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SCH10-028

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February, 2010

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QUARTERLY REMEDIAL ACTION PROGRESS REPORT, THIRD QUARTER 2009
PSEG NUCLEAR, LLC, SALEM GENERATING STATION

Dear Ms. Tuccillo:

PSEG Nuclear LLC (PSEG) has prepared this Quarterly Remedial Action Progress Report (RAPR) summarizing groundwater remediation activities performed since the submission of the previous RAPR in December 2009 at the PSEG Nuclear, LLC, Salem Generating Station (Station). The Station is located on Artificial Island in Hancock's Bridge, Salem County, New Jersey. Groundwater remediation activities are being conducted to address tritium detected in shallow groundwater adjacent to and south of the Salem Unit 1 Reactor Containment and Fuel Handling Building. **Figure 1** provides an overview of the Site including Salem Generating Units 1 and 2. **Figure 2** depicts the portion of the Station relevant to this groundwater remediation project.

Tritium was historically released to the environment near well AC. The release ceased in February 2003 when the Salem Unit 1 telltale drains were cleared and the Spent Fuel Pool (SFP) water that had accumulated behind the liner was drained. Following the draining of the tell-tales and the tritiated water accumulated behind the liner, remaining concentrations of tritiated water in the seismic gap continued to supply the plume until the seismic gap draining program was implemented. The program was modified several times in order to establish hydraulic control over the flow paths within the seismic gap. The seismic gap drains installed as part of the seismic gap draining program continue to provide a hydraulic gradient which directs water present in the seismic gap to a controlled capture mechanism preventing migration to the environment. The GRS continues to control the flow of shallow groundwater in the shallow unconsolidated zone maintaining the plume to the on-site area while removing the remaining tritiated groundwater. A routine maintenance program for the spent fuel pool (SFP) telltale drains has been implemented and is designed to preclude further flow restrictions in those drains thereby eliminating the release mechanism which initially caused the plume.

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The monitoring program provides data to support the adaptive management program and analyze the efficiency of the program. Plant-related gamma-emitting radioisotopes have not been detected and tritium concentrations have continued to decline in groundwater samples indicating that current activities meets the objectives of the program as provided in the RAWP.

The most recent annual recalculation of the mass of tritium remaining in the plume produced an estimate of less than 1 Curie of tritium remaining in the plume where it exists above the NJDEP Ground Water Quality Criteria (NJGWQC). The mass is estimated based upon a number of factors including: the density of the monitoring network, the actual degree of variability in the tritium concentrations of the groundwater, the amount of tritium drawn back through the seismic gap by gap draining activities, and the amount of mass held in dead end pore space. Additionally, the existing monitoring network was designed to monitor a much more extensive plume; therefore the great reductions in plume mass achieved to date has resulted in the present situation where only a few wells indicate concentrations above the NJGWQC.

The following sections present the background of environmental investigation and remedial action at the site, the details and results of activities conducted since the recent submittal of the Second Quarter 2009 RAPR, and provide a discussion of upcoming activities projected for the next reporting period.

1 Project Background

In April 2004, a Remedial Investigation Report (RIR) was submitted to the New Jersey Department of Environmental Protection Bureau of Nuclear Engineering (NJDEP-BNE) presenting the details and results of a groundwater investigation conducted following the discovery of tritium in groundwater adjacent to Salem Unit 1. The results of the remedial investigation indicated that the source of tritium detected in groundwater was the Spent Fuel Pool through the tell-tales, the clogging/malfunctioning of which permitted the migration of tritiated water into the seismic gap from which tritiated water moved into the environment. Following inspection and cleaning of the tell-tales it was established that the tritium release to the environment had been stopped, and that tritium had not migrated to the property boundary above the New Jersey GWQC.

