Connecticut Yankee Atomic Power Company

Haddam Neck Plant
362 Injun Hollow Road
East Hampton, CT 06424-3099

Semi-Annual Groundwater Monitoring Report
March and June 2004
Quarterly Sampling Events

Prepared by
Connecticut Yankee Atomic Power Company

October 5, 2004

Connecticut Yankee Atomic Power Company

Haddam Neck Plant
362 Injun Hollow Road
East Hampton, CT 06424-3099

Semi-Annual Groundwater Monitoring Report
March and June 2004
Quarterly Sampling Events

Prepared by
Connecticut Yankee Atomic Power Company

October 5, 2004

Table of Contents

Table of Contents

List of Tables

List of Figures

Number.....Page

List of Figures

List of Figures

List of Figures

List of Appendices

1 Introduction

1.1 Groundwater Monitoring Program Overview

This report presents a compilation of the groundwater analytical results and related field measurements associated with two groundwater-sampling events conducted during March and June 2004 at the Connecticut Yankee Atomic Power Company (CYAPCo) Haddam Neck Plant (HNP) located in Haddam Neck, Connecticut (CT). These groundwater-sampling events were performed in compliance with the quarterly groundwater monitoring program Quality Assurance Project Plan (GMP QAPP 2004) and to provide characterization data input to the CY License Termination Plan (LTP 2002).

The objective of this monitoring report is to provide a summary and evaluation of the groundwater analytical results and groundwater elevation data to develop an understanding of plume status concerning substances of concern (SOCs) at the HNP. A focused list of individual radioactive and non-radioactive constituents has been identified as SOCs contributing most of the groundwater contamination at the site. The radiological SOCs at HNP have been identified as tritium, Cs-137, Co-60, and Sr-90, all predictable byproducts of the nuclear fission reaction that was the heat source for this nuclear power generating plant. Boron, the only non-radioactive SOC identified at the facility, was used as a neutron absorber in the primary cooling water, and when detected in environmental samples at HNP is used as an indication of plant-related contamination and also as an effective tracer of potentially-contaminated groundwater. In order to assess general site groundwater geochemistry and potential contaminant migration mechanism(s), supplemental analyses were collected during the June 2004 event. An integral component of this data summary and evaluation is a discussion of quality-related activities performed to support validation of data collected during these two sampling events.

The primary scope of the Groundwater Monitoring Program (GWMP) is to assess groundwater conditions in the industrial area, the site of former plant operations and probable source areas, and the upper peninsula area, which is adjacent to the industrial area, by conducting quarterly sampling events. These two areas comprise the area where SOCs have been historically been detected and where migration pathways are likely, resulting in the greater number of wells in the monitoring network. One well in both the Emergency Operations Facility (EOF) and the lower peninsula area are sampled and analyzed to provide control for monitoring groundwater conditions at the boundaries of the plant property. An overview of the HNP property and the various area designations is provided in Figure 1-1.

1.2 Groundwater Monitoring Program Plans and Procedures

The March and June 2004 quarterly GWMP sampling and analysis was conducted following specific guidance under applicable CY procedures. The framework for the GWMP is outlined as an internal CY HNP procedure that describes the methodology for implementing the required quarterly groundwater sampling and analysis (RPM 5.3-0). The GWMP Work Plan and Inspection Record (WP&IR) states specific permits, tags, and the required approval signatures needed to complete each quarterly sampling event. The Groundwater Sampling Event Planning and Data Management procedure (RPM 5.3-3) documents what should be in a Groundwater Sampling Event Plan, including data quality objectives (DQOs), sample records, analysis parameters, and equipment. The methodology for representative sample collection and field measurements, including groundwater levels, are described in the Groundwater Level Measurement and Sample Collection in Monitoring Wells procedure (RPM 5.3-1) as attached in Appendix A.

Additional sampling event-specific plans were developed for the both the March and June 2004 sampling events. A Groundwater Sampling Event Plan was developed following guidelines set forth in the Groundwater Sampling Event Planning and Data Management procedure. All sampling and analysis was performed in accordance with the requirements of the GMP QAPP (Reference GMP QAPP 2004).

2 Groundwater Flow and Direction

2.1 Background

Groundwater elevation measurements are collected from each monitoring well sampled during the quarterly groundwater sampling events to provide a synoptic picture of hydrogeologic conditions at the facility. These groundwater elevation data are collected to develop an understanding of groundwater flow and direction, which are essential to assessment of plume status for the primary SOCs at HNP. The groundwater elevations were measured in accordance with the Groundwater Level Measurement and Sample Collection in Monitoring Wells procedure (RPM 5.3-1).

The groundwater and surface monitoring well network at HNP is shown by specific area in Figures 2-1 through 2-3. The EOF and parking lot area monitoring locations are shown in Figure 2-1, industrial area and upper peninsula area locations in Figure 2-2, and other peninsula area locations in Figure 2-3.

The characterization of hydrogeologic conditions at HNP is ongoing, with many factors that must be considered and evaluated before an accurate depiction of groundwater flow and direction can be developed. Site conditions such as definition and interconnection of hydrostratigraphic units, horizontal and vertical flow components, fractured flow elements, recharge/discharge zones, the impact of tidal influences, precipitation, and barometric pressure changes will be incorporated into the evaluation of hydraulic data. In addition, the mat sump hydraulic control operations and subsurface barriers to groundwater flow complicate the hydrogeologic conditions, and potentially the contaminant transport, in the industrial area. Another critical aspect concerning evaluation of groundwater flow and direction at HNP is providing an accurate datum to determine exact groundwater elevations during groundwater level gauging events.

As part of the plant characterization effort, measures have been recently implemented to ensure valid, consistent data are collected to provide adequate quality control for the evaluation of hydraulic data and development of the hydrogeologic conceptual site model (CSM) at the facility. A civil survey to establish horizontal and vertical position of a portion of the monitoring wells at HNP was performed by Kratzert and Jones of Middletown during November and December 2003 to address inconsistent well records, primarily in the industrial area. In addition to providing horizontal control for the wells surveyed, an accurate vertical datum was established for the wells surveyed to the nearest 0.01-foot, enabling adequate quality control to determine accurate groundwater elevations.

A network of pressure transducers was installed in selected groundwater monitoring wells and 2 surface water monitoring locations to collect continuous water levels and

temperatures throughout HNP for an extended period of time. The pressure transducers network was installed between January 14 and January 27 2004, and the pressure transducer have been collecting elevation data since January 27, 2004. The groundwater elevation data collected from this network will enable evaluation of hydrogeologic conditions and refinement of the CSM.

The current hydrogeologic CSM at the HNP has identified three primary hydrostratigraphic units as part of the Phase I hydrogeologic characterization effort. The current hydrostratigraphic unit designation is defined as follows: 1) the unconsolidated deposits, 2) the shallow bedrock, and 3) the deep bedrock. The unconsolidated deposits hydrostratigraphic unit is composed of the shallow, non-lithified clastic materials at the facility, including both sedimentary deposits and man-made fill. The shallow bedrock hydrostratigraphic unit is defined as the upper ten (10) feet of the bedrock interval, immediately underlying the unconsolidated unit. Based on preliminary evaluation of hydrogeologic data, wells screened either across the unconsolidated deposits/bedrock interface or within the upper 10 feet of the bedrock display a hydraulic response similar to the unconsolidated deposits, rather than wells screened 10 feet or deeper within the bedrock interval, which is the current definition of the deep bedrock hydrostratigraphic unit. Current understanding of the shallow bedrock hydrostratigraphic unit component of the hydrogeologic CSM suggests that it may contain partially weathered rock and, therefore, may be more intensely fractured than the deeper bedrock interval, possibly exhibiting a hydraulic response more characteristic of porous media than fractured media.

Table 2-1 provides well specifications for the groundwater-monitoring network. The information includes revised horizontal coordinates and the vertical elevation of the measuring points for water level gauging for each well, screen intervals, and the hydrostratigraphic unit monitored in each well.

Considering the complicated site conditions previously mentioned at HNP and the preliminary status of the hydrogeologic characterization effort, the evaluation of groundwater flow velocity and direction at the industrial area and upper peninsula area has not been finalized. Once the groundwater elevations are divided into the three hydrostratigraphic units, there are sparse data available for each unit, particularly for the deep bedrock. The presence of subsurface barriers to flow and foundation dewatering operations also complicate evaluation efforts.

The data from the recently installed pressure transducer network has been used to generate potentiometric maps for each of the three hydrostratigraphic units which provide a framework to evaluate groundwater flow and direction at the facility. The relationship between groundwater flow and direction at the industrial and upper peninsula areas, and the distribution of SOCs is discussed in Section 6 of this report.

2.2 March 2004 Groundwater Elevation Data

A system of 33 data-logging pressure transducers was installed in monitoring wells at HNP and in the Connecticut River adjacent to the plant in January 2004. This system

was designed to provide a regular automated record of changes in water level elevation across the industrial portion of the site. The long-term water elevation data form the basis for meeting the following data needs:

- Quantify the horizontal hydraulic gradient across the site.
- Identify the apparent groundwater flow direction across the site.
- Quantify the apparent vertical pressure differences between the identified aquifer units across the site.
- Identify aquifer response to recharge events (e.g., rainfall events) and groundwater extraction events (e.g., mat sump operation).
- Provide monitoring data for aquifer tests conducted as part of site characterization (e.g., aquifer pumping tests).
- Quantify aquifer response to tidal fluctuations and general river stage variations in the Connecticut River.

As a secondary data point, the pressure transducers also log water temperature at the same frequency as the water level.

The transducer system was installed starting in the last week of January 2004. The data loggers were initially set up to record measurements on one-minute intervals and were subsequently re-programmed to record measurements on five-minute intervals in May 2004. The transducers are routinely downloaded on a quarterly basis with more frequent downloads if data are required for specific needs. Significant events related to the water level monitoring system are shown in Table 2-2.

The transducer system includes two data-logging barometric pressure transducers. These units are maintained at atmospheric conditions because the submersible transducers deployed in the monitoring wells are not barometric pressure-compensated. The electronic data are downloaded from the monitoring well data loggers and the barometric pressure transducers using a portable computer. The data from the submerged transducers are then corrected for barometric pressure fluctuations using the data from the barometric pressure transducer(s) and proprietary software from the transducer manufacturer that calculates the corrected pressure indicated by the submerged transducers. The resulting pressure measurements are converted to water elevations by calculating the resultant height of the water column in each well at the time of measurement and adjusting for the measured well head elevation. The water elevations produced from the transducer data are then compared to periodic hand measurements collected using water level sounders for accuracy and precision assessment.

The detailed hydrographs for each instrumented location (i.e., the monitoring wells and the river) are included in Appendix B of this document. The hydrographs are presented by quarter and for each monitored location, three individual hydrographs are presented; one graph of the observed water elevation only, one graph of the water level and associated temperature, and one graph of the water level compared to total daily rainfall

as recorded at HNP. At the time of quarterly data collection, the transducer displayed in MW-101D was determined to have failed and produced erroneous results. The transducer has been repaired, but no hydrographs are presented for MW-101D. The overall hydrographs are summarized and discussed in the following subsections.

2.2.1 March 2004 Hydrographs

The hydrographs for the first quarter of calendar year 2004 are discussed in the following narrative.

Connecticut River

The Connecticut River exhibited strong, regular tidal fluctuation and only small variations in seasonal river stage during the period from January through March 2004. Upon retrieval of the quarterly results in March, it was determined that the on-board batteries had failed in the transducer on February 25, 2004, apparently as a result of the cold temperature to which the unit was exposed. The transducer was restored to function on April 10, 2004.

An analysis of the hydrographs from the monitoring wells on site indicated that the water level in well TW-1 exhibits very close temporal and range efficiency with the river. This is consistent with the proximity of TW-1 to the river and the coarse nature of the formation in which the well is screened. A comparative analysis revealed that the river elevation was closely approximated by subtracting 1.37 feet from the observed elevation of groundwater in TW-1. This value, using TW-1 as a surrogate, was used to complete the river level hydrograph for the remainder of the first quarter and the affected portion of the second quarter.

Starting in early March 2004, the Connecticut River started to exhibit fluctuations that were apparently related to base flow changes in the river due to the start of the freshet. The tidal fluctuation remains superimposed over the base flow fluctuations of the river. The highest elevation (approximately 2.0 feet MSL) observed in the Connecticut occurred on March 11, 2004 during a high tide. A rising base flow shift started during the last week of March. Although the river stage does respond to the local rainfall, the drainage area of the Connecticut River is so large and rainfall sufficiently variable throughout the drainage that there is not always a good apparent correlation between observed river stage and local rainfall as recorded at HNP. The river exhibited a general elevation of 0 feet MSL +/- about 2 feet of regular fluctuation due to tide.

Reactor Foundation Mat Dewatering Sump

The foundation mat dewatering sump, located adjacent to the reactor containment building on the plant-south side, has been in nearly-continuous operation for the life of the HNP. Evaluation of the construction drawings of the mat sump indicate that the sump is in apparent communication with all three of the hydrostratigraphic units identified at the site. A data logging pressure transducer was also placed in the sump to record water levels there. The mat sump is equipped with two submersible electric pumps that operate on a level control system to maintain a depressed water level in the sump. The sump pumps operate on a six-foot control level, with the pumps starting when water reaches approximately elevation -13 feet MSL, and stopping when water reaches approximately elevation -23 feet MSL. The long-term average dynamic water

level in the mat sump is approximately elevation -20 feet MSL. The mat sump was operating with a faulty level control when the transducer was installed on 4 February. This resulted in operation of the pumps at a partial drawdown of the groundwater to an average elevation of about +3 feet MSL. The level control was repaired and the drawdown increased to about -17 feet MSL. Further adjustment of the level control system on 12 February resulted in the drawdown increasing to its current average level of -20 feet MSL. Because the mat sump is under continuous active pumping, the observed water level in the mat sump does not exhibit response to local rain fall events.

Unconsolidated deposits hydrostratigraphic unit:
All of the wells screened in the unconsolidated aquifer exhibited seasonal variations in water level. All of the wells that were sampled as part of the quarterly groundwater monitoring event exhibited transient drawdown effects during pumping for sample collection. The characteristics of the wells screened in the unconsolidated formation are summarized in Table 2-3. Several of the wells were observed to exhibit drawdown in response to dewatering activities in the foundation mat sump and in specifically-installed dewatering wells in the vicinity of the plant tank farm and the primary auxiliary building.

Shallow bedrock hydrostratigraphic unit:
Wells that are screened within the upper ten feet of the bedrock underlying the unconsolidated formation are considered to be in the shallow bedrock hydrostratigraphic unit. As with the unconsolidated formation wells, all of the wells that were sampled as part of the quarterly groundwater monitoring event exhibited transient drawdown effects during pumping for sample collection. The characteristics of the wells screened in the shallow bedrock formation are summarized in Table 2-4. Several of the wells also were observed to exhibit drawdown in response to dewatering activities in the foundation mat sump and in specifically-installed dewatering wells in the vicinity of the plant tank farm and the primary auxiliary building. Hydraulic responses in wells completed in the shallow bedrock appear to mimic the responses observed in wells completed in the overlying unconsolidated formation. This suggests that in some locations, the shallow bedrock unit may be directly hydraulically connected to, and perhaps continuous with, the unconsolidated formation.

Deep bedrock hydrostratigraphic unit:
Wells that are screened deeper that ten feet into the bedrock underlying the unconsolidated formation are considered to be in the deep bedrock hydrostratigraphic unit. These wells generally exhibit hydraulic responses that are substantially different from those observed in the unconsolidated and shallow bedrock units. The characteristics of the wells screened in the deep bedrock formation are summarized in Table 2-5. The deep bedrock wells are generally not clearly and immediately responsive to local precipitation, however, most of them do exhibit pressure fluctuations that appear to be coincidental with the tidal fluctuations observed in the river. The temporal relation of the pressure transients observed in deep bedrock wells to the tidal fluctuations in the Connecticut River suggest that at least some of these wells exhibit the

characteristics of confined or semi-confined aquifer units. As with the wells completed in the other two units, the wells that were sampled as part of the quarterly groundwater monitoring event exhibited transient drawdown effects during pumping for sample collection. The characteristics of the wells screened in the deep bedrock formation are summarized in Table 2-5.

2.2.2 March 2004 Groundwater Flow Maps

Groundwater flow maps for each of the three hydrostratigraphic units have been developed based on groundwater elevations measured on February 12, 2004 (Table 2-6). To evaluate potential impacts of tidal fluctuations on groundwater flow, groundwater flow maps for both high and low tides have been completed for each of the hydrostratigraphic units and are discussed in the following sections.

Unconsolidated deposits hydrostratigraphic unit:
Groundwater elevations and flow in the unconsolidated hydrostratigraphic unit for the first quarter sampling effort are shown in Figures 2-4 and 2-5 for both high and low tides. The groundwater elevations measured in the unconsolidated hydrostratigraphic unit are representative of the water table surface in the plant property. Groundwater contours mapped in the unconsolidated unit are largely inferred, and generally consistent with the surface topography. Based on the inferred contours, groundwater flow in the unconsolidated unit is generally southwest, towards the Connecticut River. The groundwater contours are mapped to depict discharge to the Connecticut River.

Although tidal changes do not appear to significantly alter the groundwater flow direction in the unconsolidated unit, monitoring wells adjacent to the river (e.g., MW-109S and MW-110S) have water level elevations one to two tenths of a foot lower at low tide (Figures 2-4 and 2-5). Monitoring wells in the northern portion of the industrial area (e.g., MW-100S and MW-101S) are less impacted by tidal fluctuations, as measured groundwater elevations are typically on the order of one or two hundredths of a foot lower at low tide. The overall effects of the Connecticut River tidal change (approximately 0.5 to 0.75 foot) on groundwater flow in the unconsolidated unit is to create a slight decrease in the groundwater gradient adjacent to the river during high tide.

Groundwater flow in the unconsolidated hydrostratigraphic unit is impacted by the presence of subsurface barriers to flow. In the central portion of the industrial area several deep concrete structures are present from the ground surface to the top of bedrock. These structures include the reactor containment building (RCB), the discharge tunnel and the primary auxiliary building (PAB). As shown in Figures 2-4 and 2-5, the 10-foot and 5-foot groundwater contours are mapped much farther to the south in the western portion of the industrial area relative to the eastern portion of the site where the deep concrete structures are located. The displacement of the contours is a function of the presence of the subsurface concrete structures that impede groundwater flow in the unconsolidated unit in the area of the RCB, discharge tunnel, and PAB.

Another important feature in the industrial area is the presence of the mat sump. The sump is located adjacent to the southeast side of the RCB, and is installed approximately 40 feet below ground surface into the bedrock. The sump cycles regularly, keeping the water level in the sump between -23 and -17 feet below mean sea level (MSL). The presence of the sump creates a small, but deep depression in the groundwater surface, and with the RCB acts to inhibit flow in the unconsolidated unit (Figures 2-4 and 2-5).

Shallow bedrock hydrostratigraphic unit:

Groundwater flow in the shallow bedrock unit for the first quarter for both high and low tides is illustrated in Figures 2-6 and 2-7. The inferred groundwater contours are representative of the potentiometric surface of groundwater within the shallow bedrock as measured in monitoring wells screened within the shallow bedrock. Similar to flow in the unconsolidated unit, groundwater flow in the shallow bedrock is generally to the south and southeast towards the Connecticut River.

Tidal effects in the shallow bedrock of one to two tenths of a foot are observed in monitoring wells adjacent to the river (MW-109D and MW-508D), while only several hundredths of a foot variation occur in monitoring wells in the northern portion of the industrial area (MW-101D and MW-102D) (Figures 2-6 and 2-7). The tidal changes do not significantly impact groundwater flow in the shallow bedrock hydrostratigraphic unit.

Based on the large upward gradients observed in monitoring well pairs MW-109D/S and MW-110D/S, groundwater in the shallow bedrock is interpreted to discharge to the Connecticut River. These monitoring well pairs are screened in the shallow bedrock and unconsolidated, respectively adjacent to the river. The strong upward gradients are consistent with both discharge to the river, and a flow direction towards the river.

A cone of depression associated with the mat sump is also present in the shallow bedrock unit (Figures 2-6 and 2-7). Groundwater levels in monitoring wells adjacent to the mat sump in the shallow bedrock indicate that a large area of influence occurs in the shallow bedrock (Figures 2-4 through 2-7).

Deep Bedrock hydrostratigraphic unit:

Groundwater flow in the deep bedrock unit for the first quarter for both high and low tides is illustrated in Figures 2-8 and 2-9. Groundwater flow in the deep bedrock hydrostratigraphic unit is characterized in a limited portion of the HNP, as deep bedrock monitoring wells are only present in the central and northern portions of the industrial area. The deep bedrock monitoring wells in this area are all influenced by the mat sump, and form a significant cone of depression in that area (Figures 2-8 and 2-9).

Interpretation of the hydrographs for the deep bedrock monitoring wells indicates that tidal influences are observed in these monitoring wells (Appendix B). Although deep monitoring wells are not present across the industrial area, the documented tidal influence in the deep bedrock wells indicates that outside the influence of the mat sump groundwater flow in the deep bedrock is towards the Connecticut River.

2.2.3 June 2004 Hydrographs

The hydrographs for the second quarter 2004 time period are discussed in the following sections.

Connecticut River

The adjusted water elevation recorded for well TW-1 was used as a surrogate to complete the hydrograph for the river during the first twelve days of the second quarter. The Connecticut River continued to exhibit clear tidal fluctuations during the second quarter. The river also exhibited several cycles of rising base flow which peak on 4 April 2004 (peak river water elevation at +6 feet MSL), 15 April 2004 (peak river water elevation at +3.5 feet MSL), and 27 May 2004 (peak river elevation at +2.5 feet MSL). The general river water elevation during first half of the quarter was slightly above 0 feet MSL and slightly lower than 0 feet MSL during the second half of the quarter. The observed range of tidal fluctuation continued at +/- 1.5 to 2 feet.

Reactor Foundation Mat Dewatering Sump

The mat dewatering sump continued in nearly continuous operation during the second quarter of 2004 with average dynamic water level at about -20 feet MSL. Two shutdowns were experienced from 18 April and 20 April 2004 and again from 28 May through 31 May. During the first event the water level recovered to a maximum elevation of +12 feet MSL and during the second event the water level recovered to a maximum of +8 feet MSL.

Unconsolidated deposits hydrostratigraphic unit:

All of the wells screened in the unconsolidated aquifer exhibited seasonal variations in water level. All of the wells that were sampled as part of the quarterly groundwater monitoring event exhibited transient drawdown effects during pumping for sample collection. The characteristics of the wells screened in the unconsolidated formation are summarized in Table 2-7. Several of the wells were observed to exhibit drawdown in response to dewatering activities in the foundation mat sump and in specifically-installed dewatering wells in the vicinity of the plant tank farm and the primary auxiliary building.

Shallow bedrock hydrostratigraphic unit:

Wells that are screened within the upper ten feet of the bedrock underlying the unconsolidated formation are considered to be in the shallow bedrock hydrostratigraphic unit. As with the unconsolidated formation wells, all of the wells that were sampled as part of the quarterly groundwater monitoring event exhibited transient drawdown effects during pumping for sample collection. The characteristics of the wells screened in the shallow bedrock formation are summarized in Table 2-8. Several of the wells also were observed to exhibit drawdown in response to dewatering activities in the foundation mat sump and in specifically-installed dewatering wells in the vicinity of the plant tank farm and the primary auxiliary building. Hydraulic

responses in wells completed in the shallow bedrock appear to mimic the responses observed in wells completed in the overlying unconsolidated formation. This suggests that in some locations, the shallow bedrock unit may be directly hydraulically connected to, and perhaps continuous with, the unconsolidated formation. This is particularly apparent in the inland wells in the vicinity of the reactor containment building. In the riverward portion of the industrial area, the shallow bedrock unit more nearly mimics the deep bedrock with clear tidal influence and apparent response to changes in river stage. The characteristics of the wells screened in the shallow bedrock formation are summarized in Table 2-8.

Deep bedrock hydrostratigraphic unit:
Wells that are screened deeper that ten feet into the bedrock underlying the unconsolidated formation are considered to be in the deep bedrock hydrostratigraphic unit. These wells generally exhibit hydraulic responses that are substantially different from those observed in the unconsolidated and shallow bedrock units. The characteristics of the wells screened in the deep bedrock formation are summarized in Table 2-9. The deep bedrock wells are generally not clearly and immediately responsive to local precipitation, however, most of them do exhibit pressure fluctuations that appear to be coincidental with the tidal fluctuations and changes in river stage observed in the Connecticut River. The temporal relation of the pressure transients observed in deep bedrock wells to the tidal fluctuations in the Connecticut River suggest that at least some of these wells exhibit the characteristics of confined or semi-confined aquifer units. Well MW-101D exhibited a clear response to operation of dewatering well DW-3. The transducer in MW-101D, however, was found to be inaccurate and the response cannot be quantified. The clear response in MW-101D indicates apparent connectivity of fractures in the bedrock between the well locations. As with the wells completed in the other two units, the wells that were sampled as part of the quarterly groundwater monitoring event exhibited transient drawdown effects during pumping for sample collection.

2.2.4 June 2004 Groundwater Flow Maps

Groundwater flow maps for each of the three hydrostratigraphic units have been developed based on groundwater elevations measured on June 12, 2004 (Table 2-6). To evaluate potential impacts of tidal fluctuations on groundwater flow, groundwater flow maps for both high and low tides have also been completed for each of the hydrostratigraphic units and are discussed in the following sections.

Unconsolidated deposits hydrostratigraphic unit:
Groundwater elevations and flow in the unconsolidated hydrostratigraphic unit for the second quarter sampling effort are shown in Figures 2-10 and 2-11 for both high and low tides. The groundwater elevations measured in the unconsolidated hydrostratigraphic unit are representative of the water table surface in the plant property. Potentiometric contours mapped in the unconsolidated unit are largely inferred, and generally

consistent with the surface topography. Consistent with the first quarter groundwater flow maps, groundwater flow in the unconsolidated unit is generally southwest, towards the Connecticut River. Groundwater elevations across the HNP are generally lower in the second quarter relative to the first quarter. The groundwater contours are mapped to depict discharge to the Connecticut River.

Similar to the observations in the first quarter, the tidal variations do have a significant impact on groundwater flow direction. Water level changes of up to only several tenths of a foot are observed in the high and low tide water levels (Figures 2-10 and 2-11).

The impacts of subsurface barriers interpreted in the first quarter results are also evident in the second quarter water levels. The five- and ten-foot contours are displaced to the north in the central portion of the industrial area, consistent with the presence of subsurface barriers to groundwater flow (Figures 2-10 and 2-11). These structures include the reactor containment building (RCB), the discharge tunnel and the primary auxiliary building (PAB). The displacement of the contours is a function of the presence of the subsurface concrete structures that impede groundwater flow in the unconsolidated unit in the area of the RCB, discharge tunnel, and PAB.

The impact of the mat sump is also observed in the second quarter groundwater levels. Consistent with the first quarter groundwater levels, the presence of the sump creates a deep depression in the groundwater surface, and with the RCB acts to inhibit flow in the unconsolidated unit.

Shallow bedrock hydrostratigraphic unit:

Groundwater flow in the shallow bedrock unit for the second quarter for both high and low tides is illustrated in Figures 2-12 and 2-13. Similar to groundwater flow interpreted for shallow bedrock in the first quarter, groundwater flow in the shallow bedrock for the second quarter is generally to the south and southeast towards the Connecticut River. Groundwater levels are somewhat lower in the shallow bedrock wells relative to the first quarter results, and the effects of the mat sump are somewhat greater in the area south and east of the RCB relative to the first quarter results (Figures 2-6, 2-7, 2-12 and 2-13).

Tidal effects in the shallow bedrock of one to two tenths of a foot are observed in monitoring wells adjacent to the river (MW-109D and MW-508D), while only several hundredths of a foot variation occur in monitoring wells in the northern portion of the area (MW-101D and MW-102D) (Figures 2-12 and 2-13). The tidal changes do not significantly impact groundwater flow in the shallow bedrock hydrostratigraphic unit.

The large upward gradients observed in monitoring well pairs MW-109D/S and MW-110D/S in the first quarter results are also present in the second quarter, consistent with both discharge to the river, and a flow direction towards the river.

Deep bedrock hydrostratigraphic unit:

Groundwater flow in the deep bedrock unit for the second quarter for both high and low tides is illustrated in Figures 2-14 and 2-15. Consistent with the results for the first quarter, the deep bedrock monitoring wells in this area are all influenced by the mat sump, and form a significant cone of depression in that area (Figures 2-14 and 2-15).

Interpretation of the hydrographs for the deep bedrock monitoring wells indicates that tidal influences are observed in the deep bedrock hydrostratigraphic unit (Appendix B). Although deep monitoring wells are not present across the industrial area, the documented tidal influence in the deep bedrock wells indicates that outside the influence of the mat sump groundwater flow is towards the Connecticut River.

3 Groundwater Sampling and Analysis

This monitoring report includes the radio-analytical and boron analytical results for two quarterly groundwater-sampling events. In addition, select geochemical analyses were performed on samples collected during the June 2004 sample event. One quarterly sampling event occurred between March 15 and March 18, 2004. The other sampling event occurred between June 22 and July 6, 2004. The results of analysis of these samples are discussed in detail in Section 4.

The groundwater samples were forwarded to the GEL laboratory for radiochemical and boron analyses. This report includes discussion of data validation and provides a summary of the radio-analytical results and associated quality assurance (QA) data. Some biases were observed in the radio-analytical data at low-level concentrations near the reported MDC. These positive and negative biases were observed in rank order trend plots for several nuclides. In some cases where a positive bias was observed, these results were concluded to be false positives and part of the underlying background or baseline distribution based on the homogeneity and normality of the results. These biases are generally limited to analyses performed via liquid scintillation counting (LSC) and gas proportional counting (GPC).

Measurements of field parameters were included as components of the groundwater sampling and are discussed in Section 3.1 and Section 3.2. A copy of the groundwater sampling procedure is contained within Appendix A.

Groundwater samples were collected by low-flow sampling methodology utilizing either a peristaltic pump or a stainless steel submersible pump with dedicated polyethylene tubing. As a result of low water level conditions, monitoring wells MW-102D and MW-103D were manually purged and sampled during both sample events with a dedicated polyethylene bailer rather than using a pump.

3.1 Field Measurements

Several types of field measurements were recorded in each well prior to sampling. Data obtained from these measurements included groundwater levels, the presence or absence of separate-phase fluid, and water quality parameters. These field measurements are essential components for the evaluation of water quality and hydrogeologic conditions at the plant.

