CONNECTICUT YANKEE ATOMIC POWER COMPANY

HADDAM NECK PLANT
362 INJUN HOLLOW ROAD • EAST HAMPTON, CT 06424-3099

November 20, 2002
CY-02-046

Mr. Peter Hill
Groundwater Division
Bureau of Water Management
Connecticut Department of Environmental Protection
79 Elm Street
Hartford, CT 06106-5127

Haddam Neck Plant
Groundwater Analysis Results for Three
Quarterly Sampling Rounds

Dear Mr. Hill:

Connecticut Yankee Atomic Power Company (CYAPCO) herein submits the groundwater analysis report for the sampling rounds conducted in December 2001 and March and June 2002. The report includes the results of two additional sampling rounds (January and February 2002) from system water supply wells, and one sampling round from six peninsula monitoring wells. CYAPCO and Bechtel Power Corporation representatives presented the results of the three quarterly sampling rounds to you and Mr. Michael Firsick on October 29, 2002.

Based on our evaluation of the analytical results from these three sampling rounds, CYAPCO believes that it is more beneficial to compare the results of two quarterly sampling rounds in a semi-annual groundwater monitoring report. A concurrent analysis of two consecutive quarterly sampling rounds allows for a more effective evaluation of analytical trend results affected by seasonal changes and longer period groundwater recharge conditions. In an effort to better evaluate trends in groundwater monitoring results, CYAPCO requests that the groundwater monitoring plan be modified to include semi-annual reporting with continued quarterly sampling rounds. CYAPCO will continue to notify the CTDEP if any unexpected quarterly sampling results are identified.

CYAPCO also requests that an alternate methodology be utilized for the advancement of soil borings in the overburden materials. The CTDEP-approved Phase 2 Hydrogeologic Investigative Work Plan specifies that the overburden

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materials be drilled with a "cut and wash" method in association with driving steel casing. The alternate methodology proposed is "mud rotary" for advancement through the overburden materials to bedrock. This alternate drilling methodology utilizes the same fundamental principals. However, "mud rotary" advancement is generally faster and produces less noise. With exception of the drilling methodology, the balance of the drilling specifications presented within the Work Plan will remain in effect.

Approximately 39 monitoring wells were sampled each quarter. Overall, there was no significant change in groundwater flow direction or horizontal flow gradient since October 2001, except near the mat sump. Anomalous water levels and a reversal of vertical flow gradient were identified at Monitoring Wells (MW) 102 and 103. This anomaly is attributed to temporary cessation of pumping the mat sump and local groundwater flow paths and interactions with building or tank base footings.

Samples from the 39 monitoring wells were analyzed for boron, tritium and reactor-generated gamma-emitting radionuclides. Samples from a subset of 21 monitoring wells were analyzed each quarter for hard-to-detect (HTD) radionuclides. The HTD radionuclides included gross alpha, gross beta, C-14, Fe-55, Ni-63, Sr-90, Tc-99, Pu-241 and alpha-emitting transuranics. The overall groundwater sampling results for the three sampling rounds are:

1. Tritium – generally decreasing with all well concentrations considerably below the EPA drinking water maximum contaminant level (MCL) of 20,000 pCi/L (15,000 pCi/L was the highest in June 2002). Some wells indicated increases in the tritium concentration. The tritium concentration in the wells may have been possibly impacted by cessation of pumping the mat sump.
2. Boron – generally decreasing trend within the industrial and peninsula area. The highest concentration continues to be generally in MW-105S, which is adjacent to the chemistry laboratory area. The boron concentration ranged from <50 to 201 ug/L for the June 2002 round.
3. Gross alpha – higher radionuclide concentrations generally in deeper bedrock wells. Concentrations ranged from "not-detected" (ND) to 17.2 pCi/L. The likely source of gross alpha is naturally-occurring Ra-226 and Rn-222 that is present in local bedrock.
4. Gross beta – radionuclide concentrations ranged from ND to 242 pCi/L (highest level in MW-105S that is adjacent to the chemistry laboratory weir box). The occurrence of elevated gross beta concentrations generally correlates to the presence of Sr-90 in the wells. Other naturally-occurring beta emitters may also be present.

5. Sr-90 – radionuclide concentrations detected in 10 monitoring wells in the Radiologically Controlled Area (RCA) and Industrial Area during the last three quarters. Only 3 of the MWs with Sr-90 detection are above the EPA drinking water MCL of 8 pCi/L (143 to 116 pCi/L at MW-105S, chemistry lab area; MW-103S, RWST area; and MW-106S, north of the maintenance building; all are adjacent to the containment building).
6. Cs-137 – radionuclide concentrations were detected in MW-103S at 58.5 pCi/L in June 2002 (RWST area), and MW-115S (south of Spent Fuel Building) ranging from 1.59 and 3.18 pCi/L, June 2002 and March 2002, respectively. All of these concentrations are well below the EPA drinking water MCL value of 200 pCi/L.

Anomalous results for hard-to-detect radionuclides in the December 2001 sampling round resulted in CYAPCO evaluating the quality of the contract laboratory utilized. A quality assurance audit identified laboratory performance problems that impacted the data. The audit results indicated performance problems regarding analytical procedures used, and inadequate expertise of laboratory personnel. Subsequently, CYAPCO changed laboratories and has experienced more consistent and reliable results. CYAPCO will continue to monitor laboratory performance through the use of radiochemistry technical experts, trend reporting, increased quality assurance measures and additional sampling analysis to address any anomalous results. See Section 7.0 of the Groundwater Monitoring Report for a more complete discussion of the on-going activities associated with laboratory performance.

CYAPCO recently completed the third quarter 2002 sampling round. With your concurrence, CYAPCO will combine the results of the third and fourth quarter 2002 sampling rounds into a semi-annual monitoring report to be issued in April 2003. During your October 29, 2002 visit, CYAPCO identified that the proposed location for MW-103B would have to be moved due to logistical conflicts with the tent structure around the tank farm that is currently under demolition. The new location is identified on Figure 1 of the attached "Groundwater Monitoring Report December 2001, March and June 2002 Quarterly Sampling Events." CYAPCO requests approval of the new location with the understanding that the proposed groundwater monitoring well where the RWST was demolished be evaluated at a later date. Once sufficient soil and groundwater data from the RWST area has been gathered, full characterization of the source and extent of radiological contaminants in the area may preclude installation of another well where the RWST was located.

If you have any questions regarding this submittal, please do not hesitate to contact Frostie White at (860) 267-3952.

Sincerely,

Noah W. Fetherston
Site Manager

Attachment - November 2002 Groundwater Monitoring Report

Cc: Mr. Michael Firsick, CTDEP, Bureau of Radiation Protection
Ms. Corinne Fitting, CTDEP, Planning and Standards Division
Mr. Ron Bellamy, USNRC Region 1
NRC Document Control Desk
Mr Jack Donohew, USNRC Headquarters
Mr. Jon Pekenpaugh, USNRC Region 1
Mr Juan Perez, USEPA Region 1
Mr. Jim Cherniak, USEPA Region 1

Connecticut Yankee Atomic Power Company
Haddam Neck Plant
East Hampton, Connecticut

Groundwater Monitoring Report
December 2001, March and June 2002 Quarterly
Sampling Events

Prepared by
Bechtel Power Corporation

Prepared for
Connecticut Yankee Atomic Power Company

November 2002

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Executive Summary

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1 Introduction

This monitoring report presents the compilation of five (5) groundwater-sampling events. The samples collected during these events were analyzed for various radiological parameters. The events include quarterly sampling in December 2001, March 2002 and June 2002, as well as follow-up sampling conducted in January and February 2002. The objective of this monitoring report is to provide a summary of the multiple sampling events to enhance the understanding of the radiological groundwater quality beneath the Connecticut Yankee Atomic Power Company (CYAPCO) facilities and property.

Approximately thirty-nine (39) monitoring wells from the existing site-wide monitoring well network were sampled during the quarterly groundwater-sampling events. Additional analyses were completed in January and February 2002 on samples from the Water Supply Well "B" infrastructure because Sr-90 was detected in a November 2001 sample. The follow-up analyses detected Sr-90 at low levels near the Minimum Detectable Concentration (MDC). Because the low level detections are so close to the lower limit of the measuring technique, which may be indicative of "false positives", additional sampling and analysis of groundwater from the Water Supply Well B infrastructure are required. Water Supply Wells "A" and "B" provide non-potable water to the Haddam Neck plant. The results of analysis of these samples are discussed in detail in Section 3.4.

The groundwater samples were forwarded to off-site, certified laboratories for analysis of radiological constituents and boron. This monitoring report provides a summary of the resulting data, as well as an evaluation of the data relative to the Connecticut Department of Environmental Protection (CTDEP) Remediation Standard Regulations (RSRs) for groundwater classified as GA by CTDEP.

During the period of the sampling events reported here, CYAPCO was evaluating the adequacy and quality of the commercial laboratory performing the radiochemical analyses. As a result of this evaluation, CYAPCO changed laboratories after the February sampling and completed a Quality Assurance evaluation of the new certified laboratory.

On-site audits at both laboratories indicated positive biases associated with analytical blank analysis data. These trends were generally limited to techniques that employed liquid scintillation counting methods (at both labs) and alpha isotopic analysis (at the first lab, Antech, only). Positive trends and biases were also observed in rank order plots of the quarterly sampling data for several nuclides at levels near the reported MDC. In many cases, these results were concluded to be false positive based on sample reanalysis or subsequent quarterly sampling event trends.

CYAPCO now feels confident that the new laboratory chosen can perform high quality analyses of radioactive groundwater contaminants at the Haddam Neck Plant (HNP) site. Nevertheless, positive biases are still evident in liquid scintillation counting results at low levels near the MDC. CYAPCO is currently pursuing a second certified laboratory. A quality assurance evaluation will be performed on this lab as well, to ensure the integrity of the laboratory results.

CYAPCO is beginning to implement a work plan for a Phase II Hydrogeologic Investigation that will further characterize and develop an understanding of the hydrogeologic conditions across the site. This Plan was developed with assistance from CTDEP, EPA and Nuclear Regulatory Commission (NRC) personnel. When fully implemented, the Plan will allow for a better understanding of these hydrogeologic conditions.

2 Groundwater Flow Direction

Depth-to-water measurements were collected in all monitoring wells that were sampled during each sampling event. Additionally, measurements were collected on separate occasions for the specific purpose of developing groundwater contour maps for the industrial/northern peninsula areas, as well as the landfill area. Table 1 presents these data along with the surveyed elevation of the measuring point of each monitoring well, as referenced within the Malcolm Pirnie report entitled, "Groundwater Monitoring Report", dated September 1999. Groundwater elevations, referenced to mean sea level (msl), are calculated by subtracting the recorded depth-to-water measurement in each monitoring well from the elevation of the monitoring point of the well.

Table 1 presents a summary of the depth-to-water measurements and corresponding groundwater elevations. Also included within Table 1 are calculations of vertical gradients between the upper and lower wells within a cluster (i.e., two wells at different depths in one location) and the change in groundwater elevations over time for the wells monitored during groundwater monitoring events. The purpose for collecting these data is to gain an understanding of the temporal and spatial variations in groundwater elevations and flow paths over time.

2.1 December 2001 Quarterly Sampling Event

Based upon the data in Table 1, monitoring well clusters MW-102, MW-103 and MW-107 exhibited a change in their respective vertical gradients between the June and December 2001 sampling events. During June 2001, the vertical gradient was downward between the shallow and deep clustered monitoring wells MW-102, MW-103 and MW-107; in December 2001, the gradients reversed to an upward direction at these locations. A possible reason for these reversals may be the termination of pumping the containment mat sump on October 9, 2001, and/or a continued overall decline in groundwater elevations within the power station area due to seasonal variation in precipitation accumulation. Between June and December 2001, the decline in groundwater elevations ranged from a minimum of 0.41 feet at MW-110S to a maximum of 3.69 feet at MW-115S (Table 1).

Four monitoring wells sampled during December 2001 exhibited increases in groundwater elevations relative to June 2001. Monitoring wells MW-100D and MW-100S increased by 0.20 and 0.66 feet, respectively. Monitoring wells MW-102D and MW-103D increased by 13.63 and 13.18 feet, respectively (Table1). The large increase in groundwater elevations in monitoring wells MW-102D and MW-103D may be due to the termination of pumping the containment mat sump. The pump was turned off to minimize the potential for inducing the flow of contaminants below the reactor containment.

Four of the six monitoring wells located on the peninsula that were sampled during the December 2001 event exhibited an overall decline in groundwater elevations compared to June 2001. Monitoring well MW-117S decreased by 2.56 feet and MW-111S decreased by 0.47 feet (Table1). The decline in groundwater elevations over this period is most likely attributable to a seasonal trend caused by depletion of soil moisture by plants and trees during the growing season and may also be due, in part, to tidal influences in the Connecticut River. The monitoring wells located at the landfill area also exhibited an overall decrease in groundwater elevations over the same period of between 2.52 feet at MW-206 and 5.90 feet at MW-207.

The December 2001 groundwater elevation data in Table 1 are plotted on a map to illustrate the groundwater flow direction at that time. Malcolm Pirnie prepared the groundwater contour map, dated January 8, 2002, for the industrial/northern peninsula areas (Figure 1), as well as the contour map for the landfill area dated January 8, 2002 (Figure 2). The data for the development of these maps were collected during the December 2001 ground-water sampling event on those specific days.

As illustrated on Figure 1, with the termination of pumping the containment mat sump, the horizontal shallow groundwater flow direction in the industrial area in January 2002 was generally from the hillside in the north to the south toward the river, with a minor component of flow toward the head of the discharge canal.

Based on facility design drawings, the shallow groundwater flow paths continue to be influenced by the presence of building subsurface structures. The current inactive status of the containment mat sump decreases the complexity of the shallow groundwater flow paths. However, the flow paths are still affected by the subsurface structures. As indicated on Figure 1, some hydraulic influence to flow paths remains in the vicinity of the structures, as evidenced by the localized variability in shallow groundwater elevations.

In spite of this hydraulic variance, the overall shallow water table hydraulic gradient, or slope of the shallow groundwater table, between monitoring well MW-101S and MW-110S during the December 2001 sampling event was approximately 0.017 foot per foot (ft/ft). The calculated hydraulic gradient between these locations during the June 2001 sampling event was 0.016 ft/ft. This minor difference in overall hydraulic gradient between June and December 2001 suggests that there was no significant change in the rate of shallow ground water flow across the site during the period.

As illustrated on Figure 2, the groundwater flow direction in the area of the landfill changed slightly in January 2002 with respect to the historical data presented within the Malcolm Pirnie September 1999 Report. The overall shallow groundwater flow beneath the landfill area was eastward, in the general direction of Salmon Cove. However, the minor component of flow toward Dibble Creek (the beaver pond) measured in April 1999 and June 2001 was not evident during the December 2001 monitoring event. This fluctuation may be attributable to the overall general lowering of the water table aquifer in the area of Dibble Creek during December 2001 relative to the earlier sampling events (Table 1).

The hydraulic gradient between monitoring wells MW-202 and MW-201, at the northwest and southeast perimeters of the landfill area, was approximately 0.023 ft/ft, in June 2001, and 0.024 ft/ft in December 2001. As in the industrial area of the site, this relatively small difference in hydraulic gradients between June and December 2001 suggests that there was no significant change in the rate of shallow ground water flow across the landfill area during the period.

