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QUARTERLY REMEDIAL ACTION PROGRESS REPORT, THIRD QUARTER 2008
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 November 2008 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. A segment of the Station site plan is depicted on **Figure 1**.

The release of tritium contaminated water to the environment 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. Maintenance of the spent fuel pool (SFP) telltale drains has precluded further flow restrictions in those drains. The installed seismic gap drains continue to provide a hydraulic gradient into the building and to the waste treatment systems, and away from the environment. The Groundwater Recovery System 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.

The monitoring program provides data to support the adaptive management program and analyze the efficiency of the program. Short-lived 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 Remedial Action Work Plan (RAWP).

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At present, it is estimated that 1.2 to 4.2 Curies of tritium remain in the plume where it exists above the NJDEP Ground Water Quality Criteria (GWQC). The range is dependent on the amount of tritium drawn back through the seismic gap, the actual degree of variability in the tritium concentrations of the groundwater, and the amount of mass held in dead end pore space.

The following sections present the background of environmental investigation and remedial action at the site, the details and results of activities conducted since the submittal of the November 2008 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, 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 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 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.

In April 2005, weekly draining of the Unit 1 seismic gap was initiated to ensure that the flow of water entering the seismic gap was directed toward the interior of the building for treatment rather than outward toward the environment. Continuous draining of the Unit 1 seismic gap was initiated in February 2007 and the program has been 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.

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 1**. Included on **Figure 1** 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 2007; and, panel 3) the extent of tritium in groundwater in September 2008. Based on a review of **Figure 1**, 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.

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. Concentrations of tritium increased slightly at well CB following the March/April 2008 outage, during which the steam generators in Unit 2 were replaced. This process involved the removal and replacement of four 400-ton steam generators. These steam generators required equipment weighing nearly as much as the steam generators themselves to lift and remove the four steam generators from the containment. This process applied a significant but temporary compressive stress to the Kirkwood clay and overlying units as the steam generators were removed from the containment and then transported away by crawler. The resulting compression of the Kirkwood Clay likely remobilized some tritiated water present in and above the immobile porosity fraction of the Kirkwood and overlying units as a result of historic above ground steam releases in this area. The tritium concentrations which may have been present

within the Kirkwood are a result of concentration gradient driven diffusion into the immobile pore water of the clay. Since the removal of the steam generators tritium concentrations in groundwater exhibited a slight increase followed by a decrease. Tritium levels in Well CB are trending toward levels historically observed in other wells completed in the Vincentown formation. At no time did tritium concentrations 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.

Groundwater collected from Well AC, Well AM, and Well AN exhibit some of the highest concentrations of tritium remaining at the Site, likely due to their location relative to the original release. Tritium concentrations in groundwater at these wells exhibits general decreasing trends since the initiation of monitoring in 2003. Well AC, for example, the location of the historic highest concentrations, has exhibited steadily decreasing concentrations (from a maximum of 15,000,000 pCi/L in April 2003 to 23,562 pCi/L during the sampling event in September 2008). The decrease in tritium concentrations observed at Well AC provides confirmation that tritium impacted groundwater is no longer being released to the environment and that the remedial groundwater recovery system (GRS) is effectively reducing concentrations of previously released tritium. Additionally the recent reversal in the relationship of concentrations at Wells AM and AC suggests that the remnants of the plume may be detaching and consolidating in the area of recovery wells AD, AJ, and AN. However, some instability is expected in this area as a result of the complex flow patterns created by the relationship of the Turbine Building, Seismic structures around the Containment and the Circulating water pipes.

The mobile extraction unit was moved from Well AM to Well O and then to Well AR during the second quarter of 2008 to address seasonal fluctuations. The mobile system is only typically used during the period between March and November in order to avoid potential freeze damage.

Tritium concentrations at Well N, Well R, Well AE, and Well AI are below GWQC and generally show consistent declining temporal trends. 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 the areas of greatest concentration. Variations in concentration occur primarily due to the complex flow patterns and limited flushing within the limits of the cofferdam.

