissue. In addition, alpha particles are biologically more effective than gamma rays and beta particles in producing health effects (cancers). That is, for the same amount of energy deposited per unit mass of tissue (absorbed dose), the probability of a health effect is much higher for alpha particles than for other radiations.[4] The increased biological effectiveness of alpha particles is taken into account in radiation protection by multiplying absorbed dose in rads by a factor of 20 to calculate dose equivalent in rem.

There is an additional consideration for tritium that is not taken into account in the dose per unit activity intake of 6.7×10^{-8} mrem per pCi currently recommended by the ICRP and given in Table 1. This value assumes that the biological effectiveness of low-energy beta particles in tritium decay is the same as that of gamma rays and higher-energy beta particles, such as those emitted in decay of Sr-90 and its decay product Y-90. However, many studies in a variety of organisms have indicated that tritium beta particles are biologically more effective than gamma rays and higher-energy beta particles. A representative factor to describe this effect that we have developed for use in human health risk assessments is about 2.4;[5] this modification

---

[4] The biological effectiveness of ionizing radiations is believed to depend on the density of ionization in tissue (i.e., the amount of energy deposited per unit path length in passing through matter), and alpha particles have a much higher density of ionization than gamma rays and beta particles, due to their high energies and very short ranges in matter.

[5] The increased biological effectiveness of tritium beta particles has been incorporated, for example, in the methodology developed by SENES Oak Ridge for the National Institute of Occupational Safety and Health (NIOSH) for use in estimating probability of causation of cancers for the purpose of evaluating claims for compensation by workers at U.S. Department of Energy facilities who develop radiogenic cancers.

of absorbed dose from exposure to tritium is analogous to the factor of 20 for alpha particles used in radiation protection, as described above.[6] Taking into account the increased biological effectiveness of tritium beta particles, the dose to an adult per unit activity intake by ingestion would be 1.6 × 10^{-7} mrem per pCi; this is the second value listed in Table 1.

Doses per unit activity intake given in Table 1 apply to adults. However, the general population consists of younger age groups as well as adults. Doses per unit activity intake of radionuclides by younger age groups generally are higher than values for adults, due primarily to the smaller masses of body organs and, in many cases (but not for tritium), the higher absorption of ingested radionuclides in the GI tract at younger ages. For ingestion of tritium in the form of water, doses per unit activity intake at different ages currently recommended by the ICRP are given in Table 2.[7] At age 1 year or less, for example, we see that doses per unit activity intake of tritium are about a factor of 3 to 4 higher than the value for adults. However, in assessing doses to the public resulting from ingestion of tritium in water, the increased dose per unit activity intake at younger ages is compensated to some extent by the generally lower intake rates of water at those ages. Therefore, the dose per unit intake is not, by itself, indicative of doses to younger age groups from intakes of water containing a known concentration of tritium compared with the dose to adults.

Even though the dose per unit activity intake of tritium (and other radionuclides) is higher at younger ages than in adults, it is nonetheless reasonable to focus on assessing exposures of adults if the objective of the assessment is to gain a general understanding of doses and risks to the public from exposure to known concentrations of radionuclides in the environment. This approach can be justified based on the consideration that if intakes over a normal lifetime of about 70 years are assumed, as is often the case in dose assessments for routine exposures of the public, the total dose and associated lifetime cancer risk usually will be dominated by the dose and risk resulting from intakes during adult years. More refined calculations that take into account the age-dependence of intakes and dose per unit activity intake do not change estimates of lifetime dose and risk by a large amount, as is illustrated by calculations of the risk from ingestion of tritium in drinking water over a lifetime in a later section. Many dose assessments for the public performed by the U.S. Nuclear Regulatory Commission (NRC) and Environmental Protection Agency (EPA) assume exposure of adults only.