2.2 March 2002 Quarterly Sampling Event

Ground water levels were generally higher across the site in March 2002, compared to December 2001. We believe this trend is due to the normal seasonal occurrence of increasing water levels in the spring. Notable exceptions were in MW-102D and MW-103D, where water levels went from 17.51 to 2.51 feet and from 14.86 to 8.01 feet, respectively. In addition, the vertical flow gradient in the MW-102 and MW-103 well clusters reversed from upward in December 2001 to downward in March 2002. Vertical flow gradients in all other well clusters were unchanged between the two sampling dates. It is likely that the anomalous response observed in the two well clusters is related to the termination of pumping from the containment mat sump.

Figures 3 and 4 are maps showing contours of ground-water levels in the Industrial/Peninsula area and Landfill area, respectively, in March. These figures show similar flow directions to those shown in December 2001.

2.3 June 2002 Quarterly Sampling Event

Ground water levels were lower in about half of the wells in the power station area in June, compared to March 2002. This trend is likely related to the effects of a relatively dry spring. The vertical flow direction in all well clusters was unchanged during this period, with the exception of MW-103. Figures 5 and 6 are maps showing contours of ground-water levels in the Industrial/Peninsula area and Landfill area, respectively, in June. These figures show similar flow directions to those shown in March.

3 Groundwater Sampling and Analyses

This monitoring report includes the radio-analytical results for three quarterly ground-water sampling events. One quarterly sampling event occurred between December 10, 2001 and January 8, 2002. Others occurred in March and June 2002. A limited sampling event occurred between February 11 and 14, 2002. This sampling event was completed in wells located on the peninsula as a result of a suspect low-level detection of Sr-90 in water from Supply Well B. The limited peninsula groundwater-sampling event is discussed in Section 3.4.

Measurements of field parameters were included as components of the groundwater sampling and are discussed in Section 3.1. Copies of the applicable procedures that were used to direct the groundwater sampling activities are contained within Appendix A.

Groundwater samples were collected using a Grundfos low-flow stainless steel submersible pump with dedicated polyethylene tubing. There were three exceptions with this sampling technique; monitoring well AST-1 was purged and sampled with a dedicated polyethylene bailer and monitoring wells MW-13 and TW-1 were purged and sampled with a Waterra pump and associated dedicated tubing and foot valves. Based upon results obtained from the June 2001 sampling event, a dedicated bailer was used to purge and collect a representative groundwater sample from AST-1. The construction details of monitoring wells MW-13 and TW-1 necessitated that these monitoring wells be sampled with a Waterra pump. The Grundfos pump did not fit into the 1.25-inch diameter well screen at these locations. Therefore, a Waterra pump, with an appropriate foot valve, was employed to collect a representative groundwater sample from each of these well screens.

3.1 Groundwater Field Tests

Several forms of field-testing were implemented during each sampling event, including gauging of water levels, evaluation of the potential presence of separate-phase fluid and measurement of groundwater field parameters. Each of these tests yields different information that allows for the evaluation of water quality and conditions within the respective monitoring wells.

Depth-to-water and bottom-of-monitoring-well measurements were collected with a Solinst electronic interface meter. This device can electronically differentiate between the presence of light non-aqueous phase liquids (LNAPLs), dense non-aqueous phase liquids (DNAPLs) and water. The resolution of the instrument is 0.01 foot. An example of an LNAPL, which has a specific gravity less than that of water and floats on the water table, is gasoline; whereas a DNAPL, which has a specific gravity greater than water and sinks through the water column, may include chlorinated solvents. During each sampling event, neither LNAPL nor DNAPL were detected in any of the monitoring wells gauged with this device.

Additional monitoring well-specific groundwater parameters were collected during the sampling of each well, including specific conductivity, pH, dissolved oxygen, temperature, oxidation-reduction potential and turbidity. The purpose of collecting these data is to confirm that stagnant water standing in each monitoring well is removed so that a representative groundwater sample can be collected from the aquifer of interest. This is accomplished by making several iterative measurements of field parameters while ground water is removed from the well, until the parameters have stabilized to within a 10% variation. These parameters were measured using an Horiba multi-parameter meter, with sensors arrayed within a flow-through cell. The resulting measurements are included within this report as Appendix B.

As presented within Appendix B, the field parameters typically stabilized within an acceptable range. One of the goals of the sampling event was to collect samples with a turbidity level in the range of 5 to 15 nephelometric turbidity units (NTUs). This range is typically used to indicate the absence of fine silt that may adversely affect the analytical results of the groundwater sample. In general, with few exceptions, the turbidity levels of the groundwater samples were within this range and were fairly consistent with previously collected data.

As noted within the June 2001 report, one exception to this trend was the pH measured within monitoring well MW-106D that ranged from 11.18 to 11.39. During the December 2001 ground-water sampling event, the pH readings from monitoring well MW-106D were within the range of 8.43 to 8.83. In March 2002 the range in pH in this well was from 7.20 to 8.43 and in June 2002 the range was from 10.22 to 10.27. Accordingly, based upon this apparent variability, any future pH measurements from this location will be monitored and evaluated closely.

3.2 Quarterly Site-wide Groundwater Analyses

Thirty-nine (39) locations from across the CYAPCO Haddam Neck Plant (HNP) facility and the Emergency Operation Facility (EOF) were targeted for sampling during each monitoring wells as a result of the overall decline in groundwater elevations. In March 2002 MW-200 and MW-201 were not sampled due to insufficient water within the wells. AST-1, TW-1 and MW-13 were not sampled in June 2002 because these wells were deleted from the list to be sampled in the work plan for the Phase II Hydrogeologic Investigation. The locations that were sampled are located within the power station, peninsula, support building(s) and landfill areas, as indicated below:

- Power Station Area (23 wells):

MW-100D	MW-100S	MW-101D	MW-101S	MW-102D	MW-102S
MW-103D	MW-103S	MW-104S	MW-105D	MW-105S	MW-106D
MW-106S	MW-107D	MW-107S	MW-108S	MW-109D	MW-109S
MW-110D	MW-110S	MW-114S	MW-115S	AST-1	

- Landfill Area (8 wells):

MW-200	MW-202	MW-204	MW-206
MW-201	MW-203	MW-205	MW-207

- Peninsula Areas (6 wells):
  MW-111S MW-112S MW-113S MW-117S MW-13 TW-1

- Emergency Operations Facility Area (2 wells):
  EOF-2, EOF Supply Well

Groundwater samples that exhibited satisfactory turbidity values were collected unfiltered. Samples that exhibited higher turbidity values were filtered prior to preservation. All samples were analyzed by certified, off-site laboratories for the following constituents and by the listed methodologies:

- Boron via EPA method 6010B;
- Tritium via EPA method 906.0; and
- Reactor-generated radionuclides using gamma spectroscopy (e.g., Cs-137, Co-60).

The results of analysis of the quarterly site-wide groundwater samples are discussed in Section 4.0.

3.2.1 Special Groundwater Analyses – Alpha and Beta-Emitting HTD Plant-Related Radionuclides

In addition to the above analyses, samples from a subset of twenty one (21) monitoring wells were planned to be analyzed during each sampling event via special analyses for HTD plant-related, alpha-emitting and beta-emitting radionuclides. Wells MW-114S, as a result of the overall decline in groundwater elevations. MW-107S and MW-201 were not sampled in March 2002. MW-201, MW-203 and MW-207 were not sampled in June. The subset of monitoring wells included the following:

MW-102S	MW-102D	MW-103S	MW-103D	MW-105S	MW-105D
MW-106S	MW-106D	MW-107S	MW-107D	MW-109S	MW-109D
MW-110S	MW-110D	MW-111S	MW-114S	MW-115S	
MW-201	MW-203	MW-207	EOF Supply Well		

Each sample was analyzed for gross alpha and gross beta activity. In addition, the HTD analytes and analytical methodologies included the following:

- Carbon-14 via liquid scintillation;
- Iron-55 via liquid scintillation;
- Nickel-63 via liquid scintillation;
- Plutonium-241 via liquid scintillation;
- Strontium-89 via EPA method 905.5 (December 2001 only);
- Strontium-90 via EPA method 905.5 in December and liquid scintillation in March and June;
- Technetium-99 via liquid scintillation analysis; and
- Alpha-emitting transuranics (isotopic plutonium, curium, americium) via alpha spectroscopy.

Strontium-89 was not detected in any well sampled during the December 2001 sampling round. Revision 1 of the plant License Termination Plan notes that the nuclide is not expected to be present at HNP due to its 60-day half-life and the seven years since the plant has been shut down. For this reason, Sr-89 has been deleted from the list of nuclides to be analyzed for. The results of analysis for HTD constituents in the subset of monitoring wells listed above are discussed in Section 4.4.

3.3 Limited Sampling and Analyses of Groundwater at Additional Locations

Water Supply Wells "A" and "B" provide non-potable water via a pipeline from the manifold at the wells to the plant screen-well house located at the cooling water intake structure on the shore of the Connecticut River. Strontium-90 was detected at a concentration of 4.02 pCi/L in a sample of groundwater that was collected in November 2001 from a sample port in the screen-well house. This result was suspect and additional sampling and analyses were completed to verify the result. Further, results of analysis of other HTD nuclides fell suspect due to detection of contaminants in areas where they previously had not been found. CYAPCO undertook a quality assurance evaluation of the analyzing laboratory, using the expertise of a radiochemist. The radiochemist concluded that the laboratory had sufficient deficiencies to cause the analytical results to be suspect.

As a result, CYAPCO pursued a new certified laboratory.

The additional sampling and analyses conducted during limited sampling events included collection of water samples from the plant water supply pipeline in the screen-well house, sampling of water Supply Well B located on the peninsula, sampling six monitoring wells on the peninsula in the vicinity of water Supply Well B and sampling the Emergency Operations Facility (EOF) water supply well system. All samples from the water supply pipeline and water supply wells were collected directly from a sample port that discharged directly to the sample container and were then preserved with nitric acid to a pH of less than 2.0.

3.3.1 Sampling and Analysis at the Screen-Well House and Supply Well B

The plant water supply pipeline was re-sampled at a sample port in the screen-well house in January and February 2002 in order to confirm the detection of Sr-90 in November 2001. The identical location in the pipeline at the screen-well house was re-sampled. In addition, one sample was collected directly from the Supply Well B pump structure in January and February 2002. Supply well A was not sampled because the well had been removed from service to make repairs in mid 2001 and was still inactive in February 2002. In addition to these samples, a "blank" sample was collected from the bottled water supply to act as a quality control sample. These samples were analyzed for Sr-90. The results of the re-sampling and analysis are discussed in Section 5.1.

3.3.2 Sampling and Analyses of Peninsula Monitoring Wells

On January 24, 2002, a meeting was convened with CTDEP regarding the detection of Sr-90 in the Supply Well B distribution system. As an outcome of this meeting, the collective decision was to sample existing monitoring wells located in the proximity of the supply well. Initially, nine (9) monitoring wells were to be sampled. However, due to inaccessibility and excessively silty samples from some wells, six monitoring wells were sampled. This sampling event occurred between February 11 and 14, 2002 and included the full suite of analyses for HTD constituents. The monitoring wells sampled were MW-117S, MW-4, TW-4, MW-1, MW-2, and TW-3. The results of sampling and analysis of these wells are discussed in Section 5.2.

3.3.3 Sampling and Analysis at the EOF Supply Well

As with the peninsula water Supply Well B system, the EOF supply well was tested for Sr-90 in January and February 2002, with follow-up testing again in March. The purpose of this sampling was to determine if Sr-90, which has been detected in groundwater in the industrial portion of the facility, might have migrated to a different portion of the CYAPCO property. The results of testing groundwater from the EOF supply well are discussed in Section 5.3.

4 Radiochemical Analytical Results for Quarterly Site-wide Groundwater Sampling

4.1 Boron

Boron is a good indicator element in groundwater at the HNP because it is chemically stable and was added to the water in the reactor vessel to control neutron flux when the plant was in operation. Therefore, the occurrence of elevated concentrations of boron in groundwater may be a general indication of areas that have been impacted by reactor cooling water. Sheets 2 and 3 in the September 1999 Groundwater Monitoring Report show that the boron and tritium plumes in groundwater beneath the power station are roughly coincident.

Over time, there continues to be a declining trend in boron concentrations within the power station area. Monitoring well MW-105S continues to exhibit the highest concentrations of boron, within the downward trend. Groundwater analytical results for boron analyses are summarized in Table 2.

Twenty-one (21) monitoring wells contained concentrations of boron greater than the contract required detection limit (CRDL) of 50 micrograms per liter (ug/L) during the December 2001 sampling event. Concentrations above the CRDL for boron during December 2001 ranged from a minimum of 56 ug/L at the EOF supply well to a maximum of 2,400 ug/L at MW-105S. The highest concentration of boron was again found in MW-105S in March 2002, although the level had decreased to 1,340 ug/L. In June 2002 boron was not found in any well at a concentration greater than 250 ug/L.

CYAPCO is in the planning phase to propose alternative groundwater protection criteria for boron, pursuant to Section 22a-133k-3(h)(1) of the CTDEP RSRs. This proposed criteria is based upon the risk-based equation and constants provided in the RSRs, as well as the boron reference dose provided by the USEPA.

4.2 Tritium

Generally, there has been a significant downward trend in Tritium (H-3) concentrations over time within the Industrial Area. Tritium concentrations were less than the drinking water standard in all wells sampled during both the March and June 2002 sampling rounds. Summary H-3 analytical results from the eight quarterly groundwater sampling events are provided in Table 3 and select locations are represented graphically on Figure 7. Laboratory analytical data packages in support of the ground-water sampling events are included as Appendix C.

Groundwater analytical results from the December 2001 sampling event indicate that samples from monitoring wells MW-102S and MW-110D contained H-3 at concentrations greater than the United States Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) of 20,000 pCi/L. Concentrations in these wells were 20,600 pCi/L and 21,300 pCi/L, respectively. These results differ from the June 2001 data. At that time monitoring well MW-103D exhibited the highest concentration of H-3 at 20,800 pCi/L. As indicated on Figure 1, monitoring well MW-102S is located near the south end of the overhead yard crane. Monitoring well MW-102D (next to and deeper than MW-102S) exhibited an increase in H-3 concentrations over the June to December 2001 period, from 2,620 to 4,110 pCi/L. These values are well below the EPA drinking water standard.

Monitoring well MW-103D, which is the deeper well in the cluster located in the vicinity of the former RWST, exhibited fairly constant H-3 concentrations in the 20,000 pCi/L range over the sampling events prior to December 2001. In December 2001 H-3 in MW-103D exhibited a marked decrease in concentration to 8,100 pCi/L. This substantial decrease may be attributable to the overall change in the groundwater elevation at monitoring well cluster MW-103 (Table 1), termination of pumping the mat sump, natural attenuation and/or a dynamic combination of these factors.

In March 1999, monitoring well MW-105S exhibited the highest concentration of H-3 recorded to date at 138,700 pCi/L. The December 2001 sampling event indicated that the H-3 concentration in that well had decreased to 1,800 pCi/L. The apparent decreasing trend in the H-3 concentration may be attributable to several factors including, but not necessarily limited to the following: attainment of a "naturally" occurring asymptotic concentration curve due to natural attenuation, a continued overall decrease in groundwater elevation (Table 1), contaminant transport over unidentified groundwater migration pathways, or a combination of these factors.