Based on the results of the remedial investigation a remedial action strategy was developed to enhance control of water levels on the south side of the station and consequentially hydraulically limit further migration and reduce the concentration of tritium remaining in groundwater adjacent to Salem Unit 1. In April 2004, PSEG initiated a pilot study designed to demonstrate the effectiveness of groundwater extraction for achieving remedial objectives. The pilot study proved to be effective, and in July 2004, a Remedial Action Work Plan (RAWP) proposing the operation of a full-scale groundwater extraction system was prepared and submitted to the NJDEP-BNE. The RAWP was approved by the NJDEP-BNE in November 2004 and a full-scale groundwater extraction system was subsequently installed.

Additionally in April 2005, following installation of the seismic gap drains, a weekly schedule for the draining of the Unit 1 seismic gap was initiated to ensure an inward gradient and therefore flow of water into the seismic gap rather than outward toward the environment. Continuous draining of the Unit 1 seismic gap was initiated in February 2007 and that program has continued to date.

2 Continued Groundwater Monitoring

Groundwater monitoring activities continued through this reporting period in accordance with the schedule provided to NJDEP-BNE. The sampling program is designed to provide the representative data necessary to evaluate plume containment. Monitoring activities include the periodic collection of groundwater samples from the 36 Station monitoring wells. Plume area monitoring well locations are depicted on **Figure 1**.

Groundwater samples are initially submitted to Salem Chemistry for analysis for tritium and gamma-emitting radioisotopes. Samples indicating tritium concentrations less than 50,000 picocuries per liter (pCi/L) are sent to Maplewood Testing Services for more refined analysis yielding lower detection limits. The Maplewood laboratory does not receive the high concentration samples that the Salem laboratory typically does and therefore is able to achieve lower detection limits.

Historical and current analytical data indicate that plant related gamma-emitting radioisotopes have not been detected in groundwater from any monitoring well since monitoring was initiated in 2003.

Historical analytical tritium results for groundwater collected from the Station monitoring wells are presented on **Figure 2**. Included on **Figure 2** are: panel 1) the extent of tritium in groundwater at the completion of the remedial investigation (Baseline Plume); panel 2) the extent of tritium in groundwater one year prior to the reporting period, September 2008; and, panel 3) the extent of tritium in groundwater in September 2009. Based on a review of **Figure 2**, it is apparent that the mass of tritium in groundwater has been significantly reduced by the remedial efforts conducted to date. Details regarding these activities are discussed below. **Figure 1** shows the location of GRS wells beyond the active remediation area.

The analytical results for groundwater samples collected from the monitoring wells were evaluated based on the water-bearing zone in which they are screened. The three primary water-bearing units investigated beneath the Station are: 1) the Vincentown Formation; 2) the shallow water-bearing unit within the limits of the cofferdam surrounding Salem Unit 1; and, 3) the shallow, water-bearing unit outside the limits of the cofferdam.

2.1 Tritium Analytical Results for the Vincentown Formation

The following wells are screened in the Vincentown Formation: Well V, Well K, Well L, Well P, Well Q, and, Well CB. Groundwater quality for Well K, Well L, Well P, and Well Q is currently monitored on a semi-annual basis. Groundwater quality for Well V and Well CB is currently monitored on a quarterly and monthly basis, respectively.

Tritium has consistently not been detected above laboratory detection limits or detected at relatively low levels in groundwater at all monitoring wells screened within the Vincentown formation since the initiation of monitoring at these locations, with the recent exception of Well CB. As discussed in previous RAPRs, concentrations of tritium increased slightly at well CB following the March/April 2008 outage, during which the steam generators in Unit 2 were replaced and Well CB was damaged. Presently the concentrations are similar to the concentrations typically observed in Well CA which is completed in the shallow water bearing zone above and slightly south of Well CB. At no time did tritium concentrations in Well CB rise to a level approaching the New Jersey Groundwater Quality Criteria. Thus, the groundwater monitoring results continue to indicate that the previous release of tritium impacted water from the SFP has not significantly migrated below the shallow water-bearing unit.