Depth-to-water and bottom-of-monitoring-well sounding measurements were determined using an electronic water level meter with a 0.01 foot resolution. Water quality parameters recorded included specific conductance, pH, dissolved oxygen, temperature, oxidation-reduction potential and turbidity. These parameters are continuously measured prior to the sampling of each well until they have stabilized

within a 10 percent variation. This procedure is performed to confirm that well conditions have stabilized during the low-flow purging step, indicating enough water has been removed from the well so that a representative groundwater sample can be collected. These parameters were measured using a multi-parameter meter, with sensors arrayed within a flow-through cell. The resulting measurements are included within this report as Appendix C.

3.2 Summary of Field Measurements

The water quality parameter field measurements for the March and June 2004 sampling event are summarized in Tables 3-1 and 3-2, respectively. Field Daily Reports (FDRs), which are field notes that document the sampling of each well, are provided in Appendix C. As recorded in the field notes, the field parameters typically stabilized within an acceptable range. One of the criteria for low-flow sampling methodology employed was to collect samples where the turbidity level had stabilized in the range of 5 to 15 nephelometric turbidity units (NTUs). This range is typically used to indicate the absence of fine silt and particulate matter 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 previously noted in past groundwater reports, pH continues to trend high at monitoring well MW-106D and 122D. During the March and June 2004 groundwater-sampling events, the pH readings from monitoring well MW-106D and 122D were reported to be in the 9.3 to 9.4 pH range. These wells have trended as high as 11.18 to 11.39 during the June 2001 sampling event. The most likely cause of the elevated pH in these wells is intrusion of cement grout into the screened intervals during well construction. Future pH measurements from this location will be monitored and evaluated closely.

3.3 Routine Lab Analyses and Locations

All wells sampled as part of the two quarterly sampling events were analyzed for gross alpha, gross beta and gamma isotopic analysis. A number of industrial area monitoring wells were also sampled and analyzed for boron and stronium-90. A sub-set of these monitoring wells is routinely analyzed for select HTD radionuclides.

The locations that were sampled during the March 2004 event are located within the industrial area, peninsula and support building areas, as indicated below:

March 2004 Monitoring Event

- Industrial Area (28 samples from 27 wells in 17 clusters or locations):

MW-100D, S	MW-101D, S	MW-102D, S	MW-103D, S	MW-104S
MW-105D, S	MW-106D, S	MW-107D, S	MW-108S	MW-109D(2), S
MW-110D, S	MW-114S	MW-115S	MW-122D, S	MW-123S
MW-124S	MW-125S			

- Peninsula Areas (4 samples):
  MW-111S MW-112S MW-113S MW-117S

- Emergency Operations Facility Area (1 sample):
  EOF-2

Both filtered and unfiltered groundwater samples were collected at the following locations during the March 2004 sampling event to provide analytical data to determine if metal concentrations are related to suspended particulate matter.

- Filtered Sample Locations (4 samples at 2 locations):
  MW-105D, S MW-106D, S

June 2004 Monitoring Event

Monitoring well MW-115S was not sampled during the June 2004 event due to insufficient water. The locations that were sampled are located within the industrial area, parking lot, peninsula and support building areas, as indicated below:

- Industrial Area (29 samples from 29 wells at 19 clusters or locations):

MW-100D, S	MW-101D, S	MW-102D, S	MW-103D, S	MW-104S
MW-105D, S	MW-106D, S	MW-107D, S	MW-108S	MW-109D, S
MW-110D, S	MW-114S	MW-122D, S	MW-123S	MW-124S
MW-125S	MW-1	MW-2	MW-3	

- Parking Lot (8 samples from 8 wells at 6 locations):
  MW-502 MW-503 MW-504 MW-505 MW-507D, S MW-508D, S

- Peninsula Areas (4 samples):
  MW-111S MW-112S MW-113S MW-117S

- Emergency Operations Facility Area (1 sample):
  EOF-2

The parking lot area wells were analyzed to provide additional boron and tritium distribution information for the northern side of the industrial area. The additional peninsula area wells (MW-1,2,3) were analyzed to provide additional Sr-90 distribution information (i.e., confirm previous detects at MW-117S).

Note that the landfills wells were not analyzed during these sample events. Sampling of the landfill wells has been suspended pending completion of remedial activities in the old landfill area.

Samples were analyzed for the following constituents and by the listed methodologies:

- Boron via EPA method 6010B and 6020
- Gross Alpha via EPA method 900
- Gross Beta via EPA method 900
- Tritium via EPA method 906.0
- Gamma emitting fission and activation products by gamma spectroscopy
- Sr-90 via EPA method 905.5 and gas proportional counting

Additional location-specific analyses are described below.

3.4 Special HTD Lab Analyses and Locations

In addition to the above analyses, samples from a subset of various locations were analyzed during each sampling event via special analyses for Hard-To-Detect (HTD) plant-related radionuclides. These HTDs include alpha, beta and X-ray emitting, fission and activation product radionuclides. The subset of monitoring wells analyzed for HTDs, for both monitoring events, included the following:

- **March & June 2004 Monitoring Event**

  MW-103D,S MW-104S MW-105D, S MW-106D, S

Each sample was analyzed for gross alpha, gross beta, tritium and gamma isotopic 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
- Stronium-90 via EPA method 905.5 and gas proportional counting
- Tc-99 via liquid scintillation
- Alpha-emitting transuranics (isotopic plutonium, curium, americium) via alpha spectroscopy
- Beta-emitting Pu-241 via liquid scintillation

The results of analyses for HTD constituents in the subset of monitoring wells listed above are discussed below.

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

4 Laboratory Analytical Results

The observed concentrations of the SOCs were compared to selected standards—in this instance, to the maximum contaminant level (MCL) promulgated under the Federal Safe Drinking Water Act regulations by the United States Environmental Protection Agency, and subsequently implemented by the State of Connecticut as the state's drinking water standards. The MCLs do not strictly apply to groundwater at HNP because the plant groundwater is not a source of community drinking water. The MCLs do, however, provide an accepted metric for comparison and evaluation of the apparent degree of groundwater contamination.

The MCL for beta and photon emitters (such as Sr-90 and Cs-137) is a dose-based 4 mrem/year, calculated using an agency-specified target organ dose methodology. The concentration of a single nuclide in water that would result in a dose of 4 mrem/year is often used as the MCL. This concentration is referred to as the C_4 concentration, or the derived dose concentration. If only a single beta/photon emitter is present in drinking water, the derived concentration is the MCL for that nuclide. If, however, multiple beta/photon emitters are present in the sample, the fractional dose contribution of each nuclide is summed to determine the total dose. It may be noted that by applying the NRC Total Effective Dose Equivalent (TEDE) calculation method, the yearly dose corresponding to the MCL concentrations for tritium and Sr-90 would be less than 1 mrem/yr for each nuclide.

Thirty-seven (37) groundwater samples from thirty-six (36) locations within the existing site-wide monitoring well network were collected and analyzed during the March 2004 quarterly groundwater-sampling event. Boron and radiochemical analytical results are summarized in Appendix D.1 and complete lab analytical data packages are included as Appendix D.2. Total, or unfiltered, and filtered fraction groundwater samples were collected at several locations within the industrial area during the March 2004 round.

A total of thirty-nine (39) samples were collected for analysis from thirty-eight (38) monitoring wells during the June 2004 sampling event. Total, or unfiltered, and filtered fraction groundwater samples were collected at several locations within the industrial area during this round as well. The filtered fractions were field filtered with a 0.45-µm filter. Boron and radiochemical results are summarized in Appendix D.3 and complete lab analytical packages are provided in Appendix D.4.

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 indicator of areas that have been impacted by previous releases.

Thirty-two (32) samples were collected as part of the March 2004 round resulting in thirty-one (31) samples detected greater than the Minimum Detection Limit (MDL) of 0.54 micrograms per liter (µg/L). Results ranged from 38 µg/L at MW-107D to 767 µg/L at MW-105S (filtered). Results were not received from the lab for the MW-106S sample. Groundwater analytical results for the March 2004 boron analyses are summarized in Table 4-1.

Boron was detected in all forty-three (43) unfiltered and filtered samples analyzed in June 2004 with results from all above the MDC of 0.54 µg/L. The highest concentrations were detected in wells MW-106S (490 µg/L) and MW-114S (1260 µg/L). Groundwater analytical results for filtered and unfiltered boron analyses are summarized in Table 4-1.

4.2 Gross Alpha

The likely source of most gross alpha activity in the vicinity of HNP is dissolution of naturally occurring mineral deposits, including Radium (Ra) -226 and Ra-224, which are likely present in the underlying crystalline bedrock. Natural levels of gross alpha activity can range as high as a few hundred pCi/L. Although it is possible that plant-related radionuclides contribute to some of the observed gross alpha activity, it is not probable since alpha isotopic analysis generally results in non-detects with nominal detection sensitivity on the order of 0.3 pCi/L, or less.

Thirty-seven (37) samples were collected in March 2004 for gross alpha activity analysis resulting in seven (7) samples detected greater than the laboratory required Minimum Detection Concentration (MDC) of 3 picocuries per liter (pCi/L). None of the reported results exceeded the Environmental Protection Agency (EPA) maximum contaminant level (MCL) of 15 pCi/L. Gross alpha results for March 2004 are provided in Table 4-2.

Forty-three (43) samples were collected in June 2004 for gross alpha activity analysis resulting in thirteen (13) samples detected greater than the laboratory required Minimum Detection Concentration (MDC) of 3 picocuries per liter (pCi/L). Results at monitoring well MW-508S, 28 pCi/L, exceeded the Environmental Protection Agency (EPA) maximum contaminant level (MCL) of 15 pCi/L. Gross alpha results for June 2004 are provided in Table 4-2.

4.3 Gross Beta

Gross beta activity in the vicinity of HNP may result from either naturally occurring or plant-related sources. Potassium-40 (K-40) is a radionuclide resulting from naturally occurring mineral deposits, which may account for relatively high percentage of gross beta activity in certain wells. High levels of gross beta activity in areas of plant-related contamination may be associated with beta emitters Sr-90 and Cs-137. The CT Public Drinking Water Quality Standard for gross beta radioactivity is 50 pCi/L though background levels may range as high as a few hundred pCi/L.

Twenty-seven (27) out of thirty-seven (37) samples analyzed detected gross beta activity greater than the laboratory required MDC of 4 pCi/L during the March 2004 sampling event. These concentrations ranged from 4.11 to 203 pCi/L. The highest gross beta activity concentration was identified in well MW-105S (filtered). This concentration is

greater than the CT Public Drinking Water Quality Standard MCL of 50 pCi/L. Gross beta results for March 2004 are provided in Table 4-2.

Twenty-eight (28) out of forty-three (43) samples analyzed detected gross beta activity greater than the laboratory required MDC of 4 pCi/L during the June 2004 sampling event. These concentrations ranged from 4.35 to 44.3 pCi/L. The highest gross beta activity concentration was identified in well MW-105S (filtered). All results were less than the CT Public Drinking Water Quality Standard MCL of 50 pCi/L. Gross beta results for March 2004 are provided in Table 4-2.

4.4 Tritium Results

The presence of tritium in groundwater at HNP is the result of the nuclear fission reaction that was the heat source for the HNP nuclear power generating station.

Tritium was detected in twenty-three (23) of the thirty-seven (37) wells sampled. Twenty-two of these detects were at concentrations greater than the required MDC of 400 pCi/L. All detected H-3 concentrations were below the C_4 activity concentration of 20,000 pCi/L. The highest tritium concentrations were observed at monitoring wells MW-102S (6,740 pCi/L) and MW-103D (12,000 pCi/L). Tritium results for the March 2004 sampling event are summarized in Table 4-3.

Tritium was detected in twenty-four (24) of the forty-three (43) wells sampled. Seventeen (17) of these detects were at concentrations greater than the required MDC of 400 pCi/L. All detected H-3 concentrations were below the C_4 activity concentration of 20,000 pCi/L. The highest tritium concentrations were observed at monitoring wells MW-114S (6,730 pCi/L) and MW-110D (8,300 pCi/L). Tritium results for the June 2004 sampling event are summarized in Table 4-3.

4.5 Co-60

Any occurrence of Co-60 in groundwater at HNP is the result of plant-related processes. Cobalt-60 was detected in two (2) wells at concentrations greater than the 2-σ TPU level. The Co-60 concentration ranged form 1.7 pCi/L at MW-108S to 3.2 pCi/L at MW-105S. Only Co-60 concentration results at MW-105S were greater than the sample MDC during the March 2004 sample event.

Cobalt-60 was detected in seven (7) of the forty-three (43) samples analyzed during the June 2004 sample event. Results for five (5) wells were confirmed with replicate analysis. Only results at wells MW-104S (6.28 pCi/L) and MW-103S (11.4 pCi/L) were greater than the sample MDC. The detected values are well below the C_4 concentration of 100 pCi/L. Table 4-4 summarizes Co-60 results in all wells that were part of the June 2004 sampling round.

4.6 Cs-137

Any occurrence of Cs-137 in groundwater at HNP is the result of plant-related processes. Cesium-137 was detected in three (3) samples analyzed during the March 2004 event at concentrations greater than the 2-σ TPU level. Only one (1) sample from well MW-103S out of the thirty-seven (37) samples analyzed detected Cs-137 above the

laboratory required MDC of 15 pCi/L, well below the C_4 concentration of 200 pCi/L. Table 4-2 summarizes Cs-137 analytical results in all wells for the March 2004 sampling round.

The sample collected from MW-103S was the only well where Cs-137 was detected (7.5 pCi/L) out of the forty-three (43) samples analyzed during the June 2004 sampling event. This detected value is well below the C_4 concentration of 200 pCi/L. Table 4-2 summarizes Cs-137 results in all wells that were part of the June 2004 sampling round.

4.7 Alpha Isotopic Results

Alpha isotopic analyses including isotopic plutonium (Pu) and isotopic americium (Am) were determined by chemical separation and alpha spectroscopy. Isotopic plutonium analyses include the alpha emitters, Pu-238 and Pu-239/240 and Pu-241, which is a beta emitter. Isotopic americium and curium analyses include Am-241, Cm-242 and Cm-243/244.

All of the ninety-two (92) alpha isotopic results from the March 2004 sampling event were less than 2-σ TPU and not statistically significant. Alpha isotopic results are summarized in Table 4-4. Two (2) results were observed with concentrations greater than the nominal sample specific MDC of 0.3 pCi/L. These results are believed to be false positive artifacts based on the following discussion.

Statistically significant activity is identified by concentrations that are greater than 2-σ TPU and near the MDC level. 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. The observed positive rate for all alpha isotopic analyses was 0% for the March 2004 sampling event, which is on the order of the expected false positive rate if no significant alpha-emitters are present.

All forty (40) alpha isotopic for the June 2004 sampling event were non-detects with nominal sample specific MDCs or detection sensitivities on the order of 0.3 pCi/L or less. Table 4-4 summarizes alpha isotopic results for June 2004. The observed positive rate for all alpha isotopic analyses was 0% for the June 2004 sampling event. These sample analytical results suggest that the potential for statistically significant plant-related alpha activity in groundwater is small.

4.8 Sr-90 Results

Strontium-90 in groundwater at HNP is also associated with past nuclear power operations. Fifteen (15) out of twenty-eight (28) samples analyzed for the March 2004 sampling event detected Sr-90 at concentrations greater than 2-σ TPU, but only six (6) samples displayed values above the laboratory required MDC of 4 pCi/L. Only one (1) well contained Sr-90 concentrations that exceeded the C_4 concentration of 8 pCi/L. Monitoring well MW-105S exhibited a Sr-90 concentration of 92.4 pCi/L. The Sr-90 analytical results for March 2004 are provided in Table 4-2.

Seventeen (17) out of thirty (30) samples analyzed for the June 2004 sampling event detected Sr-90 at concentrations greater than 2-σ TPU, but only four (4) samples displayed values above the laboratory required MDC of 4 pCi/L. Only one (1) well contained Sr-90 concentrations that exceeded the C_4 concentration of 8 pCi/L. Monitoring well MW-105S exhibited a Sr-90 concentration of 16.2 pCi/L. The Sr-90 analytical results for June 2004 are provided in Table 4-2.

Trend analysis of radionuclide data at these 2-σ TPU levels and near the sample specific MDC has indicated the presence of bias in the Sr-90 analyses. Specifically, analytical results determined by liquid scintillation counting (LSC) and gas proportional counting (GPC) exhibited the most significant analytical bias. In most cases, the magnitude of the analytical bias was less than sample specific MDC. Additional trend data, to be collected during future groundwater sampling events, will determine if these reported detections at the MDC level are statistically significant, or false positive values.

5 Data Quality Assessment

Current quality assurance/quality control (QA/QC) efforts in support of the Groundwater 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. General quality requirements are provided in References LTP 2002 and GMP-QAPP 2002.

5.1 Data Quality Metrics

On the analytical side, accuracy, precision, and detection sensitivity are the primary indicators used to assess laboratory data 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. Numerical criteria for evaluating precision, accuracy and completeness performance are generally available, while metrics for representativeness and comparability are more qualitative in nature.

5.1.1 Precision

Precision was evaluated through the use of field duplicate samples and laboratory split or replicate 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 collected during the course of each quarterly sampling event, after considerations for well yield and sample volume requirements. Approximately 25% of the total number of samples analyzed, for radiochemical and boron constituents were internal lab duplicates or replicates. Approximately 6% of the analyzed samples were analytical blanks.

5.1.2 Accuracy

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. Measurement accuracy was evaluated by three methods:

- Calculation of percent recovery of laboratory control samples (e.g., calibration standards, blank spikes, and matrix spikes);

- Comparison of reported minimum detectable concentration (MDC) to selected performance standards (e.g., drinking water standards);
- Comparison of method blank analyses to the MDC.

5.1.3 Completeness

Completeness was evaluated by comparison of the number of valid measurements produced to the number of measurements planned. The target for completeness of valid measurements for all radionuclides for this sampling event was 100%. This objective was selected because critical sample locations (i.e., locations that define maximum concentration and/or maximum extent of contaminant plumes) have not been established for all radionuclides or geochemical constituents.

5.1.4 Comparability

Comparability was evaluated qualitatively through assessment of sampling and measurement methods and apparent spatial distribution of substances of concern.

5.1.5 Analytical Bias Assessment

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. Historically, commercial analytical laboratories used by CYAPCo have exhibited some difficulty with the reporting of false-positive results. Sstatistical methods were employed to evaluate analytical bias with regard to the underlying baseline or background distribution.

5.1.6 Laboratory Audits/Assessments/Oversight Activities

Laboratory activities are periodically assessed through surveillance and/or auditing activities to ensure that quality problems are prevented and/or detected. Periodic assessments support the continuous process improvement.

5.1.7 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.

5.2 Data Quality Results

The data quality metrics for radiochemical constituents are summarized as follows:

- Precision — Relative Percent Difference (RPD) < 25% or within 2-σ TPU of the Initial Value
- Accuracy — Laboratory Control Sample Recovery 100% +/- 30

		Laboratory Blank Analysis Results Non-Detect
		Laboratory Blank Analysis Results < MDC
•	Representativeness	Qualitative assessment of sample location, sample timing, sample collection method, sample preservation, handling, shipment
•	Completeness	Valid measurements for critical samples = 100%
•	Comparability	Qualitative assessment of sample collection and measurement methods
		Assignment of sample locations to hydrostratigraphic units.
		Sample MDC < CRDL

5.2.1 Precision

Results of the data quality assessment for precision are discussed in the following subsections.

5.2.1.1 Field Duplicates

The duplicate sample for the March 2004 sampling round was collected from MW-114S, and identified as MW-210. This blind duplicate sample was analyzed for gross alpha, gross beta, H-3, Sr-90 and gamma isotopic nuclides. Results of the field duplicate evaluation are summarized in Table 5-2. Only those reported radiochemical results with a sample-to-uncertainty concentration ratio greater than 5 are evaluated and summarized. The uncertainty used in this ratio is the 1-σ total propagated uncertainty for radiochemical results. Boron results that are greater than the contract required detection limit (CRDL) are also included in this evaluation. All evaluated field duplicate results are within 17% of the initial sample results, indicating satisfactory precision for the field duplicate samples.

The duplicate sample for the June 2004 sampling round was collected from MW-105S, and identified as MW-600S. This blind duplicate sample was analyzed for gross alpha, gross beta, H-3, boron, gamma isotopic and the hard-to-detect (HTD) nuclides. Results of the field duplicate evaluation are summarized in Table 5-3. Again, only those radiochemical results with a sample-to-uncertainty concentration ratio greater than 5 or boron concentrations greater than the CRDL are evaluated and summarized. All evaluated field duplicate results are within 7% of the initial sample results and indicate satisfactory precision.

5.2.1.2 Lab Duplicates

Approximately 25% of the samples analyzed by GEL in a quarterly sampling event are internal or lab QC samples. These lab QC samples are comprised of lab control spikes, matrix spikes, method blanks, duplicates and replicates. The reproducibility of lab measurements is evaluated through the use of matrix duplicates. These duplicates are processed at a frequency of one matrix duplicate per batch. Internal acceptance criteria for duplicate samples are summarized as follows:

- Accuracy within 20%
- Accuracy within allowed uncertainty and based on contract required detection limit (CRDL)

Sample and duplicate analysis results greater than 5 times the CRDL, must fall within ± 20% of the observed value. Sample or duplicate analysis results less than the product of 5 times the CRDL, the difference should be less than or equal to the CRDL.

Results of the lab duplicate evaluation for March 2004 are summarized in Table 5-4. Seven (7) of eight (8) lab duplicate results are within 17% of the initial sample results and indicate satisfactory precision. Results for boron MW-114S replicate analysis were outside the acceptance criteria at +27.6%.

Results of the lab duplicate evaluation for June 2004 are summarized in Table 5-5. Five (5) of six (6) lab duplicate results are within 19% of the initial sample results and indicate satisfactory precision. Results for H-3 MW-110S analysis were outside the acceptance criteria at -21.9%, but were within statistical agreement given the uncertainty of the measurements.

5.2.2 Accuracy

Results of the data quality assessment for accuracy are discussed in the following subsections.

5.2.2.1 External Laboratory Performance Evaluations

This section provides a detailed discussion of external performance indicators for the GEL laboratories. The GEL lab took part in US Department of Energy (DOE) Quality Assessment Program and the DOE's Mixed Analyte Performance Evaluation Program. The GEL lab also participated in the Environmental Resource Associates (ERA) RadCheM™ PT program. Results of those studies related to GW monitoring at HNP, are described in this section.

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 program is coordinated by the Environmental Measurements Laboratory (EML) in New York City, 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 nine (9) QAP studies conducted from June 2000 through June 2004 (see References EML-608, 611, 613, 615, 617, 618, 621, QAP59 and QAP60), the percentages of acceptable or acceptable with warning results are summarized as a function of media and analysis type in Table 5-6. Overall, approximately 97.1% of the GEL data was in the acceptable or acceptable with warning performance category. For gamma isotopic analyses, 97.4% of the reported lab data was in the acceptable or acceptable with warning category. Approximately 98% of the alpha isotopic results and 94% of the HTD beta results were in the acceptable or acceptable with warning range. The DOE QAP60 program is the last performance that will be provided by the DOE.

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 semi-volatile 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. Analytical results with a reported bias less than or equal to 20% are flagged as acceptable. Analytical results with a reported bias greater than 20% but less than or equal to 30% are flagged as acceptable with warning.

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, Cs-134 and Cs-137. 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. Acceptable performance is indicated when the reported range encompassing the results (i.e., net concentration $\pm$ 3-σ uncertainty) included zero. Unacceptable performance is indicated when this range does not include zero.

For the ten MAPEP studies conducted through May 2002 (see References MAPEP-S6, S7, S8, S9, S10 and MAPEP-W7, W8, W9, W10, W11), the percentages of acceptable or acceptable with warning results are summarized as a function of media in Table 5-7.

Overall, about 96% of the GEL 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. Approximately 96% of the alpha isotopic results and 86% of the HTD beta results were in the acceptable or acceptable with warning range. GEL experienced some problems with the low level

false positive testing where 70% of the reported results were in the acceptable or acceptable with warning range.

ERA RadCheM™ Proficiency Testing (PT) Program

Environmental Resource Associates (ERA) RadCheM™ PT program is based on the National Standards for Water Proficiency Testing Studies Criteria Document (Reference NSWPT 1998). ERA examines laboratory performance in the analysis of water samples containing gross alpha/beta, naturals including uranium, mixed beta and gamma emitters. The program is conducted by ERA in Arvada, Colorado. ERA evaluates the accuracy of submitted results for radiological samples by determining if they fall within EPA or NELAC control limits.

ERA provides blind standards that contain specific amounts of one or more radionuclides to participating laboratories. Gamma emitters typically include Co-60, Zn-65, I-131, Ba-133, Cs-134, Cs-137 and Ra-226. Alpha and beta analyses typically include gross alpha, gross beta, H-3, Sr-89, Sr-90, Ra-228 and natural uranium.

The GEL lab participated in five (5) of the last (6) ERA studies (see References ERA-52, 53, 54, 55 and 57). The percentages of acceptable or acceptable with warning results for these five (5) studies are summarized as a function of analysis type in Table 5-8. Overall, 98.4% of the GEL reported lab data was in the acceptable or acceptable with warning performance category for all media.

5.2.2.2 Field Blank Results

A decontamination station is typically established near monitoring wells sampled with non-dedicated equipment to provide for the proper decontamination of dedicated sampling equipment. 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 not collected during the March or June 2004 sample events since all monitoring wells were sampled using dedicated equipment.

5.2.2.3 Internal Lab Performance Evaluations

Individual internal QC results are contained within Appendices D-1 and D-2 and indicate that the recovery rates for the laboratories are within acceptable ranges for the analyses performed. Approximately 25% of the samples analyzed by GEL in a quarterly sampling event are QC samples. These lab QC samples are comprised of lab control spikes, matrix spikes, method blanks, duplicates and replicates. Attached in Tables 5-9 and 5-10 is a summary of the number of QC samples processed by the GEL lab during the March and June 2004 sample events.

Internal Performance Criteria

GEL performed a minimum of one laboratory control sample (LCS), one method or reagent blank (MB), and one duplicate sample analysis for each analysis performed in a batch of samples according to References GEL QAP 2003 and CY-ISC-SOW 2003. Batch sizes are composed of one to a maximum of 20 environmental samples. Matrix spike

(MS) samples are also analyzed when the analytical method involves chemical or physical separation and does not use an internal standard or carrier, and sufficient sample volume exists.

Internal acceptance criteria for LCS and MS samples are summarized as follows:

- Accuracy within QC acceptance limits (see Table 5-9)
- Results within 2-σ TPU of the observed value
- Accuracy within allowed uncertainty and based on contract required detection limit (CRDL)

Matrix Spikes (MS) are first corrected for any ambient test nuclide activity. Samples with ambient activity greater than 4 times the expected value of the spike are not required to fulfill MS acceptance criteria. The activity levels of target analytes in LCS and MS samples are greater than 10 times but less than 100 times the *a priori* lower limit of detection (LLD). Acceptance criteria for LCS and MS samples are 75% to 125%. Additionally, all QC and sample results must have chemical recoveries or chemical yields within the range of 15% to 125%.

Internal Performance Results for Accuracy

The percentages of acceptable results are summarized as a function of analysis method in Table 5-12. Overall, about 95% of the GEL performance data for LCS and MS samples were acceptable according to performance criteria. For alpha isotopic and gamma isotopic analyses, 100% of the internal lab QC data was within acceptance limits. Approximately 97% of the LSC results and 96% of the GPC results were within acceptable limits. GEL experienced some problems with the boron analyses where 64% of the reported results were within acceptable limits.

Internal Performance – Method Blank Results

Method or reagent blank results are evaluated or compared to the contract required detection limit (CRDL) and the lowest sample activity in a batch. Acceptable method blanks are those results that are less than the CRDL or less than 5% of the lowest sample activity in the batch. Method blank results that do not meet the acceptance criteria are critically examined according to the GEL SOPs and documented through GEL's nonconformance reporting (NCR) system. Method blank failures are also documented in the case narrative of the analytical report. Method blank activity levels are not subtracted from sample activity levels.

5.2.3 Completeness

Valid results were generated for a total of 692 radionuclide tests, resulting in completeness of 99.9%. The requested boron analysis for MW-106S was not reported. For the June 2004 sampling event valid results were generated for 715 radionuclide tests, resulting in a completeness of 100%.

5.2.4 Comparability

Comparability was evaluated qualitatively through assessment of sampling and measurement methods and apparent spatial distribution of substances of concern. The

analytical methods used for this determination are comparable to methods used to measure dissolved species in natural waters. The sampling method and analytical techniques used in both sampling events were comparable to previous events, with the exception of the analysis of field filtered samples at some industrial area locations. These results generally indicate that boron and radiochemical constituents detected in all wells was present in a soluble form and the filtered results are comparable to the current and previous unfiltered measurements.

5.2.4.1 Sample Methods

Sample collection and control was performed using work processes and trained staff according to References RPM 5.3-0, GW-WPIR 2001 and RPM 5.3-1. The tasks included sample planning, sample collection, chain-of-custody preparation and sample shipping. The General Engineering Lab (GEL) in Charleston, SC was used as the primary lab for the radiological and boron analyses. Methods employed for radiological constituents were developed by the vendor laboratory and are recognized as acceptable within the radiochemical industry. The boron methods employed were standard EPA methods. The contract required detection limits (CRDL) are identified in the laboratory Statement of Work (CY-ISC-SOW 2003) are summarized in Table 5-1.

The GEL 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 on-site HNP laboratory performed tritium and gamma isotopic analyses to support off-site sample shipments. These analyses were not used for reporting actual groundwater analytical sample results.

5.2.4.2 Radiochemical Data Reporting Convention

All reported analytical results include the net concentration, the 1-σ or 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. Total propagated uncertainty values reported at 2-σ allow direct comparison with the net concentration for statistical significance. Total propagated uncertainty values reported at 1-σ are converted to 2-σ for comparison purposes.

Detection limits are essential for evaluating data quality and demonstrating that the desired sample analytical 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 laboratory Statement of Work (CY-ISC-SOW 2003) are summarized in Table 5-1. These contract required detection limits (CRDL) are based on the resident farmer scenario with a 1 millirem per year Total Effective Dose Equivalent (TEDE) annual dose. All reported MDC concentrations are *a posteriori* and include sample specific corrections for radioactive decay, chemical yield and sample mass.

5.2.4.3 Radiochemical Data Review

All analytical results in the form of the sample specific MDC were evaluated against the contractual MDCs to ensure that sensitivity requirements were met. The sensitivity requirement is relaxed when statistically significant activity is identified in order to conserve lab cost and instrument resources. Several instances were identified in the case narrative where required sensitivities were not achieved (i.e., the sample specific MDCs were greater than the CRDL). In some cases this is attributed to a small sample mass or a low chemical recovery resulting in a low recovered sample mass. Ideally, these samples are reanalyzed with a larger sample volume, when available. In all cases, the CRDL for Am-241 of 0.5 pCi/liter was not achieved when analyzed by gamma spectrometry, but it was easily achieved by alpha spectrometry. Results that were statistically significant were tracked and trended with previous results. Results greater than the MCL and CRDL requires continued sampling.