Monitoring well MW-110D is located on the northern peninsula, approximately midway between the head of the discharge canal and the Connecticut River (Figure 1). Tritium concentrations were initially identified in this well in March 1999 at 27,630 pCi/L. In June 2000, the concentration was 18,300 pCi/L and in June 2001 the concentration was 18,700 pCi/L (Table 3). The analytical results from the December 2001 event indicate that the H-3 concentration in MW-110D had increased to 21,300 pCi/L, or slightly above the EPA MCL. By June of 2002, H-3 in MW-110D had decreased to its lowest concentration to date of 10,700 pCi/L.

4.3 Cs-137

Cesium-137 was the only gamma-emitting radionuclide detected at concentrations greater than the MDC during the December 2001, March and June 2002 sampling events. Very low levels of other gamma-emitters were detected at concentrations slightly greater than the 2-σ TPU (see discussion below), but not consistently in any well. We believe these very low-level "detections" are false positive noise at the lower limit of the measuring technique.

During the December 2001 ground-water sampling round, Cs-137 was detected in one monitoring well, MW-103S, at a concentration of 8.39* pCi/L (Tables 3 and 4). MW-103S is the shallow monitoring well in the cluster located in the vicinity of the former Refueling Water Storage Tank (RWST). In March 2002 the concentration of Cs-137 in MW-103S increased to 30.2 pCi/L and in June it increased again to 58.5 pCi/L. The nuclide was also detected in MW-115S in March and June at concentrations of 3.18 and 1.59* pCi/L, respectively. The first row of data on Table 3 presents the historical Cs-137 analytical results for monitoring well MW-103S and Table 4 summarizes Cs-137 analytical results in all wells since June 2001.

Over the period of record the concentration of Cs-137 in MW-103S has varied between a minimum of 8.39 pCi/L (December 2001) and a maximum of 76 pCi/L (March 1999). The federal MCL for Cs-137 is 200 pCi/L. Laboratory analytical data packages in support of the ground-water sampling events are included as Appendix C.

4.4 Alpha and Beta-Emitting, HTD Plant-related Radionuclides

As discussed in Section 3.2.1, samples from a subset of twenty-one monitoring wells were also analyzed via special analyses for HTD plant-related, alpha-emitting and beta-emitting radionuclides during the quarterly sampling rounds. Table 5 presents a summary of the analytical results and the laboratory data reports are included as Appendix C to this report.

As illustrated on several of the summary data tables, several of the reported analytical values are shaded. When discussed in the text of this report, these values are footnoted (*). The shading or footnote indicates that the reported value is greater than the 2-σ total propagated uncertainty (TPU) of the analysis, but less than the MDC. As such, these very low concentrations are statistically significant at the 95% confidence level, but have a relatively high level of uncertainty. Some of the relative 2-σ uncertainties range on the order of 75 to 95 percent. Additional data, to be collected during future ground water sampling events, will allow trends to be identified to determine if these reported detections are false positive values.

Factors that may affect the uncertainty of radiological analyses, and the ability to discern plant-related activity include interference from naturally occurring radionuclides due to incomplete specificity of radiochemical separation and counting technique, difficulty in

* Relatively high level of uncertainty.

identifying ambient background or blank contribution. Section 6.0 provides a more detailed discussion of the issues related to measurement of low concentrations of the HTD nuclides. CYAPCO will continue to monitor and investigate these apparent irregularities to determine if they are the result of false positive analytical results.

4.4.1 Gross Alpha and Gross Beta

Gross alpha and gross beta results for the three quarterly sampling events are summarized in Table 4. Gross alpha activity for the three quarterly sampling events ranges from not detectable (MW-109S and MW-110S) to 17.2 picocuries per liter (pCi/L) in the EOF Supply Well. The higher values are generally detected in the deeper wells completed in bedrock. Although it is possible that plant-related radionuclides contribute to some of the observed gross alpha activity, we believe the source of most of the activity is naturally occurring alpha-emitting nuclides, including Ra-226 and Rn-222 that are likely present in the granitic gneiss bedrock.

Gross beta activity for the three quarterly sampling events ranges from not detectable (MW-105D and MW-111S) to 242 pCi/L (MW-105S). As shown on Table 4, gross beta activity roughly correlates with Sr-90 (a beta emitter), in that the highest concentration of Sr-90 is also found in MW-105S. Another beta emitter, Cs-137, has been detected in MW-103S and MW-115S. Table 4 shows that groundwater from those wells also has relatively high concentrations of gross beta activity.

4.4.2 Alpha Isotopic Analyses

Alpha isotopic results were determined by alpha spectroscopy. The alpha isotopic results submitted by STL Richland for the March and June 2002 sample rounds indicated positive activity rates of 1.9% and 1.1%, respectively, of the samples analyzed. Positive activity is identified by concentrations that are greater than 2-σ TPU and near the MDC level. These percentages are slightly less than the expected rate of 2.5% if there were no significant alpha-emitters present. One would expect a "false positive" rate of 2.5% based on the area under the standard normal distribution around a limiting mean concentration of zero at the 95% confidence level.

In contrast, approximately 35% of the alpha isotopic results reported by Antech for the December 2001 sample round were greater than 2-σ TPU. These results were not confirmed during the March and June sample rounds and indicate a significant positive bias in alpha analytical results reported by Antech at concentrations near the MDC. Rank order plots of the analytical data for each radionuclide, by quarter, are included in Appendix D. As discussed in Section 6.4, many of these rank order plots demonstrate a positive bias in the alpha isotopic analyses.

The presence of alpha-emitting HTD nuclides is in question, due to positive bias in the data. CYAPCO is attempting to verify the presence of these HTD constituents by continuing to analyze for them in samples from the wells in question during future quarterly sample events, until absence of the HTD constituents can be confirmed.

4.4.3 Other Beta Isotopic Analyses

Beta isotopic results were determined by chemical separation followed by liquid scintillation counting (LSC). The beta isotopic results submitted by Antech for the December 2001 sample round indicated a positive activity rate of 18.7% of the samples analyzed. STL Richland results for the March and June 2002 sample rounds indicated positive activity rates of 25.8% for both rounds. These results were normally distributed around a limiting mean concentration and are substantially greater than the expected rate of 2.5%, indicating a significant false positive bias in the LSC analytical results at concentrations at or near the MDC.

Carbon-14 was analyzed for in the December 2001 samples but an audit of the laboratory data revealed that an unapproved subcontracted lab used a draft analytical method that was not specific to carbon. This condition resulted in the December data being invalidated. Similarly, as discussed in Section 6, the analytical data for Fe-55 for the December 2001 sample round are invalid because of very high reported uncertainties. Refer to Appendix D for rank order plots of each radionuclide, by quarter, and to Section 6.3 for a discussion of the positive bias in beta isotopic results by LSC.

Strontium-90 was detected in four monitoring wells during each of the last three quarterly sampling events, at generally increasing concentrations on each successive sampling round for the wells exhibiting lower concentrations and a leveling off of the highest concentration well, MW-105S (Table 5). The wells where Sr-90 has been consistently detected are MW-103S, MW-105S, MW-106S and MW-109S, at concentrations ranging from 0.656 (MW-109S) to 122 pCi/L (MW-103S). With the exception of MW-109S, the concentration of Sr-90 in each of these wells in June 2002 was greater than the EPA MCL of 8 pCi/L. In addition, the nuclide was also found in MW-114S and MW-115S during both the March and June sampling rounds at concentrations ranging from 3.63 to 0.524* pCi/L. Low levels of Sr-90 have also been detected in a few other wells during one of the last three sampling events. Additional sampling will be required to determine if these low-level detections are false positives.

The presence of many of the HTD nuclides analyzed for is in question, due to positive bias in the data. CYAPCO is attempting to verify the presence or absence of these HTD constituents by continuing to analyze for them during future quarterly sample events.

5 Radiochemical Analytical Results for Limited Groundwater Sampling at Additional Locations

* Relatively high level of uncertainty, result in question and to be evaluated.

As a result of the initial detection of Sr-90 in the plant water supply at the screen-well house, two limited sampling events were completed in addition to the quarterly groundwater sampling activities. The results of these activities are summarized in Table 6 and all results, including the QA/QC results, are presented within Appendix E.

5.1 Analytical results from the Screen-Well House and Supply Well B

The plant water supply was re-sampled at the screen-well house in January and February 2002 in order to confirm the earlier detection of Sr-90 at 4.02 pCi/L. The identical location was re-sampled at a sample port in the water pipeline in the screen-well house. In addition, one sample was collected directly from the Supply Well B pump structure in January and February 2002. In addition to these samples, a "blank" sample was collected from the bottled water supply to provide a quality control sample. This sample was identified as "E Well Supply". All of the samples were analyzed for Sr-90 by Antech.

The sampling results at the screen-well house in January and February 2002 identified Sr-90 at 0.222* pCi/l and less than 0.34 pCi/L, respectively. The MDC associated with the January detection was 0.35 pCi/L, with an uncertainty of +/- 0.22, resulting in a relative uncertainty of 99 percent at 2-σ. The blank sample "E Well Supply" had a reported Sr-90 concentration of less than the MDC of 0.56 pCi/L.

The sample from the Supply Well B pump structure contained a concentration of Sr-90 of 1.02 pCi/L in January 2002 and 0.584* pCi/L in February 2002. The MDC associated with the January detection in Supply Well B was 0.45 pCi/L, with an uncertainty of +/- 0.35, which results in a relative uncertainty of 60 percent at 2-σ. The relative uncertainty for the February result was 87 percent at 2-σ. No rank order plot of the data was constructed to evaluate the presence of a bias in the data because of the limited number of samples in this limited sampling event. However, the Sr-90 detections in January at the screen-well house and at Supply Well B in February have high relative uncertainties. Additional sampling and analysis of groundwater from the Water Supply Well B infrastructure are required to determine if the low-level detections are false positive, which are essentially noise at the lower limit of the measuring technique. CYAPCO will continue to monitor the plant water supply distribution system as appropriate.

5.2 Analytical results from the Peninsula Monitoring Wells

As discussed in Section 3.3.2, between February 11 and 14, 2002 six monitoring wells on the peninsula in the vicinity of water Supply Well B were sampled for the full suite of HTD constituents. The samples from these wells were analyzed by Antech.

Monitoring wells MW-117S and MW-2 each exhibited low levels of Sr-90 at 0.404 and 0.572 pCi/l, respectively. The relative uncertainties associated with these values are 74 percent and 54 percent, respectively, at 2-σ. Because these low-level detections are so

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* Relatively high level of uncertainty, result in question and to be evaluated.

close to the lower limit of the measuring technique, they may be false positives. In an effort to further develop an understanding of these questionable results, CYAPCO will continue to monitor these locations for the constituents that have been identified.

Monitoring well MW-2 also exhibited relatively low levels of H-3 in February 2002 at a concentration of 601 pCi/L, Pu-238 at 0.615 pCi/L, Pu-241 at 31.0 pCi/L and Am-241 at 0.063 pCi/L. As discussed in Section 6, the low-level detections of Pu-238, Pu-241 and Am-241, with high levels of relative uncertainty (72, 35 and 100 percent, respectively, at 2-σ) may be false positives due to positive biases in the analyses during this period and will be further evaluated by additional sampling until absence of these nuclides is confirmed.

5.3 Analytical results from the EOF Supply Well

The EOF supply well has been sampled for Sr-90 on three occasions, January, February and March 2002, to determine if plant-related radionuclides may be present in other areas of the property. Each of the results indicated that Sr-90 was not detected above the MDC concentration of 0.031, 0.031 and 0.495 pCi/L, respectively.

In January and March of 2002, this location was analyzed for the full suite of plant-generated radionuclides. As discussed in Section 6, a positive bias was identified in the analytical results for many of the HTD nuclides. CYAPCO will continue to monitor this location until the absence of plant-related radioactivity is confirmed.

6 Data Assessment

All reported analysis results include the net concentration, the 2-σ total propagated uncertainty concentration (TPU), and the minimum detectable concentration (MDC). Net concentration results greater than the 2-σ TPU generally imply that statistically significant activity is present with a 95% certainty. Net concentration results less than the 2-σ TPU indicate zero or statistically insignificant activity. Net concentration results reported as negative values imply that the radioactivity in the sample is less than the average or long-term background.

The reported TPU is a combination of the counting uncertainty and any other factors that contribute to the overall uncertainty including uncertainties in the sample mass, chemical yield and determination of calibration factors. All TPU values are reported at 2-σ and allow direct comparison with the net concentration for statistical significance.

Detection limits are essential for evaluating data quality and demonstrating that the desired sample analysis sensitivity was achieved. The lower limit of detection (LLD) is the lower limit at which a measurement can be differentiated from background with some degree of confidence. The LLD for a radionuclide is typically computed from the counting error associated with the instrument background or blank counting conditions at the time of analysis and is usually expressed in terms of counts or count rate. In contrast, the MDC includes conversion factors to relate background count rate to radionuclide activity or concentration. The contractual (or *a priori*) MDCs for these results identified in the SOW are summarized in Table 7. All reported MDC concentrations are *a posteriori* and include sample specific corrections for radioactive decay, chemical yield and sample mass.

All analytical results were evaluated against Table 7 to ensure that sensitivity requirements were met. Several instances were identified in the case narrative where the sample specific MDCs were greater than the contract required detection limit (CRDL). In all cases, the CRDL for Am-241 of 1 pCi/liter was not achieved via gamma spectrometry, but it was easily achieved by alpha spectrometry. MDC sensitivities were not met for Eu-154 via gamma spectrometry on several gamma isotopic analyses. Iron-55 results from the Antech lab did not meet the sensitivity requirements of the SOW.

Simple rules of thumb were used to evaluate analytical results that were not statistically significant with respect to background. The MDC-to-uncertainty ratio was evaluated for reasonableness. In this case the 2-σ TPU uncertainty was used in the evaluation and MDC-to-uncertainty ratios less than 1.5 were flagged for additional review. These thumb rules do not apply to low count rate results typical of alpha isotopic analysis where MDC-to-TPU ratios can range from 1 to 25. The Fe-55 results from the Antech lab exhibited MDC-to-TPU ratios that ranged from 0.12 to 0.27. Further inspection of these results indicated that the TPU was overestimated by a factor of 5 to 10 and/or the MDC was underestimated. For this reason, the Fe-55 results for the December 2001 sampling event have been flagged as unacceptable, and we are working with the lab to resolve this issue.

6.1 Statistical Methods

A false-positive error is an instance when a nuclide or analyte is declared to be present but is, in fact, absent. A false-negative error is an instance when an analyte is declared to be absent but is, in fact, present. Both laboratories exhibited problems with the reporting of false-positive results, based on MAPEP performance evaluation (PE) data and trend analysis of analytical sample results.