Estimation of Dose from Ingestion of Tritium in Drinking Water

Estimation of dose from ingestion of drinking water containing a known activity concentration of tritium (or any other radionuclide) is a straightforward procedure. The dose frequently calculated in an assessment of radiological impacts on workers or the public is the

---

[6] In early ICRP recommendations issued in 1960, a modifying factor of 1.7 was used to calculate dose equivalent from exposure to tritium, to account for the increased biological effectiveness of tritium beta particles, but this factor has not been retained in recommendations since 1977.

[7] Doses per unit activity intake in Table 2 represent an effective dose to the whole body over a period from the age at intake to age 70; intakes by adults are assumed to occur at age 20.

dose resulting from one year's intakes of a radionuclide.[8] The annual dose from a known concentration of a radionuclide in drinking water is given by

$$\text{Dose (mrem per year)} = \text{Concentration (pCi per liter)} \times \text{Intake rate (liters per day)} \times \text{Exposure frequency (days per year)} \times \text{Dose per unit intake (mrem per pCi)} .$$

As an example, consider the annual dose to an adult corresponding to the EPA's current drinking water standard for tritium; this standard is a concentration limit of 20,000 pCi per liter.[9] For purposes of estimating dose and risk corresponding to drinking water standards, an intake rate of 2 liters (L) per day often is assumed; this intake rate is a reasonable value for an adult who consumes above-average amounts of drinking water. The annual dose to an adult corresponding to 20,000 pCi/L of tritium in water then is given by

$$\text{Dose} = (20{,}000 \text{ pCi/L})(2 \text{ L/day})(365 \text{ days/year})(1.6 \times 10^{-7} \text{ mrem/pCi}) = 2.3 \text{ mrem/year} .$$

This calculation assumes the higher dose per unit activity intake of tritium in Table 1, which incorporates an assumption of a higher biological effectiveness of tritium beta particles. If this assumption were not included, as is presently the case in dose assessments performed by the EPA and NRC, the annual dose would be a factor of 2.4 lower, or about 1 mrem per year.

To put the annual dose associated with the drinking water standard for tritium into perspective, we note that the average dose to a member of the public from exposure to natural background radiation, excluding the dose from indoor radon, is about 100 mrem per year, and that the average dose from indoor radon is about 200 mrem per year. Thus, the drinking water standard for tritium corresponds to a dose that is about 1% of the total dose from natural background. This comparison is not intended to trivialize potential exposures to tritium in groundwater, or to convince the public that they should not be concerned about such exposures. Rather, the purpose is to illustrate that limits on acceptable exposures of the public to man-made sources of radiation often are set at a small fraction of unavoidable exposures to natural background radiation.

The procedure given above also can be used to estimate annual doses to other age groups using doses per unit activity intake given in Table 2, increased by a factor of 2.4 to account for the greater biological effectiveness of tritium beta particles. However, especially at the youngest ages, a substantially lower intake rate of water should be assumed. For example, during the first

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[8] Calculation of an annual dose is particularly appropriate when the purpose of the assessment is to demonstrate compliance with a limit on dose in any year. Many radiation standards for workers and the public in the U.S. are expressed in terms of limits on annual dose.

[9] The EPA's drinking water standards strictly apply at the tap (i.e., after treatment by a municipal water supply), rather than the source. However, the EPA often applies these standards to protection of groundwater resources, regardless of whether groundwater is being used to supply drinking water; see, for example, the report on *Protecting the Nation's Ground Water: EPA's Strategy for the 1990s* (1991), Office of Solid Waste and Emergency Response (OSWER) Directive 9200.4-18 (1997), which applied to cleanup of radioactively contaminated sites under CERCLA (Superfund), standards for hazardous waste disposal facilities regulated under Subtitle C of RCRA (40 CFR Part 264), and standards for disposal of spent fuel, high-level radioactive waste, and transuranic waste (40 CFR Parts 191 and 197).

year of life, a reasonable maximum intake rate of water is about 1 L/day. Based on doses per unit activity intake by a 3-month-old and 1-year-old in Table 2, the dose during the first year of life would be between 11 and 15 mrem.