Simple rules of thumb were used to evaluate analytical results that were not statistically significant with respect to background. Based on the theoretical relationship of the 1-σ net concentration uncertainty and the 1-σ background concentration uncertainty (which is the basis for the MDC), the MDC-to-uncertainty ratio was evaluated numerically for consistency and reasonableness. In this case, the 2-σ TPU uncertainty was used as the estimator for the 1-σ net concentration 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 analyses where MDC-to-TPU ratios can span the range from 1 to 25.

5.2.5 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 Appendixes D.1 and D.2 with the laboratory analytical data sheets. Specific issues identified by the GEL lab during the reporting of March 2004 sampling event data included:

- The serial dilution for boron did not meet the acceptance criteria of less than 10% for the ICP and ICPMS batches. Serial dilution is used to assess matrix suppression or enhancement.
- Gross alpha and beta samples MW-113S, MW-113S and the LCS samples were reprepped due to recovery outside acceptance criteria.
- High hygroscopic salt content in evaporated samples can cause the sample mass to fluctuate due to moisture absorption during gross alpha and beta sample preparation. The salts were converted to an oxide by heating under a flame. Volatile radioisotopes of carbon, hydrogen, technetium, polonium and some cesium may be lost during this process.
- Samples MW-101D and MW-105D (filtered) were recounted for americium alpha isotopic analysis due to a peak shift.
- Samples MW-106D (filtered), MW-123S, method blank, MW-123S duplicate, MW-123S matrix spike and the LCS samples were reprepped due to carrier yield.
- The Pu-241 sample batch was recounted due to high MDCs. An NCR was issued for Pu-241 samples MW-103S and MW-105S (filtered) which did not meet the CRDL after counting for 180-minutes each.
- Gross alpha results for MW-114S matrix spike and matrix spike duplicate did not meet the alpha recovery requirements due to sample matrix effects.
- The Sr-90 results for MW-103S, MW-105S, MW-105S (filtered), MW-106S, MW-106S (filtered), MW-106S lab duplicate, MW-114S, MW-114S field duplicate, MW-115S and MW-125S were verified by recounting the samples at least 5-days from the initial count.
- The Fe-55 sample batch was recounted due to extremely negative results. The reported negative concentrations were greater than three (3) times the error due to the Fe-59 cross-talk correction.
- The Fe-55 samples for MW-106D matrix spike and the LCS were recounted due to low/high recovery.

Specific issues identified by the GEL lab during the reporting of June 2004 sampling event data included:

- The H-3 sample bottles for MW-507D and MW-507S leaked during transit. The H-3 aliquots were retained from preserved aliquots and neutralized prior to analysis.
- Manual integration of the plutonium alpha energy spectra was performed for the method blank sample, to separate regions-of-interest.
- Gross alpha/beta samples MW-108S and MW-108S lab duplicate were recounted due to recovery outside acceptance criteria.
- High hygroscopic salt content in evaporated samples can cause the sample mass to fluctuate due to moisture absorption during gross alpha and beta sample preparation. The salts were converted to an oxide by heating under a flame. Volatile radioisotopes of carbon, hydrogen, technetium, polonium and some cesium may be lost during this process.
- The Sr-90 results for MW-125S, MW-103S and MW-106S were verified by the gross beta results. The Sr-90 results for MW-105S, MW-105S field duplicate,

MW-107S and MW-122D were verified by recounting at least 5-days from the separation date.

- Results for Fe-55 batch are extremely negative due to the Fe-59 cross-talk correction. The reported negative concentrations were greater than three (3) times the error.
- An NCR was generated for batch control of plutonium alpha isotopic and Pu-241 samples. Samples were not scanned into the LIMS system prior to analysis.
- The lab duplicate sample for gross alpha/beta analysis MW-109S was recounted due to a high relative percent difference/relative error ratio. The matrix spike sample for gross alpha/beta analysis MW-109S was recounted due to a low/high recovery.
- Sample MW-105D for Fe-55 was recounted due to low/high recovery. Samples MW-105D and MW-103D for Fe-55 were recounted to verify activity. The recounts are reported.
- Samples MW-107S and the method blank for H-3 were recounted due to spectral interferences.
- Sample MW-2 for H-3 was recounted due to high relative percent difference/relative error ratio. Samples MW-2, MW-117S, method blank and the lab duplicate (MW-2) were recounted for H-3 due to high lumex and low quench numbers.

In some cases, these occurrences initiated internal non-conformance action on the part of GEL Charleston lab with additional follow-up documentation. CYAPCo is specifically working with the lab to resolve the Fe-59 cross-talk correction issues identified above and through trend analysis of the Fe-55 data. We will continue to monitor these case narratives and their impact on lab data quality.

5.2.6 Representativeness

Representativeness of sample analyses was evaluated qualitatively. The following observations relative to sample representativeness were made:

5.2.6.1 General

Samples collected during the March and June sampling events exhibited variability in turbidity. The cause of this variability is not apparent, but probably results from accumulation of fine geologic material in the wells due to variations in degree of well development as well as variations in the content of fine material at the various locations sampled. Redevelopment of existing monitoring wells should be considered to attempt to provide samples with more uniform turbidity across the site. Comparison of observed turbidity measurements to analysis of radiochemical constituents in both filtered and unfiltered samples indicates no apparent correlation. Essentially all observed radiochemical constituents appear to be present in a soluble state. Therefore it is concluded that variations in sample turbidity did not affect radiochemical analyses.

- Monitoring wells have been allocated to unique hydrostratigraphic units based on the relative placement of screened intervals. These units vary from the previous assignment of well pairs as either "deep" or "shallow". Three discrete units have been identified as follows – 1) an unconsolidated formation defined as the

unconsolidated material overlying bedrock; 2) shallow bedrock, defined as the upper ten feet of bedrock underlying the unconsolidated formation, regardless of depth below ground surface; and 3) deep bedrock which consists of the bedrock formation below the uppermost ten feet of bedrock. This assignment of wells to unique hydrostratigraphic units affects interpretation of results with respect to the spatial distribution of substances of concern.

- Samples collected from wells MW-106D and MW-122D exhibited elevated pH relative to other wells at the site. The cause of the elevated pH is not apparent and could result from either natural processes (e.g., encountering localized carbonate-rich rock) or from man-made processes. Review of well logs indicates that these wells were constructed using 2-inch diameter casing inside 3-inch boreholes. The elevated pH may result from intrusion of cement grout into the screened interval during well construction in these inadequately-sized boreholes. These two wells also exhibit higher dissolved carbonate concentrations than other deep wells.

5.2.6.2 Boron

- Boron contamination is likely present in groundwater at HNP as the orthoborate oxyanion (BO_3^{-3}) which results directly from aqueous dissolution of boric acid (H_3BO_3). Substantial quantities of boric acid solution were historically released from the former HNP tank farm and potentially from other locations within the industrial area. In addition to plant-related boron in groundwater, there appears to be a measurable naturally-occurring boron background concentration. A definitive background boron study has not been performed at HNP, however, inspection of the boron analytical results suggests that a natural boron background concentration of about 50 µg/L or less is present at the site. The actual ionic species of naturally-occuring boron at HNP is not defined and may differ from the orthoborate ion. Observed boron concentrations of greater than 100 ug/L appear to be related to plant-related releases. It is difficult to discern the apparent source of boron concentrations in groundwater between 50 µg/L and 100 µg/L; thus, the distal boundaries of plant-related boron plumes are not clearly defined.

- Monitoring wells have been allocated to unique hydrostratigraphic units based on the relative placement of screened intervals. These units vary from the previous assignment of well pairs as either "deep" or "shallow". Three discrete units have been identified as follows – 1) an unconsolidated formation defined as the unconsolidated material overlying bedrock; 2) shallow bedrock, defined as the upper ten feet of bedrock underlying the unconsolidated formation, regardless of depth below ground surface; and 3) deep bedrock which consists of the bedrock formation below the uppermost ten feet of bedrock. This assignment of wells to unique stratigraphic units affects interpretation of results with respect to the spatial distribution of substances of concern. The highest concentrations of boron observed at HNP are reported in shallow wells, with high concentrations historically found in the immediate vicinity of apparent release areas. The boron concentration in deep bedrock wells is substantially less than that in the areas of apparent contamination, although boron was detected in all but one sample collected in March and samples collected in June. This is consistent with the presence of a measurable boron background at the site.

- Boron is expected to be present in groundwater as a soluble oxyanion and, therefore, the measured concentrations are not expected to be affected by variations in sample turbidity. The low-flow sampling method is expected to produce representative samples for boron analysis.

5.2.7 Lab Audits

No onsite audits or assessments were conducted at the GEL facility during this time period. A commercial grade survey was performed initially, prior to sending samples to the GEL. As a result of this evaluation, GEL was placed on the CYAPCo Approved Suppliers List. In addition, an Annual Supplier Evaluation was performed by the CYAPCo nuclear safety department.

5.2.8 Analytical Bias Assessment

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. Historically, commercial analytical laboratories used by CYAPCo have exhibited some difficulty with the reporting of false-positive results, based on MAPEP performance evaluation (PE) data and trend analysis of analytical sample results. These difficulties were generally limited to radioisotopes analyzed via liquid scintillation counting (LSC) and to a lesser extent, gas proportional counting (GPC).

Positive trends and biases have been observed in the past with the following nuclides analyzed via LSC at levels near the reported MDC: Fe-55, Ni-63, Tc-99 and Pu-241. Low-level analytical positive trends have also been observed for Sr-90, gross alpha and gross beta analyses, which are analyzed via gas proportional counting (GPC). Significant trends with gamma or alpha isotopic analysis results are less common.

A positive bias was observed for C-14 results analyzed via LSC during the March sample event. The magnitude of the positive bias was less than the analysis sensitivity or average MDC. Positive bias was also observed in the gross alpha and gross beta results analyzed by GPC methods. No bias was observed for gamma isotopic analysis methods. Negative biases were observed for Fe-55, Ni-63 and Tc-99, which were all analyzed by LSC.

A positive bias was observed for H-3 analyzed via LSC during the June sample event. The magnitude of the positive bias was less than the analysis sensitivity or average MDC. Positive bias was also observed in the gross alpha, gross beta and Sr-90 results analyzed by GPC methods. A positive bias was observed in the Co-60 results analyzed by gamma spectrometry. A negative bias was observed for Fe-55 results analyzed by LSC.

Statistical and visual methods were employed to evaluate trends in the analytical results as a function of nuclide. Rank order plots for the March and June 2004 sample events

were prepared as a function of nuclide (see Appendix E). The analytical data were treated as follows:

- Net concentration results at all well locations were arranged in ascending order
- Standard distributional statistics were calculated (i.e., mean, median, minimum, maximum and standard deviation for the net concentration, 2-σ TPU and MDC)
- Net concentration results with associated TPU error bars were graphed as a function of rank order
- Expected zero mean concentration and 2-σ zero mean concentration control limits graphed as a function of rank order
- 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, which is subject to the influence from positive outliers. 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.

Statistical methods were used in order to accurately identify and quantify biases in analytical lab data. Some basis statistical parameters for the March and June 2004 events are summarized in Tables 5-10 and 5-11, respectively. These methods included segregation of the analytical data into logical subsets, use of outlier detection methodology, and identification of statistical significant bias. Logical data subsets were typically comprised of an individual nuclide by sample event or sample analysis batch. For LSC analysis, a logical subset may consist of samples counted in a single batch. Due to the number of samples collected, multiple batches may be processed for each analyte in a typical sampling event.

A typical groundwater analysis data subset (i.e., by nuclide) was assumed to be comprised of two distributions, an underlying background or zero analyte component randomly distributed around zero, and an unknown spatially or temporal varying distribution characterized by statistically significant or higher analyte concentrations. In most circumstances, the limiting mean value of the underlying blank is expected to be a constant with random fluctuations normally distributed around zero, after correcting for instrument background or blank conditions. In the case of a systematic bias in the blank, the limiting mean value of the blank distribution will be normal and randomly distributed around a non-zero (i.e., positive or negative) value. When the data are sorted in ascending order with regard to analyte concentration, the underlying background will be distributed on the low analyte concentration end while the spatially or temporally varying analyte results (i.e., statistically significant results), will be distributed on the high concentration end of the data sub-set.

Given the rank order of the data set, a modified Z-score method was used starting on the low analyte concentration end, to identify statistical outliers on the high analyte concentration end of the data set. The Z-score test is a standard statistical method to identify outlier data. Positive outliers as identified were assumed to be nonzero or part of the spatially or temporally distributed data. All others results were considered to be part of the zero analyte or baseline distribution. The limiting mean and standard deviation of these baseline mean results were used as an indicator for technique bias at concentrations near the MDC.

The underlying background or baseline data were evaluated for normality based on Filliben's r-statistic, also known as the normal probability plot correlation coefficient. Filliben's r-statistics near unity are characteristic of normally distributed data. Results of the normality testing for the March and June 2004 sample events are summarized in Tables 5-12 and 5-13, respectively. Standard hypothesis testing was also used to determine if the limiting mean bias was statistically different from zero. The limiting mean baseline results were evaluated for statistical significance using the Student's t-test. In order to concentrate our efforts on analyses with the most significant bias, we used a 3-σ criterion to identify with a high degree of confidence (i.e., at the 99.97 % confidence level) analyses with significant bias with respect to the underlying background or baseline. Our selection of a 3-σ criterion in this case is based on conventional control chart theory where the analytical technique is said to be in control (i.e., no apparent bias) when the observed limiting mean value is within $\pm$ 3-σ of the expected zero analyte concentration. Results of t-testing for the March and June 2004 sample events are also included in Tables 5-12 and 5-13, respectively. Some typical examples of the application of these statistical based methods as a function of general analysis type or nuclide-of-interest are as follows.

5.2.8.1 Gamma Emitters

Manganese-54 is a gamma emitter, determined by photon counting or gamma isotopic analysis. Manganese-54 is produced by neutron reactions with structural stainless steel and has an expected low radionuclide inventory due to a short radioactive half-life of 312.7 days. It has decayed through greater than 7 half-lives since plant shutdown and less than 0.5% of its shutdown activity or inventory remains. Mn-54 is not expected to be present in detectable quantities in groundwater samples from the HNP and is a good candidate analysis to demonstrate a zero analyte or underlying background distribution.

Figure 5-1 is a rank order plot of Mn-54 concentrations in groundwater for the March 2004 sampling event. The Mn-54 results are graphed with their corresponding 2-σ TPU error bars. An average and 1-σ standard deviation concentration of -0.31 $\pm$ 0.73 pCi/L was observed in this data set while the average MDC was 3.1 pCi/L. The control limits are $\pm$ 1.45 pCi/L based on the 2-σ standard deviation of the limiting mean. Approximately half the data points are distributed above or below the zero concentration level. Note that the 2-σ TPU error bars generally cross zero except in the extreme positive or negative regions of the data.

The limiting mean value of -0.31 pCi/L is statistically equal to a zero concentration level based on the t-statistic and 34 (n-1) degrees of freedom. The data are also normally

distributed around the limiting mean value as illustrated by the frequency distribution in Figure 5-2. 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.

Cesium-137 is a gamma emitter, determined by photon counting or gamma isotopic analysis. Cesium-137 is a fission product with a 30.17-year radioactive half-life. Due to a high radionuclide inventory and radioactive half-life, or decay considerations, Cs-137 has been detected in groundwater samples from the HNP.

Figure 5-3 is a rank order plot of Cs-137 concentrations from the March 2004 sampling event. Only results with concentrations less than 10 pCi/L are displayed in order focus attention on the underlying baseline distribution. An average and 1-σ standard deviation concentration of -0.30 ± 1.03 pCi/L was observed for the limiting zero mean while the average MDC was 3.4 pCi/L. The control limits are ± 2.06 pCi/L based on 2-σ standard deviations of the limiting mean. Results with concentrations greater than 2.84 pCi/L were determined to be statistically different from the underlying background based on outlier testing. The baseline data are normally distributed around the limiting mean value of -0.30 pCi/L in Figure 5-4 and the limiting mean value is not statistically different from zero, based on the t-test. These results are again typical of gamma isotopic analysis with zero analyte data.

Cobalt-60 is a gamma emitter with a high radionuclide inventory at HNP due to its presence in structural material. Cobalt-60 has a radioactive half-life of 5.271-years and about 42% of its shutdown inventory or activity remains. Cobalt is a common impurity in stainless steel and is the dominant external dose producing isotope in reactor interior components on a 10-year time scale.

Figure 5-5 is a rank order plot of Co-60 concentrations in groundwater for the June 2004 sampling event. An average and 1-σ standard deviation concentration of 0.43 ± 0.74 pCi/L was observed for the limiting zero mean while the average MDC was 3.5 pCi/L. The control limits are ± 1.48 pCi/L based on 2-σ standard deviations. The baseline data are normally distributed around the limiting mean value of 0.43 pCi/L (Figure 5-6). The limiting mean is statistical greater than zero based on the t-test. There were six (6) positive outliers in this Co-60 data set.

It is important to note that Co-60 is also a common trace contaminant in materials used in the construction of high-purity germanium (HPGe) detectors. These HPGe detectors are used for the gamma isotopic analyses. It is not uncommon to observe Co-60 peak background response rates on the order of 0.001 count per second, depending on the HPGe detector size and configuration. Given the sensitivity requirements for these analyses, the ability to accurately distinguish low-level Co-60 (i.e., pCi/L amounts) in groundwater from the detector background contribution is non-trivial. These results are typical of gamma isotopic analysis where the underlying baseline distribution is homogenous and normally distributed, and the presence of statistically significant Co-60

is indicated near the MDC. In the past, we have observed positive biases for Co-60 on the order of.0.4 pCi/L.

5.2.8.2 Beta and X-Ray Emitters via LSC

Figure 5-7 is a rank order plot of C-14 concentrations in groundwater for the March 2004 sampling event. C-14 is a beta emitter, determined by chemical separation and LSC. Due to an expected low radionuclide inventory, C-14 is not expected to be present in detectable quantities in groundwater samples from the HNP. An average and 1-σ standard deviation concentration of 72.3 ± 41.0 pCi/L was observed in this data set while the average MDC was 155 pCi/L. The control limits are ± 82.0 pCi/L based on the average 2-σ standard deviation. Note that all of the data points are distributed above the zero concentration level.

The limiting mean value of 72.3 pCi/L is statistically greater than the zero concentration level based on the t-statistic and 11 (n-1) degrees of freedom. The data are also normally distributed around the limiting mean value as illustrated by the frequency distribution in Figure 5-8. A significant positive bias is indicated in this trend plot and the data are equally distributed around the limiting mean. These results are typical of LSC analysis where a significant positive systematic bias in the underlying baseline distribution exists.

Figure 5-9 is a rank order plot of Fe-55 in water for the June 2004 sampling event. Iron-55, which decays by electron capture and subsequent X-ray emission, is determined by LSC analysis. Iron-55 has a radioactive half-life of 2.7-years and only 19% of its shutdown inventory or activity remains. An average and 1-σ standard deviation concentration of -22.8 ± 4.1 pCi/L was observed in this sample event data set with an average MDC of 11.7 pCi/L. The Fe-55 data are normally distributed around the limiting mean value of -22.8 pCi/L as indicated in Figure 5-10. The limiting mean value is statistically less than zero, based on the t-test. These results are typical of LSC analysis where a significant negative systematic bias in the underlying baseline distribution exists. In the past, we have observed both positive and negative biases with Fe-55 analytical results. This suggests that the analytical laboratory has some difficulty in determining the appropriate analytical blank contribution for Fe-55.

Similar results were obtained for other LSC radionuclides. CYAPCo will continue to statistically evaluate and monitor these data. In the meantime, we will report the data *as is* in order to evaluate any dose risk associated with groundwater monitoring in a conservative manner.

5.2.8.3 Beta and Alpha Emitters via GPC

Figure 5-11 is a rank order plot of Sr-90 in water for the June 2004 sampling event. An average and 1-σ standard deviation concentration of 0.43 ± 0.39 pCi/L was observed in the limiting mean baseline data set after removing statistically significant or positive outliers. The control limits are ± 0.78 pCi/L based on the average 2-σ standard deviation of the limiting mean. Results with concentrations greater than 1.1 pCi/L were determined to be statistically different from the underlying background based on outlier testing. It is easy to visually identify the transition from the underlying background

data to the statistically significant data in Figure 5-11. Note that 27 of the 32 reported Sr-90 results for this data set were greater than the zero concentration.

The baseline Sr-90 data consisted of 24 data points and were normally distributed around the limiting mean value of 0.43 pCi/L as indicated in Figure 5-12. The baseline limiting mean value was statistically greater than zero based on the t-test. These results are typical of GPC analysis where a positive systematic bias in the underlying baseline distribution exists.

Similar results were obtained for gross alpha and gross beta analyses performed via GPC. In the case of gross alpha and gross beta, the positive trends observed in these analyses, is actually attributed to natural levels of gross alpha and beta radioactivity.

5.2.8.4 HTD Alpha Emitters

Figure 5-13 is a rank order plot of Cm-242 concentrations in groundwater for the June 2004 sampling event. Curium-242 is an alpha emitter with an expected low radionuclide inventory at HNP due to radioactive decay. Curium-242 has a radioactive half-life of 163.2 days and has decayed through greater than 14 half-lives since shutdown. Since less than 0.01% of the shutdown activity or inventory remains, Cm-242 is not expected to be present in detectable quantities in groundwater samples from the HNP.

An average and 1-σ standard deviation concentration of 0.004 ± 0.017 pCi/L was observed in this data set while the average MDC was 0.18 pCi/L. The control limits are ± 0.034 pCi/L based on 2-σ standard deviations in the analytical blank. Note that the individual 2-sigma error bars generally span the region of the control limits except in the negative regions of the graph. Here the 2-σ TPU is underestimated due to the presence of zeros in the analytical counting results. This is characteristic of low-level alpha counting where zero results are sometimes observed (i.e., zero counts observed in the detector region-of-interest) during the finite counting interval.

The baseline data are normally distributed around the limiting mean value of 0.004 pCi/L in Figure 5-14 and the limiting mean value is not statistically different from zero, based on the t-test. Low-level counting data are not expected to be normal, around a limiting mean value. This is a characteristic of low-level alpha counting where the expected shape of the limiting mean distribution is Poisson in nature. The Poisson distribution is asymmetric and representative of a distribution that is bounded by zero on the low frequency side. T-test results for low-level counting are only qualitative in nature, since normality is a required condition for this statistical test. CYAPCo will continue to develop statistical tests to evaluate this low-level counting data in the future. As expected, no significant Cm-242 activity is indicated in this trend plot. These results are typical of low-level alpha isotopic analysis where no analyte is present.

Figure 5-15 is a rank order plot of Am-241 concentrations in groundwater for the June 2004 sampling event. Americium-241 is an alpha emitter that has been detected in HNP process streams attributed to failed fuel. An average and 1-σ standard deviation concentration of 0.023 ± 0.049 pCi/L was observed in this data set while the average MDC was 0.23 pCi/L. The control limits are ± 0.098 pCi/L based on the average 2-σ

TPU in the analytical blanks. Note that the individual 2-sigma error bars generally span the region of the control limits except in the negative regions of the graph.

The data are normally distributed around the limiting mean value of 0.023 pCi/L in Figure 5-16. This is not expected based on the typical count rates observed via alpha counting as previously discussed. The limiting mean value of 0.023 pCi/L is not statistically greater than zero analyte level based on the t-statistic and 39 (n-1) degrees of freedom. Note that a slight elevation in Am-241 activity is indicated in this trend plot as compared to the Cm-242 trend plot and as 27 of 39 results are greater than zero concentration. No significant positive trends were observed with other alpha isotopic data.

In the past CYAPCo lab vendors have had some minor difficulties with "false positive" detects for Am-241 during the course of performance evaluation (PE) testing. It is important to note that Am-241 is a common alpha-emitting radiotracer used in the radiochemistry lab. Solid-state alpha detectors are subject to recoil contamination after repetitive source and sample analysis. Alpha recoil contamination, which increases the detector background, occurs when fragments from the source or sample are implanted in the detector surface, by the recoil energy imparted on the nucleus of an alpha-emitting atom. Solid-state alpha detector background rates are extremely low, typically on the order of 1 count per 100,000 seconds. Given typical sample analysis parameters and the sensitivity requirements for these analyses, the ability to accurately distinguish sub-pCi/L amounts of Am-241 groundwater from the detector background contribution is non-trivial. These results are typical of low-level alpha isotopic analysis where the underlying baseline distribution is subject to large fluctuations due to the extremely low ambient background count rate.

5.2.8.5 Radiochemical Bias Summary

Attached in Table 5-14 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. Know statistically positive results were removed from these summaries. Only about 3.2% 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 for the March and June 2004 sample events indicated overall positive activity rates of 0%, which also indicates no significant alpha activity present in these samples with minimal bias in the analytical technique at levels near the MDC.

The percentage of HTD beta results determined via LSC and with concentration levels greater than 2-σ TPU ranged from 4.3% to 1.9%. These results were generally normally distributed around a limiting mean concentration in most cases. Only 2 of the 12 LSC

analyses indicated limiting mean distributions that were positive. Negative limiting mean distributions were observed for 4 of the 12 LSC analyses
Factors that may affect the uncertainty of radiological analyses, and the ability to discern plant-related activity from the natural background activity include; interference from naturally occurring radionuclides due to incomplete radiochemical separation, specificity of radiochemical counting technique, and difficulty in identifying the ambient background or blank contribution. In low-level radiochemical counting, these limitations are imposed by the accurate determination of the systematic and random uncertainty associated with the analytical blank. Generally speaking, gamma isotopic and alpha isotopic analyses are the most specific counting methods with the least amount of systematic bias in the underlying background or blank. GPC and LSC are less specific counting methods and may be subject to systematic and random variability in the underlying blank distribution. CYAPCo will continue to statistically evaluate and trend lab data in order to understand limitations and irregularities in analytical results.

Based upon the work performed during the implementation and development of this Groundwater Monitoring Report for the March and June 2004 quarterly sampling events, the following conclusions and recommendations have been developed for the radiochemical analyses presented in this report:

- Systematic biases were observed in several of the HTD analyses based on statistical and graphical evaluations of the reported analytical data. Negative biases were observed for several radioisotopes analyzed by LSC. The affected analyses included Fe-55, Ni-63 and Tc-99.
- Positive systematic biases were observed in several of the HTD analyses by LSC and GPC. The affected analyses included gross alpha, gross beta, He-3, C-14 and Sr-90. An overall false positive rate on the order of 1.9% was observed for the LSC analyses results. This is nominally similar to the expected false positive rate of 2.5%, which is a noted overall improvement in the LSC analyses.
- A positive bias was also observed for Co-60 which is a gamma emitter. CYAPCo will continue to statistically evaluate and trend the biases identified within this report.
- Field collected and laboratory completed QA/QC sample results were within acceptable protocol ranges for all analyses.
- External laboratory performance evaluation data was excellent for all gamma emitters and good to average for the alpha and beta HTD analysis. Less than 50% of the false positive test results were in the acceptable or acceptable with warning range.
- Internal laboratory performance evaluation data was excellent for all analyses. Greater than 98% of the results met the acceptance criteria.

5.3 Data Quality Summary

Analysis of radiochemical constituents was performed on unfiltered water samples collected from groundwater monitoring wells at HNP during March and June 2004. In addition, filtered and unfiltered samples were analyzed at several locations to evaluate the presence of radiochemical and boron dissolved species (as observed in the filtered

sample results) as well as species associated with suspended particulate in the groundwater (as observed in the unfiltered sample results, which represent both dissolved and suspended contents). Selected groundwater samples were field filtered using 0.45 micrometer in-line filters prior to preservation.

Overall, assessments of QA/QC information indicate that groundwater monitoring data are acceptable for groundwater characterization and monitoring efforts. Groundwater sampling was performed in accordance with sample plans and work processes. No contamination or other sampling-related problems were identified that affected data integrity in the field. Laboratory external performance data was good to excellent for all constituents. MAPEP performance results for false positive testing requires some improvement. Laboratory internal performance data was good to excellent for all constituents but boron, which requires improvement. Measurement of boron and radiochemical constituents in samples collected from HNP met the identified data quality metrics for these two sampling events.

6 Spatial and Trend Analysis

6.1 Spatial Distribution of SOCs

The spatial distribution of detected SOCs (boron, tritium, Sr-90) have been mapped for the unconsolidated, shallow bedrock, and deep bedrock deposits hydrostratigraphic units for the March and June 2004 sampling events, and are summarized below. The shallow bedrock hydrostratigraphic unit is defined as bedrock within 10 feet of the unconsolidated/bedrock boundary. Bedrock greater than 10 feet below the bedrock surface is considered deep bedrock.

There is uncertainty in mapping groundwater flow and contaminant distribution in fractured rock. The maps of contaminants in shallow and deep bedrock, and the text discussing spatial distribution is intended to show general distribution of contaminants; actual flow through the fractured rock may vary significantly from that depicted and discussed. The inferred distribution of SOCs represent interpretations of site conditions.

6.1.1 Spatial Distribution of SOCs from March 2004 Groundwater Sampling

The concentrations of boron, tritium, and ,mmSr-90, for the March 2004 sampling results for the industrial area and peninsula area are displayed on Figures 6-1 and 6-2. A discussion of the distribution of the SOCs in each hydrostratigraphic unit is presented in the following sections.

6.1.1.1 Boron

Boron is detected in all three of the hydrostratigraphic units at concentrations ranging from non-detect up to 735 µg/L. There is no MCL established for boron. A discussion of the boron distribution in groundwater for the three hydrostratigraphic units is presented in the following sections.

Unconsolidated deposits hydrostratigraphic unit:

In the unconsolidated deposits (Figure 6-3), boron concentrations appear highest around the southwest and southern perimeter of the RCB in MW-105S (735 µg/L) and MW-106S (670 µg/L), with plume concentration decreasing to the south and southeast. As discussed in Section 2, the discharge tunnel is located south of the RCB and forms a barrier for flow in the unconsolidated deposits. In the area of the discharge tunnel, groundwater flow in the unconsolidated unit is redirected to the southeast where the tunnel base is no longer on/in bedrock. East of the discharge tunnel the unconsolidated unit thickens considerably, and groundwater flow in the unconsolidated unit continues due south toward the Connecticut River (Figure 6-3). The effects of the discharge tunnel are clearly reflected in the boron distribution as the boron plume wraps around the tunnel and continues to the south and southeast towards the Connecticut River (Figure 6-3).

A second, lower concentration plume occurs in the western portion of the industrial area. Elevated boron concentrations are observed in MW-100S (212 µg/L), MW-104S (299 µg/L), MW-124 (228 µg/L), and MW-109S (254 µg/L). Elevated boron was observed in this portion of the site in previous studies. These monitoring wells form a plume of elevated boron south from MW-100S south towards the Connecticut River. This second boron plume is not associated with tritium or other radionuclides suggesting a source other than borated water from the power plant process.