Statistical and visual methods were employed to evaluate trends in the analytical results as a function of nuclide. Rank order plots for the December 2001, March 2002 and June 2002 sampling events were prepared as a function of nuclide (see Appendix D). The analytical data were treated as follows:

1. Net concentration results at all well locations were arranged in ascending order
2. Standard distributional statistics were calculated (i.e., mean, median, minimum, maximum and standard deviation for the net concentration, 2-σ TPU and MDC)

3. Net concentration results with associated TPU error bars were graphed as a function of rank order
4. Expected zero mean concentration and 2-σ zero mean concentration control limits graphed as a function of rank order
5. Average MDC graphed as a function of rank order

Graphing the expected zero mean and associated 2-σ zero mean concentration control limits provides a visual indication of biases in the analytical technique at concentration levels near or below the MDC. The expected ± 2-σ zero mean control limits were based on actual sample data when activity was near or less than the MDC. In most cases, the average 2-σ TPU provides restrictive control limits that are more sensitive than the standard deviation of the mean concentration in the data set. For analyses that were generally statistically significant with respect to background (i.e., gross alpha, gross beta), analytical blank data were used to estimate the 2-σ zero mean control limits.

6.2 Gamma Emitters

Attached in Figure 8 is a rank order plot of Mn-54 concentrations in ground water for the March 2002 sampling event. Manganese-54 is a gamma emitter, determined by photon counting or gamma isotopic analysis. Due to an expected low radionuclide inventory, radioactive half-life and decay considerations, Mn-54 is not expected to be present in detectable quantities in ground water samples from the HNP. The Mn-54 results are graphed with their corresponding 2-σ TPU error bars. An average and 1-σ standard deviation concentration of -0.01 ± 1.50 pCi/L was observed in this data set while the average MDC was 4.2 pCi/L. The control limits are ± 2.7 pCi/L based on the average 2-σ TPU. Approximately half the data points are distributed above or below the zero concentration level. Note that the 2-sigma error bars generally cross zero except in the extreme positive or negative regions of the data. The data are also normally distributed around the mean value based on Filliben's r-statistic, also known as the normal probability plot correlation coefficient (See Appendix F, Figure F.1). As expected, no significant Mn-54 activity is indicated in this trend plot and the data are equally distributed around zero. These results are typical of gamma isotopic analysis where no analyte is present and the background or energy baseline is easily and accurately determined.

6.3 HTD Beta Emitters

Attached in Figure 9 is a rank order plot of Tc-99 in water for the March 2002 sampling event. Technitium-99 is a beta emitter that is determined by liquid scintillation counting (LSC). Due to an expected low radionuclide inventory attributed to its low specific activity, Tc-99 is generally not expected to be present in detectable quantities in ground water samples from the HNP. An average and 1-σ standard deviation concentration of 5.8 ± 3.6 pCi/L was observed in this sample event data set. Note that the Tc-99 data are also normally distributed around the mean concentration of 5.5 pCi/L (based on Filliben's r-statistic at the 95% confidence level) and all 23 reported results are greater than zero concentration (See Appendix F, Figure F.2).

As previously noted, we do not expect Tc-99 to be present due to low radionuclide inventory. Furthermore, if Tc-99 were present in sufficient quantities, we would expect a large degree of variability in the data due to sample proximity with respect to the ground water plume, as indicated in H-3 sample event data. The fact that all reported concentrations in this data set are greater than zero and distributed normally about the mean concentration suggest that there is a slight positive bias in the measurement methodology at concentrations near the reported MDC level. This bias may be attributed to many factors including the following:

- Underestimated background or ambient blank contribution
- Interference from natural radionuclides due to low chemical specificity
- Trace amounts of contamination in processing glassware or radiochemical tracers

Attached in Figure 10 is a rank order plot of Fe-55 in ground water in March 2002. Iron-55 decays by electron capture and is also determined by LSC after chemical separation. An average and 1-σ standard deviation concentration of 5.2 ± 4.0 pCi/L was observed in this sample event data set. The control limits are ± 2.8 pCi/L based on the average 2-σ TPU. Note that all Fe-55 data near or less than the MDC are also normally distributed around the mean concentration (based on the Filliben's r-statistic at the 95% confidence level) and all 23 reported results are greater than the zero concentration level (See Appendix F, Figure F.3). Similar trends were observed with other HTD beta emitters including Ni-63 and Sr-90 (Appendix F, Figures F.4 thru F.6).

Attached in Figure 11 is a rank order plot of Pu-241 in ground water for the March 2002 sample event. Plutonium-241 is a low energy beta emitter also determined by LSC after chemical separation. An average and 1-σ standard deviation concentration of 4.6 ± 3.0 pCi/L was observed in this sample event data set. The upper and lower control limits of ± 3.9 pCi/L are based on the average 2-σ TPU. The Pu-241 data are also normally distributed with 22 of the 23 reported results greater than the zero concentration level (See Appendix F, Figure F.7).

Attached in Figure 12 is a rank order plot of Pu-241 in ground water for the June 2002 sample event. An average and 1-σ standard deviation concentration of -4.8 ± 5.6 pCi/L was observed in this sample event data set. The upper and lower control limits of ± 3.5 pCi/L are based on the average 2-σ TPU. The Pu-241 data are also normally distributed with 16 of the 20 reported results less than the zero concentration level A (See Appendix F, Figure F.8).

These Pu-241 results suggest that there is some difficulty in obtaining an accurate estimate of the average or ambient background contribution. The March 2002 data suggest an underestimated background contribution and the June 2002 data suggest the effects of an overestimated background contribution.

As a result of these evaluations and lab audits and assessments, we have initiated follow-up action with the labs in an attempt to minimize the occurrence of positive and negative trends with future data. We will continue to evaluate and monitor the data. In the meantime, we will report the data *as is* in order to evaluate any dose risk associated with ground water monitoring in a conservative manner.

6.4 HTD Alpha Emitters

Attached in Figure 13 is a rank order plot of Pu-238 in ground water for the December 2001 sample event as reported by Antech. Plutonium-238 is an alpha emitter determined by chemical separation and alpha spectrometry. The average Pu-238 concentration in this sampling event data was 0.29 pCi/L and the observed 1-σ standard deviation concentration was 0.17 pCi/L. The upper and lower control limits of $\pm$ 0.16 pCi/L are based on the average of the reported 2-σ TPU values. The average reported MDC was 0.16 pCi/L. As can be seen in Appendix F, Figure F.9, the Pu-238 data are normally distributed, but not around the zero mean concentration. This is unexpected due to the low count rate nature of alpha counting. A total of 24 of the 26 reported Pu-238 results are greater than the zero concentration level. This evaluation indicates a positive bias in the lab analysis or the introduction of a contaminant in the sample preparation process.

Attached in Figures 14 and 15 are rank order plots of Pu-238 in ground water for the March and June 2002 sample events. The average Pu-238 concentration in the March 2002 sampling event data was 0.003 pCi/L and the observed 1-σ standard deviation concentration was 0.014 pCi/L. The upper and lower control limits are $\pm$ 0.09 pCi/L for both data sets based on the average of the non-zero reported 2-σ TPU values. The average reported MDC was 0.16 pCi/L for the March 2002 data set and 0.14 pCi/L for the June 2002 data set. Note that all of the reported Pu-238 concentration results for both data sets are distributed around the zero concentration level with no apparent bias (Appendix F, Figures F.10 and F.11).

Similar trends were observed with Am-241 alpha isotopic analysis results as reported by the Antech lab. Positive bias trends were observed in Pu-238 and Am-241 batch blank results during an onsite assessment. The positive bias in the Am-241 batch blank results was attributed to indigenous concentrations of Am-241 in the Am-243 radiochemical tracer (Appendix F, Figure F.12). This positive bias is not seen in the analysis results from the STL-Richland Lab. in March of 2002 (Appendix F, Figure F.13).

On-site assessments also indicated positive trends associated with analytical blank analysis data at both laboratories. These trends were generally limited to techniques that employed LSC methods (at both STL-Richland and Antech labs) and alpha isotopic analysis (Antech lab only). Positive trends and biases were generally observed with the following nuclides at levels near the reported MDC: Fe-55, Ni-63, Sr-90, Tc-99 and Pu-241. A negative trend and bias was also observed with Pu-241 data from the June 2002 sampling event. Alpha isotopic analysis results with similar positive trends were Pu-238, Pu-239/240 and Am-241. In many cases, these results were concluded to be false positive based on sample reanalysis or subsequent quarterly sampling event trends.

7 Groundwater Monitoring Program QA/QC

Current quality assurance/quality control (QA/QC) efforts in support of the Ground Water (GW) monitoring program at the Haddam Neck Plant (HNP) are designed to assess and enhance the reliability and validity of field and laboratory measurements conducted to support these programs. Sample quality is maintained based on guidance in Reference 1. On the analytical side, accuracy, precision, and detection sensitivity are the primary indicators used to assess laboratory data quality. Representativeness, completeness and comparability may also be evaluated for overall quality. These parameters are evaluated through laboratory QC checks (e.g., matrix spikes, laboratory blanks), replicate sampling and analysis, analysis of blind standards and blanks, and inter-laboratory comparisons. Acceptance criteria have been established for each of these parameters. When a parameter is outside the criteria, corrective actions are taken to minimize future occurrence.

7.1 Sample Analysis

Sample collection and control was performed using controlled work processes and trained staff (see Reference 2). The tasks included sample collection, chain-of-custody and sample shipping. The statement of work (SOW) for environmental and waste characterization analytical services defines quality requirements for lab analysis activities (Reference 3). Antech, Ltd. (certification number: PH-0694) was the primary radiological laboratory for GW sample analysis from December 2001 sampling events through February 2002. The Severn Trent Lab in Richland, WA (STL-Richland) was selected and used as the primary lab for the March and June 2002 sampling events. Methods employed for radiological constituents were developed by the vendor laboratories and are recognized as acceptable within the radiochemical industry. Descriptions of the analytical methods used by Antech, Ltd. and STL-Richland are maintained in the Bechtel file.

Each lab supplied all sample containers used in the collection of the groundwater samples that they analyzed. Sample containers were delivered to the site by courier and maintained in a secure manner until use by the sampling team. Samples were packaged for transport to the laboratory with protective packing material in insulated coolers with custody seals.

The HNP laboratory performed tritium, gross alpha/beta and gamma isotopic analyses to support offsite sample shipment but these analyses were not used for reporting actual GW analytical sample results.

7.2 Field Quality Control Samples

Field QC samples typically consist of duplicates, splits and blank samples. Field duplicate samples are used to assess sampling and measurement precision. Field split samples are used to assess measurement precision. Field splits and duplicates are typically examined to monitor laboratory operations and to identify potential problem areas where improvements are necessary. One field duplicate sample was randomly collected during the course of each quarterly sampling event, after considerations for well yield and sample volume requirements.

The blind duplicate sample for the December 2001 sampling round was a duplicate of a sample from MW-108S, and identified as MW- 801S. The March duplicate sample from MW-204 was identified as MW-402, and the June duplicate sample from MW-105S was identified as MW-862. The blind duplicate samples from the December 2001 and March 2002 sample rounds were analyzed for H-3, boron and gamma spectroscopy. The June 2002 duplicate was analyzed for H-3, boron, gamma spectroscopy, as well as hard to detect nuclides.

Attached in Table 8 are the reported results for the three field duplicate samples collected from December 2001 through June 2002. Only those reported results with a sample-to-uncertainty concentration ratio greater than 5 are evaluated and summarized. The uncertainty in this ratio is the 1-σ total propagated uncertainty. All field duplicate results are within 5% of the initial sample results.

A decontamination station was established near each monitoring well location to provide for the proper decontamination of dedicated sampling equipment. The following decontamination process was used during each quarterly sampling event:

1) Wash with non-phosphate detergent (Alconox-brand utilized),
2) Rinse with potable water, and
3) Place equipment into a protective cover.

All non-disposable equipment used during the program was subject to decontamination. These components included the groundwater sampling pump, electrical lead wires and support cable, as well as the flow-through cell in which field parameters were measured.

An equipment rinsate blank sample was collected using bottled spring water and served to evaluate the effectiveness of decontamination efforts. The equipment blanks were collected as needed to verify the effectiveness of the decontamination process for reusable sampling equipment. The equipment blank sample consisted of water pumped through the decontaminated sampling pump into a laboratory-supplied container. This sample was analyzed for H-3, boron and gamma spectroscopy. Equipment rinses associated with at least one randomly selected monitoring well were submitted with each sampling event batch of GW samples. Significant contamination was not identified in equipment blank rinses and contamination control efforts were effective with minimal impact on lab analytical data.

7.3 Laboratory Performance Evaluation

Laboratory performance is measured by several indicators, including nationally based performance evaluation studies, double-blind standard analyses, laboratory audits, and internal laboratory QA/QC programs. This section provides a detailed discussion of the performance indicators for the Antech and STL-Richland laboratories.

7.3.1 DOE Performance Evaluations

Both the Antech and STL-Richland labs took part in US Department of Energy (DOE) Quality Assessment Program and the DOE 's Mixed Analyte Performance Evaluation Program. Results of those studies related to GW monitoring at HNP, are described in this section.

7.3.1.1 DOE Quality Assessment Program

DOE 's Quality Assessment Program (QAP) evaluates how laboratories perform when they analyze radionuclides in water, air filter, soil, and vegetation samples. This discussion considers only water sample testing. This program is coordinated by the Environmental Measurements Laboratory (EML) in New York. EML provides blind standards that contain specific amounts of one or more radionuclides to participating laboratories. Gamma emitters typically include K-40, Mn-54, Co-60, Cs-137, Bi-212, Pb-212, Bi-214 and Pb-214. Alpha emitters typically include U-234, Th-234, U-238, Pu-238, Pu-239, Am-241 and Cm-244. The beta and hard-to-detect (HTD) radionuclides typically include H-3, Fe-55, Ni-63 and Sr-90.

After sample analysis, each participating laboratory forwards the results to EML for comparison with known values and with results from other laboratories. Using a cumulative normalized distribution, acceptable performance yields results between the 15th and 85th percentiles. Acceptable with warning results are between the 5th and 15th percentile and between the 85th and 95th percentile. Not acceptable results include the outer 10% (less than 5th percentile or more than 95th percentile) of historical data.

For the five QAP studies conducted from June 2000 through June 2002 (see References 4 through 7), the percentages of acceptable or acceptable with warning results are summarized as a function of analysis type and laboratory in Table 9. Overall, approximately 90% of all reported data was in the acceptable or acceptable with warning performance category.

7.3.1.2 DOE Mixed Analyte Performance Evaluation Program

DOE 's Mixed Analyte Performance Evaluation Program (MAPEP) examines laboratory performance in the analysis of soil and water samples containing metals, volatile and semivolatile organic compounds and radionuclides. The program is conducted at the Radiological and Environmental Sciences Laboratory (RESL) in Idaho Falls, Idaho, and is similar in operation to DOE 's QAP discussed above. DOE evaluates the accuracy of the MAPEP results for radiological and inorganic samples by determining if they fall within a 30% bias of the reference value.

RESL provides blind standards that contain specific amounts of one or more radionuclides to participating laboratories. Gamma emitters typically include K-40, Mn-54, Co-57, Co-60, Zn-65, and Cs. Alpha emitters typically include U-234, U-238, Pu-238, Pu-239 and Am-241. The beta and hard-to-detect (HTD) radionuclides typically include Fe-55, Ni-63 and Sr-90.

The MAPEP program also uses false positive testing on a routine basis to identify laboratory results that indicate the presence of a particular radionuclide in a sample, when in fact the actual activity of the radionuclide is far below the required detection limit. False positive test nuclides typically include Sr-90, Fe-55 or Pu-238.

