Connecticut Yankee Atomic Power Company

Haddam Neck Plant
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Semi-Annual Groundwater Monitoring Report
Third and Fourth Quarter 2004
Quarterly Sampling Events

Prepared by
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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 third and fourth quarter 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 to most of the groundwater contamination at the site. The radiological SOCs at HNP have been identified as tritium, Sr-90, Cs-137, and Co-60, 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 above background levels in environmental samples at HNP is used as an indication of plant-related contamination and also as an effective tracer of potentially contaminated groundwater. Boron will be evaluated as part of the ongoing RCRA Corrective Action Program (CAP) under regulatory authority of the USEPA and in accordance with the Connecticut Property Transfer Act.

In order to assess general site groundwater geochemistry and potential contaminant migration mechanism(s), supplemental analyses were collected during the third quarter 2004 event. Additionally, both SOCs and the supplemental geochemistry analyses were conducted on seeps that are located in excavated portions of the industrial area of the plant. 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 detected and where migration pathways are likely, resulting in the greater number of wells in the monitoring network. Several wells in both the Emergency Operations Facility (EOF)/Parking Lot area, the lower peninsula area, and the landfill area are also sampled and analyzed to provide control for

monitoring groundwater conditions at the boundaries of the plant property. Several wells installed at the HNP as part of the RCRA CAP were not included as part of the GWMP. 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 third and fourth quarter of 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 both the third and fourth quarter 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 2-4. 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, other peninsula area locations in Figure 2-3, and the landfill area in Figure 2-4.

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, other groundwater pumping activities associated with decommissioning, 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 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, Connecticut 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 were installed in selected groundwater monitoring wells and two 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.

As part of the Phase I hydrogeologic characterization effort, the hydrogeologic CSM at the HNP proposed three primary hydrostratigraphic units. Those units were 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 was defined as the upper ten (10) feet of the bedrock interval, immediately underlying the unconsolidated unit, and the deep bedrock unit included all bedrock below the upper 10-foot depth. 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 displayed a hydraulic response similar to the unconsolidated deposits, rather than wells screened 10 feet or deeper within the bedrock interval. Current understanding of the shallow bedrock hydrostratigraphic unit component of the hydrogeologic CSM suggests that in many cases it contains 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.

Additional information developed from the hydraulic response to various pumping and de-watering activities within the hydrogeologic units associated with decommissioning has further developed the understanding of the hydrogeologic CSM at the site. Based on the hydraulic response to the pumping activities, the hydrostratigraphy has been refined to include two major units that comprise an unconfined aquifer and a confined aquifer. The unconfined aquifer occurs within the unconsolidated deposits and the more fractured portions of the shallow bedrock and is defined by the water table. The portions of shallow bedrock that are included in the unconfined aquifer typically do not include a layer of till that acts to confine the bedrock. The confined aquifer comprises the deeper, more competent bedrock and typically has a layer of till capping the bedrock.

A third perched aquifer is recognized in the northwestern portion of the site. In this restricted portion of the property shallow groundwater occurs within swampy deposits present in that area. This groundwater is believed to be in equilibrium with the small pond located adjacent to the perched water (Figure 2-1). A small stream discharges to the pond, and the pond water flows through a weir to a culvert on the southeast end of the pond. This perched groundwater is not believed to contribute significant recharge to the unconfined aquifer, due to the low permeability of the swampy deposits and the continuous discharge from the pond to the culvert.

The aquifer designation for all monitoring wells included in the third and fourth quarter sampling effort is included in Table 2-1. Table 2-1 also provides well specifications for the groundwater-monitoring network, including revised horizontal coordinates and the vertical elevation of the measuring points for water level gauging for each well and screen intervals 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 is ongoing.

The data from the pressure transducer network has been used to generate potentiometric maps for each of the three aquifers, 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 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. A data quality assessment of the hydrograph data evaluation was developed and is also included in Appendix B. The overall hydrographs are summarized and discussed in the following subsections.

2.2.1 Third Quarter 2004 Hydrographs

The hydrographs for the third quarter of calendar year 2004 are discussed in the following subsections.

Connecticut River

The Connecticut River exhibited strong, regular tidal fluctuation and only small variations in seasonal river stage during the period from July through August 2004.

During the third quarter 2004, the Connecticut River exhibited a steady water level elevation of approximately 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 the unconfined and confined aquifers at the site. A data logging pressure transducer in the sump has been recording water levels since the beginning of 2004. 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. Because the mat sump is under continuous active pumping, the observed water level in the mat sump does not exhibit response to local rainfall events. One shutdown of the mat sump was experienced from August 11 through 12 2004. During this event the water level recovered to a maximum elevation of –4 feet MSL.

Perched Aquifer

Wells screened within the underground bog deposits in and around the pond to the north-east of the industrial are considered to be in the perched aquifer. Of the four perched aquifer monitoring wells (MW505S, MW507S, MW508S and MW104), MW508S and MW104 possess data-logging pressure transducers. Monitoring wells MW508S and MW104 consistently have groundwater elevations of approximately 10 to 13 ft MSL and do not exhibit response to dewatering activities onsite. The transducer in MW508S, however, was found to be inaccurate and the response cannot be quantified. With the exception of MW104, water levels in monitoring wells screened in the perched aquifer do not show signs of seasonal variations.

MW104 is most likely screened across both the perched and unconfined aquifers. It has water chemistry closely related to that of the other unconfined aquifer monitoring wells in the industrial area of the HNP (see Section 6.1), but has groundwater elevations that are more similar to the perched aquifer wells. Most likely, MW104 is on the edge of the underground bog deposits, which make it difficult to categorize definitely in one aquifer or the other. Because of this uncertainty, MW104 was utilized in the perched aquifer groundwater elevation contour maps, but contoured in the unconfined aquifer contamination plume maps. The characteristics of the wells screened in the perched aquifer are summarized in Table 2-3.

Unconfined Aquifer

All of the wells screened in the unconfined aquifer exhibited seasonal variations in water level. The characteristics of the wells screened in the unconfined aquifer are summarized in Table 2-4. 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.

Confined Aquifer

Wells that are screened within bedrock underlying the unconfined formation are considered to be in the confined aquifer. The characteristics of the wells screened in the confined aquifer are summarized in Table 2-5. The confined aquifer 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.

During the third quarter of 2004, several of the confined aquifer monitoring exhibited responses to the hydrophysical testing in bedrock boreholes 118A, 119 and 121A. Monitoring well MW106D responded to hydrophysical testing in borehole 118A. Monitoring well MW119 responded to hydrophysical testing in borehole 119.

Monitoring wells MW107D, MW110D and MW122D responded to hydrophysical testing in borehole 121A.

2.2.2 Third Quarter 2004 Groundwater Flow Maps

Groundwater flow maps for each of the three aquifers have been developed based on groundwater elevations measured on August 22, 2004 (Table 2-6). The groundwater flow maps for each aquifer are discussed in the following sections.

Perched Aquifer

Groundwater elevations and flow in the perched aquifer for the third quarter sampling effort are shown in Figure 2-5. The groundwater elevations measured in the perched aquifer are representative of groundwater perched within swampy deposits that occur in the northwester portion of the Site. The perched aquifer appears to be in equilibrium with the small pond adjacent to the perched water, and most likely is recharged by the pond. Groundwater within the perched aquifer flows radially from the southeast end of the pond within the parking lot area, and may extend as far southeast as MW104S (Figure 2-5).

Unconfined Aquifer

The groundwater elevations measured in the unconfined aquifer are representative of the water table surface across the plant property. Groundwater contours mapped in the unconfined aquifer are largely inferred, and generally consistent with the surface topography. Based on the inferred contours, groundwater flow in the unconfined aquifer is generally south and southwest, towards the Connecticut River. The groundwater contours are mapped to depict discharge to the Connecticut River (Figure 2-6).

Groundwater flow in the unconfined aquifer 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 Figure 2-6, the 5-foot groundwater contour is mapped much farther to the south in the western portion of the industrial area relative to the eastern portion of the site. In the central portion of the industrial area, the 5-foot contour is truncated by the discharge tunnel, is mapped around the PAB, and is continued on the north side of the RCB. The displacement of the contours is a function of the presence of the subsurface concrete structures that impede groundwater flow in the unconsolidated portion of the unconfined aquifer 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 unconfined aquifer (Figure 2-6)

Confined Aquifer

Groundwater flow in the confined aquifer for the first quarter is illustrated in Figure 2-7. The bedrock monitoring wells in the northern portion of the industrial area within the confined aquifer are all influenced by the mat sump, and form a significant cone of depression in that area (Figures 2-7). Based on the large upward gradients observed in monitoring well pairs MW109D/S and MW110D/S, groundwater in the confined aquifer is interpreted to discharge to the Connecticut River. These monitoring well pairs are screened in the confined and unconfined aquifers, respectively adjacent to the river. The strong upward gradients are consistent with both discharge to the river, and a flow direction towards the Connecticut River for the confined aquifer.

2.2.3 Fourth Quarter 2004 Hydrographs

The hydrographs for the fourth quarter 2004 time period are discussed in the following subsections.

Connecticut River

The Connecticut River continued to exhibit clear tidal fluctuations during the fourth quarter. The river also exhibited several cycles of rising base flow which peak on 20 September 2004 (peak river water elevation at +3.2 feet MSL), 30 September 2004 (peak river water elevation at +3.4 feet MSL), 12 December 2004 (peak river water elevation at +3.9 feet MSL), and 27 December 2004 (peak river elevation at +3.1 feet MSL). Upon retrieval of the quarterly results in December, it was determined that the on-board batteries had failed in the transducer on November 21, 2004, apparently as a result of the cold temperature to which the unit was exposed. The transducer was restored to function on December 21, 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 20 minutes and 0.99 feet MSL from the observed elevations of groundwater in TW-1. This value, using TW-1 as a surrogate, was used to complete the river level hydrograph for the remainder fourth quarter.

Reactor Foundation Mat Dewatering Sump

The mat dewatering sump continued in nearly continuous operation during the fourth quarter 2004 with average dynamic water levels at about -20 feet MSL. Three shutdowns were experienced from September 19 through September 22 2004 and again, from November 10 through November 12 and from December 23 through December 26. During these events the water level recovered to a maximum elevations between +1 and +3 feet MSL.

Perched Aquifer

Wells screened within the underground bog deposits in and around the pond are considered to be in the perched aquifer. Of the four perched aquifer monitoring wells, MW508S and MW104 possess data-logging transducers. Monitoring wells MW508S and MW104 consistently have groundwater elevations of approximately 10 to 13 ft MSL and do not exhibit response to dewatering activities onsite. The transducer in MW508S, however, was found to be inaccurate and the response cannot be quantified.

MW104 is most likely screened across the perched and unconfined aquifers due to the fact that it has water chemistry closely related to that of the other unconfined aquifer monitoring wells in the industrial area of the HNP, but has groundwater elevations that are more similar to the perched aquifer wells. Most likely, MW104 is on the edge of the underground bog deposits, which make it difficult to categorize definitely in one aquifer or the other. Because of this uncertainty, MW104 was utilized in the perched aquifer groundwater elevation contour maps, but contoured in the unconfined aquifer contamination plume maps. The characteristics of the wells screened in the unconfined aquifer are summarized in Table 2-3.

Unconfined Aquifer

All of the wells screened in the unconfined 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 2-4. Several of the wells were observed to exhibit drawdown in response to dewatering activities in the foundation mat sump, in specifically-installed dewatering wells in the vicinity of the plant tank farm and the primary auxiliary building, and in the RHR facility pit.

Confined Aquifer

Wells that are screened within bedrock underlying the unconfined formation are considered to be in the confined aquifer. The characteristics of the wells screened in the confined aquifer are summarized in Table 2-5. The confined aquifer 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.

Monitoring wells MW101D, MW102D, MW103D and MW106D all exhibited a clear response to dewatering operations in the RHR facility pit. The transducer in MW101D, however, was found to be inaccurate and the response cannot be quantified. 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 Fourth Quarter 2004 Groundwater Flow Maps

Groundwater flow maps for each of the three aquifers have been developed based on groundwater elevations measured on December 1, 2004 (Table 2-6). The groundwater flow maps for each aquifer are discussed in the following sections.

Perched Aquifer

Groundwater elevations and flow in the perched aquifer for the fourth quarter sampling effort are shown in Figure 2-8. The groundwater elevations measured in the perched aquifer are representative of groundwater perched within swampy deposits that occur in the northwester portion of the Site. The perched aquifer appears to be in equilibrium with the small pond adjacent to the perched water, and most likely is recharged by the pond. Similar to that observed in the third quarter, groundwater within the perched aquifer flows radially from the southeast end of the pond within the parking lot area, and may extend as far southeast as MW104S (Figure 2-8). Groundwater levels in the perched water table are slightly higher in the fourth quarter relative to the third quarter levels.

Unconfined Aquifer

Groundwater elevations and flow in the unconfined aquifer for the fourth quarter sampling effort are shown in Figure 2-9. The groundwater elevations measured in the unconfined aquifer 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 third quarter groundwater flow maps, groundwater flow in the unconsolidated unit is generally southwest, towards the Connecticut River. Groundwater elevations across the HNP are generally higher in the fourth quarter relative to the third quarter. The groundwater contours are mapped to depict discharge to the Connecticut River.

The impacts of subsurface barriers interpreted in the third quarter results are also evident in the fourth quarter water levels. The five -foot contour is displaced to the south in the western portion of the industrial area, and is mapped around the PAB and to on northern side of the RCB (Figures 2-9). The displacement of the contours is a function of the presence of the subsurface concrete structures (i.e., RCB, discharge tunnel, and PAB) that impede groundwater flow in the unconsolidated portion of the unconfined aquifer.

The impact of the mat sump is also observed in the fourth quarter groundwater levels. Consistent with the third 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 unconfined aquifer.

Confined Aquifer

Groundwater flow in the confined aquifer for the fourth quarter is illustrated in Figure2-10. Consistent with the results for the third quarter, the deep bedrock monitoring wells in the northern portion of the industrial area within the confined aquifer are all influenced by the mat sump, and form a significant cone of depression in that area (Figure 2-10).

The large upward gradients observed in monitoring well pairs MW109D/S and MW110D/S in the third quarter results are also present in the fourth quarter, consistent with both discharge to the Connecticut River, and a flow direction towards the river.

2.2.5 Fourth Quarter 2004 Groundwater Flow Map – Landfill Area

Groundwater elevations and flow in the unconfined aquifer within the landfill area for the fourth quarter sampling effort are shown in Figure 2-11. Potentiometric contours mapped in the unconfined aquifer in the landfill area are largely inferred, and generally consistent with the surface topography. The groundwater elevations measured in the landfill area are representative of the water table surface on the plant property adjacent to the Salmon River. The groundwater flow direction in the landfill area is to the southeast towards the Salmon River and Salmon Cove (Figure 2-11). The groundwater contours are mapped to depict groundwater discharge to the Salmon River and Salmon Cove.

2.3 Seeps in the Industrial Area

Groundwater was observed discharging from the exposed bedrock surface as excavation of contaminated soil progressed in the service alley and PAB area. In November 2004, HNP staff collected samples of the groundwater being expressed at visible bedrock seeps in the excavation area. The samples were submitted for on-site and off-site analysis, which resulted in detection of tritium, boron, and Sr-90. No gamma-emitting radioisotopes or hard-to-detect nuclides other than Sr-90 were detected in the seep water. The seeps were sampled and analyzed for SOCs on several occasions to monitor any apparent changes in concentration of SOCs. The nature and distribution of the seeps is discussed below, and analytical results from the seep samples are discussed in Section 6.1.4.

The seeps observed in the exposed bedrock appear as expressions of groundwater discharging from fractures in the rock. Bedrock in the area where seeps are observed was exposed by excavation of contaminated soil, and active dewatering has continued to maintain the bedrock surface in a dry condition. The appearance of the seeps is a function of the local groundwater depression caused by the dewatering effort to support structure demolition and removal of contaminated soil.

The elevation of plant grade is approximately 21.5 feet above mean sea level (AMSL), while historical groundwater elevation in the vicinity of the seeps was approximately 8 feet AMSL. The exposed bedrock surface in the vicinity of the observed seeps exhibits variable elevation ranging from approximately mean sea level to about 5 feet below mean sea level (BMSL). As excavation of the unconsolidated soil in the area continues, active dewatering has maintained the groundwater elevation in the unconfined aquifer in the excavation area substantially below mean sea level. As a result, groundwater from surrounding area enters the excavation area by discharging from the exposed faces of unconsolidated soil fill at the periphery of the excavation and through exposed open fractures in the exposed bedrock. Based on water level measurements in surrounding monitoring wells and the observed fracture distribution in the bedrock, the groundwater

discharged from the seeps is flowing into the excavation area from the general direction of the Connecticut River, which exhibits a water level generally around mean sea level. In the seep locations, this flow direction away from the Connecticut River is approximately 180 degrees different from the groundwater flow direction inferred for the area under natural hydraulic head conditions.

During the time period covered by this report (i.e., through February 2005), five seeps were identified in the excavation area (Figure 2-12). The seeps are typically observed to flow from near-vertical fractures in the exposed bedrock surface that are visible at an elevation range from about 2 feet BMSL to about 4 feet BMSL. One seep (Seep #5) was observed to be ephemeral (i.e., flow discontinued after time), while the others have been persistent. Seeps 1, 2, 3, and 4 all exhibit estimated discharge flow rates of approximately 1 to 3 gallons per minute.

Seeps 1 and 2 are located within 20 feet of the former location of monitoring well MW105S (Figure 2-2) and occur at an elevation approximately equal to the bottom of the screened interval in MW105S (note: MW105S was abandoned prior to initiating soil excavation in the area). Seep 3 is adjacent to the wall of the cable vault and Seep 4 is located near the northwest (relative to plant north) corner of the former PAB footprint. The approximate seep locations are shown in plan view in Figure 2-12. Photographs of the seep locations are shown in Figures 2-13 and 2-14.

3 Groundwater Sampling and Analysis

This monitoring report includes the lab analytical results for two quarterly groundwater-sampling events. In addition, select analyses were performed on samples collected from groundwater seeps located within the Service Building/Primary Auxiliary Building (SB/PAB) excavation area. The third quarter (2004 Q3) sampling event occurred between September 20 and October 6, 2004. The fourth quarter (2004 Q4) sampling event occurred between December 6 and 16, 2004. The groundwater seep samples were collected during the course of five (5) sample events between November 2004 and February, 2005. 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 inorganic 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 péristaltic pump or a stainless steel submersible pump with dedicated polyethylene tubing. As a result of low water level conditions, monitoring wells MW102D and MW103D were manually purged and sampled during both sample events with a dedicated polyethylene bailer rather than using a pump.

Groundwater seeps samples were collected by direct immersion into the groundwater seep with consideration for seep discharge. Seep samples were filtered (0.45-micron filter) and preserved onsite prior to shipment offsite. A weathered rock sample was also collected in the vicinity of Seep #1. Containment Mat Sump (CMS) and Extraction Point (EP) samples were collected at the outlet of the pump following a continuous run.

3.1 Description of 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 third and fourth 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 MW106D and MW122D. During the third and fourth quarter 2004 groundwater-sampling events, the pH readings from monitoring well MW106D and MW122D were reported to be in the 8.6 to 9.4 pH range. These wells have trended as high as 11.18 to 11.39 during the December 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 Sample Locations

Monitoring wells sampled during the third quarter 2004 event are located within the industrial area, parking lot, peninsula and support building areas, as indicated in Table 3-3. Monitoring wells MW114S, MW115S and dewatering well DW105 were planned but not sampled during this sample event due to insufficient water.

Several monitoring wells (MW103S, MW114S, MW115S and MW201) were planned but not sampled during the fourth quarter event due to insufficient water. Dewatering wells

DW1 through DW5 were planned but not sampled since the current water level was below the wells. Monitoring wells sampled during the fourth quarter 2004 sample event are located within the industrial area, parking lot, peninsula, EOF and landfill areas, as indicated in Table 3-4. The landfills wells were sampled during this sample event pending a decision regarding the need for additional remedial activities in the old landfill area. Samples were also collected from the Containment Mat Sump (CMS) and extraction points (EP) in the Residual Heat Removal (RHR) Pit. Two of the extraction points were located in the floor and one was located in the wall at a nominal elevation below grade. Extraction point and CMS samples were collected from the sample port or discharge hose following continuous pump operations.

Groundwater seeps samples were collected from a total of seven (7) locations in the Primary Auxiliary Buiding (PAB)/Service Building Alley excavation. The seep samples were collected at nominally weekly intervals from November 2004 through February 2005.

3.4 Routine Lab Analyses

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, tritium and Sr-90. 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

3.5 HTD Lab Analyses and Locations

In addition to the above analyses, samples from a subset of various locations were analyzed during each sampling event for Hard-To-Detect (HTD) plant-related radionuclides. These HTDs include alpha, beta and X-ray emitting, fission and activation product radionuclides. 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 lab analytical results are discussed in Section 4.0.

3.6 Geochemical Analyses and Locations

During the third quarter 2004 sampling event, samples were analyzed for the following geochemical constituents and by the listed methodologies:

- Cations via Ion Chromatography EPA method 300.0
- Anions via EPA method 300.0
- Bicarbonate/Carbonate Alkalinity vie EPA method 310.1
- Total Uranium via ASTM method D5174

3.7 Isotopic Uranium Analyses and Locations

During the fourth quarter 2004 sampling event, a sub-set of the samples analyzed for total uranium, were selected for uranium isotopic analysis. These samples were analyzed for the following isotopic constituents and by the listed methodologies:

- U-234, U-235 and U-238 via alpha spectroscopy
- U-235/Total Uranium ratio via inductively coupled mass spectrometry (ICP-MS)

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-nine (39) groundwater samples from thirty-eight (38) locations within the existing site-wide monitoring well network were collected and analyzed during the third quarter 2004, quarterly groundwater-sampling event. Boron, geochemical 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 groundwater samples were collected for the boron and radiochemical constituents while geochemical analyses were performed on filtered samples. The filtered fractions were field filtered with a 0.45-μm filter.

A total of fifty-eight (58) samples were collected for analysis from fifty-seven (57) monitoring wells or locations during the fourth quarter 2004 sampling event. Total or unfiltered samples were collected at all locations during this round. Boron, total uranium and radiochemical results are summarized in Appendix D.3 and complete lab analytical packages are provided in Appendix D.4.

A total of thirty-five (35) samples were collected from 7 seep locations within the PAB/Service Building Alley during the November 2004 to February 2005 time frame. The samples were collected on a nominal weekly basis given groundwater seep flow considerations. In some seep locations, as many as 6 rounds of samples were collected

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-nine (39) samples were collected and analyzed for boron as part of the third quarter 2004 round. All results were detects with reported concentrations greater than the Minimum Detection Limit (MDL) of 0.54 micrograms per liter (µg/L). Results ranged from 5.2 µg/L at MW1 to 581 µg/L at MW106S. Groundwater analytical results for the Third quarter 2004 boron analyses are summarized in Table 4-1.

Boron was detected in all fifty-two (52) locations sampled and analyzed in the fourth quarter 2004 with all results above the MDL of 0.54 µg/L. The highest concentration was detected in well MW106S (802 µg/L). Groundwater analytical results for the fourth quarter 2004 boron analyses are summarized in Table 4-1.

Boron was detected at all seven (7) of the groundwater seep locations at a concentration greater than the MDL. Results ranged from 117 µg/L at seep #3 to 567 µg/L at seep #2. Groundwater seep analytical results are summarized in Appendix D.5.

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 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. Boron will be evaluated as part of the ongoing RCRA CAP and Connecticut Property Transfer Act investigations.

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 This is consistent with the presence of a measurable boron background at the site.

4.2 Gross Alpha

The likely source of most gross alpha activity in the vicinity of HNP is dissolution of naturally occurring mineral deposits. These mineral deposits include natural uranium, thorium and their radioactive progeny including radium (Ra-226, 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. Alpha isotopic analyses for HNP related alpha-emitters (plutonium, americium, curium) generally result in non-detects with nominal detection sensitivities on the order of 0.3 pCi/L, or less.

Thirty-nine (39) samples were collected and analyzed for gross alpha activity in Third quarter 2004 including the field duplicate. Twenty-three (23) locations were detects with concentrations greater than the 2-σ random uncertainty. Fifteen (15) samples detected concentrations greater than the laboratory required Minimum Detection Concentration (MDC) of 3 picocuries per liter (pCi/L). Three (3) reported results exceeded the Environmental Protection Agency (EPA) maximum contaminant level (MCL) of 15 pCi/L. The highest gross alpha concentrations were observed at monitoring wells MW103S (17.5 pCi/L), MW508D (22.3 pCi/L) and MW507D (40.8 pCi/L). Gross alpha results for Third quarter 2004 are provided in Table 4-2.

Fifty-two (52) samples were collected in fourth quarter 2004 for gross alpha activity analysis resulting in eleven (11) samples detected greater than the laboratory required Minimum Detection Concentration (MDC) of 3 picocuries per liter (pCi/L). The maximum gross alpha concentration was observed at monitoring well MW508D, 15.7 pCi/L. With the exception of MW508D, none of the other detected results exceeded the Environmental Protection Agency (EPA) maximum contaminant level (MCL) of 15 pCi/L. Gross alpha results for Fourth quarter 2004 are provided in Table 4-2.

Gross alpha analyses were performed on three (3) seep samples collected during the 2nd round of seep sampling. Gross alpha activity ranged from non-detect at Seep #3 to 7.3 pCi/L at Seep #1. Groundwater seep analytical results are summarized in Appendix D.5.

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 and natural background levels may range as high as a few hundred pCi/L.

Thirty-nine (39) samples were collected and analyzed in third quarter 2004 for gross beta activity and all results but one (MW503) were detects with concentrations greater than the 2-σ random uncertainty. Thirty-two (32) samples detected gross beta activity at a concentration greater than the laboratory required MDC of 4 pCi/L. These

concentrations ranged from 4.01 (EOF2) to 47.6 pCi/L (MW103S). None of these concentrations exceeded the CT Public Drinking Water Quality Standard MCL of 50 pCi/L. Gross beta results for Third quarter 2004 are provided in Table 4-2.

Thirty-four (34) out of fifty-two (52) samples analyzed detected gross beta activity greater than the laboratory required MDC of 4 pCi/L during the fourth quarter 2004 sampling event. These concentrations ranged from 4.12 to 39.3 pCi/L. The highest gross beta activity concentration was identified in well MW106S. All results were less than the CT Public Drinking Water Quality Standard MCL of 50 pCi/L. Gross beta results for fourth quarter 2004 are provided in Table 4-2.

Gross beta analyses were performed on three (3) seep samples collected during the 2nd round of seep sampling. Gross beta activity was detected at all three (3) locations sampled with results ranging from 20.5 pCi/L at Seep #3, to 55.4 pCi/L at Seep #2. Results at Seep #2 exceed the CT Public Drinking Water Quality Standard MCL of 50 pCi/L. Groundwater seep analytical results are summarized in Appendix D.5.

4.4 Tritium

In the third quarter of 2004, H-3 was detected in twenty-one (21) of the thirty-eight (38) wells sampled at a concentration greater than the 2-σ random uncertainty. Fifteen (15) of these detects were at concentrations greater than the required MDC of 400 pCi/L. Tritium was detected at monitoring wells MW102S (12,600 pCi/L) and MW110D (13,600 pCi/L). The highest tritium concentrations was observed at monitoring well MW103S (31,000 pCi/L), which is greater than the C_4 activity concentration of 20,000 pCi/L. Tritium results for the Third quarter 2004 sampling event are summarized in Table 4-3.

Tritium was detected in eighteen (18) of the fifty-two (52) wells sampled during fourth quarter 2004. Sixteen (16) 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 in monitoring wells were observed at MW102S (8,930 pCi/L) and MW103D (10,800 pCi/L). Tritium was detected at a groundwater extraction point (EP171) at a concentration of 9,040 pCi/L. Tritium results for the fourth quarter 2004 sampling event are summarized in Table 4-3.

Tritium analyses were performed on seep samples collected during four (4) of the five (5) seep sampling rounds. Tritium activity was detected at all four (4) locations sampled with results ranging from 262 pCi/L at Seep #3 (round 4), to 3250 pCi/L at Seep #1 (round 2). All detected H-3 concentrations were below the C_4 activity concentration of 20,000 pCi/L. Groundwater seep analytical results are summarized in Appendix D.5.

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 three (3) wells at concentrations greater than the 2-σ random uncertainty level during the third quarter 2004. The concentration observed at MW106D was 2.3 pCi/L, which was less than the sample MDC of 3.8 pCi/L. Results ranged from

16.4 at MW508S to 44.6 pCi/L at MW102S. These results were not confirmed by reanalysis, resulting in non-detects of less than 7.9 (MW508S) and 3.3 pCi/L (MW102S).

Cobalt-60 was detected in nine (9) of the fifty-two samples analyzed during the fourth quarter 2004 sample event. Only results at well MW103D (10.2 pCi/L) were detected with a concentration 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 fourth quarter 2004 sampling round.

Cobalt-60 was only detected in Seep #2 during the second (3.03 pCi/L) and fifth (3.08 pCi/L) sampling rounds, at concentration levels that were less than the sample MDC. The detected values are well below the C_4 concentration of 100 pCi/L. Groundwater seep analytical results for Co-60 are summarized in Appendix D.5.

4.6 Sr-90

Strontium-90 in groundwater at HNP is also associated with past nuclear power operations. Ten (10) out of twenty-five (25) wells sampled in Third quarter 2004 detected Sr-90 at concentrations greater than the 2-σ random uncertainty. Four (4) of these samples detected Sr-90 concentrations above the laboratory required MDC of 4 pCi/L. None of the observed Sr-90 concentrations exceeded the C_4 concentration of 8 pCi/L. Monitoring well MW106S exhibited the highest Sr-90 concentration (7.3 pCi/L). The Sr-90 analytical results for Third quarter 2004 are provided in Table 4-2.

Ten (10) out of forty-three (43) wells sampled in fourth quarter 2004 sampling event detected Sr-90 at concentrations greater than 2-σ random uncertainty, but only three (3) samples detected 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 MW106S exhibited a Sr-90 concentration of 8.6 pCi/L. The Sr-90 analytical results for Fourth quarter 2004 are provided in Table 4-2.

Strontium-90 analyses were performed on seep samples collected during all five (5) seep sampling rounds. Statistically significant Sr-90 activity was detected in four (4) locations sampled. Strontium-90 results ranged from non-detects (Seep #5 and #6) to 28.6 pCi/L, at Seep #2 (round 4). Detected Sr-90 concentrations at Seep #1 through #3 were greater than the C_4 concentration of 8 pCi/L. Groundwater seep analytical results are summarized in Appendix D.5.

Trend analysis of radionuclide data at these 2-σ random uncertainty levels and near the sample specific MDC has indicated the presence of a positive 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.

4.7 Cs-137

Any occurrence of Cs-137 in groundwater at HNP is the result of plant-related processes. Cesium-137 was detected in four (4) samples analyzed during the third quarter 2004 event at concentrations greater than the 2-σ TPU level. Only one sample from well MW102S 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. The level of the detection in MW102S, was not confirmed by reanalysis, resulting in a detect at 2.3 pCi/L. Table 4-2 summarizes Cs-137 analytical results in all wells for the third quarter 2004 sampling round.

Cesium-137 was detected in five (5) of the fifty-two (52) samples analyzed during the fourth quarter 2004 event at concentrations greater than the 2-σ TPU level. All of these detections were less than the sample MDC, that ranged from 3.8 to 6.5 pCi/L and these detections were 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 fourth quarter 2004 sampling round.

Gamma isotopic analyses were performed on seep samples collected during four (4) of the five (5) seep sampling rounds. Statistically significant Cs-137 activity was not detected in any of the four (4) locations sampled. All Cs-137 results were less than 6.9 pCi/L. Groundwater seep analytical results are summarized in Appendix D.5.

4.8 Alpha Isotopic

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 twenty-five (25) alpha isotopic results from the third quarter 2004 sampling event were less than 2-σ TPU and not statistically significant. All alpha isotopic results were less than the required MDC of 0.5 pCi/L. Alpha isotopic results are summarized in Table 4-4.

Two of the ninety-two (92) alpha isotopic results for the fourth quarter 2004 sampling event were detects with nominal sample specific MDCs or detection sensitivities on the order of 0.3 pCi/L or less. Results at MW208 for Pu-238 (0.13 ± 0.12) were just greater than the 2-σ random uncertainty. Results at EP166 for Am-241 (0.22 ± 0.18) were also just greater than the 2-σ random uncertainty. Table 4-4 summarizes alpha isotopic results for fourth quarter 2004. The observed positive rate for all alpha isotopic analyses was 2.2% for the fourth quarter 2004 sampling event. These sample analytical results suggest that the potential for statistically significant plant-related alpha activity in groundwater at these levels is quite small.

Statistically significant activity is identified by concentrations that are greater than 2-σ random uncertainty 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 2.2% for the fourth quarter 2004 sampling event, which is on the order of the expected false positive rate if no significant alpha-emitters are present.

Alpha isotopic analyses were performed on three (3) groundwater seep samples and one weathered rock sample collected during the 2nd round of seep sampling. Statistically significant alpha isotopic activity was not detected in any of the four (4) locations sampled. All alpha isotopic results were less than 0.5 pCi/L. Groundwater seep analytical results are summarized in Appendix D.5.

4.9 Total Uranium

Total uranium analyses were determined by kinetic phosphorescence analysis (KPA). The method has trace analysis capabilities for soluble uranium on the order of parts per trillion (sensitivity of 0.2 µg/liter based on the reported MDA). Total uranium analysis would include the response from isotopes of natural and enhanced uranium which include U-234, U-235 and U-238. Total uranium analysis results would also include the response from additional uranium isotopes characteristic of irradiated or spent nuclear fuel (SNF), if present. The SNF uranium isotopes include U-233 and U-236.

Twenty (20) wells were sampled and analyzed for total uranium as part of the third quarter 2004 round. Twelve (12) of these results were detects with reported concentrations greater than the Minimum Detection Limit (MDL) of 0.2 micrograms per liter (µg/L). Positive results were typically observed in the deeper wells. Total uranium concentrations ranged from 0.6 µg/L at MW122D to 27.3 µg/L at MW103S. All results were less than the EPA MCL of 30 µg/L. Total uranium analytical results for third quarter 2004 are summarized in Table 4-5.

Thirty-two (32) wells were sampled and analyzed for total uranium as part of the fourth quarter 2004 round. Twenty (20) of these results were detects with reported concentrations greater than the Minimum Detection Limit (MDL) of 0.2 micrograms per liter (µg/L). Higher concentrations were typically observed in the deeper wells. Total uranium concentrations ranged from 0.003 µg/L at MW205 to 22.4 µg/L at MW101D. All results were less than the EPA MCL of 30 µg/L. Total uranium analytical results for fourth quarter 2004 are summarized in Table 4-5.