Shallow bedrock hydrostratigraphic unit:
In the shallow bedrock boron is detected in both the western and eastern portions of the industrial area. Elevated boron is detected in MW-109D (210 µg/L) and MW-123S (107 µg/L) located in the eastern portion of the industrial area. Boron is also detected in a plume extending south from MW-103S (85.7 µg/L), past MW-107D (38 µg/L), and on to MW-110D (179 µg/L) (Figure 6-4). Both areas of detected boron appear to flow from north to south towards the Connecticut River (Figure 6-4).

The highest concentrations of boron in both plumes occurs in the downgradient portion of the plume and higher boron concentrations have been historically observed in the upgradient wells associated with both plumes. This suggests that a slug of elevated boron has historically migrated through the industrial area towards the Connecticut River.

Deep bedrock hydrostratigraphic unit:
One area of elevated boron occurs within the bedrock hydrostatic unit (Figure 6-5). Boron is detected in several monitoring wells in the vicinity of the RCB including MW-122D (224 µg/L), MW-102D (113 µg/L and MW-103D (90.9 µg/L). The remainder of the deep bedrock boron detections are below 75 µg/L and may represent background conditions.

6.1.1.2 Tritium

Tritium is detected in all three of the hydrostratigraphic units at concentrations ranging from non-detect up to 12,000 pCi/L. All detections in all three hydrostratigraphic units are under the C_4 concentration for tritium of 20,000pCi/L.

Unconsolidated deposits hydrostratigraphic unit:
In the unconsolidated deposits (Figure 6-6), tritium was detected above activity concentrations of 1,000 pCi/L in two locations. One of these locations exists in a fairly small area southwest of the RCB in MW-105S (5,520 pCi/L). This elevated tritium appears to extend southwest along the probable path of groundwater flow around the northwest end of the discharge tunnel including MW-124 (1,530 pCi/L), as the water level in MW-124 is significantly less than that measured in MW-105S (Figure 6-6).

The second area with concentrations above 1,000 pCi/L occurs form the northeast side of the RBC southeastwards towards the discharge canal (Figure 6-6). This plume of elevated tritium includes monitoring wells MW-115S (5,740 pCi/L), MW-114S (1,350 pCi/L), MW-125 (2,350 pCi/L) and MW-110S (2,050 pCi/L) and is interpreted to flow from the RCB, past the discharge canal, and towards the Connecticut River.

Shallow bedrock hydrostratigraphic unit:
In the shallow bedrock (Figure 6-7), tritium is detected to the north of the RCB in MW-103S (1,090 pCi/L) and northeast of the RCB in MW-102S (6,740 pCi/L). based on the groundwater contour maps for the shallow bedrock, it appears that groundwater flows from the east side of the RCB, and then continues south toward the Connecticut River, passing through the area of MW-110D (5,890 pCi/L) Figures 6-7, 2-6 and 2-7).

A second distinct area of elevated tritium in the shallow bedrock occurs at MW-109D where 4550 pCi/L is detected (Figure 6-7).

Deep bedrock hydrostratigraphic unit:
In the deep bedrock (Figure 6-8), tritium is detected in the vicinity of the RCB, and appears to be centered around the north and east edge in MW-103D (12,000 pCi/L) and MW-102D (4,940 pCi/L). There are no deep bedrock monitoring wells south of the eastern edge of the RCB to determine if the deep bedrock tritium is moving south of its current location, but the effects of the mat sump most likely limit the southward migration (Figures 2-8 and 2-9). The general groundwater flow direction in the deep bedrock is to the south and southeast towards the Connecticut River as tidal effects are present in the deep bedrock monitoring wells. The deep bedrock plume is bounded on the south of the RCB by monitoring well MW-106D (1,110 pCi/L).

6.1.1.3 Strontium-90

Sr-90 is detected in all three of the hydrostratigraphic units at concentrations ranging from non-detect up to 91.8 pCi/L. The C_4 concentration for Sr-90 is 8 pCi/L. One well (MW-105S) exceeds that concentration at 91.8 pCi/L.

Unconsolidated deposits hydrostratigraphic unit:
In the unconsolidated deposits hydrostratigraphic unit the highest Sr-90 is detected in MW-105S (91.8 pCi/L) located adjacent to the southwest side of the RCB (Figure 6-9). Additional detected Sr-90 occurs in MW-114S (3.92 pCi/L), MW-115S (1.64 pCi/L), and MW-106S (1.21 pCi/L). These three monitoring wells are located adjacent to the northeast and southeast sides of the RCB, and along with MW-105S form a plume of Sr-90 that flows around the discharge tunnel the south towards MW-125 (3.15 pCi/L) (Figure 6-9). Based on the groundwater flow maps developed for the unconsolidated unit, it appears that the Sr-90 is migrating south toward the Connecticut River (Figures 2-4 and 2-5).

Shallow bedrock hydrostratigraphic unit:
In the shallow bedrock Sr-90 is detected in three isolated monitoring wells, MW-103S (2.27 pCi/L) just north of the RCB, MW-123 (0.866 pCi/L), west of B Switchgear building, and in MW-110D (0.657 pCi/L) located south of the discharge canal (Figure 6-10). Based on the limited data available in the vicinity of the RCB and the PAB in this hydrostratigraphic unit and the non-detect values in all of the other monitoring wells, no distinct plume can be mapped in the shallow bedrock hydrostratigraphic unit.

Deep bedrock hydrostratigraphic unit:
In the deep bedrock hydrostratigraphic unit Sr-90 was detected only in monitoring wells MW-122D (0.552 pCi/L) east of the RCB. All other deep bedrock monitoring wells had non-detect Sr-90 concentrations (Figure 6-11).

6.1.2 Spatial Distribution of SOCs from June 2004 Groundwater Sampling

The concentrations of boron, tritium, and Sr-90 for the June 2004 sampling results for the industrial area, EOF, parking lot, and peninsula area are displayed on Figures 6-12, 6-13, and 6-14. A discussion of the distribution of the SOCs in each hydrostratigraphic unit is presented in the following sections.

6.1.2.1 Boron

Boron is detected in all three of the hydrostratigraphic units at concentrations ranging from 10.4 µg/L up to 1260 µg/L. There is no MCL established for boron. A discussion of boron in the three hydrostratigraphic units follows.

Unconsolidated deposits hydrostratigraphic unit:

In the unconsolidated deposits (Figure 6-15), boron concentrations appear highest around the perimeter of the RCB. The highest boron concentration occurs in MW-114S (1,260 µg/L) located adjacent to the northeastern portion of the RCB. Elevated boron concentrations also occur in MW-105S (484 µg/L) and MW-106-S (490 µg/L) south of the RCB. Consistent with the groundwater flow contours in the unconsolidated unit, a plume of boron occurs the south and east of the RBC with concentration decreasing to the south (Figures 2-10, 2-11 and 6-15). The discharge tunnel forms a barrier for flow in the unconsolidated deposits, so flow is redirected south east past where the tunnel base is no longer on/in bedrock, and then continues due south toward the Connecticut River. The boron distribution in the southeastern, downgradient portion of the plume is characterized by MW-125 (445 µg/L) and MW-110S (291 µg/L).

A second, lower concentration plume occurs in the western portion of the industrial area. Elevated boron concentrations are observed MW-104S (274 µg/L), MW-124 (225 µg/L), and MW-109S (124 µg/L). These monitoring wells form a plume of elevated boron that flows south from MW-104S south towards the Connecticut River, consistent with mapped groundwater flow in the unconsolidated unit (Figures 6-15, 2-10 and 2-11). This second boron plume is not associated with tritium or other radionuclides suggesting a source other than borated water from the power plant process.

Shallow bedrock hydrostratigraphic unit:
The distribution of boron in the shallow bedrock unit defined by the June 2004 data is similar to the distribution mapped for the March 2004 results. Two linear areas of elevated boron occur in the eastern and western portions of the industrial area (Figure 6-16). Boron concentrations are detected in MW-103S (165 µg/L) and along a linear plume running from just east of the RCB near MW-102S (92.1µg/L), south through MW-110D

(236 µg/L). A second, lower concentration location area occurs at MW-101S (68.6µg/L), continuing south through MW-123S (90 µg/L) and MW-120D (191 µg/L). Based on the groundwater flow maps interpreted for the shallow bedrock, both plumes appear to be flowing in the general direction of the Connecticut River (Figures 6-16, 2-12 and 2-13).

Deep bedrock hydrostratigraphic unit:
Boron concentrations in the deep bedrock are highest in MW-122D (223 µg/L), declining north and south of that location (Figure 6-17). All other detections are below 100 µg/L.

6.1.2.2 Tritium

All detections in all three hydrostratigraphic units are below the C_4 concentration for tritium of 20,000 pCi/L. Elevated tritium concentrations are observed in all three hydrostratigraphic units, with the highest concentration observed in the unconsolidated unit.

Unconsolidated deposits hydrostratigraphic unit:
Similar to the tritium distribution of tritium mapped from the March 2004 results, detections of tritium appear to be distributed primarily in two locations (Figure 6-20). The first location appears just east of the RCB at MW-114S (6,730 pCi/L) and forms a plume that flows south, consistent with the mapped groundwater contours, through MW-125 (2,170 pCi/L) and MW-110S (1,010 pCi/L) toward the Connecticut River (Figures 6-18, 2-10, and 2-11).

The second area occurs at MW-105S (3,350pCi/L). Elevated tritium levels are also observed at MW-124 (1,770 pCi/L), and based on the lower groundwater level in MW-124, are interpreted to flow from the area of MW-105S between the primary auxiliary building and the northwest end of the discharge tunnel (Figures 6-20, 2-10, and 2-11). There remains uncertainty regarding actual connection of inferred SOC plumes in this area.

Shallow bedrock hydrostratigraphic unit:
In the shallow bedrock detections of tritium appear to be distributed primarily in two locations (Figure 6-21). The first appears similar to the eastern distribution in the unconsolidated hydrostratigraphic unit identified in the March 2004 results (Figures6-7 and 6-20). Elevated tritium concentrations are observed north and east of the RCB in MW-103S (5,300 pCi/L) and MW-102S (5,740 pCi/L), and continuing on south through MW-110D (8,300 pCi/L), toward the Connecticut River, consistent with the mapped groundwater contours for the shallow bedrock (Figures 2-12 and 2-13).

The second location of elevated tritium is detected in MW-109D (3,140 pCi/L), and from there along the mapped groundwater flow direction south toward the Connecticut River (Figures 2-12 and 2-13).

Deep bedrock hydrostratigraphic unit:
Tritium in the deep bedrock stratigraphic unit is focused in the area of the RCB. The highest concentrations occur north of the RCB in MW-103D (6,530 pCi/L) and MW-102D (4,690 pCi/L). Lower tritium concentrations occur in MW-106D (1,520 pCi/L) south of

the RCB. The lack of deep bedrock monitoring wells further to the south do not allow the plume to be further characterized in that area.

6.1.2.3 Strontium 90

Sr-90 is primarily detected in the unconsolidated and shallow bedrock hydrostratigraphic units with concentrations ranging from non-detect to 16.2 pCi/L. The C_4 concentration for Sr-90 is 8 pCi/L, which is exceeded in MW-105S. The Sr-90 distribution in the three hydrostratigraphic units is discussed in the following sections.

Unconsolidated deposits hydrostratigraphic unit:

The highest Sr-90 concentrations in the unconsolidated unit are located adjacent to and south of the RCB (Figure 6-21). The highest Sr-90 concentration occurs in MW-105S (16.2 pCi/L) with 3.7 pCi/L detected in MW-106S located south of the RCB (Figure 6-21). As groundwater cannot flow south of the discharge tunnel, Sr-90-contaminated groundwater appears to flow around both the east and west ends of the tunnel and is detected in MW-124 (1.33 pCi/L) and MW-125 (1.78 pCi/l). Low Sr-90 concentrations are observed in MW-109S (0.801 pCi/L) and MW-110S (0.689 pCi/L), both located downgradient of the higher concentrations (Figures 6-21, 2-10, and 2-11).

Although MW-105S had the highest Sr-90 concentration in the June sampling event, MW-105 exhibited the lowest concentration of Sr-90 observed since monitoring for that constituent began in 1992 (Appendix H). While the cause of this relatively large decline in concentration is not clearly identified, a number of conditions may have contributed to the decline. These possible explanations are discussed below:

- MW-105 has exhibited measurable turbidity during all previous sample events. The well was redeveloped prior to the June 2004 sampling event. Subsequent radiochemical analysis of a sample of the sediment removed during redevelopment indicated measurable Sr-90 in the sediment. Contaminated sediment in the well may have contributed the historical elevated Sr-90 concentration causing a localized area of elevated groundwater.
- The former contaminated wastewater handling activities that were conducted in the tank farm were discontinued within the past two years and the primary source material was removed. This remedial activity was performed inside the containment tent constructed over the tank farm. Both the removal of the source of contamination and the placement of the tent over the residual contaminated soil, thus eliminating local recharge of precipitation infiltrating through the contaminated soil, may have reduced the Sr-90 contribution to the groundwater.
- Active dewatering was initiated early in 2004. This activity lowered the water level in the tank farm and in the vicinity of MW-105 and may have reduced continuing contamination contribution from subsurface soils to the groundwater.

Shallow bedrock hydrostratigraphic unit:

Sr-90 was detected in only one monitoring well in the shallow bedrock hydrostratigraphic unit. Monitoring well MW-103S located north of the RCB had a concentration of 1.34 pCi/L (Figure 6-22). All of the other monitoring wells were non-detect for Sr-90.

Deep bedrock hydrostratigraphic unit:
In the deep bedrock Sr-90 was detected in the vicinity of the RCB in MW-122D (3.29 pCi/L), 102S (0.928 pCi/L), MW-105D (1.11 pCi/L), and MW-103D (1.26 pCi/L) (Figure 6-23). All of the other deep bedrock monitoring wells were non-detect for Sr-90. The detection of Sr-90 in MW-122D is greater than recent monitoring results (Appendix H). Evaluation of the monitoring well indicates that the well cap was not secured, indicating the potential for sample bias.

6.2 Trend Analysis of SOCs

6.2.1 Boron Trend Analysis

There has been a general decrease in the observed maximum boron concentration at HNP since March 1999. Boron concentrations have generally fluctuated over the time-frame of the GWMP without any discernable temporal or spatial trends. The boron quarterly monitoring analytical results from March 1999 through June 2004 are summarized in Table 4-1. Time series plots of the boron concentrations from March 1999 to June 2004 are provided in Appendix F.

The higher boron concentrations have generally been detected in the shallow wells, typically those wells screened in the unconsolidated deposits hydrostratigraphic unit. Boron levels in deep bedrock wells have typically been relatively low compared to wells completed in shallower intervals, probably reflective of background concentrations. This generalization is well illustrated by the time series plot of well pair MW100S and 100D. Boron concentrations that have fluctuated greatly in MW100S, screened in the unconsolidated deposits, ranging as high as 1,145 µg/L as recently as June 2003, to a stable trend of non-detections exhibited in MW-100D, a deep bedrock well. Similar trends are also shown in the MW105S/D andMW106S/D well pairs, both of which have shown greatly elevated boron concentrations in the shallow unconsolidated deposits wells and low boron levels in the deep bedrock wells probably near background concentrations.

Attached in Figure 6-24 is a box plot for Boron concentrations as a function of time ranging from March 1999, through June 2004. Box plots provide a mechanism to graphically compare 2 or more sets of data, in this case, temporal or seasonal groundwater monitoring results from multiple quarterly sampling events. In particular, trends with respect to the median, extreme values and data dispersion over time are visually evident. The median value provides an unbiased central tendency of the data that is not affected by extreme outliers. The position of the median value in the vertical box provides information regarding the symmetry of the inter-quartile range when viewed on a linear scale. The inter-quartile range describes the spread of the central 50% of the data. The length of the vertical boxes shows the extent of the inter-quartile range. The length of the vertical lines or whiskers shows the overall extent of the data above and below the inter-quartile range. We have selected a log concentration scale since the detectable concentrations ranged over 2 or more orders of magnitude.

The box plot displays a quartile summary of quarterly sample event data with some key statistics. The quarterly sample event results are sorted in increasing numerical order and divided into 2 groups at the median or second quartile (Q_2). The median of the lower group is the first quartile (Q_1) and the median of the upper group is the third quartile (Q_3). The difference between Q_3 and Q_1 is the inter-quartile range and is represented by the central vertical box or rectangle in the box plot diagram. The horizontal line dividing the central vertical box is the second quartile (Q_2) or median value of the data set. The two lines extending out from the center box are the whiskers and the end points in this case represent the minimum or zero quartile (Q_0) and maximum or fourth quartile (Q_4) values.

The plotted values in Figure 6-24 display results for all wells sampled during the sampling event with concentrations greater than the method detection limit (MDL). There has been a general decrease in the observed maximum boron concentration since March 1999. Median results have fluctuated from a low of about 45 µg/L in June 2001 to a high of 188 µg/L during September of 2002 with no apparent temporal or seasonal trend.

6.2.2 Gross Alpha Trend Analysis

Gross alpha concentrations for the past 10 sample events for unconsolidated, shallow and deep bedrock wells are plotted in Figures 6-25 through 6-27. Higher gross alpha levels were generally detected in the deeper wells completed in bedrock during these sampling events (Figures 6-26 and 6-27). The source of most of the activity is erosion of naturally occurring alpha-emitting nuclides that are likely present in the granitic gneiss bedrock. Natural levels of gross alpha activity can range as high as a few hundred pCi/L, when special sampling techniques designed to capture the volatile and short-lived natural alpha emitters are observed. Although it is possible that plant-related radionuclides contribute to some of the observed gross alpha activity, it is not probable since alpha isotopic analysis generally results in non-detects with nominal detection sensitivity on the order of 0.3 pCi/L or less.

Figure 6-28 is a box plot for site-wide gross alpha concentrations as a function of time ranging from December 2001, through June 2004. Plotted values in this case represent statistically significant results with concentrations greater than the 2-σ TPU. The maximum gross alpha concentration has ranged from 7.8 to 28.8 pC/L since December of 2001. Median results have fluctuated from a low of about 1.3 pCi/L to a high of 5.1 pCi/L. There were no apparent temporal or seasonal trends.

6.2.3 Gross Beta

Gross beta results for the two quarterly sampling events are summarized in Table 4-2. Gross beta results ranged from 1.6 to 490 pCi/L. The CT Public Drinking Water Quality Standard screening level for gross beta radioactivity is 50 pCi/L though natural levels may range as high as a few hundred pCi/L.

As shown on Table 4-2, gross beta activity at high levels roughly correlates with Sr-90 (a beta emitter) data, in that the highest concentration of Sr-90 is also found in MW-105S. Another beta emitter which contributes to gross beta activity is Cs-137 and has been detected in MW-102D, MW-103S and MW-115S. Table 4-2 shows that groundwater from these locations also has relatively high concentrations of gross beta activity.

Gross beta concentrations from the past 10 sample events for unconsolidated, shallow and deep bedrock wells are plotted in Figures 6-29 through 6-31. With the exception of wells MW-103S, MW-105S, MW-106S and MW-102D which have measured levels of Sr-90 and Cs-137, gross beta results are all less than the CT Public Drinking Water Quality Standard screening level of 50 pCi/L.

Figure 6-32 is a box plot for site-wide gross beta concentration as a function of time ranging from December 2001, through June 2004. The maximum gross beta concentration has ranged from 142 to 490 pC/L, since December of 2001. Median results have fluctuated from a low of about 5.4 pCi/L, to a high of 10.0 pCi/L. There are no apparent temporal trends associated with gross beta results. There does appear to be a seasonal trend associated with the maximum gross beta results. The maximum gross beta levels observed to date are at MW-105S, and these levels tend to coincide with sampling events associated with peak groundwater elevation including March and June time periods.

6.2.4 Tritium Trend Analysis

There has been a general decrease in tritium activity concentrations at HNP since the quarterly GWMP sampling was implemented in March 1999. A summary of tritium results from the GWMP is provided in Table 4-3. The higher tritium activity concentrations have typically been exhibited in the bedrock wells, notably deep bedrock wells MW-102D and MW-103D, and shallow bedrock well MW-110D. MW-105S, a well screened in the unconsolidated deposits hydrostratigraphic unit, has historically displayed the highest tritium activity concentrations at the facility. None of these wells detected tritium above the EPA MCL of 20,000 pCi/L during the March and June 2004 sampling events. Time series plots showing tritium activity concentrations from the GWMP quarterly sampling events are shown in Appendix G.

Historically, the highest tritium activity concentration observed at MW-102D was 28,630 pCi/L during the June 2003 sample event (see Figure 6-33). Tritium results for MW-102D ranged from 4,940 to 4,690 pCi/L, in March and June 2004, respectively, suggesting a leveling off in the concentrations at this well. MW-102D, a deep bedrock well, exhibited fairly stable tritium concentrations in the 20,000-pCi/L range over the sampling events prior to December 2001.

Since December 2001, tritium levels in MW-103D have ranged from 8,100 pCi/L to 12,900 pCi/L, suggesting a substantial short-term decrease in concentrations in this well (see Figure 6-34). Analytical results for MW-103D ranged from 12,000 pCi/L during the March 2004 event to 6,530 pCi/L during the June 2004 event.

Tritium levels in well MW-110D have decreased substantially from the 27,630 pCi/L detected when quarterly monitoring commenced in March 1999. In December 2002,

tritium levels decreased to 11,100 pCi/L (see Figure 6-35). Results have ranged from 5,890 pCi/L in March 2004, to 8,300 pCi/L, during the June 2004 sampling event.

The highest tritium concentration recorded to date was 138,700 pCi/L at well MW-105S during the March 1999 sampling event. There has been a significant downward trend in tritium concentrations at this well with results ranging from 5,520 to 3,280 pCi/L during the March and June 2004 sampling events (see Figure 6-36).

There has been a significant upward trend in tritium concentrations at MW-114S with results ranging from 1,350 to 6,730 pCi/L during the March and June 2004 sampling events (see Figure 6-37).

Tritium concentrations from the past 10 sample events for unconsolidated, shallow and deep bedrock wells are plotted in Figures 6-38 through 6-40. With the exception of well MW-102D, all H-3 results during these sample events were less than the EPA MCL of 20,000 pCi/L.

Figure 6-41 is a box plot for site-wide H-3 concentrations as a function of time ranging from March 1999, through June 2004. Maximum H-3 concentrations have ranged from 13,900 to 28,630 pCi/L since September of 1999. Median results from have fluctuated from a low of about 1170 pCi/L to a high of 4430 pCi/L during this same period. There were no apparent seasonal trends in the median results. An overall downward trend in the site-wide median H-3 concentrations has been observed since March 1999.

6.2.5 Strontium-90 Trend Analysis

Tables 4-2 summarizes Sr-90 concentrations from the quarterly sampling events. Historically, monitoring well MW-105S has exhibited the highest concentration of Sr-90 (see Figure 6-42). Strontium-90 activity concentrations in MW-105S have fluctuated over the quarterly sampling events with March 2004 levels reported at 91.8 pCi/L, above the C_4 concentration of 8 pCi/L. Elevated Sr-90 concentrations have also been noted at MW-106S (see Figure 6-43). Other wells where Sr-90 concentrations greater than the CRDL of 2 pCi/L included MW-103S and MW-104S (see Figures 6-44 and 6-45).

Strontium-90 concentrations from the past 10 sample events for unconsolidated, shallow and deep bedrock wells are plotted in Figures 6-46 through 6-49. With the exception of well MW-103S, all Sr-90 results for shallow bedrock wells were less than the EPA MCL of 8.0 pCi/L. All results for deep bedrock wells were less than the CRDL of 2 pCi/L and no result to date has exceeded this level.

Figure 6-50 presents a box plot for site-wide Sr-90 concentration as a function of time ranging from December 2001, through June 2004. The maximum Sr-90 concentration has ranged from 69.7 to 197 pC/L since December of 2001. Median results have fluctuated from a low of about 0.8 pCi/L to a high of 4.6 pCi/L. There were no apparent temporal or seasonal trends in the median values. There appears to be a seasonal trend in the highest values which all occur in MW-105S. These maximum values levels tend to

coincide with March and June sampling events, which are typically characterized by peak groundwater elevation levels.

6.2.6 Cesium-137 Trend Analysis

Cesium-137 was detected at statistically significant concentrations and greater than the MDC during the March and June 2004 sampling events. Table 4-2 summarizes Cs-137 analytical results in all wells since December 2001. Prior to the March and June 2004 sampling events, Cs-137 has been consistently identified in groundwater at location MW-103S between a minimum of 8.39 pCi/L and a maximum of 87.6 pCi/L (Figure 6-51). MW-103S is the shallow monitoring well in the cluster located in the vicinity of the former RWST. Cesium-137 has also been consistently detected at two additional monitoring wells, MW-115S and MW-102D. Cesium-137 has been detected in MW-115S in concentrations ranging from 1.6 to 7.59 pCi/L (Figure 6-52). Cesium-137 concentrations have ranged from 2.0 to 12.7 pCi/L in MW-102D (Figure 6-53).

Cesium-137 concentrations from the past 10 sample events for unconsolidated, shallow and deep bedrock wells are plotted in Figures 6-54 through 6-56. With the exception of well MW-103S, all Cs-137 results during these sample events were less than the CRDL of 15 pCi/L. The EPA MCL for Cs-137 is 200 pCi/L and no result to date has exceeded this level. Combined time series plots for Sr-90 and Cs-137 are provided in Appendix H.

6.2.7 Alpha Isotopic Analyses

Americium-241 concentrations from the past 10 sample events for unconsolidated, shallow and deep bedrock wells are plotted in Figures 6-57 through 6-59. With the exception of well MW-103D, all Am-241 results during these sample events were less than the CRDL of 0.5 pCi/L. The EPA MCL for alpha emitters is 15 pCi/L and no result to date has exceeded this level.

6.3 Linear Regression Analysis

6.3.1 Sr/Y-90 + Cs-137 vs Gross Beta

Figure 6-60 is a correlation plot of gross beta activity versus total Sr/Y-90 and Cs-137 concentration. Only sample results with detectable Sr-90 or Cs-137 were used in this comparison. Yttrium-90 (Y-90) is the radioactive decay product of Sr-90. Since the half-life of Sr-90 is significantly longer than Y-90, secular equilibrium is observed where both nuclides are characterized by the same concentration levels and the total concentration, denoted as Sr/Y-90, is doubled. A slope of 0.89 with a positive correlation coefficient (R) of 0.964 was observed (see Figure 6-60). The squared correlation term (R^2) was 0.929. These results suggest that Sr-90 and/or Cs-137 comprise at least 93% of the gross beta response at higher levels (i.e. greater than 25 pCi/L gross beta activity) and can be used to obtain screening or reasonable estimates of total Sr/Y-90 and Cs-137 in groundwater.

7 Conclusions and Recommendations

7.1 Groundwater Quality Status

The GWMP at the HNP provides the framework for data collection, quality assurance, and reporting groundwater quality status at the facility. Analytical results from the quarterly sampling program implemented at the plant provide the data for comparing to standards, regulatory limits, and developing metrics for evaluating overall groundwater quality and potentially; plume status at the HNP.

Groundwater contamination by plant-related SOCs has been observed in all three aquifer units currently described at the facility. The general configuration of contaminant plumes extend from the area immediately upgradient of the reactor containment building to the Connecticut River. The observed groundwater contamination at the plant appears to have originated from unplanned releases of contaminated process and waste waters within the general vicinity of the reactor containment building, primary auxiliary building, and other facilities immediately surrounding the reactor containment building.

Tritium, Sr-90, and boron account for the majority of the observed contamination with less-frequent detections of Cs-137. Tritium, boron, and Sr-90 are broadly distributed across the HNP industrial area. Although plant-related tritium concentrations in groundwater have declined substantially below the MCL in recent years, localized areas of other constituents (e.g., Sr-90) have remained relatively elevated. Strontium-90 concentrations in localized areas between the containment building and primary auxiliary building, as exemplified by the observed concentration of Sr-90 in well MW-105S, continues to exceed drinking water standards. Although the Sr-90 concentration currently exceeds the drinking water standard of 8 pCi/L, the concentration measured in the June 2004 sampling round (16.2 pCi/L) has decreased significantly from that measures in previous sampling rounds (164 pCi/L to 197 pCi/L). The observed decrease of Sr-90 in MW-105S is most likely related to redevelopment of the monitoring well and remedial/dewatering activities upgradient of the monitoring well. Overall, groundwater contamination has declined substantially in the industrial area of the HNP since quarterly sampling began in 1999 (Appendices F through G).

7.2 Recommendations for Subsequent Groundwater Monitoring Sampling Events

Based on the review of the results of the March 2004 and June 2004 quarterly sampling and observed long-term trends in some wells, several recommendations concerning subsequent groundwater monitoring sampling events are suggested in this section. The recommended analytical suite for the upcoming September 2004 GWMP quarterly sampling event should be the same as the one implemented for June 2004, with

geochemical parameters sampled and analyzed to compare to previous results. Collecting filtered and unfiltered samples, however, is not necessary based on the data reduction effort and evaluation of analytical results performed in previous reports. Unfiltered groundwater samples should be collected from all of the wells in the industrial area and analyzed for all constituents during the September 2004 quarterly sampling event. Otherwise, the wells sampled should stay the same as previous sampling rounds.

Several additional monitoring well locations are suggested for addition to the GWMP based on the evaluation of groundwater quality and plume status performed as part of this report. These include the following:

- Background wells upgradient of the industrial area and parking lot. The MW-100 well pair appears to have been historically affected by boron from some undefined source.
- A well completed in the unconsolidated formation near the northwest end of the discharge tunnel.