2.2 Tritium Analytical Results for Wells Installed Within the Limits of the Cofferdam

The following wells are screened in the shallow, water-bearing unit within the limits of the cofferdam: Well M, Well N, Well O, Well R, Well AC, Well AE, Well AI, Well AM, Well AN, and Well AO. Groundwater quality for these wells is currently monitored on a monthly basis. However, Well AO has been inaccessible due to site constraints and has not been sampled since April, 2009.

Tritium concentrations in groundwater at these wells exhibits general decreasing temporal tritium concentration trends since the initiation of monitoring in 2003. Well AC, for example, the location of the historically highest location, exhibited steadily decreasing concentrations (from a maximum of 15,000,000 pCi/L in April 2003 to 22,400 pCi/L in July 2005). Since 2005 the concentrations at Well AC have exhibited fluctuations of decreasing magnitude. Over the past year the concentrations have been limited to the 19,000-28,000 pCi/L range. The decrease in tritium concentrations observed at Well AC provides confirmation that tritium impacted groundwater is no longer being released to the environment through the seismic gap and that the remedial groundwater recovery system (GRS) is effectively reducing concentrations of previously released tritium.

Tritium concentrations at Well M, Well AI, Well O and Well AE are typically below GWQC. However, some seasonal fluctuations are typically observed in these areas. Fluctuations are believed to be associated with the changes that occur in the plume as

a result of seasonal variation in the precipitation-based groundwater flow patterns. Wells M and O both exhibited a general increase concentration between November 2008 and January 2009. Throughout 2009 Well M had been relatively stable and trending generally downward towards the GWQC threshold until June, when seasonal fluctuations again affected groundwater flow patterns. Well O had continued to exhibit an increase in concentration through April 2009 and has experienced a marked decrease since then. Detections at Well O have occurred consistently each winter as the groundwater flow field changes in response to increase in water levels typically observed during the winter. The concentration trends at Well O are therefore not unexpected. Well AE also exhibited an increase however this increase followed the increase at Well O, as it has in past years and represents concentrations moving northward along the preferential pathway created by the intersection of the buried face of the building, the cofferdam, and the geologic materials. This appears to be confirmed by the decrease in tritium concentrations beginning in May of 2009. Groundwater is believed to move from the main plume area along seasonally defined flow pathways which vary as a result of seasonally changing water levels. The water level increases in recharge areas causing groundwater to flow away from these areas to reduce the potential energy present in these recharge areas. The flow directions following recharge events are expected to be different than the flow direction during times when water levels are low. The mobile extraction unit is typically inactive during the winter, but towards the end of the quarter was moved to Well O to address these fluctuations.

Tritium concentrations at Well N and Well R are below GWQC and generally show consistent stable to declining temporal trends. A brief increase in concentration above the GWQC at Well N was observed in June 2009, and is likely due to its proximity to the remaining mass and a temporary change in groundwater flow patterns. In July and August, tritium in Well N returned to concentration levels seen earlier in the year (~1,000 pCi/L). Tritium concentrations at all well locations within the cofferdam have generally decreased by one order of magnitude or more since the initiation of monitoring, indicating that remedial activities are effectively removing mass from engineered backfill overlying the cofferdams.

2.3 Tritium Analytical Results for Wells Installed Outside the Limits of the Cofferdam

The wells installed in the shallow, water-bearing unit beyond the limits of the cofferdam are Well S, Well T, Well U, Well W, Well Y, Well Z, Well AA, Well AB, Well AD, Well AF, Well AG (Shallow and Deep), Well AH (Shallow and Deep), Well AJ, Well AL, Well AP, Well AQ, Well AR, Well AS, Well AT, and Well CA. These wells are screened either just above the clay confining unit that separates the shallow water-bearing unit from the Vincentown Formation, or in the interval indicating the highest tritium concentrations found in the shallow water-bearing unit at each boring location at the time of the Supplemental Investigation completed in August 2003.