4.10 Uranium Isotopic/U-235 Enrichment

Isotopic uranium analysis was performed by chemical separation and alpha spectrometry. Alpha spectrometry results for U-234, U-235 and U-238 in groundwater have a nominal sensitivity of 0.5 pCi/L. The U-235 enrichment ratio (U-235 to total uranium ratio) was also determined via inductively coupled plasma – mass spectrometry (ICP-MS).

Eight (8) wells which exhibited the highest concentration of total uranium (via KPA) were analyzed for isotopic uranium by alpha spectrometry as part of the Third quarter 2004 sample event. These wells exhibited total uranium concentrations greater than, 6.8 µg/liter. All eight (8) wells exhibited detectable U-234 results with concentrations ranging from, 1.7 pCi/L (MW100D) to 8.5 pCi/L (MW103S). All wells also exhibited detectable U-238 results with concentrations ranging from, 2.2 pCi/L (MW100D), to 9.9 pCi/L (MW103S). Uranium-235 was only detected in two (2) wells, MW101D (0.4 pCi/L) and MW103S (0.5 pCi/L), with a concentration greater than the 2-σ random uncertainty. All U-235 concentration results exhibited a large analytical uncertainty (i.e., 2-σ random uncertainties greater than 77%). All results were less than the EPA MCL of 15 pCi/L. Isotopic uranium analytical results for the third quarter 2004 are summarized in Table 4-6.

Uranium-234 is a progeny of U-238 following the decay of Th-234 as follows:

U-238 (α decay, $T_{1/2}=4.5 \times 10^9$ years)
→ Th-234 (β^- decay, $T_{1/2}=24.1$ days)
→ Pa-234 (β^- decay, $T_{1/2}=1.17$ minutes)
→ U-234 (α decay, $T_{1/2}=2.4 \times 10^5$ years)

In an ideal, closed system, a U-234/U-238 ratio of unity is expected, due to radioactive decay equilibrium. Radioactive decay can influence this ratio somewhat in the natural environment. The presence of the intermediate progeny (i.e., Th-234, Pa-234) with associated solubility differences and alpha recoil mechanisms are such that the actual observed ratio of U-234 to U-238 in natural groundwater can vary from 0.5 to 40. In Table 4-7 is a summary of the U-234/U-238 isotopic ratios measured by alpha spectrometry. The U-234/U-238 ratios ranged from 0.78 to 2.1, with an average and standard deviation of 1.08 ± 0.42. These U-234/U-238 results are typical of groundwater with natural uranium ratios.

These same wells were also analyzed for U-235 enrichment (i.e, U-235 to total uranium on a mass basis) via ICP-MS. The expected U-235 enrichment ratio for uranium in groundwater or other environmental samples is less than 1% or about 0.72% (Reference GENE 1996). Uranium-235 enrichment results for these samples ranged from less than zero to 1.65% at MW100D and are included in Table 4-7. These observed enrichment results are on the order of the average ICP-MS enrichment sensitivity of 0.7%, suggesting a large analytical uncertainty on the order of 33% (relative) at 1-σ, given an MDL based on 3 standard deviations of the method blank or background noise. The average and 1-σ standard deviation enrichment value for these samples is 0.82% ± 0.58%. These results are normally distributed around the limiting mean enrichment value of 0.82% and are not statistically different from the expected natural enrichment value of 0.72%, based on the t-test. These results are typical of groundwater with natural U-235 enrichment ratios and relatively large analytical uncertainty.

Included in Table 4-8 is a summary of the total uranium results as measured by alpha spectrometry compared to the total uranium via KPA. The total uranium results represent the sum of the isotopic U-234, U-235 and U-238 results after conversion to

mass units. Isotopic results (reported as pCi/L) were divided by the nuclide specific activity constant (in units of pCi/μg) prior to summing. The uncertainty in the total uranium results (via alpha spectrometry) are based on standard uncertainty propagation methods where the isotopic random uncertainties are summed in quadrature. The total uranium results determined by alpha spectrometry agree to within ± 25% of the total uranium results determined by KPA. These results indicate statistical agreement of the two techniques.

4.11 Geochemical Constituents

Twenty (20) filtered samples were collected from groundwater monitoring wells and analyzed for major cations and anions. The major cations analyzed included calcium (Ca^{+Z}), magnesium (Mg^{+Z}), sodium (Na^{+}), and potassium (K^{+}). Major anions analyzed included carbonate (CaO_3^{-Z}), bicarbonate (HCO_3^{-}), sulfate (SO_4^{-Z}), and chloride (Cl^{-}). The analytical results for major cations and anions are summarized in Table 4-9.

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 2005.

5.1 Data Quality Metrics

On the analytical side, precision, accuracy, representativeness, comparability and completeness (PARCC) 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 is a measurement of the repeatability of a measurement or measurement technique. 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.

A commonly applied and useful metric for precision is known as the Relative Percent Difference (RPD). The RPD is determined for duplicate measurements by applying the following equation:

$$RPD = \frac{|S_1 - S_2|}{(S_1 + S_2)/2} \times 100$$

Where:

RPD	≡	Relative Percent Difference as %
S_1	≡	Initial measurement value
S_2	≡	Duplicate or replicate measurement value
$\|S_1 - S_2\|$	≡	Absolute measurement difference
$(S_1 + S_2)/2$	≡	Average measurement value

A typical acceptable target RPD is 20% for most chemical or radiological constituents in environmental media. For samples that are heterogeneous, an acceptable RPD may be as high as %100 percent.

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

Accuracy refers to the degree to which a measurement can reflect the known or true value. The accuracy of a lab analytical measurement is determined by analyzing known or reference standards or solutions. A metric used to express accuracy in analytical measurements is the Recovery (R) which is given by the following equation:

$$R = \left[1 + \left(\frac{Y - X}{X}\right)\right] \times 100$$

Where:

R	≡	Recovery as %
Y	≡	Measured value
X	≡	Known or reference value

Laboratory performance for accuracy is measured by several indicators, including external programs such as nationally based performance evaluation studies, that may include blind or double-blind standard analyses and internal laboratory QA/QC

programs. Another important measure of accuracy is sensitivity. Measurement techniques vary in their ability to detect and quantify chemical or radiochemical constituents. For acceptable sensitivity, a measurement technique must demonstrate the capability to quantify at a level that is no more than 10% of an applicable limit (e.g., a drinking water standard).

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 Representativeness

Sample representativeness refers to the degree in which sample data accurately and precisely represent a characteristic of the environmental conditions at that sample point. Sample representativeness is an important PARCC parameter that is difficult to assess quantitatively.

Different measurement techniques may produce dramatically differing results, based on the ability of the technique to represent the system. This is especially true at low-levels at or near the analytical limit of detection. One aspect of analytical representativeness was evaluated quantitatively by evaluation of method blank samples. Equipment or method blank samples that exhibited contamination (i.e., positive detects) were considered analytically non-representative. The presence of statistically significant analyte concentrations at similar levels in measured samples may not be representative of the sampled aquifer.

5.1.4 Completeness

Completeness was evaluated by comparison of the number of valid measurements produced to the number of measurements planned. The Completeness (C) metric is given by the following equation:

$$C = \left[1 + \left(\frac{Y - X}{X}\right)\right] \times 100$$

Where:

C	≡	Completeness as %
Y	≡	Number of valid data points
X	≡	Total number of data points

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.

5.1.5 Comparability

Comparability was evaluated qualitatively through assessment of sampling and measurement methods and apparent spatial distribution of substances of concern. Comparability was evaluated quantitatively by comparison of the measurement sensitivity to the contract required detection limit (CRDL). Measurements performed to these levels are comparable to previous or historical measurements.

5.1.6 Bias

Bias is defined as a systematic error in a measurement where the measured value displays a consistent positive or negative bias, as compared to the true value. Bias in an analytic method at low levels close to the limit of detection can impact the ability to identify statistically significant levels of an analyte. 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, attributed to positive analytical bias at the detection limit. Statistical methods were employed to evaluate this analytical bias with regard to the underlying baseline or background distribution.

5.1.7 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.

5.1.8 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

This field duplicate is a blind duplicate identified as MW600 on sample submission and chain-of-custody paperwork submitted to the laboratory. The duplicate sample is typically analyzed for radioactive and inorganic constituents. Only those reported radiochemical results with a sufficient signal-to-noise ratio (i.e., sample-to-uncertainty concentration ratio greater than 5) are evaluated and summarized. The uncertainty used in this ratio is the 1-σ random uncertainty reported with the radiochemical results. Inorganic results that are greater than the contract required detection limit (CRDL) are also included in this evaluation.

The duplicate sample for the third quarter 2004 sampling round was collected from MW122S. The radioactive analyses included gross alpha, gross beta, H-3, Sr-90 and gamma isotopic. Results of the radiochemical field duplicate evaluation are summarized in Table 5-2. All radiochemical field duplicate results are within ± 15% or 2-σ standard deviations of the initial sample results.

Results of the inorganic field duplicate evaluation are also summarized in Table 5-2. The inorganic analyses for third quarter 2004 included boron, cations and anions. Seven (7) of the nine (9) inorganic field duplicate results are within ± 20% of the initial sample

results Field duplicate results for carbonate alkalinity were a factor of 3 lower than the initial analysis. The initial carbonate alkalinity results are only 3 times the MDL suggesting a large uncertainty with the carbonate alkalinity at these levels (i.e., 2 to 6 mg/l). Field duplicate results for bicarbonate alkalinity were a factor of 2 greater than the initial analysis results.

The duplicate sample for the fourth quarter 2004 sampling round was collected from MW102S The blind duplicate sample was analyzed for gross alpha, gross beta, H-3, boron, Sr-90, gamma isotopic and total uranium. Additional boron duplicate samples were collected at MW106S and MW125. Results of the field duplicate evaluation are summarized in Table 5-3. Again, only those radiochemical and inorganic results with a sufficient signal-to-noise ratio are evaluated and summarized. All evaluated field duplicate results are within ±15% of the initial sample results and indicate satisfactory precision.
Duplicate samples were not collected during the groundwater seep sampling rounds due to the data quality objectives of these samples. These samples were collected for characterization purposes only.

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 third quarter 2004 are summarized in Table 5-4. Seven (7) of twelve (12) lab duplicate results are within ± 20% of the initial observed value. Three (3) of the remaining duplicate results are within 2 standard deviations of the initial value based on a standard Z-score indicating satisfactory statistical precision. Results for gross beta (MW109S) and Ni-63 (MW103S) replicate analysis were outside the acceptance criteria at -30.8% and -39.9%, respectively. All eighteen (18) geochemical lab duplicate results are within ± 6.6% of the initial sample results.

Results of the lab duplicate evaluation for fourth quarter 2004 are summarized in Table 5-5. Thirteen (13) of sixteen (16) radiochemical lab duplicate results are within 17% of the initial sample results and indicate satisfactory precision. One gross alpha result (MW508D) and two (2) gross beta results (MW113S, MW508D) were outside acceptance

limits. Eleven (11) of thirteen (13) geochemical lab duplicate results are within ± 12% of the initial sample results and indicate satisfactory precision. Two (2) boron results (MW100D, MW100S) were outside acceptance limits at +22.3% and +31.2%, respectively. Results of the lab duplicate evaluation for groundwater seep samples are summarized in Table 5-6. Twelve (12) of thirteen (13) radiochemical lab duplicate results are within ± 18.5% of the initial sample results and indicate satisfactory precision. One result for Sr-90 (Seep 1) analysis was outside the acceptance criteria at -27.1%. All eighteen (18) geochemical lab duplicate results are within ± 7.1% of the initial sample results.

5.2.1.3 Reanalysis Duplicates

During the third quarter 2004 sample event, CYAPCo requested that several samples be reanalyzed to confirm the original analysis results. Reanalysis of gross alpha, gross beta, Co-60 and Cs-137 constituents were performed on sample MW102S. The original gross alpha and gross beta results were confirmed by the reanalysis. The original levels of Co-60 (16.4 pCi/L) and Cs-137 (27.2 pCi/L) were not confirmed by the reanalysis, which indicated non-detections. Reanalysis of the Ni-63 fraction was also requested for MW103S. The original results were confirmed.

During the fourth quarter 2004 sample event, CYAPCo requested that several samples be reanalyzed to confirm the original analysis results. Reanalysis of the complete set of americium alpha isotopic sampes were requested due to the unexpected number and level of detections. Nine (9) of nineteen (19) reported results for Am-241 and twelve (12) of nineteen (19) reported results for Cm-243,244 were greater than sample MDC with concentrations ranging from 0.3 to 5 pCi/L. Results of the reanalyses did not confirm the initial reported results. The analytical lab attributed these initial results to alpha particle recoil contamination effects. The original americium/curium analysis results have been flagged as rejected in the analytical database. Results of the reanalysis indicated fifty (50) of fifty-one (51) non-detects for alpha americium.

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 December 2000 through December 2004 (see References QAP-52 through QAP-60), 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, water and particulate filter 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. Analytical results for gross alpha and gross beta analyses with an analytical bias less than 100% and 50%, respectively, are acceptable.

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. Recently, gross alpha and gross beta analysis tests for water and particulate filters have been included.

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 ± 3-σ uncertainty) included zero. Unacceptable performance is indicated when this range does not include zero.

For the eleven (11) MAPEP studies conducted through October 2004 (see References MAPEP-S6, S7, S8, S9, S10, MAPEP-W7, W8, W9, W10, W11 and MAPEP-12), the percentages of acceptable or acceptable with warning results are summarized as a function of media in Table 5-7.

Overall, about 95% 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 94% of the alpha isotopic results and 84% 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 67% of the reported results were in the acceptable 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 six (6) of the last seven (7) ERA studies (see References ERA RAD 52, 53, 54, 55, 57 and 58). The percentages of acceptable or acceptable with warning results for these six (6) studies are summarized as a function of analysis type in Table 5-8. Overall, 98.7% 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 third quarter or fourth quarter of 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 Third quarter and Fourth quarter 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 2005 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 99% of the GEL performance data for LCS and MS samples were acceptable according to performance criteria. For GPC, alpha isotopic and gamma isotopic analyses, 100% of the internal lab QC data was within acceptance limits. Approximately 98% of the LSC results and 97% of the boron, geochemical and total uranium 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 544 radionuclide tests and 228 geochemical tests in the third quarter of 2004, resulting in completeness of 100%. For the fourth quarter 2004 sampling event valid results were generated for 850 radionuclide tests and 86 geochemical 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 standard EPA methods or were developed by the vendor laboratory and are recognized as acceptable within the radiochemical industry. All inorganic methods are 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.

5.2.4.2 Radiochemical Data Reporting Convention

All reported analytical results include the net concentration, the 1-σ or 2-σ random uncertainty, 1-σ or 2-σ total propagated uncertainty concentration (TPU), and the minimum detectable concentration (MDC). Net concentration results greater than the 2-σ random uncertainty, generally imply that statistically significant activity is present with a 95% certainty. Net concentration results less than the 2-σ random uncertainty 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. Uncertainty values reported at 2-σ allow direct comparison with the net concentration for statistical significance. 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 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 or the CRDL require 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 with the laboratory analytical data sheets. Specific quality issues identified by the GEL lab during the reporting of third quarter and fourth quarter 2004 sampling event data are summarized in Tables 5.15 and 5.16, respectively.

Specific issues identified by the GEL lab during the reporting of Seep sampling event data included in Table 5.17. In some cases, these occurrences initiated internal non-conformance action on the part of GEL Charleston lab with additional follow-up documentation. 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. Samples collected during the Third and Fourth quarter 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 has been performed on a limited number of wells in an 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.

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.

Monitoring wells have been assigned to unique hydrostratigraphic units based on the relative placement of screen intervals in each of the wells. The wells retain the designation of shallow or deep as these generally differentiate whether the screens are placed in unconsolidated sediments or bedrock. Three distinct hydrostratigraphic units are recognized, 1) the unconsolidated sediments are those non-indurated, friable materials overlying the bedrock, and are the host to the unconfined aquifer, 2) the bedrock unit which is the host to the confined aquifer and generally recognized as a gneissic formation, 3) a silt and peat/organic rich layer has been designated as a perching horizon in the area of the parking lot extending to the north where the perched water table occupies an elevation of about 10 feet AMSL. A glacial till is present locally

over a small part of the land area, and where present typically acts as a confining layer. The assignment of wells to specific units affects the spatial distribution interpretation for the substances of concern.

Samples collected from wells MW106D and MW122D 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.

5.2.7 Lab Audits

No onsite audits or assessments were conducted at the GEL facility during this time period.

5.2.8 Analytical Bias Assessment

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 H-3 results analyzed via LSC during the third quarter 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 beta and Sr-90 results analyzed by GPC methods. No bias was observed for gamma isotopic analysis methods. Negative biases were not observed during the third quarter 2004 round.

A positive bias was observed for H-3 analyzed via LSC during the fourth quarter 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 beta and Sr-90 results analyzed by GPC methods. Negative biases were not observed during the Fourth quarter 2004 round.

Statistical and visual methods were employed to evaluate trends in the analytical results as a function of nuclide. Rank order plots for the third and fourth quarter 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 random uncertainty and MDC)
- Net concentration results with associated random uncertainty 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 third and fourth quarter 2004 events are summarized in Tables 5-15 and 5-16, 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

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 third and fourth quarter 2004 sample events are summarized in Tables 5-17 and 5-18, 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 third and fourth quarter 2004 sample events are also included in Tables 5-17 and 5-18, 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 third quarter 2004 sampling event. The Mn-54 results are graphed with their corresponding 2-σ error bars. An average and 1-σ standard deviation concentration of -0.32 $\pm$ 0.99 pCi/L was observed in this data set while the average MDC was 3.8 pCi/L. The control limits are $\pm$ 1.98 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 error bars generally cross zero except in the extreme positive or negative regions of the data.

The limiting mean value of -0.32 pCi/L is statistically equal to a zero concentration level based on the t-statistic and 41 (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 third quarter 2004 sampling event. Only results with concentrations less than 10 pCi/L, are displayed in order to focus attention on the underlying baseline distribution. An average and 1-σ standard deviation concentration of 0.55 ± 1.15 pCi/L, was observed for the limiting zero mean while the average MDC was 3.91 pCi/L. The control limits are ± 2.30 pCi/L based on 2-σ standard deviations of the limiting mean. Results with concentrations greater than, 2.8 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 0.55 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 Fourth quarter 2004 sampling event. An average and 1-σ standard deviation concentration of 0.40 ± 1.35 pCi/L was observed for the limiting zero mean while the average MDC was 5.6 pCi/L. The control limits are ± 2.70 pCi/L based on 2-σ standard deviations. The baseline data are normally distributed around the limiting mean value of 0.40 pCi/L (Figure 5-6). The limiting mean is statistical greater than zero based on the t-test. There were seven (7) 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 H-3 concentrations in groundwater for the fourth quarter 2004 sampling event. Tritium is a beta emitter, determined by distillation and LSC. An average and 1-σ standard deviation concentration of 51.5 ± 83.6 pCi/L was observed in this data set while the average MDC was 327 pCi/L. The control limits are ± 167.2 pCi/L based on the average 2-σ standard deviation. Note that thirty-one (31) of the forty-one (41) data points are distributed above the zero concentration level.

The limiting mean value of 51.5, pCi/L is statistically greater than the zero concentration level based on the t-statistic and 40 (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. In the case of tritium, this underlying baseline may be attributed to natural background levels of tritium, which are expected to be on the order of 20 to 100, pCi/L.

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 fourth quarter 2004 sampling event. An average and 1-σ standard deviation concentration of 0.14 ± 0.22 pCi/L was observed in the limiting mean baseline data set after removing statistically significant or positive outliers. The control limits are ± 0.44 pCi/L based on the average 2-σ standard deviation of the limiting mean. Results with concentrations greater than 0.52 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 forty (40)

of the fifty-two (52) reported Sr-90 results for this data set were greater than the zero concentration.

The baseline Sr-90 data consisted of 41 data points and were normally distributed around the limiting mean value of 0.14 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 fourth quarter 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 0.019 ± 0.033 pCi/L was observed in this data set while the average MDC was 0.23 pCi/L. The control limits are ± 0.066 pCi/L based on 2-σ standard deviations of the limiting mean. 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 error 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, 0.018 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 always 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. 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 Fourth quarter 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 0.027 ± 0.040 pCi/L was observed in this data set while the average MDC was 0.28 pCi/L. The control limits are ± 0.080 pCi/L based on the average 2-σ

standard deviation of the limiting mean. Note that the individual 2-sigma error bars generally span the region of the control limits.

The data are normally distributed around the limiting mean value of 0.027 pCi/L in Figure 5-16. The limiting mean value of 0.027 pCi/L is not statistically greater than zero analyte level based on the t-statistic and 17 (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 fifteen (15) of nineteen (19) 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 random error and near the MDC level. This table provides an indication of the percentage of false positive results as a function of analysis method. Known statistically positive results were removed from these summaries. Only about 3.9% of the gamma isotopic analysis results were greater than the 2-σ random error 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 third and fourth quarter 2004 sample events indicated overall positive activity rates of 0.8%, 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 random error was 6.7%. These results were generally normally distributed around a limiting mean concentration in most cases. Only 2 of the 12 LSC

analyses (by nuclide) indicated limiting mean distributions that were positive. Negative limiting mean distributions were not observed for any of the 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 third and fourth quarter 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, which have been observed in the past for radionuclides analyzed by LSC, were not observed in any of the sample event data sets.
- Positive systematic biases were observed in several of the HTD analyses by LSC and GPC. The affected analyses included gross beta, H-3 and Sr-90. An overall false positive rate on the order of 6.7% was observed for the LSC analyses results. This is higher than the expected false positive rate of 2.5%.
- A positive bias was also observed for Co-60 which is a gamma emitter. This positive bias was not based on baseline trend analysis but based on reanalysis requests that were not substantiated in the follow-up analyses. 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 67% 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 boron and radiochemical constituents was performed on unfiltered water samples collected from groundwater monitoring wells at HNP during the third and fourth quarter of 2004. In addition, filtered samples were analyzed for geochemical constituents at several locations during the third quarter 2004 sampling round.

Geochemical 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, geochemical and radiochemical constituents in samples collected from HNP met the identified data quality metrics for these 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 perched, unconfined and confined aquifers for the third and fourth quarter 2004 sampling events, and are summarized below.

There is uncertainty in mapping groundwater flow and contaminant distribution in fractured rock. The maps of contaminants 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 represents interpretations of site conditions.

6.1.1 Spatial Distribution of SOCs from Third Quarter 2004

The concentrations of boron, tritium, and, Sr-90, for the third quarter 2004 sampling results for the industrial area and peninsula area are displayed on Figures 6-1, 6-2 and 6-3. A discussion of the distribution of the SOCs in each aquifer is presented in the following sections.

6.1.1.1 Boron

Boron is detected in the three aquifers at concentrations ranging from 5.2 µg/L up to 581 µg/L. There is no MCL or CTDEP Remediation Standard Regulation (RSR) established for boron, however criteria is currently being evaluated by the CTDEP as part of the ongoing RCRA CAP and Property Transfer program. Boron will be assessed against RSR criteria as part of the RCRA CAP/Property Transfer program. In the context of this report boron is used as an indication of plant-related contamination and also as an effective tracer of potentially contaminated groundwater. A discussion of the boron distribution in groundwater for the three aquifers is presented in the following sections.

Perched Aquifer

Boron in the perched aquifer ranges from 58 µg/L to 65.5 µg/L in perched wells MW505, MW507S, and MW508S (Figure 6-2). Due to it's high water level, MW104S is included in the perched aquifer, and is located near the eastern edge of the aquifer. The boron concentration in MW104S is significantly higher (268 µg/L) than that observed in the other perched wells and is consistent with the boron distribution observed in the unconfined aquifer. Likewise, MW104S is located near the eastern edge of the swampy deposits and is screened in both the unconsolidated material and the shallow bedrock below. Based on the elevated boron and the screened interval for MW104S, the monitoring well is included in the SOC distribution for the unconfined aquifer. Aside from MW104S, boron concentrations in the perched are interpreted as background, and indicate that no impacts from plant activities are apparent in the perched aquifer.

Unconfined Aquifer

A large area of elevated boron is observed in the unconfined aquifer from upgradient portions of the site (MW100S) to downgradient areas of the site (MW110S) (Figure 6-4). In the unconfined aquifer boron concentrations appear highest around the southern perimeter of the RCB in MW106S (581 μg/L), with plume concentration decreasing to the south and southeast (Figure 6-4). As discussed in Section 2, the discharge tunnel is located south of the RCB and forms a barrier for flow in the unconsolidated portion of the unconfined aquifer. In the area of the discharge tunnel, groundwater flow in the shallow portion of the unconfined aquifer 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 and shallow bedrock of the unconfined aquifer continues due south toward the Connecticut River (Figures 6-4 and 2-6). The effects of the discharge tunnel are clearly reflected in the boron distribution as the boron plume id deflected to the southeast by the tunnel and continues to the south and southeast towards the Connecticut River (Figure 6-4).

While the source of the highest boron concentrations is focused on the RCB area, elevated boron is also observed in the western portion of the industrial area (MW104S; 268 μg/L, MW124; 244 μg/L, and) and upgradient of the RCB area (MW100S; 151 μg/L and MW101S; 144 μg/L) (Figure 6-4). Likewise, these monitoring wells do not typically have elevated tritium concentrations that are present in monitoring wells in the RCB area (Figure 6-1). The elevated boron observed in the upgradient and western monitoring wells in this portion of the site may indicate another source (i.e., warehouse storage areas or an historic spill) for boron in the western portion of the unconfined aquifer.

Elevated boron is also detected in MW113S (130 μg/L) located south of the discharge canal in the southeaster portion of the site (Figure 6-4). This location is well south and east of the mapped boron plume, but is adjacent to septic leaching beds that may be releasing boron to the shallow groundwater in that area.

Confined Aquifer

In the confined aquifer boron is detected in both the western and eastern portions of the industrial area (Figure 6-5). Elevated boron is detected in MW109D (184 μg/L) and MW123S (134 μg/L) located in the western portion of the industrial area (Figure 6-5). Boron is also detected in a plume extending south from MW102S (174 μg/L), past MW122D (264 μg/L), and on to MW110D (400 μg/L) in the eastern portion of the industrial area (Figure 6-5). Both areas of detected boron appear to flow from north to south towards the Connecticut River (Figure 6-5).

The highest concentrations of boron in plume on the eastern side of the industrial area occur in the downgradient portion of the plume, and higher boron concentrations have been historically observed in the upgradient wells (MW102D and MW122D) associated with the plume. This suggests that a slug of elevated boron has historically migrated through this portion of the industrial area towards the Connecticut River.

A second, lower concentration plume occurs in the western portion of the industrial area. Elevated boron concentrations are observed in MW123 (134 μg/L) and MW109D (184 μg/L). Elevated boron was observed in this portion of the site in previous studies.

These monitoring wells form a second plume of elevated boron that flows towards the Connecticut River (Figure 6-5).

6.1.1.2 Tritium

Tritium is detected in the three aquifers at concentrations ranging from non-detect up to 31,000 pCi/L. All detections in the three aquifers are below the C_4 concentration for tritium of 20,000pCi/L except for MW103S where 31,000 pCi/L was reported.

Perched Aquifer

Tritium results in the perched aquifer were all non-detect (Figure 6-2). Consistent with the low, background boron detections, the tritium distribution also indicates no impacts from plant activities in this portion of the site.

Unconfined Aquifer

In the unconfined aquifer (Figure 6-6), tritium was detected above activity concentrations of 1,000 pCi/L in several locations. The highest tritium levels in the unconfined aquifer occur in MW103S (31,000 pCi/L) and MW102S (12,600 pCi/L) (Figure 6-6). Elevated tritium flows to the southwest and southeast from the RCB area (Figure 6-6). The plume to the southwest of the RCB flows towards MW124 (2,080 pCi/L). This area of elevated tritium is downgradient of the RCB and an area of elevated tritium that was formerly associated with abandoned well MW105S, and is believed to flow from the RCB area around the northwest end of the discharge tunnel (Figure 6-6). This plume of tritium-contaminated groundwater would be expected to flow to the south towards the Connecticut River (Figure 2-6).

The second plume of tritium flows from the RCB southeastwards around the eastern end of the discharge canal and towards the Connecticut River (Figure 6-6). This plume of elevated tritium includes monitoring wells MW106S (1,260 pCi/L), MW125 (2,390 pCi/L) and MW110S (1,670 pCi/L) and is interpreted to flow from the RCB, past the discharge canal, and towards the Connecticut River (Figures 6-6 and 2-6).

Confined Aquifer

In the confined aquifer, tritium is detected adjacent to the northwest side of the RCB in MW103D (8,950 pCi/L) and northeast of the RCB in MW102D (5,120 pCi/L) (Figure 6-7). Based on the groundwater contour maps for the confined aquifer, it appears that groundwater flows from the RCB area, and then continues south toward the Connecticut River, passing through the area of MW106D (2,700 pCi/l), MW110D (13,600 pCi/L) and MW109D (3,480 pCi/L) Figures 6-7 and 2-7). The elevated concentration of tritium observed in MW110D, relative to the lower upgradient concentrations mapped in the plume, suggests that a slug of higher concentration tritium-contaminated groundwater has passed through this downgradient portion of the site in the past. The monitoring wells downgradient of the RCB area in the confined aquifer appear to be part of the tritium plume that is sourced in the RCB area. The general groundwater flow direction in the confined aquifer is to the south and southeast towards the Connecticut River (Figure 2-7).

6.1.1.3 Strontium-90

Sr-90 is detected in both the unconfined and confined aquifers at concentrations ranging from non-detect up to 7.3 pCi/L. The C_4 concentration for Sr-90 is 8 pCi/L and all reported Sr-90values in the monitoring wells are below the C_4 value.

Perched Aquifer

Sr-90 was not analyzed in any of the monitoring wells included in the perched aquifer except for MW104S located on the eastern edge of the perched aquifer. As discussed in Section 6.1.1.1, the boron concentration in MW104S is more consistent with the distribution observed in the unconfined aquifer. Thus, the non-detect Sr-90 concentration reported in MW104S most likely does not characterize the perched aquifer.

Unconfined Aquifer

In the unconfined aquifer the highest Sr-90 is detected in MW106S (7.3 pCi/L) located adjacent to the southern side of the RCB (Figure 6-8). Additional detected Sr-90 occurs in MW103S (3.67 pCi/L), MW125 (1.93 pCi/L), and MW122S (1.23 pCi/L). MW125 is located southeast and downgradient of MW106S (Figure 6-8 and 2-6), while MW –123S MW103S, and MW122S are located to the west, north, and east of the RCB, respectively (Figure 6-8). The highest Sr-90 concentration is located adjacent to the RCB, which appears to be the source area for the Sr-90 detections. Based on the groundwater flow map developed for the unconfined aquifer and similar to the plumes mapped for tritium and boron in the unconfined aquifer, it appears that the Sr-90 is migrating around the eastern edge of the discharge tunnel and flowing south toward the Connecticut River (Figures 6-8 and 2-6).

Confined Aquifer

In the confined aquifer Sr-90 is detected in one monitoring well (MW123S, 0.55 pCi/L), located west of the RCB and PAB (Figure 6-9). Based on the limited data available in the vicinity of the RCB and the PAB in this aquifer and the non-detect values in all of the other monitoring wells, no distinct plume can be mapped in the confined aquifer.

6.1.2 Spatial Distribution of SOCs from Fourth Quarter 2004

The concentrations of boron, tritium, and Sr-90 for the fourth quarter 2004 sampling results for the industrial area, EOF, parking lot, peninsula area, and landfill area are displayed on Figures 6-10, 6-11, 6-12, and 6-13. 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 the three aquifers at concentrations ranging from 11.2 μg/L up to 802 μg/L. There is no MCL or CTDEP Remediation Standard Regulation (RSR) established for boron, however criteria is currently being evaluated by the CTDEP as part of the ongoing RCRA CAP and Property Transfer program. Boron will be assessed against RSR criteria as part of the RCRA CAP/Property Transfer program. In the context of this report boron is used as an indication of plant-related contamination and also as an effective tracer of potentially contaminated groundwater. A discussion of boron in the three aquifers follows.

Perched Aquifer

Boron in the perched aquifer ranges from 57 μg/L to 80 μg/L in MW505, MW507S, and MW508S (Figure 6-11). Similar to the third quarter results, the boron concentration in MW104S is consistent with the distribution mapped for the unconfined aquifer. Aside from the boron observed in MW104S, the low boron concentrations are interpreted as background, and generally indicate that no impacts from plant activities are apparent in the perched aquifer.

Unconfined Aquifer

In the unconfined aquifer (Figure 6-14), boron concentrations appear highest around the perimeter of the RCB. The highest boron concentration occurs in MW106S (802 μg/L) located adjacent to the southeastern portion of the RCB. Elevated boron concentrations also occur in EP-171 (364 μg/L), EP-166 (157 μg/L) located west of the RCB, and CMS (111 μg/L) MW122 (187 μg/L) east of the RCB (Figure 6-14). Consistent with the groundwater flow contours in the unconfined aquifer, a plume of boron occurs to the south and east of the RCB with concentration decreasing to the south toward the Connecticut River (Figures 2-9 and 6-14). The boron distribution in the southeastern, downgradient portion of the plume is characterized by MW125 (308 μg/L) and MW110S (281 μg/L).

MW100S is well upgradient of the RCB and has elevated boron (109 μg/L), but no other SOCs. Similarly, the monitoring wells downgradient of MW100S along the western portion of the boron plume (MW104S (172 μg/L) MW124 (258 μg/L)) are not associated with elevated tritium or other radionuclides suggesting a source other than borated water from the power plant for the elevated boron on the west side of the plant (Figure 6-14).

Similar to that observed in the third quarter, elevated boron is also detected in MW113S (106 μg/L) located south of the discharge canal in the southeaster portion of the site (Figure 6-14). This location is well south and east of the mapped boron plume, but is adjacent to septic leaching beds, that may be releasing boron to the shallow groundwater in that area.

Confined Aquifer

The distribution of boron in the unconfined aquifer unit defined by the fourth quarter 2004 data show a broad area of boron concentrations greater than 100 μg/L, but with no boron concentration greater than 176 μg/L (Figure 6-15). The area of elevated boron extends south from the RCB down to the Connecticut River, and appears to be sourced in the RCB area (Figure 6-15).

The elevated boron in the wells in the western portion of the plume (MW123S; 113μg/L) is not associated with other SOCs, suggesting a source other than borated water from the power plant process (Figure 6-15).