8 References

CY-ISC-SOW- 2003	Statement of Work for Environmental, Bioassay and Waste Characterization Analytical Services, Revision 0, August 27, 2003
EML-608	Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (QAP 52), June 2000
EML-611	Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (QAP 53), December 2000
EML-613	Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (QAP 54), June 2001
EML-615	Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (QAP 55), December 2001
EML-617	Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (QAP 56), June 2002
EML-618	Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (QAP 57), December 2002
EML-621	Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (QAP 58), June 2004 Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (QAP 59), December 2003 Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (QAP 60), June 2004
ERA RAD-49	ERA's RadChem™ Proficiency Testing Study RAD-49, July 25, 2002
ERA RAD-50	ERA's RadChem™ Proficiency Testing Study RAD-50, November 8, 2002
ERA RAD-51	ERA's RadChem™ Proficiency Testing Study RAD-51, January 23, 2003
ERA RAD-52	ERA's RadChem™ Proficiency Testing Study RAD-52, April 16, 2003
ERA RAD-53	ERA's RadChem™ Proficiency Testing Study RAD-53, July 24, 2003
ERA RAD-54	ERA's RadChem™ Proficiency Testing Study RAD-54

ERA RAD-55	ERA's RadChem™ Proficiency Testing Study RAD-55
ERA RAD-57	ERA's RadChem™ Proficiency Testing Study RAD-57
GMP-QAPP 2004	Groundwater Monitoring Program Quality Assurance Project Plan, Revision 1, 2004
GMR 1999	Groundwater Monitoring Report, Malcolm Pirnie, September 1999
GW WPIR 2001	Groundwater Sample Collection Work Plan and Inspection Record, WP&IR # 24265-000-GEN-5000-00067-000, 12/06/2001
HIWP 2002	Phase II Hydrogeologic Investigation Work Plan, May 2002
LTP 2002	Haddam Neck Plant - License Termination Plan (LTP), Rev. 1a, 2002
MAPEP-99-S6	Mixed Analyte Performance Evaluation Program - Soil Sample Participating Laboratory Report, 2/8/2000
MAPEP-00-S7	Mixed Analyte Performance Evaluation Program – Soil Sample Performance Report, 1/29/2001
MAPEP-00-S8	Mixed Analyte Performance Evaluation Program – Soil Sample Performance Report, 8/8/2002
MAPEP-00-S9	Mixed Analyte Performance Evaluation Program – Soil Sample Preliminary Report, 12/5/2002
MAPEP-00-S10	Mixed Analyte Performance Evaluation Program – Soil Sample Preliminary Report, 12/2003
MAPEP-99-W7	Mixed Analyte Performance Evaluation Program – Water Sample Performance Report, 7/6/2000
MAPEP-00-W8	Mixed Analyte Performance Evaluation Program – Water Sample Performance Report, 5/8/2002
MAPEP-00-W9	Mixed Analyte Performance Evaluation Program – Water Sample Performance Report, 2/11/2003
MAPEP-01-W10	Mixed Analyte Performance Evaluation Program – Water Sample Performance Report
MAPEP-03-W11	Mixed Analyte Performance Evaluation Program – Water Sample Performance Report
NSWPT 1998	National Standards for Water Proficiency Testing Studies Criteria Document, USEPA December 30, 1998
RPM 5.3-0	Groundwater Monitoring Program, Revision 0, September 2002
RPM 5.3-1	Groundwater Level Measurement and Sample Collection in Monitoring Wells, Revision CY-001, March 2004
RPM 5.3-2	Monitoring Well Drilling and Completion, June 2003
RPM 5.3-3	Groundwater Sampling Event Planning and Data Management, June 2003
SEP-0304	Sample Event Plan for March 2004
SEP-0604	Sample Event Plan for June 2004
GELQAP 2003	GEL Quality Assurance Plan, Revision 15 , June 2003

9 Definitions

C_4 Concentration (C_4) – The concentration level for a single analyte that will result in a 4-mrem per year total effective dose equivalent (TEDE) based on target organ dose methodology.

Contract Required Detection Limit (CRDL) - Analysis sensitivity requirements required by contract or SOW. Compliance is determined by comparison with sample specific MDCs or MDLs.

False Negative Rate (β, β^*) – The rate at which the statistical procedure does not indicate possible contamination, when contamination is present at some level (β denotes one sample and one constituent, β^* denotes multiple samples and one constituent).

False Positive Rate (α, α^*) – The rate at which the statistical procedure indicates possible contamination, when contamination is not present (α denotes one sample and one constituent, α^* denotes multiple samples and one constituent).

Freshet– A rapidly rising flood of minor severity and short duration, attributed to heavy rains or rapidly melting snow.

Instrument Detection Limit (IDL) – The level at which a measurement can be differentiated from background with some degree of confidence. Computed from the counting error associated with the instrument background or blank counting conditions usually expressed in terms of counts or count rate.

Lab Control Sample (LCS) - A sample prepared by adding a known amount of target analyte to deionized distilled water. Used to assess the method accuracy and long-term analytical precision.

Lower Limit of Detection (LLD) - The level at which a measurement can be differentiated from background with some degree of confidence. Computed from the counting error associated with the analytical blank counting conditions usually expressed in terms of counts or count rate.

Matrix Spike (MS) - A sample prepared by adding a known amount of target analyte to a specified amount of matrix sample for which an independent estimate of the target analyte concentration is available. Used to determine the effect of matrix on a method's recovery efficiency.

Matrix Spike Duplicate (MSD) - A known amount of target analyte added to two samples taken from and representative of the same population and carried through all steps of the analytical procedures in an identical manner. Used to assess variance of the sample analysis.

Maximum Contaminant Level (MCL) - The average concentration level for a single analyte that will result in a 4-mrem per year total effective dose equivalent (TEDE) based on target organ dose methodology.

Method Detection Limit (MDL) - The concentration of a substance that can be measured and reported at the 99% confidence level to be greater than zero.

Minimum Detectable Activity (MDA) – Analogous to the LLD but includes conversion factors to relate background count rate to analyte activity.

Minimum Detectable Concentration (MDC) - A level analogous to the LLD but includes conversion factors to relate background count rate to analyte concentration.

Relative Percent Difference (RPD) - A measure of the precision of two results, defined as the absolute difference divided by the average of the two results multiplied by 100.

Required Detection Limit (RDL) – Analysis sensitivity requirements required by contract or SOW. Compliance is determined by comparison with sample specific MDCs or MDLs.

Total Propagated Uncertainty (TPU) - Includes all factors that contribute to the overall uncertainty including counting statistics, sample mass, chemical yield and calibration factors.

10 Acronyms

Co-60	Cobalt -60
CRDL	Contract required Detection Limit
CSM	Conceptual Site Model
Cs-137	Cesium 137
CYAPCo	Connecticut Yankee Atomic Power Company
DOE	Department of Energy
EOF	Emergency Operations Facility
EPA	Environmental Protection Agency
FDR	Field Daily Reports
GMP	Groundwater Monitoring Program
GPC	Gas Proportional Counting
GWMP	Groundwater Monitoring Program
HNP	Haddam Neck Plant
HTD	Hard to Detect
LCS	Laboratory Control Sample
LSC	Liquid Scintillation Counting
LTP	License Termination Plan
MAPEP	Mixed Analyte Performance Evaluation Program
MCL	Maximum Contaminant Level
MDC	Minimum Detection Concentration
MDL	Minimum Detection Limit
MS	Matrix Spike
MSL	Mean Sea Level
NCR	Nonconformance Reporting
NELAC	The National Environmental Laboratory Accreditation Conference
NSWPT	National Standards for Water Proficiency Testing Studies Criteria

NRC	Nuclear Regulatory Commission
NTU	Nephelometric Turbidity Unit
PAB	Primary Auxiliary Building
pCi/L	picocurie per liter
QAP	Quality Assurance Program
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
RCB	Reactor Containment Building
RESL	Radiological and Environmental Sciences Laboratory
RPD	Relative Percent Difference
SOC	Substance of Concern
SOP	Standard Operation Procedure
Sr-90	Strontium-90
TEDE	Total Effective Dose Equivalent
TPU	Total Propagated Uncertainty
WP&IR	Work Plan and Inspection Record

TABLES

Table 2-1: Summary of Monitoring Well Information

Well ID	Northing	Easting	Elevation[1]	Depth[2] toTop of Screen (ft)	Depth[2] to Bottom of Screen (ft)	Hydro-stratigraphic Unit	Well Status
AST-1	236310.83	668931.59	**21.55**	10	20	Unconsolidated	09/17/2004[A]
AST-2	236322.94	668948.16	**19.99**	5	15	Unconsolidated	09/17/2004[A]
AST-3	236327.17	668909.46	**21.2**	5	15	Unconsolidated	09/17/2004[A]
AST-4	236341.10	668927.83	**20.73**	5	15	Unconsolidated	09/17/2004[A]
EOF Supply-1	NSD	NSD	NSD	780	800	Deep Bedrock	Active
EOF Supply-2	NSD	NSD	NSD	1130	1150	Deep Bedrock	Active
MW-EOF-1	237503.96	667408.75	24.08	6	16	Unconsolidated	Active
MW-EOF-2	237513.48	667418.44	24.12	7	17	Unconsolidated	Active
MW-1	235304.54	670604.26	12.21	28	38	Unconsolidated	Active
MW-2	235677.79	670527.35	15.99	29	39	Unconsolidated	Active
MW-3	235488.22	670555.25	10.75	12	22	Unconsolidated	Active
MW-4	235638.02	670371.60	15.03	26.5	36.5	Unconsolidated	Active
MW-5	NSD	NSD	NSD	73	93	Unconsolidated	07/07/2004[A]
MW-6	NSD	NSD	NSD	58	108	Unconsolidated	07/07/2004[A]
MW-7	NSD	NSD	NSD	38	58	Unconsolidated	07/07/2004[A]
MW-8	NSD	NSD	NSD	58	88	Unconsolidated	07/07/2004[A]
MW-9	NSD	NSD	NSD	66	116	Unconsolidated	07/06/2004[A]
MW-10	NSD	NSD	NSD	48	98	Unconsolidated	07/07/2004[A]
MW-11	NSD	NSD	NSD	56	66	Unconsolidated	07/07/2004[A]
MW-12	NSD	NSD	NSD	57	97	Unconsolidated	07/06/2004[A]
MW-13	235130.81	670766.81	20.04	66	96	Unconsolidated	Active
MW-14	NSD	NSD	NSD	66	86	Unconsolidated	07/08/2004[A]
MW-15	NSD	NSD	NSD	31	81	Unconsolidated	07/07/2004[A]
MW-16D	NSD	NSD	NSD	43	113	Unconsolidated	07/07/2004[A]
MW-16S	NSD	NSD	NSD	4.5	24.5	Unconsolidated	07/07/2004[A]
MW-17	NSD	NSD	NSD	37	107	Unconsolidated	07/07/2004[A]
MW-18	NSD	NSD	NSD	30	60	Unconsolidated	07/06/2004[A]
MW-100D	236964.21	668415.29	16.45	21	31	Deep Bedrock	Active
MW-100S	236959.88	668418.62	16.45	3.50	9	Unconsolidated	Active
MW-101D	236845.02	668655.36	20.82	39.80	49.8	Deep Bedrock	Active
MW-101S	236842.33	668653.70	20.62	8.00	18	Shallow Bedrock	Active
MW-102D	236651.79	668905.29	20.66	43.00	53	Deep Bedrock	Active
MW-102S	236655.03	668907.67	20.53	12.80	22.5	Shallow Bedrock	Active
MW-103D	236672.34	668730.02	21.05	45.00	55	Deep Bedrock	Active
MW-103S	236671.52	668726.05	20.94	15.50	24.5	Shallow Bedrock	Active
MW-104S	236673.17	668493.30	20.1	13.00	23	Unconsolidated	Active
MW-105D	236534.06	668645.74	20.66	45.50	55.5	Deep Bedrock	08/12/2004[A]
MW-105S	236536.03	668642.86	20.66	14.50	24.5	Unconsolidated	08/12/2004[D]
MW-106D	236464.64	668730.32	20.7	45.00	55	Deep Bedrock	Active
MW-106S	236473.85	668738.10	20.56	14.50	24.5	Shallow Bedrock	Active
MW-107D	236374.52	668874.54	20.52	90.00	100	Shallow Bedrock	Active
MW-107S	236371.27	668871.82	20.39	15.00	25	Unconsolidated	Active

NOTES

1: Elevations from Kratzert, Jones and Associates, **Bold values are based on Malcolm Pirnie data.**

2: Screen depths based on construction logs.

NSD: No survey data available

A Well abandoned on this date D: Well was converted to DW-105 on this date.

Table 2-1: Summary of Monitoring Well Information (continued)

Well ID	Northing	Easting	Elevation[1]	Depth[2] toTop of Screen (ft)	Depth[2] to Bottom of Screen (ft)	Hydro-stratigraphic Unit	Well Status
MW-108	236243.62	669142.69	12.15	15	25	Unconsolidated	Active
MW-109D	236327.48	668450.18	20.54	45.00	55	Shallow Bedrock	Active
MW-109S	236329.11	668448.13	20.64	15.00	25	Unconsolidated	Active
MW-110D	236083.96	668812.01	22.83	70.00	80	Shallow Bedrock	Active
MW-110S	236081.77	668815.38	22.47	15.00	25	Unconsolidated	Active
MW-111S	235931.47	668940.43	18.21	15	25	Unconsolidated	09/17/2004[A]
MW-112S	235797.44	669204.17	14.51	15	25	Unconsolidated	Active
MW-113S	235773.51	669398.06	13.56	15	25	Unconsolidated	Active
MW-114S	236615.50	668820.92	20.76	7.5	17.5	Unconsolidated	Active
MW-115S	236603.10	668837.00	20.81	7	17	Unconsolidated	Active
MW-117S	235070.57	671286.68	15.95	15	25	Unconsolidated	Active
MW-122D	236490.49	668988.55	19.99	184.70	194.7	Deep Bedrock	Active
MW-122S	236486.50	668988.86	19.84	9	19	Unconsolidated	Active
MW-123	236629.95	668473.66	20.19	23.5	33.47	Shallow Bedrock	Active
MW-124	236478.85	668448.53	20.81	11	21	Unconsolidated	Active
MW-125	236324.23	668797.83	20.31	11	22	Unconsolidated	Active
MW-200	236230.82	673217.72	54.68	8	18	Unconsolidated	Active
MW-201	235811.20	673214.61	58.74	25	35	Unconsolidated	Active
MW-202	236176.51	672987.49	51.64	10	20	Unconsolidated	Active
MW-203	236099.24	672994.67	46.21	8	18	Unconsolidated	Active
MW-204	235928.48	673033.93	41.88	5	15	Unconsolidated	Active
MW-205	235826.44	673093.28	40.57	5	15	Unconsolidated	Active
MW-206	235789.83	673016.63	43.10	5	15	Unconsolidated	Active
MW-207	236021.60	673148.93	46.99	15	25	Unconsolidated	Active
MW-208	235742.54	673120.08	50.21	12	32	Unconsolidated	Active
MW-502	236770.63	668013.02	17.90	20.54	30.22	Unconsolidated	Active
MW-503	236928.27	667916.80	15.31	25.14	34.83	Unconsolidated	Active
MW-504	236881.63	668116.16	16.66	18.97	28.67	Unconsolidated	Active
MW-505	237062.99	668090.60	14.98	16.37	25.07	Deep Bedrock	Active
MW-507D	236799.08	668299.65	18.56	67	77	Deep Bedrock	Active
MW-507S	236795.86	668303.57	18.46	10.88	20.88	Deep Bedrock	Active
MW-508D	236663.18	668190.54	17.78	81.5	91.5	Shallow Bedrock	Active
MW-508S	236666.79	668193.26	17.63	14	24	Unconsolidated	Active
TPW-1	NSD	NSD	**9.5**	80	100	Unconsolidated	Active
TPW-2	NSD	NSD	**9.5**	80	110	Unconsolidated	Active
TW-1	235020.46	670967.37	17.73	94	112	Unconsolidated	Active
TW-2	235292.04	670515.44	9.67	101	104	Unconsolidated	Active
TW-3	235285.23	670802.16	13.02	49	89	Unconsolidated	Active
TW-4	235087.35	671193.58	10.71	80	120	Unconsolidated	Active
Well-A	NSD	NSD	NSD	37	47	Unconsolidated	Active
Well-B	NSD	NSD	NSD	45	57	Unconsolidated	Active
10-2	NSD	NSD	**10.2**	58	63	Unconsolidated	Active
8-2	NSD	NSD	NSD	40	47	Unconsolidated	Active
9-2	NSD	NSD	NSD	50	57	Unconsolidated	Active

NOTES

1: Elevations from Kratzert, Jones and Associates, **Bold values are based on Malcolm Pirnie data**

2: Screen depths based on construction logs.

NSD: No survey data available

A Well abandoned on this date

Table 2-2: Selected Events in Operation of the Water Level Monitoring System at HNP

	Event	Date	Comment
1	Transducer system installed	January 2004	Recording water level at 1-minute intervals
2	Batteries fail in river transducer	22 February 2004	Cold weather caused early battery failure. Missing data were approximated using TW-1 as a surrogate.
3	Reconfigured wellheads to improve transducer suspension system	May 2004	Suspension systems were added to allow removal of well caps without disturbing the transducers. Reprogrammed to record on 5-minute intervals.

Table 2-3: Summary of Groundwater Elevation Conditions Observed in the Unconsolidated Hydrostratigraphic Unit During the First Quarter 2004

Well ID	General Water Elevation Conditions	Responsive to Local Precipitation?	Exhibits Tidal Response?	Responsive to Dewatering Activities?
MW-100S	Variable but generally stable at approx +14 ft MSL	Yes	No	No
MW-104S	Variable around Approx +10 ft MSL	Yes	No	No
MW-105S	Declining from +8.5 ft MSL to +5 ft MSL	Yes	No	Yes
MW-107S	Declining from +7.5 ft MSL to +5 ft MSL	Yes	Yes	Yes
MW-108	Approx +5 ft MSL	Yes	Yes	No
MW-109S	Approx +3 ft MSL	Possible	Yes	No
MW-110S	Approx +2 ft MSL	Yes	Yes	No
MW-113S	Approx +2 ft MSL	Yes	Yes	No
MW-114S	Declining from +8 ft MSL to +6 ft MSL	Yes	No	Yes
MW-122S	Declining from +9.5 ft MSL to +6.5 ft MSL	Yes	Yes	No
MW-124	Approx. +3.5 ft MSL	No	No	No
MW-504S	Approx +4 ft MSL	No	No	No
MW-508S	Approx +11.5 ft MSL	Yes	No	No
TW-1	Approx +2 ft MSL	Yes	Yes	No

NOTES
MSL: Mean sea level elevation

Table 2-4: Summary of Groundwater Elevation Conditions Observed in the Shallow Bedrock Hydrostratigraphic Unit During the First Quarter 2004

Well ID	General Water Elevation Conditions	Responsive to Local Precipitation?	Exhibits Tidal Response?	Responsive to Dewatering Activities?
MW-101S	Small variations around +16 ft MSL	Yes	No	No
MW-102S	Variable around +11 ft MSL	Yes	No	No
MW-103S	Variable with general decline from +10 ft MSL to +7 ft MSL	Yes	No	Not apparent
MW-106S	General decline from +7 ft MSL to +4 ft MSL	Yes	No	Yes – slight response to mat sump
MW-107D	General decline from +7 ft MSL to +5 ft MSL	Yes – slight	Yes	Not apparent
MW-109D	Generally stable at about +6 ft MSL	Responds to river changes	Yes	No
MW-110D	Small variations around +4 ft MSL	Responds to river changes	Yes	No
MW-508D	Small variations around +4 ft MSL	Responds to river changes	Yes	No

NOTES
MSL: Mean sea level elevation

Table 2-5: Summary of Groundwater Elevation Conditions Observed in the Deep Bedrock Hydrostratigraphic Unit During the First Quarter 2004

Well ID	General Water Elevation Conditions	Responsive to Local Precipitation?	Exhibits Tidal Response?	Responsive to Dewatering Activities?
MW-101D	Variable with general decline from +10 ft MSL to +5 ft MSL	Yes	No	Slight response to mat sump
MW-102D	General decline from +10 ft MSL to +6 ft MSL	Yes	No	Very slight response to mat sump
MW-103D	General decline from +10 ft MSL to +6 ft MSL	Slight	No	Very slight response to mat sump
MW-105D	General decline from +10 ft MSL to +6 ft MSL	Yes	Very slight	Not apparent
MW-106D	General decline from +8 ft MSL to +5 feet MSL	Slight	Very slight	Very slight response to mat sump
MW-122D	Slight decline from +5 ft MSL to +4 ft MSL	Responds to river changes	Yes	No

NOTES
MSL: Mean sea level elevation

Table 2-6: Summary of Static Water Levels in Monitoring Wells for March and June 2004 Used to Complete Groundwater Flow Maps

	1st. Quarter			2nd. Quarter			
Well Name	TOC Elevation	2/12/04 at 4:35 High Tide Groundwater Elevation[1]	2/12/04 at 11:35 Low Tide Groundwater Elevation[1]	TOC Elevation[2]	6/12/04 at 21:00 High Tide Groundwater Elevation[1]	6/12/04 @15:10 Low Tide Groundwater Elevation[1]	Material Well Screened In (U, SB, DB)
MW-101D	20.86	9.46	9.41	20.82	8.92	9.00	DB
MW-102D	20.65	8.33	8.30	20.66	6.02	6.11	DB
MW-103D	21.06	8.05	8.00	21.05	5.19	5.23	DB
MW-105D	20.68	9.15	9.05	20.66	5.25	5.28	DB
MW-106D	20.69	7.14	7.03	20.70	4.86	4.80	DB
Mat Sump	21.72	-20.37	-17.67	21.72	-18.21	-21.67	DB
MW-122D	20.00	4.78	4.33	19.99	3.81	3.60	DB
MW-101S	20.66	16.22	16.18	20.62	14.67	14.69	SB
MW-102S	20.57	11.54	11.50	20.53	8.34	8.43	SB
MW-103S	20.94	9.48	9.43	20.94	5.11	5.13	SB
MW-106S	20.57	5.88	5.84	20.56	8.36	8.42	SB
MW-107D	20.54	6.36	6.13	20.52	4.86	4.60	SB
MW-109D	20.56	6.44	6.29	20.54	6.14	6.04	SB
MW-110D	22.86	3.18	2.86	22.83	2.94	2.46	SB
Mat Sump	21.72	-20.37	-17.67	21.72	-18.21	-21.67	SB
MW-508D	17.79	4.59	4.25	17.78	2.48	2.23	SB
MW-100S	16.47	14.79	14.78	16.45	13.23	13.34	U
MW-104S	20.11	11.28	11.26	20.10	8.96	9.04	U
MW-105S	20.69	7.30	7.26	20.66	5.13	5.17	U
MW-107S	20.44	6.11	6.06	20.39	5.22	5.21	U
MW-108	12.30	5.80	4.89	12.15	4.99	3.82	U
MW-109S	20.65	2.97	2.88	20.64	2.62	2.53	U
MW-110S	22.48	1.44	1.40	22.47	1.39	1.35	U
MW-113S	13.60	1.33	1.26	13.56	0.43	0.33	U
MW-114S	20.78	8.43	8.38	20.76	5.37	5.41	U
MW-122S	19.84	8.26	8.25	19.84	6.87	6.95	U
MW-124	20.82	3.41	3.39	20.81	2.93	2.95	U
MW-504S	16.67	3.99	3.98	16.66	3.80	3.81	U
MW-508S	17.81	11.52	11.49	17.63	9.45	9.46	U
Mat Sump	21.72	-20.37	-17.67	21.72	-18.21	-21.67	U
RIVER	7.90	0.66	-1.28	7.90	2.47	-0.40	U
TW-1	17.73	2.05	0.19	17.73	3.00	0.31	U

NOTES

U: Unconsolidated deposits
SB: Shallow bedrock
DB: Deep bedrock

Table 2-7: Summary of Groundwater Elevation Conditions Observed in the Unconsolidated Hydrostratigraphic Unit During the Second Quarter 2004

Well ID	General Water Elevation Conditions	Responsive to Local Precipitation?	Exhibits Tidal Response?	Responsive to Dewatering Activities?
MW-100S	Declined from +15 ft MSL to +12 ft MSL	Yes	No	No
MW-104S	Varied with general decline between +16 ft MSL to +7 feet MSL	Yes	No	Possibly
MW-105S	Varied with general decline between+10 ft MSL to +4 ft MSL	Yes	No	Yes
MW-107S	Varied with general decline from +8.5 ft MSL to +3.5 ft MSL	Yes	Yes	Yes
MW-108	Varied with general decline from +9 ft MSL to +4 ft MSL	Yes	Yes	No
MW-109S	Varied with general decline from +6 ft MSL to +2 ft MSL	Yes	Yes	No
MW-110S	Varied with general decline from +7 ft MSL to +1 ft MSL	Yes	Yes	No
MW-113S	Varied with general decline from +7 ft MSL to 0 ft MSL	Yes	Yes	No
MW-114S	Varied with general decline from +13 ft MSL to +5 ft MSL	Yes	No	Yes
MW-122S	Varied with general decline from +11 ft MSL to +5 ft MSL	Yes	Yes	No
MW-124	Varied with general decline from +6 ft MSL to +3 ft MSL	No	Yes	No
MW-504S	Varied with general decline from +7 ft MSL to +3 ft MSL	Yes	Possible	No
MW-508S	Varied with general decline from +12 ft MSL to +9 ft MSL	Yes	No	No
TW-1	Varied with general decline from +7 ft MSL to 0 MSL	Yes	Yes	No

NOTES
MSL: Mean sea level elevation

Table 2-8: Summary of Groundwater Elevation Conditions Observed in the Shallow Bedrock Hydrostratigraphic Unit During the Second Quarter 2004

Well ID	General Water Elevation Conditions	Responsive to Local Precipitation?	Exhibits Tidal Response?	Responsive to Dewatering Activities?
MW-101S	Variable with general decline from +18 ft MSL to +14 MSL	Yes	No	No
MW-102S	Variable with general decline from +15 ft MSL to +6 ft MSL	Yes	No	Yes
MW-103S	Variable with general decline from +13 ft MSL to +3 ft MSL	Yes	No	Yes
MW-106S	Variable with increase from +4 ft MSL to +11 ft MSL between March and May and subsequent decline from +11 ft MSL to +7 ft MSL	Yes	No	Yes
MW-107D	Variable with general decline from +10 ft MSL to +3 ft MSL	Yes – also responds to river change	Yes	Yes
MW-109D	Variable with general decline from +8 ft MSL to +6 ft MSL	Responds to river change	Yes	No
MW-110D	Variable with general decline from +7 ft MSL to +2 ft MSL	Responds to river change	Yes	No
MW-508D	Variable with general decline from +7 ft MSL to +3 ft ML	Responds to river change	Yes	No

NOTES
MSL: Mean sea level elevation

Table 2-9: Summary of Groundwater Elevation Conditions Observed in the Deep Bedrock Hydrostratigraphic Unit During the Second Quarter 2004

Well ID	General Water Elevation Conditions	Responsive to Local Precipitation?	Exhibits Tidal Response?	Responsive to Dewatering Activities?
MW-101D	The transducer at this location failed, and the exact time of failure cannot be determined	Yes	No	Yes. Clearly responds to operation of DW-3.
MW-102D	Variable with general decline from +12 ft MSL to +4 ft MSL	Yes	No	Yes
MW-103D	Variable with general decline from +12 ft MSL to +3 ft MSL	Yes	No	Yes
MW-105D	Variable with general decline from +12 ft MSL to +4 ft MSL	Yes	No	Yes
MW-106D	Variable with general decline from +11 ft MSL to +3 MSL	Possible	Yes	Yes
MW-122D	Variable with general decline from +7 ft MSL to +3 ft MSL	Possible	Yes	Possible. Responds to changes in river stage.