By 2007, tritium concentrations at Well AR had been reduced to approximately 80,000 pCi/L. In the spring of 2008, recovery Wells AS and AT began to lose efficiency as the pumps degraded. As a result, slight increases in tritium concentrations were indicated at Well AS and Well AT during the summer of 2008. Subsequent servicing of the GRS (October 2008) revealed that by October these two wells were wholly non-functional and although the installed check valves prevented backflow into the well, the sampling ports were producing samples more representative of total system effluent than of the concentrations in Wells AR, AS and AT. These increases were determined to be an artifact of reduced functionality of the pumps coupled with the location of the sampling ports. PSEG is conducting a study of sampling procedures to evaluate and eliminate the potential for sample cross contamination during sampling. The system service event addressed valve and pump difficulties. The recent increase in concentrations at Well AR is attributed to the use of the mobile pumping unit and reduced functionality of Well AB which formerly captured much of the water in this area. The pumping has likely extracted residual mass in less permeable zones within the historical extent of the plume. Groundwater collected from Well S, Well AB, Well AD and Well AR currently exhibit some of the highest remaining concentrations of tritium being recovered by the system. These wells are located within the core of the plume as it existed at the implementation of the remedy. As such, it would be expected for concentrations in these wells to remain elevated after the concentrations at wells closer to the source of the release, such as Well AC, have exhibited more persistent reductions in concentration. PSEG will be implementing a more structured program to periodically recondition and refurbish the GRS wells and pumps. This program will take effect in 2010.

Tritium concentration trends for wells screened in the shallow, water-bearing unit indicate that the operation of the groundwater extraction system is achieving the remedial action objectives (i.e., reduce the mass of tritium in groundwater and maintain hydraulic control). The distribution of tritium in groundwater in September 2009 is presented on **Figure 2**, along with the distribution of tritium prior to the initiation of the pilot study in March 2004, and in September 2008. As shown on **Figure 2**, the mass of tritium in groundwater has continued to decrease through the operation of the groundwater extraction pilot study system and operation of the full-scale system.

3 Groundwater Extraction

Groundwater extraction as a remedial strategy at the site was initiated with the operation of a pilot test from April 2004 to February 2005. In accordance with the RAWP, groundwater extraction activities completed to date consisted of the operation of the pilot-study from April 26, 2004 to February 11, 2005 and operation of the full scale GRS from February 16, 2005 to the present.

3.1 Full-Scale System

The objectives of the full-scale GRS consist of:

- maintaining hydraulic containment of the tritium plume; and
- reducing tritium concentrations in groundwater

The present operation of the GRS consists of groundwater extraction from Wells AB, AD, AJ, AN and AT. Pumping at Well S has not occurred since 2006 as a result of its low yield and resulting pump failures. Pumping at Well S has been restored on an intermittent basis to address concentrations remaining in the plume area. This well will continue to be operated periodically to aid in the remediation of the remaining tritium concentrations in the plume. Pumping at Well AS was discontinued during the 1st quarter 2009 due repeated pump failures. The GRS system was inactive for several weeks during the first quarter of 2008 for system servicing and again at the end of the third quarter of 2008. As discussed above, a regular system service program has been planned and will be implemented in 2010 to approximately coincide with scheduled Station outages. The program will focus on servicing of four wells on a semi-annual basis (spring and fall). Additional details concerning the service program will be included in the Q4 report. Groundwater extracted from the wells is processed in accordance with the Station's United States Nuclear Regulatory Commission (USNRC) license and plant procedures. Details of the extracted effluent are discussed below.