6.1.2.2 Tritium

All detections in the three aquifers are below the C_4 concentration for tritium of 20,000 pCi/L, and range from non-detect to 10,800 pCi/L. Elevated tritium concentrations are observed in both the unconfined and confined aquifers, with the highest concentration observed in the confined aquifer.

Perched Aquifer

Tritium results in the perched aquifer were all non-detect (Figure 6-11). Consistent with the low, background boron detections, the tritium distribution also indicates no impacts from plant activities in this portion of the site.

Unconfined Aquifer

Similar to the tritium distribution of tritium mapped from the third quarter 2004 results, the highest tritium concentrations are observed on the north and adjacent to the RCB in MW102S (8,930 pCi/L) and EP-171 (9,040 pCi/L) (Figure 6-16). The elevated tritium in the RCB area flows to southeast and southwest south of the RCB on both sides of the discharge tunnel (Figure 6-16). The southeastern plume flows east of the RCB near the CMS (3,260 pCi/L) and flows south, consistent with the mapped groundwater contours, through MW125 (861 pCi/L) and MW110S (1,820 pCi/L) toward the Connecticut River (Figures 6-16 and 2-9).

The second area of elevated tritium occurs west of the RCB in EP-171 (9040 pCi/L) and EP-166 (3,610 pCi/l), and also flows to the south towards the Connecticut River. Elevated tritium is also observed at MW124 (968 pCi/L) that appears to be in the downgradient portion of the plume mapped from the western side of the RCB (Figure 6-16 and 2-9).

Confined Aquifer

The tritium distribution in the confined aquifer defined by the fourth quarter 2004 data is very similar to that identified in the third quarter 2004 results (Figures 6-7 and 6-17). As depicted in the third quarter 2004 results, the highest tritium concentrations are observed north and northeast of the RCB in MW103D (10,800 pCi/L) and MW102D (6,480 pCi/L). The elevated tritium detected in the RCB area is mapped to the south through MW106D (3,670 pCi/L) and continuing on south through MW109D (3,390 pCi/L) and MW110D (3,900 pCi/L) toward the Connecticut River, consistent with the mapped groundwater flow for the confined aquifer (Figures 6-17 and 2-10).

6.1.2.3 Strontium 90

Sr-90 is detected in the both the unconfined and confined aquifers, with concentrations ranging from non-detect to 8.56 pCi/L. The C_4 concentration for Sr-90 of 8 pCi/L is exceeded in MW106S. The Sr-90 distribution in the three aquifers is discussed in the following sections.

Perched Aquifer

As with the third quarter 2004 results, Sr-90 was not analyzed in any of the monitoring wells included in the perched aquifer, except for MW104S located on the eastern edge of the perched aquifer. As discussed in Section 6.1.1.1, the boron concentration in MW104S is more consistent with the distribution observed in the unconfined aquifer. Thus, the

non-detect Sr-90 concentration reported in MW104S most likely does not characterize the perched aquifer.

Unconfined Aquifer

The highest Sr-90 concentrations in the unconfined aquifer are located adjacent to and south of the RCB (Figure 6-18). The highest Sr-90 concentration occurs in MW106S (8.56 pCi/L) with 2.43 pCi/L detected in the CMS located adjacent to the RCB (Figure 6-18). Sr-90 is also detected in MW125 (3.08 pCi/L) located southeast of the RCB. These three monitoring wells with detected Sr-90 form a plume of Sr-90 that flows south from the RCB area towards the Connecticut River (Figures 6-18 and 2-8). All other monitoring wells screened within the unconfined aquifer are non-detect for Sr-90

Confined Aquifer

Sr-90 was detected in only one monitoring well in the unconfined aquifer. The CMS located east and adjacent to the RCB had 2.43 pCi/L (Figure 6-19). All of the other monitoring wells were non-detect for Sr-90.

6.1.3 Distribution of SOCs from the Landfill Area

The distribution of SOCs in the Landfill Area is consistent with no impacts from the industrial portion of the property. The landfill area is upgradient of the industrial area, and both Sr-90 and tritium are non-detect in all landfill area monitoring wells (Figure 6-13). Boron concentrations range from 10.7 µg/L to 57 µg/L (Figure 6-13), consistent with a background distribution. Both the non-detect Sr-90 and tritium concentrations and background boron distribution, indicate that the industrial area has not impacted the landfill area.

6.1.4 Distribution of SOCs from Seep Sampling

A total of six seeps have been sampled from November 2004 through February 2005. These seeps are located in the industrial area in the vicinity of the former PAB building (Figure 2-12). As discussed in Section 2.3, the seeps began flowing in late fall 2004 following the excavation of the soil that exposed bedrock in the PAB area and groundwater pumping that drew down the unconfined water table in that area. A complete set of analyses for the seep water has been performed for four of the seeps, and consistent detections of boron, tritium, and Sr-90 have been reported in the seep samples. The following sections summarize the seep results.

6.1.4.1 Boron

Boron was analyzed in Seeps 1 through 4 in both January and February 2005. The seep results are included in Table 6-1 and boron concentrations have ranged from 117 µg/L to 567 µg/L. The highest boron concentrations have been reported in Seeps 1 and 2 where boron concentrations have ranged from 505 µg/L to 567 µg/L. These two seeps are only several feet apart and most likely are sampling the same groundwater. Lower boron concentrations are observed in both Seep 3 (117 µg/L to 261) and Seep 4 (351 µg/L to 415 µg/L) and these two seeps appear to sample different groundwater relative to Seeps 1 and 2.

6.1.4.2 Tritium

Tritium was analyzed in the four seeps in both January and February 2005, and concentrations ranged from non-detect to 3,250 pCi/L (Table 6-1). Similar to the boron results, the highest tritium concentrations were observed in Seep 1 and 2 (2,660 pCi/L to 3,250 pCi/L). The lowest tritium levels were reported in Seep 3 (non-detect to 1,510 pCi/L), with slightly higher tritium concentrations in Seep 2 (2,370 pCi/L to 2,370 pCi/L). Consistent with the boron results, the lower tritium levels in Seeps 3 and 4 suggest that these seeps are sampling different groundwater than Seeps 1 and 2.

6.1.4.3 Strontium 90

Sr-90 was analyzed in the four seeps in November 2004 and January and February 2005. Consistent with the boron and tritium results, the Sr-90 values in Seeps 1 and 2 were very similar with concentrations ranging from 22.3 pCi/L to 25.6 pCi/L (Table 6-1). Much lower values were detected in Seep 4 with Sr-90 ranging from non-detect to 2.93 pCi/L. The Sr-90 values in Seep 3 varied through time. Initial concentrations measured in November 2004 were low (4.81 pCi/L). Sr-90 in Seep 3 increased to 9.86 pCi/L in January 2005, further increased to 17.2 pCi/L in early-February 2005, and decreased to 4.63 pCi/L in mid-February. The results from Seep 4 are in contrast to the consistent and high Sr-90 values observed in Seeps 1 and 2 and the consistent low Sr-90 levels observed in Seep 4. The Sr-90 seep results also show that Seeps 1 and 2 are sampling groundwater very different from that associated either Seep 3 or 4.

The presence of the SOCs in the seeps, especially the elevated Sr-90 concentrations suggest that a potential source of groundwater contamination is present in the nearby locality of the seeps. The long-term and consistent elevated concentration of Sr-90 in Seeps 1 and 2 further suggest that the source for the seeps may be contaminated soil with sorbed concentrations of Sr-90, boron, and tritium. Additional characterization is underway to address this potential contamination source.

6.1.5 General Geochemistry Across the Site

In addition to the SOC analysis, monitoring wells sampled in the third quarter were also analyzed for major dissolved ions (i.e., calcium, magnesium, sodium, potassium, chloride, sulfate, carbonate, bicarbonate). The analyses were performed on field-filtered samples and results are included in Table 4-9. The analytical results were generated in mass concentration units (i.e., mg/L). To evaluate the analytical results for the dissolved ions, the mass concentrations were converted to equivalent concentrations (i.e., eq/L) by dividing the mass concentrations by the respective ionic equivalent weights. The equivalent concentrations were then plotted using the "radar plot" function in Microsoft Excel™ to create the comparative diagrams shown in Figures 6-20 through 6-24. Radar plots for individual wells are also presented in Appendix F. The major ions were previously analyzed in selected monitoring wells in December 2003. Where multiple rounds of analyses are available for individual wells, both sampling rounds for each well are presented on a single radar plot for the well (Appendix F). Due to similarity in ion distribution patterns, all of the wells located at the HNP landfill area are included in a single plot (Figure 6-20). Selected wells in the HNP industrial area were identified for

comparisons between wells identified as "deep" and "shallow" and upgradient and downgradient.

The wells located at the facility landfill area appear to be consistent in ion distribution and of very low total dissolved ion concentration (Figure 6-20 and Table 4-9). Based on the low total ion concentrations, the consistent distribution of ions, and the general upgradient location of the landfill relative to the industrial area, these wells may be considered to be unimpacted by industrial activities and are likely representative of the "pristine" groundwater condition for site groundwater.

In the 2004 data set, selected wells in the developed portion of the plant site (i.e., MW101S, MW101D, MW100D, MW100S) share a similar ion distribution and magnitude to the landfill wells and also appear to represent a "pristine" groundwater condition (Figure 6-21). The wells that may be considered "pristine" are all located on the inland and up-gradient (relative to groundwater flow) side of the plant (Figures 2-6 and 2-9). Monitoring wells MW111 and MW112 also exhibited ion characteristics similar to the "pristine" wells when sampled in December 2003 (Figure 6-21). These two wells are located adjacent to the river on the downgradient side of the Plant, but are located in the eastern portion of the site and are not downgradient of the industrial area (Figures 2-6 and 2-9).

The remaining wells located down-gradient of the inland wells and directly within or downgradient of the industrial area of the plant typically exhibit generally increased relative concentrations of calcium and chloride, consistent with historical, and continuing, application of road salt for control of ice in road and walk ways (Figure 6-22). Selected wells also exhibit increased relative concentrations of magnesium and sodium, also consistent with application of road salt (Appendix F). Calcium chloride, magnesium chloride and sodium chloride have all been used for ice control at HNP. The apparent impact of salt on groundwater ion concentrations is also greater in the wells identified as "shallow" than in the "deep" wells, as would be expected from surface application of the various salt compounds (Figures 6-23 and 6-24). The observed changes in ion concentration from upgradient to downgradient along with the greater impact of shallow relative to deeper wells indicates that the salting activities within the industrial area at the plant contribute to the ion distribution in groundwater.

Comparison of the 2003 and 2004 data sets indicates substantial seasonal variability in ion concentrations in many wells, while the shape of the shape of the ion distribution displayed in the radar plots was typically similar from the two sampling rounds (Appendix F). These seasonal changes are interpreted to be a function of dilution and varied seasonal application of the salts.

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 September 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 September 1999 through December 2004 are summarized in Table 4-1. Time series plots of the boron concentrations from September 1999 to December 2004 are provided in Appendix G.

The higher boron concentrations have generally been detected in the shallow wells, typically those wells screened in the unconfined aquifer. Boron levels in deep bedrock or confined aquifer 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 unconfined aquifer, ranging as high as 1,145 µg/L as recently as December 2003, to a stable trend of non-detections exhibited in MW100D, a deep bedrock or confined aquifer 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 unconfined aquifer 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 September 1999, through December 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 September 1999. Median results have fluctuated from a low of about 45 µg/L in December 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 unconfined and confined aquifer wells are plotted in Figures 6-25 through 6-26. Higher gross alpha levels were generally detected in the deeper wells completed in bedrock during these sampling events (Figure 6-26). 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 6-27 is a box plot for site-wide gross alpha concentrations as a function of time ranging from December 2001, through December 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 40.8 pC/L since December of 2001. Median results have fluctuated from a low of 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 Trend Analysis

Gross beta results since 1999 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 MW105S. Another beta emitter which contributes to gross beta activity is Cs-137 and has been detected in MW102D, MW103S and MW115S. 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 the unconfined and confined aquifer wells are plotted in Figures 6-28 through 6-29. All 3rd quarter and 4th quarter gross beta results are less than the CT Public Drinking Water Quality Standard screening level of 50 pCi/L.

Figure 6-30 is a box plot for site-wide gross beta concentration as a function of time ranging from December 2001, through December 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.

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 September 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 confined aquifer wells, notably deep bedrock wells MW102D and MW103D, and shallow bedrock well MW110D. MW105S, a well screened in the unconfined aquifer, has historically displayed the highest tritium activity concentrations at the facility. None of these confined aquifer wells detected tritium above the EPA MCL of 20,000 pCi/L during the September and December 2004 sampling events. Time series plots showing tritium activity concentrations from the GWMP quarterly sampling events are shown in Appendix H.

Historically, the highest tritium activity concentration observed at MW102D was 28,630 pCi/L during the June 2003 sample event (see Figure 6-31). Tritium results for MW102D ranged from 5,120 to 6,480 pCi/L, in September and December 2004, respectively, suggesting consistent concentrations at this well over the last 5 sample events. This well is a confined aquifer or deep bedrock well, which has 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 MW103D have consistently ranged from 8,100 pCi/L to 12,900 pCi/L (see Figure 6-32). Analytical results for MW103D ranged from 8,950 pCi/L during the September 2004 event to 10,800 pCi/L during the December 2004 event.

Tritium levels in well MW110D have decreased substantially from the 27,630 pCi/L detected when quarterly monitoring commenced in September 1999. In December 2002, tritium levels decreased to 11,100 pCi/L (see Figure 6-33). Results have ranged from 8,300 pCi/L in September 2004, to 13,600pCi/L, during the December 2004 sampling event.

The highest tritium concentration recorded to date was 138,700 pCi/L at well MW105S during the September 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 sampling events (see Figure 6-34). This well was physically removed from the monitoring network in August 2004 as part of the PAB excavation.

There has been an upward trend in tritium concentrations at MW114S with results ranging from 1,350 to 6,730 pCi/L during the March and June 2004 sampling events (see Figure 6-35). No samples were collected at this location during the third and fourth quarter due to site dewatering activities.

Tritium concentrations from the past 10 sample events for the unconfined and confined aquifer wells are plotted in Figures 6-36 and6-37. With the exception of well MW102D and MW103S, all H-3 results during these sample events were less than the EPA MCL of 20,000, pCi/L.

Figure 6-38 is a box plot for site-wide H-3 concentrations as a function of time ranging from September 1999, through December 2004. Maximum H-3 concentrations have ranged from 13,900 to 31,270 pCi/L since September of 1999. Median results from have fluctuated from a low of about 900 pCi/L to a high of 4430 pCi/L during this same period. There were no apparent seasonal trends in the median results.

6.2.5 Strontium-90 Trend Analysis

Table 4-2 summarizes Sr-90 concentrations from the quarterly sampling events. Historically, monitoring well MW105S has exhibited the highest concentration of Sr-90 (see Figure 6-39). Historically, Sr-90 results in MW105S have consistently exhibited the highest results before this well was removed from service due to PAB excavation activities. Elevated Sr-90 concentrations have also been noted at MW106S (see Figure 6-40). Other wells where Sr-90 concentrations greater than the CRDL of 2 pCi/L included MW103S and MW104S (see Figures 6-41 and 6-42).

Strontium-90 concentrations from the past 10 sample events for unconfined and confined aquifer wells are plotted in Figures 6-43 through 6-44. With the exception of well MW103S, MW105S and MW106S, all Sr-90 results for unconfined aquifer wells were less than the EPA MCL of 8.0 pCi/L. All results for confined or deep bedrock wells were less than the CRDL of 2 pCi/L and no result to date has exceeded this level.

Figure 6-45 presents a box plot for site-wide Sr-90 concentration as a function of time ranging from December 2001, through December 2004. The maximum Sr-90 concentration has ranged from 69.7 to 197 pC/L, at MW105S, 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 MW105S. These maximum values levels tend to coincide with September and December 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 September and December 2004 sampling events. Table 4-2 summarizes Cs-137 analytical results in all wells since December 2001. Prior to the September and December 2004 sampling events, Cs-137 has been consistently identified in groundwater at location MW103S between a minimum of 8.39 pCi/L and a maximum of 87.6 pCi/L (Figure 6-46). MW103S 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, MW115S and MW102D. Cesium-137 has been detected in

MW115S in concentrations ranging from 1.6 to 7.59 pCi/L (Figure 6-47). Cesium-137 concentrations have ranged from 2.0 to 12.7 pCi/L in MW102D (Figure 6-48).

Cesium-137 concentrations from the past 10 sample events for unconfined and confined aquifer wells are plotted in Figures 6-49 through 6-50. With the exception of well MW103S, 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 I.

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 6-51 through 6-52. With the exception of well MW103D, 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 6-53 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 6-54). 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.

6.3.2 Total Uranium vs Gross Alpha Regression Analysis

Figure 6-55 is a correlation plot of the total uranium concentration (ug/L) versus gross alpha concentration (pCi/L) in groundwater. Only sample results with detectable total uranium and gross alpha activity were used in this comparison. A positive correlation coefficient (R) of 0.92 was observed for the data set. The squared correlation term (R^2) suggests that at least 84% of the gross alpha response can be attributed to the total uranium results.

Figure 6-56 is a similar correlation plot of the total uranium concentration (pCi/L) versus gross alpha concentration (pCi/L). Total uranium concentrations were estimated as the product of the total uranium (µg/L) and the specific activity of natural uranium (pCi/µg). Total uranium was assumed to be comprised of a natural mix of U-234, U-235 and U-238, with a U-234/U-238 ratio of 1.03, and a specific activity of 0.698 pCi/µg. The natural uranium radionuclides all decay by alpha emission with radioactive half-lives greater than 2.44×10^5 years. Only sample results with calculated total uranium concentrations greater than the average MDC of 1.7 pCi/L and detectable gross alpha

activity were used in this comparison. Screening for gross alpha activity in the presence of high concentrations of salts and dissolved solids can result in erratic and anomalous results. For this reason, filtered samples with high concentrations of dissolved solids and unfiltered samples, which exhibited high concentrations of suspended solids or turbidity, were removed from this evaluation. A slope near unity of 0.93 and a positive correlation coefficient (R) of 0.93 was observed for the data set (see Figure 6-56). The squared correlation term (R^2) was 0.86. These results suggest that at least 86% of the gross alpha response can be attributed to the total uranium results. These results suggest that gross alpha activity can be used to estimate levels of non-volatile, long-lived alpha emitters such as total uranium in groundwater, provided the necessary precautions for solids and dissolved solids are taken.

6.3.3 K^+ Ion vs Gross Beta Regression Analysis

Figure 6-57 is a correlation plot of the K^+ ion concentration (ug/L) versus gross beta concentration (pCi/L) in groundwater. Only sample results from wells that did not contain Sr-90 or Cs-137 with detectable K^+ ion and gross beta activity were used in this comparison. A positive correlation coefficient (R) of 0.844 was observed for the data set. The squared correlation term (R^2) suggests that at least 71% of the gross beta response, in the absence of Sr-90 and Cs-137, can be attributed to the K^+ ion results.

Figure 6-58 is a similar correlation plot of the K^+ ion as K-40 concentration (pCi/L) versus gross beta concentration (pCi/L). Potassium-40 concentrations were estimated as the product of the K^+ ion (ug/L) and the specific activity of natural potassium (pCi/ug). A natural potassium abundance of 0.0117% K-40 with a specific activity of 0.698 pCi/ug was assumed. Potassium-40 is a relatively energetic beta emitter with a radioactive half-life of 1.277×10^9 years. Only sample results from wells that did not contain Sr-90 or Cs-137, with calculated K-40 concentrations greater than the average gross beta MDC of 3.1 pCi/L and detectable gross beta activity, were used in this comparison. A slope of 1.62 with a positive correlation coefficient (R) of 0.809 was observed (Figure 6-58). The squared correlation term (R^2) was 0.734. These results suggest that in the absence of plant-related radionuclides, such as Sr-90 and Cs-137, at least 73% of the gross beta response can be attributed to the K^+ ion as K-40.

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 both the unconfined and confined 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 wastewaters 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 SOCs 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 localized seeps, continues to exceed drinking water standards. Although the maximum observed Sr-90 concentration currently exceeds the drinking water standard of 8 pCi/L groundwater contamination has declined substantially in the industrial area of the HNP since quarterly sampling began in 1999 (Appendices G through I). Boron will be evaluated as part of the ongoing RCRA CAP and Connecticut Property Transfer Act investigations.

7.2 Contaminant Source Removal Effects

Excavation of soil from the vicinity of the PAB, tank farm, and service alley has effectively removed a substantial portion of the previously identified contaminated soil that served as a secondary source of groundwater contamination. This is evidenced by removal of the entire portion of the unconfined aquifer in the vicinity of the former well MW105S, which historically exhibited the highest Sr-90 concentration on site. Other previously identified soil contamination areas are yet to be removed (e.g., the soil surrounding the spent resin facility, the remainder of soil in the tank farm area, and other areas). In addition, the Sr-90 contamination exhibited by the bedrock seeps in the excavation area suggests the presence of additional secondary sources, most likely related to contaminated backfill soil in the central industrial area.

7.3 Recommendations for Subsequent Sampling Events

Based on the review of the results of the third and fourth quarter 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 first quarter 2005 GWMP quarterly sampling event should be the same as the one implemented for third quarter 2004. Specific recommendations are as follows:

- Collecting paired filtered and unfiltered samples 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 first quarter 2005 quarterly sampling event.
- The "500" series wells located in the parking lot should be sampled and analyzed for the full suite of radionuclides on one occasion to confirm that they are not impacted by plant-related radionulcides.
- Basic geochemistry analysis should be performed on the "500" series wells in the parking lot. This will require collection of field-filtered sample aliquots for analysis of cations and anions.
- Monitoring of the groundwater seeps in the excavation area should be continued.
- Sampling of the landfill wells should be suspended pending completion of soil remediation activities.

Otherwise, the wells sampled should remain the same as previous sampling rounds.

8 References

CY-ISC-SOW-2003	Statement of Work for Environmental, Bioassay and Waste Characterization Analytical Services, Revision 0, August 27, 2003
ERA RAD-49	ERA's RadChem™ Proficiency Testing Study RAD-49, July 2002
ERA RAD-50	ERA's RadChem™ Proficiency Testing Study RAD-50, November 2002
ERA RAD-51	ERA's RadChem™ Proficiency Testing Study RAD-51, January 2003
ERA RAD-52	ERA's RadChem™ Proficiency Testing Study RAD-52, April 2003
ERA RAD-53	ERA's RadChem™ Proficiency Testing Study RAD-53, July 2003
ERA RAD-54	ERA's RadChem™ Proficiency Testing Study RAD-54, October 2003
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ERA RAD-57	ERA's RadChem™ Proficiency Testing Study RAD-57, July 2004
ERA RAD-58	ERA's RadChem™ Proficiency Testing Study RAD-58, October 2004
GEL QAP 2005	GEL Quality Assurance Plan, Revision 18 , February 2005
GMP-QAPP 2004	Groundwater Monitoring Program Quality Assurance Project Plan, Revision 1, 2004
GMR 1999	Groundwater Monitoring Report, Malcolm Pirnie, September 1999
GW WPIR 2004	Groundwater Sample Collection Work Plan and Inspection Record, WP&IR # 24265-000-GEN-SITE-1011-000, May 2004
HIWP 2002	Phase II Hydrogeologic Investigation Work Plan, May 2002
LTP 2002	Haddam Neck Plant - License Termination Plan (LTP), Rev. 2, August 2004
MAPEP-S6	Mixed Analyte Performance Evaluation Program - Soil Sample Participating Laboratory Report, 2/8/2000
MAPEP-S7	Mixed Analyte Performance Evaluation Program – Soil Sample Performance Report, 1/29/2001
MAPEP-S8	Mixed Analyte Performance Evaluation Program – Soil Sample Performance Report, 8/8/2002
MAPEP-S9	Mixed Analyte Performance Evaluation Program – Soil Sample Preliminary Report, 12/5/2002
MAPEP-S10	Mixed Analyte Performance Evaluation Program – Soil Sample Preliminary Report, 12/2003
MAPEP-W7	Mixed Analyte Performance Evaluation Program – Water Sample Performance Report, 7/6/2000
MAPEP-W8	Mixed Analyte Performance Evaluation Program – Water Sample Performance Report, 5/8/2002
MAPEP-W9	Mixed Analyte Performance Evaluation Program – Water Sample Performance Report, 2/11/2003
MAPEP-W10	Mixed Analyte Performance Evaluation Program – Water Sample Performance Report, February 2002

8 References

MAPEP-W11	Mixed Analyte Performance Evaluation Program – Water Sample Performance Report, May 2004
MAPEP-12	Mixed Analyte Performance Evaluation Program Study 12 - Soil, Water and Radiological Filter Sample Performance Report, November 2004
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-0904	Sample Event Plan for September 2004
SEP-1204	Sample Event Plan for December 2004
QAP 52	Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (EML-608), June 2000
QAP 53	Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (EML-611), December 2000
QAP 54	Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (EML-613), June 2001
QAP 55	Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (EML-615), December 2001
QAP 56	Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (EML-617), June 2002
QAP 57	Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (EML-618), December 2002
QAP 58	Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program (EML-621), June 2004
QAP-59	Office of Environmental Management, Quality Assessment Program (QAP 59), December 2003
QAP-60	Office of Environmental Management, Quality Assessment Program (QAP 60), June 2004

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.

9 Definitions

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

CAP	Corrective Action Program
CRDL	Contract required Detection Limit
CSM	Conceptual Site Model
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
RCRA	Resource Conservation and Recovery Act
RESL	Radiological and Environmental Sciences Laboratory
RPD	Relative Percent Difference
RSR	Remediation Standard Regulation
SOC	Substance of Concern
SOP	Standard Operation Procedure
TEDE	Total Effective Dose Equivalent
TPU	Total Propagated Uncertainty
WP&IR	Work Plan and Inspection Record

Table 2-1: Summary of Monitoring Well Information

Well ID	Northing	Easting	TOC Elevation [1]	Top of Screen [2] (ft bgs)	Bottom of Screen [2] (ft bgs)	Hydrostratigraphic Unit	Aquifer	Well Status
AST1	236310.83	668931.59	21.55	10	20	Unconsolidated	unconfined	09/17/2004[3]
AST2	236322.94	668948.16	19.99	5	15	Unconsolidated	unconfined	09/17/2004[3]
AST3	236327.17	668909.46	21.2	5	15	Unconsolidated	unconfined	09/17/2004[3]
AST4	236341.1	668927.83	20.73	5	15	Unconsolidated	unconfined	09/17/2004[3]
EOF Supply-1	NSD	NSD	NSD	780	800	Deep Bedrock	confined	Active
EOF Supply-2	NSD	NSD	NSD	1130	1150	Deep Bedrock	confined	Active
MW-EOF-1	237503.96	667408.75	24.08	6	16	Unconsolidated	unconfined	Active
MW-EOF-2	237513.48	667418.44	24.12	7	17	Unconsolidated	unconfined	Active
MW1	235304.54	670604.26	12.21	28	38	Unconsolidated	unconfined	Active
MW2	235677.79	670527.35	15.99	29	39	Unconsolidated	unconfined	Active
MW3	235488.22	670555.25	10.75	12	22	Unconsolidated	unconfined	Active
MW4	235638.02	670371.6	15.03	26.5	36.5	Unconsolidated	unconfined	Active
MW5	NSD	NSD	NSD	73	93	Unconsolidated	unconfined	07/07/2004[3]
MW6	NSD	NSD	NSD	58	108	Unconsolidated	unconfined	07/07/2004[3]
MW7	NSD	NSD	NSD	38	58	Unconsolidated	unconfined	07/07/2004[3]
MW8	NSD	NSD	NSD	58	88	Unconsolidated	unconfined	07/07/2004[3]
MW9	NSD	NSD	NSD	66	116	Unconsolidated	unconfined	07/06/2004[3]
MW10	NSD	NSD	NSD	48	98	Unconsolidated	unconfined	07/07/2004[3]
MW11	NSD	NSD	NSD	56	66	Unconsolidated	unconfined	07/07/2004[3]
MW12	NSD	NSD	NSD	57	97	Unconsolidated	unconfined	07/06/2004[3]
MW13	235130.81	670766.81	20.04	66	96	Unconsolidated	unconfined	Active
MW14	NSD	NSD	NSD	66	86	Unconsolidated	unconfined	07/08/2004[3]
MW15	NSD	NSD	NSD	31	81	Unconsolidated	unconfined	07/07/2004[3]
MW16D	NSD	NSD	NSD	43	113	Unconsolidated	unconfined	07/07/2004[3]
MW16S	NSD	NSD	NSD	4.5	24.5	Unconsolidated	unconfined	07/07/2004[3]
MW17	NSD	NSD	NSD	37	107	Unconsolidated	unconfined	07/07/2004[3]
MW18	NSD	NSD	NSD	30	60	Unconsolidated	unconfined	07/06/2004[3]
MW100D	236964.21	668415.29	16.45	21	31	Deep Bedrock	confined	Active
MW100S	236959.88	668418.62	16.45	3.5	9	Unconsolidated	unconfined	Active
MW101D	236845.02	668655.36	20.82	39.8	49.8	Deep Bedrock	confined	Active
MW101S	236842.33	668653.7	20.62	8	18	Bedrock	unconfined	Active
MW102D	236651.79	668905.29	20.66	43	53	Deep Bedrock	confined	Active
MW102S	236655.03	668907.67	20.53	12.8	22.5	Bedrock	unconfined	Active
MW103D	236672.34	668730.02	21.05	45	55	Deep Bedrock	confined	Active
MW103S	236671.52	668726.05	20.94	15.5	24.5	Bedrock	unconfined	Active
MW104S	236673.17	668493.3	20.1	13	23	Shallow Bedrock	Perched	Active
MW105D	236534.06	668645.74	20.66	45.5	55.5	Deep Bedrock	confined	08/12/2004[3]
MW105S	236536.03	668642.86	20.66	14.5	24.5	Unconsolidated	unconfined	08/12/2004[4]
MW106D	236464.64	668730.32	20.7	45	55	Deep Bedrock	confined	Active
MW106S	236473.85	668738.1	20.56	14.5	24.5	Shallow Bedrock	unconfined	Active
MW107D	236374.52	668874.54	20.52	90	100	Shallow Bedrock	confined	Active

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

Well ID	Northing	Easting	TOC Elevation [1]	Top of Screen [2] (ft bgs)	Bottom of Screen [2] (ft bgs)	Hydrostratigraphic Unit	Aquifer	Well Status
MW107S	236371.27	668871.82	20.39	15	25	Unconsolidated	unconfined	Active
MW108	236243.62	669142.69	12.15	15	25	Unconsolidated	unconfined	Active
MW109D	236327.48	668450.18	20.54	45	55	Bedrock	confined	Active
MW109S	236329.11	668448.13	20.64	15	25	Unconsolidated	unconfined	Active
MW110D	236083.96	668812.01	22.83	70	80	Bedrock	confined	Active
MW110S	236081.77	668815.38	22.47	15	25	Unconsolidated	unconfined	Active
MW111S	235931.47	668940.43	18.21	15	25	Unconsolidated	unconfined	09/17/2004[3]
MW112S	235797.44	669204.17	14.51	15	25	Unconsolidated	unconfined	Active
MW113S	235773.51	669398.06	13.56	15	25	Unconsolidated	unconfined	Active
MW114S	236615.5	668820.92	20.76	7.5	17.5	Unconsolidated	unconfined	Active
MW115S	236603.1	668837	20.81	7	17	Unconsolidated	unconfined	Active
MW117S	235070.57	671286.68	15.95	15	25	Unconsolidated	unconfined	Active
MW122D	236490.49	668988.55	19.99	184.7	194.7	Deep Bedrock	confined	Active
MW122S	236486.5	668988.86	19.84	9	19	Unconsolidated	unconfined	Active
MW123	236629.95	668473.66	20.19	23.5	33.47	Shallow Bedrock	confined	Active
MW124	236478.85	668448.53	20.81	11	21	Unconsolidated	unconfined	Active
MW125	236324.23	668797.83	20.31	11	22	Unconsolidated	unconfined	Active
MW200	236230.82	673217.72	54.68	8	18	Unconsolidated	unconfined	Active
MW201	235811.2	673214.61	58.74	25	35	Unconsolidated	unconfined	Active
MW202	236176.51	672987.49	51.64	10	20	Unconsolidated	unconfined	Active
MW203	236099.24	672994.67	46.21	8	18	Unconsolidated	unconfined	Active
MW204	235928.48	673033.93	41.88	5	15	Unconsolidated	unconfined	Active
MW205	235826.44	673093.28	40.57	5	15	Unconsolidated	unconfined	Active
MW206	235789.83	673016.63	43.1	5	15	Unconsolidated	unconfined	Active
MW207	236021.6	673148.93	46.99	15	25	Unconsolidated	unconfined	Active
MW208	235742.54	673120.08	50.21	12	32	Unconsolidated	unconfined	Active
MW502	236770.63	668013.02	17.9	20.54	30.22	Unconsolidated	unconfined	Active
MW503	236928.27	667916.8	15.31	25.14	34.83	Unconsolidated	unconfined	Active
MW504	236881.63	668116.16	16.66	18.97	28.67	Unconsolidated	unconfined	Active
MW505	237062.99	668090.6	14.98	16.37	25.07	Deep Bedrock	Perched	Active
MW507D	236799.08	668299.65	18.56	67	77	Deep Bedrock	confined	Active
MW507S	236795.86	668303.57	18.46	10.88	20.88	Unconsolidated	Perched	Active
MW508D	236663.18	668190.54	17.78	81.5	91.5	Shallow Bedrock	confined	Active
MW508S	236666.79	668193.26	17.63	14	24	Unconsolidated	Perched	Active
TPW1	NSD	NSD	9.5	80	100	Unconsolidated	unconfined	Active
TPW2	NSD	NSD	9.5	80	110	Unconsolidated	unconfined	Active
TW1	235020.46	670967.37	17.73	94	112	Unconsolidated	unconfined	Active
TW2	235292.04	670515.44	9.67	101	104	Unconsolidated	unconfined	Active
TW3	235285.23	670802.16	13.02	49	89	Unconsolidated	unconfined	Active
TW4	235087.35	671193.58	10.71	80	120	Unconsolidated	unconfined	Active
Well-A	NSD	NSD	NSD	37	47	Unconsolidated	unconfined	Active
Well-B	NSD	NSD	NSD	45	57	Unconsolidated	unconfined	Active
10-2	NSD	NSD	10.2	58	63	Unconsolidated	unconfined	Active
8-2	NSD	NSD	NSD	40	47	Unconsolidated	unconfined	Active
9-2	NSD	NSD	NSD	50	57	Unconsolidated	unconfined	Active

Notes:

(1) Top of Casing elevations from Kratzert, Jones and Associates, **Bold values are based on Malcolm Pirnie data.**

(2) Screen depths, in feet below ground surface, are based on construction logs.