Estimation of Lifetime Cancer Risk from Ingestion of Tritium in Drinking Water

Once the annual dose from ingestion of tritium in drinking water is estimated, it is a straightforward procedure to obtain an estimate of the risk of cancer incidence that would result from exposure over a lifetime. The lifetime cancer risk is given by

$$\text{Risk} = \text{Annual dose (mrem per year)} \times \text{Exposure duration (years)} \times \text{Risk per unit dose} .$$

As an example, radiation risk assessments for hypothetical and prospective exposures of the public often assume that exposure occurs over a 70-year lifetime. Then, using a standard assumption developed by the EPA that the risk of cancer incidence per unit dose in the general population is 7.6×10^{-7} per mrem,[10] the lifetime risk of cancer incidence corresponding to the drinking water standard of 20,000 pCi/L for tritium is

$$\text{Risk} = (2.3 \text{ mrem/y})(70 \text{ years})(7.6 \times 10^{-7} \text{ per mrem}) = 1.2 \times 10^{-4} .$$

That is, there would be slightly more than one chance in 10,000 of a radiation-induced cancer from a lifetime's exposure to tritium in water at the drinking water standard.

The calculated lifetime risk given above is highly simplistic in that it assumes that the concentration of tritium in drinking water remains constant over 70 years. More realistically, if there were no further releases of tritium to the source of drinking water, the concentration would decrease substantially over time as a result of radioactive decay and dilution by inflow from uncontaminated sources, such as rainwater. For example, taking only radioactive decay into account, the average concentration of tritium over 70 years would be about 25% of the initial concentration, and the same reduction in lifetime risk resulting from exposure over 70 years would occur. On the other hand, the concentration could remain fairly constant or even increase over time if there were continuing releases of tritium.

The calculated lifetime risk of slightly above 1 in 10,000 corresponding to the drinking water standard for tritium is at the upper end of the range of acceptable risks of 1 in 10,000 (10^{-4}) to 1 in 1,000,000 (10^{-6}) used by the EPA to establish preliminary remediation goals (PRGs) at contaminated sites subject to cleanup under CERCLA (Superfund).[11] A limit on acceptable risk of about 1 in 10,000 also is incorporated in other EPA regulations that apply to releases of

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[10] The risk of cancer incidence per unit dose estimated by the EPA is an average value in a population of all ages, and it takes into account that the risk per unit dose depends on age at time of exposure and is generally highest at the youngest ages.

[11] Risks corresponding to drinking water standards for radionuclides generally fall in the acceptable risk range under CERCLA when an exposure time of 70 years is assumed and risks of cancer incidence to the public per unit activity of radionuclides in drinking water are estimated in accordance with current federal guidance.

radionuclides to the environment or radioactive waste disposal.[12] We also note that risk assessments at Superfund sites often assume a shorter exposure duration of 30 years. This assumption would reduce estimates of lifetime cancer risk from ingestion of radionuclides in drinking water, assuming also that the concentration remains constant, by a factor of 0.43. To put risks corresponding to the drinking water standard for tritium in perspective, we note that the lifetime risk of cancer incidence from exposure to natural background radiation at an average dose of about 300 mrem per year, including the dose from indoor radon, is nearly 2 in 100.

The calculation of lifetime cancer risk described above ignores the age-dependence of intake rates of drinking water and doses per unit activity intake of tritium. More refined calculations that incorporate the age-dependence of intakes and dose are given in the EPA's Federal Guidance Report No. 13, *Cancer Risk Coefficients for Environmental Exposure to Radionuclides*. For ingestion of tritium in drinking water, the EPA has estimated a lifetime risk of cancer incidence per unit activity intake in the whole population of 5.1×10^{-14} per pCi. This calculation does not incorporate an enhanced biological effectiveness of tritium beta particles by a factor of about 2.4; if this factor were included as in the dose calculations given above, the risk per unit activity intake would increase to 1.2×10^{-13} per pCi. For example, if the tritium concentration in water is at the drinking water standard of 20,000 pCi/L, the activity intake over a 70-year lifetime, assuming a water intake of 2 L/day, would be 1.0×10^{9} pCi, and the resulting lifetime risk of cancer incidence would be 1.2×10^{-4}, or slightly above 1 in 10,000. Thus, for tritium, the refined calculation of risk that accounts for age-dependent effects gives essentially the same answer as our calculation based on an assumption of intakes by adults only.[13]