For the four MAPEP studies conducted through May 2002 (see references 8 through 11), the percentages of acceptable or acceptable with warning results are summarized as a function of analytical lab in Table 10. Overall, about 72% of the reported lab data was in the acceptable or acceptable with warning performance category for all media. For gamma isotopic analyses, 100% of the reported lab data was in the acceptable or acceptable with warning category. Both labs utilized by CY experienced problems with the HTD beta analyses and false positive testing.

7.3.2 Laboratory Internal QA/QC Programs

Commercial analytical laboratories generate internal analytical performance data by analyzing method blanks, laboratory control samples (LCS), matrix spikes, matrix spike duplicates, matrix duplicates and surrogates. This information provides a means to assess laboratory performance and the suitability of a method on a batch sample analysis basis. The STL-Richland lab provided a detailed summary of all internal lab performance data with each data package. The Antech lab only provided exception-style reporting (e.g. when experiencing unusual performance problems with an analytical method). Performance summaries of internal laboratory QC data are not provided with the analytical reports provided by Antech.

7.3.2.1 Lab Internal Quality Control Samples

For the Antech lab, QC limits or numerical performance indicators for LCS are typically ± 3-σ based on a simple z-statistic (Reference 13). Radiochemical tracer and yield acceptance criteria range from 30% to 110% for radiochemical parameters. For matrix spikes and matrix spike duplicates, QC limits are typically 75% to 125%. For matrix spikes and duplicates, QC limits are typically ≤ 25% (relative percent difference) for general chemical parameters, ammonia and anions, metals and radiochemical parameters.

Approximately 16% of the samples analyzed in a quarterly sampling event by the Antech Lab are QC samples. The majority of these are method blanks and spikes as summarized in Table 11.

STL performed a minimum of one LCS, one method or reagent blank, and one duplicate sample analysis for each analysis performed in a batch of samples according to Reference 14. Internal acceptance criteria for LCS recovery samples are summarized as follows:

- Recovery within QC acceptance limits (see Table 12)
- Results within 2-σ TPU of the observed value
- Recovery within allowed uncertainty (based on contracted detection limit)

Method or reagent blank results are evaluated or compared to the contracted detection limit (CDL). Acceptable method blanks are those results that are less than the CDL. Method blank results greater than CDL are critically examined and documented in a Nonconformance Memo (NCM).

Duplicate analysis results greater than 5 times the CDL, must fall within ± 3-σ TPU of the observed value. If either the sample or duplicate sample is less than 5 times the CDL, the difference in the results should be less than or equal to the CDL.

Matrix Spikes (MS) are first corrected for any ambient test nuclide activity. Samples with ambient activity greater than 5 times the expected value of the spike are not required to fulfill MS acceptance criteria. Acceptance criteria for MS samples are 60% to 140% with a chemical yield monitor and 40% to 160% for nuclides without a chemical yield monitor. Additionally, all QC and sample results must have chemical recoveries or chemical yields within the range of 20 to 115 percent. Individual internal QC results are contained within Appendix C and indicate that the recovery rates for the laboratories are within acceptable ranges for the analyses performed.

Approximately 10% to 20% of the samples analyzed by STL-Richland in a quarterly sampling event are QC samples. The majority of these are method blanks and duplicates. Attached in Tables 13 and 14 are summaries of the number of QC samples processed by the STL-Richland lab during the March and June 2002 sample events.

7.3.2.2 Issue Resolution/Case Narrative

Case narrative documents record detailed documentation of the analyses requested and provide additional documentation regarding problems encountered with sample receipt, sample analysis and data reporting. The forms are generated by the laboratory as required in the SOW and forwarded to the GW monitoring project with all hard copy data packages. The documentation is intended to identify occurrences, deficiencies and/or issues that may potentially have an adverse effect on data integrity. These case narratives are included in Appendix C with the laboratory analytical data sheets. Some of the specific issues identified by the Antech lab during the reporting of December 2001 sample event data included:

- Samples filtered prior to processing
- Lack of significance in trailing zeros and decimals
- Carbon-14 test performed by vendor laboratory
- Tracer yield for Pu-241 LCS sample was unacceptable
- Tritium value verified by duplicate analysis
- Typographical errors with 0 exponent results

Some of the specific issues identified by the STL-Richland lab during the reporting of March and June 2002 sampling event data included:

- All Am-241 MDCs greater than 1 pCi/L CRDL for gamma spectroscopy
- LCS, sample duplicate, batch blank and sample results are within contractual requirements

7.3.3 Laboratory Audits/Assessments/Oversight Activities

Laboratory activities are regularly assessed through surveillance and auditing processes to ensure that quality problems are prevented and/or detected. Regular assessment supports continuous process improvement.

7.3.3.1 Antech Audits/Assessments

National Environmental Laboratory Accreditation Conference (NELAC) representatives audited the Antech lab facility in December of 2001. Based on corrective actions taken and their plan for completing the remaining corrective actions identified during the audit, they were accredited by NELAC on February 21, 2002.

Routine oversight following routine sample reporting events identified the following issues and concerns:

- MDCs not achieved
- Potentially false positive reporting of Pu-238 in groundwater
- Use of unapproved vendor and lack of vendor controls
- Loss of key personnel
- Internal audits not performed by qualified auditor

Onsite audits and assessments of Antech, Ltd. were conducted in February and May of 2002 (see References 15 and 16). Bechtel and CY representatives conducted the audits. The purpose of the assessments was to evaluate the continued support of analytical services to HNP as specified in the SOW between Bechtel, CY and Antech, Ltd.

The assessment scope for the February 2002 audit was to verify implementation of Antech's quality assurance program so that they could be placed on the Bechtel Evaluated Supplier List (ESL) for analytical laboratory analyses. The Antech QA program was determined to comply with the applicable requirements of ANSI/ASQC E4 and EPA QA/R-5 except as noted in 4 Corrective Action Reports (CAR), issued as a result of the audit. It was concluded that despite the 4 CARs, Antech, Ltd. was placed conditionally on the Bechtel ESL. Three of the four findings have been resolved to date, while the 4th finding is pending the status of the internal auditor to experience 5 audits.

In April 2002, a CY consultant performed a technical review of Antech Lab procedures (Reference 17). Several findings and observations were noted that were related to lack of specificity for calibration and QC measurements, lack of detail for corrective actions in gamma spectrometry, lack of inspection of liquid scintillation spectra, interference in Tc-99 procedure and use of unapproved, draft procedure for C-14. These items were reviewed in detail during a follow-up audit performed in May 2002.

The audit scope for the May 2002 audit was to evaluate the adequacy of the Antech lab programs and processes to perform Final Site Survey and Ground Water Monitoring sample analyses as specified in the lab SOW. The primary areas of focus were organization, order entry, programs and procedures, vendor controls, document controls, corrective actions, software controls, lab QA/QC controls, lab practices, reagent control, sample control, validation of non-standard methodologies, data validation and reporting criteria, vendor/client interface and communications. This evaluation consisted of Bechtel and CY representatives who performed document reviews, personnel interviews and direct observations of activities.

Two findings and seven observations were noted in the May assessment of Antech, Ltd. The findings related to deficiencies in vendor controls and software documentation and control. The finding related to vendor control involved the use of a sub-contractor lab to perform C-14 analysis. It was identified during routine project follow-up, that the vendor lab was performing C-14 analysis with an unapproved procedure that was not specific for carbon. For this reason, the C-14 results for the December 2001 sampling event have been flagged as unacceptable. Corrective-action responses to the assessment findings and observations have not been received to date. Immediately following this assessment, a decision was made to use the STL-Richland lab for primary lab services.

7.3.3.2 STL-Richland Audits/Assessments

A surveillance of the STL-Richland lab facility was performed on June 25 and 26, 2002. The audit scope was to evaluate the adequacy of STL-Richland lab programs and processes to perform Final Site Survey and Ground Water Monitoring sample analyses as specified in the lab SOW. The primary areas of focus were organization, order entry, programs and procedures, vendor controls, document controls, corrective actions, software controls, lab QA/QC controls, lab practices, reagent control, sample control, validation of non-standard methodologies, data validation and reporting criteria, vendor/client interface and communications. This evaluation consisted of Bechtel and CY representatives who performed document reviews, personnel interviews and direct observations of activities.

Seven observations were noted for process improvement in the June assessment and submitted to STL-Richland on July 22, 2002 (Reference 19). The observations related to documentation of quarterly QA trend analyses, method blank assessments, MDC-to-TPU ratios, interference monitoring in liquid scintillation analysis, alpha peak resolution criterion, alpha-tracer impurity and contamination control monitoring levels. The STL-Richland laboratory addressed 6 of the 7 observations in a response dated August 15, 2002 and is in the process of providing documentation to satisfy all 7 observations.

7.3.3.3 Sample Collection Surveillances

Connecticut Yankee Oversight Group performed surveillances during each of the quarterly sampling evolutions. The emphasis was on sample collection, work process implementation and control, staff training, equipment decontamination and paperwork processing. No major problems were identified, and all minor deviations that were noted have been corrected.

Overall, assessments of QA/QC information indicate that ground water monitoring data are generally acceptable for ground water characterization and monitoring efforts.

Ground water sampling was conducted in accordance with sample plans and work processes. No contamination or other sampling-related problems were encountered that affected data integrity in the field. Laboratory performance was good to excellent for all gamma emitters but mixed for the alpha and HTD analysis. Performance was good to excellent for alpha, HTD and gamma isotopic analyses based on the large percentages of acceptable laboratory results in duplicate analysis and DOEQAP performance evaluation studies. MAPEP performance results for alpha emitters were average and HTD and false positive testing results require improvement.

Attached in Table 15 is a summary of the percentage of positive results detected at concentrations that were greater than 2-σ TPU and near the MDC level. This table provides an indication of the percentage of false positive results as a function of analysis method. Only about 3.7 % of the gamma isotopic analysis results were greater than the 2-σ TPU level, which is just slightly higher than the expected rate of 2.5% if there were no significant gamma emitters present. One would expect a "false positive" rate of 2.5% based on the area under the standard normal distribution around a limiting mean concentration of zero, at the 95% confidence level. These results suggest that there is little bias in the gamma isotopic analytical results at levels near the MDC, and there is little gamma isotopic activity in these samples.

Alpha isotopic results submitted by STL Richland for the March and June 2002 sample events indicated positive activity rates that ranged from 1.1% to 1.9% which also indicates little or no significant alpha activity present in these samples and little bias in the analytical technique at levels near the MDC. In contrast, approximately 35% of the alpha isotopic results reported by the Antech lab where greater than 2-σ TPU. These results were not confirmed in subsequent sampling events and indicate a significant positive bias in alpha analytical results reported by Antech at concentrations near the MDC.

The percentage of HTD results that were found at levels greater than 2-σ TPU ranged from 18.7% to 25.8%. These results were normally distributed around a limiting mean concentration indicating a significant false positive bias in LSC analysis techniques at concentrations at or near the MDC.

All C-14 and Fe-55 results reported by the Antech Lab were determined to be unacceptable for groundwater monitoring purposes. The C-14 results were obtained using an unapproved procedure that was not specific for carbon. The Fe-55 results were invalid due to problems associated with the determination of the TPU uncertainty and the MDC. Finally, there were several compliance issues identified during the February and May audits that are pending a response from the Antech lab.

8 Overview Discussion and Comments

The EPA has promulgated Drinking Water Standards for a wide variety of constituents of concern. However, the CTDEP RSRs provide for an alternative method for the determination of criteria for contaminants in groundwater. The regulations are detailed within Section 22a-133k-3(a)(2) of the CTDEP RSRs. Because no public water supply distribution system exists within 200 feet of the CYAPCO property and adjacent properties, background concentrations are the default RSR groundwater criteria within the GA aquifer that exists beneath the Haddam Neck plant. Given this requirement within the CTDEP RSRs, background concentrations for all contaminants identified within the groundwater at the site must be determined. Likewise, pursuant to Section 22a-133k-3(h)(1) of the CTDEP RSRs, CYAPCO will submit for written approval from the Commissioner of the CTDEP, proposed groundwater protection criteria for all contaminants identified in groundwater at the site that do not currently have established CTDEP RSR criteria.

9 Conclusions and Recommendations

Based upon the work performed during the implementation and development of this Groundwater Monitoring Report for the December 2001, March 2002 and June 2002 quarterly sampling events, the following conclusions and recommendations have been developed:

- The overall shallow groundwater flow beneath the industrial/peninsula area in December 2001, March and June 2002 was in the general direction from the hillside to the south-southwest toward the Connecticut River, consistent with previous calculations.
- Local deflections in groundwater flow toward the containment mat drain sump prior to October 9, 2001 are no longer evident after pumping from the sump was terminated on that date.
- The overall shallow groundwater flow beneath the landfill area in December 2001, March and June 2002 was in the general direction of eastward, toward Salmon Cove.
- Little change in the horizontal groundwater flow gradients over the monitoring period suggests no significant change in the rate of horizontal groundwater flow across the study areas.
- In December 2001 the vertical gradient reversed in MW-102, MW-103 and MW-107 from down to up, compared to June. In March 2002 the vertical gradient reversed in MW-102 and MW-103 from up to down, compared to December 2001. In June 2002 the vertical gradient reversed in MW-103 from down to up, compared to March 2002. These reversals in vertical flow gradient may be due, in part, to discontinuation of pumping from the mat sump in October 2001, as well as seasonal variations in

groundwater recharge or interactions between unidentified local groundwater flow paths.

- Over time, the overall downward trend in boron concentrations remains consistent within the Industrial/Peninsula Area.
- Gross Alpha activity appears to be highest in deeper wells completed in bedrock. The source is likely to be naturally-occurring alpha-emitting nuclides Ra-226 and Rn-222 that are likely present in the local bedrock.
- Gross Beta activity appears to roughly correlate with the occurrence of Sr-90 (a beta emitter) in that Sr-90 is generally present in those samples where a relatively high concentration of gross beta is measured. Exceptions to this trend are in MW-110D and the EOF Supply Well, where other naturally-occurring beta emitters may also be present.
- Tritium was detected in about half of the wells sampled at concentrations ranging from less than the MDC to a maximum of 21,300 pCi/L in December 2001. A notable downward trend in H-3 concentrations has been observed across the site since March 1999. Tritium was not detected in any monitoring well at a concentration greater than the drinking water standard of 20,000 pCi/L in March or June 2002.
- Strontium-90 was detected in ten wells in the RCA and Industrial area during at least one of the three quarterly sampling events at concentrations ranging from 0.222 to 122 pCi/L. In June 2002 three wells contained concentrations greater than the MCL of 8 pCi/L. A positive bias is evident in the March quarterly data, but is not clearly evident in the December 2001 or June 2002 data. Where present, a positive bias in analytical results may lead to false positive detections at very low concentrations near the MDC.
- Strontium-90 was detected in the plant water supply distribution piping in the screen-well house in November 2001 at a concentration of 4.02 pCi/L. The nuclide was detected with relatively high uncertainty at that location during follow-up sampling in January 2002 at 0.222 pCi/L and was not detected in February 2002. The nuclide was also detected in January and February 2002 in Supply Well B at 1.02 and 0.584 pCi/L, respectively. The February detection was at a high relative uncertainty. Additional sampling is required from the screen-well house and Supply Well B to determine if these low-level detections of Sr-90 are false positives.
- Cesium-137 was detected in MW-103S at concentrations that ranged from 8.39 pCi/L in December 2001 to 30.2 and 58.5 pCi/L in March and June 2002, respectively. The nuclide was also detected in MW-115S in March and June at 3.18 and 1.59 pCi/L, respectively.
- Relatively high uncertainty values are associated with some of the HTD analytical results, including Ni-63, Fe-55, Sr-90, Tc-99 and Am-241. Uncertainties may be dependent upon count times, background interferences, groundwater geochemistry, laboratory analytical techniques, as well as other potential sources. The positive bias in analytical results identified by rank order plots for several nuclides (Appendix D)

may result in false positive detections at very low concentrations near the MDC. CYAPCO will continue to evaluate the detections identified within this report.