NOTES
MSL: Mean sea level elevation

Table 3-1: Summary of Field Parameters for March 2004

Well ID	Field Turbidity (NTU)	Field DO (mg/L)	Field ORP (mV)	Field pH	Field Specific Conductance (µS/cm)	Field Temp (°C)	Static Water Level (ft below MP)
EOF-2	1.4	5.8	150	7.3	2710	12.2	9.78
MW-100D	0.1	0.5	63	6.4	67	9.4	8.63
MW-100S	0.1	3.3	143	6.7	1630	5.9	6.1
MW-101D	0.9	1.6	185	8.1	0.178	12	13.54
MW-101S	2	12	275	6.1	0.127	7.2	5.1
MW-102D	15	6.7	170	8.3	601	8	NM
MW-102S	4	10	231	6.5	0.505	7.2	11.27
MW-103D	14	13	206	7.6	380	11	NM
MW-103S	0.9	13	243	6.4	0.46	11	13.64
MW-104S	9.1	10	255	6.2	264	12	11.31
MW-105S	2	3.5	204	7	0.461	12	15.09
MW-105D	2.1	7.8	196	7.7	0.387	14	14.18
MW-106S	3.5	<0.02	162	6.4	2130	12	15.19
MW-106D	2.5	4.5	140	9.3	335	13	18.88
MW-107D	2.4	3.7	180	6.3	159	13	18.57
MW-107S	2	0.9	280	5.9	412	13	15.87
MW-108S	2.1	<0.01	-42	6.3	115	9	7.17
MW-109D	0.6	1.6	93	7.7	578	12	20.02
MW-109S	3.1	3.4	156	6.4	798	11.9	18.12
MW-110D	2.9	0.1	17	7.5	282	9.1	20.44
MW-110S	0.4	3	204	6	106	8.8	20.89
MW-111S	2.6	7	256	5.9	170	10.6	17.02
MW-112S	0.8	1	234	5.5	64	10.2	13.21
MW-113S	0.5	0.1	195	5.8	414	11	12.38
MW-114S	3.8	1.4	138	6.9	1440	14	15.15
MW-115S	3.3	6.1	184	6.5	1200	13	15.2
MW-117S	3.5	0	-100	6.6	707	8.9	11.18
MW-122D	59.5	<0.1	-160	9.4	186	12	17.64
MW-122S	8.9	<0.1	-6	6.5	624	11	14.01
MW-123S	0.1	8.5	148	6.7	856	12.4	14.82
MW-124S	2.3	3.6	240	6.3	406	11	17.57
MW-125S	4.2	1.5	89	6.7	731	7	16.35

NOTES

NM: No measurements were taken for this parameter

NS: Well was not sampled during this event due to low water level

Well was sampled with a bailer

Table 3-2: Summary of Field Parameters for June 2004

Well ID	Field Turbidity (NTU)	Field DO (mg/L)	Field ORP (mV)	Field pH	Field Specific Conductance (µS/cm)	Field Temp (°C)	Static Water Level (ft below MP)
EOF-2	1.6	7.10	103	7.29	577	17.62	12.26
MW 100D	5.11	0.00	22	6.22	103	12.82	9.24
MW 100S	4.4	7.80	220	5.9	88	14.4	6.73
MW 101D	-10	1.67	127	8.1	186	16.5	16.40
MW 101S	-10	8.01	13	7.01	138	17.8	6.40
MW 102D	2.9	5.10	100	7.63	411	15.4	14.19
MW 102S	1.8	5.94	184	6.46	155	12.8	15.65
MW 103D	4.1	10.50	220	5.3	522	16.5	21.40
MW 103S	-10	6.97	158	6.71	238	11.3	16.70
MW 104S	1.6	13.74	178	6.69	583	17.51	17.60
MW 105D	3.8	7.90	110	7.7	517	15.1	17.24
MW 105S	1.9	1.60	160	6.9	540	14.6	16.61
MW 106D	2.7	4.89	62	9.38	363	18	18.62
MW 106S	2.3	1.76	155	6.29	1770	15.4	16.52
MW 107D	3	2.66	99	6.28	108	19.38	19.80
MW 107S	3.7	3.47	199	5.76	737	18.37	16.77
MW 108S	4.7	1.00	-72	6.48	109	13.41	9.30
MW 109D	8	2.31	134	7.37	414	16.91	18.99
MW 109S	3	8.87	285	5.13	2	22.84	18.49
MW 110D	7	0.70	40	7.4	311	18.5	21.20
MW 110S	1.9	5.30	200	6.1	508	17.3	21.26
MW 111S	2.4	7.80	180	6.3	151	14.6	17.29
MW 112S	2.4	1.10	290	5.1	104	13.1	13.70
MW 113S	2.5	0.40	250	5.8	298	15.2	12.65
MW 114S	-10	1.39	85	6.96	318	16.2	16.97
MW 115	NS						
MW 117S	21	6.50	-100	6.5	637	13.4	12.81
MW 122D	27	1.00	-150	9.3	183	17.6	18.61
MW 122S	4.7	11.00	-2	6.79	763	18.09	14.81
MW 123	1.1	12.70	186	6.61	747	15.47	15.55
MW 124	0.6	10.26	153	6.66	368	17.64	17.91
MW 125	2.2	1.42	22	6.85	578	18.4	16.62
MW-1	6.9	0.80	-110	6.6	1900	7.6	0.93
MW-2	3	0.04	98	6.32	253	17.64	14.57
MW-3	180	0.04	-80	6.5	130	12	11.36
MW 502	3.83	0.00	-159	7.02	450	14.66	14.57
MW 503	2.22	0.94	-106	6.21	467	14.22	11.95
MW 504S	3	0.35	-90	6.6	321	20.4	13.85
MW 505	3.1	0.00	-139	7.26	556	12.03	4.09
MW 507D	3.68	0.40	-83	7.5	179	22.19	16.22

NOTES

NM: No measurements were taken for this parameter

NS: Well was not sampled during this event due to low water level
Well was sampled with a bailer

Table 3-2: Summary of Field Parameters for June 2004 (continued)

Well ID	Field Turbidity (NTU)	Field DO (mg/L)	Field ORP (mV)	Field pH	Field Specific Conductance (µS/cm)	Field Temp (°C)	Static Water Level (ft below MP)
MW 507S	5.29	0.00	-110	6.67	430	16.78	8.20
MW 508D	2.6	7	120.00	7.5	174	16.4	15.85
MW 508S	3.1	5.70	-60	6.6	398	20.2	7.92

NOTES

NM: No measurements were taken for this parameter

NS: Well was not sampled during this event due to low water level

Well was sampled with a bailer

Table 4-1: Boron Concentrations (μG/L) in Groundwater

Well ID	Mar-99	Apr-99	Sep-99	Jun-00	Jun-01	Dec-01	Mar-02	Jun-02	Sep-02	Dec-02	Mar-03	Jun-03	Sep-03	Dec-03	Mar-04	Jun-04
100D	<50	30.8	ND	10.8	<200	<50	68	<250	<50	<50	<27	<10	<27	6.3	19.9	10.4
100S	<50	22.8	ND	NS	<200	<50	710	<250	188	84.9	123	1,145	428	140	212	25.3
101D	61.3	57.7	ND	38.1	25.4	<50	<50	<250	NS	<50	83.5	47	42.3	30	49.4	54
101S	29.7	28.2	ND	53.8	34.4	77	<50	<250	NS	<50	NS	43	235	47	49	68.6
102D	270.4	114.7	ND	87.5	80. 1	290	96.4	<250	NS	428	64.2	392	110	98	113	97.1
102S	43.9	29.7	ND	63 .4	80.8	220	64.3	<250	NS	<50	49	19	117	49	60.8	91.2
103D	253.3	165.2	ND	63.6	57.9	88	165	<250	NS	69.5	105	76	58	48	90.9	57.1
103S	214.9	364.5	ND	150.0	111	260	55.4	<250	NS	118	96.2	92	184	33	85.7	165
104S	<50	47	ND	NS	54.2	82	74	70.2	81.8	75.6	76.4	110	143	200	299	274
105D	144.2	65.2	ND	51. 7	34.7	64	<50	<250	NS	58.5	60.4	41	67.1	59	67.5	60.8
105S	7,470	9,590	ND	2,940	1,760	2,400	1,340	<250	NS	945	915	618	1,200	540	735	484
106D	76.8	69.2	ND	52.2	40.4	<50	<50	<250	NS	69.4	51.3	51	51.7	59	74.3	64.7
106S	2,074	1,307	ND	NS	960	720	468	<250	NS	222	348	239	786	530	670	490
107D	41.2	95.4	ND	30.9	18.4	<50	<50	<250	<50	<50	<27	173	<30	21	38	32.1
107S	100	108.7	ND	91. 0	169	180	160	<250	<50	102	105	66	278	120	192	177
108S	<50	62.8	ND	NS	82.9	120	100	<250	NS	NS	NS	NS	NS	NS	NS	68.3
109D	523	577	ND	401.0	157	200	150	<250	NS	59.4	183	26	NS	NS	210	191
109S	70	88.7	ND	107.0	112	170	54	<250	510	179	76.8	126	203	190	254	124
110D	337.7	316.5	ND	234.0	289	320	250	<250	265	203	93.3	127	334	170	179	236
110S	172.6	547	ND	131.0	90.7	81	100	<250	97.3	179	320	162	206	180	238	291
111S	<50	61.8	ND	60.9	45.8	<50	52	<250	NS	61.5	37.2	52	58.1	NS	NS	55.5
112S	<50	65.1	ND	NS	23.9	61	<50	<50	NS	NS	NS	NS	NS	NS	NS	47.8
113S	120	141.7	ND	NS	136	180	100	89.8	NS	NS	NS	NS	NS	NS	NS	110
114S	422	290.2	ND	265.0	240	NS	134	201	NS	127	NS	90	203	140	173	1260
115S	76.3	145.6	ND	94.2	80.7	NS	175	149	NS	178	90.4	78	NS	100	195	NS
117S	50	62.2	ND	NS	17.8	57	75	59.7	NS	NS	NS	NS	NS	NS	NS	68.5
122D	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	178	179	178	180	224	223

NOTES

NI: Well was not installed during sample event.
NS: Well was not sampled during sample event.
ND: Well was sampled but data is not available.
<50: Observed boron concentration was less than the Method Detection Limit (MDL)

Table 4-1: Boron Concentrations (μG/liter) in Groundwater (continued)

Well ID	Mar-99	Apr-99	Sep-99	Jun-00	Jun-01	Dec-01	Mar-02	Jun-02	Sep-02	Dec-02	Mar-03	Jun-03	Sep-03	Dec-03	Mar-04	Jun-04
122S	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	237	219	178	330	317	307
123S	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	64.6	46	67.8	88	107	90.8
124S	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	351	299	312	300	228	225
125S	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	426	365	489	360	390	445
AST-1	<50	36	ND	36.0	17.1	<50	<50	NS	NS	NS	NS	NS	NS	NS	NS	NS
MAT SUMP	NS	NS	ND	177.0	NS	NS	NS	128	NS	NS	NS	NS	NS	NS	NS	NS
EOF 2	<50	46.2	ND	NS	46.2	65	70	72.3	NS	NS	NS	NS	NS	NS	NS	63.4
TW-1	<50	12.7	ND	NS	<200	<50	<50	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-13	<50	14.7	ND	NS	13.1	<50	<50	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.08
MW2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	15.5
MW3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.67
MW502	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	65.2
MW503	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	10.7
MW504	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	42.7
MW505	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	54.4
MW507D	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	36.7
MW507S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	52.8
MW508D	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	66.1
MW508S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	41.9

NOTES

NI: Well was not installed during sample event.
NS: Well was not sampled during sample event.
ND: Well was sampled but data is not available.
<50: Observed boron concentration was less than the Method Detection Limit (MDL)

Table 4-2: Gross α, β, Sr-90 and Cs-137 Concentrations (pCi/L) in Groundwater

Well ID	Sample Event	Gross α	Gross β	Sr-90	Cs-137
MW-100D	2002 Q1	-	-	-	< 5.01
	2002 Q2	-	-	-	< 2.89
	2002 Q3	< 0.83	3.59	-	< 3.22
	2002 Q4	< 0.875	2.37	-	< 3.46
	2003 Q1	< 0.672	3.02	-	< 4.09
	2003 Q2	2.00	6.60	-	< 5.9
	2003 Q3	< 0.916	< 2.68	-	< 4.22
	2003 Q4	0.78	2.58	-	< 7.76
	2004 Q1	< 0.952	1.31	-	< 3.59
	2004 Q2	2.38	< 2.29	-	< 4.32
MW-100S	2002 Q1	-	-	-	3.21
	2002 Q2	-	-	-	< 2.18
	2002 Q3	0.60	5.72	-	< 3.59
	2002 Q4	< 4.02	19.30	-	< 3.18
	2003 Q1	< 1.24	8.73	-	< 4.65
	2003 Q2	< 1.8	4.76	-	< 6.5
	2003 Q3	< 0.914	4.00	-	< 4.18
	2003 Q4	< 1.41	6.52	-	< 7.48
	2004 Q1	< 2.8	4.23	-	< 3.13
	2004 Q2	< 2.27	1.51	-	< 2.21
MW-101D	2002 Q1	-	-	-	< 2.92
	2002 Q2	-	-	-	< 3.12
	2002 Q3	5.84	6.18	< 0.583	< 3.52
	2002 Q4	4.80	5.84	-	< 3.11
	2003 Q1	5.34	6.65	-	< 6.21
	2003 Q2	5.09	9.12	-	< 8.7
	2003 Q3	6.41	5.81	-	< 3.82
	2003 Q4	6.02	4.95	-	< 8.19
	2004 Q1	6.52	1.70	< 1.16	< 7.09
	2004 Q2	8.50	6.18	< 1.23	< 3.52
MW-101S	2002 Q1	-	-	-	< 2.78
	2002 Q2	-	-	-	1.64
	2002 Q3	0.91	5.74	0.55	< 3.15
	2002 Q4	< 0.643	2.45	-	< 3.09
	2003 Q1	< 0.769	2.82	0.38	< 4.06
	2003 Q2	< 2.1	3.32	< 1.7	< 8.3
	2003 Q3	0.85	4.86	0.33	< 4.78

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was less than the MDC

Bold Sr-90 concentrations are greater than EPA MCL

Table 4-2: Gross α, β, Sr-90 and Cs-137 Concentrations (pCi/liter) in Groundwater (continued)

Well ID	Sample Event	Gross α	Gross β	Sr-90	Cs-137
	2003 Q4	0.79	7.55	0.47	< 9.3
	2004 Q1	< 0.977	1.87	< 1.2	< 4.31
	2004 Q2	1.59	3.27	< 1.2	< 3.59
MW-102D	2002 Q1	9.74	7.42	< 0.664	< 2.41
	2002 Q2	5.53	6.97	< 0.721	1.98
	2002 Q3	8.93	8.69	< 0.636	6.14
	2002 Q4	5.55	50.10	< 0.85	6.69
	2003 Q1	3.57	15.60	< 0.578	12.70
	2003 Q2	8.60	58.10	< 1.6	< 6.1
	2003 Q3	-	-	-	-
	2003 Q4	11.10	11.10	< 1.25	< 8.71
	2004 Q1	11.30	6.89	< 1.11	< 3.92
	2004 Q2	8.51	9.95	0.93	< 3.43
MW-102S	2002 Q1	1.05	6.15	< 0.716	< 3.05
	2002 Q2	1.48	4.52	< 0.716	< 3.01
	2002 Q3	1.01	5.16	< 0.52	< 2.98
	2002 Q4	0.76	3.05	< 0.644	< 3.4
	2003 Q1	< 0.84	4.68	0.38	< 4.85
	2003 Q2	1.52	4.70	1.08	< 10
	2003 Q3	0.94	5.73	0.55	< 4.61
	2003 Q4	< 1.28	4.95	< 1.26	< 7.25
	2004 Q1	< 1.5	2.28	< 1.2	< 3.67
	2004 Q2	1.66	2.05	< 1.2	< 5.06
MW-103D	2002 Q1	3.07	3.38	< 0.603	< 2.78
	2002 Q2	6.87	7.39	< 0.691	< 2.19
	2002 Q3	8.63	12.90	< 0.63	< 3.64
	2002 Q4	4.64	5.42	< 0.593	< 3.3
	2003 Q1	4.11	5.68	< 1.78	< 3.58
	2003 Q2	< 2.6	4.85	< 1.9	< 7.3
	2003 Q3	-	-	-	-
	2003 Q4	4.40	6.70	0.37	< 7.7
	2004 Q1	5.19	6.06	< 0.815	< 2.7
	2004 Q2	2.72	3.36	1.26	< 2.23
MW-103S	2002 Q1	1.85	37.6	5.23	30.2
	2002 Q2	1.64	81.5	**15.30**	58.5
	2002 Q3	1.57	46.0	3.81	38.1
	2002 Q4	0.68	40.6	5.57	38.0
	2003 Q1	4.33	76.9	6.75	87.6
	2003 Q2	< 0	42.2	1.13	26.6

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was less than the MDC

Bold Sr-90 concentrations are greater than EPA MCL

Table 4-2: Gross α, β, Sr-90 and Cs-137 Concentrations (pCi/liter) in Groundwater (continued)

Well ID	Sample Event	Gross α	Gross β	Sr-90	Cs-137
	2003 Q3	1.25	41.8	2.59	38.1
	2003 Q4	1.05	13.50	< 0.615	13.50
	2004 Q1	1.53	27.80	2.27	22.40
	2004 Q2	2.33	23.50	1.34	7.50
MW-104S	2002 Q1	-	-	-	< 5.23
	2002 Q2	-	-	-	< 2.2
	2002 Q3	2.85	14.80	-	< 3.35
	2002 Q4	1.01	6.90	-	< 3.09
	2003 Q1	0.73	7.56	-	< 5.23
	2003 Q2	6.10	42.87	3.14	< 8.5
	2003 Q3	3.86	18.00	2.02	< 4.29
	2003 Q4	1.52	9.06	0.86	< 8.76
	2004 Q1	1.25	4.11	< 0.685	< 2.09
	2004 Q2	2.49	6.23	< 1.35	< 2.26
MW-105D	2002 Q1	1.47	4.72	< 0.571	< 2.67
	2002 Q2	1.39	2.33	< 0.597	< 2.26
	2002 Q3	3.06	6.69	< 0.738	< 3.17
	2002 Q4	2.15	5.72	< 0.596	< 3.12
	2003 Q1	2.43	4.46	0.66	< 4.17
	2003 Q2	3.59	9.01	< 1.5	< 7.9
	2003 Q3	6.70	6.62	< 0.427	< 3.47
	2003 Q4	5.08	5.78	1.33	< 10.10
	2004 Q1	2.59	3.56	< 0.811	< 2.48
	2004 Q2	5.30	5.67	1.11	< 2.33
MW-105S	2002 Q1	1.11	242.	**122.**	< 2.48
	2002 Q2	< 1.34	238.	**116.**	< 2.55
	2002 Q3	< 1.17	180.	**101.**	< 3.29
	2002 Q4	< 0.872	159.	**83.3**	< 3.37
	2003 Q1	< 1.04	253.	**138.**	< 4.23
	2003 Q2	< 3.2	490.1	**181.6**	< 4.7
	2003 Q3	< 1.69	45.5 (NV)	**197.**	< 3.64
	2003 Q4	0.79	297.	**144**	< 8.14
	2004 Q1	< 1.2	192.	**91.8**	< 1.86
	2004 Q2	< 2.01	44.3	**16.2**	< 2.03
MW-106D	2002 Q1	1.03	5.89	< 0.597	< 3.18
	2002 Q2	1.13	6.01	< 0.527	1.92
	2002 Q3	1.16	8.31	< 0.546	< 2.4
	2002 Q4	1.43	4.27	< 0.624	< 2.4
	2003 Q1	1.19	7.40	0.36	< 3.97

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was less than the MDC

Bold Sr-90 concentrations are greater than EPA MCL

Table 4-2: Gross α, β, Sr-90 and Cs-137 Concentrations (pCi/liter) in Groundwater (continued)

Well ID	Sample Event	Gross α	Gross β	Sr-90	Cs-137
	2003 Q2	3.02	10.94	< 1.5	< 10
	2003 Q3	2.45	10.30	0.80	< 4.25
	2003 Q4	4.76	7.73	0.50	< 6.9
	2004 Q1	2.75	4.12	< 1.17	< 2.24
	2004 Q2	1.16	3.23	< 1.2	< 2.11
MW-106S	2002 Q1	1.36	25.40	**8.38**	< 2.05
	2002 Q2	< 1.24	34.00	**13.00**	< 2.28
	2002 Q3	< 1.49	11.20	2.26	2.76
	2002 Q4	< 1.26	23.20	**9.35**	< 2.55
	2003 Q1	1.01	36.10	**13.50**	< 4.54
	2003 Q2	< 3.1	54.60	**18.68**	< 8.5
	2003 Q3	< 5.33	801. (NV)	3.71	< 4.77
	2003 Q4	2.25	19.70	4.35	< 9.28
	2004 Q1	1.54	13.90	1.21	< 1.98
	2004 Q2	2.73	19.50	3.17	< 2.61
MW-107D	2002 Q1	1.98	5.38	< 0.628	< 3.11
	2002 Q2	1.30	3.87	< 0.6	< 2.65
	2002 Q3	0.81	5.30	< 0.557	< 2.64
	2002 Q4	1.10	3.97	< 0.572	< 2.75
	2003 Q1	1.16	4.02	-	< 3.87
	2003 Q2	< 0	4.40	< 1.7	< 5.4
	2003 Q3	< 2.56	3.72	0.33	< 4.25
	2003 Q4	0.92	3.01	< 0.669	< 9.04
	2004 Q1	1.33	5.79	< 1.23	< 4.4
	2004 Q2	< 2.53	7.00	< 1.2	< 3.61
MW-107S	2002 Q1	-	-	-	< 4.37
	2002 Q2	< 0.944	4.61	0.26	< 2.42
	2002 Q3	< 1.14	5.11	< 0.593	< 3.43
	2002 Q4	< 0.822	2.77	0.44	< 2.65
	2003 Q1	0.63	3.49	0.54	< 3.29
	2003 Q2	< 2.7	4.20	< 1.9	< 7.6
	2003 Q3	< 0.923	4.40	0.36	< 5.18
	2003 Q4	< 1.29	1.73	0.54	< 9.23
	2004 Q1	< 1.28	1.55	< 1.37	< 3.52
	2004 Q2	< 2.66	1.69	2.69	< 3.39
MW-108S	2002 Q1	-	-	-	< 4.16
	2002 Q2	-	-	-	< 2.25
	2002 Q3	1.16	9.36	-	< 3.25
	2002 Q4	0.55	2.51	-	< 2.31

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was less than the MDC

Bold Sr-90 concentrations are greater than EPA MCL

Table 4-2: Gross α, β, Sr-90 and Cs-137 Concentrations (pCi/liter) in Groundwater (continued)

Well ID	Sample Event	Gross α	Gross β	Sr-90	Cs-137
	2003 Q1	0.46	2.16	-	< 4.8
	2003 Q2	< 2.5	4.00	-	< 4.3
	2003 Q3	0.82	2.51	-	< 4.61
	2003 Q4	1.45	2.79	0.63	< 9.08
	2004 Q1	< 1.11	2.63	< 0.887	< 3.6
	2004 Q2	3.90	5.72	< 1.4	< 3.43
MW-109D	2002 Q1	3.70	7.47	< 0.666	< 2.6
	2002 Q2	4.62	5.54	< 0.495	< 2.52
	2002 Q3	3.72	6.20	< 0.568	< 2.13
	2002 Q4	< 0.834	1.82	< 0.646	< 3.13
	2003 Q1	6.52	11.90	-	2.40
	2003 Q2	9.00	11.49	< 1.9	< 8.2
	2003 Q3	0.91	5.57	< 0.39	< 4.34
	2003 Q4	-	-	< 0.497	-
	2004 Q1	6.95	7.60	< 1.01	< 2.02
	2004 Q2	7.78	9.21	< 1.16	< 8.77
MW-109S	2002 Q1	< 1.54	6.33	0.90	< 2.88
	2002 Q2	< 1.23	8.49	0.66	< 2.76
	2002 Q3	< 1.79	12.80	0.97	< 3.25
	2002 Q4	1.25	10.10	0.90	< 3.47
	2003 Q1	< 1.5	7.85	0.98	< 3.8
	2003 Q2	< 2.9	11.20	< 1.7	< 6.1
	2003 Q3	< 2.61	11.50	0.69	1.87
	2003 Q4	< 2.03	10.80	1.01	< 9.7
	2004 Q1	< 1.37	9.63	< 1.11	< 3.36
	2004 Q2	< 2.32	6.53	0.80	< 2.08
MW-110D	2002 Q1	11.00	12.60	< 0.562	< 2.84
	2002 Q2	7.78	9.14	< 0.52	< 2.48
	2002 Q3	7.73	11.20	2.54	< 2.17
	2002 Q4	8.25	8.83	< 0.696	< 3.26
	2003 Q1	6.04	9.95	< 0.551	< 5.04
	2003 Q2	6.10	12.00	< 1.7	< 7.5
	2003 Q3	5.82	20.50	0.36	< 3.96
	2003 Q4	8.15	11.50	0.45	< 8.19
	2004 Q1	7.07	7.14	0.66	< 3.34
	2004 Q2	5.63	8.50	< 1.15	< 1.94
MW-110S	2002 Q1	< 0.965	4.07	0.34	< 3.05
	2002 Q2	< 0.952	6.51	< 0.545	< 2.57
	2002 Q3	< 0.813	4.39	< 0.683	< 2.72

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was less than the MDC

Bold Sr-90 concentrations are greater than EPA MCL

Table 4-2: Gross α, β, Sr-90 and Cs-137 Concentrations (pCi/liter) in Groundwater (continued)

Well ID	Sample Event	Gross α	Gross β	Sr-90	Cs-137
	2002 Q4	< 0.863	4.28	< 0.528	< 2.31
	2003 Q1	< 0.858	7.47	0.32	< 4.97
	2003 Q2	< 2.7	7.30	< 1.6	< 4.6
	2003 Q3	< 1.93	3.99	< 0.423	< 3.45
	2003 Q4	< 1.22	4.70	0.44	< 6.15
	2004 Q1	< 1.33	1.88	< 1.7	< 3.41
	2004 Q2	< 2.44	4.35	0.69	< 3.05
MW-111S	2002 Q1	1.00	5.31	< 0.629	< 2.42
	2002 Q2	< 0.696	2.76	< 0.722	< 2.8
	2002 Q3	0.54	7.39	-	< 3.69
	2002 Q4	< 0.671	5.01	< 0.527	< 2.69
	2003 Q1	0.55	3.24	-	< 3.82
	2003 Q2	< 2.2	5.10	-	< 8.5
	2003 Q3	< 0.714	4.12	-	< 4.5
	2003 Q4	< 0.657	5.52	0.35	< 7.09
	2004 Q1	0.73	4.95	< 0.788	< 3.06
	2004 Q2	< 2.49	2.06	< 1.11	< 2.4
MW-112S	2002 Q1	-	-	-	< 3.35
	2002 Q2	-	-	-	< 1.96
	2002 Q3	< 0.788	3.61	-	< 3.01
	2002 Q4	< 0.685	1.99	-	< 2.11
	2003 Q1	< 0.717	< 2.58	-	< 4.92
	2003 Q2	< 2.1	2.02	-	< 7.5
	2003 Q3	< 0.931	2.62	-	< 4.87
	2003 Q4	< 0.595	< 2.5	5.49	< 8.17
	2004 Q1	< 0.96	< 2.38	< 0.765	< 3.44
	2004 Q2	1.56	< 1.97	0.70	< 4.43
MW-113S	2002 Q1	-	-	-	< 4.17
	2002 Q2	-	-	-	< 3.04
	2002 Q3	2.95	31.40	-	< 2.94
	2002 Q4	1.82	30.30	-	< 3.51
	2003 Q1	0.89	23.40	-	< 2.32
	2003 Q2	< 3.2	16.80	< 1.7	< 9.7
	2003 Q3	< 3.12	23.40	0.58	< 0
	2003 Q4	< 1.53	22.70	0.84	< 9.04
	2004 Q1	< 1.93	16.30	0.37	< 3.16
	2004 Q2	< 2.38	8.30	0.67	< 2.26
MW-114S	2002 Q1	0.68	20.70	3.63	< 3.4
	2002 Q2	0.95	17.30	3.26	< 2.65

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was less than the MDC

Bold Sr-90 concentrations are greater than EPA MCL

Table 4-2: Gross α, β, Sr-90 and Cs-137 Concentrations (pCi/liter) in Groundwater (continued)

Well ID	Sample Event	Gross α	Gross β	Sr-90	Cs-137
	2002 Q3	< 0.885	11.50	1.45	< 2.99
	2002 Q4	< 0.923	11.60	2.62	< 2.89
	2003 Q1	< 3.42	49.10	**16.60**	< 3.83
	2003 Q2	2.98	12.96	< 1.8	< 4.3
	2003 Q3	< 1.94	7.24	0.73	< 3.88
	2003 Q4	< 1.17	7.70	1.15	< 9.1
	2004 Q1	< 1.79	18.50	3.92	< 4.12
	2004 Q2	6.29	8.11	< 1.19	< 3.68
MW-115S	2002 Q1	6.38	23.00	3.85	3.18
	2002 Q2	< 0.827	5.95	0.52	1.59
	2002 Q3	1.30	17.60	2.40	7.59
	2002 Q4	1.50	13.20	1.42	3.72
	2003 Q1	1.56	11.90	1.33	2.55
	2003 Q2	< 2.1	4.60	< 1.5	< 6.6
	2003 Q4	1.88	8.49	1.41	< 9.79
	2004 Q1	1.42	8.62	1.64	2.84
MW-117S	2002 Q1	-	-	-	< 4.84
	2002 Q2	-	-	-	< 2.47
	2002 Q3	1.59	8.36	-	< 3.43
	2002 Q4	< 1.27	7.66	1.28	< 3.21
	2003 Q1	0.90	8.13	1.41	< 4.38
	2003 Q2	3.80	11.66	1.40	< 9.3
	2003 Q3	< 2.25	9.49	1.42	< 4.21
	2003 Q4	< 2.24	9.65	0.77	< 6.78
	2004 Q1	< 2.97	5.41	< 1.09	< 3.76
	2004 Q2	< 1.44	7.28	0.79	< 4.08
MW-122D	2003 Q1	12.00	12.00	< 0.693	< 4.64
	2003 Q2	12.60	27.70	1.21	< 9.2
	2003 Q3	21.50	18.70	< 0.398	< 4.02
	2003 Q4	9.80	10.80	0.21	< 9.7
	2004 Q1	6.20	6.64	0.55	3.19
	2004 Q2	7.14	5.21	3.29	< 3.28
MW-122S	2003 Q1	1.18	6.41	1.59	< 3.56
	2003 Q2	< 3.2	14.11	< 1.7	< 8.6
	2003 Q3	< 3.49	11.20	1.24	< 2.98
	2003 Q4	< 2.19	8.64	0.81	< 9.97
	2004 Q1	< 1.58	6.46	0.64	< 3.31
	2004 Q2	4.88	8.40	0.57	< 3.87
MW-123S	2003 Q1	12.90	18.40	0.63	< 4.26

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was less than the MDC

Bold Sr-90 concentrations are greater than EPA MCL

Table 4-2: Gross α, β, Sr-90 and Cs-137 Concentrations (pCi/liter) in Groundwater (continued)

Well ID	Sample Event	Gross α	Gross β	Sr-90	Cs-137
	2003 Q2	5.10	24.70	< 1.6	< 5.1
	2003 Q4	7.70	14.90	1.37	< 7.97
	2004 Q1	4.19	14.70	0.87	< 4.31
	2004 Q2	4.63	19.60	< 1.34	2.46
MW-124S	2003 Q1	< 1.04	6.24	0.49	< 4.94
	2003 Q2	< 2.7	8.30	< 1.6	< 6.7
	2003 Q4	< 1.22	5.90	0.54	< 8.73
	2004 Q1	< 1.61	5.12	< 1.12	< 3.32
	2004 Q2	< 2.2	4.98	1.33	< 3.22
MW-125S	2003 Q1	1.52	10.90	0.69	< 4.4
	2003 Q2	< 2.8	14.49	1.41	< 7.4
	2003 Q3	< 2.17	16.30	1.17	< 2.5
	2003 Q4	< 2.04	15.30	6.51	< 7.44
	2004 Q1	1.05	8.89	3.15	< 2.86
	2004 Q2	2.36	11.80	1.78	< 3.88
MW-200	2002 Q2	-	-	-	< 2.45
	2002 Q4	11.40	14.20	-	< 3.31
	2003 Q1	2.89	4.86	-	< 4.88
	2003 Q2	20.20	23.40	-	< 4.9
	2003 Q4	0.38	2.77	-	< 9.36
MW-201	2002 Q2	-	-	-	< 2.86
	2002 Q3	0.51	4.42	-	< 3.56
	2002 Q4	1.39	3.90	-	< 3.07
	2003 Q1	< 0.661	3.07	-	< 4.9
	2003 Q2	< 2.6	5.50	-	< 3.5
	2003 Q3	< 1.24	< 2.64	-	< 3.98
	2003 Q4	1.89	2.49	-	< 9.38
MW-203	2002 Q1	0.58	1.59	< 0.48	< 2.42
	2002 Q2	-	-	-	< 2.77
	2002 Q3	< 0.861	3.30	-	< 3.33
	2002 Q4	< 0.593	4.04	< 0.758	< 3.21
	2003 Q1	2.62	6.60	-	< 4.11
	2003 Q2	6.30	15.60	-	< 3.3
	2003 Q3	0.53	2.33	-	< 4.78
	2003 Q4	< 0.919	3.75	-	< 5.94
MW-205	2002 Q1	-	-	-	< 3.41
	2002 Q2	-	-	-	< 2.64
	2002 Q3	< 1.27	3.01	-	2.51
	2002 Q4	< 0.799	2.06	-	< 3.08

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was less than the MDC

Bold Sr-90 concentrations are greater than EPA MCL

Table 4-2: Gross α, β, Sr-90 and Cs-137 Concentrations (pCi/liter) in Groundwater (continued)