Finally, we note that the calculations of dose and risk described above involve substantial uncertainty. The uncertainty in the dose per unit activity intake of tritium recommended by the ICRP is believed to be about a factor of 2, meaning that the true value could be as much as a factor of 2 above or below the recommended values in Table 1 and 2, the uncertainty in the biological effectiveness of tritium beta particles (the factor of 2.4) used in our dose calculations is also about a factor of 2, and the uncertainty in the risk per unit dose is believed to be about a factor of 3. In addition, the uncertainty in the intake rate of drinking water by an individual is about a factor of 2 to 3, depending on age. These uncertainties generally are not taken into account in radiation protection or in dose assessments for hypothetical and prospective exposure situations. However, they are important when the purpose of an assessment is to estimate doses, cancer risks, or probability of causation of cancers in identifiable individuals.

Effects of Tritium on Aquatic and Terrestrial Biota

In addition to potential effects on human health arising from the presence of tritium (and other radionuclides) in groundwater, potential impacts on aquatic and terrestrial biota are of

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[12] See, for example, standards for airborne emissions of radionuclides developed under the Clean Air Act (40 CFR Part 61) and the standards for radioactive waste disposal identified in footnote 9.

[13] For many radionuclides, there are differences in the two approaches to calculating risk from ingestion, although the differences usually are not large and do not exceed a factor of about 5 in the worst case. When there are differences, the refined calculations that account for the age-dependence of intakes and doses per unit activity intake generally give lower risks.

concern. Approaches to radiation protection of biota differ from approaches to radiation protection of humans in two important ways.

First, a basic premise of radiation protection of humans is that all individuals should be afforded adequate protection. This objective is reflected in requirements that are intended to limit doses and health risks to individuals who could receive the highest doses. In contrast, standards for protection of biota normally focus on protection of populations of species, including species that are the most sensitive to radiation.[14] The basic premise is that the ability of all species to reproduce and maintain viable populations, which allows them to serve their functions in an ecosystem, should not be impaired, although it is recognized that individual members of a species may be harmed.

Second, the fundamental concern in radiation protection of humans is to limit the risk of cancer in exposed individuals and populations, and the approach to limiting cancer risks is based on an assumption that there is some probability of a radiation-induced cancer at any dose.[15] In contrast, based on studies of radiation effects in many organisms, the critical biological effects on populations of species that involve impairment of reproductive capability (i.e., the effects that occur at the lowest doses) are found to occur only at doses and dose rates above a threshold.[16] Therefore, biota are considered to be protected as long as the dose and dose rate is maintained below the threshold for impairment of reproductive capability in the most sensitive species. Other effects on populations of species, such as a significant increase in mortality, occur only at substantially higher doses.

Although there is no formal system of radiation protection of biota similar to the system of radiation protection for humans, the International Atomic Energy Agency (IAEA) and National Council on Radiation Protection and Measurements (NCRP) have developed recommendations on dose limits for aquatic and terrestrial biota, and the U.S. Department of Energy is applying these limits at its facilities. Specifically, it is generally considered that populations of the most sensitive species of terrestrial animals will be protected if the absorbed dose is limited to less than 0.1 rad/day, and that the absorbed dose to aquatic animals and terrestrial plants should be limited to less than 1 rad/day.[17] The recommended dose limits for

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[14] Exceptions can occur when potential exposures of individual members of threatened or endangered species are of concern.