(3) Well abandoned on this date

(4) Well was converted to DW-105 on this date.

NSD= No Survey data available

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

- Third and Fourth Quarter 2004 -

Event	Date	Comment
Packer testing	July	
Flute removal	July through August	
Deep bedrock borehole hydrophysical testing	July through August	Response to testing observed in confined aquifer monitoring wells MW-106D, MW-107D, MW-109D, MW-110D and MW-122D.
Mat Sump offline	August 11 - 12	
Aquifer test	September 15 - 18	Step draw-down and pumping
Selected transducers changed and downloaded for aquifer test	September 14 - 27	Recording water level at 1 minute, and 1 sec intervals for selected transducers
Mat sump offline	September 19- 22	Offline due to power outage
3rd quarter sampling	September 20 - October 10	
Batteries and elastomers changed, transducers downloaded	November through December	101D replaced and sent back to manufacture for repairs. 106D and 110S sent back to manufacture for repairs
Mat sump offline	November 10 - 12	
Pumping begins in RHR pit	November 18	Response seen in MW-101D, MW-102D, MW-103D and MW-106D
Batteries fail in river transducer	November 21	Premature battery failure due to cold weather. Missing data were approximated using TW-1 as a surrogate.
Transducer download	December	MW-102 S/D, 104, 106 S/D, 110S, 123, 124, and 122 could not be downloaded due to hardware and access problems
4th quarter sampling	December 7 - 16	
Mat sump offline	December 23 - 26	

Table 2-3: Groundwater Elevation Conditions Observed in the Perched Aquifer - Third and Fourth Quarter 2004 -

Well ID	General Water Elevation Conditions	Responsive to Local Precipitation?	Exhibits Tidal Response?	Responsive to Dewatering Activities?
MW508S	Generally steady at approx. 10 ft Mean Sea Level (MSL)	Yes	No	No
MW104S	Varied with general incline from +7 ft MSL to +8 feet MSL	Yes	No	No

Table 2-4: Groundwater Elevation Conditions Observed in the Unconfined Aquifer - Third and Fourth Quarter 2004 -

Well ID	General Water Elevation Conditions	Responsive to Local Precipitation?	Exhibits Tidal Response?	Responsive to Dewatering Activities?
MW100S	General incline from +12 ft MSL to +14 ft MSL	Yes	No	No
MW101S	Variable with general incline from +10 ft MSL to +16 MSL	Yes	No	No
MW102S	Variable with general incline from +5 ft MSL to +10 ft MSL	Yes	No	No
MW103S	Variable with general incline from +3 ft MSL to +6 ft MSL, then a decline to -2 ft MSI at the onset of dewatering	Yes	No	Yes
MW105S	Abandoned on 8/12/04- 3rd Qtr	--	--	--
MW106S	Variable with general decline from +3 ft MSL to +1 ft MSL	Yes	No	Yes
MW107S	Varied with general decline from +7 ft MSL to +4 ft MSL	Yes	Yes	No
MW108	Varied with general incline from +3 ft MSL to +4 ft MSL	Yes	Yes	No
MW109S	Varied with general incline from +2 ft MSL to +4 ft MSL	Yes	Yes	No
MW110S	Varied, but generally steady at approx. +1 ft MSL	Yes	Yes	No
MW113S	Varied with general incline from +2 ft MSL to +4 ft MSL	Yes	Yes	No
MW114S	Dry from dewatering activities	Yes	No	Yes
MW122S	Varied with general decline from +5 ft MSL to +3 ft MSL	Yes	Yes	No
MW124	Varied with general decline from +3 ft MSL to +1 ft MSL	No	Yes	No
MW504S	Varied with general incline from +3 ft MSL to +4.5 ft MSL	Yes	No	No
TW1	Varied, but generally steady at approx. +2.5 ft MSL	Yes	Yes	No
River	Varied, but generally steady at approx. +1 ft MSL	Yes	Yes	No

Table 2-5: Groundwater Elevation Conditions Observed in the Confined Aquifer - Third and Fourth Quarter 2004 -

Well ID	General Water Elevation Conditions	Responsive to Local Precipitation?	Exhibits Tidal Response?	Responsive to Dewatering Activities?
MW101D	Transducer exhibiting data shifts	Yes	No	Yes
MW102D	Variable with general decline from +4 ft MSL to +1 ft MSL	Yes	No	Yes
MW103D	Variable with general decline from +3 ft MSL to -8 ft MSL	Yes	No	Yes
MW105D	abandoned on 8/12/04- 3rd Qtr	--	--	--
MW106D	Variable with general decline from +3 ft MSL to -2.5 ft MSL	Yes	No	Yes
MW107D	Variable with general incline from +3 ft MSL to +4 ft MSL	Yes – also responds to river change	Yes	No
MW109D	Variable, but generally steady at approx +3 ft MSL	Responds to river change	Yes	No
MW110D	Variable with general incline from +1 ft MSL to +2 ft MSL	Responds to river change	Yes	No
MW508D	Variable with general incline from +3 ft MSL to +4 ft ML	Responds to river change	Yes	No
MW122D	Variable with general incline from +2.5 ft MSL to +3.5 ft ML	Yes	Yes	No
MW123	Varied, but generally steady at aprrox. +4.5 ft MSL	Yes	No	insufficient data

Table 2-6: Static Water Levels in Monitoring Wells
- Third and Fourth Quarter 2004 -

Well Name	TOC Elevation	3rd Quarter Groundwater Elevation[1,2] 8/22/04 at 11:15	4th Quarter Groundwater Elevation[1,2] 12/1/04 at 23:55	Aquifer Monitoring Well Screened in (U, C, P)
Industrial Area				
MW101D	20.86	ND	ND	C
MW102D	20.65	2.50	0.29	C
MW103D	21.06	2.01	-5.18	C
MW106D	20.69	2.10	-0.70	C
MW107D	20.54	1.89	1.23	C
MW109D	20.56	3.16	3.22	C
MW110D	22.86	0.75	1.51	C
MW122D	20.00	1.82	2.24	C
MW508D	17.79	3.05	3.26	C
Mat Sump	21.72	-19.87	-18.95	U/C
MW104S	20.11	13.50	11.05	P
MW508S	17.81	10.36	9.80	P
MW100S	16.47	14.32	15.61	U
MW101S	20.66	14.91	15.86	U
MW102S	20.57	6.30	9.91	U
MW103S	20.94	3.18	-1.78	U
MW106S	20.57	5.66	1.45	U
MW107S	20.44	2.74	2.33	U
MW108	12.30	2.45	3.59	U
MW109S	20.65	2.35	3.63	U
MW110S	22.48	1.69	ND	U
MW113S	13.60	2.53	3.95	U
MW114S	20.78	DRY	DRY	U
MW123	20.19	ND	ND	U
MW122S	19.84	2.81	ND	U
MW124	20.82	2.87	ND	U
MW504S	16.67	3.24	4.05	U
RIVER	7.90	-0.27	ND	U

NOTES:

1: Static water level date & time from transducers used to complete groundwater contour intervals

2: The date chosen for the contour maps preceded the groundwater sampling event to ensure that there had not been draw-down in any of the wells.

TOC: Top-of-Casing

ND: No data

U: Unconfined

C: Confined

P: Perched

Table 2-6 Static Water Levels in Monitoring Wells - Third and Fourth Quarter 2004 (continued) –

Well Name	TOC Elevation	3rd Quarter Groundwater Elevation[1,2] 8/22/04 at 11:15	4th Quarter Groundwater Elevation[1,2] 12/1/04 at 23:55	Aquifer Monitoring Well Screened in (U, C, P)
TW-1	17.73	0.42	2.02	U
Mat Sump	21.72	-19.87	-18.95	U/C
Landfill Area				
MW200	54.68	not installed	36.64	U
MW202	51.64	not installed	37.12	U
MW203	46.21	not installed	36.45	U
MW204	41.88	not installed	35.01	U
MW205	40.57	not installed	33.23	U
MW206	43.1	not installed	34.59	U
MW207	46.99	not installed	33.59	U
MW208	50.21	not installed	26.98	U

NOTES:

1: Static water levels from transducers used to complete groundwater contour intervals
2: The date chosen for the contour maps preceded the groundwater sampling event to ensure that there had not been draw-down in any of the wells.
TOC: Top-of-Casing
ND: No data
U: Unconfined
C: Confined
P: Perched

Table 3-1: Summary of Field Parameters for Third Quarter 2004

Well ID	Static Water Level	DTW (ft)	Turbidity (NTU)	DO (mg/L)	Eh (mv)	pH	Specific Conductance (ms/cm)	Temp ©
EOF2	12.28	12.69	2.4	0	158	6.91	0.524	17.1
MW1	12.39	11.71	8.4	0.01	-144	7.12	0.19	13.55
MW2	13.98	13.89	6.3	0.55	2.09	6.49	0.264	13.91
MW3	8.08	9.76	39	4.63	-26	6.55	0.097	13.25
MW100S	2.51	4.83	2.51	0	139	6.64	0.162	16.9
MW100D	2.96	9.75	4.06	0	22	6.36	0.73	13.2
MW101S	5.93	6.07	3	7.85	166	6.94	0.16	19.93
MW101D	17.33	17.55	1.92	8.77	189	7.77	163	14.72
MW102S	16.5	16.7	2	8.44	216	5.96	129	16.24
MW102D	18.22	33.12	6.72	6.07	168	7.53	0.335	17.48
MW103S	17.12	17.17	4	1.66	6	9.8	317	13.77
MW103D	18.72	39.5	4.12	6.5	258	5.86	0.91	16.77
MW104S	9.57	10.11	3.6	9.61	216	6.44	0.356	17.18
MW106S	18.18	18.57	3.9	0.43	94	6.21	3.68	16.78
MW106D	18.07	20.62	3.55	1.66	77	8.66	0.346	17.74
MW107S	17.37	17.6	3.18	0	78	5.77	0.52	17.4
MW107D	17.87	19.28	6.4	1.19	88	6.52	0.16	17.65
MW108S	8.78	8.81	2.06	0	-68	6.27	0.129	16.4
MW109S	17.99	17.98	11.6	3.42	91	6.41	0.737	15.35
MW109D	17	18.48	38	2.88	-10	7.7	0.425	15.7
MW110S	20.38	20.58	4.04	1.95	262	6.18	0.298	14.58
MW110D	20.5	21.08	6.98	0.38	31	7.71	0.291	14.66
MW112S	12.38	12.4	2.9	3.24	282	5.27	0.072	14.11
MW113S	11.29	11.33	2.7	2.16	247	5.75	0.393	16.42
MW117S	11.76	11.95	15	2.34	-88	6.42	0.523	13.24
MW122S	16.72	10.23	3	0	-57	5.87	182	17.03
MW122D	17.73	19.07	7.95	0	-242	9.43	0.135	15.15
MW123	14.55	15.13	4.89	8.28	1.99	6.63	0.893	16.38
MW124	17.71	17.78	3.78	4.96	181	6.71	0.32	14.85
MW125S	17.35	17.52	2.7	0	54	6.63	0.475	20.5
MW502	14.65	14.67	2.51	0	-132	6.58	0.449	14.4
MW503	12.18	12.23	2.3	0	-167	5.99	0.158	13.6
MW504	13.36	13.38	1.9	0	-91	6.39	0.337	20.5
MW505	4.42	4.42	2.02	0	-166	7.2	0.46	14.5
MW507D	13	14.77	7.89	0.82	-62	7.65	0.133	17.41
MW507S	7.7	7.81	16.8	0.46	-93	6.89	0.303	21.68
MW508S	7.32	7.5	32.8	0.76	-30	6.55	0.326	20.21
MW508D	14.13	14.91	10.24	2.73	30	8.06	0.168	17.17

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 Fourth Quarter 2004

Well ID	Static Water Level	DTW (ft)	Turbidity (NTU)	DO (mg/L)	Eh (mv)	pH	Specific Conductance (ms/cm)	Temp ©
ATW1	16.18	16.18	2.28	0	125	5.31	1.52	14.1
CMS			14	5.8	80	5.6	0..81	14.2
EOF2	8.33	8.51	0.75	6.03	154	7	1.61	13.54
MW1	8.55	9.14	3.9	0.28	-113	6.83	0.209	11.57
MW2	13.18	13.36	4.1	0	161	6.43	243	11.91
MW3	8.98	9.3	4.02	0	-2	6.32	0.106	10.71
MW4	11.53	11.69	2.9	0	335	5.71	0.127	11.99
MW100D	1.35	8.52	0.13	0	35	5.89	0.086	12.36
MW100S	1.05	2.38	1.12	4.55	139	6.58	0.272	10.75
MW101D	24.45	24.55	3.3	2	150	8.1	167	11
MW101S	4.88	4.95	2.5	9.7	130	7.1	88	10
MW102D	19.3	19.28	12	4	220	8.1	245	8.3
MW102S	10.09	10.14	2.3	10	140	6.8	124	11
MW103D	23	N/A	16	5.3	290	7.1	336	11
MW103S	10.73	11.19	0.23	10.1	204	6.66	0.270	12.5
MW104S	10.73	11.19	0.23	10.1	204	6.66	0.270	12.5
MW106D	21.42	22.28	2.2	0.6	90	8.8	300	14
MW106S	20.97	22.22	7.8	4.1	160	6.4	2240	15
MW107D	18.69	20.29	2.54	2.29	216	6.14	0.026	9.23
MW107S	17.44	17.59	2.93	0	92	5.56	1.02	15
MW108S	8.15	8.21	2.56	0.12	-39	0.19	0.157	14.23
MW109D	16.85	18.45	2.1	2.32	181	7.25	0.365	8.44
MW109S	16.94	16.98	3.26	0.91	99	5.98	1.13	12.7
MW110D	20.36	20.99	5.04	1.97	126	6.94	0.202	13.9
MW110S	20.19	20.41	1.12	5.16	262	5.91	0.222	13.45
MW112S	12.32	12.44	3.04	4.12	303	5.37	0.067	11.8
MW113S	11.41	11.49	4.99	0.85	278	5.44	0.96	13.33
MW117S	9.67	9.79	1.81	0	0.77	6.33	1.13	12.05
MW122D	18.1	19.22	13	1.1	-40	9.4	72	13
MW122S	17.55	18.1	7.3**	<.01	-50	6.6	726	12
MW123	15.21	15.43	1.4	7.2	180	6.5	652	13
MW124S	16.82	16.82	0.71	0.4	138	6.27	1.02	13.01
MW125S	17.55	17.79	4.01	5.2	1.69	6.47	1.11	8.93
MW200	18.04	18.3	9	7.5	400	4.9	0.069	11.9
MW202	14.52	14.63	<1	5.9	320	5.1	0.064	10.8
MW203	9.76	10.25	2.3	1.11	183	5.8	0.101	11.62
MW204	6.87	7.23	2.23	1.2	165	5.56	0.08	10.73
MW205	7.34	7.87	3.5	3.29	165	5.66	0.079	11.92
MW206	8.51	8.81	3	0	50	5.4	0.097	11.9
MW207	13.4	13.44	0.21	6.15	162	5.89	0.089	10.6

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 Fourth Quarter 2004 (continued)

Well ID	Static Water Level	DTW (ft)	Turbidity (NTU)	DO (mg/L)	Eh (mv)	pH	Specific Conductance (ms/cm)	Temp ©
MW208	23.23	23.5	6	6.4	300	5.16	0.086	10.5
MW502S	13.62	13.67	9	0	-135	6.76	0.92	11.98
MW503	10.92	10.96	3.61	0	-188	5.98	0.163	12.85
MW504	12.4	12.4	0.55	0	-197	6.28	0.92	13.64
MW505	3.66	3.67	1.9	0	-222	6.79	0.479	11.41
MW507D	12.35	14.38	0.8	0	-19	7.19	0.148	13.38
MW507S	6.93	7.09	3.49	0	-195	6.58	0.421	14.56
MW508D	13.57	14.2	2.36	0	-105	8	0.192	14.53
MW508S	6.48	6.79	4.51	0	-132	6.15	1.11	15.09
SWB	N/A	N/A	1.92	9.73	138	5.34	0.165	19.52
EP165	N/A	N/A	2	13	200	6.9	166	N/A
EP166	N/A	N/A	1.1	13	57	7.8	237	N/A
EP171	N/A	N/A	2.2	12	140	7.3	187	N/A

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 3-3: Sample Locations and Analyses Requested (Third Quarter 2004)

Well Number	Location	Boron	Gross α/β	γ-Isotopic	H-3	Sr-90	HTD	Geochem	Total U	Isotopic U
EOF-2	EOF Area	X	X	X	X	X				
MW100D	Industrial Area	X	X	X	X			X	X	X
MW100S	Industrial Area	X	X	X	X			X	X	
MW101D	Industrial Area	X	X	X	X	X		X	X	X
MW101S	Industrial Area	X	X	X	X	X		X	X	
MW102D	Industrial Area	X	X	X	X	X		X	X	X
MW102S	Industrial Area	X	X	X	X	X		X	X	
MW103D	Industrial Area	X	X	X	X	X	X	X	X	X
MW103S	Industrial Area	X	X	X	X	X	X	X	X	X
MW104S	Industrial Area	X	X	X	X	X	X	X	X	
DW105	Industrial Area	X	X	X	X	X	X	X	X	
MW106D	Industrial Area	X	X	X	X	X	X	X	X	X
MW106S	Industrial Area	X	X	X	X	X	X	X	X	
MW107D	Industrial Area	X	X	X	X	X		X	X	
MW107S	Industrial Area	X	X	X	X	X		X	X	
MW108S	Industrial Area	X	X	X	X	X		X	X	
MW109D	Industrial Area	X	X	X	X	X		X	X	X
MW109S	Industrial Area	X	X	X	X	X		X	X	
MW110D	Industrial Area	X	X	X	X	X		X	X	X
MW110S	Industrial Area	X	X	X	X	X		X	X	
MW112S	Peninsula	X	X	X	X	X				
MW113S	Peninsula	X	X	X	X	X				
MW114S	Industrial Area	X	X	X	X	X				
MW115S	Industrial Area	X	X	X	X	X				
MW117S	Peninsula	X	X	X	X	X				

Notes:

HTD: C-14, Fe-55, Ni-63, Tc-99, Pu α (Pu-238, Pu-239,240), Pu-241 Am/Cm α (Am-241, Cm-242, Cm-243,244)
γ-Isotopic: Mn-54, Co-60, Nb-94, Ag-108m, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, Am-241
Geochem: Anions (CaO_3^{-z}, HCO_3^-, SO_4^{-z}, Cl^-), Cations (Ca^{+z}, Mg^{+z}, Na^+, K^+)
Isotopic U: U-234, U-235, U-238, U-235/Total U ratio

Table 3-3: Sample Locations and Analyses Requested (Third Quarter 2004)
- continued -

Well Number	Location	Boron	Gross α/β	γ-Isotopic	H-3	Sr-90	HTD	Geochem	Total U	Isotopic U
MW122D	Industrial Area	X	X	X	X	X		X	X	
MW122S	Industrial Area	X	X	X	X	X		X	X	
MW600 (MW122S dup)	Industrial Area	X	X	X	X	X		X	X	
MW123S	Industrial Area	X	X	X	X	X				
MW124S	Industrial Area	X	X	X	X	X				
MW125S	Industrial Area	X	X	X	X	X				
MW502	Parking Lot	X	X	X	X					
MW503	Parking Lot	X	X	X	X					
MW504	Parking Lot	X	X	X	X					
MW505	Parking Lot	X	X	X	X					
MW507D	Parking Lot	X	X	X	X					
MW507S	Parking Lot	X	X	X	X					
MW508D	Parking Lot	X	X	X	X					
MW508S	Parking Lot	X	X	X	X					
MW601 (RB)	Industrial Area	X	X	X	X	X				
MW1	Peninsula	X	X	X	X					
MW2	Peninsula	X	X	X	X					
MW3	Peninsula	X	X	X	X					

Notes:

HTD: C-14, Fe-55, Ni-63, Tc-99, Pu α (Pu-238, Pu-239,240), Pu-241 Am/Cm α (Am-241, Cm-242, Cm-243,244)
γ-Isotopic: Mn-54, Co-60, Nb-94, Ag-108m, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, Am-241
Geochem: Anions (CaO_3^{-z}, HCO_3^-, SO_4^{-z}, Cl^-), Cations (Ca^{+z}, Mg^{+z}, Na^+, K^+)
Isotopic U: U-234, U-235, U-238, U-235/Total U ratio

Table 3-4: Sample Locations and Analyses Requested (Fourth Quarter 2004)

Well Number:	Location	Boron	Gross A/B	Gamma Isotopic	H-3	Sr-90	HTD	Geochem	Total U	Isotopic U
ATW1	Industrial Area	X	X	X	X	X	X		X	
CMS1	Industrial Area	X	X	X	X	X	X		X	
EP165	Industrial Area	X	X	X	X	X	X		X	
EP166	Industrial Area	X	X	X	X	X	X		X	
EP171	Industrial Area	X	X	X	X	X	X		X	
DW1	Industrial Area	X	X	X	X	X	X		X	
DW3	Industrial Area	X	X	X	X	X	X		X	
DW4	Industrial Area	X	X	X	X	X	X		X	
DW5	Industrial Area	X	X	X	X	X	X		X	
EOF2	Industrial Area	X	X	X	X	X				
MW1	Peninsula	X	X	X	X	X				
MW2	Peninsula	X	X	X	X	X				
MW3	Peninsula	X	X	X	X	X				
MW4	Peninsula	X	X	X	X	X				
MW100D	Industrial Area	X	X	X	X				X	
MW100S	Industrial Area	X	X	X	X				X	
MW101D	Industrial Area	X	X	X	X	X			X	
MW101S	Industrial Area	X	X	X	X	X			X	
MW102D	Industrial Area	X	X	X	X	X			X	
MW102S	Industrial Area	X	X	X	X	X			X	
MW103D	Industrial Area	X	X	X	X	X	X		X	
MW103S	Industrial Area	X	X	X	X	X	X		X	
MW600 (MW103S)	Industrial Area	X	X	X	X	X	X		X	
MW104S	Industrial Area	X	X	X	X	X	X		X	

Notes:

HTD: C-14, Fe-55, Ni-63, Tc-99, Pu α (Pu-238, Pu-239,240), Pu-241 Am/Cm α (Am-241, Cm-242, Cm-243,244)
γ-Isotopic: Mn-54, Co-60, Nb-94, Ag-108m, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, Am-241
Geochem: Anions (CaO_3^{-z}, HCO_3^-, SO_4^{-z}, Cl^-), Cations (Ca^{+z}, Mg^{+z}, Na^+, K^+)
Isotopic U: U-234, U-235, U-238, U-235/Total U ratio

Table 3-4: Sample Locations and Analyses Requested (Fourth Quarter 2004)
- continued -

Well Number:	Location	Boron	Gross A/B	Gamma Isotopic	H-3	Sr-90	HTD	Geochem	Total U	Isotopic U
MW106D	Industrial Area	X	X	X	X	X	X		X	
MW106S	Industrial Area	X	X	X	X	X	X		X	
MW107D	Industrial Area	X	X	X	X	X			X	
MW107S	Industrial Area	X	X	X	X	X			X	
MW108S	Industrial Area	X	X	X	X	X			X	
MW109D	Industrial Area	X	X	X	X	X			X	
MW109S	Industrial Area	X	X	X	X	X			X	
MW110D	Industrial Area	X	X	X	X	X			X	
MW110S	Industrial Area	X	X	X	X	X			X	
MW112S	Peninsula	X	X	X	X	X				
MW113S	Peninsula	X	X	X	X	X				
MW114S	Industrial Area	X	X	X	X	X			X	
MW115S	Industrial Area	X	X	X	X	X			X	
MW117S	Peninsula	X	X	X	X	X				
MW122D	Industrial Area	X	X	X	X	X			X	
MW122S	Industrial Area	X	X	X	X	X			X	
MW123S	Industrial Area	X	X	X	X	X				
MW124S	Industrial Area	X	X	X	X	X				
MW125S	Industrial Area	X	X	X	X	X				
MW200	Landfill Area	X	X	X	X	X	X		X	
MW201	Landfill Area	X	X	X	X	X	X		X	
MW202	Landfill Area	X	X	X	X	X	X		X	
MW203	Landfill Area	X	X	X	X	X	X		X	
MW204	Landfill Area	X	X	X	X	X	X		X	
MW205	Landfill Area	X	X	X	X	X	X		X	
MW206	Landfill Area	X	X	X	X	X	X		X	
MW207	Landfill Area	X	X	X	X	X	X		X	
MW208	Landfill Area	X	X	X	X	X	X		X	

Notes:

HTD: C-14, Fe-55, Ni-63, Tc-99, Pu α (Pu-238, Pu-239,240), Pu-241 Am/Cm α (Am-241, Cm-242, Cm-243,244)
γ-Isotopic: Mn-54, Co-60, Nb-94, Ag-108m, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, Am-241
Geochem: Anions (CaO_3^{-z}, HCO_3^-, SO_4^{-z}, Cl^-), Cations (Ca^{+z}, Mg^{+z}, Na^+, K^+)
Isotopic U: U-234, U-235, U-238, U-235/Total U ratio

Table 3-4: Sample Locations and Analyses Requested (Fourth Quarter 2004)
- continued -

Well Number:	Location	Boron	Gross A/B	Gamma Isotopic	H-3	Sr-90	HTD	Geochem	Total U	Isotopic U
MW502	Parking Lot	X	X	X	X					
MW503	Parking Lot	X	X	X	X					
MW504	Parking Lot	X	X	X	X					
MW505	Parking Lot	X	X	X	X					
MW507D	Parking Lot	X	X	X	X					
MW507S	Parking Lot	X	X	X	X					
MW508D	Parking Lot	X	X	X	X					
MW508S	Parking Lot	X	X	X	X	X				
MW601 (RB)	Industrial Area	X	X	X	X	X				
SWA	Peninsula	X	X	X	X	X				
SWB	Peninsula	X	X	X	X	X				

Notes:

HTD: C-14, Fe-55, Ni-63, Tc-99, Pu α (Pu-238, Pu-239,240), Pu-241 Am/Cm α (Am-241, Cm-242, Cm-243,244)
γ-Isotopic: Mn-54, Co-60, Nb-94, Ag-108m, Cs-134, Cs-137, Eu-152, Eu-154, Eu-155, Am-241
Geochem: Anions (CaO_3^{-z}, HCO_3^-, SO_4^{-z}, Cl^-), Cations (Ca^{+z}, Mg^{+z}, Na^+, K^+)
Isotopic U: U-234, U-235, U-238, U-235/Total U ratio

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

Well ID	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	Sep-04	Dec-04
100D	10.8	<200	<50	68	<250	<50	<50	<27	<10	<27	6.3	19.9	10.4	25.4	13.7
100S	NS	<200	<50	710	<250	188	84.9	123	1,145	428	140	212	25.3	151	143
101D	38.1	25.4	<50	<50	<250	NS	<50	83.5	47	42.3	30	49.4	54	55.7	56.4
101S	53.8	34.4	77	<50	<250	NS	<50	NS	43	235	47	49	68.6	144	24.9
102D	87.5	80. 1	290	96.4	<250	NS	428	64.2	392	110	98	113	97.1	124	135
102S	63 .4	80.8	220	64.3	<250	NS	<50	49	19	117	49	60.8	91.2	174	47
103D	63.6	57.9	88	165	<250	NS	69.5	105	76	58	48	90.9	57.1	70.3	57.4
103S	150.0	111	260	55.4	<250	NS	118	96.2	92	184	33	85.7	165	324	NS
104S	NS	54.2	82	74	70.2	81.8	75.6	76.4	110	143	200	299	274	268	172
105D	51. 7	34.7	64	<50	<250	NS	58.5	60.4	41	67.1	59	67.5	60.8	NS	NS
105S	2,940	1,760	2,400	1,340	<250	NS	945	915	618	1,200	540	735	484	NS	NS
106D	52.2	40.4	<50	<50	<250	NS	69.4	51.3	51	51.7	59	74.3	64.7	85.7	124
106S	NS	960	720	468	<250	NS	222	348	239	786	530	670	490	581	802
107D	30.9	18.4	<50	<50	<250	<50	<50	<27	173	<30	21	38	32.1	32.5	16.7
107S	91. 0	169	180	160	<250	<50	102	105	66	278	120	192	177	99.7	189
108S	NS	82.9	120	100	<250	NS	NS	NS	NS	NS	NS	NS	68.3	161	180
109D	401.0	157	200	150	<250	NS	59.4	183	26	NS	NS	210	191	184	176
109S	107.0	112	170	54	<250	510	179	76.8	126	203	190	254	124	130	98.6
110D	234.0	289	320	250	<250	265	203	93.3	127	334	170	179	236	408	102
110S	131.0	90.7	81	100	<250	97.3	179	320	162	206	180	238	291	284	281
111S	60.9	45.8	<50	52	<250	NS	61.5	37.2	52	58.1	NS	NS	55.5	NS	NS
112S	NS	23.9	61	<50	<50	NS	NS	NS	NS	NS	NS	NS	47.8	77.1	74.5
113S	NS	136	180	100	89.8	NS	NS	NS	NS	NS	NS	NS	110	130	106
114S	265.0	240	NS	134	201	NS	127	NS	90	203	140	173	1260	NS	NS
115S	94.2	80.7	NS	175	149	NS	178	90.4	78	NS	100	195	NS	NS	NS
117S	NS	17.8	57	75	59.7	NS	NS	NS	NS	NS	NS	NS	68.5	71.8	78.7
122D	NI	NI	NI	NI	NI	NI	NI	178	179	178	180	224	223	264	92.2

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	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	Sep-04	Dec-04
122S	NI	NI	NI	NI	NI	NI	NI	237	219	178	330	317	307	220	184
123S	NI	NI	NI	NI	NI	NI	NI	64.6	46	67.8	88	107	90.8	134	113
124S	NI	NI	NI	NI	NI	NI	NI	351	299	312	300	228	225	244	258
125S	NI	NI	NI	NI	NI	NI	NI	426	365	489	360	390	445	531	308
AST1	36.0	17.1	<50	<50	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MAT SUMP	177.0	NS	NS	NS	128	NS	NS	NS	NS	NS	NS	NS	NS	NS	111
EOF 2	NS	46.2	65	70	72.3	NS	NS	NS	NS	NS	NS	NS	63.4	65.5	85.6
TW1	NS	<200	<50	<50	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW13	NS	13.1	<50	<50	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.08	5.2	8.85
MW2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	15.5	18	19.5
MW3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	5.67	7.95	6.9
MW502	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	65.2	63.1	73.1
MW503	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	10.7	11.8	13.1
MW504	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	42.7	49.6	50.6
MW505	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	54.4	59.9	80
MW507D	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	36.7	35.4	34.4
MW507S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	52.8	58.8	57.1
MW508D	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	66.1	59.1	58.9
MW508S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	41.9	64.1	61.5

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 Alpha	Gross Beta	Sr-90	Cs-137
MW100D	2002 Q1	-	-	-	< 5.01
MW100D	2002 Q2	-	-	-	< 2.89
MW100D	2002 Q3	< 0.83	3.59	-	< 3.22
MW100D	2002 Q4	< 0.875	2.37	-	< 3.46
MW100D	2003 Q1	< 0.672	3.02	-	< 4.09
MW100D	2003 Q2	2.00	6.60	-	< 5.9
MW100D	2003 Q3	< 0.916	< 2.68	-	< 4.22
MW100D	2003 Q4	0.78	2.58	-	< 7.76
MW100D	2004 Q1	< 0.952	1.31	-	< 3.59
MW100D	2004 Q2	2.38	< 2.29	-	< 4.32
MW100D	2004 Q3	13.90	13.60	-	< 2.01
MW100D	2004 Q4	< 1.32	2.70	-	< 5.79
MW100S	2002 Q1	-	-	-	3.21
MW100S	2002 Q2	-	-	-	< 2.18
MW100S	2002 Q3	0.60	5.72	-	< 3.59
MW100S	2002 Q4	< 4.02	19.30	-	< 3.18
MW100S	2003 Q1	< 1.24	8.73	-	< 4.65
MW100S	2003 Q2	< 1.8	4.76	-	< 6.5
MW100S	2003 Q3	< 0.914	4.00	-	< 4.18
MW100S	2003 Q4	< 1.41	6.52	-	< 7.48
MW100S	2004 Q1	< 2.8	4.23	-	< 3.13
MW100S	2004 Q2	< 2.27	1.51	-	< 2.21
MW100S	2004 Q3	< 1.24	2.46	-	< 2.19
MW100S	2004 Q4	< 1.73	1.37	-	< 4.75
MW101D	2002 Q1	-	-	-	< 2.92
MW101D	2002 Q2	-	-	-	< 3.12
MW101D	2002 Q3	5.84	6.18	< 0.583	< 3.52
MW101D	2002 Q4	4.80	5.84	-	< 3.11
MW101D	2003 Q1	5.34	6.65	-	< 6.21
MW101D	2003 Q2	5.09	9.12	-	< 8.7
MW101D	2003 Q3	6.41	5.81	-	< 3.82
MW101D	2003 Q4	6.02	4.95	-	< 8.19
MW101D	2004 Q1	6.52	1.70	< 1.16	< 7.09
MW101D	2004 Q2	8.50	6.18	< 1.23	< 3.52
MW101D	2004 Q3	11.20	5.85	0.52	< 4.02
MW101D	2004 Q4	5.17	< 2.02	< 0.937	< 5.02
MW101S	2002 Q1	-	-	-	< 2.78
MW101S	2002 Q2	-	-	-	1.64
MW101S	2002 Q3	0.91	5.74	0.55	< 3.15
MW101S	2002 Q4	< 0.643	2.45	-	< 3.09
MW101S	2003 Q1	< 0.769	2.82	0.38	< 4.06

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was not statistically significant at 2-σ error level, reported as <MDC