3.2 Mobile Groundwater Recovery Unit

The mobile groundwater recovery unit was designed and built to target specific areas of the plume exhibiting greater tritium concentrations. The mobile unit typically operates between March and November (weather permitting). The mobile unit collects water in nominal 1,000 gallon batches for handling in accordance with the station's permits. The mobile unit has historically been used successfully at Wells O, AP, AM, and AR. In 2008 it was operated at Wells O and AR, where relatively elevated concentrations with respect to the remainder of the plume were present in the early part of the year. The mobile extraction unit was located at to Well O to address the tritium concentration fluctuations discussed above.

3.3 Total System Effluent Data and Evaluation

GRS operations were initiated on February 16, 2005. The system operated in various configurations as part of the optimization process for approximately the first month. The GRS discharges continuously in accordance with the Station's USNRC permit allowing the GRS to be more effective and efficient than the pilot-scale system. As of September, 2009, the GRS has recovered greater than 24 million gallons of groundwater. The system recovered an estimated average of twelve gallons per minute throughout the quarter resulting in an estimated additional 1.6 million gallons recovered. This estimated average recovery rate of approximately 12 gallons per minute is greater than 17 times the recharge rate for the extraction area (calculated to be 0.7 gallons per minute, based upon an assumed percentage of annual precipitation).

3.4 Water-Level Data and Evaluation

Water level measurements from the extraction and select observation wells have been monitored to confirm hydraulic containment of the tritium groundwater plume. Water levels are periodically collected and evaluated according to the schedule described in the Q4 2006 RAPR submitted in March 2007. Ongoing groundwater level gauging indicates that the GRS system continues to control the flow of groundwater in the Salem Unit 1 yard area and effectively captures the extent of the tritium groundwater plume. Comprehensive groundwater elevation data are presented in the Annual Remedial Action Progress Report.

3.5 Cumulative Curies Removed

The various groundwater recovery activities conducted to date have been successful in controlling the plume and recovering tritium from groundwater at and downgradient of the Salem Unit 1 seismic gap.

Figure 3 summarizes the results of groundwater remediation activities conducted using the well field including both the pilot study and the permanent system. As shown on **Figure 3,** approximately 3.25 curies of tritium have been recovered from the operation of the GRS through September, 2009. Approximately 0.93 curies of tritium were removed by the pilot system. As the mass remaining in the plume decreases so will the rate of tritium recovery by the GRS. The effectiveness of the GRS is emphasized by the decrease and stabilization of system effluent concentrations since the activation of the full scale system in February 2005. Actual system effluent concentrations for the 3rd quarter of 2009 were only available from July 30th through August 27th. An estimate of the effluent concentration for the rest of the 3rd quarter was made using average concentrations prior to and after the dates listed above. By the end of the 3rd quarter 2009 the average effluent concentration was approximately 11,480 pCi/L. This indicates that the GRS has been successful at significantly decreasing tritium concentrations in groundwater as discharge concentrations are now less than 11 percent of the peak concentration (109,000) observed in March 2005. The mass of tritium in the plume was recalculated in late 2008 to be less than one Curie where concentrations exist above the NJDEP GWQC. Therefore it is expected that GRS operations will achieve end criteria for tritium removal ahead of the previously communicated schedule although the system will likely remain in some form as a fail safe for the release mechanism.

4.0 Operation of the Seismic Gap Drain

In addition to the operation of the GRS and mobile groundwater recovery unit, the seismic gap drains in Salem Unit 1 and Unit 2 are being used to continuously drain the water from these gaps, resulting in the recovery of residual tritium concentrations from the seismic gap. The operation of these permanent gap drains creates an inward gradient towards the gaps facilitating the recovery of water from low accessibility areas and minimizing the potential for this water to enter the environment.