[15] Radiation protection of humans also is concerned with limiting the risk of severe hereditary (genetic) effects in an exposed individual's offspring, and these effects also are assumed to occur with some probability at any dose. However, the risk of radiation-induced hereditary effects in humans is believed to be much less than the risk of cancer.

[16] The threshold doses and dose rates for impairment of reproductive capability can vary greatly (e.g., by a factor of 100 to 1,000) depending on the particular species of concern. Although there are exceptions, threshold doses and dose rates tend to be lowest in mammals and birds, intermediate in higher plants, fishes, amphibians, reptiles, and crustaceans, and highest in insects, primitive plants, mollusks, and simple life forms (bacteria, protozoans, and viruses).

[17] Implicit in these daily dose limits is an assumption that exposures are occurring over a long time period (on the order of months or more), rather than over short periods of time. If exposures occur only over short time periods, species generally can tolerate higher dose rates without significant impairment of reproductive capability.

biota are much higher than the current dose limit for members of the public from all controlled sources combined, which is 0.1 rem per year.[18]

It should be noted that dose limits for biota are expressed in terms of absorbed dose, rather than dose equivalent as in standards for humans. The question of the biological effectiveness of such radiations as alpha particles and low-energy tritium beta particles in inducing threshold effects that impair reproductive capabilities of biota is controversial and unresolved at the present time. One view to which we subscribe is that if there is an increased biological effectiveness of tritium beta particles in inducing threshold effects in biota, it should be less than the value that applies to induction of cancers in humans.[19] Thus, the biological effectiveness of tritium beta particles in biota should be less than a factor of two and probably can be ignored.

Levels of tritium in water that could result in impacts on aquatic or terrestrial biota can be estimated in the following way. Since more than half of the mass of many organisms is water, it is reasonable to assume that the concentration of tritium in an organism is the same as the concentration in water to which the organism is exposed; the average concentration in all tissues of an organism generally would be lower. Then, based on the known average energy of tritium beta particles, the absorbed dose rate per unit activity concentration of tritium can be calculated; the result is 2.9×10^{-7} rad/day per pCi/gram. Since the density of water is 1,000 grams (g) per liter, the concentration of tritium in water corresponding to the dose limit for terrestrial animals of 0.1 rad/day is

$$\text{Concentration} = [(0.1\ \text{rad/day})/(2.9 \times 10^{-7}\ \text{rad/day per pCi/g})] \times (10^{3}\ \text{g/L}) = 3.4 \times 10^{8}\ \text{pCi/L}\ .$$

The concentration of tritium in water corresponding to the dose limit for aquatic animals and terrestrial plants of 1 rad/day is a factor of 10 higher, or 3.4×10^{9} pCi/L. Based on this simple analysis, it is evident that concentrations of tritium in water would need to be more than a factor of 10,000 higher than the drinking water standard of 20,000 pCi/L for there to be any potential for deleterious effects on populations of terrestrial biota, and that the difference would need to be more than a factor of 100,000 to potentially affect populations of aquatic biota.

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[18] The public dose limit of 0.1 rem per year is included in the NRC's radiation protection standards in 10 CFR Part 20. Although the public dose limit is intended to be applied to the total dose from all controlled sources combined, the NRC applies this dose limit to individual licensees, without regard for doses due to other controlled sources. However, other EPA regulations that apply to the Salem facility, including standards for operations of nuclear fuel-cycle facilities (40 CFR Part 190) and standards for airborne releases of radionuclides (40 CFR Part 61), limit doses to the public due to releases from the facility to a small fraction of the dose limit of 0.1 rem per year. The NRC also requires that releases of radionuclides to the environment be maintained as low as reasonably achievable (ALARA), and application of the ALARA requirement generally reduces doses to the public from operations at nuclear power plants to a very small fraction of the dose limit.