Bold 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 Alpha	Gross Beta	Sr-90	Cs-137
MW101S	2003 Q2	< 2.1	3.32	< 1.7	< 8.3
MW101S	2003 Q3	0.85	4.86	0.33	< 4.78
MW101S	2003 Q4	0.79	7.55	0.47	< 9.3
MW101S	2004 Q1	< 0.977	1.87	< 1.2	< 4.31
MW101S	2004 Q2	1.59	3.27	< 1.2	< 3.59
MW101S	2004 Q3	1.38	4.32	< 0.938	< 4.76
MW101S	2004 Q4	< 1.31	3.05	< 0.98	< 5.36
MW102D	2002 Q1	9.74	7.42	< 0.664	< 2.41
MW102D	2002 Q2	5.53	6.97	< 0.721	1.98
MW102D	2002 Q3	8.93	8.69	< 0.636	6.14
MW102D	2002 Q4	5.55	**50.1**	< 0.85	6.69
MW102D	2003 Q1	3.57	15.60	< 0.578	12.70
MW102D	2003 Q2	8.60	**58.1**	< 1.6	< 6.1
MW102D	2003 Q3	-	-	-	-
MW102D	2003 Q4	11.10	11.10	< 1.25	< 8.71
MW102D	2004 Q1	11.30	6.89	< 1.11	< 3.92
MW102D	2004 Q2	8.51	9.95	0.93	< 3.43
MW102D	2004 Q3	7.38	5.64	< 0.805	< 3.58
MW102D	2004 Q4	10.40	8.60	< 0.636	< 5.14
MW102S	2002 Q1	1.05	6.15	< 0.716	< 3.05
MW102S	2002 Q2	1.48	4.52	< 0.716	< 3.01
MW102S	2002 Q3	1.01	5.16	< 0.52	< 2.98
MW102S	2002 Q4	0.76	3.05	< 0.644	< 3.4
MW102S	2003 Q1	< 0.84	4.68	0.38	< 4.85
MW102S	2003 Q2	1.52	4.70	1.08	< 10
MW102S	2003 Q3	0.94	5.73	0.55	< 4.61
MW102S	2003 Q4	< 1.28	4.95	< 1.26	< 7.25
MW102S	2004 Q1	< 1.5	2.28	< 1.2	< 3.67
MW102S	2004 Q2	1.66	2.05	< 1.2	< 5.06
MW102S	2004 Q3	1.24	6.51	< 1.3	27.20
MW102S	2004 Q4	< 1.65	2.43	< 1.13	< 2.19
MW103D	2002 Q1	3.07	3.38	< 0.603	< 2.78
MW103D	2002 Q2	6.87	7.39	< 0.691	< 2.19
MW103D	2002 Q3	8.63	12.90	< 0.63	< 3.64
MW103D	2002 Q4	4.64	5.42	< 0.593	< 3.3
MW103D	2003 Q1	4.11	5.68	< 1.78	< 3.58
MW103D	2003 Q2	< 2.6	4.85	< 1.9	< 7.3
MW103D	2003 Q3	-	-	-	-
MW103D	2003 Q4	4.40	6.70	0.37	< 7.7
MW103D	2004 Q1	5.19	6.06	< 0.815	< 2.7
MW103D	2004 Q2	2.72	3.36	1.26	< 2.23
MW103D	2004 Q3	4.37	1.82	< 0.895	< 2.9

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was not statistically significant at 2-σ error level, reported as <MDC

Bold 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 Alpha	Gross Beta	Sr-90	Cs-137
MW103D	2004 Q4	5.97	5.14	< 1.0	< 3.6
MW103S	2002 Q1	1.85	37.6	5.23	30.20
MW103S	2002 Q2	1.64	**81.5**	**15.3**	58.50
MW103S	2002 Q3	1.57	46.0	3.81	38.10
MW103S	2002 Q4	0.68	40.6	5.57	38.00
MW103S	2003 Q1	4.33	**76.9**	6.75	87.60
MW103S	2003 Q2	< 0	42.2	1.13	26.60
MW103S	2003 Q3	1.25	41.8	2.59	38.10
MW103S	2003 Q4	1.05	13.5	< 0.615	13.50
MW103S	2004 Q1	1.53	27.8	2.27	22.40
MW103S	2004 Q2	2.33	23.5	1.34	7.50
MW103S	2004 Q3	**17.5**	47.6	3.67	2.62
MW104S	2002 Q1	-	-	-	< 5.23
MW104S	2002 Q2	-	-	-	< 2.2
MW104S	2002 Q3	2.85	14.8	-	< 3.35
MW104S	2002 Q4	1.01	6.90	-	< 3.09
MW104S	2003 Q1	0.73	7.56	-	< 5.23
MW104S	2003 Q2	6.10	42.87	3.14	< 8.5
MW104S	2003 Q3	3.86	18.00	2.02	< 4.29
MW104S	2003 Q4	1.52	9.06	0.86	< 8.76
MW104S	2004 Q1	1.25	4.11	< 0.685	< 2.09
MW104S	2004 Q2	2.49	6.23	< 1.35	< 2.26
MW104S	2004 Q3	1.06	4.76	< 0.962	< 4.19
MW104S	2004 Q4	< 2.14	5.59	< 0.862	< 3.39
MW105D	2002 Q1	1.47	4.72	< 0.571	< 2.67
MW105D	2002 Q2	1.39	2.33	< 0.597	< 2.26
MW105D	2002 Q3	3.06	6.69	< 0.738	< 3.17
MW105D	2002 Q4	2.15	5.72	< 0.596	< 3.12
MW105D	2003 Q1	2.43	4.46	0.66	< 4.17
MW105D	2003 Q2	3.59	9.01	< 1.5	< 7.9
MW105D	2003 Q3	6.70	6.62	< 0.427	< 3.47
MW105D	2003 Q4	5.08	5.78	1.33	< 10.10
MW105D	2004 Q1	2.59	3.56	< 0.811	< 2.48
MW105D	2004 Q2	5.30	5.67	1.11	< 2.33
MW105S	2002 Q1	1.11	**242.**	**122.**	< 2.48
MW105S	2002 Q2	< 1.34	**238.**	**116.**	< 2.55
MW105S	2002 Q3	< 1.17	**180.**	**101.**	< 3.29
MW105S	2002 Q4	< 0.872	**159.**	**83.3**	< 3.37
MW105S	2003 Q1	< 1.04	**253.**	**138.**	< 4.23
MW105S	2003 Q2	< 3.2	**490.**	**181.6**	< 4.7
MW105S	2003 Q3	< 1.69	45.50	**197.**	< 3.64
MW105S	2003 Q4	0.79	**297.**	**27.6**	< 8.14

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was not statistically significant at 2-σ error level, reported as <MDC

Bold 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 Alpha	Gross Beta	Sr-90	Cs-137
MW105S	2004 Q1	< 1.2	**192.**	**91.8**	< 1.86
MW105S	2004 Q2	< 2.01	44.30	**16.2**	< 2.03
MW106D	2002 Q1	1.03	5.89	< 0.597	< 3.18
MW106D	2002 Q2	1.13	6.01	< 0.527	1.92
MW106D	2002 Q3	1.16	8.31	< 0.546	< 2.4
MW106D	2002 Q4	1.43	4.27	< 0.624	< 2.4
MW106D	2003 Q1	1.19	7.40	0.36	< 3.97
MW106D	2003 Q2	3.02	10.94	< 1.5	< 10
MW106D	2003 Q3	2.45	10.30	0.80	< 4.25
MW106D	2003 Q4	4.76	7.73	0.50	< 6.9
MW106D	2004 Q1	2.75	4.12	< 1.17	< 2.24
MW106D	2004 Q2	1.16	3.23	< 1.2	< 2.11
MW106D	2004 Q3	4.62	6.41	< 0.991	< 3.82
MW106D	2004 Q4	14.00	14.70	< 0.524	< 3.66
MW106S	2002 Q1	1.36	25.40	**8.38**	< 2.05
MW106S	2002 Q2	< 1.24	34.00	**13.0**	< 2.28
MW106S	2002 Q3	< 1.49	11.20	2.26	2.76
MW106S	2002 Q4	< 1.26	23.20	**9.35**	< 2.55
MW106S	2003 Q1	1.01	36.10	**13.5**	< 4.54
MW106S	2003 Q2	< 3.1	**54.6**	**18.68**	< 8.5
MW106S	2003 Q3	< 5.33	**801.**	3.71	< 4.77
MW106S	2003 Q4	2.25	19.70	4.35	< 9.28
MW106S	2004 Q1	1.54	13.90	1.21	< 1.98
MW106S	2004 Q2	2.73	19.50	3.17	< 2.61
MW106S	2004 Q3	3.86	36.00	7.30	< 3.66
MW106S	2004 Q4	< 3.57	39.30	**8.56**	< 4.08
MW107D	2002 Q1	1.98	5.38	< 0.628	< 3.11
MW107D	2002 Q2	1.30	3.87	< 0.6	< 2.65
MW107D	2002 Q3	0.81	5.30	< 0.557	< 2.64
MW107D	2002 Q4	1.10	3.97	< 0.572	< 2.75
MW107D	2003 Q1	1.16	4.02	-	< 3.87
MW107D	2003 Q2	< 0	4.40	< 1.7	< 5.4
MW107D	2003 Q3	< 2.56	3.72	0.33	< 4.25
MW107D	2003 Q4	0.92	3.01	< 0.669	< 9.04
MW107D	2004 Q1	1.33	5.79	< 1.23	< 4.4
MW107D	2004 Q2	< 2.53	7.00	< 1.2	< 3.61
MW107D	2004 Q3	< 1.58	5.68	< 0.708	< 5.6
MW107D	2004 Q4	< 1.43	< 2.18	< 0.639	< 3.33
MW107S	2002 Q1	-	-	-	< 4.37
MW107S	2002 Q2	< 0.944	4.61	0.26	< 2.42
MW107S	2002 Q3	< 1.14	5.11	< 0.593	< 3.43
MW107S	2002 Q4	< 0.822	2.77	0.44	< 2.65

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was not statistically significant at 2-σ error level, reported as <MDC
Bold 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 Alpha	Gross Beta	Sr-90	Cs-137
MW107S	2003 Q1	0.63	3.49	0.54	< 3.29
MW107S	2003 Q2	< 2.7	4.20	< 1.9	< 7.6
MW107S	2003 Q3	< 0.923	4.40	0.36	< 5.18
MW107S	2003 Q4	< 1.29	1.73	0.54	< 9.23
MW107S	2004 Q1	< 1.28	1.55	< 1.37	< 3.52
MW107S	2004 Q2	< 2.66	1.69	2.69	< 3.39
MW107S	2004 Q3	2.39	8.01	< 0.988	< 3.21
MW107S	2004 Q4	1.21	5.62	0.84	< 12.40
MW108S	2002 Q1	-	-	-	< 4.16
MW108S	2002 Q2	-	-	-	< 2.25
MW108S	2002 Q3	1.16	9.36	-	< 3.25
MW108S	2002 Q4	0.55	2.51	-	< 2.31
MW108S	2003 Q1	0.46	2.16	-	< 4.8
MW108S	2003 Q2	< 2.5	4.00	-	< 4.3
MW108S	2003 Q3	0.82	2.51	-	< 4.61
MW108S	2003 Q4	1.45	2.79	0.63	< 9.08
MW108S	2004 Q1	< 1.11	2.63	< 0.887	< 3.6
MW108S	2004 Q2	3.90	5.72	< 1.4	< 3.43
MW108S	2004 Q3	0.83	4.12	0.46	< 3.1
MW108S	2004 Q4	< 1.62	3.46	< 0.812	6.61
MW109D	2002 Q1	3.70	7.47	< 0.666	< 2.6
MW109D	2002 Q2	4.62	5.54	< 0.495	< 2.52
MW109D	2002 Q3	3.72	6.20	< 0.568	< 2.13
MW109D	2002 Q4	< 0.834	1.82	< 0.646	< 3.13
MW109D	2003 Q1	6.52	11.90	-	2.40
MW109D	2003 Q2	9.00	11.49	< 1.9	< 8.2
MW109D	2003 Q3	0.91	5.57	< 0.39	< 4.34
MW109D	2003 Q4	-	-	< 0.497	-
MW109D	2004 Q1	6.95	7.60	< 1.01	< 2.02
MW109D	2004 Q2	7.78	9.21	< 1.16	< 8.77
MW109D	2004 Q3	6.18	4.19	< 0.732	< 4.66
MW109D	2004 Q4	5.08	6.38	< 0.609	< 3.14
MW109S	2002 Q1	< 1.54	6.33	0.90	< 2.88
MW109S	2002 Q2	< 1.23	8.49	0.66	< 2.76
MW109S	2002 Q3	< 1.79	12.80	0.97	< 3.25
MW109S	2002 Q4	1.25	10.10	0.90	< 3.47
MW109S	2003 Q1	< 1.5	7.85	0.98	< 3.8
MW109S	2003 Q2	< 2.9	11.20	< 1.7	< 6.1
MW109S	2003 Q3	< 2.61	11.50	0.69	1.87
MW109S	2003 Q4	< 2.03	10.80	1.01	< 9.7
MW109S	2004 Q1	< 1.37	9.63	< 1.11	< 3.36
MW109S	2004 Q2	< 2.32	6.53	0.80	< 2.08

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was not statistically significant at 2-σ error level, reported as <MDC
Bold 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 Alpha	Gross Beta	Sr-90	Cs-137
MW109S	2004 Q3	< 2.01	9.04	0.38	< 7.89
MW109S	2004 Q4	< 1.35	< 2.31	< 1.3	4.03
MW110D	2002 Q1	11.00	12.60	< 0.562	< 2.84
MW110D	2002 Q2	7.78	9.14	< 0.52	< 2.48
MW110D	2002 Q3	7.73	11.20	2.54	< 2.17
MW110D	2002 Q4	8.25	8.83	< 0.696	< 3.26
MW110D	2003 Q1	6.04	9.95	< 0.551	< 5.04
MW110D	2003 Q2	6.10	12.00	< 1.7	< 7.5
MW110D	2003 Q3	5.82	20.50	0.36	< 3.96
MW110D	2003 Q4	8.15	11.50	0.45	< 8.19
MW110D	2004 Q1	7.07	7.14	0.66	< 3.34
MW110D	2004 Q2	5.63	8.50	< 1.15	< 1.94
MW110D	2004 Q3	6.99	8.48	< 0.751	< 5.55
MW110D	2004 Q4	3.46	6.34	< 1.15	< 4.97
MW110S	2002 Q1	< 0.965	4.07	0.34	< 3.05
MW110S	2002 Q2	< 0.952	6.51	< 0.545	< 2.57
MW110S	2002 Q3	< 0.813	4.39	< 0.683	< 2.72
MW110S	2002 Q4	< 0.863	4.28	< 0.528	< 2.31
MW110S	2003 Q1	< 0.858	7.47	0.32	< 4.97
MW110S	2003 Q2	< 2.7	7.30	< 1.6	< 4.6
MW110S	2003 Q3	< 1.93	3.99	< 0.423	< 3.45
MW110S	2003 Q4	< 1.22	4.70	0.44	< 6.15
MW110S	2004 Q1	< 1.33	1.88	< 1.7	< 3.41
MW110S	2004 Q2	< 2.44	4.35	0.69	< 3.05
MW110S	2004 Q3	< 1.78	4.46	< 0.937	< 4.98
MW110S	2004 Q4	< 1.32	3.24	< 0.919	< 4.21
MW111S	2002 Q1	1.00	5.31	< 0.629	< 2.42
MW111S	2002 Q2	< 0.696	2.76	< 0.722	< 2.8
MW111S	2002 Q3	0.54	7.39	-	< 3.69
MW111S	2002 Q4	< 0.671	5.01	< 0.527	< 2.69
MW111S	2003 Q1	0.55	3.24	-	< 3.82
MW111S	2003 Q2	< 2.2	5.10	-	< 8.5
MW111S	2003 Q3	< 0.714	4.12	-	< 4.5
MW111S	2003 Q4	< 0.657	5.52	0.35	< 7.09
MW111S	2004 Q1	0.73	4.95	< 0.788	< 3.06
MW111S	2004 Q2	< 2.49	2.06	< 1.11	< 2.4
MW112S	2002 Q1	-	-	-	< 3.35
MW112S	2002 Q2	-	-	-	< 1.96
MW112S	2002 Q3	< 0.788	3.61	-	< 3.01
MW112S	2002 Q4	< 0.685	1.99	-	< 2.11
MW112S	2003 Q1	< 0.717	< 2.58	-	< 4.92
MW112S	2003 Q2	< 2.1	2.02	-	< 7.5

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was not statistically significant at 2-σ error level, reported as <MDC

Bold 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 Alpha	Gross Beta	Sr-90	Cs-137
MW112S	2003 Q3	< 0.931	2.62	-	< 4.87
MW112S	2003 Q4	< 0.595	< 2.5	5.49	< 8.17
MW112S	2004 Q1	< 0.96	< 2.38	< 0.765	< 3.44
MW112S	2004 Q2	1.56	< 1.97	0.70	< 4.43
MW112S	2004 Q3	< 1.24	1.63	< 0.823	< 3.26
MW112S	2004 Q4	< 1.43	< 1.98	< 1.05	< 5.63
MW113S	2002 Q1	-	-	-	< 4.17
MW113S	2002 Q2	-	-	-	< 3.04
MW113S	2002 Q3	2.95	31.40	-	< 2.94
MW113S	2002 Q4	1.82	30.30	-	< 3.51
MW113S	2003 Q1	0.89	23.40	-	< 2.32
MW113S	2003 Q2	< 3.2	16.80	< 1.7	< 9.7
MW113S	2003 Q3	< 3.12	23.40	0.58	< 0
MW113S	2003 Q4	< 1.53	22.70	0.84	< 9.04
MW113S	2004 Q1	< 1.93	16.30	0.37	< 3.16
MW113S	2004 Q2	< 2.38	8.30	0.67	< 2.26
MW113S	2004 Q3	< 2.88	17.50	< 0.802	< 3.28
MW113S	2004 Q4	1.09	16.20	< 1.03	2.80
MW114S	2002 Q1	0.68	20.70	3.63	< 3.4
MW114S	2002 Q2	0.95	17.30	3.26	< 2.65
MW114S	2002 Q3	< 0.885	11.50	1.45	< 2.99
MW114S	2002 Q4	< 0.923	11.60	2.62	< 2.89
MW114S	2003 Q1	< 3.42	49.10	**16.6**	< 3.83
MW114S	2003 Q2	2.98	12.96	< 1.8	< 4.3
MW114S	2003 Q3	< 1.94	7.24	0.73	< 3.88
MW114S	2003 Q4	< 1.17	7.70	1.15	< 9.1
MW114S	2004 Q1	< 1.79	18.50	3.92	< 4.12
MW114S	2004 Q2	6.29	8.11	< 1.19	< 3.68
MW115S	2002 Q1	6.38	23.00	3.85	3.18
MW115S	2002 Q2	< 0.827	5.95	0.52	1.59
MW115S	2002 Q3	1.30	17.60	2.40	7.59
MW115S	2002 Q4	1.50	13.20	1.42	3.72
MW115S	2003 Q1	1.56	11.90	1.33	2.55
MW115S	2003 Q2	< 2.1	4.60	< 1.5	< 6.6
MW115S	2003 Q4	1.88	8.49	1.41	< 9.79
MW115S	2004 Q1	1.42	8.62	1.64	2.84
MW117S	2002 Q1	-	-	-	< 4.84
MW117S	2002 Q2	-	-	-	< 2.47
MW117S	2002 Q3	1.59	8.36	-	< 3.43
MW117S	2002 Q4	< 1.27	7.66	1.28	< 3.21
MW117S	2003 Q1	0.90	8.13	1.41	< 4.38
MW117S	2003 Q2	3.80	11.66	1.40	< 9.3

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was not statistically significant at 2-σ error level, reported as <MDC

Bold 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 Alpha	Gross Beta	Sr-90	Cs-137
MW117S	2003 Q3	< 2.25	9.49	1.42	< 4.21
MW117S	2003 Q4	< 2.24	9.65	0.77	< 6.78
MW117S	2004 Q1	< 2.97	5.41	< 1.09	< 3.76
MW117S	2004 Q2	< 1.44	7.28	0.79	< 4.08
MW117S	2004 Q3	< 1.33	6.91	0.81	< 2.3
MW117S	2004 Q4	< 1.65	4.91	< 1.55	< 5.39
MW122D	2003 Q1	12.00	12.00	< 0.693	< 4.64
MW122D	2003 Q2	12.60	27.70	1.21	< 9.2
MW122D	2003 Q3	**21.5**	18.70	< 0.398	< 4.02
MW122D	2003 Q4	9.80	10.80	0.21	< 9.7
MW122D	2004 Q1	6.20	6.64	0.55	3.19
MW122D	2004 Q2	7.14	5.21	3.29	< 3.28
MW122D	2004 Q3	4.53	4.76	< 0.852	< 3.72
MW122D	2004 Q4	6.68	1.96	< 0.825	< 4.55
MW122S	2003 Q1	1.18	6.41	1.59	< 3.56
MW122S	2003 Q2	< 3.2	14.11	< 1.7	< 8.6
MW122S	2003 Q3	< 3.49	11.20	1.24	< 2.98
MW122S	2003 Q4	< 2.19	8.64	0.81	< 9.97
MW122S	2004 Q1	< 1.58	6.46	0.64	< 3.31
MW122S	2004 Q2	4.88	8.40	0.57	< 3.87
MW122S	2004 Q3	< 2.47	9.86	1.23	< 5.29
MW122S	2004 Q4	< 1.87	< 2.37	< 0.936	< 5.25
MW123S	2003 Q1	12.90	18.40	0.63	< 4.26
MW123S	2003 Q2	5.10	24.70	< 1.6	< 5.1
MW123S	2003 Q4	7.70	14.90	1.37	< 7.97
MW123S	2004 Q1	4.19	14.70	0.87	< 4.31
MW123S	2004 Q2	4.63	19.60	< 1.34	2.46
MW123S	2004 Q3	6.37	22.10	0.55	2.45
MW123S	2004 Q4	8.04	28.60	0.52	< 7.75
MW124S	2003 Q1	< 1.04	6.24	0.49	< 4.94
MW124S	2003 Q2	< 2.7	8.30	< 1.6	< 6.7
MW124S	2003 Q4	< 1.22	5.90	0.54	< 8.73
MW124S	2004 Q1	< 1.61	5.12	< 1.12	< 3.32
MW124S	2004 Q2	< 2.2	4.98	1.33	< 3.22
MW124S	2004 Q3	< 1.23	6.50	< 0.687	< 4.88
MW124S	2004 Q4	< 1.51	5.54	< 0.639	< 3.48
MW125S	2003 Q1	1.52	10.90	0.69	< 4.4
MW125S	2003 Q2	< 2.8	14.49	1.41	< 7.4
MW125S	2003 Q3	< 2.17	16.30	1.17	< 2.5
MW125S	2003 Q4	< 2.04	15.30	6.51	< 7.44
MW125S	2004 Q1	1.05	8.89	3.15	< 2.86
MW125S	2004 Q2	2.36	11.80	1.78	< 3.88

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was not statistically significant at 2-σ error level, reported as <MDC

Bold 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 Alpha	Gross Beta	Sr-90	Cs-137
MW125S	2004 Q3	< 1.39	13.50	1.93	< 2.82
MW125S	2004 Q4	< 1.7	12.70	3.08	< 2.84
MW200	2002 Q2	-	-	-	< 2.45
MW200	2002 Q4	11.40	14.20	-	< 3.31
MW200	2003 Q1	2.89	4.86	-	< 4.88
MW200	2003 Q2	**20.2**	23.40	-	< 4.9
MW200	2003 Q4	0.38	2.77	-	< 9.36
MW200	2004 Q4	< 0.988	2.09	< 1.18	< 3.23
MW201	2002 Q2	-	-	-	< 2.86
MW201	2002 Q3	0.51	4.42	-	< 3.56
MW201	2002 Q4	1.39	3.90	-	< 3.07
MW201	2003 Q1	< 0.661	3.07	-	< 4.9
MW201	2003 Q2	< 2.6	5.50	-	< 3.5
MW201	2003 Q3	< 1.24	< 2.64	-	< 3.98
MW201	2003 Q4	1.89	2.49	-	< 9.38
MW203	2002 Q1	0.58	1.59	< 0.48	< 2.42
MW203	2002 Q2	-	-	-	< 2.77
MW203	2002 Q3	< 0.861	3.30	-	< 3.33
MW203	2002 Q4	< 0.593	4.04	< 0.758	< 3.21
MW203	2003 Q1	2.62	6.60	-	< 4.11
MW203	2003 Q2	6.30	15.60	-	< 3.3
MW203	2003 Q3	0.53	2.33	-	< 4.78
MW203	2003 Q4	< 0.919	3.75	-	< 5.94
MW203	2004 Q4	< 1.98	< 3.27	< 1.2	< 2.69
MW205	2002 Q1	-	-	-	< 3.41
MW205	2002 Q2	-	-	-	< 2.64
MW205	2002 Q3	< 1.27	3.01	-	2.51
MW205	2002 Q4	< 0.799	2.06	-	< 3.08
MW205	2003 Q1	< 0.679	< 2.54	-	< 3.5
MW205	2003 Q2	< 1.8	2.15	-	< 3.5
MW205	2003 Q3	< 1.16	1.31	-	< 3.58
MW205	2003 Q4	< 0.574	1.62	-	< 8.18
MW205	2004 Q4	< 1.32	2.42	< 0.769	< 3.76
MW207	2002 Q1	0.60	3.63	< 0.565	< 3.09
MW207	2002 Q2	-	-	-	< 2.83
MW207	2002 Q3	< 0.635	4.35	-	< 3.22
MW207	2002 Q4	0.49	5.40	-	< 2.64
MW207	2003 Q1	< 0.642	3.08	-	< 3.94
MW207	2003 Q2	< 1.9	3.48	-	< 7.6
MW207	2003 Q3	< 0.571	1.48	0.44	< 9.35
MW207	2003 Q4	< 0.695	2.38	-	< 9.63
MW207	2004 Q4	< 1.34	< 2.28	< 1.03	< 2.82

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was not statistically significant at 2-σ error level, reported as <MDC

Bold 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 Alpha	Gross Beta	Sr-90	Cs-137
MW208	2003 Q2	**24.1**	42.70	-	< 7.6
MW208	2003 Q3	< 0.549	4.14	-	< 4.72
MW208	2003 Q4	< 0.888	3.45	0.89	< 9.88
MW208	2004 Q4	< 1.25	7.35	< 0.741	< 3.19
MW1	2004 Q2	< 0	< 1.84	0.94	< 2.41
MW1	2004 Q3	< 1.35	1.33	-	< 5.15
MW1	2004 Q4	< 1.42	< 2.29	< 1.29	2.80
MW2	2002 Q4	< 0.967	2.75	0.41	< 3.09
MW2	2004 Q2	< 1.29	4.43	< 1.02	< 3.51
MW2	2004 Q3	1.04	3.47	-	1.73
MW2	2004 Q4	< 2.14	7.61	< 0.91	< 7.71
MW3	2004 Q2	< 1.81	0.79	< 1.24	< 2.47
MW3	2004 Q3	< 1.93	1.53	-	< 2.76
MW3	2004 Q4	< 1.62	< 2.45	< 0	< 4.21
MW4	2004 Q4	< 1.35	1.64	< 1.26	< 6.22
MW502	2004 Q2	1.65	5.02	-	< 2.26
MW502	2004 Q3	0.87	6.95	-	< 3.03
MW502	2004 Q4	< 1.88	5.37	-	< 3.17
MW503	2004 Q2	3.23	1.74	-	< 2.35
MW503	2004 Q3	< 1.31	< 2.05	-	< 1.96
MW503	2004 Q4	< 1.3	< 2.35	-	< 2.96
MW504	2004 Q2	< 1.97	3.40	-	< 2.34
MW504	2004 Q3	< 1.16	4.77	-	< 3.2
MW504	2004 Q4	< 1.61	5.28	-	< 4.08
MW505	2004 Q2	1.82	4.88	-	< 3.12
MW505	2004 Q3	0.87	6.38	-	< 2.38
MW505	2004 Q4	1.08	5.36	-	< 3.57
MW507D	2004 Q2	**28.8**	15.20	-	< 2.39
MW507D	2004 Q3	**40.8**	19.90	-	< 4.59
MW507D	2004 Q4	11.60	9.16	-	< 3.72
MW507S	2004 Q2	1.42	3.95	-	< 2.25
MW507S	2004 Q3	2.12	6.17	-	< 4.43
MW507S	2004 Q4	1.46	5.64	-	< 2.96
MW508D	2004 Q2	7.58	6.68	-	< 2.76
MW508D	2004 Q3	**22.3**	32.50	-	< 4.17
MW508D	2004 Q4	**15.7**	21.40	-	< 15.10
MW508S	2004 Q2	< 2.28	4.50	-	< 3.16
MW508S	2004 Q3	1.37	6.25	-	< 10
MW508S	2004 Q4	< 2.38	7.60	< 0.931	< 5.91
EOF2	2002 Q1	1.03	3.43	< 0.539	< 2.36
EOF2	2002 Q2	-	-	-	< 2.7
EOF2	2002 Q3	< 0.919	4.61	-	< 3.54

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was not statistically significant at 2-σ error level, reported as <MDC

Bold 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 Alpha	Gross Beta	Sr-90	Cs-137
EOF2	2002 Q4	0.63	4.90	-	< 3.28
EOF2	2003 Q1	1.31	5.00	-	< 5.34
EOF2	2003 Q2	< 3.1	4.30	-	< 4.6
EOF2	2003 Q3	< 1.63	3.76	-	< 5.57
EOF2	2003 Q4	1.20	4.33	-	< 9.22
EOF2	2004 Q1	-	-	-	-
EOF2	2004 Q2	2.58	3.30	< 1.34	< 3.27
EOF2	2004 Q3	1.02	4.01	0.88	< 2.28
EOF2	2004 Q4	1.44	5.92	< 1.34	< 5.15
SUPPLY WELL B	2002 Q4	-	-	< 0.579	-

NOTES

-: Well was not sampled for analyte

<50: Observed concentration was not statistically significant at 2-σ error level, reported as <MDC

Bold concentrations are greater than EPA MCL

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

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	Sep'04	Dec'04
100D	< 700	< 1000	NS	< MDC	< 270	<210	< 271	< 260	134	< 293	< 259	< 360	< 301	170	< 262	< 306	< 344	< 302
100S	< 700	< 1000	NS	NS	< 270	<200	< 273	< 261	< 284	< 294	< 256	< 320	< 310	186	< 267	< 284	183	< 295
101D	< 700	< 1000	NS	NS	< 260	<210	< 280	< 276	137	< 275	< 258	250	< 309	< 295	< 276	< 242	< 258	< 359
101S	< 700	< 1000	NS	< MDC	< 260	<210	< 284	< 278	< 284	< 273	< 255	< 350	< 255	233	< 271	252	456	< 303
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	4,940	4,690	5,120	6,480
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	6,740	5,740	12,600	8,930
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	12,000	6,530	8,950	10,800
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	1,090	5,300	**31,000**	NS
104S	< 700	< 1000	NS	NS	< 270	186	< 273	< 261	293	142	< 258	390	< 307	< 255	285	241	< 314	262
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	953	1,280	NS	NS
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	5,520	3,350	NS	NS
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	1,110	1,520	2,710	3,760
106S	**24,290**	16,370	NS	NS	780	2,130	2,450	1,130	514	1,500	2,330	1,550	332	752	542	850	1,260	415
107D	< 700	< 1000	NS	< MDC	< 270	<210	217	211	214	242	481	630	647	424	732	656	776	< 287
107S	< 700	< 1000	NS	< MDC	< 270	219	254	274	< 284	< 292	346	580	< 250	232	225	< 352	206	< 359
108S	< 700	< 1000	NS	NS	< 270	156	290	221	256	< 291	< 251	240	206	< 287	< 268	< 251	340	399
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	4,550	3,140	3,480	3,390
109S	<700	< 1000	NS	< MDC	< 270	<240	< 265	< 261	< 288	< 276	< 257	< 350	< 300	< 242	< 279	< 275	< 320	< 349
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	5,890	8,300	13,600	3,400
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	2,050	1,010	1,670	1,820
111S	< 700	< 1000	NS	< MDC	< 270	<210	< 273	< 259	222	< 292	< 253	< 350	299	< 278	< 269	233	NS	NS
112S	< 700	< 1000	NS	NS	< 270	<240	< 277	< 259	< 277	< 293	< 249	< 340	< 306	159	< 272	< 277	< 286	< 361
113S	< 700	< 1000	NS	NS	< 270	<240	< 272	< 263	160	< 290	149	< 340	118	215	< 260	180	< 272	<360
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	1,350	6,730	NS	NS
115S	< 700	< 1000	NS	5,550	4,500	NS	1,870	4,090	1,900	2,180	2,230	3,410	NS	2,630	5,740	NS	NS	NS
117S	< 700	< 1000	NS	NS	< 180	<240	< 272	< 261	< 279	< 294	< 249	< 340	< 253	< 255	< 283	< 324	< 352	< 359
122D	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	< 258	< 360	< 305	120	< 298	222	< 261	610
122S	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	720	850	895	898	750	645	621	609
123S	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	< 260	< 340	128	201	< 249	< 306	< 266	< 299
124S	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	4850	4,350	4,340	1,910	1,530	1,770	2,080	968
125S	NI	NI	NI	NI	NI	NI	NI	NI	NI	NI	1,540	1,900	873	2,110	2,350	2,170	2,390	861
AST-1	< 700	<1000	NS	NS	< 260	144	245	NS	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	3,260

Notes:

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

(<) Non-detect reported as less than 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 4-3: Tritium Concentrations (pCi/L) in Groundwater (continued)

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	Sep'04	Dec'04
TW-1	< 700	< 1000	NS	NS	< 270	< 250	< 267	NS	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	NS
TW-4	NS	NS	NS	NS	NS	< 200	NS	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	223	< 305	< 363
MW-2	NS	NS	NS	NS	NS	601	NS	NS	NS	229	NS	NS	NS	NS	NS	< 397	439	< 357
MW-4	NS	NS	NS	NS	NS	< 200	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 245	NS	< 312
MW-13	< 700	< 1000	NS	NS	< 270	< 240	< 267	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 348
200	<MDC	<MDC	NS	NS	< 180	NS	NS	< 261	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 319
201	< MDC	<MDC	NS	NS	< 180	NS	NS	< 262	NS	NS	NS	NS	NA	NA	NS	NS	NS	< 314
202	< MDC	<MDC	NS	NS	< 180	< 210	< 266	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 318
203	< MDC	<MDC	NS	NS	< 270	< 250	< 267	< 263	NS	< 329	NS	NS	NA	NA	NS	NS	NS	< 315
204	< MDC	<MDC	NS	NS	< 180	< 210	< 266	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 290
205	< MDC	<MDC	NS	NS	< 180	< 210	< 264	< 275	NS	NS	NS	NS	NA	NA	NS	NS	NS	< 310
206	< MDC	<MDC	NS	NS	< 180	< 210	< 261	NS	NS	NS	NS	NS	NA	NA	NS	NS	NS	< 311
207	< MDC	<MDC	NS	NS	< 180	< 250	< 259	< 278	NS	NS	NS	NS	< 238	NA	NS	NS	NS	< 286
EOF Supply	NS	NS	NS	NS	NS	< 210	< 265	NS	NS	NS	< 249	NS	NS	NS	NS	NS	NS	NS
EOF 2	< 700	< 1000	NS	NS	< 270	< 200	< 270	< 263	< 285	NS	NS	< 340	< 302	< 246	< 265	196	< 306	< 344
Schmidt	NS	NS	NS	NS	NS	NS	< 267	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
MW502	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 302	235	< 315
MW503	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 303	222	< 291
MW504	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	276	< 294	< 293
MW505	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 284	233	< 301
MW507D	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 306	< 303	< 359
MW507S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 292	< 323	< 355
MW508D	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 270	< 296	< 284
MW508S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	< 282	< 306	< 360