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 began to degrade. As a result, slight increases in tritium concentration were observed at Well AS and Well AT, which was later determined to be an artifact of reduced functionality of the pumps coupled with the location of the sampling ports. Subsequent servicing of the GRS revealed that by October 2008 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. Grab samples collected at the wells indicated that the concentrations in Well AS and AT were below GWQC which was inconsistent with some of the second and third quarter analytical results obtained from the samples collected at the sampling ports in the control shed.

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 2008 is presented on **Figure 1**, along with the distribution of tritium prior to the initiation of the pilot study in March 2004, and in September 2007. As shown on **Figure 1**, 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. As discussed above, system service was scheduled and performed in October 2008 to address valve and pump difficulties.

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, AS, and AT. Pumping at Well S has not occurred since 2006 as a result of low yield and resulting pump failures. The 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. A regular system service schedule has been planned and implemented to maximize system operation and efficiency. 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 groundwater 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 AP, AM, and AR. Recently it has operated at Wells O and AR which have shown relatively elevated concentrations with respect to the remainder of the plume.

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 June 30, 2008, the GRS has recovered greater than 18 million gallons of groundwater. This is equivalent to an average recovery rate of approximately 10.8 gallons per minute or greater than 15 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 recovering tritium from groundwater at and downgradient of the Salem Unit 1 seismic gap.

Figure 2 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 2,** greater than 2.8 curies of tritium have been recovered from the operation of the GRS through September 2008. 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. System effluent concentrations averaged 54,558 pCi/L during the third quarter 2008. This indicates that the GRS has been successful at significantly decreasing tritium concentrations in groundwater as discharge concentrations are 50 percent of the peak concentration (109,000 pCi/L) observed in March 2005. The mass of tritium in the plume was recalculated in early 2006 to be approximately 2 to 5 Curies (depending on the amount of tritium drawn back through the seismic gap, the actual variability in discharge concentrations and the amount of tritium remaining in dead end pore spaces) at concentrations above the NJDEP GWQC. Based upon the tritium removed since the last recalculation, the present estimate would indicate that the plume retains approximately 1.2 to 4.2 Curies of tritium. Therefore, GRS operations may achieve end criteria for tritium removal ahead of the previously communicated schedule. Ongoing data collection will provide additional data to confirm this preliminary conclusion later in 2008.

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 3** summarizes the results of periodic tritium analysis from the seismic gap. A comparison of **Figure 1** and **Figure 3** 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 residual SFP water in the seismic gap, resulting in the reduction of tritium concentrations in groundwater adjacent to the seismic gap. Tritium concentrations in water presently being removed from the gap are close to the concentrations present in the Unit 1 SFP indicating that the continuous draining program has been successful in establishing a more direct flow path between the seismic gap drain and any SFP water.

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 positive assurance that the engineering control established by the seismic gap drain is effective at capturing any SFP water that enters the seismic 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. Concentrations of tritium from the Unit 1 seismic gap (summarized by week) are shown on **Figure 3.**

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.

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.

Upcoming Activities

Activities projected for the fourth quarter of 2008 (October through December) include the following:

- Continue to monitor continuous draining of seismic gap drains;
- Ongoing evaluation of the data to refine the procedures and protocols as necessary to adaptively manage the operation and sampling of the GRS;
- Continue to measure groundwater levels and evaluate flow and plume containment;
- Perform calculations of the residual tritium remaining in the plume and estimate the time remaining to completing the remediation;
- Continued groundwater sampling and analysis; and,
- Continued operation and evaluation of the GRS performance.

If you have any questions or comments regarding the contents of this report, please do not hesitate to contact me at (856) 339-5066.

Sincerely,

Greg Suey
Manager –
Salem Chemistry, Environmental, and Radwaste

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NRC – Salem Resident Inspector
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"Figure 1, GROUNDWATER TRITIUM RESULTS."