Water samples from the seismic gap drains are periodically collected for tritium analysis. **Figure 4** summarizes the results of periodic tritium analysis from the seismic gap. A comparison of **Figure 2** and **Figure 4** indicates that concentrations of tritium in water recovered in the Unit 1 seismic gap have been consistently significantly higher than those detected in groundwater samples collected from Well AC and Well AM located to the southeast and southwest of the seismic gap, respectively. Thus, continuous operation of the Unit 1 seismic gap drain is effectively removing SFP water in the seismic gap, and resulting in the reduction of tritium concentrations in groundwater adjacent to the seismic gap. Tritium concentrations in water presently being removed from the gap have dropped over the last quarter from levels close to the concentrations present in the pool to concentrations within the historical normal range of concentrations. This recent drop is believed to have followed the recent cleaning of the tell tale drains near the end of the second quarter of 2009. This drop is apparent on Figure 4 which shows the historical tritium concentration is water captured from the seismic gap drain.

Continuous or nearly continuous draining (resulting in a hydraulic head less than that which is present in the geologic materials present outside the seismic gap) provides a positive assurance that the engineering control established by the seismic gap drain is effective at capturing any SFP water that enters the gap. The gap drain creates an inward gradient such that groundwater flows into the seismic gap assuring that no further potential exists for a discharge to the environment from the gap. This is further supported by the reversal in the concentration relationship between Wells AC and AM, suggesting that the plume is detaching from the location of the original release.

Monitoring of water drained from the Unit 2 seismic gap acts as a screen for a potential release from the Unit 2 SFP. Water collected in the Unit 2 seismic gap drain indicate tritium levels several orders of magnitude below the Unit 1 seismic gap drain concentration, and consistent with the trends in the Unit 1 seismic gap drain. The tritium concentrations observed in the Unit 2 seismic gap drain reflect the water from the Unit 1 SFP as it travels within the connected seismic gap.

Water samples will continue to be periodically obtained from the Unit 1 and Unit 2 seismic gap drain to evaluate the potential for the release of radioisotopes to the environment.

5.0 Upcoming Activities

Activities projected for the 4th quarter 2009 include the following:

- Continue to monitor continuous draining of seismic gap drains;
- Ongoing evaluation of the Unit 1 Seismic Gap to refine the procedures and protocols as necessary to adaptively manage the operation and sampling of the GRS;

- Evaluation of GRS well sampling procedures.
- Evaluation of methodology to collect interim samples from out of service wells (Well AB and Well S)
- Continue to measure groundwater levels and evaluate flow and plume containment;
- Continued groundwater sampling and analysis;
- Continued operation and evaluation of the GRS performance; and
- Video survey of Well CB for integrity;

If you have any questions or comments regarding the contents of this report, please do not hesitate to contact me at (856) 339-2331.