Notes:

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

(<) Non-detect reported as less than 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-90	Tc-99	Pu-238	Pu-239,40	Pu-241	Am-241	Cm-242	Cm-243,44
MW100D	2004 Q1	-	-	-	-	-	-	-	-	< 0.173	-	-
MW100S	2004 Q1	-	-	-	-	-	-	-	-	< 0.196	-	-
MW101D	2002 Q3	< 8.22	< 15.10	< 0	< 0.583	< 10.80	< 0.134	< 0.134	7.40	< 0.131	< 0.132	< 0.132
MW101D	2004 Q1	-	-	-	< 1.16	-	-	-	-	< 0.26	-	-
MW101D	2004 Q2	-	-	-	< 1.23	-	-	-	-	-	-	-
MW101D	2004 Q3	-	-	-	0.52	-	-	-	-	-	-	-
MW101D	2004 Q4	-	-	-	< 0.937	-	-	-	-	-	-	-
MW101S	2002 Q3	4.46	< 17.60	< 4.26	0.55	< 11.20	< 0.156	< 0.156	7.59	< 0.319	< 0.244	< 0.244
MW101S	2003 Q1	-	-	-	0.38	-	< 0.284	< 0.284	6.77	< 0.254	< 0.194	< 0.194
MW101S	2003 Q2	-	-	-	< 1.7	-	-	-	-	-	-	-
MW101S	2003 Q3	-	-	-	0.33	-	-	-	-	-	-	-
MW101S	2003 Q4	-	-	-	0.47	-	-	-	-	-	-	-
MW101S	2004 Q1	-	-	-	< 1.2	-	-	-	-	< 0.298	-	-
MW101S	2004 Q2	-	-	-	< 1.2	-	-	-	-	-	-	-
MW101S	2004 Q3	-	-	-	< 0.938	-	-	-	-	-	-	-
MW101S	2004 Q4	-	-	-	< 0.98	-	-	-	-	-	-	-
MW102D	2002 Q1	< 8.06	< 6.71	< 3.51	< 0.664	< 10.40	< 0.182	< 0.271	< 10.70	< 0.213	< 0.215	< 0.215
MW102D	2002 Q2	< 7.85	< 8.32	< 2.84	< 0.721	< 11.30	< 0.14	< 0.139	< 7.74	< 0.203	< 0.187	< 0.187
MW102D	2002 Q3	< 8.57	< 11.40	4.67	< 0.636	< 10.70	< 0.252	< 0.143	4.69	< 0.139	< 0.14	< 0.14
MW102D	2002 Q4	< 8.08	4.14	3.42	< 0.85	14.30	< 0.134	< 0.236	10.70	< 0.152	< 0.317	< 0.317
MW102D	2003 Q1	-	-	-	< 0.578	-	< 0.295	< 0.295	< 18.60	< 0.113	< 0.113	< 0.113
MW102D	2003 Q2	-	-	-	< 1.6	-	-	-	-	-	-	-
MW102D	2003 Q4	-	< 10.50	< 3.42	< 1.25	< 9.01	< 0.168	< 0.168	< 9.5	< 0.15	< 0.151	< 0.151
MW102D	2004 Q1	-	-	-	< 1.11	-	-	-	-	< 0.259	-	-
MW102D	2004 Q2	-	-	-	0.93	-	-	-	-	-	-	-
MW102D	2004 Q3	-	-	-	< 0.805	-	-	-	-	-	-	-
MW102D	2004 Q4	-	-	-	< 0.636	-	-	-	-	-	-	-

Notes:

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

(<) Non-detect reported as less than 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 Concentrations (pCi/L) in Groundwater (continued)

Well ID	Sample Event	C-14	Fe-55	Ni-63	Sr-90	Tc-99	Pu-238	Pu-239,40	Pu-241	Am-241	Cm-242	Cm-243,44
MW102S	2002 Q1	< 8.07	2.54	< 3.88	< 0.716	< 10.50	< 0.283	< 0.19	< 11.30	< 0.133	< 0.293	< 0.293
MW102S	2002 Q2	7.32	14.20	< 2.89	< 0.716	9.75	< 0.178	< 0.208	< 9.3	< 0.0954	< 0.0959	< 0.0959
MW102S	2002 Q3	< 8.57	< 11.30	4.18	< 0.52	< 10.90	< 0.132	< 0.132	< 7.69	< 0.129	< 0.13	< 0.13
MW102S	2002 Q4	< 8.08	10.30	< 3.8	< 0.644	17.90	< 0.139	< 0.246	11.60	< 0.121	< 0.121	< 0.121
MW102S	2003 Q1	< 8.07	7.89	< 4.5	0.38	< 12.30	< 0.133	< 0.133	< 9.88	< 0.116	< 0.117	< 0.117
MW102S	2003 Q2	-	-	-	1.08	-	-	-	-	-	-	-
MW102S	2003 Q3	-	-	-	0.55	-	-	-	-	-	-	-
MW102S	2003 Q4	-	-	-	< 1.26	-	-	-	-	-	-	-
MW102S	2004 Q1	-	-	-	< 1.2	-	-	-	-	< 0.36	-	-
MW102S	2004 Q2	-	-	-	< 1.2	-	-	-	-	-	-	-
MW102S	2004 Q3	-	-	-	< 1.3	-	-	-	-	-	-	-
MW102S	2004 Q4	-	-	-	< 1.13	-	-	-	-	-	-	-
MW103D	2002 Q1	< 8.06	6.27	< 3.74	< 0.603	< 10.40	< 0.199	< 0.199	9.03	0.69	< 0.159	< 0.159
MW103D	2002 Q2	< 7.85	2.86	< 2.78	< 0.691	< 11.40	< 0.0982	< 0.0981	< 7.78	< 0.239	< 0.24	< 0.24
MW103D	2002 Q3	< 8.56	< 21.10	8.01	< 0.63	< 9.89	< 0.305	< 0.305	5.27	< 0.119	< 0.12	< 0.12
MW103D	2002 Q4	< 8.08	9.04	< 3.93	< 0.593	< 12.30	< 0.263	< 0.148	14.70	< 0.111	< 0.111	< 0.111
MW103D	2003 Q1	-	-	-	< 1.78	-	< 0.238	< 0.238	8.76	< 0.112	< 0.113	< 0.113
MW103D	2003 Q2	-	-	-	< 1.9	-	-	-	-	-	-	-
MW103D	2003 Q4	-	-	-	0.37	-	-	-	-	-	-	-
MW103D	2004 Q1	< 150.0	< 11.70	< 6.41	< 0.815	< 11.90	< 0.103	< 0.103	< 12.10	< 0.121	< 0.099	< 0.099
MW103D	2004 Q2	< 73.50	< 12.30	< 11.80	1.26	< 8.31	< 0.414	< 0.208	< 11.40	< 0.369	< 0.349	< 0.349
MW103D	2004 Q3	< 11.90	< 13.60	< 15	< 0.895	< 8.37	< 0.213	< 0.0793	< 10.50	< 0.31	< 0.272	< 0.272
MW103D	2004 Q4	< 10.80	21.50	< 11.30	< 0	< 9.16	< 0.235	< 0.282	< 5.76	< 0.188	< 0.141	< 0.141
MW103S	2002 Q1	< 8.07	3.50	3.71	5.23	< 10.40	< 0.18	< 0.121	< 7.11	< 0.149	< 0.278	< 0.278
MW103S	2002 Q2	5.46	4.96	3.38	**15.30**	< 11.20	< 0.188	< 0.221	< 7.23	< 0.0924	< 0.156	< 0.156
MW103S	2002 Q3	< 8.56	< 11.90	6.57	3.81	9.64	< 0.151	< 0.266	7.08	< 0.12	< 0.121	< 0.121
MW103S	2002 Q4	< 8.08	8.55	< 3.7	5.57	19.00	< 0.21	< 0.119	14.50	< 0.115	< 0.116	< 0.116
MW103S	2003 Q1	< 8.07	8.81	< 10.60	6.75	< 12.40	< 0.149	< 0.263	< 9.58	< 0.128	< 0.128	< 0.128
MW103S	2003 Q2	-	< 9.2	< 9.7	1.13	-	< 0.23	-	< 2.9	0.25	-	-
MW103S	2003 Q3	< 31.70	30.50	< 34.10	2.59	< 9.5	< 0.134	< 0.134	< 7.7	< 0.411	< 0.234	< 0.234

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-90	Tc-99	Pu-238	Pu-239,40	Pu-241	Am-241	Cm-242	Cm-243,44
MW103S	2003 Q4	< 16.90	4.23	< 3.24	< 0.615	< 8.81	< 0.165	< 0.291	< 9.67	< 0.214	< 0.122	< 0.122
MW103S	2004 Q1	< 170.0	< 10.10	< 6.46	2.27	< 10.90	< 0.0407	< 0.127	16.60	< 0.0995	< 0.218	< 0.218
MW103S	2004 Q2	< 11.80	< 10.80	< 13.80	1.34	< 10	< 0.23	< 0.156	< 14.50	< 0.256	< 0.248	< 0.248
MW103S	2004 Q3	8.03	< 12.30	37.30	3.67	< 8.38	< 0.175	< 0.254	< 9.55	< 0.232	< 0.304	< 0.304
MW104S	2003 Q2	-	-	-	3.14	-	-	-	-	-	-	-
MW104S	2003 Q3	-	-	-	2.02	-	-	-	-	-	-	-
MW104S	2003 Q4	13.40	2.72	< 3.56	0.86	< 8.87	< 0.127	< 0.127	< 7.25	< 0.119	< 0.119	< 0.119
MW104S	2004 Q1	< 151.0	< 10.30	< 5.71	< 0.685	< 10.80	< 0.125	< 0.113	< 14.60	< 0.0921	< 0.0923	< 0.0923
MW104S	2004 Q2	< 11.70	< 11.60	< 12.60	< 1.35	< 8.94	< 0.293	< 0.178	< 14.40	< 0.19	< 0.211	< 0.211
MW104S	2004 Q3	14.40	< 19.30	< 14.30	< 0.962	< 6.85	< 0.37	< 0.271	< 10.60	< 0.308	< 0.4	< 0.4
MW104S	2004 Q4	< 10.80	< 17	< 6.18	< 0.862	< 8.41	< 0.149	< 0.149	< 5.19	< 0.344	< 0.403	< 0.403
MW105D	2002 Q1	< 8.07	< 6.19	< 3.48	< 0.571	0.90	< 0.221	< 0.25	< 8.84	< 0.272	< 0.242	< 0.242
MW105D	2002 Q2	< 7.85	5.10	< 0	< 0.597	< 11.30	< 0.179	< 0.101	< 5.85	< 0.247	< 0.119	< 0.119
MW105D	2002 Q3	< 8.56	< 11.70	3.61	< 0.738	< 11	< 0.128	< 0.128	5.77	< 0.11	< 0.11	< 0.11
MW105D	2002 Q4	< 8.08	8.14	2.69	< 0.596	< 12	< 0.174	< 0.174	12.50	< 0.162	< 0.0918	< 0.0918
MW105D	2003 Q1	-	-	-	0.66	-	< 0.184	< 0.325	< 11.20	< 0.174	< 0.175	< 0.175
MW105D	2003 Q2	-	-	-	< 1.5	-	-	-	-	-	-	-
MW105D	2003 Q3	-	-	-	< 0.427	-	-	-	-	-	-	-
MW105D	2003 Q4	-	-	-	1.33	-	-	-	-	-	-	-
MW105D	2004 Q1	< 151.0	< 6.85	< 9.67	< 0.811	< 10.30	< 0.144	< 0.0804	< 12.30	< 0.0417	< 0.0417	< 0.0417
MW105D	2004 Q2	< 74.50	< 11.80	< 13.40	1.11	< 8.36	< 0.252	< 0.18	< 11.30	< 0.358	< 0.35	< 0.35
MW105S	2002 Q1	< 8.07	4.40	2.95	**122.**	8.89	< 0.118	< 0.118	< 6.94	< 0.159	< 0.161	< 0.161
MW105S	2002 Q2	7.02	11.20	2.48	**116.**	8.57	< 0.201	< 0.17	< 5.74	< 0.12	< 0.121	< 0.121
MW105S	2002 Q3	< 8.57	< 11.70	4.35	**101.**	11.80	< 0.117	< 0.244	< 7.51	< 0.25	< 0.142	< 0.142
MW105S	2002 Q4	< 8.08	13.40	< 3.83	**83.3**	9.96	< 0.127	< 0.295	6.70	< 0.118	< 0.209	< 0.209
MW105S	2003 Q1	5.91	12.10	< 4.67	**138.**	< 12.50	< 0.116	< 0.116	< 7.46	< 0.132	< 0.133	< 0.133
MW105S	2003 Q2	< 66	< 10	< 10	**181.6**	< 5.6	< 0.27	-	< 3.6	< 0.32	-	-
MW105S	2003 Q3	< 31.80	7.48	< 3.63	**197.**	6.06	< 0.48	< 0.271	< 16.60	< 0.234	< 0.236	< 0.236
MW105S	2003 Q4	< 15.90	5.76	< 3.45	**27.6**	< 8.95	< 0.175	< 0.174	6.40	< 0.134	< 0.134	< 0.134
MW105S	2004 Q1	< 152.0	< 7.77	< 5.51	**91.8**	< 10.20	< 0.085	< 0.085	< 12.50	< 0.129	< 0.142	< 0.142

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-90	Tc-99	Pu-238	Pu-239,40	Pu-241	Am-241	Cm-242	Cm-243,44
MW105S	2004 Q2	< 74.30	< 12.60	< 13.10	**16.2**	< 8.33	< 0.392	< 0.221	8.32	< 0.207	< 0.341	< 0.341
MW106D	2002 Q1	< 8.08	< 6.68	< 3.6	< 0.597	< 10.40	< 0.133	< 0.197	5.52	< 0.177	< 0.178	< 0.178
MW106D	2002 Q2	< 7.85	6.94	4.22	< 0.527	< 11.30	< 0.108	< 0.108	< 9.27	< 0.22	< 0.221	< 0.221
MW106D	2002 Q3	< 8.57	< 9.7	3.82	< 0.546	< 11	< 0.182	< 0.378	9.68	< 0.156	< 0.157	< 0.157
MW106D	2002 Q4	5.92	13.90	< 3.86	< 0.624	< 12.30	< 0.119	< 0.21	15.40	< 0.108	< 0.108	< 0.108
MW106D	2003 Q1	-	-	-	0.36	-	< 0.188	< 0.188	< 11.30	< 0.118	< 0.119	< 0.119
MW106D	2003 Q2	-	-	-	< 1.5	-	-	-	-	-	-	-
MW106D	2003 Q3	-	-	-	0.80	-	-	-	-	-	-	-
MW106D	2003 Q4	-	-	-	0.50	-	-	-	-	-	-	-
MW106D	2004 Q1	< 151.0	< 8.78	< 6.61	< 1.17	< 10.10	< 0.137	< 0.178	12.10	< 0.218	< 0.234	< 0.234
MW106D	2004 Q2	< 11.90	< 11.60	< 13.60	< 1.2	< 8.99	< 0.175	< 0.143	< 14.40	< 0.275	< 0.36	< 0.36
MW106D	2004 Q3	< 11.80	< 15.30	< 13.90	< 0.991	< 8.27	< 0.189	< 0.189	< 10.90	< 0.254	< 0.237	< 0.237
MW106D	2004 Q4	< 10.80	< 19.50	< 10.60	< 0.524	< 9.21	< 0.39	< 0.219	< 10.10	< 0.405	< 0.388	< 0.388
MW106S	2002 Q1	< 8.07	0.80	0.90	**8.38**	< 10.50	< 0.137	< 0.203	5.27	< 0.172	< 0.174	< 0.174
MW106S	2002 Q2	6.03	< 6.67	2.09	**13.0**	< 11.20	< 0.196	< 0.111	8.34	0.44	< 0.219	< 0.219
MW106S	2002 Q3	< 8.57	< 11.10	4.44	2.26	< 10.90	< 0.112	< 0.197	4.40	< 0.179	< 0.213	< 0.213
MW106S	2002 Q4	< 8.08	14.10	< 3.79	**9.35**	< 12.30	< 0.133	< 0.133	12.20	< 0.158	< 0.0898	< 0.0898
MW106S	2003 Q1	14.40	7.54	< 4.75	**13.5**	< 12.30	< 0.105	< 0.105	< 9.36	< 0.126	< 0.127	< 0.127
MW106S	2003 Q2	< 96	< 11	< 6.7	**18.68**	< 5.8	< 0.2	-	< 3.5	0.24	-	-
MW106S	2003 Q3	< 31.70	4.99	< 3.62	3.71	< 9.3	< 0.169	< 0.169	< 9.59	< 0.143	< 0.255	< 0.255
MW106S	2003 Q4	< 15.90	< 9.93	< 3.49	4.35	< 8.94	< 0.135	< 0.238	< 7.3	< 0.253	< 0.254	< 0.254
MW106S	2004 Q1	< 151.0	< 8.42	< 5.72	1.21	< 11.10	< 0.145	< 0.0389	< 12	< 0.166	< 0.263	< 0.263
MW106S	2004 Q2	< 11.80	< 11.50	< 11.70	3.17	< 14.40	< 0.294	< 0.172	< 15.10	< 0.264	< 0.342	< 0.342
MW106S	2004 Q3	< 27.70	< 14.60	< 14.30	7.30	< 8.26	< 0.0922	< 0.0922	< 9.69	< 0.265	< 0.349	< 0.349
MW106S	2004 Q4	7.79	< 17.90	< 10.50	**8.56**	< 10	< 0.234	< 0.362	< 12.10	< 0.378	< 0.436	< 0.436
MW107D	2002 Q1	< 8.23	0.70	1.00	< 0.628	< 11.20	< 0.196	< 0.11	4.36	< 0.124	< 0.223	< 0.223
MW107D	2002 Q2	< 7.84	0.50	< 3.11	< 0.6	8.25	< 0.091	< 0.0909	< 7.18	< 0.204	< 0.188	< 0.188
MW107D	2002 Q3	< 8.21	< 16.40	4.76	< 0.557	< 11.10	< 0.219	< 0.124	6.46	< 0.143	< 0.144	< 0.144
MW107D	2002 Q4	< 7.88	< 5.83	< 3.66	< 0.572	< 11.40	< 0.161	< 0.161	10.70	< 0.12	< 0.213	< 0.213
MW107D	2003 Q2	-	-	-	< 1.7	-	-	-	-	-	-	-

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-90	Tc-99	Pu-238	Pu-239,40	Pu-241	Am-241	Cm-242	Cm-243,44
MW107D	2003 Q3	-	-	-	0.33	-	-	-	-	-	-	-
MW107D	2003 Q4	-	-	-	< 0.669	-	-	-	-	-	-	-
MW107D	2004 Q1	-	-	-	< 1.23	-	-	-	-	< 0.301	-	-
MW107D	2004 Q2	-	-	-	< 1.2	-	-	-	-	-	-	-
MW107D	2004 Q3	-	-	-	< 0.708	-	-	-	-	-	-	-
MW107D	2004 Q4	-	-	-	< 0.639	-	-	-	-	-	-	-
MW107S	2002 Q2	< 7.85	8.73	< 0	0.26	< 11.20	< 0.159	< 0.159	< 9.13	< 0.0954	< 0.096	< 0.096
MW107S	2002 Q3	4.10	< 15.40	3.02	< 0.593	< 11.30	< 0.12	< 0.12	< 7.84	< 0.127	< 0.266	< 0.266
MW107S	2002 Q4	< 7.88	< 5.56	< 3.64	0.44	< 11.40	< 0.193	< 0.109	10.30	< 0.163	< 0.0924	< 0.0924
MW107S	2003 Q1	-	-	-	0.54	-	< 0.329	< 0.186	< 11.90	< 0.219	< 0.124	< 0.124
MW107S	2003 Q2	-	-	-	< 1.9	-	-	-	-	-	-	-
MW107S	2003 Q3	-	-	-	0.36	-	-	-	-	-	-	-
MW107S	2003 Q4	-	-	-	0.54	-	-	-	-	-	-	-
MW107S	2004 Q1	-	-	-	< 1.37	-	-	-	-	< 0.373	-	-
MW107S	2004 Q2	-	-	-	2.69	-	-	-	-	-	-	-
MW107S	2004 Q3	-	-	-	< 0.988	-	-	-	-	-	-	-
MW107S	2004 Q4	-	-	-	0.84	-	-	-	-	-	-	-
MW108S	2003 Q4	-	-	-	0.63	-	-	-	-	-	-	-
MW108S	2004 Q1	-	-	-	< 0.887	-	-	-	-	< 0.0919	-	-
MW108S	2004 Q2	-	-	-	< 1.4	-	-	-	-	-	-	-
MW108S	2004 Q3	-	-	-	0.46	-	-	-	-	-	-	-
MW108S	2004 Q4	-	-	-	< 0.812	-	-	-	-	-	-	-
MW109D	2002 Q1	< 8.24	4.68	3.13	< 0.666	< 11.40	< 0.109	< 0.109	6.27	< 0.275	< 0.158	< 0.158
MW109D	2002 Q2	< 7.85	3.89	< 2.95	< 0.495	< 11.10	< 0.152	< 0.152	< 7.79	< 0.211	< 0.212	< 0.212
MW109D	2002 Q3	< 8.56	< 9.22	4.91	< 0.568	< 11.10	< 0.213	< 0.12	4.28	< 0.257	< 0.124	< 0.124
MW109D	2002 Q4	< 8.08	11.00	< 3.82	< 0.646	9.88	< 0.0959	< 0.169	20.90	< 0.121	< 0.122	< 0.122
MW109D	2003 Q2	-	-	-	< 1.9	-	-	-	-	-	-	-
MW109D	2003 Q3	-	-	-	< 0.39	-	-	-	-	-	-	-
MW109D	2003 Q4	< 15.90	< 9.34	< 3.56	< 0.497	< 9.77	< 0.293	< 0.293	9.51	< 0.162	< 0.163	< 0.163
MW109D	2004 Q1	-	-	-	< 1.01	-	-	-	-	< 0.373	-	-

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-90	Tc-99	Pu-238	Pu-239,40	Pu-241	Am-241	Cm-242	Cm-243,44
MW109D	2004 Q2	-	-	-	< 1.16	-	-	-	-	-	-	-
MW109D	2004 Q3	-	-	-	< 0.732	-	-	-	-	-	-	-
MW109D	2004 Q4	-	-	-	< 0.609	-	-	-	-	-	-	-
MW109S	2002 Q1	4.70	9.90	< 3.94	0.90	< 11.40	< 0.108	< 0.108	4.45	< 0.159	< 0.161	< 0.161
MW109S	2002 Q2	< 7.85	5.35	< 3.07	0.66	< 11.40	< 0.182	< 0.242	< 9.91	< 0.1	< 0.17	< 0.17
MW109S	2002 Q3	< 8.21	< 15.30	< 4.96	0.97	< 11.30	< 0.127	< 0.224	9.06	< 0.277	< 0.367	< 0.367
MW109S	2002 Q4	< 8.08	11.10	< 4.12	0.90	11.20	< 0.173	< 0.203	13.20	< 0.131	< 0.233	< 0.233
MW109S	2003 Q1	-	-	-	0.98	-	< 0.324	< 0.324	< 11.90	< 0.14	< 0.141	< 0.141
MW109S	2003 Q2	-	-	-	< 1.7	-	-	-	-	-	-	-
MW109S	2003 Q3	-	-	-	0.69	-	-	-	-	-	-	-
MW109S	2003 Q4	-	-	-	1.01	-	-	-	-	-	-	-
MW109S	2004 Q1	-	-	-	< 1.11	-	-	-	-	< 0.369	-	-
MW109S	2004 Q2	-	-	-	0.80	-	-	-	-	-	-	-
MW109S	2004 Q3	-	-	-	0.38	-	-	-	-	-	-	-
MW109S	2004 Q4	-	-	-	< 1.3	-	-	-	-	-	-	-
MW110D	2002 Q1	< 8.24	5.06	< 3.99	< 0.562	10.50	< 0.21	< 0.118	3.78	< 0.183	< 0.164	< 0.164
MW110D	2002 Q2	< 7.85	5.76	< 3.12	< 0.52	< 11.10	< 0.151	< 0.151	< 7.82	< 0.231	< 0.111	< 0.111
MW110D	2002 Q3	< 8.56	< 9.96	4.15	2.54	< 11	< 0.121	< 0.121	< 7.06	< 0.286	< 0.288	< 0.288
MW110D	2002 Q4	< 8.08	8.85	< 3.9	< 0.696	9.99	< 0.177	< 0.37	21.30	< 0.213	< 0.121	< 0.121
MW110D	2003 Q1	-	-	-	< 0.551	-	< 0.158	< 0.158	< 9.8	< 0.147	< 0.147	< 0.147
MW110D	2003 Q2	-	-	-	< 1.7	-	-	-	-	-	-	-
MW110D	2003 Q3	-	-	-	0.36	-	-	-	-	-	-	-
MW110D	2003 Q4	-	-	-	0.45	-	-	-	-	-	-	-
MW110D	2004 Q1	-	-	-	0.66	-	-	-	-	< 0.311	-	-
MW110D	2004 Q2	-	-	-	< 1.15	-	-	-	-	-	-	-
MW110D	2004 Q3	-	-	-	< 0.751	-	-	-	-	-	-	-
MW110D	2004 Q4	-	-	-	< 1.15	-	-	-	-	-	-	-
MW110S	2002 Q1	< 11	4.05	3.10	0.34	8.44	< 0.12	< 0.119	6.91	< 0.169	< 0.171	< 0.171
MW110S	2002 Q2	4.19	10.60	< 3.07	< 0.545	7.58	< 0.196	< 0.231	< 7.57	< 0.122	< 0.123	< 0.123
MW110S	2002 Q3	< 8.57	< 10.60	< 5.32	< 0.683	< 10.80	< 0.134	< 0.237	4.12	< 0.13	< 0.131	< 0.131

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-90	Tc-99	Pu-238	Pu-239,40	Pu-241	Am-241	Cm-242	Cm-243,44
MW110S	2002 Q4	< 7.88	< 6.23	< 3.79	< 0.528	< 11.50	< 0.129	< 0.228	13.20	< 0.104	< 0.105	< 0.105
MW110S	2003 Q1	-	-	-	0.32	-	< 0.242	< 0.241	< 15.10	< 0.116	< 0.117	< 0.117
MW110S	2003 Q2	-	-	-	< 1.6	-	-	-	-	-	-	-
MW110S	2003 Q3	-	-	-	< 0.423	-	-	-	-	-	-	-
MW110S	2003 Q4	-	-	-	0.44	-	-	-	-	-	-	-
MW110S	2004 Q1	-	-	-	< 1.7	-	-	-	-	< 0.354	-	-
MW110S	2004 Q2	-	-	-	0.69	-	-	-	-	-	-	-
MW110S	2004 Q3	-	-	-	< 0.937	-	-	-	-	-	-	-
MW110S	2004 Q4	-	-	-	< 0.919	-	-	-	-	-	-	-
MW111S	2002 Q1	< 8.24	5.61	< 4.15	< 0.629	1.00	< 0.198	< 0.112	6.14	< 0.169	< 0.303	< 0.303
MW111S	2002 Q2	< 7.85	4.48	4.14	< 0.722	< 11.30	< 0.0885	< 0.0884	< 8.24	< 0.178	< 0.179	< 0.179
MW111S	2002 Q4	< 7.88	< 5.4	< 3.68	< 0.527	< 11.60	< 0.0992	< 0.175	6.12	< 0.209	< 0.247	< 0.247
MW111S	2003 Q4	-	-	-	0.35	-	-	-	-	-	-	-
MW111S	2004 Q1	-	-	-	< 0.788	-	-	-	-	< 0.264	-	-
MW111S	2004 Q2	-	-	-	< 1.11	-	-	-	-	-	-	-
MW112S	2003 Q4	-	-	-	5.49	-	-	-	-	-	-	-
MW112S	2004 Q1	-	-	-	< 0.765	-	-	-	-	< 0.0936	-	-
MW112S	2004 Q2	-	-	-	0.70	-	-	-	-	-	-	-
MW112S	2004 Q3	-	-	-	< 0.823	-	-	-	-	-	-	-
MW112S	2004 Q4	-	-	-	< 1.05	-	-	-	-	-	-	-
MW113S	2003 Q2	-	-	-	< 1.7	-	-	-	-	-	-	-
MW113S	2003 Q3	-	-	-	0.58	-	-	-	-	-	-	-
MW113S	2003 Q4	-	-	-	0.84	-	-	-	-	-	-	-
MW113S	2004 Q1	-	-	-	0.37	-	-	-	-	< 0.248	-	-
MW113S	2004 Q2	-	-	-	0.67	-	-	-	-	-	-	-
MW113S	2004 Q3	-	-	-	< 0.802	-	-	-	-	-	-	-
MW113S	2004 Q4	-	-	-	< 1.03	-	-	-	-	-	-	-
MW114S	2002 Q1	< 8.07	4.84	< 3.61	3.63	7.14	< 0.187	< 0.125	5.81	< 0.247	< 0.168	< 0.168
MW114S	2002 Q2	< 7.84	2.17	< 2.61	3.26	< 11.20	< 0.11	< 0.109	< 7.52	< 0.119	< 0.12	< 0.12
MW114S	2002 Q3	< 8.56	< 10.70	< 3.93	1.45	< 11.10	< 0.462	< 0.261	7.83	< 0.125	< 0.126	< 0.126

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-90	Tc-99	Pu-238	Pu-239,40	Pu-241	Am-241	Cm-242	Cm-243,44
MW114S	2002 Q4	< 8.08	7.58	< 3.65	2.62	14.70	< 0.157	< 0.157	11.50	< 0.129	< 0.229	< 0.229
MW114S	2003 Q1	< 8.07	7.43	< 4.67	**16.6**	< 12.30	< 0.253	< 0.143	< 11.20	< 0.214	< 0.122	< 0.122
MW114S	2003 Q2	-	-	-	< 1.8	-	-	-	-	-	-	-
MW114S	2003 Q3	-	-	-	0.73	-	-	-	-	-	-	-
MW114S	2003 Q4	-	-	-	1.15	-	-	-	-	-	-	-
MW114S	2004 Q1	-	-	-	3.92	-	-	-	-	< 0.259	-	-
MW114S	2004 Q2	-	-	-	< 1.19	-	-	-	-	-	-	-
MW115S	2002 Q1	< 8.07	7.19	< 3.89	3.85	< 10.60	< 0.165	< 0.245	< 9.5	< 0.183	< 0.274	< 0.274
MW115S	2002 Q2	< 7.85	< 8.14	< 2.41	0.52	< 11.30	< 0.112	< 0.111	< 6.8	< 0.131	< 0.131	< 0.131
MW115S	2002 Q3	< 8.56	< 11.90	3.39	2.40	< 10.90	< 0.202	< 0.201	11.60	< 0.232	< 0.132	< 0.132
MW115S	2002 Q4	< 8.08	< 15.10	< 3.85	1.42	< 12.20	< 0.145	< 0.145	11.30	< 0.224	< 0.266	< 0.266
MW115S	2003 Q1	-	-	-	1.33	-	< 0.146	< 0.146	< 9.29	< 0.226	< 0.128	< 0.128
MW115S	2003 Q2	-	-	-	< 1.5	-	-	-	-	-	-	-
MW115S	2003 Q4	-	-	-	1.41	-	-	-	-	-	-	-
MW115S	2004 Q1	-	-	-	1.64	-	-	-	-	< 0.198	-	-
MW117S	2002 Q4	-	-	-	1.28	-	-	-	-	-	-	-
MW117S	2003 Q1	-	-	-	1.41	-	-	-	-	-	-	-
MW117S	2003 Q2	-	-	-	1.40	-	-	-	-	-	-	-
MW117S	2003 Q3	-	-	-	1.42	-	-	-	-	-	-	-
MW117S	2003 Q4	-	-	-	0.77	-	-	-	-	-	-	-
MW117S	2004 Q1	-	-	-	< 1.09	-	-	-	-	< 0.27	-	-
MW117S	2004 Q2	-	-	-	0.79	-	-	-	-	-	-	-
MW117S	2004 Q3	-	-	-	0.81	-	-	-	-	-	-	-
MW117S	2004 Q4	-	-	-	< 1.55	-	-	-	-	-	-	-
MW122D	2003 Q1	-	-	-	< 0.693	-	< 0.108	< 0.108	-	< 0.198	< 0.234	< 0.234
MW122D	2003 Q2	-	< 10	< 11	1.21	-	< 0.22	-	< 5.3	< 0.34	-	-
MW122D	2003 Q3	-	-	-	< 0.398	-	-	-	-	-	-	-
MW122D	2003 Q4	-	-	-	0.21	-	-	-	-	-	-	-
MW122D	2004 Q1	-	-	-	0.55	-	-	-	-	< 0.148	-	-
MW122D	2004 Q2	-	-	-	3.29	-	-	-	-	-	-	-