- Alpha-emitting nuclides Am-241 and Pu-238 were detected at several locations during the December 2001 quarterly sampling round (analyzed by Antech) but, with the exception of low levels of Am-241 in MW-103D in March and MW-106S in June, were not detected during the March or June 2002 rounds (analyzed by STL-Richland). These results, in addition to rank order plots of the data, suggests that the earlier detections were false positives. Plutonium-239/240 was detected one time (June) in MW-107D. The reported value was statistically insignificant at 2-σ, but greater than the MDC. A rank order plot of the June data suggests that the detection was a false positive.
- A significant false positive bias exists in the LSC analytical results at concentrations at or near the MDC. This bias potentially affects the low-level results for the following beta-emitting nuclides: C-14, Fe-55, Ni-63, Sr-90, Tc-99 and Pu-241. CYAPCO is in consultation with STL-Richland in an effort to resolve the issues that have resulted in the biased data and will strive to minimize any analytical biases during future sampling rounds.
- Field collected and laboratory completed QA/QC sample results were within acceptable protocol ranges. Laboratory performance was good to excellent for all gamma emitters but mixed for the alpha and beta HTD analysis. All C-14 and Fe-55 results reported by the Antech Lab were determined to be unacceptable for groundwater monitoring purposes.
- Based upon review of these analytical results, the groundwater beneath the industrial facility continues to be "polluted", as defined by Section 22a-423 of the Connecticut General Statutes, with additional analytes including Sr-90.
- Pursuant to Section 22a-133k-3(a)(2) of the CTDEP RSRs, because no public water supply distribution system exists within 200 feet of the CYAPCO property and adjacent properties, background concentrations are the default RSR groundwater criteria within the area where the groundwater quality is classified GA.
- Pursuant to Section 22a-133k-3(h)(1) of the CTDEP RSRs, CYAPCO will submit for written approval from the Commissioner of the CTDEP, proposed groundwater protection criteria for contaminants identified in groundwater at the site that do not currently have established CTDEP RSR criteria.

10 References

1. HNP License Termination Plan (LTP), current revision.
2. Ground Water Sample Collection Work Plan and Inspection Record (WP&IR # 24265-000-GEN-5000-00067-000) approved 12/06/2001.
3. Statement of Work for Bechtel Connecticut Yankee Project Environmental and Waste Characterization Analytical Services, Revision 0, February 2001.

4. EML-608, Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (QAP 52), June 2000.
5. EML-611, Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (QAP 53), December 2000.
6. EML-613, Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (QAP 54), June 2001.
7. EML-615, Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (QAP 55), December 2001.
8. EML-617, Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (QAP 56), June 2002.
9. MAPEP-00-S7, Mixed Analyte Performance Evaluation Program, December 2000
10. MAPEP-00-W8 Mixed Analyte Performance Evaluation Program, August 2001
11. MAPEP-00-S8, Mixed Analyte Performance Evaluation Program, November 2001
12. MAPEP-00-W9, Mixed Analyte Performance Evaluation Program, May 2002
13. Waltz Mill Quality Assurance Manual, Revision 2, December 2001.
14. STL-Richland Quality Assurance Manual, Revision 4, April 26, 2002.
15. Project Audit No. 24265-QSVA-02-001, issued March 11, 2002.
16. QSR-02-017-CY, Quality Surveillance Report Vendor Evaluation for Antech Ltd. Laboratory, June 2002.
17. SOV-02-054, Hard to Detect Radionuclide Analysis Assessments Performed by Dr. David McCurdy, April 30, 2002.
18. Bechtel Audit Report No 24265-QSSS-02-013, issued June 24, 2002.
19. Bechtel Audit Report No 24265-QSSS-02-014, issued July 22, 2002.

Table 1 – Summary Groundwater Measurements and Groundwater Elevations, Facility-wide

TABLE 1

Connecticut Yankee Atomic Power Company

Summary Depth-to-Water Measurements and Groundwater Elevations

		April 1999 Sampling Event			June 2001 Sampling Event				December 2001 Sampling Event				March 2002 Sampling Event				April 2002 Sampling Event				June 2002 Sampling Event				
Location	M P (TIC)	Groundwater Data DTW (TIC)	Groundwater Data Elevation (MSL)	Vertical Gradient (ft)	Groundwater Data DTW (TIC)	Groundwater Data Elevation (MSL)	Vertical Gradient (ft)	+/- change Elevation	Groundwater Data DTW (TIC)	Groundwater Data Elevation (MSL)	Vertical Gradient (ft)	+/- change Elevation	Groundwater Data DTW (TIC)	Groundwater Data Elevation (MSL)	Vertical Gradient (ft)	+/- change Elevation	Groundwater Data DTW (TIC)	Groundwater Data Elevation (MSL)	Vertical Gradient (ft)	+/- change Elevation	Groundwater Data DTW (TIC)	Groundwater Data Elevation (MSL)	Vertical Gradient (ft)	+/- change Elevation	Historical Change
Power Station (23 wells)																									
MW-100D	16.47	0.55	15.92	0.95	3.91	12.56	-0.20	-3.36	3.71	12.76	-0.66	0.20	5.62	10.85	-3.99	-1.91	2.35	14.12	-0.72	3.27	5.70	10.77	-0.52	-3.35	-1.79
MW-100S	16.45	1.48	14.97	up	3.69	12.76	down	-2.21	3.03	13.42	down	0.66	1.61	14.84	down	1.42	1.61	14.84	down	0.00	5.16	11.29	down	-3.55	-1.47
MW-101D	20.53	8.15	12.38	-3.11	11.89	8.64	-5.78	-3.74	15.10	5.43	-9.33	-3.21	10.44	10.09	-5.68	4.66	8.61	11.92	-3.81	1.83	10.39	10.14	-4.12	-1.78	1.50
MW-101S	20.54	5.05	15.49	down	6.12	14.42	down	-1.07	5.78	14.76	down	0.34	4.77	15.77	down	1.01	4.81	15.73	down	-0.04	6.28	14.26	down	-1.47	-0.16
MW-102D	20.06	9.30	10.76	-1.25	16.18	3.88	-4.95	-6.88	2.55	17.51	11.86	13.63	17.55	2.51	-8.56	-15.00	7.22	12.84	1.35	10.33	11.28	8.78	-1.29	-4.06	4.90
MW-102S	20.48	8.47	12.01	down	11.65	8.83	down	-3.18	14.83	5.65	up	-3.18	9.41	11.07	down	5.42	8.99	11.49	up	0.42	10.41	10.07	down	-1.42	1.24
MW-103D	20.95	10.50	10.45	-1.97	19.27	1.68	-6.98	-8.77	6.09	14.86	9.37	13.18	12.94	8.01	-2.15	-6.85	10.61	10.34	-1.65	2.33	9.65	11.30	1.09	0.96	9.62
MW-103S	20.85	8.43	12.42	down	12.19	8.66	down	-3.76	15.36	5.49	up	-3.17	10.69	10.16	down	4.67	8.86	11.99	down	1.83	10.64	10.21	up	-1.78	1.55
MW-104S	20.16	6.71	13.45	NA	9.41	10.75	NA	-2.70	11.93	8.23	NA	-2.52	6.98	13.18	NA	4.95	6.43	13.73	NA	0.55	9.36	10.80	NA	-2.93	0.05
MW-105D	20.58	8.57	12.01	2.47	12.06	8.52	0.66	-3.49	15.37	5.21	0.94	-3.31	11.03	9.55	2.19	4.34	9.03	11.55	2.07	2.00	10.45	10.13	0.57	-1.42	1.61
MW-105S	20.59	11.05	9.54	up	12.73	7.86	up	-1.68	16.32	4.27	up	-3.59	13.23	7.36	up	3.09	11.11	9.48	up	2.12	11.03	9.56	up	0.08	1.70
MW-106D	20.63	10.73	9.90	-0.31	13.65	6.98	-0.66	-2.92	16.34	4.29	-0.29	-2.69	12.92	7.71	-0.50	3.42	10.91	9.72	-0.71	2.01	11.82	8.81	-0.95	-0.91	1.83
MW-106S	20.51	10.30	10.21	down	12.87	7.64	down	-2.57	15.93	4.58	down	-3.06	12.30	8.21	down	3.63	10.08	10.43	down	2.22	10.75	9.76	down	-0.67	2.12
MW-107D	20.48	11.57	8.91	0.51	14.77	5.71	-0.39	-3.20	17.05	3.43	0.21	-2.28	14.29	6.19	0.62	2.76	12.43	8.05	0.88	1.86	13.59	6.89	0.01	-1.16	1.18
MW-107S	20.35	11.95	8.40	up	14.25	6.10	down	-2.30	17.13	3.22	up	-2.88	14.78	5.57	up	2.35	13.18	7.17	up	1.60	13.47	6.88	up	-0.29	0.78
MW-108S	12.23	5.92	6.31	NA	7.70	4.53	NA	-1.78	9.81	2.42	NA	-2.11	8.11	4.12	NA	1.70	7.08	5.15	NA	1.03	9.40	2.83	NA	-2.32	-1.70
MW-109D	20.50	15.04	5.46	0.77	16.68	3.82	1.34	-1.64	17.91	2.59	0.58	-1.23	16.69	3.81	0.82	1.22	16.25	4.25	1.29	0.44	16.89	3.61	1.47	-0.64	-0.21
MW-109S	20.57	15.88	4.69	up	18.09	2.48	up	-2.21	18.56	2.01	up	-0.47	17.58	2.99	up	0.98	17.61	2.96	up	-0.03	18.43	2.14	up	-0.82	-0.34
MW-110D	22.85	17.48	5.37	0.73	20.06	2.79	1.00	-2.58	20.95	1.90	0.52	-0.89	20.18	2.67	0.14	0.77	19.53	3.32	1.28	0.65	20.33	2.52	1.00	-0.80	-0.27
MW-110S	22.49	17.85	4.64	up	20.70	1.79	up	-2.85	21.11	1.38	up	-0.41	19.96	2.53	up	1.15	20.45	2.04	up	-0.49	20.97	1.52	up	-0.52	-0.27
MW-114S	20.73	9.50	11.23	NA	15.58	5.15	NA	-6.08	16.15	4.58	NA	-0.57	12.21	8.52	NA	3.94	9.81	10.92	NA	2.40	10.93	9.80	NA	-1.12	4.65
MW-115S	20.73	9.53	11.20	NA	12.65	8.08	NA	-3.12	16.34	4.39	NA	-3.69	12.47	8.26	NA	3.87	9.96	10.77	NA	2.51	11.04	9.69	NA	-1.08	1.61
AST-1	23.59	16.43	7.16	NA	17.00	6.59	NA	-0.57	18.53	5.06	NA	-1.53	17.45	6.14	NA	1.08	17.39	6.20	NA	0.06	NA	NA	NA	NA	-0.39
River Gauge on Boat Dock	8.00	4.90	3.10	NA	5.41	2.59	NA	-0.51	7.11	0.89	NA	-1.70	5.39	2.61	NA	1.72	5.37	2.63	NA	0.02	7.45	0.55	NA	-2.08	-2.04

Notes M P.: Measuring Point based on survey elevation, Malcolm Pirnie-9/99 Report
DTW Depth-to-water from M P.
TIC: Top of inner PVC well casing
MSL Mean sea level
+/- change in elevation difference from previous elevation
Vertical Gradient. apparent vertical component of groundwater flow (i e , up or down)
NA Not Applicable
Historical Change Overall change in groundwater elevation between the first and last sampling events

TABLE 1

Connecticut Yankee Atomic Power Company

Summary Depth-to-Water Measurements and Groundwater Elevations

Location	M P (TIC)	April 1999 Sampling Event Groundwater Data DTW (TIC)	April 1999 Elevation (MSL)	April 1999 Vertical Gradient (ft)	June 2001 Sampling Event Groundwater Data DTW (TIC)	June 2001 Elevation (MSL)	June 2001 Vertical Gradient (ft)	+/- change Elevation	December 2001 Sampling Event Groundwater Data DTW (TIC)	December 2001 Elevation (MSL)	December 2001 Vertical Gradient (ft)	+/- change Elevation	March 2002 Sampling Event Groundwater Data DTW (TIC)	March 2002 Elevation (MSL)	March 2002 Vertical Gradient (ft)	+/- change Elevation	April 2002 Sampling Event Groundwater Data DTW (TIC)	April 2002 Elevation (MSL)	April 2002 Vertical Gradient (ft)	+/- change Elevation	June 2002 Sampling Event Groundwater Data DTW (TIC)	June 2002 Elevation (MSL)	June 2002 Vertical Gradient (ft)	+/- change Elevation	Historical Change
Peninsula Area (6 wells)·																									
MW-111S	18.11	13 79	4 32	NA	17 20	0 91	NA	-3 41	16 73	1 38	NA	0 47	15 81	2 30	NA	0 92	16 38	1 73	NA	-0 57	16 43	1 68	NA	-0 05	0.77
MW-112S	14 33	10 10	4 23	NA	13 39	0 94	NA	-3 29	12 78	1.55	NA	0 61	13 28	1 05	NA	-0 50	12.16	2.17	NA	1.12	12 84	1 49	NA	-0 68	0 55
MW-113S	13 48	9.15	4 33	NA	12 30	1 18	NA	-3 15	11 80	1 68	NA	0 50	12 31	1.17	NA	-0 51	11.13	2 35	NA	1.18	11 71	1 77	NA	-0 58	0 59
MW-117S (1)	15 70	9 88	5 82	NA	11 00	4 70	NA	-1.12	13 56	2.14	NA	-2.53	10 96	4 74	NA	2 60	NA	NA	NA	NA	11.38	4 32	NA	NA	-0 38
MW-13 (1)	20 50	16 67	3 83	NA	18 64	1 86	NA	-1 97	18 85	1 65	NA	-0 21	17.45	3 05	NA	1 40	NA	NA	NA	NA	NA	NA	NA	NA	1 19
TW-1 (1)	18 00	14 30	3.70	NA	16 31	1 69	NA	-2.01	16 71	1 29	NA	-0 40	15.11	2 89	NA	1 60	NA	NA	NA	NA	NA	NA	NA	NA	1.20
EOF Area (1 well)·																									
EOF-2	24 12	9 40	14 72	NA	10.17	13 95	NA	-0 77	13 38	10 74	NA	-3 21	9 22	14 90	NA	4 16	NA	NA	NA	NA	10 56	13 56	NA	NA	-0 39
Landfill Area (8 wells)																									
MW-200	54 67	17 27	37 40	NA	15 83	38 84	NA	1 44	DRY	NA	NA	NA	DRY	NA	NA	NA	19 56	35 11	NA	NA	17.31	37 36	NA	2 25	-1 48
MW-201	58 78	30 41	28 37	NA	30 44	28 34	NA	-0 03	35 90	22 88	NA	-5 46	35 91	22 87	NA	-0 01	34 75	24 03	NA	1.16	31 81	26 97	NA	2 94	-1 37
MW-202	51 62	12 85	38 77	NA	13 48	38 14	NA	-0 63	18 25	33 37	NA	-4 77	16 69	34 93	NA	1 56	15 07	36 55	NA	1 62	14 13	37 49	NA	0 94	-0 65
MW-203	46 23	8 87	37 36	NA	8 82	37 41	NA	0 05	12.98	33 25	NA	-4 16	11 58	34 65	NA	1 40	10 29	35 94	NA	1 29	9 41	36 82	NA	0 88	-0 59
MW-204	41 85	5 70	36 15	NA	5 95	35 90	NA	-0 25	9 14	32 71	NA	-3 19	7 77	34 08	NA	1.37	7 10	34 75	NA	0 67	6 45	35 40	NA	0 65	-0 50
MW-205	40 55	7.77	32 78	NA	7 42	33 13	NA	0 35	10 16	30 39	NA	-2 74	10 09	30 46	NA	0 07	9 13	31.42	NA	0 96	7 50	33 05	NA	1 63	-0 08
MW-206	43 08	6 95	36 13	NA	7 74	35 34	NA	-0 79	10 26	32 82	NA	-2 52	8 96	34 12	NA	1 30	8 55	34 53	NA	0 41	8 25	34 83	NA	0 30	-0 51
MW-207	45 98	11 68	34 30	NA	11.18	34 80	NA	0 50	17 08	28 90	NA	-5 90	15 99	29 99	NA	1 09	14 03	31 95	NA	1 96	12 00	33 98	NA	2 03	-0 82