Sincerely,

Mark D. Pyle

Mark Pyle
Manager –
Salem Chemistry, Environmental, and Radwaste

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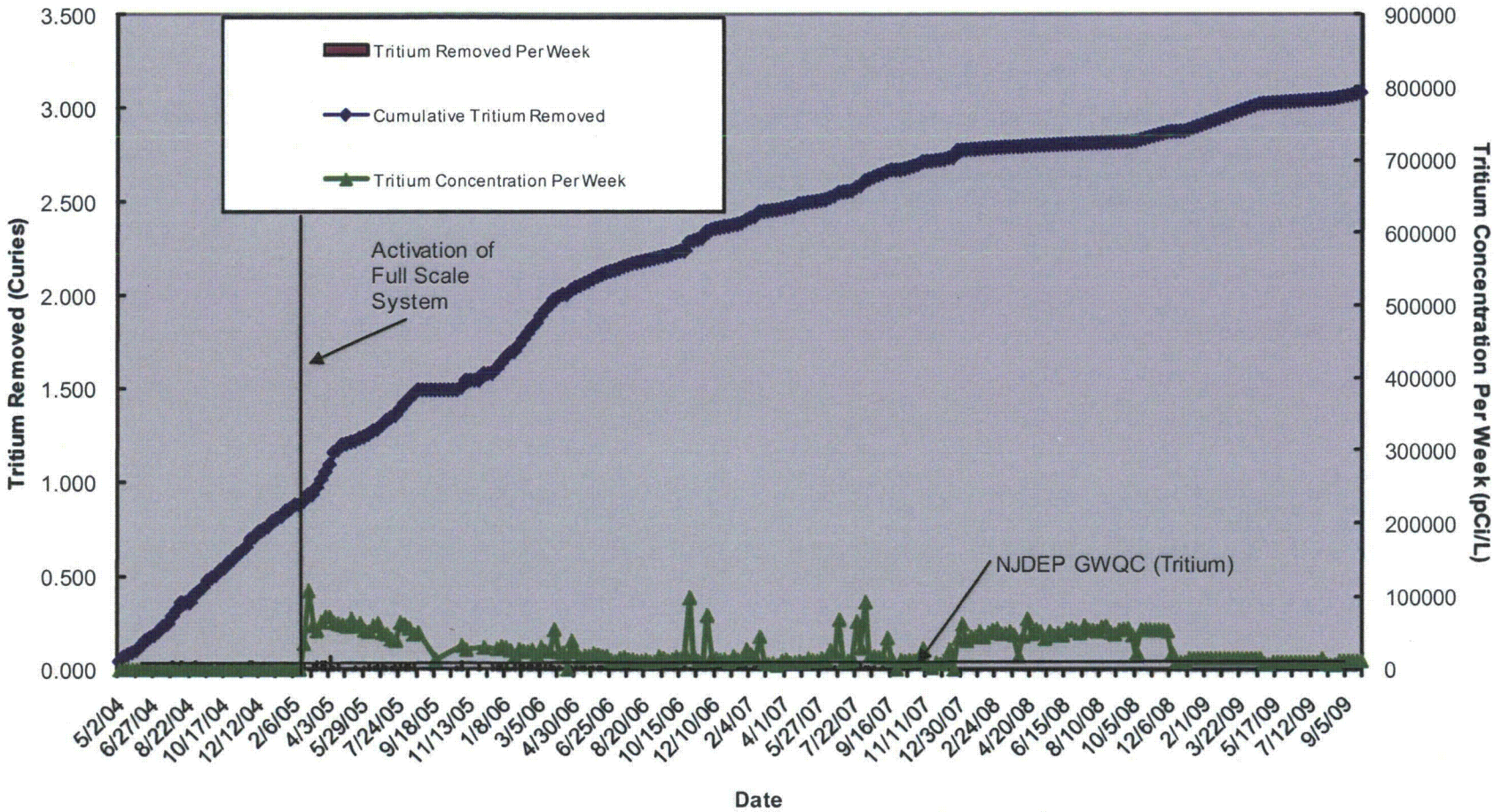
PSEG Nuclear, LLC Salem Generating Station - Unit 1
Tritium Recovered Through Well Field Operation



Area Manager: R. GAN	ARCADIS 6 Terry Drive Suite 300 Newtown, Pa 18940 Tel: 267/685-1800 Fax: 267/685-1801 www.arcadis-us.com	PSEG NUCLEAR, LLC SALEM GENERATING STATION HISTORIC TRITIUM RECOVERED THROUGH WELL FIELD OPERATION HANCOCK'S BRIDGE, NEW JERSEY	Project Number: NP000571.0009
Project Director: P. MILIONIS			Drawing Date: 20 MAY, 2009
Task Manager: C. SHARPE			Figure: 3
Technical Review: C. SHARPE			