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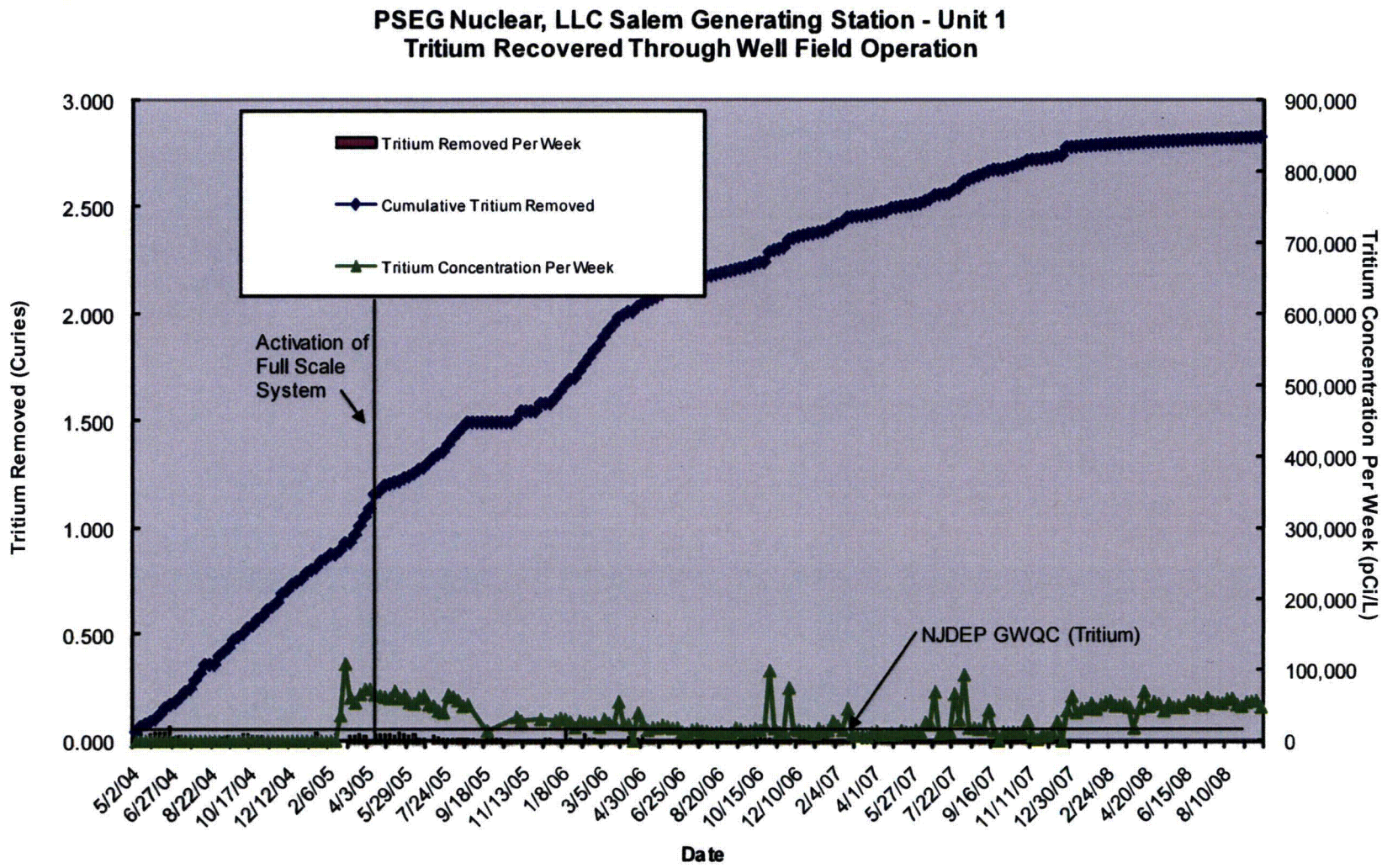