[19] This view is based on the notion that radiation effects on biota occur only at high doses where the density of ionization is high for any radiation type (including gamma rays) and, therefore, that there should be less difference in the biological effectiveness of different radiations at high doses than at the much lower doses of concern in assessing cancer risks in humans.

Summary

These discussions have sought to establish the following points.

- Tritium has a substantially lower dose per unit activity intake than other radionuclides, either man-made or naturally occurring, to which workers and members of the public normally could be exposed.
- Based on many studies of the effects of tritium in various organisms, we believe that calculations of radiation doses to humans from ingestion (or inhalation) of tritium should take into account an increased biological effectiveness of beta particles emitted in tritium decay of a factor of about 2.4, even though this effect is not yet incorporated in estimates of dose per unit activity intake recommended by the ICRP or used by the EPA and NRC.
- The dose per unit activity intake of tritium is higher in younger age groups than in adults, with the increase being the highest in infants. However, when the lower intake rates of water by younger age groups are taken into account, the dose per unit activity concentration of tritium in water is less than a factor of 2 higher for infants than adults, and the total dose and cancer risk resulting from intakes of water over a lifetime are dominated by the dose from intakes during adult years.
- Doses and health risks to the public that would result from consumption of drinking water that contains tritium at concentrations equal to the EPA's drinking water standard of 20,000 pCi/L are low and are only a small fraction of the unavoidable doses and risks from exposure to natural background radiation.
- The lowest concentrations of tritium in water that could be of concern in regard to ensuring protection of populations of the most sensitive species of aquatic and terrestrial biota are more than a factor of 10,000 higher than the drinking water standard of 20,000 pCi/L.

Table 1. Doses to adults per unit activity intake of radionuclides by ingestion[a]

Radionuclide	Radioactive half-life	Dose per activity intake (mrem per pCi)
H-3 (tritium)	12.33 years	6.7×10^{-8} (1.6×10^{-7})[b]
K-40	1.277×10^{9} years	2.3×10^{-5}
Mn-54	312.11 days	2.6×10^{-6}
Co-58	70.86 days	2.7×10^{-6}
Co-60	5.27 years	1.3×10^{-5}
Sr-90	28.79 years	1.0×10^{-4}
Sb-125	2.75856 years	4.1×10^{-6}
I-129	1.57×10^{7} years	4.1×10^{-4}
I-131	8.0207 days	8.1×10^{-5}
Cs-134	2.07 years	7.0×10^{-5}
Cs-137	30.07 years	4.8×10^{-5}
Ra-226	1600 years	1.0×10^{-3}
Ra-228	5.75 years	2.6×10^{-3}
Th-228	1.9116 years	2.7×10^{-4}
Th-232	1.405×10^{10} years	8.5×10^{-4}
U-234	2.455×10^{5} years	1.8×10^{-4}
U-235	7.038×10^{8} years	1.7×10^{-4}
U-238	4.468×10^{9} years	1.7×10^{-4}
Pu-239	24,110 years	9.3×10^{-4}
Am-241	432.2 years	7.4×10^{-4}

[a] Except as noted, values are current recommendations of the International Commission on Radiological Protection (ICRP) for exposure of adults in the general population (see footnote 2 in text).

[b] Value in parentheses takes into account an assumption of an increased biological effectiveness of low-energy beta particles emitted in tritium decay by a factor of 2.4 (see text).

Table 2. Doses to individuals of various ages per unit activity intake of tritium by ingestion[a]

Age at time of intake	Dose per activity intake (mrem per pCi)
3 months	2.4×10^{-7}
1 year	1.8×10^{-7}
5 years	1.1×10^{-7}
10 years	8.5×10^{-8}
15 years	6.7×10^{-8}
Adult	6.7×10^{-8}

[a] Values are current recommendations of the International Commission on Radiological Protection (ICRP) for exposures of members of the general population (see footnotes 2 and 7 in text). If an increased biological effectiveness of tritium beta particles is assumed, values should be increased by a factor of about 2.4 (see text).