Notes: M P : Measuring Point based on survey elevation, Malcolm Pirnie-9/99 Report
DTW· Depth-to-water from M P
TIC Top of inner PVC well casing
MSL: Mean sea level
+/- change in elevation· difference from previous elevation
(1) : Malcolm Pirnie Report lists these elevations as approximate
Vertical Gradient. vertical component of groundwater flow (e g , up or down)
NA· Not Applicable
Historical Change· Overall change in groundwater elevation between the first and last sampling events

Table 2 – Summary Groundwater Analytical Results - Boron

Table 2
Connecticut Yankee Atomic Power Company

Summary Groundwater Analytical Results
Boron

June 2002

Well Number	March-99 Round 1	April-99 Round 2	September-99 Round 3	June-00 Round 4	June-01 Round 5	December-01 Round 6	March-02 Round 7	June-02 Round 8
100D	<50	30.8	No Data	10.8B	<200	<50	68	<250
100S	<50	22.8	No Data	NS	<200	<50	710	<250
101D	61.3	57.7	No Data	38.1B	25.4B	<50	<50	<250
101S	29.7	28.2	No Data	53.8B	34.4B	77	<50	<250
102D	270.4	114.7	No Data	87.5B	80.1B	290	96.4	<250
102S	43.9	29.7	No Data	63.4B	80.8B	220	64.3	<250
103D	253.3	165.2	No Data	63.6B	57.9	88	165	<250
103S	214.9	364.5	No Data	150	111B	260	55.4	<250
104S	<50	47	No Data	NS	54.2B	82	74	70.2
105D	144.2	65.2	No Data	51.7B	34.7B	64	<50	<250
105S	7,470	9,590	No Data	2,940	1,760	2,400	1340	<250
106D	76.8	69.2	No Data	52.2B	40.4B	<50	<50	<250
106S	2,074	1,307	No Data	NS	960	720	468	<250
107D	41.2	95.4	No Data	30.9B	18.4B	<50	<50	<250
107S	100	108 7	No Data	91.0B	169B	180	160	<250
108S	<50	62.8	No Data	NS	82.9B	120	100	<250
109D	523	577	No Data	401	157B	200	150	<250
109S	70	88.7	No Data	107	112B	170	54	<250
110D	337.7	316.5	No Data	234	289	320	250	<250
110S	172.6	547	No Data	131	90.7B	81	100	<250
111S	<50	61.8	No Data	60.9B	45.8B	<50	52	<250
112S	<50	65.1	No Data	NS	23.9B	61	<50	<50
113S	120	141.7	No Data	NS	136B	180	100	89.8
114S	422	290.2	No Data	265	240	NS	134	201
115S	76.3	145.6	No Data	94.2B	80.7B	NS	175	149
117S	50	62.2	No Data	NS	17.8B	57/84 (1)	75	59.7
AST-1	<50	36	No Data	36B	17.1B	<50	<50	NS
MAT SUMP	NS	NS	No Data	177	NS	NS	NS	128
EOF 2	<50	46.2	No Data	NS	46.2B	65	70	72.3
TW-1	<50	12.7	No Data	NS	<200	<50	<50	NS
MW-13	<50	14.7	No Data	NS	13.1B	<50	<50	NS
MW-200	NS	NS	No Data	NS	19.1B	NS	NS	<50
MW-201	NS	NS	No Data	NS	33.2B	NS	NS	<50
MW-202	NS	NS	No Data	NS	11.8B	<50	<50	NS
MW-203	NS	NS	No Data	NS	19.8B	<50	<50	<50
MW-204	NS	NS	No Data	NS	24.2B	<50	<50	NS
MW-205	NS	NS	No Data	NS	21.6B	<50	<50	<50
MW-206	NS	NS	No Data	NS	14.1B	<50	<50	NS
MW-207	NS	NS	No Data	NS	20.6B	60	55	<50
EOF Supply Well	NS	NS	NS	NS	NS	56	60	NS
Schmidt Well	NS	NS	NS	NS	NS	NS	<50	NS

Notes. All reported concentraions are in micrograms per liter (ug/L), or parts per billion
B - Indicates analyte result is between the instrument detection limit and the contract required detection limit of 200 ug/L.
NS - Not Sampled
(1) : 57 from 01/02 and 84 from 02/02 sampling events

Table 3 – Summary Groundwater Analytical Results - Tritium and Cs-137

Table 3
Connecticut Yankee Atomic Power Company

Summary Groundwater Analytical Results
Tritium and Cesium

June 2002

Well Number	March-99 Round 1	April-99 Round 2	September-99 Round 3	June-00 Round 4	June-01 Round 5	December-01 Round 6	March-02 Round 7	June-02 Round 8
Cesium, MW-103S	76	33	29	72	35	8.39	30.2	58.5
100D	<700	<1000	NS	<MDC	<270	<210	< 271	<260
100S	<700	<1000	NS	NS	<270	<200	< 273	<261
101D	<700	<1000	NS	NS	<260	<210	< 280	<276
101S	<700	<1000	NS	<MDC	<260	<210	< 284	<278
102D	2,740	3,160	2,640	2,470	2,620	4,110	9,400	6,390
102S	<700	<1000	NS	5,540	7,250	**20,600**	6,320	4,500
103D	**22,180**	17,550	19,660	**20,900**	**20,800**	8,100	12,900	13,400
103S	2,580	9,260	2,980	1,230	1,120	5,350	627	6,460
104S	<700	<1000	NS	NS	<270	186	< 273	<261
105D	4,590	2,450	3,030	2,150	1,360	2,110	1,780	1,510
105S	**138,700**	**67,400**	**23,480**	15,900	12,200	1,800	1,870	7,860
106D	3,320	1,590	5,830	1,810	1,450	14,200	1,730	1,630
106S	**24,290**	16,370	NS	NS	780	2,130	2,450	1,130
107D	<700	<1000	NS	<MDC	<270	<210	217	211
107S	<700	<1000	NS	<MDC	<270	219	254	274
108S	<700	<1000	NS	NS	<270	156	290	221
109D	**33,070**	**31,600**	**21,230**	15,800	6,550	5,720	3,810	5,660
109S	<700	<1000	NS	<MDC	<270	<240	< 265	<261
110D	**27,630**	**23,280**	**27,230**	18,300	18,700	**21,300**	16,500	10,700
110S	3,090	<1000	2,470	2,360	1,890	3,270	2,980	1,470
111S	<700	<1000	NS	<MDC	<270	<210	< 273	<259
112S	<700	<1000	NS	NS	<270	<240	< 277	<259
113S	<700	<1000	NS	NS	<270	<240	< 272	<263
114S	<700	1,180	2,850	2,760	1,940	NS	3,730	1,140
115S	<700	<1000	NS	5,550	4,500	NS	1,870	4,090
117S	<700	<1000	NS	NS	<180	<240	< 272	<261
AST-1	<700	<1000	NS	NS	<260	144	245	NS
Mat Sump	2,630	2,320	NS	2,890	NS	NS	NS	2,180
EOF 2	<700	<1000	NS	NS	<270	<200	< 270	<263
TW-1	<700	<1000	NS	NS	<270	<250	< 267	NS
MW-13	<700	<1000	NS	NS	<270	<240	< 267	NS
MW-200	<MDC	<MDC	NS	NS	<180	NS	NS	<261
MW-201	<MDC	<MDC	NS	NS	<180	NS	NS	<262
MW-202	<MDC	<MDC	NS	NS	<180	<210	< 266	NS
MW-203	<MDC	<MDC	NS	NS	<270	<250	< 267	<263
MW-204	<MDC	<MDC	NS	NS	<180	<210	< 266	NS
MW-205	<MDC	<MDC	NS	NS	<180	<210	< 264	<275
MW-206	<MDC	<MDC	NS	NS	<180	<210	< 261	NS
MW-207	<MDC	<MDC	NS	NS	<180	<250	< 259	<278
EOF Supply Well	NS	NS	NS	NS	NS	<210	< 265	NS
Schmidt Well	NS	NS	NS	NS	NS	NS	<267	NS

Notes: All values are concentrations of tritium unless noted otherwise.
All reported concentrations are in picocuries per liter (pCi/L)
<1000: represents less than the MDC value. **Bold** values are above EPA DWS of 20,000 pCi/L.
Shaded values are statistically significant at the 95% confidence level, but are less than the Minimum Detectable Concentration. NS indicates well not sampled.

Table 4 – Summary Groundwater Analytical Results – Gross Alpha, Gross Beta, Sr-90 and Cs-137

Table 4
Connecticut Yankee Atomic Power Company

Summary Groundwater Analytical Results
Gross Alpha, Gross Beta, Strontium-90 and Cesium-137

June 2002

Well No.	Sample Date	Gross Alpha	Gross Beta	Strontium-90	Cesium-137
MW-102D	Dec ' 01	13.4	9.5	**0.606**	<12
	March ' 02	9.74	7.42	<0.664	<2.41
	June ' 02	5.53	6.97	<0.721	1.98
MW-102S	Dec ' 01	2.12	7.99	<0.23	<10
	March ' 02	1.05	6.15	<0.716	<3.05
	June ' 02	1.48	4.52	<0.716	<3.01
MW-103D	June ' 01	NA	NA	<0.69	<11
	Dec ' 01	8.48	12.9	<0.24	<11
	March ' 02	3.07	3.38	<0.603	<2.78
	June ' 02	6.87	7.39	<0.691	<2.19
MW-103S	June ' 01	NA	NA	**2.55 J**	**35**
	Dec ' 01	3.43	20.8	**1.82**	8.39
	March ' 02	1.85	37.6	**5.23**	**30.2**
	June ' 02	1.64	81.5	**15.3**	**58.5**
MW-105D	Dec ' 01	<1.7	5.45	<0.28	<10
	March ' 02	1.47	4.72	<0.571	<2.67
	June ' 02	1.39	<2.72	<0.597	<2.26
MW-105S	June ' 01	NA	NA	**143**	<12
	Dec ' 01	<1.8	226	**69.7**	<9.8
	March ' 02	1.11	242	**122**	<2.48
	June ' 02	<1.34	238	**116**	<2.55
MW-106D	Dec ' 01	<1.7	6.25	<0.35	<10
	March ' 02	1.03	5.89	<0.597	<3.18
	June ' 02	1.13	6.01	<0.527	1.92
MW-106S	June ' 01	NA	NA	**6.6**	<13
	Dec ' 01	<1.9	25.4	**4.67**	<15
	March ' 02	1.36	25.4	**8.38**	<2.05
	June ' 02	<1.24	34	**13**	<2.28
MW-107D	Dec ' 01	NA	21.5	<1.3	<11
	March ' 02	1.98	5.38	<0.628	<3.11
	June ' 02	1.3	3.87	<0.600	<2.65
MW-107S	Dec ' 01	NA	NA	<0.36	<12
	March ' 02	NA	NA	NA	<4.37
	June ' 02	<0.944	4.61	0.260	<2.42
MW-109D	June ' 01	NA	NA	<0.82	<14
	Dec ' 01	4.3	6.92	<0.36	<13.
	March ' 02	3.7	7.47	<0.666	<2.6
	June ' 02	4.62	5.54	<0.495	<2.52
MW-109S	Dec ' 01	<2	5.76	**0.825**	<15
	March ' 02	<1.54	6.33	**0.903**	<2.88
	June ' 02	<1.23	8.49	**0.656**	<2.76
MW-110D	June ' 01	NA	NA	<0.81	<12
	Dec ' 01	NA	14	**1.62**	<9.6
	March ' 02	11	12.6	<0.562	<2.84
	June ' 02	7.78	9.14	<0.52	<2.48

Table 4
Connecticut Yankee Atomic Power Company

Summary Groundwater Analytical Results
Gross Alpha, Gross Beta, Strontium-90 and Cesium-137

June 2002

Well No.	Sample Date	Gross Alpha	Gross Beta	Strontium-90	Cesium-137
MW-110S	Dec ' 01	<0.94	2.79	<0.39	<9
	March ' 02	<0.965	4.07	0.339	<3.05
	June ' 02	<0.952	6.51	<0.545	<2.57
MW-111S	June ' 01	NA	NA	<0.68	<12
	Dec ' 01	<0.56	4.23	<0.37	<13
	March ' 02	1	5.31	<0.629	<2.42
	June ' 02	<0.696	<2.86	<0.722	<2.8
MW-114S	Dec ' 01	NA	NA	NA	<16
	March ' 02	0.684	20.7	**3.63**	<3.4
	June ' 02	<1.09	17.3	**3.26**	<2.65
MW-115S	June ' 01	NA	NA	NA	7.3
	Dec ' 01	NS	NS	NS	NS
	March ' 02	6.38	23	**3.85**	**3.18**
	June ' 02	<0.827	5.95	0.524	1.59
EOF-2	Dec ' 01	NA	NA	0.222	NA
	March ' 02	1.03	3.43	<0.539	NA
	June ' 02	NA	NA	NA	NA
MW-203	Dec ' 01	<0.45	2.19	<0.71	<15
	March ' 02	0.577	1.59	<0.48	<2.42
	June ' 02	NA	NA	NA	<2.77
MW-207	June ' 01	NA	NA	<1.3	<8.9
	Dec ' 01	<0.81	2.77	<0.86	<14
	March ' 02	0.598	3.63	<0.565	<3.09
	June ' 02	NA	NA	NA	<2.83
EOF Supply	Dec ' 01	16	7.8	<0.31	<15
	March ' 02	17.2	13.9	<0.495	<2.67
	June ' 02	NA	NA	NA	NS

Notes:
All concentrations are in picocuries per liter.
<0.45 indicates a value less than the MDC.
NA: Not analyzed; NS: Not sampled
Bold values indicate the nuclide was detected at a concentration greater than the MDC.
Shaded values are statistically significant at the 95% confidence level, but less than the MDC.
J: Estimated value. The reported concentration is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit.