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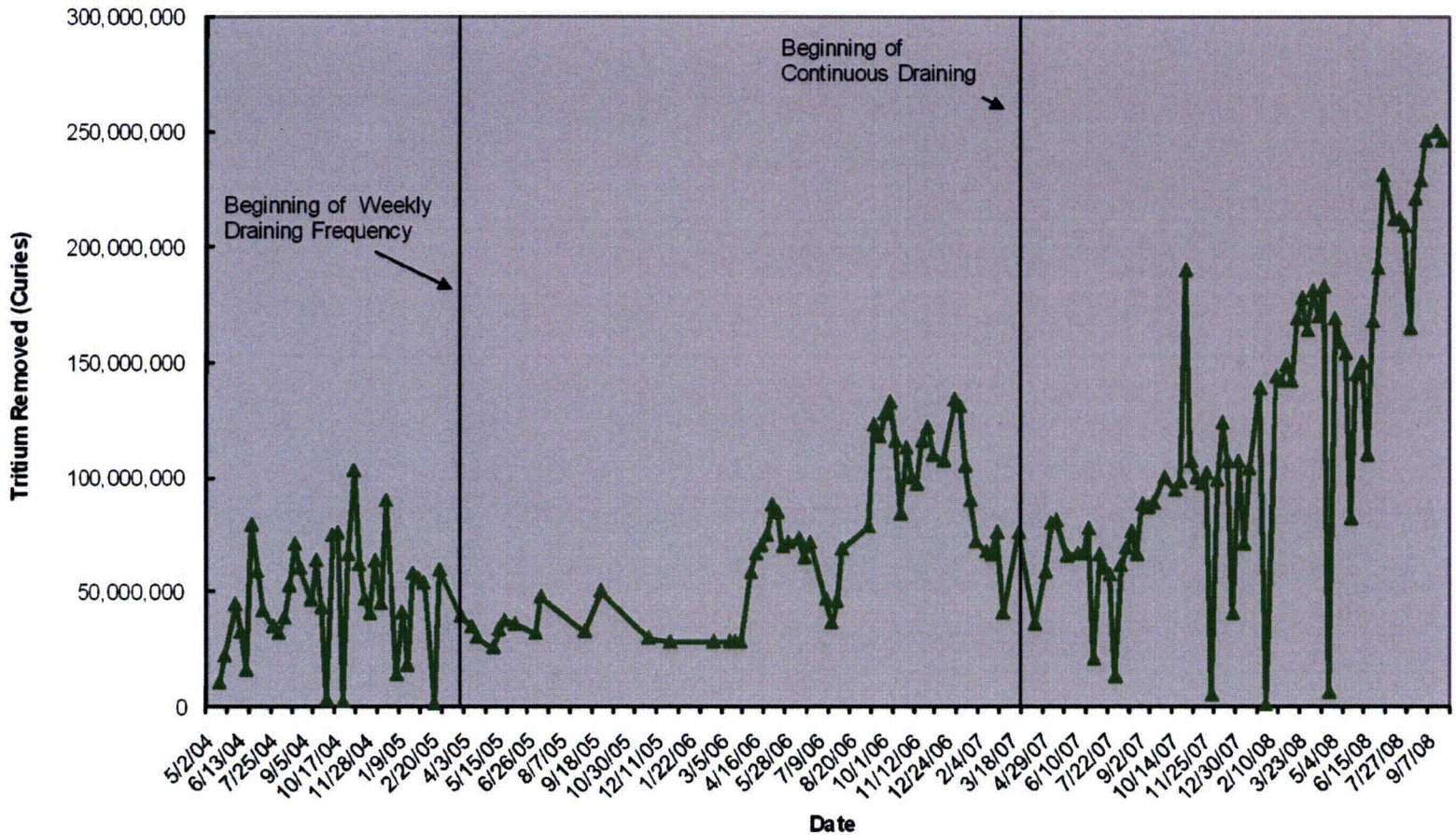
PSEG NUCLEAR, LLC
SALEM GENERATING STATION

HISTORIC TRITIUM RECOVERED THROUGH WELL FIELD OPERATION

HANCOCK'S BRIDGE, NEW JERSEY

Project Number	NP000571.0007
Drawing Date	28 JANUARY, 2009
Figure	2

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



Area Manager: R. GAN Project Director: P. MILIONIS Task Manager: C. SHARPE Technical Review: C. SHARPE	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 TRITIUMCONCENTRATIONS OBSERVED DURING SEISMIC GAP DRAIN OPERATION HANCOCK'S BRIDGE, NEW JERSEY	Project Number: NP000571.0007 Drawing Date: 28 JANUARY, 2009 Figure: 3