Well ID	Sample Event	Gross α	Gross β	Sr-90	Cs-137
	2003 Q1	< 0.679	< 2.54	-	< 3.5
	2003 Q2	< 1.8	2.15	-	< 3.5
	2003 Q3	< 1.16	1.31	-	< 3.58
	2003 Q4	< 0.574	1.62	-	< 8.18
MW-207	2002 Q1	0.60	3.63	< 0.565	< 3.09
	2002 Q2	-	-	-	< 2.83
	2002 Q3	< 0.635	4.35	-	< 3.22
	2002 Q4	0.49	5.40	-	< 2.64
	2003 Q1	< 0.642	3.08	-	< 3.94
	2003 Q2	< 1.9	3.48	-	< 7.6
	2003 Q3	< 0.571	1.48	0.44	< 9.35
	2003 Q4	< 0.695	2.38	-	< 9.63
MW-208	2003 Q2	24.10	42.70	-	< 7.6
	2003 Q3	< 0.549	4.14	-	< 4.72
	2003 Q4	< 0.888	3.45	0.89	< 9.88
MW-1	2004 Q2	< 0	< 1.84	0.94	< 2.41
MW-2	2002 Q4	< 0.967	2.75	0.41	< 3.09
MW-2	2004 Q2	< 1.29	4.43	< 1.02	< 3.51
MW-3	2004 Q2	< 1.81	0.79	< 1.24	< 2.47
MW-502	2004 Q2	1.65	5.02	-	< 2.26
MW-503	2004 Q2	3.23	1.74	-	< 2.35
MW-504	2004 Q2	< 1.97	3.40	-	< 2.34
MW-505	2004 Q2	1.82	4.88	-	< 3.12
MW-507D	2004 Q2	28.80	15.20	-	< 2.39
MW-507S	2004 Q2	1.42	3.95	-	< 2.25
MW-508D	2004 Q2	7.58	6.68	-	< 2.76
MW-508S	2004 Q2	< 2.28	4.50	-	< 3.16
AST-1	2002 Q1	-	-	-	< 5.83
EOF-2	2002 Q1	17.20	13.90	< 0.539	< 2.67
	2002 Q2	< 0.463	< 2.59	-	< 3.27
	2003 Q1	0.73	2.84	-	< 5.32
	2003 Q3	< 1.63	3.76	-	< 5.57
	2004 Q2	2.58	3.30	-	< 3.27
SUPPLY WELL B	2002 Q4	-	-	< 0.579	-

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was less than the MDC

Bold Sr-90 concentrations are greater than EPA MCL

Table 4-3: Tritium Concentrations (pCi/L) in Groundwater

Well ID	Mar'99	Apr'99	Sep'99	Jun'00	Jun'01	Dec'01	Mar'02	Jun'02	Sep'02	Dec'02	Mar'03	Jun'03	Sep'03	Dec'03	Dec'03[D]	Mar'04	Jun'04
100D	< 700	< 1000	NS	< MDC	< 270	<210	< 271	< 260	134	< 293	< 259	< 360	< 301	170	189	< 262	< 306
100S	< 700	< 1000	NS	NS	< 270	<200	< 273	< 261	< 284	< 294	< 256	< 320	< 310	186	< 240	< 267	< 284
101D	< 700	< 1000	NS	NS	< 260	<210	< 280	< 276	137	< 275	< 258	250	< 309	< 295	< 295	< 276	< 242
101S	< 700	< 1000	NS	< MDC	< 260	<210	< 284	< 278	< 284	< 273	< 255	< 350	< 255	233	166	< 271	252
102D	2,740	3,160	2,640	2,470	2,620	4,110	9,400	6,390	5,590	13,900	**27,100**	**28,630**	8,200	4,910	5,240	4,940	4,690
102S	< 700	< 1000	NS	5,540	7,250	**20,600**	6,320	4,500	12,200	1,100	2,370	770	4,880	5,270	5,130	6,740	5,740
103D	**22,180**	17,550	19,660	**20,900**	**20,800**	8,100	12,900	13,400	12,900	10,100	10,300	11,460	10,500	9,130	9,060	12,000	6,530
103S	2,580	9,260	2,980	1,230	1,120	5,350	627	6,460	495	1,760	886	2,610	3,500	195	263	1,090	5,300
104S	< 700	< 1000	NS	NS	< 270	186	< 273	< 261	293	142	< 258	390	< 307	< 255	152	285	241
105D	4,590	2,450	3,030	2,150	1,360	2,110	1,780	1,510	2,060	2,390	854	1,400	905	1,240	1,170	953	1,280
105S	**138,700**	**67,400**	**23,480**	15,900	12,200	1,800	1,870	7,860	4,140	8,070	5,410	4,470	4,850	3,370	3,280	5,520	3,350
106D	3,320	1,590	5,830	1,810	1,450	14,200	1,730	1,630	2,610	1,430	1,120	1,310	1,590	1,090	1,340	1,110	1,520
106S	**24,290**	16,370	NS	NS	780	2,130	2,450	1,130	514	1,500	2,330	1,550	332	752	784	542	850
107D	< 700	< 1000	NS	< MDC	< 270	<210	217	211	214	242	481	630	647	424	664	732	656
107S	< 700	< 1000	NS	< MDC	< 270	219	254	274	< 284	< 292	346	580	< 250	232	255	225	< 352
108S	< 700	< 1000	NS	NS	< 270	156	290	221	256	< 291	< 251	240	206	< 287	< 283	< 268	< 251
109D	**33,070**	**31,600**	**21,230**	15,800	6,550	5,720	3,810	5,660	4,150	593	4,550	3,350	< 305	4,210	3,890	4,550	3,140
109S	<700	< 1000	NS	< MDC	< 270	<240	< 265	< 261	< 288	< 276	< 257	< 350	< 300	< 242	< 260	< 279	< 275
110D	**27,630**	**23,280**	**27,230**	18,300	18,700	**21,300**	16,500	10,700	15,200	11,100	4,630	5,310	11,300	6,620	6,550	5,890	8,300
110S	3,090	< 1000	2,470	2,360	1,890	3,270	2,980	1,470	2,390	2,050	1,430	1,370	1,420	1,290	1,090	2,050	1,010
111S	< 700	< 1000	NS	< MDC	< 270	<210	< 273	< 259	222	< 292	< 253	< 350	299	< 278	< 282	< 269	233
112S	< 700	< 1000	NS	NS	< 270	<240	< 277	< 259	< 277	< 293	< 249	< 340	< 306	159	153	< 272	< 277
113S	< 700	< 1000	NS	NS	< 270	<240	< 272	< 263	160	< 290	149	< 340	118	215	181	< 260	180
114S	< 700	1,180	2,850	2,760	1,940	NS	3,730	1,140	1,190	927	1,530	1,070	481	1,280	1,610	1,350	6,730
115S	< 700	< 1000	NS	5,550	4,500	NS	1,870	4,090	1,900	2,180	2,230	3,410	NS	2,630	2,680	5,740	NS
117S	< 700	< 1000	NS	NS	< 180	<240	< 272	< 261	< 279	< 294	< 249	< 340	< 253	< 255	< 287	< 283	< 324
122D	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	< 258	< 360	< 305	120	< 237	< 298	222
122S	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	720	850	895	898	631	750	645
123S	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	< 260	< 340	128	201	228	< 249	< 306
124S	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	4850	4,350	4,340	1,910	2,020	1,530	1,770
125S	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	1,540	1,900	873	2,110	1,930	2,350	2,170
AST-1	< 700	<1000	NS	NS	< 260	144	245	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mat Sump	2,630	2,320	NS	2,890	NS	NS	NS	2,180	NS	NS	NS	NS	NS	NS	NS	NS	NS
TW-1	< 700	< 1000	NS	NS	< 270	< 250	< 267	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
TW-3	NS	NS	NS	NS	NS	< 200	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Notes:

Bold values are greater than EPA 4-mrem maximum contaminant level (MCL).

(<) Non-detect with minimum detection concentration (MDC).

Table 4-3: Tritium Concentrations (pCi/L) in Groundwater (continued)

Well ID	Mar'99	Apr'99	Sep'99	Jun'00	Jun'01	Dec'01	Mar'02	Jun'02	Sep'02	Dec'02	Mar'03	Jun'03	Sep'03	Dec'03	Dec'03[b]	Mar'04	Jun'04
TW-4	NS	NS	NS	NS	NS	< 200	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW-1	NS	NS	NS	NS	NS	< 200	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	223
MW-2	NS	NS	NS	NS	NS	601	NS	NS	NS	229	NS	NS	NS	NS	NS	NS	< 397
MW-4	NS	NS	NS	NS	NS	< 200	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 245
MW-13	< 700	< 1000	NS	NS	< 270	< 240	< 267	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
200	< MDC	< MDC	NS	NS	< 180	NS	NS	< 261	NS	NS	NS	NS	NS	NS	NS	NS	NS
201	< MDC	< MDC	NS	NS	< 180	NS	NS	< 262	NS	NS	NS	NS	NA	NA	NA	NS	NS
202	< MDC	< MDC	NS	NS	< 180	< 210	< 266	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
203	< MDC	< MDC	NS	NS	< 270	< 250	< 267	< 263	NS	< 329	NS	NS	NA	NA	NA	NS	NS
204	< MDC	< MDC	NS	NS	< 180	< 210	< 266	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
205	< MDC	< MDC	NS	NS	< 180	< 210	< 264	< 275	NS	NS	NS	NS	NA	NA	NA	NS	NS
206	< MDC	< MDC	NS	NS	< 180	< 210	< 261	NS	NS	NS	NS	NS	NA	NA	NA	NS	NS
207	< MDC	< MDC	NS	NS	< 180	< 250	< 259	< 278	NS	NS	NS	NS	< 238	NA	NA	NS	NS
EOF Supply	NS	NS	NS	NS	NS	< 210	< 265	NS	NS	NS	< 249	NS	NS	NS	NS	NS	NS
EOF 2	< 700	< 1000	NS	NS	< 270	< 200	< 270	< 263	< 285	NS	NS	< 340	< 302	< 246	< 243	< 265	196
Schmidt	NS	NS	NS	NS	NS	NS	< 267	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
502	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 302
503	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 303
504	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	276
505	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 284
507D	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 306
507S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 292
508D	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 270
508S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 282

Notes:

Bold values are greater than EPA 4-mrem maximum contaminant level (MCL).

(<) Non-detect with minimum detection concentration (MDC).

(D) Indicates dissolved sample, all other results are for total sample.

(NI) Well not installed. (NS) Well not sampled. (NA) Well sampled but not analyzed.

Table 4-4: Hard-to-Detect (HTD) Concentrations (pCi/L) in Groundwater

Well ID	Sample Event	C-14	Fe-55	Ni-63	Sr-89	Sr-90	Tc-99	Pu-238	Pu239/40	Pu-241	Am-241	Cm243/44
MW-100D	2004 Q1	-	-	-	-	-	-	-	-	-	< 0.173	-
MW-100S	2004 Q1	-	-	-	-	-	-	-	-	-	< 0.196	-
MW-101D	2002 Q3	< 8.22	< 15.10	< 0	-	< 0.583	< 10.80	< 0.134	< 0.134	7.40	< 0.131	< 0.132
	2004 Q1	-	-	-	-	< 1.16	-	-	-	-	< 0.26	-
	2004 Q2	-	-	-	-	< 1.23	-	-	-	-	-	-
MW-101S	2002 Q3	4.46	< 17.60	< 4.26	-	0.55	< 11.20	< 0.156	< 0.156	7.59	< 0.319	< 0.244
	2003 Q1	-	-	-	-	0.38	-	< 0.284	< 0.284	6.77	< 0.254	< 0.194
	2003 Q2	-	-	-	< 40	< 1.7	-	-	-	-	-	-
	2003 Q3	-	-	-	-	0.33	-	-	-	-	-	-
	2003 Q4	-	-	-	-	0.47	-	-	-	-	-	-
	2004 Q1	-	-	-	-	< 1.2	-	-	-	-	< 0.298	-
	2004 Q2	-	-	-	-	< 1.2	-	-	-	-	-	-
MW-102D	2002 Q1	< 8.06	< 6.71	< 3.51	-	< 0.664	< 10.40	< 0.182	< 0.271	< 10.70	< 0.213	< 0.215
	2002 Q2	< 7.85	< 8.32	< 2.84	-	< 0.721	< 11.30	< 0.14	< 0.139	< 7.74	< 0.203	< 0.187
	2002 Q3	< 8.57	< 11.40	4.67	-	< 0.636	< 10.70	< 0.252	< 0.143	4.69	< 0.139	< 0.14
	2002 Q4	< 8.08	4.14	3.42	-	< 0.85	14.30	< 0.134	< 0.236	10.70	< 0.152	< 0.317
	2003 Q1	-	-	-	-	< 0.578	-	< 0.295	< 0.295	< 18.60	< 0.113	< 0.113
	2003 Q2	-	-	-	< 38	< 1.6	-	-	-	-	-	-
	2003 Q4	-	< 10.50	< 3.42	-	< 1.25	< 9.01	< 0.168	< 0.168	< 9.5	< 0.15	< 0.151
	2004 Q1	-	-	-	-	< 1.11	-	-	-	-	< 0.259	-
	2004 Q2	-	-	-	-	0.93	-	-	-	-	-	-
MW-102S	2002 Q1	< 8.07	2.54	< 3.88	-	< 0.716	< 10.50	< 0.283	< 0.19	< 11.30	< 0.133	< 0.293
	2002 Q2	7.32	14.20	< 2.89	-	< 0.716	9.75	< 0.178	< 0.208	< 9.3	< 0.0954	< 0.0959
	2002 Q3	< 8.57	< 11.30	4.18	-	< 0.52	< 10.90	< 0.132	< 0.132	< 7.69	< 0.129	< 0.13
	2002 Q4	< 8.08	10.30	< 3.8	-	< 0.644	17.90	< 0.139	< 0.246	11.60	< 0.121	< 0.121
	2003 Q1	< 8.07	7.89	< 4.5	-	0.38	< 12.30	< 0.133	< 0.133	< 9.88	< 0.116	< 0.117
	2003 Q2	-	-	-	< 37	1.08	-	-	-	-	-	-
	2003 Q3	-	-	-	-	0.55	-	-	-	-	-	-
	2003 Q4	-	-	-	-	< 1.26	-	-	-	-	-	-

Notes:

Bold values are greater than EPA 4-mrem maximum contaminant level (MCL).

(<) Non-detect with minimum detection concentration (MDC).

Table 4-4: Hard-to-Detect Concentrations (pCi/L) in Groundwater (continued)

Well ID	Sample Event	C-14	Fe-55	Ni-63	Sr-89	Sr-90	Tc-99	Pu-238	Pu239/40	Pu-241	Am-241	Cm243/44
	2004 Q1	-	-	-	-	< 1.2	-	-	-	-	< 0.36	-
	2004 Q2	-	-	-	-	< 1.2	-	-	-	-	-	-
MW-103D	2002 Q1	< 8.06	6.27	< 3.74	-	< 0.603	< 10.40	< 0.199	< 0.199	9.03	0.69	< 0.159
	2002 Q2	< 7.85	2.86	< 2.78	-	< 0.691	< 11.40	< 0.098	< 0.0981	< 7.78	< 0.239	< 0.24
	2002 Q3	< 8.56	< 21.10	8.01	-	< 0.63	< 9.89	< 0.305	< 0.305	5.27	< 0.119	< 0.12
	2002 Q4	< 8.08	9.04	< 3.93	-	< 0.593	< 12.30	< 0.263	< 0.148	14.70	< 0.111	< 0.111
	2003 Q1	-	-	-	-	< 1.78	-	< 0.238	< 0.238	8.76	< 0.112	< 0.113
	2003 Q2	-	-	-	< 43	< 1.9	-	-	-	-	-	-
	2003 Q4	-	-	-	-	0.37	-	-	-	-	-	-
	2004 Q1	< 150.0	< 11.70	< 6.41	-	< 0.815	< 11.90	< 0.103	< 0.103	< 12.10	< 0.121	< 0.099
	2004 Q2	< 73.50	< 12.30	< 11.80	-	1.26	< 8.31	< 0.414	< 0.208	< 11.40	< 0.369	< 0.349
MW-103S	2002 Q1	< 8.07	3.50	3.71	-	5.23	< 10.40	< 0.18	< 0.121	< 7.11	< 0.149	< 0.278
	2002 Q2	5.46	4.96	3.38	-	**15.30**	< 11.20	< 0.188	< 0.221	< 7.23	< 0.0924	< 0.156
	2002 Q3	< 8.56	< 11.90	6.57	-	3.81	9.64	< 0.151	< 0.266	7.08	< 0.12	< 0.121
	2002 Q4	< 8.08	8.55	< 3.7	-	5.57	19.00	< 0.21	< 0.119	14.50	< 0.115	< 0.116
	2003 Q1	< 8.07	8.81	< 10.60	-	6.75	< 12.40	< 0.149	< 0.263	< 9.58	< 0.128	< 0.128
	2003 Q2	-	< 9.2	< 9.7	< 38	1.13	-	< 0.23	-	< 2.9	0.25	-
	2003 Q3	< 31.70	30.50	< 34.10	-	2.59	< 9.5	< 0.134	< 0.134	< 7.7	< 0.411	< 0.234
	2003 Q4	< 16.90	4.23	< 3.24	-	< 0.615	< 8.81	< 0.165	< 0.291	< 9.67	< 0.214	< 0.122
	2004 Q1	< 170.0	< 10.10	< 6.46	-	2.27	< 10.90	< 0.041	< 0.127	16.60	< 0.0995	< 0.218
	2004 Q2	< 11.80	< 10.80	< 13.80	-	1.34	< 10	< 0.23	< 0.156	< 14.50	< 0.256	< 0.248
MW-104S	2003 Q2	-	-	-	< 44	3.14	-	-	-	-	-	-
	2003 Q3	-	-	-	-	2.02	-	-	-	-	-	-
	2003 Q4	13.40	2.72	< 3.56	-	0.86	< 8.87	< 0.127	< 0.127	< 7.25	< 0.119	< 0.119
	2004 Q1	< 151.0	< 10.30	< 5.71	-	< 0.685	< 10.80	< 0.125	< 0.113	< 14.60	< 0.0921	< 0.0923
	2004 Q2	< 11.70	< 11.60	< 12.60	-	< 1.35	< 8.94	< 0.293	< 0.178	< 14.40	< 0.19	< 0.211
MW-105D	2002 Q1	< 8.07	< 6.19	< 3.48	-	< 0.571	0.90	< 0.221	< 0.25	< 8.84	< 0.272	< 0.242
	2002 Q2	< 7.85	5.10	< 0	-	< 0.597	< 11.30	< 0.179	< 0.101	< 5.85	< 0.247	< 0.119
	2002 Q3	< 8.56	< 11.70	3.61	-	< 0.738	< 11	< 0.128	< 0.128	5.77	< 0.11	< 0.11

Notes:

Bold values are greater than EPA 4-mrem maximum contaminant level (MCL).

(<) Non-detect with minimum detection concentration (MDC).

Table 4-4: Hard-to-Detect Concentrations (pCi/L) in Groundwater (continued)

Well ID	Sample Event	C-14	Fe-55	Ni-63	Sr-89	Sr-90	Tc-99	Pu-238	Pu239/40	Pu-241	Am-241	Cm243/44
	2002 Q4	< 8.08	8.14	2.69	-	< 0.596	< 12	< 0.174	< 0.174	12.50	< 0.162	< 0.0918
	2003 Q1	-	-	-	-	0.66	-	< 0.184	< 0.325	< 11.20	< 0.174	< 0.175
	2003 Q2	-	-	-	< 36	< 1.5	-	-	-	-	-	-
	2003 Q3	-	-	-	-	< 0.427	-	-	-	-	-	-
	2003 Q4	-	-	-	-	1.33	-	-	-	-	-	-
	2004 Q1	< 151.0	< 6.85	< 9.67	-	< 0.811	< 10.30	< 0.144	< 0.0804	< 12.30	< 0.0417	< 0.0417
	2004 Q2	< 74.50	< 11.80	< 13.40	-	1.11	< 8.36	< 0.252	< 0.18	< 11.30	< 0.358	< 0.35
MW-105S	2002 Q1	< 8.07	4.40	2.95	-	**122.**	8.89	< 0.118	< 0.118	< 6.94	< 0.159	< 0.161
	2002 Q2	7.02	11.20	2.48	-	**116.**	8.57	< 0.201	< 0.17	< 5.74	< 0.12	< 0.121
	2002 Q3	< 8.57	< 11.70	4.35	-	**101.**	11.80	< 0.117	< 0.244	< 7.51	< 0.25	< 0.142
	2002 Q4	< 8.08	13.40	< 3.83	-	**83.3**	9.96	< 0.127	< 0.295	6.70	< 0.118	< 0.209
	2003 Q1	5.91	12.10	< 4.67	-	**138.**	< 12.50	< 0.116	< 0.116	< 7.46	< 0.132	< 0.133
	2003 Q2	< 66	< 10	< 10	< 43	**181.6**	< 5.6	< 0.27	-	< 3.6	< 0.32	-
	2003 Q3	< 31.80	7.48	< 3.63	-	**197.**	6.06	< 0.48	< 0.271	< 16.60	< 0.234	< 0.236
	2003 Q4	< 15.90	5.76	< 3.45	-	**144**	< 8.95	< 0.175	< 0.174	6.40	< 0.134	< 0.134
	2004 Q1	< 152.0	< 7.77	< 5.51	-	**91.80**	< 10.20	< 0.085	< 0.085	< 12.50	< 0.129	< 0.142
	2004 Q2	< 74.30	< 12.60	< 13.10	-	**16.20**	< 8.33	< 0.392	< 0.221	8.32	< 0.207	< 0.341
MW-106D	2002 Q1	< 8.08	< 6.68	< 3.6	-	< 0.597	< 10.40	< 0.133	< 0.197	5.52	< 0.177	< 0.178
	2002 Q2	< 7.85	6.94	4.22	-	< 0.527	< 11.30	< 0.108	< 0.108	< 9.27	< 0.22	< 0.221
	2002 Q3	< 8.57	< 9.7	3.82	-	< 0.546	< 11	< 0.182	< 0.378	9.68	< 0.156	< 0.157
	2002 Q4	5.92	13.90	< 3.86	-	< 0.624	< 12.30	< 0.119	< 0.21	15.40	< 0.108	< 0.108
	2003 Q1	-	-	-	-	0.36	-	< 0.188	< 0.188	< 11.30	< 0.118	< 0.119
	2003 Q2	-	-	-	< 38	< 1.5	-	-	-	-	-	-
	2003 Q3	-	-	-	-	0.80	-	-	-	-	-	-
	2003 Q4	-	-	-	-	0.50	-	-	-	-	-	-
	2004 Q1	< 151.0	< 8.78	< 6.61	-	< 1.17	< 10.10	< 0.137	< 0.178	12.10	< 0.218	< 0.234
	2004 Q2	< 11.90	< 11.60	< 13.60	-	< 1.2	< 8.99	< 0.175	< 0.143	< 14.40	< 0.275	< 0.36
MW-106S	2002 Q1	< 8.07	0.80	0.90	-	**8.38**	< 10.50	< 0.137	< 0.203	5.27	< 0.172	< 0.174
	2002 Q2	6.03	< 6.67	2.09	-	**13.0**	< 11.20	< 0.196	< 0.111	8.34	0.44	< 0.219

Notes:

Bold values are greater than EPA 4-mrem maximum contaminant level (MCL).

(<) Non-detect with minimum detection concentration (MDC).

Table 4-4: Hard-to-Detect Concentrations (pCi/L) in Groundwater (continued)

Well ID	Sample Event	C-14	Fe-55	Ni-63	Sr-89	Sr-90	Tc-99	Pu-238	Pu239/40	Pu-241	Am-241	Cm243/44
	2002 Q3	< 8.57	< 11.10	4.44	-	2.26	< 10.90	< 0.112	< 0.197	4.40	< 0.179	< 0.213
	2002 Q4	< 8.08	14.10	< 3.79	-	**9.35**	< 12.30	< 0.133	< 0.133	12.20	< 0.158	< 0.0898
	2003 Q1	14.40	7.54	< 4.75	-	**13.50**	< 12.30	< 0.105	< 0.105	< 9.36	< 0.126	< 0.127
	2003 Q2	< 96	< 11	< 6.7	< 52	**18.68**	< 5.8	< 0.2	-	< 3.5	0.24	-
	2003 Q3	< 31.70	4.99	< 3.62	-	3.71	< 9.3	< 0.169	< 0.169	< 9.59	< 0.143	< 0.255
	2003 Q4	< 15.90	< 9.93	< 3.49	-	4.35	< 8.94	< 0.135	< 0.238	< 7.3	< 0.253	< 0.254
	2004 Q1	< 151.0	< 8.42	< 5.72	-	1.21	< 11.10	< 0.145	< 0.0389	< 12	< 0.166	< 0.263
	2004 Q2	< 11.80	< 11.50	< 11.70	-	3.17	< 14.40	< 0.294	< 0.172	< 15.10	< 0.264	< 0.342
MW-107D	2002 Q1	< 8.23	0.70	1.00	-	< 0.628	< 11.20	< 0.196	< 0.11	4.36	< 0.124	< 0.223
	2002 Q2	< 7.84	0.50	< 3.11	-	< 0.6	8.25	< 0.091	< 0.0909	< 7.18	< 0.204	< 0.188
	2002 Q3	< 8.21	< 16.40	4.76	-	< 0.557	< 11.10	< 0.219	< 0.124	6.46	< 0.143	< 0.144
	2002 Q4	< 7.88	< 5.83	< 3.66	-	< 0.572	< 11.40	< 0.161	< 0.161	10.70	< 0.12	< 0.213
	2003 Q1	-	-	-	-	-	-	-	-	-	-	-
	2003 Q2	-	-	-	< 40	< 1.7	-	-	-	-	-	-
	2003 Q3	-	-	-	-	0.33	-	-	-	-	-	-
	2003 Q4	-	-	-	-	< 0.669	-	-	-	-	-	-
	2004 Q1	-	-	-	-	< 1.23	-	-	-	-	< 0.301	-
	2004 Q2	-	-	-	-	< 1.2	-	-	-	-	-	-
MW-107S	2002 Q1	-	-	-	-	-	-	-	-	-	-	-
	2002 Q2	< 7.85	8.73	< 0	-	0.26	< 11.20	< 0.159	< 0.159	< 9.13	< 0.0954	< 0.096
	2002 Q3	4.10	< 15.40	3.02	-	< 0.593	< 11.30	< 0.12	< 0.12	< 7.84	< 0.127	< 0.266
	2002 Q4	< 7.88	< 5.56	< 3.64	-	0.44	< 11.40	< 0.193	< 0.109	10.30	< 0.163	< 0.0924
	2003 Q1	-	-	-	-	0.54	-	< 0.329	< 0.186	< 11.90	< 0.219	< 0.124
	2003 Q2	-	-	-	< 44	< 1.9	-	-	-	-	-	-
	2003 Q3	-	-	-	-	0.36	-	-	-	-	-	-
	2003 Q4	-	-	-	-	0.54	-	-	-	-	-	-
	2004 Q1	-	-	-	-	< 1.37	-	-	-	-	< 0.373	-
	2004 Q2	-	-	-	-	2.69	-	-	-	-	-	-
MW-108S	2003 Q4	-	-	-	-	0.63	-	-	-	-	-	-

Notes:

Bold values are greater than EPA 4-mrem maximum contaminant level (MCL).

(<) Non-detect with minimum detection concentration (MDC).

Table 4-4: Hard-to-Detect Concentrations (pCi/L) in Groundwater (continued)

Well ID	Sample Event	C-14	Fe-55	Ni-63	Sr-89	Sr-90	Tc-99	Pu-238	Pu239/40	Pu-241	Am-241	Cm243/44
	2004 Q1	-	-	-	-	< 0.887	-	-	-	-	< 0.0919	-
	2004 Q2	-	-	-	-	< 1.4	-	-	-	-	-	-
MW-109D	2002 Q1	< 8.24	4.68	3.13	-	< 0.666	< 11.40	< 0.109	< 0.109	6.27	< 0.275	< 0.158
	2002 Q2	< 7.85	3.89	< 2.95	-	< 0.495	< 11.10	< 0.152	< 0.152	< 7.79	< 0.211	< 0.212
	2002 Q3	< 8.56	< 9.22	4.91	-	< 0.568	< 11.10	< 0.213	< 0.12	4.28	< 0.257	< 0.124
	2002 Q4	< 8.08	11.00	< 3.82	-	< 0.646	9.88	< 0.096	< 0.169	20.90	< 0.121	< 0.122
	2003 Q1	-	-	-	-	-	-	-	-	-	-	-
	2003 Q2	-	-	-	< 39	< 1.9	-	-	-	-	-	-
	2003 Q3	-	-	-	-	< 0.39	-	-	-	-	-	-
	2003 Q4	< 15.90	< 9.34	< 3.56	-	< 0.497	< 9.77	< 0.293	< 0.293	9.51	< 0.162	< 0.163
	2004 Q1	-	-	-	-	< 1.01	-	-	-	-	< 0.373	-
	2004 Q2	-	-	-	-	< 1.16	-	-	-	-	-	-
MW-109S	2002 Q1	4.70	9.90	< 3.94	-	0.90	< 11.40	< 0.108	< 0.108	4.45	< 0.159	< 0.161
	2002 Q2	< 7.85	5.35	< 3.07	-	0.66	< 11.40	< 0.182	< 0.242	< 9.91	< 0.1	< 0.17
	2002 Q3	< 8.21	< 15.30	< 4.96	-	0.97	< 11.30	< 0.127	< 0.224	9.06	< 0.277	< 0.367
	2002 Q4	< 8.08	11.10	< 4.12	-	0.90	11.20	< 0.173	< 0.203	13.20	< 0.131	< 0.233
	2003 Q1	-	-	-	-	0.98	-	< 0.324	< 0.324	< 11.90	< 0.14	< 0.141
	2003 Q2	-	-	-	< 36	< 1.7	-	-	-	-	-	-
	2003 Q3	-	-	-	-	0.69	-	-	-	-	-	-
	2003 Q4	-	-	-	-	1.01	-	-	-	-	-	-
	2004 Q1	-	-	-	-	< 1.11	-	-	-	-	< 0.369	-
	2004 Q2	-	-	-	-	0.80	-	-	-	-	-	-
MW-110D	2002 Q1	< 8.24	5.06	< 3.99	-	< 0.562	10.50	< 0.21	< 0.118	3.78	< 0.183	< 0.164
	2002 Q2	< 7.85	5.76	< 3.12	-	< 0.52	< 11.10	< 0.151	< 0.151	< 7.82	< 0.231	< 0.111
	2002 Q3	< 8.56	< 9.96	4.15	-	2.54	< 11	< 0.121	< 0.121	< 7.06	< 0.286	< 0.288
	2002 Q4	< 8.08	8.85	< 3.9	-	< 0.696	9.99	< 0.177	< 0.37	21.30	< 0.213	< 0.121
	2003 Q1	-	-	-	-	< 0.551	-	< 0.158	< 0.158	< 9.8	< 0.147	< 0.147
	2003 Q2	-	-	-	< 37	< 1.7	-	-	-	-	-	-
	2003 Q3	-	-	-	-	0.36	-	-	-	-	-	-

Notes:

Bold values are greater than EPA 4-mrem maximum contaminant level (MCL).