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-90	Tc-99	Pu-238	Pu-239,40	Pu-241	Am-241	Cm-242	Cm-243,44
MW122D	2004 Q3	-	-	-	< 0.852	-	-	-	-	-	-	-
MW122D	2004 Q4	-	-	-	< 0.825	-	-	-	-	-	-	-
MW122S	2003 Q1	-	-	-	1.59	-	< 0.122	< 0.216	< 7.5	< 0.0932	< 0.0935	< 0.0935
MW122S	2003 Q2	< 89	< 10	< 10	< 1.7	< 6.8	< 0.13	-	< 4.3	< 0.35	-	-
MW122S	2003 Q3	-	-	-	1.24	-	-	-	-	-	-	-
MW122S	2003 Q4	-	-	-	0.81	-	-	-	-	-	-	-
MW122S	2004 Q1	-	-	-	0.64	-	-	-	-	< 0.317	-	-
MW122S	2004 Q2	-	-	-	0.57	-	-	-	-	-	-	-
MW122S	2004 Q3	-	-	-	1.23	-	-	-	-	-	-	-
MW122S	2004 Q4	-	-	-	< 0.936	-	-	-	-	-	-	-
MW123S	2003 Q1	-	-	-	0.63	-	< 0.186	< 0.186	< 11.10	< 0.122	< 0.122	< 0.122
MW123S	2003 Q2	-	< 9.4	< 12	< 1.6	-	< 0.15	-	< 0	< 0.33	-	-
MW123S	2003 Q4	-	-	-	1.37	-	-	-	-	-	-	-
MW123S	2004 Q1	-	-	-	0.87	-	-	-	-	< 0.284	-	-
MW123S	2004 Q2	-	-	-	< 1.34	-	-	-	-	-	-	-
MW123S	2004 Q3	-	-	-	0.55	-	-	-	-	-	-	-
MW123S	2004 Q4	-	-	-	0.52	-	-	-	-	-	-	-
MW124S	2003 Q1	-	-	-	0.49	-	< 0.163	< 0.163	< 10.10	< 0.201	< 0.114	< 0.114
MW124S	2003 Q2	< 100.0	< 9.3	< 7.7	< 1.6	< 5.3	< 0.15	-	< 3.6	0.30	-	-
MW124S	2003 Q4	-	-	-	0.54	-	-	-	-	-	-	-
MW124S	2004 Q1	-	-	-	< 1.12	-	-	-	-	< 0.486	-	-
MW124S	2004 Q2	-	-	-	1.33	-	-	-	-	-	-	-
MW124S	2004 Q3	-	-	-	< 0.687	-	-	-	-	-	-	-
MW124S	2004 Q4	-	-	-	< 0.639	-	-	-	-	-	-	-
MW125S	2003 Q1	-	-	-	0.69	-	< 0.18	< 0.102	< 6.34	< 0.114	< 0.202	< 0.202
MW125S	2003 Q2	< 100.0	< 9.7	< 7.9	1.41	< 5.7	< 0.27	-	< 5.4	< 0.36	-	-
MW125S	2003 Q3	-	-	-	1.17	-	-	-	-	-	-	-
MW125S	2003 Q4	-	-	-	6.51	-	-	-	-	-	-	-
MW125S	2004 Q1	-	-	-	3.15	-	-	-	-	< 0.307	-	-
MW125S	2004 Q2	-	-	-	1.78	-	-	-	-	-	-	-

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-90	Tc-99	Pu-238	Pu-239,40	Pu-241	Am-241	Cm-242	Cm-243,44
MW125S	2004 Q3	-	-	-	1.93	-	-	-	-	-	-	-
MW125S	2004 Q4	-	-	-	3.08	-	-	-	-	-	-	-
MW200	2004 Q4	< 11	< 19.90	< 13.10	< 1.18	< 10.20	< 0.148	< 0.166	< 10.70	< 0.247	< 0.336	< 0.336
MW203	2002 Q1	< 8.24	< 5.97	< 4.22	< 0.48	13.90	< 0.187	< 0.105	3.50	< 0.254	< 0.145	< 0.145
MW203	2002 Q4	< 7.89	< 5.49	< 3.85	< 0.758	< 11.50	< 0.105	< 0.219	10.30	< 0.119	< 0.211	< 0.211
MW203	2004 Q4	< 10.90	< 19.80	< 8.26	< 1.2	< 10.30	< 0.387	< 0.309	< 11.40	< 0.244	< 0.323	< 0.323
MW205	2004 Q4	< 10.90	< 17.40	< 6.8	< 0.769	< 8.55	< 0.249	< 0.161	< 11.30	< 0.244	< 0.354	< 0.354
MW207	2002 Q1	< 8.23	4.04	< 4.02	< 0.565	< 11.40	< 0.105	< 0.105	5.14	< 0.15	< 0.151	< 0.151
MW207	2003 Q3	< 31.70	12.10	< 16.10	0.44	< 9.52	< 0.223	< 0.52	< 13	< 0.326	< 0.186	< 0.186
MW207	2004 Q4	< 10.80	< 20	< 13.40	< 1.03	6.80	< 0.399	< 0.238	< 10.10	< 0.213	< 0.389	< 0.389
MW208	2003 Q4	< 15.80	3.77	< 3.55	0.89	< 10.10	< 0.308	< 0.174	< 9.48	< 0.116	< 0.116	< 0.116
MW208	2004 Q4	< 10.90	< 18.20	< 6.63	< 0.741	< 8.57	0.13	< 0.156	< 11.90	< 0.267	< 0.394	< 0.394
MW1	2004 Q2	-	-	-	0.94	-	-	-	-	-	-	-
MW1	2004 Q4	-	-	-	< 1.29	-	-	-	-	-	-	-
MW2	2002 Q4	< 7.89	< 5.72	< 3.83	0.41	< 11.40	< 0.176	< 0.0998	11.20	< 0.175	< 0.0997	< 0.0997
MW2	2004 Q2	-	-	-	< 1.02	-	-	-	-	-	-	-
MW2	2004 Q4	-	-	-	< 0.91	-	-	-	-	-	-	-
MW3	2004 Q2	-	-	-	< 1.24	-	-	-	-	-	-	-
MW3	2004 Q4	-	-	-	< 0	-	-	-	-	-	-	-
MW4	2004 Q4	-	-	-	< 1.26	-	-	-	-	-	-	-
MW508S	2004 Q4	-	-	-	< 0.931	-	-	-	-	-	-	-
EOF2	2002 Q1	< 8.24	5.56	< 4.03	< 0.539	< 11.30	< 0.118	< 0.118	5.70	< 0.137	< 0.139	< 0.139
EOF2	2004 Q2	-	-	-	< 1.34	-	-	-	-	-	-	-
EOF2	2004 Q3	-	-	-	0.88	-	-	-	-	-	-	-
EOF2	2004 Q4	-	-	-	< 1.34	-	-	-	-	-	-	-
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 4-5: Total Uranium Concentrations (µg/L) in Groundwater

Well ID	Sep-04 Conc. ± 2-σ Uncert.	Dec-04 Conc. ± 2-σ Uncert.
ATW1	- n.s. -	0.11 ± 0.01
CMS	- n.s. -	0.80 ± 0.03
EP165	- n.s. -	2.43 ± 0.09
EP166	- n.s. -	5.29 ± 0.14
EP171	- n.s. -	0.67 ± 0.03
MW100D	8.38 ± 0.23	0.28 ± 0.03
MW100S	< 0.2	0.08 ± 0.01
MW101D	16.6 ± 1.1	22.4 ± 1.4
MW101S	0.20 ± 0.03	0.13 ± 0.01
MW102D	9.95 ± 0.27	10.5 ± 0.7
MW102S	1.56 ± 0.05	0.80 ± 0.03
MW103D	6.79 ± 0.18	6.76 ± 0.17
MW103S	27.3 ± 1.9	- n.s. -
MW104S	0.14 ± 0.02	0.10 ± 0.01
MW106D	8.48 ± 0.23	22.1 ± 1.4
MW106S	1.27 ± 0.04	3.49 ± 0.10
MW107D	1.37 ± 0.04	0.04 ± 0.00
MW107S	< 0.2	0.04 ± 0.01
MW108S	< 0.2	0.23 ± 0.02
MW109D	9.17 ± 0.24	9.51 ± 0.24
MW109S	< 0.2	0.21 ± 0.02
MW110D	15.1 ± 1.1	5.95 ± 0.15
MW110S	< 0.2	0.00 ± 0.00
MW122D	0.61 ± 0.03	7.78 ± 0.21
MW122S	< 0.2	0.26 ± 0.03
MW200	- n.s. -	0.27 ± 0.02
MW202	- n.s. -	-0.03 ± 0.00
MW203	- n.s. -	0.12 ± 0.01
MW204	- n.s. -	0.11 ± 0.01
MW205	- n.s. -	0.00 ± 0.00
MW206	- n.s. -	0.15 ± 0.01
MW207	- n.s. -	0.21 ± 0.02
MW208	- n.s. -	0.31 ± 0.03

Notes:

- n.s. - Location was not sampled during this round.
(<) Non-detect with minimum detection level (MDL).

Table 4-6: Isotopic Uranium Concentrations (pCi/L) in Groundwater

Well ID	U-234 Conc. ± 2-σ Uncert.	MDC	U-235 Conc. ± 2-σ Uncert	MDC	U-238 Conc. ± 2-σ Uncert	MDC
MW100D	1.73 ± 0.79	0.60	0.24 ± 0.33	0.57	2.23 ± 0.90	0.70
MW101D	5.72 ± 1.29	0.38	0.40 ± 0.35	0.22	5.06 ± 1.21	0.21
MW102D	6.20 ± 1.26	0.64	0.26 ± 0.27	0.34	3.00 ± 0.87	0.43
MW103D	2.38 ± 0.78	0.59	-0.03 ± 0.14	0.39	2.50 ± 0.77	0.31
MW103S	8.46 ± 1.52	0.58	0.50 ± 0.39	0.37	9.88 ± 1.63	0.35
MW106D	2.17 ± 0.71	0.43	0.09 ± 0.18	0.37	2.27 ± 0.72	0.29
MW109D	4.10 ± 0.94	0.40	0.19 ± 0.24	0.39	3.82 ± 0.90	0.15
MW110D	4.33 ± 1.11	0.52	0.12 ± 0.22	0.46	5.32 ± 1.22	0.36

Table 4-7: U-234/U-238 & U-235/U Ratios in Groundwater

Well ID	U-234 Conc. ± 2-σ Uncert.	U-238 Conc. ± 2-σ Uncert.	U-234/U-238 Activity Ratio ± 2-σ Uncert.	U-235 to Total U (%) Mass Ratio
MW100D	1.73 ± 0.79	2.23 ± 0.90	0.78 ± 0.47	1.65
MW101D	5.72 ± 1.29	5.06 ± 1.21	1.13 ± 0.37	1.22
MW102D	6.20 ± 1.26	3.00 ± 0.87	2.07 ± 0.73	1.32
MW103D	2.38 ± 0.78	2.50 ± 0.77	0.95 ± 0.43	-0.195
MW103S	8.46 ± 1.52	9.88 ± 1.63	0.86 ± 0.21	0.787
MW106D	2.17 ± 0.71	2.27 ± 0.72	0.96 ± 0.43	0.643
MW109D	4.10 ± 0.94	3.82 ± 0.90	1.07 ± 0.35	0.78
MW110D	4.33 ± 1.11	5.32 ± 1.22	0.81 ± 0.28	0.341

Table 4-8: Comparison of Total Uranium Concentrations (μg/L) in Groundwater

Well ID	U-234 Conc. ± 2-σ Unc.	U-235 Conc. ± 2-σ Unc.	U-238 Conc. ± 2-σ Unc.	Total U (Sum)	Total U (KPA)	%Diff	Ratio	Z-score
MW100D	0.0003 ± 0.0001	0.138 ± 0.035	6.63 ± 2.69	6.77 ± 2.69	8.38 ± 0.23	-19%	0.81	-1.19
MW101D	0.0009 ± 0.0002	0.203 ± 0.053	15.1 ± 3.6	15.3 ± 3.6	16.60 ± 1.14	-8%	0.92	-0.71
MW102D	0.0010 ± 0.0002	0.131 ± 0.033	8.92 ± 2.60	9.06 ± 2.60	9.95 ± 0.27	-9%	0.91	-0.69
MW103D	0.0004 ± 0.0001	-0.013 ± 0.003	7.44 ± 2.29	7.42 ± 2.29	6.79 ± 0.18	9%	1.09	0.55
MW103S	0.0014 ± 0.0002	0.215 ± 0.056	29.4 ± 4.8	29.6 ± 4.8	27.30 ± 1.87	8%	1.08	0.89
MW106D	0.0003 ± 0.0001	0.055 ± 0.014	6.75 ± 2.13	6.81 ± 2.13	8.48 ± 0.23	-20%	0.80	-1.56
MW109D	0.0007 ± 0.0002	0.072 ± 0.018	11.4 ± 2.7	11.4 ± 2.7	9.17 ± 0.24	25%	1.25	1.68
MW110D	0.0007 ± 0.0002	0.051 ± 0.013	15.8 ± 3.6	15.9 ± 3.6	15.10 ± 1.05	5%	1.05	0.41

Table 4-9: Major Cation and Anion Concentrations in Groundwater

Well ID	Na cation (mg/l)	Mg cation (mg/l)	K cation (mg/l)	Ca cation (mg/l)	Cl ion (mg/l)	Sulfate anion (mg/l)	Carb. Alkalinity (mg/l)	Bicarb. Alkalinity (mg/l)
MW100D	7.39	1.79	1.17	9.13	2.4	16.9	2	12.1
MW100S	6.89	5.78	2.21	14.3	9.82	7.71	2	40.5
MW101D	6.59	2.01	2.38	27.1	9	18	2	59.2
MW101S	7.11	1.79	4.07	24.4	12.1	12.9	2	50.5
MW102D	17.0	3.45	2.34	45.7	61.9	17.6	2	63.7
MW102S	4.56	3.16	4.26	14.0	5.13	13.2	2	40.4
MW103D	15.9	3.55	2.03	44.9	73.7	12.8	2	35.3
MW103S	50.3	0.959	13.20	18.8	24.2	19.4	27.8	79.6
MW104S	24.7	7.23	5.90	32.6	87.6	9.22	2	37.4
MW106D	12.9	2.66	4.58	46.5	83.9	12.1	2	63.6
MW106S	77.3	78.50	13.30	354.	890	21.4	2	60.5
MW107D	11.5	3.38	3.36	13.1	23.5	17.2	2	20.2
MW107S	36.4	4.25	3.73	33.2	119	6.95	2	25.3
MW108S	4.53	1.80	2.35	19.0	4.47	0.358	2	30.4
MW109D	14.6	6.24	6.54	66.3	106	11.4	2	63.6
MW109S	78.9	4.64	13.10	74.9	213	9.01	2	35.4
MW110D	11.7	6.40	6.98	38.0	55.8	18.1	2	42.3
MW110S	19.4	5.13	4.98	34.3	63.8	23.8	2	16.2
MW122D	26.0	0.405	3.17	6.53	6.27	6.95	2	53.2
MW122S	97.2	6.79	6.41	89.6	297	2.96	5.95	40.8

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	14	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 (MW122S) for Third Quarter 2004

Analyte	Sample Concentration ± 2-σ Uncert.	Duplicate Concentration ± 2-σ Uncert.	Units	Ratio	Residual	Z-Score
Gross Beta	9.86 ± 1.67	8.55 ± 1.61	(pCi/L)	0.87	-0.13	-1.13
H-3	621 ± 171	541 ± 167	(pCi/L)	0.87	-0.13	-0.67
Sr-90	1.23 ± 0.456	0.684 ± 0.358	(pCi/L)	0.56	-0.44	-1.88
Boron	220	223	(µg/L)	0.99	-0.01	
Na cation	97.2	94.3	(mg/L)	1.03	0.03	
Mg cation	6.79	6.66	(mg/L)	1.02	0.02	
Cl ion	297	249	(mg/L)	1.19	0.19	
K cation	6.41	6.28	(mg/L)	1.02	0.02	
Ca cation	89.6	87.5	(mg/L)	1.02	0.02	
Sulfate anion	2.96	2.98	(mg/L)	0.99	-0.01	
Carbonate Alkalinity	5.95	2	(mg/L)	2.98	1.98	
Bicarbonate Alkalinity	40.8	77.9	(mg/L)	0.52	-0.48	

Table 5-3: Field Duplicate Results for Fourth Quarter 2004

Sample ID	Analyte	Sample Concentration ± 2-σ Uncert.	Duplicate Concentration ± 2-σ Uncert.	Units	Ratio	Residual	Z-Score
MW102S	Boron	47	48.4	(µg/L)	0.97	-2.9%	
MW125S	Boron	308	335	(µg/L)	0.92	-8.1%	
MW106S	Boron	802	754	(µg/L)	1.06	6.4%	
MW102S	H-3	8930 ± 554	9580 ± 574	(pCi/L)	1.07	7.3%	1.63
MW102S	Total U	0.795 ± 0.0292	0.687 ± 0.0259	(µg/L)	0.86	-13.6%	-5.53

Table 5-4: Lab Duplicate Results for Third Quarter 2004

Sample ID	Analyte	Sample Concentration ± 2-σ Uncert.	Duplicate Concentration ± 2-σ Uncert.	Units	Ratio	Residual	Z-Score
MW106D	H-3	2710 ± 230	2630 ± 225	(pCi/L)	0.97	-3.0%	-0.50
MW100S	Gross β	2.46 ± 1.21	2.2 ± 1.14	(pCi/L)	0.89	-10.6%	-0.31
MW109S	Gross β	9.04 ± 1.29	6.26 ± 1.05	(pCi/L)	0.69	-30.8%	-3.34
MW125S	Gross β	13.5 ± 1.88	14.1 ± 2.02	(pCi/L)	1.04	4.4%	0.43
MW103S	Ni-63	37.3 ± 9.97	31.5 ± 9.39	(pCi/L)	0.84	-15.5%	-0.85
MW103S	Ni-63	37.3 ± 9.97	22.4 ± 8.76	(pCi/L)	0.60	-39.9%	-2.25
MW103S	Ni-63	37.3 ± 9.97	29.6 ± 9.85	(pCi/L)	0.79	-20.6%	-1.10
MW122S	Sr-90	1.23 ± 0.456	1.13 ± 0.392	(pCi/L)	0.92	-8.1%	-0.33
MW106D	U-234	2.17 ± 0.709	1.67 ± 0.7	(pCi/L)	0.77	-23.0%	-1.00
MW109D	U-234	4.1 ± 0.942	3.97 ± 1.03	(pCi/L)	0.97	-3.2%	-0.19
MW106D	U-238	2.27 ± 0.717	3.19 ± 0.935	(pCi/L)	1.41	40.5%	1.56
MW109D	U-238	3.82 ± 0.902	3.35 ± 0.93	(pCi/L)	0.88	-12.3%	-0.73
MW106D	U-235/U total	0.643	1.43	(%)	0.45	-55.0%	
MW109D	U-235/U total	0.78	1.22	(%)	0.64	-36.1%	
MW110S	Bicarb. Alkalinity	16.2	15.2	(mg/L)	1.07	6.6%	
MW102S	Bicarb. Alkalinity	40.4	40.4	(mg/L)	1.00	0.0%	
MW505	Boron	59.9	60.3	(µg/l)	0.99	-0.7%	
MW107S	Boron	99.7	102	(µg/l)	0.98	-2.3%	
MW104S	Boron	268	277	(µg/l)	0.97	-3.2%	
MW100D	Ca cation	9.13	8.83	(mg/L)	1.03	3.4%	
MW108S	Ca cation	19.0	19.6	(mg/L)	0.97	-3.1%	
MW102S	Cl ion	5.13	5.14	(mg/L)	1.00	-0.2%	
MW110S	Cl ion	63.8	63.4	(mg/L)	1.01	0.6%	
MW103D	Cl ion	73.7	72.7	(mg/L)	1.01	1.4%	
MW100D	K cation	1170	1130	(µg/L)	1.04	3.5%	
MW100D	Mg cation	1790	1880	(µg/L)	0.95	-4.8%	
MW100D	Na cation	7390	7110	(µg/L)	1.04	3.9%	
MW103D	Sulfate anion	12.8	12.8	(mg/L)	1.00	0.0%	
MW102S	Sulfate anion	13.2	13.2	(mg/L)	1.00	0.0%	
MW110S	Sulfate anion	23.8	23.8	(mg/L)	1.00	0.0%	
MW102S	Carb. Alkalinity	2	2	(mg/L)	1.00	0.0%	
MW110S	Carb. Alkalinity	2	2	(mg/L)	1.00	0.0%	

Table 5-5: Lab Duplicate Results for Fourth Quarter 2004

Sample ID	Analyte	Sample Concentration ± 2-σ Uncert.	Duplicate Concentration ± 2-σ Uncert.	Units	Ratio	Residual	Z-Score
MW113S	Gross α	1.09 ± 0.628	0.914 ± 0.788	(pCi/L)	0.84	-16.1%	-0.35
MW110D	Gross α	3.46 ± 0.797	2.88 ± 0.927	(pCi/L)	0.83	-16.8%	-0.95
MW102D	Gross α	10.4 ± 1.66	10.4 ± 1.62	(pCi/L)	1.00	0.0%	0.00
MW508D	Gross α	15.7 ± 1.97	7.51 ± 1.62	(pCi/L)	0.48	-52.2%	-6.42
MW100D	Gross β	2.7 ± 1.16	2.47 ± 1.54	(pCi/L)	0.91	-8.5%	-0.24
MW113S	Gross β	3.24 ± 1.07	15.4 ± 1.69	(pCi/L)	4.75	375.3%	12.16
MW110D	Gross β	6.34 ± 1	7.08 ± 1.5	(pCi/L)	1.12	11.7%	0.82
MW102D	Gross β	8.6 ± 1.34	7.7 ± 1.35	(pCi/L)	0.90	-10.5%	-0.95
MW508D	Gross β	21.4 ± 1.87	16.5 ± 1.79	(pCi/L)	0.77	-22.9%	-3.79
MW122S	H-3	609 ± 195	570 ± 266	(pCi/L)	0.94	-6.4%	-0.24
MW110S	H-3	1820 ± 354	2030 ± 363	(pCi/L)	1.12	11.5%	0.83
MW110D	H-3	3400 ± 439	3900 ± 421	(pCi/L)	1.15	14.7%	1.64
MW107S	Sr-90	0.838 ± 0.533	0.897 ± 0.485	(pCi/L)	1.07	7.0%	0.16
MW125S	Sr-90	3.08 ± 0.53	2.86 ± 0.517	(pCi/L)	0.93	-7.1%	-0.59
EP171	Total U	0.672 ± 0.0271	0.687 ± 0.0252	(µg/L)	1.02	2.2%	0.81
MW102S	Total U	0.795 ± 0.0292	0.74 ± 0.0323	(µg/L)	0.93	-6.9%	-2.53
MW3	Boron	6.9	6.36	(µg/L)	1.08	8.5%	
MW100D	Boron	13.7	11.2	(µg/L)	1.22	22.3%	
MW102S dup	Boron	48.4	46.2	(µg/L)	1.05	4.8%	
MW102S dup	Boron	48.4	43.2	(µg/L)	1.12	12.0%	
MW508D	Boron	58.9	60.4	(µg/L)	0.98	-2.5%	
EOF2	Boron	85.6	88.6	(µg/L)	0.97	-3.4%	
MW109S	Boron	98.6	103	(µg/L)	0.96	-4.3%	
MW110D	Boron	102	103	(µg/L)	0.99	-1.0%	
MW100S	Boron	143	109	(µg/L)	1.31	31.2%	
MW122S	Boron	184	187	(µg/L)	0.98	-1.6%	
MW110S	Boron	281	292	(µg/L)	0.96	-3.8%	
MW125S dup	Boron	308	335	(µg/L)	0.92	-8.1%	
MW125S dup	Boron	335	316	(µg/L)	1.06	6.0%	

Table 5-6: Lab Duplicate Results for Seep Sample Events

– November 2004 through February 2005 –

Sample ID	Analyte	Sample Concentration ± 2-σ Uncert.	Duplicate Concentration ± 2-σ Uncert.	Units	Ratio	Residual	Z-Score
Seep 2	Gross β	55.4 ± 2.5	50.0 ± 2.41	(pCi/L)	0.90	-9.7%	-3.11
Seep 3	Gross β	20.5 ± 2.27	22.2 ± 2.37	(pCi/L)	1.08	8.3%	1.04
Seep 1	H-3	3250 ± 290	3360 ± 307	(pCi/L)	1.03	3.4%	0.52
Seep 1	H-3	2660 ± 248	2860 ± 260	(pCi/L)	1.08	7.5%	1.11
Seep 2	H-3	2970 ± 271	3010 ± 271	(pCi/L)	1.01	1.3%	0.21
Seep 2	H-3	1790 ± 339	1920 ± 334	(pCi/L)	1.07	7.3%	0.55
Seep 3	H-3	1510 ± 305	1660 ± 311	(pCi/L)	1.10	9.9%	0.69
Seep 1 Rock	Sr-90	567 ± 82.6	604 ± 77.3	(pci/kg)	1.07	6.5%	0.65
Seep 1	Sr-90	25.6 ± 1.41	24.4 ± 1.35	(pCi/L)	0.95	-4.7%	-1.23
Seep 1	Sr-90	21.4 ± 3.63	15.6 ± 2.51	(pCi/L)	0.73	-27.1%	-2.63
Seep 2	Sr-90	22.3 ± 1.36	23.6 ± 1.41	(pCi/L)	1.06	5.8%	1.33
Seep 2	Sr-90	28.6 ± 2.13	23.3 ± 1.68	(pCi/L)	0.81	-18.5%	-3.91
Seep 3	Sr-90	9.86 ± 1.29	10.0 ± 1.28	(pCi/L)	1.01	1.4%	0.15
Seep 1	Bicarb. Alkalinity	77.5	78.5	(mg/L)	0.99	-1.3%	
Seep 2	Boron	508	521	(µg/L)	0.98	-2.5%	
Seep 2	Boron	500	484	(µg/L)	1.03	3.3%	
Seep 3	Boron	215	217	(µg/L)	0.99	-0.9%	
Seep 1	Ca cation	68700	68100	(µg/L)	1.01	0.9%	
Seep 3	Ca cation	46800	47200	(µg/L)	0.99	-0.8%	
Seep 1	Cl ion	115	115	(mg/L)	1.00	0.0%	
Seep 3	Cl ion	53.3	52.8	(mg/L)	1.01	0.9%	
Seep 1	K cation	8370	8210	(µg/L)	1.02	1.9%	
Seep 3	K cation	6040	6060	(µg/L)	1.00	-0.3%	
Seep 1	Mg cation	5980	5960	(µg/L)	1.00	0.3%	
Seep 3	Mg cation	4400	4500	(µg/L)	0.98	-2.2%	
Seep 1	Na cation	22400	22200	(µg/L)	1.01	0.9%	
Seep 3	Na cation	13200	13300	(µg/L)	0.99	-0.8%	
Seep 1	Sulfate anion	22.5	22.6	(mg/L)	1.00	-0.4%	
Seep 3	Sulfate anion	14.5	15.6	(mg/L)	0.93	-7.1%	
Seep 3	TDS	354	344	(mg/L)	1.03	2.9%	
Seep 3	TDS	354	347	(mg/L)	1.02	2.0%	

Table 5-7: 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 5-8: MAPEP Lab Performance Data Summary

Sample Media	Gamma Isotopic	Alpha Isotopic	HTD	False Positive	Total
Filter	100%	100%	100%	-	100%
Water	100.%	96.7%	90.9%	66.7%	96.6%
Soil	100.%	90.0%	73.3%	66.7%	92.0%
All Totals	100.%	93.8%	84.2%	66.7%	94.7%

Table 5-9: ERA Lab Performance Data Summary

Gamma Isotopic	Alpha Isotopic	HTD	Total
97.0%	100.%	100.%	98.7%

Table 5-10: QC Summary for Third Quarter 2004 Sample Event

Sample Type	Analyte Tests	Percent of Total Samples
Samples	845	68.4%
QC Blanks	98	7.9%
QC Lab Controls	110	8.9%
QC Matrix Spikes	88	7.1%
QC Duplicates	95	7.7%
Sample/QC Totals	1236	100%

Table 5-11: QC Summary for Fourth Quarter 2004 Sample Event

Sample Type	Analyte Tests	Percent of Total Samples
Samples	991	67.4%
QC Blanks	93	6.3%
QC Lab Controls	103	7.0%
QC Matrix Spikes	88	6.0%
QC Duplicates	196	13.3%
Sample/QC Totals	1471	100%

Table 5-12: QC Summary for Seep Sample Events

Sample Type	Analyte Tests	Percent of Total Samples
Samples	274	37.5%
QC Blanks	125	17.1%
QC Lab Controls	128	17.5%
QC Matrix Spikes	100	13.7%
QC Duplicates	103	14.1%
Sample/QC Totals	730	100%

Table 5-13: Lab QC Acceptance Limits

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

Table 5-14: Internal Performance Data Summary (LCS, MS)

Method	Sep. 2004	Dec. 2004	Seeps	Total
Boron/Geochem	100%	100%	90.3%	96.9%
γ-isotopic	100%	100%	100%	100%
α-isotopic	100%	100%	100%	100%
LSC	100%	100%	94.9%	97.9%
GPC	100%	100%	100%	100%
All Totals	100%	100%	96.5%	98.7%

Table 5-15: Case Narrative Summary for Third Quarter 2004

Analyte	Samples	Quality Issue Identified	Resolution/Comments
Gross α/β	100S & dup, 109S & dup	High relative percent difference/relative error ratio	Recounted samples
Gross α/β	All	High hygroscopic salt content causes sample mass to fluctuate with moisture content	Salts converted to oxide by flaming planchet, volatile radionuclides lost (H, C, Tc, Cs)
Gross α/β	Process batch	Samples not scanned into process batch prior to analysis	COC maintained, NCR issued
Gross α/β	MB	False positive based on sample type	Recounted sample
Gross α/β	102S, 102S dup, MB, MS, MSD	Low/high recovery observed	Samples were re-prepped and recounted
C-14	Process batch	High lumex or quench indicator	Samples recounted
C-14	104S & dup	No detectable activity to calculate RPD	Sample MDC used to calculate the RPD
Fe-55	104S	Sample not scanned into process batch prior to analysis	COC maintained, NCR issued
Fe-55	104S, MB	Negative result greater than 3 times the counting uncertainty	Recounted samples
Ni-63	104S, MB	Samples did not meet required analysis sensitivity (MDC>RDL)	MW104S was recounted. MB reported as is. NCR issued to document low yield in MB.
Ni-63	104S & dup	High relative percent difference/relative error ratio	Recounted samples
Sr-90	103S, 106S, 122S, 123S, 125S, 600	Statistically significant or high Sr-90 activity results	Sample results were verified by recounting at least 5-days from the initial scan
γ-isotopic	507S	False positive based on duplicate analysis	Sample recounted and reported.
Pu α-isotopic	104S	Alpha peak region-of-interest (ROI) resolution	Manual integration of peak ROI
Total U.	Process batch	High relative percent difference/relative error ratio	Re-prepped samples
Ions	Multiple	High concentrations	Samples diluted prior to analysis
Ions	100D, 102S	Software peak integration errors	Manual peak integration
ICP-MS	104S, 107D, 109S&D, QC samples	Serial dilution difference greater than 10% for boron, K and Na	Noted in case narrative

Table 5-16: Case Narrative Summary for Fourth Quarter 2004

Analyte	Samples	Quality Issue Identified	Resolution/Comments
Gross α/β	All	High hygroscopic salt content causes sample mass to fluctuate with moisture content	Salts converted to oxide by flaming planchet. Volatile radionuclides may be lost (H, C, Tc, Cs)
Gross α/β	202, 203, 204, 503	Statistically significant activity results	Samples recounted to verify results. Second count reported
Gross α/β	Multiple	Statistically significant activity results	Samples were verified by recounting.
Gross α/β	106S	Sample did not meet required analysis sensitivity (MDC>RDL). Volume limited by allowed sample mass	Recounted sample for 500-min. Reported results.
H-3	LCS	The H-3 recovery (%R) was greater than acceptance criteria	Recounted LCS sample
H-3	MB	Sample did not meet required analysis sensitivity (MDC>RDL)	Recounted sample
H-3	100D&S, 101S, 104S, 106S, 122S, 123S, 503, 505	Sample activity between critical level and detection limit	Recounted samples
H-3	109S, 110D, 122S	Samples were preserved. MW110D was preserved but labeled as non-preserved	Sodium hydroxide pellets added to samples. NCR issued. Results reported.
Fe-55	103D, 106D, ATW, MB, MS, LCS, 200, 202, 203, 204, 206, 207, CMS	Sample did not meet required analysis sensitivity (MDC>RDL)	Recounted samples
Ni-63	CMS, ATW1, MB, 202, 203, 204, 206	Negative result greater than 3 times the counting uncertainty	Recounted samples
Ni-63	CMS, ATW1, MB, 200, 202, 203, 204, 206, 207	Sample did not meet required analysis sensitivity (MDC>RDL).	Recounted samples
Ni-63	MB, 200, 207	Sample activity between critical level and detection limit	Recounted samples
Sr-90	3	Sample did not meet required analysis sensitivity due to limited volume (MDC>RDL)	Sample was re-prepped and recounted for 500-min. NCR issued to document MDC>RDL

Table 5-16: Case Narrative Summary for Fourth Quarter 2004 (continued)

Analyte	Samples	Quality Issue Identified	Resolution/Comments
Sr-90	CMS, 106S, 107S, 110D, 108S, 109S, 125S	Statistically significant or high Sr-90 activity results	Sample results were verified by recounting at least 5-days from the initial scan.
Sr-90	MB, 106D, 122S, 124S,	Statistically significant Sr-90 activity results	Samples recounted and recounts were reported.
Tc-99	MB, 104S, 203, 205, 207, 208, EP166	Sample activity between critical level and detection limit	Samples recounted to verify results.
Tc-99	106S	Suspected false positive	Recounted samples
γ-isotopic	None	Non-rad sample processed with rad samples	No contamination noted. NCR issued
Pu α-isotopic	EP166	Poor alpha peak resolution	Recounted samples
Pu-241	204	Sample did not meet required analysis sensitivity (MDC>RDL)	Recounted samples
Pu-241	104S	Statistically significant activity results	Recounted sample to confirm detect.
Am/Cm α-isotopic	All	Suspected false positive for Am-241, Cm-243,244.	Polonium α-recoil contamination from previous samples. Future Po, U, Th samples will be segregated.
Am/Cm α-isotopic	103D	Negative result greater than 3 times the counting uncertainty	Recounted sample
Am/Cm α-isotopic	EP171, 106D, 202	Suspected false positive for Am/Cm	Recounted sample
Am/Cm α-isotopic	CMS, CMS dup, 106D, 106D dup	High relative percent difference/relative error ratio. Relative error ratio for Cm-243,44 passes at 0.618	Recounted CMS samples. NCR issued for MW106D.
Am/Cm α-isotopic	106D	Poor alpha peak resolution	Recounted samples
Am/Cm α-isotopic	MB, 203, 206, 200	Sample did not meet required analysis sensitivity (MDC>RDL)	Recounted samples
ICP-MS	Batch	B serial dilution difference was greater than 10%	Noted in case narrative