Table 5 – Summary Groundwater Analytical Results, Quarterly Sampling Events, Plant-Related Hard To Detect Radionuclides

Table 5

Connecticut Yankee Atomic Power Company

Summary Groundwater Analytical Results, Quarterly Sampling Events
Plant-Related Hard-to-Detect Radionuclides

June 2002

	Monitoring Well	Sample Event	Carbon-14	Iron-55	Nickel-63	Strontium-89	Strontium-90	Technetium-99	Americium 241	Plutonium-241	Plutonium-238	Plutonium-239/240	Curium 243/244
Radiological Controlled Area (RCA)	MW-102D	Dec ' 01	**	**	<11.0	<0.63	**0.606**	<10 0	<0 065	**12.1**	<0.14	<0.30	<0.12
		March ' 02	<8.06	<6.71	<3 51	NA	<0 664	<10 4	<0 213	<10.7	<0.182	<0.271	<0 215
		June ' 02	<7.85	<8.32	<2.84	NA	<0.721	<11.3	<0.203	<7.74	<0.140	<0.139	<0.187
	MW-102S	Dec ' 01	**	**	<9.4	<0.50	<0.23	<10.0	0.094	**14.4**	**0.307**	<0.24	0.135
		March ' 02	<8.07	2.54	<3.88	NA	<0.716	<10.5	<0.133	<11 3	<0.283	<0.19	<0.293
		June ' 02	7.32	14.2	<2.89	NA	<0.716	9.75	<0.095	<9.30	<0.178	<0.208	<0.096
	MW-103D	June ' 01	NA	<49.7	<16 6	<0.90	<0 69	3.9J	<0.22	<14.8	<0.16	<0.29	<0.16
		Dec ' 01	**	**	<11.0	<0.46	<0.24	<10 0	**0.116**	<15 0	**0.308**	<0.18	<0 07
		March ' 02	<8.06	6.27	<3.74	NA	<0.603	<10 4	**0.694**	9.03	<0.199	<0.199	<0.159
		June ' 02	<7.85	2.86	<2.78	NA	<0.691	<11.4	<0.239	<7.78	<0.098	<0.098	<0.240
	MW-103S	June ' 01	NA	<49.2	<14.7	<0.81	**2.55J**	<3 8	<0.33	<11.6	<0.13	<0.13	<0.16
		Dec ' 01	**	**	6.95	<0 97	**1.82**	<12.0	<0.100	<12.0	**0.236**	<0.14	<0 056
		March ' 02	<8.07	3.50	**3.71**	NA	**5.23**	<10.4	<0 149	<7.11	<0.180	<0.121	<0.359
		June ' 02	5.46	4.96	**3.38**	NA	**15.3**	<11.2	<0.092	<7.23	<0.188	<0.221	<0.156
	MW-105D	Dec ' 01	**	**	<8.3	<0.50	<0 28	<12.0	<0.065	**16.9**	<0 25	<0.14	<0.065
		March ' 02	<8.07	<6.19	<3 48	NA	<0.571	**11.6**	<0.270	<8.84	<0.221	<0.250	<0.242
		June ' 02	<7.85	5.10	<3 00	NA	<0.597	<11.3	<0.247	<5.85	<0.179	<0.101	<0.119

Table 5
Connecticut Yankee Atomic Power Company

Summary Groundwater Analytical Results, Quarterly Sampling Events
Plant-Related Hard-to-Detect Radionuclides

June 2002

	Monitoring Well	Sample Event	Carbon-14	Iron-55	Nickel-63	Strontium-89	Strontium-90	Technetium-99	Americium 241	Plutonium-241	Plutonium-238	Plutonium-239/240	Curium 243/244
RCA	MW-105S	June ' 01	NA	<53 5	<16.8	<1.0	**143**	<4.2	<0 22	<12.5	<0.13	<0.19	<0.22
		Dec ' 01	**	**	<11 0	<4.90	**69.7**	<14.0	<0.073	<11.0	<0.43	<0.25	<0.073
		March ' 02	<8.07	4.40	2.95	NA	**122**	8.89	<0.159	<6 94	<0.118	<0.118	<0.161
		June ' 02	7.02	11.20	2.48	NA	**116**	8.57	<0.120	<5 74	<0.201	<0.170	<0.121
	MW-106D	Dec ' 01	**	**	<9.1	<0.55	<0.35	<10.0	<0.27	7.37	<0.37	<0 24	<0.23
		March ' 02	<8.08	<6.68	<3.60	NA	<0.597	<10.4	<0.177	5.52	<0.133	<0.197	<0.178
		June ' 02	<7.85	6.94	**4.22**	NA	<0.527	<11.3	<0.220	<9.27	<0.108	<0.108	<0.221
	MW-106S	June ' 01	NA	<49.8	<15.2	<1.8	**6.6**	<4.1	<0 31	<11.9	<0.13	<0.19	<0.19
		Dec ' 01	**	**	<8.2	<1.40	**4.67**	<14.0	<0.16	<12.0	<0.15	<0.15	<0.19
		March ' 02	<8.07	5.24	<3.76	NA	**8.38**	<10.5	<0.172	5.27	<0.137	<0.203	<0.174
		June ' 02	6.03	<6.67	2.09	NA	**13.0**	<11.2	**0.436**	**8.34**	<0.196	<0.111	<0 219
	MW-114S	June ' 01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		Dec ' 01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		March ' 02	<8.07	4.84	<3.61	NA	**3.63**	7.14	<0.247	5.81	<0.187	<0.125	<0.168
		June ' 02	<7.84	2.17	<2.61	NA	**3.26**	<11.2	<0.119	<7.52	<0.110	<0.109	<0.120
	MW-115S	June ' 01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		Dec ' 01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		March ' 02	<8.07	7.19	<3.89	NA	**3.85**	<10.6	<0.183	<9.5	<0.165	<0.245	<0.274
		June ' 02	<7.85	<8.14	<2.41	NA	0.524	<11.3	<0.131	<6.80	<0.112	<0.111	<0.131

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Summary Groundwater Analytical Results, Quarterly Sampling Events
Plant-Related Hard-to-Detect Radionuclides

June 2002

	Monitoring Well	Sample Event	Carbon-14	Iron-55	Nickel-63	Strontium-89	Strontium-90	Technetium-99	Americium 241	Plutonium-241	Plutonium-238	Plutonium-239/240	Curium 243/244
Industrial Area	MW-107D	Dec '01	NA	NA	NA	NA	<1.3	<5 0	<0.19	<6.9	**0.319**	<0.083	NA
		March '02	<8.23	**19.7**	<4 29	NA	<0.628	<11.2	<0.124	4.36	<0.196	<0.11	<0.223
		June '02	<7.84	8.13	<3.11	NA	<0.600	8.25	<0 204	<7.18	<0.091	0.134	<0.188
	MW-107S	Dec '01	NA	NA	NA	NA	<0.36	NA	NA	NA	NA	NA	NA
		March '02	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		June '02	<7.85	8.73	<3.00	NA	0.260	<11.2	<0 095	<9.13	<0.159	<0.159	<0.096
	MW-109D	June '01	NA	<51.4	<15.0	<1.4	<0 82	<4.8	<0.32	<13 2	<0.21	<0.14	<0.26
		Dec '01	**	**	<6.6	<0 96	<0.36	<10.0	<0.36	<14 0	**0.432**	<0.14	<0 21
		March '02	<8 24	4.68	3.13	NA	<0.666	<11.4	<0 275	**6.27**	<0.109	<0.109	<0.158
		June '02	<7.85	3.89	1.98	NA	<0.495	<11.1	<0.211	<7.79	<0.152	<0.152	<0 212
	MW-109S	Dec '01	**	**	**17.0**	<0.86	**0.825**	<12 0	**0.250**	<13.0	**0.572**	<0.12	<0.24
		March '02	4.7	**9.9**	<3 94	NA	**0.903**	<11.4	<0.159	4.45	<0.108	<0.108	<0.161
		June '02	<7.85	5.35	<3 07	NA	**0.656**	<11.4	<0.100	<9.91	<0.182	<0.242	<0.170
	MW-110D	June '01	NA	<50.8	<17.1	<1.2	<0.81	<4.1	<0 31	<16.9	<0.17	<0.26	<0.15
		Dec '01	**	**	<6.6	<1.6	**1.62**	<11.0	**0.084**	<12 0	**0.805**	<0 056	<0.44
		March '02	<8.24	5.06	<3.99	NA	<0.562	10.5	<0.183	3.78	<0 21	<0.118	<0.164
		June '02	<7.85	5.76	<3.12	NA	<0.520	<11.1	<0.231	<7.82	<0.151	<0.151	<0.111
	MW-110S	Dec '01	**	**	4.71	<0.60	<0.39	<11.0	0.132	<13.0	**0.574**	<0.13	0.132
		March '02	<11	4.05	3.10	NA	0.339	8.44	<0.169	**6.91**	<0.12	<0.119	<0.171
		June '02	4.19	10.60	<3.07	NA	<0.545	7.58	<0.122	<7.57	<0.196	<0 231	<0.123

Table 5
Connecticut Yankee Atomic Power Company

Summary Groundwater Analytical Results, Quarterly Sampling Events
Plant-Related Hard-to-Detect Radionuclides

June 2002

Area	Monitoring Well	Sample Event	Carbon-14	Iron-55	Nickel-63	Strontium-89	Strontium-90	Technetium-99	Americium 241	Plutonium-241	Plutonium-238	Plutonium-239/240	Curium 243/244
Landfill Area	MW-201	June ' 01	NA	<53.6	<17.8	<1.0	<0.63	<3 8	<0.30	<9.22	<0.30	<0.073	<0.15
		Dec ' 01	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		March ' 02	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
		June ' 02	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	MW-203	Dec ' 01	**	**	**7.43**	<1.0	<0.71	7.91	**0.199**	<11	**0.136**	<0.055	<0.13
		March ' 02	<8.24	<5.97	<4.22	NA	<0.48	**13.9**	<0.254	3.50	<0.187	<0.105	<0.145
		June ' 02	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
	MW-207	June ' 01	NA	<50 5	<18 2	<2.1	<1.3	<4.6	<0 21	<9 68	<0.19	<0.28	<0.14
		Dec ' 01	**	**	5.13	<0.87	<0 86	<11.0	<0.30	<12.0	**0.379**	<0.071	<0 2
		March ' 02	<8.23	4.04	<4 02	NA	<0 565	<11.4	<0.15	5.14	<0.105	<0.105	<0.151
		June ' 02	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Peninsula Area	MW-111S	June ' 01	NA	<50.9	<15 8	<1.0	<0.68	<3.9	<0.26	<13.4	<0.15	<0.22	<0.19
		Dec ' 01	**	**	4.83	<0.91	<0.37	<12.0	<0 19	<12.0	**0.698**	<0 055	<0.19
		March ' 02	<8.24	5.61	<4.15	NA	<0 629	<11.3	<0.169	6.14	<0.198	<0.112	<0.303
		June ' 02	<7.85	4.48	**4.14**	NA	<0.722	<11.3	<0.178	<8.24	<0 088	<0.088	<0.179

Table 5

Connecticut Yankee Atomic Power Company

Summary Groundwater Analytical Results, Quarterly Sampling Events
Plant-Related Hard-to-Detect Radionuclides

June 2002

Monitoring Well	Sample Event	Carbon-14	Iron-55	Nickel-63	Strontium-89	Strontium-90	Technetium-99	Americium 241	Plutonium-241	Plutonium-238	Plutonium-239/240	Curium 243/244
EOF Area												
EOF Supply Well	Jan ' 02	**	**	<5.9	<1.4	<0.31	<10.0	**0.232**	<12.0	**0.298**	<0.12	<0.058
	Feb ' 02	NA	NA	NA	NA	<0.31	NA	<0.071	NA	<0.016	<0.028	<0.026
	March ' 02	<8.23	**9.36**	<3.9	NA	<0.495	9.00	**0.297**	<5.85	<0.105	<0.105	<0.163
	June ' 02	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Notes: All concentrations are in picocuries per liter (pCi/L).

<0.22 represents a value less than the Minimum Detectable Concentration (MDC).

Bold values indicate that the nuclide was detected at a concentration greater than the MDC.

Lightly Shaded values are statistically significant at the 95% confidence level, but less than the MDC.

Darkly Shaded values are statistically insignificant at the 95% confidence level, but greater than the MDC.

**: Invalidated data - refer to discussion of laboratory audit.

NS: Not sampled; NA: Not Analyzed

J: Estimated value. The reported concentration is greater than the Instrument Detection Limit but less than the Contract Required Detection Limit.

Table 6 – Summary Groundwater Analytical Results, Additional Locations, Plant-Related Hard To Detect Radionuclides and Tritium

Table 6
Connecticut Yankee Atomic Power Company

Summary Groundwater Analytical Results, Additional Locations
Plant-Related Hard-to-Detect Radionuclides and Tritium

February 2002

Sample Locations	Sample Event	Tritium	Carbon-14	Iron-55	Nickel-63	Strontium-89	Strontium-90	Technetium-99	Plutonium-238	Plutonium-239/240	Plutonium-241	Americium 241	Curium 243/244
Screen-Well House	Nov ' 01	NA	NA	NA	NA	NA	**4.23**	NA	NA	NA	NA	NA	NA
	Jan ' 02	NA	NA	NA	NA	NA	0.222	NA	NA	NA	NA	NA	NA
	Feb ' 02	NA	NA	NA	NA	NA	<0.34	NA	NA	NA	NA	NA	NA
Supply Well B	Jan ' 02	NA	NA	NA	NA	NA	**1.02**	NA	NA	NA	NA	NA	NA
	Feb ' 02	NA	NA	NA	NA	NA	0.584	NA	NA	NA	NA	NA	NA
MW-117S	Feb ' 02	<200	**	NA	NA	<0.63	**0.404**	<13.0	<11.0	<0.31	10.2	<0.66	<0.56
MW-4	Feb ' 02	<200	**	NA	NA	<0.63	0.29	<13.0	0.142	<0.20	<12.0	<0.13	<0.21
TW-4	Feb ' 02	<200	**	NA	NA	<0.74	<0.41	**12.9**	<0.50	<0.50	<13.0	0.191	<0.08
MW-1	Feb ' 02	<200	**	NA	NA	<0.75	<0.35	<9.8	<0.32	<0.32	<15.0	<0.075	<0.075
MW-2	Feb ' 02	**601**	**	NA	NA	<0.50	**0.572**	<13.0	**0.615**	<0.23	**31.0**	**0.063**	<0.047
TW-3	Feb ' 02	<200	**	NA	NA	<0.56	<0.36	<14.0	<0.19	<0.19	9.74	<0.060	<0.060

Table 6
Connecticut Yankee Atomic Power Company

Summary Groundwater Analytical Results, Additional Locations
Plant-Related Hard-to-Detect Radionuclides and Tritium

February 2002

Notes: **Bold values indicate the nuclide was detected at a concentration greater than the MDC.**
Shaded values are statistically significant at the 95% confidence level, but less than the MDC.
**: Invalidated data - refer to discussion of laboratory audit.
All concentrations are in picocuries per liter (pCi/L).
<0.22 indicates less than the MDC value.
NA: Not analyzed