(<) Non-detect with minimum detection concentration (MDC).

Table 4-4: Hard-to-Detect Concentrations (pCi/L) in Groundwater (continued)

Well ID	Sample Event	C-14	Fe-55	Ni-63	Sr-89	Sr-90	Tc-99	Pu-238	Pu239/40	Pu-241	Am-241	Cm243/44
	2003 Q4	-	-	-	-	0.45	-	-	-	-	-	-
	2004 Q1	-	-	-	-	0.66	-	-	-	-	< 0.311	-
	2004 Q2	-	-	-	-	< 1.15	-	-	-	-	-	-
MW-110S	2002 Q1	< 11	4.05	3.10	-	0.34	8.44	< 0.12	< 0.119	6.91	< 0.169	< 0.171
	2002 Q2	4.19	10.60	< 3.07	-	< 0.545	7.58	< 0.196	< 0.231	< 7.57	< 0.122	< 0.123
	2002 Q3	< 8.57	< 10.60	< 5.32	-	< 0.683	< 10.80	< 0.134	< 0.237	4.12	< 0.13	< 0.131
	2002 Q4	< 7.88	< 6.23	< 3.79	-	< 0.528	< 11.50	< 0.129	< 0.228	13.20	< 0.104	< 0.105
	2003 Q1	-	-	-	-	0.32	-	< 0.242	< 0.241	< 15.10	< 0.116	< 0.117
	2003 Q2	-	-	-	< 39	< 1.6	-	-	-	-	-	-
	2003 Q3	-	-	-	-	< 0.423	-	-	-	-	-	-
	2003 Q4	-	-	-	-	0.44	-	-	-	-	-	-
	2004 Q1	-	-	-	-	< 1.7	-	-	-	-	< 0.354	-
	2004 Q2	-	-	-	-	0.69	-	-	-	-	-	-
MW-111S	2002 Q1	< 8.24	5.61	< 4.15	-	< 0.629	1.00	< 0.198	< 0.112	6.14	< 0.169	< 0.303
	2002 Q2	< 7.85	4.48	4.14	-	< 0.722	< 11.30	< 0.089	< 0.0884	< 8.24	< 0.178	< 0.179
	2002 Q3	-	-	-	-	-	-	-	-	-	-	-
	2002 Q4	< 7.88	< 5.4	< 3.68	-	< 0.527	< 11.60	< 0.099	< 0.175	6.12	< 0.209	< 0.247
	2003 Q4	-	-	-	-	0.35	-	-	-	-	-	-
	2004 Q1	-	-	-	-	< 0.788	-	-	-	-	< 0.264	-
	2004 Q2	-	-	-	-	< 1.11	-	-	-	-	-	-
MW-112S	2003 Q4	-	-	-	-	5.49	-	-	-	-	-	-
	2004 Q1	-	-	-	-	< 0.765	-	-	-	-	< 0.0936	-
	2004 Q2	-	-	-	-	0.70	-	-	-	-	-	-
MW-113S	2003 Q2	-	-	-	< 44	< 1.7	-	-	-	-	-	-
	2003 Q3	-	-	-	-	0.58	-	-	-	-	-	-
	2003 Q4	-	-	-	-	0.84	-	-	-	-	-	-
	2004 Q1	-	-	-	-	0.37	-	-	-	-	< 0.248	-
	2004 Q2	-	-	-	-	0.67	-	-	-	-	-	-
MW-114S	2002 Q1	< 8.07	4.84	< 3.61	-	3.63	7.14	< 0.187	< 0.125	5.81	< 0.247	< 0.168

Notes:

Bold values are greater than EPA 4-mrem maximum contaminant level (MCL).

(<) Non-detect with minimum detection concentration (MDC).

Table 4-4: Hard-to-Detect Concentrations (pCi/L) in Groundwater (continued)

Well ID	Sample Event	C-14	Fe-55	Ni-63	Sr-89	Sr-90	Tc-99	Pu-238	Pu239/40	Pu-241	Am-241	Cm243/44
	2002 Q2	< 7.84	2.17	< 2.61	-	3.26	< 11.20	< 0.11	< 0.109	< 7.52	< 0.119	< 0.12
	2002 Q3	< 8.56	< 10.70	< 3.93	-	1.45	< 11.10	< 0.462	< 0.261	7.83	< 0.125	< 0.126
	2002 Q4	< 8.08	7.58	< 3.65	-	2.62	14.70	< 0.157	< 0.157	11.50	< 0.129	< 0.229
	2003 Q1	< 8.07	7.43	< 4.67	-	**16.60**	< 12.30	< 0.253	< 0.143	< 11.20	< 0.214	< 0.122
	2003 Q2	-	-	-	< 41	< 1.8	-	-	-	-	-	-
	2003 Q3	-	-	-	-	0.73	-	-	-	-	-	-
	2003 Q4	-	-	-	-	1.15	-	-	-	-	-	-
	2004 Q1	-	-	-	-	3.92	-	-	-	-	< 0.259	-
	2004 Q2	-	-	-	-	< 1.19	-	-	-	-	-	-
MW-115S	2002 Q1	< 8.07	7.19	< 3.89	-	3.85	< 10.60	< 0.165	< 0.245	< 9.5	< 0.183	< 0.274
	2002 Q2	< 7.85	< 8.14	< 2.41	-	0.52	< 11.30	< 0.112	< 0.111	< 6.8	< 0.131	< 0.131
	2002 Q3	< 8.56	< 11.90	3.39	-	2.40	< 10.90	< 0.202	< 0.201	11.60	< 0.232	< 0.132
	2002 Q4	< 8.08	< 15.10	< 3.85	-	1.42	< 12.20	< 0.145	< 0.145	11.30	< 0.224	< 0.266
	2003 Q1	-	-	-	-	1.33	-	< 0.146	< 0.146	< 9.29	< 0.226	< 0.128
	2003 Q2	-	-	-	< 37	< 1.5	-	-	-	-	-	-
	2003 Q3	-	-	-	-	-	-	-	-	-	-	-
	2003 Q4	-	-	-	-	1.41	-	-	-	-	-	-
	2004 Q1	-	-	-	-	1.64	-	-	-	-	< 0.198	-
MW-117S	2002 Q4	-	-	-	-	1.28	-	-	-	-	-	-
	2003 Q1	-	-	-	-	1.41	-	-	-	-	-	-
	2003 Q2	-	-	-	< 45	1.40	-	-	-	-	-	-
	2003 Q3	-	-	-	-	1.42	-	-	-	-	-	-
	2003 Q4	-	-	-	-	0.77	-	-	-	-	-	-
	2004 Q1	-	-	-	-	< 1.09	-	-	-	-	< 0.27	-
	2004 Q2	-	-	-	-	0.79	-	-	-	-	-	-
MW-122D	2003 Q1	-	-	-	-	< 0.693	-	< 0.108	< 0.108	-	< 0.198	< 0.234
	2003 Q2	-	< 10	< 11	< 45	1.21	-	< 0.22	-	< 5.3	< 0.34	-
	2003 Q3	-	-	-	-	< 0.398	-	-	-	-	-	-
	2003 Q4	-	-	-	-	0.21	-	-	-	-	-	-

Notes:

Bold values are greater than EPA 4-mrem maximum contaminant level (MCL).

(<) Non-detect with minimum detection concentration (MDC).

Table 4-4: Hard-to-Detect Concentrations (pCi/L) in Groundwater (continued)

Well ID	Sample Event	C-14	Fe-55	Ni-63	Sr-89	Sr-90	Tc-99	Pu-238	Pu239/40	Pu-241	Am-241	Cm243/44
	2004 Q1	-	-	-	-	0.55	-	-	-	-	< 0.148	-
	2004 Q2	-	-	-	-	3.29	-	-	-	-	-	-
MW-122S	2003 Q1	-	-	-	-	1.59	-	< 0.122	< 0.216	< 7.5	< 0.0932	< 0.0935
	2003 Q2	< 89	< 10	< 10	< 42	< 1.7	< 6.8	< 0.13	-	< 4.3	< 0.35	-
	2003 Q3	-	-	-	-	1.24	-	-	-	-	-	-
	2003 Q4	-	-	-	-	0.81	-	-	-	-	-	-
	2004 Q1	-	-	-	-	0.64	-	-	-	-	< 0.317	-
	2004 Q2	-	-	-	-	0.57	-	-	-	-	-	-
MW-123S	2003 Q1	-	-	-	-	0.63	-	< 0.186	< 0.186	< 11.10	< 0.122	< 0.122
	2003 Q2	-	< 9.4	< 12	< 40	< 1.6	-	< 0.15	-	< 0	< 0.33	-
	2003 Q3	-	-	-	-	-	-	-	-	-	-	-
	2003 Q4	-	-	-	-	1.37	-	-	-	-	-	-
	2004 Q1	-	-	-	-	0.87	-	-	-	-	< 0.284	-
	2004 Q2	-	-	-	-	< 1.34	-	-	-	-	-	-
MW-124S	2003 Q1	-	-	-	-	0.49	-	< 0.163	< 0.163	< 10.10	< 0.201	< 0.114
	2003 Q2	< 100.0	< 9.3	< 7.7	< 40	< 1.6	< 5.3	< 0.15	-	< 3.6	0.30	-
	2003 Q4	-	-	-	-	0.54	-	-	-	-	-	-
	2004 Q1	-	-	-	-	< 1.12	-	-	-	-	< 0.486	-
	2004 Q2	-	-	-	-	1.33	-	-	-	-	-	-
MW-125S	2003 Q1	-	-	-	-	0.69	-	< 0.18	< 0.102	< 6.34	< 0.114	< 0.202
	2003 Q2	< 100.0	< 9.7	< 7.9	< 42	1.41	< 5.7	< 0.27	-	< 5.4	< 0.36	-
	2003 Q3	-	-	-	-	1.17	-	-	-	-	-	-
	2003 Q4	-	-	-	-	6.51	-	-	-	-	-	-
	2004 Q1	-	-	-	-	3.15	-	-	-	-	< 0.307	-
	2004 Q2	-	-	-	-	1.78	-	-	-	-	-	-
MW-203	2002 Q1	< 8.24	< 5.97	< 4.22	-	< 0.48	13.90	< 0.187	< 0.105	3.50	< 0.254	< 0.145
	2002 Q4	< 7.89	< 5.49	< 3.85	-	< 0.758	< 11.50	< 0.105	< 0.219	10.30	< 0.119	< 0.211
MW-207	2002 Q1	< 8.23	4.04	< 4.02	-	< 0.565	< 11.40	< 0.105	< 0.105	5.14	< 0.15	< 0.151
	2003 Q3	< 31.70	12.10	< 16.10	-	0.44	< 9.52	< 0.223	< 0.52	< 13	< 0.326	< 0.186

Notes:

Bold values are greater than EPA 4-mrem maximum contaminant level (MCL).

(<) Non-detect with minimum detection concentration (MDC).

Table 4-4: Hard-to-Detect Concentrations (pCi/L) in Groundwater (continued)

Well ID	Sample Event	C-14	Fe-55	Ni-63	Sr-89	Sr-90	Tc-99	Pu-238	Pu239/40	Pu-241	Am-241	Cm243/44
MW-208	2003 Q4	< 15.80	3.77	< 3.55	-	0.89	< 10.10	< 0.308	< 0.174	< 9.48	< 0.116	< 0.116
MW-1	2004 Q2	-	-	-	-	0.94	-	-	-	-	-	-
MW-2	2002 Q4	< 7.89	< 5.72	< 3.83	-	0.41	< 11.40	< 0.176	< 0.0998	11.20	< 0.175	< 0.0997
MW-2	2004 Q2	-	-	-	-	< 1.02	-	-	-	-	-	-
MW-3	2004 Q2	-	-	-	-	< 1.24	-	-	-	-	-	-
EOF-2	2002 Q1	< 8.24	5.56	< 4.03	-	< 0.539	< 11.30	< 0.118	< 0.118	5.70	< 0.137	< 0.139
EOF-2	2002 Q3	-	-	-	-	-	< 10.80	-	-	-	-	-
SUPPLY WELL B	2002 Q4	-	-	-	-	< 0.579	-	-	-	-	-	-

Notes:

Bold values are greater than EPA 4-mrem maximum contaminant level (MCL).
(<) Non-detect with minimum detection concentration (MDC).

Table 5-1: Required MDC Values

Nuclide	MDC (pCi/L)	Analysis Type	Nuclide	MDC (pCi/L)	Analysis Type
Gross α	3	Gas Prop.	Ag-108m	50	γ Spec.
Gross β	4	Gas Prop.	Cs-134	15	γ Spec.
H-3	400	LSC	Cs-137	15	γ Spec.
C-14	200	LSC	Eu-152	50	γ Spec.
Mn-54	50	γ Spec.	Eu-154	50	γ Spec.
Fe-55	25	LSC	Eu-155	50	γ Spec.
Co-60	25	γ Spec.	Pu-238	0.5	α Spec.
Ni-63	15	LSC	Pu-239	0.5	α Spec.
Sr-90	2	GPC	Pu-241	15	LSC
Nb-94	50	γ Spec.	Am-241	0.5	α Spec.
Tc-99	15	LSC	Cm-243	0.5	α Spec.

Table 5-2: Field Duplicate Results for March 2004

Sample ID	Analyte	Sample Concentration ± 2-σ TPU	Duplicate Concentration ± 2-σ TPU	Units	Ratio	Residual	Agreement
MW-114S	Boron	173	174	μg/L	1.01	+0.6%	-
	Gross β	18.5 ± 1.55	16.3 ± 1.66	pCi/L	0.88	-11.9%	-1.9σ
	H-3	1350 ± 260	1570 ± 266	pCi/L	1.16	+16.3%	+1.2σ
	Sr-90	3.92 ± 0.79	3.39 ± 0.73	pCi/L	0.86	-13.5%	-1.0σ

Table 5-3: Field Duplicate Results for June 2004

Sample ID	Analyte	Sample Concentration ± 2-σ TPU	Duplicate Concentration ± 2-σ TPU	Units	Ratio	Residual	Agreement
MW-105S	Boron	484	518	μg/L	1.07	+7.0%	-
	Gross β	44.3 ± 2.7	43.2 ± 2.7	pCi/L	0.97	-2.5%	-0.6σ
	H-3	3350 ± 263	3270 ± 260	pCi/L	0.98	-2.4%	-0.4σ
	Sr-90	16.2 ± 1.71	16.8 ± 1.73	pCi/L	1.04	+3.7%	+0.5σ

Table 5-4: Lab Duplicate Results for March 2004

Sample ID	Analyte	Sample Concentration ± 2-σ TPU	Duplicate Concentration ± 2-σ TPU	Units	Ratio	Residual	Agreement
MW-106S	Boron	670	635	µg/L	0.95	-5.2%	-
MW-122D[1]	Boron	224	223	µg/L	0.99	-0.4%	-
MW-122D[2]	Boron	197	199	µg/L	1.01	+1.0%	-
MW-109S	Gross β	9.63 ± 1.02	8.06 ± 0.96	pCi/L	0.84	-16.3%	-2.2σ
MW-113S	Gross β	16.3 ± 2.07	13.7 ± 2.05	pCi/L	0.84	-16.0%	-1.8σ
MW-114S	Gross β	18.5 ± 1.55	16.3 ± 1.66	pCi/L	0.88	-11.9%	-1.9σ
MW-114S Rep.	Gross β	16.3 ± 1.66	20.8 ± 1.85	pCi/L	1.28	+27.6%	3.6σ
MW-106S	H-3	542 ± 202	494 ± 194	pCi/L	0.91	-8.9%	-0.3σ

Table 5-5: Lab Duplicate Results for June 2004

Sample ID	Analyte	Sample Concentration ± 2-σ TPU	Duplicate Concentration ± 2-σ TPU	Units	Ratio	Residual	Agreement
MW-2	Boron	15.5	14.0	µg/L	0.90	-9.7%	-
MW-108S	Boron	68.3	68.7	µg/L	1.00	+0.6%	-
MW-110S	Boron	291	301	µg/L	1.03	+3.4%	-
MW-508S	Boron	41.9	41.8	µg/L	1.00	-0.2%	-
MW-117S	Gross β	7.28 ± 1.55	8.65 ± 1.58	pCi/L	1.19	+18.8%	+1.2σ
MW-110S	H-3	1010 ± 220	789 ± 171	pCi/L	0.78	-21.9%	-1.6σ

Table 5-6: DOE QAP Lab Performance Data Summary

Sample Media	Gamma Isotopic	Alpha Isotopic	HTD	Total
Air Filter	96.6%	97.2%	100.%	96.9%
Soil	97.2%	97.7%	100.%	97.7%
Vegetation	100.%	100.%	85.7%	98.0%
Water	96.9%	97.2%	91.7%	96.2%
All Totals	97.4%	97.8%	94.3%	97.1%

Table 5-7: MAPEP Lab Performance Data Summary

Sample Media	Gamma Isotopic	Alpha Isotopic	HTD	False Positive	Total
Water	100.%	96.0%	94.1%	60.0%	97.2%
Soil	100.%	96.0%	75.0%	80.0%	94.4%
All Totals	100.%	96.0%	86.2%	70.0%	95.8%

Table 5-8: ERA Lab Performance Data Summary for Water (ERA 52 – 55, 57)

Gamma Isotopic	Alpha Isotopic	HTD	Total
96.2%	100.%	100.%	98.4%

Table 5-9: QC Summary for March 2004 Sample Event

Sample Type	Nuclide Tests	Percent of Total Samples
Samples	692	77.4%
QC Blanks	49	5.5%
QC Lab Controls	55	6.2%
QC Matrix Spikes	49	5.5%
QC Duplicates	49	5.5%
Sample/QC Totals	894	100.%

Table 5-10: QC Summary for June 2004 Sample Event

Sample Type	Nuclide Tests	Percent of Total Samples
Samples	715	68.9%
QC Blanks	79	7.6%
QC Lab Controls	85	8.2%
QC Matrix Spikes	76	7.3%
QC Duplicates	82	7.9%
Sample/QC Totals	1037	100.%

Table 5-11: Lab QC Acceptance Limits

QC Category	GEL Acceptance Limits (%)
Duplicates	± 20%
Blank Spikes, Matrix Spikes	± 25%
Method Blanks	< CRDL

Table 5-12: Internal Performance Data Summary (LCS, MS)

Method	March 2004	June 2004	Total
Boron	50.0%	75.0%	64.3%
γ-isotopic	100.%	100.%	100.%
α-isotopic	100.%	100.%	100.%
LSC	92.9%	100.%	97.4%
GPC	90.9%	100.%	95.8%
All Totals	91.4%	97.9%	95.2%

Table 5-13: Summary Statistics for March 2004

Nuclide	Method	# of Samples	Min. Conc. (pCi/L)	Max. Conc. (pCi/L)	Mean Conc. (pCi/L)	Sdev. Conc. (pCi/L)	Median Conc. (pCi/L)	EPA MCL (pCi/L)	Conc.> 2-σ TPU	Conc.> MCL
Gross α	GPC	38	-0.164	11.30	2.126	2.525	1.290	15	22	0
Gross β	GPC	38	0.778	203.0	17.68	43.40	6.135	50(S)	37	2
H-3	LSC	39	-59.9	12000	1771	2656	732	20000	25	0
C-14	LSC	12	11.9	140	72.32	40.97	84.55	2000	2	0
Mn-54	γ	39	-2.12	2.64	-0.064	1.01	-0.12	300	2	0
Fe-55	LSC	12	-45.7	9.53	-21.32	20.43	-25.05	2000	0	0
Co-60	γ	39	-3.31	3.23	0.245	1.230	0.247	100	2	0
Ni-63	LSC	12	-5.23	0.483	-2.315	1.703	-2.575	50	0	0
Sr-90	GPC	37	-0.753	92.4	6.049	21.04	0.325	8	15	2
Nb-94	γ	39	-1.27	2.78	0.457	0.935	0.453	-	3	0
Tc-99	LSC	12	-4.95	0.71	-2.020	1.658	-2.165	900	0	0
Ag-108m	γ	39	-2.27	1.84	-0.117	0.846	-0.18	-	2	0
Cs-134	γ	39	-1.22	3.33	0.409	1.044	0.383	20000	2	0
Cs-137	γ	39	-2.72	22.4	0.652	3.865	-0.068	200	3	0
Eu-152	γ	39	-6.26	8.83	-0.166	3.452	-0.292	60	3	0
Eu-154	γ	39	-7.34	4.74	0.002	2.498	0.292	200	0	0
Eu-155	γ	39	-5.85	6.56	-0.015	2.758	-0.080	600	0	0
Pu-238	α	12	-0.0271	0.0778	0.0135	0.0289	0.0035	15	0	0
Pu-239,240	α	12	-0.0153	0.0311	0.0101	0.0121	0.0105	15	0	0
Pu-241	LSC	12	-2.42	16.6	3.254	5.681	1.99	-	2	0
Am-241	γ	39	-17.9	16.9	-0.447	6.182	0.342	15	0	0
Am-241	α	40	-0.0863	0.11	0.0234	0.0488	0.248	15	2	0
Cm-242	α	13	-0.0265	0.0357	0.0035	0.0168	0	15	0	0
Cm-243,44	α	13	-0.089	0.0452	-0.011	0.0356	0	15	0	0
Totals		692							122	4

Table 5-14: Summary Statistics for June 2004

Nuclide	Method	# of Samples	Min. Conc. (pCi/L)	Max. Conc. (pCi/L)	Mean Conc. (pCi/L)	Sdev. Conc. (pCi/L)	Median Conc. (pCi/L)	EPA MCL (pCi/L)	Conc.> 2-σ TPU	Conc.> MCL
Gross α	GPC	42	-0.24	28.8	3.24	4.78	1.74	15	27	1
Gross β	GPC	42	0.23	44.3	7.22	7.81	5.12	-	39	-
H-3	LSC	42	-251.	8300.	1339.	2212.	222.	20000	24	0
C-14	LSC	7	-14.7	3.53	-3.52	5.78	-3.61	2000	0	0
Mn-54	γ	42	-1.86	1.82	-0.05	0.76	0.00	300	0	0
Fe-55	LSC	7	-27.1	9.02	-10.6	15.7	-17.9	2000	0	0
Co-60	γ	42	-1.17	11.4	1.23	2.32	0.48	100	7	0
Ni-63	LSC	7	-6.43	6.13	-0.55	4.92	-0.89	50	0	0
Sr-90	GPC	32	-0.24	16.2	1.29	2.86	0.62	8	17	1
Nb-94	γ	42	-1.44	1.71	0.23	0.77	0.32	-	1	-
Tc-99	LSC	7	-7.78	0.56	-3.23	2.78	-3.40	900	0	0
Ag-108m	γ	42	-2.46	2.23	0.20	0.97	0.34	-	3	-
Cs-134	γ	42	-1.75	3.84	0.40	0.99	0.40	20000	0	0
Cs-137	γ	42	-1.42	7.50	0.44	1.37	0.28	200	2	0
Eu-152	γ	42	-7.03	4.12	0.29	2.38	0.36	60	0	0
Eu-154	γ	42	-3.43	3.66	0.40	1.95	0.40	200	0	0
Eu-155	γ	42	-5.68	6.45	0.42	2.95	-0.16	600	1	0
Pu-238	α	7	-0.064	0.067	0.020	0.047	0.025	15	0	0
Pu-239,240	α	7	-0.023	0.123	0.038	0.062	0.013	15	0	0
Pu-241	LSC	7	-8.25	8.32	0.012	5.46	0.000	-	1	-
Am-241	γ	42	-18.8	19.2	1.41	6.57	1.39	15	1	0
Am-241	α	7	-0.045	0.090	0.012	0.049	0.003	15	0	0
Cm-242	α	7	-0.031	0.061	0.005	0.035	0.000	15	0	0
Cm-243,44	α	7	-0.088	0.064	-0.016	0.055	-0.004	15	0	0
Totals		648							123	0

Table 5-15: Limiting Mean Distribution Summary for March 2004

Nuclide	Analysis Method	Limiting Mean (pCi/L)	Limiting Sdev. (pCi/L)	# of Results (n)	Calculated t-value	Critical t-value[1]	Limiting Mean Bias	Filliben's r-statistic	Critical r-statistic[2]	Distribution
Gross α	GPC	0.815	0.586	26	7.087	3.330	Positive	0.997	0.959	Normal
Gross β	GPC	1.750	0.569	8	8.696	4.530	Positive	0.988	0.905	Normal
H-3	LSC	54.61	61.60	15	3.434	3.636	-	0.909	0.937	Non-normal
C-14	LSC	72.32	40.97	12	6.115	3.850	Positive	0.963	0.926	Normal
Mn-54	γ	-0.306	0.725	35	2.500	3.236	-	0.978	0.968	Normal
Fe-55	LSC	-43.0	3.182	4	-27.0	9.218	Negative	0.917	0.868	Normal
Co-60	γ	0.013	0.958	36	0.078	3.229	-	0.963	0.968	Non-normal
Ni-63	LSC	-2.315	1.703	12	-4.709	3.850	Negative	0.984	0.926	Normal
Sr-90	GPC	0.133	0.318	25	2.089	3.345	-	0.978	0.958	Normal
Nb-94	γ	0.396	0.864	38	2.821	3.216	-	0.981	0.972	Normal
Tc-99	LSC	-2.020	1.658	12	-4.222	3.850	Negative	0.993	0.926	Normal
Ag-108m	γ	-0.168	0.793	37	-1.310	3.222	-	0.992	0.970	Normal
Cs-134	γ	0.332	0.939	38	2.178	3.216	-	0.987	0.970	Normal
Cs-137	γ	-0.303	1.025	34	-1.721	3.243	-	0.984	0.967	Normal
Eu-152	γ	-0.746	2.872	35	-1.560	3.236	-	0.990	0.968	Normal
Eu-154	γ	0.002	2.498	39	0.004	3.210	-	0.969	0.971	Non-normal
Eu-155	γ	-0.015	2.758	39	-0.035	3.210	-	0.991	0.971	Normal
Pu-238	α	0.0135	0.0289	12	1.620	3.850	-	0.962	0.926	Normal
Pu-239,40	α	0.0101	0.0121	12	2.876	3.850	-	0.978	0.926	Normal
Pu-241	LSC	1.035	2.342	10	1.398	4.094	-	0.967	0.917	Normal
Am-241	α	0.0234	0.0488	40	3.038	3.204	-	0.994	0.972	Normal
Am-241	γ	-1.236	5.238	37	-1.435	3.222	-	0.944	0.969	Non-normal
Cm-242	α	0.0035	0.0168	13	0.754	3.764	-	0.969	0.931	Normal
Cm-243,44	α	-0.0111	0.0356	13	-1.128	3.764	-	0.940	0.931	Normal

Notes:

[1]Student t-statistic at the 99% Confidence Interval for n-1 degrees of freedom
[2]Filliben's r-statistic at the 95% Confidence Interval for n degrees of freedom

Table 5-16: Limiting Mean Distribution Summary for June 2004

Nuclide	Analysis Method	Limiting Mean (pCi/L)	Limiting Sdev. (pCi/L)	# of Results (n)	Calculated t-value	Critical t-value[1]	Limiting Mean Bias	Filliben's r-statistic	Critical r-statistic[2]	Distribution
Gross α	GPC	0.75	0.65	22	5.388	3.400	Positive	0.970	0.954	Normal
Gross β	GPC	1.30	0.66	9	5.963	4.277	Positive	0.973	0.912	Normal
H-3	LSC	99.3	126.6	26	4.000	3.330	Positive	0.964	0.959	Normal
C-14	LSC	-3.52	5.78	7	-1.614	4.904	-	0.929	0.899	Normal
Mn-54	γ	-0.14	0.65	40	-1.366	3.204	-	0.989	0.972	Normal
Fe-55	LSC	-22.8	4.1	4	-11.19	9.219	Negative	0.989	0.868	Normal
Co-60	γ	0.43	0.74	36	3.540	3.229	Positive	0.980	0.968	Normal
Ni-63	LSC	-0.55	4.92	7	-0.296	4.904	-	0.965	0.899	Normal
Sr-90	LSC	0.43	0.39	24	5.434	3.361	Positive	0.969	0.957	Normal
Nb-94	γ	0.23	0.77	42	1.940	3.194	-	0.984	0.973	Normal
Tc-99	LSC	-3.23	2.78	7	-3.073	4.904	-	0.982	0.899	Normal
Ag-108m	γ	0.10	0.88	40	0.748	3.204	-	0.971	0.972	Non-normal
Cs-134	γ	0.26	0.78	40	2.102	3.204	-	0.968	0.972	Non-normal
Cs-137	γ	0.22	0.73	40	1.891	3.204	-	0.987	0.972	Normal
Eu-152	γ	0.29	2.38	42	0.795	3.194	-	0.959	0.973	Non-normal
Eu-154	γ	0.40	1.95	42	1.345	3.194	-	0.991	0.973	Normal
Eu-155	γ	0.42	2.95	42	0.920	3.194	-	0.986	0.973	Normal
Pu-238	α	0.020	0.047	7	1.148	4.904	-	0.957	0.899	Normal
Pu-239,40	α	0.038	0.062	7	1.588	4.904	-	0.936	0.899	Normal
Pu-241	LSC	0.01	5.46	7	0.006	4.904	-	0.992	0.899	Normal
Am-241	γ	-0.16	5.14	37	-0.188	3.222	-	0.928	0.969	Non-normal
Am-241	α	0.012	0.049	7	0.657	4.904	-	0.978	0.899	Normal
Cm-242	α	0.005	0.035	7	0.402	4.904	-	0.951	0.899	Normal
Cm-243,44	α	-0.016	0.055	7	-0.748	4.904	-	0.986	0.899	Normal

Notes:

[1]Student t-statistic at the 99% Confidence Interval for n-1 degrees of freedom
[2]Filliben's r-statistic at the 95% Confidence Interval for n degrees of freedom

Table 5-17: Observed False-Positive Rates

Analysis Type	March 2004 (GEL)	June 2004 (GEL)	Average Rate
Gamma Isotopic	4.3%	2.3%	3.2%
Alpha Isotopic	0.0%	0.0%	0.0%
HTD Beta via LSC	4.3%	1.9%	3.0%

Table 5-18: Data Quality Metrics

Parameter	Data Quality Metric
Precision	▪ Relative Percent Difference (RPD) < 20%
Accuracy	▪ Laboratory Control Sample Recovery 100% +/- 25 ▪ MDC < 0.1 * Drinking Water Standard ▪ Laboratory Blank Analysis Results < MDC
Representativeness	▪ Qualitative assessment of sample location, sample timing, sample collection method, sample preservation, handling, shipment
Completeness	▪ Valid measurements for critical samples = 100%
Comparability	▪ Qualitative assessment of sample collection and measurement methods and assignment of sample locations to hydrostratigraphic units. ▪ Sample MDC < CRDL