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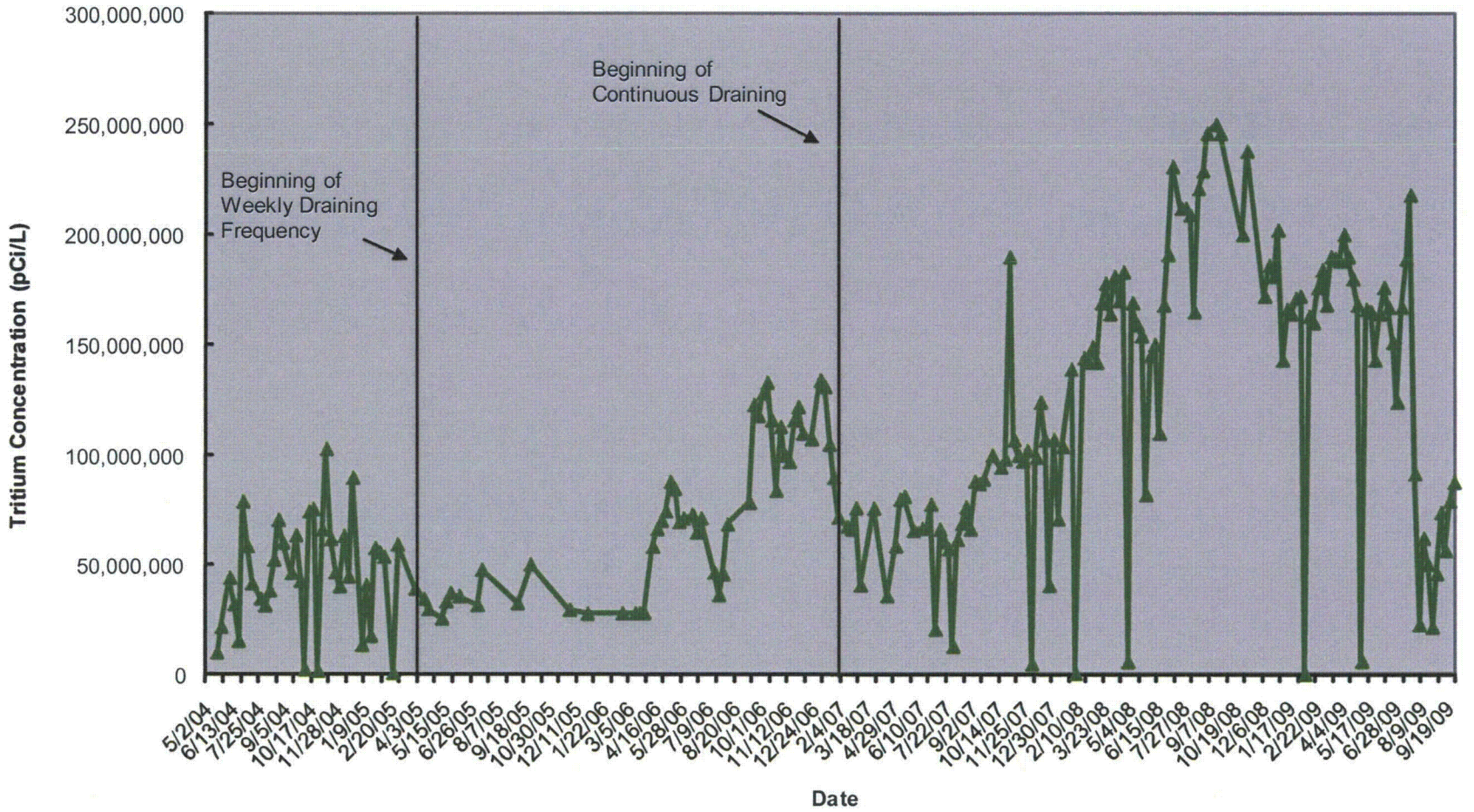
PSEG Nuclear, LLC Salem Generating Station - Unit 1
Concentrations of Tritium in Water Recovered Through Seismic Gap Drain Operation



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PSEG NUCLEAR, LLC
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HISTORIC TRITIUMCONCENTRATIONS OBSERVED DURING SEISMIC GAP DRAIN OPERATION

HANCOCK'S BRIDGE, NEW JERSEY

Project Number	NP000571.0009
Drawing Date	20 AUGUST, 2009
Figure	4