Table 5-17: Case Narrative Summary for Bedrock Seep Samples

Analyte	Samples	Quality Issue Identified	Resolution/Comments
Gross α/β	All	High hygroscopic salt content causes sample mass to fluctuate with moisture content	Salts converted to oxide by flaming planchet. Volatile radionuclides may be lost (H, C, Tc, Cs)
Gross α/β	Seep 2, dup	High relative percent difference/relative error ratio observed	Samples were recounted
H-3	LCS	Low/high recovery observed	Sample was recounted
H-3	MB	Negative result greater than 3 times the uncertainty	Recounted samples
Fe-55	MB, Seep 1, dup, 2, 3	Sample did not meet required analysis sensitivity due to limited volume (MDC>RDL)	Samples were recounted for 120-min. NCR issued to document MDC>RDL
Sr-90	Seep 2, 3	Statistically significant or high Sr-90 activity results	Sample results were verified by historical data or recounting at least 5-days from the initial scan.
Sr-90	Seep 2, dup	High relative percent difference/relative error ratio observed. %R fails at 21%. Relative error at 0.973	Samples were recounted. Issued NCR for failed RPD.
Tc-99	MB	Blank was greater than MDC but less than RDL	Noted in case narrative
Pu α-isotopic	Seep 1, 2, 3, LCS, 1 weathered rock	Poor alpha peak resolution	Manual integration of peak ROI or recounted sample
Pu-241	MB	Sample did not meet required analysis sensitivity (MDC>RDL).	Recounted samples
Pu-241	Seep 1 weathered rock	Low/high recovery observed	Sample was recounted
Pu-241	Seep 1 weathered rock, MB, dup, MS, LCS	High background count observed.	Sample batch was recounted
Am/Cm α-isotopic	Seep 1	Poor alpha peak resolution	Recounted sample
ICP Metals	Batch	B, Mg, K serial dilution difference (%D) was greater than 10%	Noted in case narrative
Ions	Seep 1, 2, 3	High concentrations	Samples diluted prior to analysis
Ions	Seep 3	Samples run on two different instruments	NCR issued
Anions	Seep 1	Matrix spike recovery outside acceptance limits for chloride and sulfate due to matrix interference	Noted in case narrative. NCR issued
TDS	Seep 1, 2, 3	Insufficient time to prep and analyze with method-specified holding time	Samples analyzed as soon as possible. NCR issued

Table 5-18: Summary Statistics for Third Quarter 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 Uncert.	Conc.> MCL
Gross α	GPC	43	-1.08	40.80	3.84	7.62	1.04	15	24	3
Gross β	GPC	43	0.42	47.60	9.12	9.62	6.25	50	42	0
H-3	LSC	42	-153	31000	2211	5519	214	20000	21	1
C-14	LSC	7	-10.00	14.40	1.13	8.19	0.84	2000	2	0
Mn-54	Gamma	42	-2.61	1.35	-0.31	0.99	-0.09	300	0	0
Fe-55	LSC	7	-36.0	9.3	-3.9	17.0	3.7	2000	0	0
Co-60	Gamma	44	-3.47	44.60	1.53	7.18	0.32	100	3	0
Ni-63	LSC	9	-6.93	37.30	12.12	17.78	3.99	50	4	0
Sr-90	GPC	29	-0.15	7.30	0.78	1.46	0.34	8	11	0
Nb-94	Gamma	42	-2.20	3.35	0.28	1.03	0.42	-	1	0
Tc-99	LSC	7	-4.46	1.31	-2.08	2.31	-1.73	900	0	0
Ag-108m	Gamma	42	-2.99	3.33	-0.24	1.33	-0.20	-	0	0
Cs-134	Gamma	42	-2.38	2.44	0.32	1.15	0.32	20000	1	0
Cs-137	Gamma	44	-1.89	27.20	1.16	4.18	0.47	20	5	1
Eu-152	Gamma	42	-6.81	7.69	-0.26	3.20	-0.66	60	1	0
Eu-154	Gamma	42	-4.03	5.89	-0.01	2.43	-0.12	200	1	0
Eu-155	Gamma	42	-9.63	12.70	0.80	4.19	0.58	600	1	0
U-234	Alpha	10	1.67	8.46	4.07	2.22	4.04	20	8	0
U-235	Alpha	10	-0.03	0.50	0.23	0.15	0.25	20	2	0
U-238	Alpha	10	2.23	9.88	4.06	2.31	3.27	20	8	0
Pu-238	Alpha	7	-0.048	0.034	-0.006	0.025	-0.008	15	0	0
Pu-239,240	Alpha	7	-0.034	0.076	0.015	0.036	0.019	15	0	0
Pu-241	LSC	7	-1.99	5.76	1.13	2.74	0.54	-	0	0
Am-241	Gamma	42	-22.2	14.6	-1.3	7.6	-0.1	15	2	0
Am-241	Alpha	7	-0.007	0.099	0.044	0.037	0.027	15	0	0
Cm-242	Alpha	7	-0.041	0.038	-0.011	0.027	-0.008	15	0	0
Cm-243,44	Alpha	7	-0.075	0.066	-0.004	0.048	-0.009	15	0	0
Totals		683							137	5

Table 5-19: Summary Statistics for Fourth Quarter 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 Uncert.	Conc.> MCL
Gross α	GPC	64	-0.9310	15.7000	1.8606	3.755	0.262	15	17	1
Gross β	GPC	64	-1.080	39.300	5.9378	6.893	5.025	50	40	0
H-3	LSC	63	-98.00	10800.00	1234.8	2552.090	101.000	20000	18	0
C-14	LSC	18	-1.7800	7.7900	1.5013	2.281	1.310	2000	1	0
Mn-54	Gamma	65	-3.5000	2.8600	-0.3737	1.349	-0.476	300	1	0
Fe-55	LSC	19	-15.100	21.500	3.1915	11.357	4.080	2000	3	0
Co-60	Gamma	65	-3.1700	11.1000	1.1516	2.654	0.412	100	9	0
Ni-63	LSC	19	-8.190	3.950	-0.8728	3.953	0.504	50	2	0
Sr-90	GPC	52	-1.0100	8.5600	0.5043	1.356	0.209	8	10	1
Nb-94	Gamma	65	-3.7000	7.7900	0.0371	1.695	-0.060	-	3	0
Tc-99	LSC	20	-3.000	6.800	1.3936	2.515	1.845	900	1	0
Ag-108m	Gamma	65	-6.5900	4.4400	0.0332	1.543	0.009	-	1	0
Cs-134	Gamma	65	-2.7000	5.4700	0.4961	1.461	0.434	20000	4	0
Cs-137	Gamma	65	-5.4200	6.6100	0.3957	1.982	0.263	20	5	0
Eu-152	Gamma	65	-25.9000	11.1000	-0.283	5.557	0.463	60	1	0
Eu-154	Gamma	65	-9.6300	10.7000	-0.1613	4.175	-0.754	200	2	0
Eu-155	Gamma	65	-15.8000	9.9200	-0.1997	4.908	0.149	600	1	0
Pu-238	Alpha	19	-0.1500	0.1450	-0.0025	0.082	-0.027	15	1	0
Pu-239,240	Alpha	19	-0.0704	0.0758	0.0031	0.035	0.000	15	0	0
Pu-241	LSC	23	-8.430	17.500	0.2522	6.278	-1.350	-	3	0
Am-241	Gamma	65	-55.4000	21.4000	-1.305	10.578	-0.207	15	2	0
Am-241	Alpha	19	-0.0590	0.2190	0.0373	0.059	0.036	15	1	0
Cm-242	Alpha	18	-0.0438	0.1830	0.0279	0.051	0.018	15	0	0
Cm-243,44	Alpha	19	-0.1310	0.0600	-0.0284	0.054	-0.034	15	0	0
Totals		1086							126	2

Table 5-20: Limiting Mean Distribution Summary for Third Quarter 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	0.3460	0.7326	27	2.454	3.590	-	0.981	0.96	Normal
Gross β	GPC	1.627	0.660	7	6.523	5.625	Positive	0.988	0.899	Normal
H-3	LSC	92.31	111.63	24	4.051	3.646	Positive	0.962	0.957	Normal
C-14	LSC	1.13	8.19	7	0.365	5.625	-	0.988	0.899	Normal
Mn-54	Gamma	-0.3147	0.9901	42	-2.060	3.440	-	0.984	0.973	Normal
Fe-55	LSC	5.4253	3.9312	5	3.086	7.959	-	0.96	0.879	Normal
Co-60	Gamma	0.2405	1.0820	41	1.423	3.446	-	0.985	0.973	Normal
Ni-63	LSC	-2.338	3.982	5	-1.313	7.959	-	0.942	0.879	Normal
Sr-90	GPC	0.2559	0.2101	22	5.713	3.693	Positive	0.981	0.954	Normal
Nb-94	Gamma	0.3321	0.7498	39	2.766	3.460	-	0.984	0.971	Normal
Tc-99	LSC	-2.075	2.315	7	-2.372	5.625	-	0.954	0.899	Normal
Ag-108m	Gamma	-0.2433	1.3315	42	-1.184	3.440	-	0.986	0.973	Normal
Cs-134	Gamma	0.3208	1.1487	42	1.810	3.440	-	0.98	0.973	Normal
Cs-137	Gamma	0.5553	1.1524	43	3.160	3.434	-	0.993	0.973	Normal
Eu-152	Gamma	-0.2570	3.1988	42	-0.521	3.440	-	0.994	0.973	Normal
Eu-154	Gamma	-0.0146	2.4334	42	-0.039	3.440	-	0.985	0.973	Normal
Eu-155	Gamma	0.7960	4.1928	42	1.230	3.440	-	0.985	0.973	Normal
U-234	Alpha	1.9875	0.3437	4	11.565	11.675	-	0.956	0.868	Normal
U-235	Alpha	0.2341	0.1534	10	4.826	4.568	Positive	0.987	0.917	Normal
U-238	Alpha	2.3333	0.1457	3	27.738	27.190	Positive	0.926	0.879	Normal
Pu-238	Alpha	-0.0058	0.0253	7	-0.607	5.625	-	0.974	0.899	Normal
Pu-239,240	Alpha	0.0149	0.0358	7	1.101	5.625	-	0.984	0.899	Normal
Pu-241	LSC	1.135	2.738	7	1.097	5.625	-	0.97	0.899	Normal
Am-241	Alpha	-2.3447	5.3125	37	-2.685	3.475	-	0.986	0.969	Normal
Am-241	Gamma	0.044	0.037	7	3.173	5.625	-	0.974	0.899	Normal
Cm-242	Alpha	-0.0106	0.0269	7	-1.043	5.625	-	0.961	0.899	Normal
Cm-243	Alpha	-0.0040	0.0479	7	-0.221	5.625	-	0.997	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 5-21: Limiting Mean Distribution Summary for Fourth Quarter 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	-0.014	0.449	44	-0.213	3.428	-	0.996	0.974	Normal
Gross β	GPC	1.244	1.005	27	6.434	3.590	Positive	0.983	0.96	Normal
H-3	LSC	51.50	83.62	41	3.944	3.446	Positive	0.983	0.973	Normal
C-14	LSC	1.131	1.706	17	2.735	3.872	-	0.979	0.942	Normal
Mn-54	Gamma	-0.374	1.349	65	-2.234	3.352	-	0.994	0.982	Normal
Fe-55	LSC	3.192	11.357	19	1.225	3.787	-	0.982	0.947	Normal
Co-60	Gamma	0.398	1.346	58	2.255	3.371	-	0.991	0.98	Normal
Ni-63	LSC	-0.873	3.953	19	-0.962	3.787	-	0.956	0.947	Normal
Sr-90	GPC	0.140	0.221	41	4.069	3.446	Positive	0.986	0.973	Normal
Nb-94	Gamma	-0.084	1.396	64	-0.482	3.355	-	0.986	0.981	Normal
Tc-99	LSC	1.394	2.515	20	2.478	3.752	-	0.972	0.95	Normal
Ag-108m	Gamma	0.027	0.905	60	0.230	3.365	-	0.996	0.981	Normal
Cs-134	Gamma	0.361	1.260	63	2.276	3.357	-	0.995	0.981	Normal
Cs-137	Gamma	0.236	1.482	61	1.245	3.362	-	0.988	0.981	Normal
Eu-152	Gamma	0.117	4.560	64	0.206	3.355	-	0.985	0.981	Normal
Eu-154	Gamma	-0.161	4.175	65	-0.311	3.352	-	0.993	0.982	Normal
Eu-155	Gamma	0.044	4.532	64	0.078	3.355	-	0.998	0.981	Normal
Pu-238	Alpha	-0.003	0.082	19	-0.133	3.787	-	0.989	0.947	Normal
Pu-239,240	Alpha	0.003	0.035	19	0.387	3.787	-	0.988	0.947	Normal
Pu-241	LSC	-2.178	3.696	20	-2.635	3.752	-	0.956	0.95	Normal
Am-241	Alpha	0.027	0.040	18	2.856	3.827	-	0.982	0.945	Normal
Am-241	Gamma	-1.120	7.379	62	-1.195	3.360	-	0.996	0.981	Normal
Cm-242	Alpha	0.019	0.034	17	2.295	3.872	-	0.99	0.942	Normal
Cm-243	Alpha	-0.028	0.054	18	-2.223	3.827	-	0.986	0.945	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 5-22: Observed False-Positive Rates

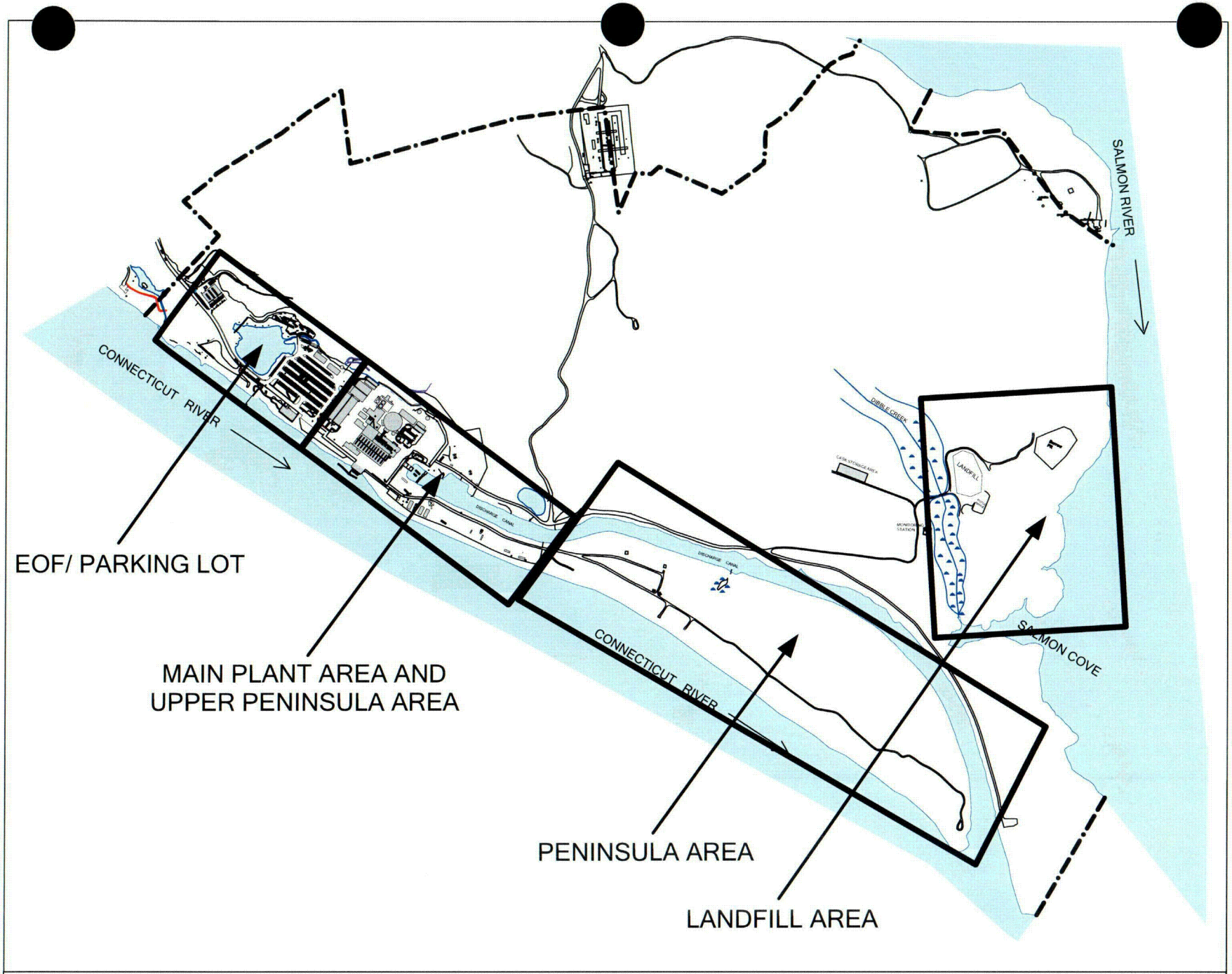
Analysis Type	September 2004	December 2004	Average Rate
Gamma Isotopic	2.9%	4.5%	3.9%
Alpha Isotopic	0.0%	1.2%	0.8%
HTD Beta via LSC	7.0%	6.7%	6.7%

Table 5-23: 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

Table 6-1: Summary of Seep SOCs in the Plant Area

Well ID	Boron	Analysis Date	Tritium	Analysis Date	Sr-90	Analysis Date
Seep #1			3,250	24-Jan-05	25.6	24-Jan-05
Seep #1	505	16-Feb-05	2,660	5-Feb-05	21.4	5-Feb-05
Seep #2					25.5	30-Nov-04
Seep #2			3,000	24-Jan-05	24.8	24-Jan-05
Seep #2	567	16-Feb-05	2,800	5-Feb-05	24.7	5-Feb-05
Seep #2	508	21-Feb-05	2,970	18-Feb-05	22.3	18-Feb-05
Seep #3					4.81	30-Nov-04
Seep #3	261	25-Jan-05	1,510	23-Jan-05	9.86	21-Jan-05
Seep #3	215	16-Feb-05	1,020	5-Feb-05	17.2	5-Feb-05
Seep #3	117	21-Feb-05	262	18-Feb-05	4.63	18-Feb-05
Seep #4					2.79	30-Nov-04
Seep #4	351	16-Feb-05	2,650	5-Feb-05	3.14	5-Feb-05
Seep #4	415	21-Feb-05	2,370	18-Feb-05	2.93	18-Feb-05
Seep #1	468	16-Feb-05	Not Analyzed		Not Analyzed	
Seep #1	505	16-Feb-05	Not Analyzed		Not Analyzed	
Seep #2	478	16-Feb-05	Not Analyzed		Not Analyzed	
Seep #2	505	16-Feb-05	Not Analyzed		Not Analyzed	
Seep #3	262	16-Feb-05	Not Analyzed		Not Analyzed	
Seep #3	277	16-Feb-05	Not Analyzed		Not Analyzed	
Seep #4	378	16-Feb-05	Not Analyzed		Not Analyzed	



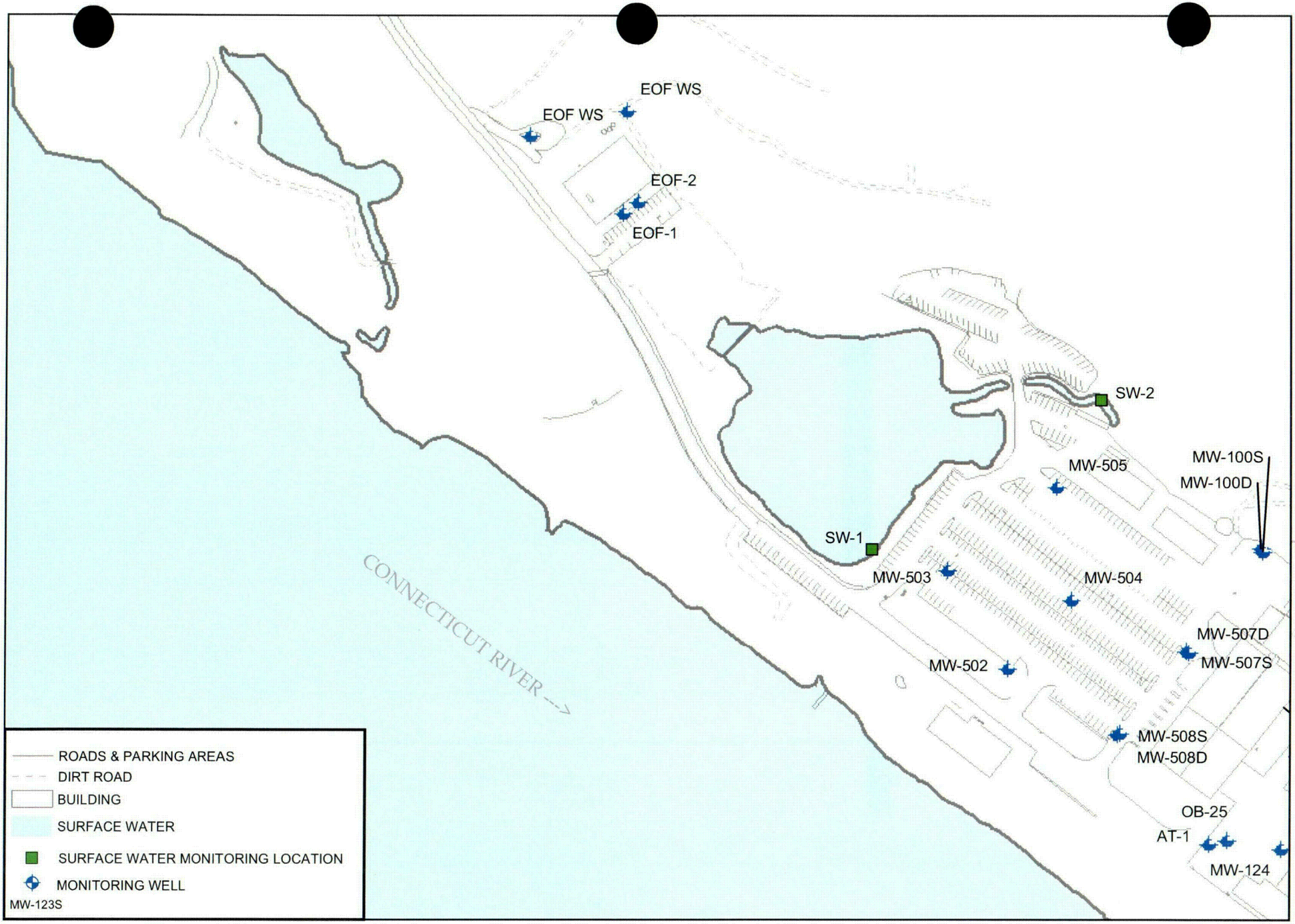
BUILDINGS
SWAMP
SURFACE WATER
PROPERTY LINE
N

CH2MHILL

FIGURE 1-1
HADDAM NECK PLANT PROPERTY MAP
HADDAM NECK, CT

27feb04_CY Site Map of HNP

C01



N

0 100 200 Feet

CH2MHILL

FIGURE 2-1
GROUNDWATER AND SURFACE WATER MONITORING LOCATIONS
AT THE EOF AND PARKING LOT AREA OF THE HADDAM NECK PLANT
HADDAM NECK, CT

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\BaseMap_EOF_ParkingLot.mxd JKelly 3/3/2005

C02

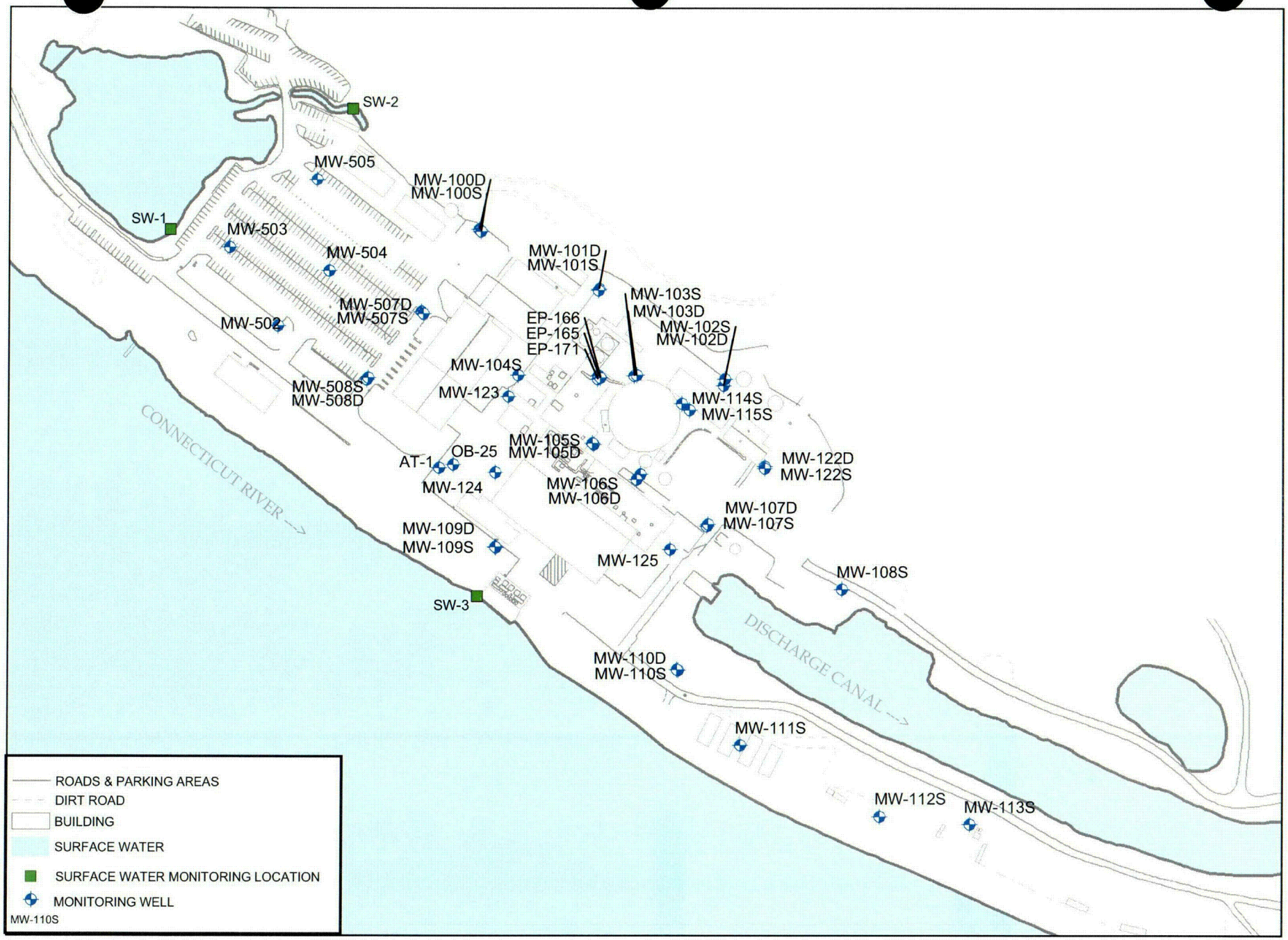
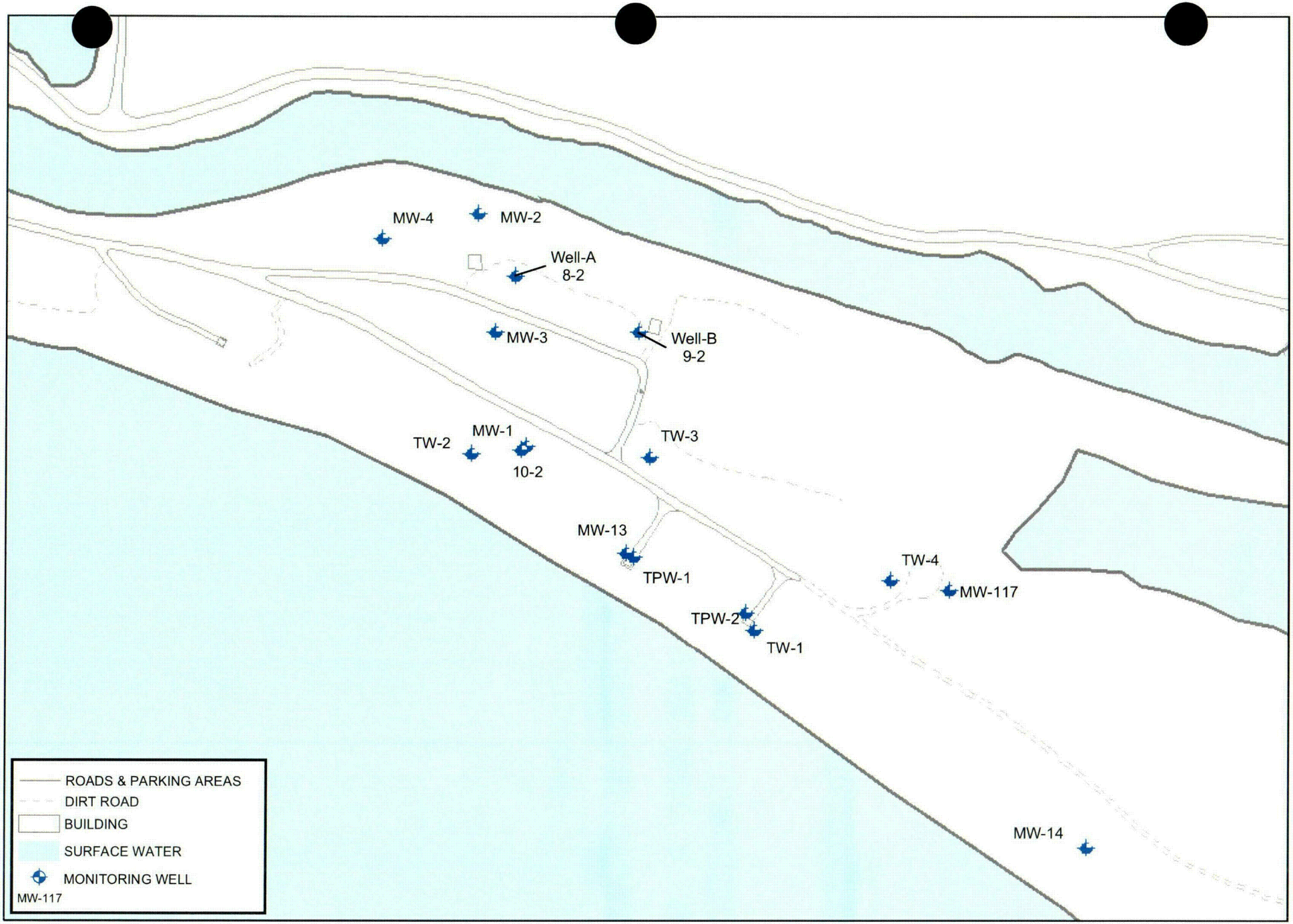


FIGURE 2-2
GROUNDWATER AND SURFACE WATER MONITORING LOCATIONS AT THE INDUSTRIAL AREA AND UPPER PENINSULA AREA OF THE HADDAM NECK PLANT
HADDAM NECK, CT

CH2MHILL

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\BaseMap_IndustrialArea.mxd JKelly 3/29/2005

C03



N

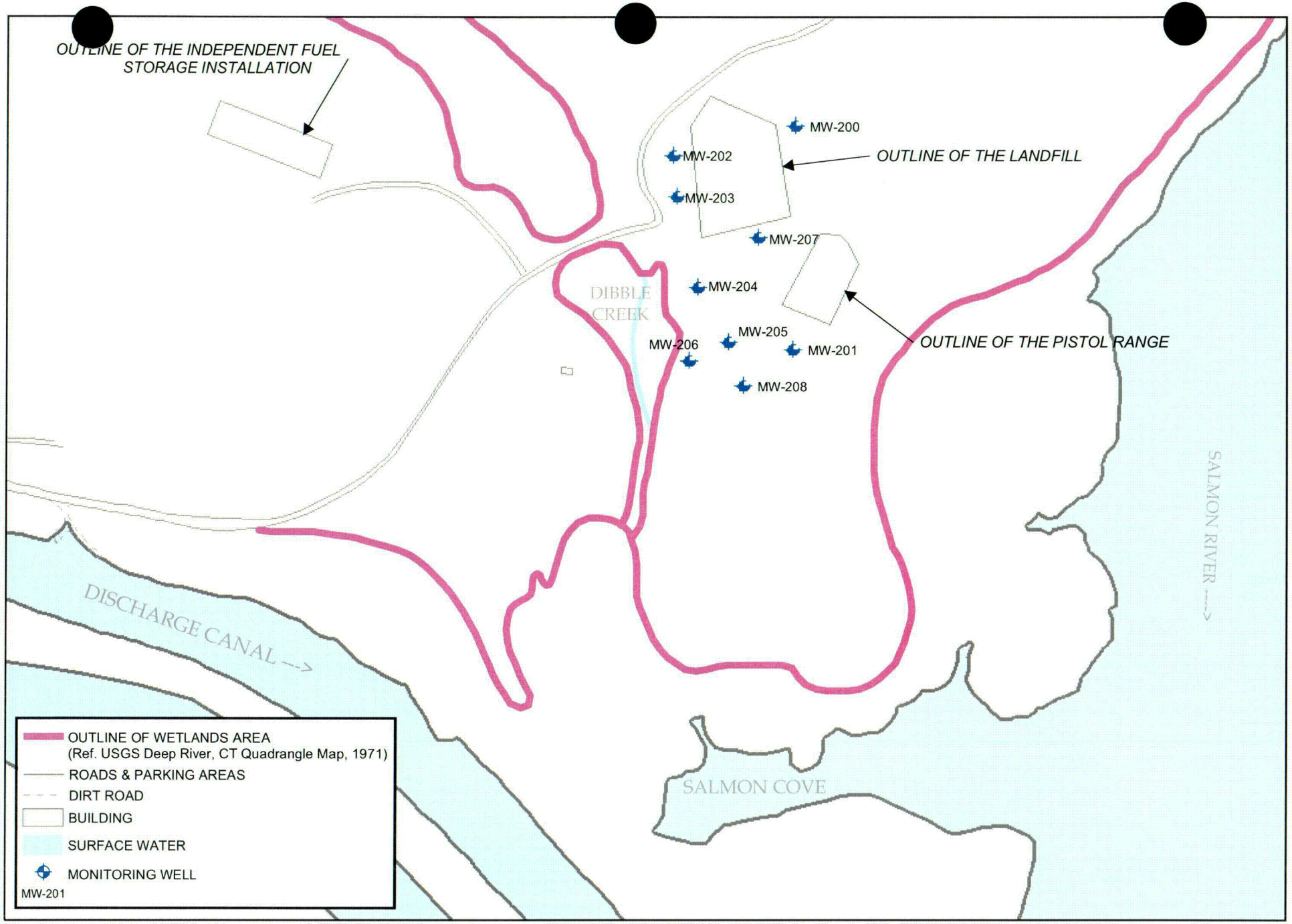
0 100 200 Feet

CH2MHILL

FIGURE 2-3
GROUNDWATER MONITORING LOCATIONS AT THE PENINSULA AREA OF THE HADDAM NECK PLANT
HADDAM NECK, CT

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_4_2004\BaseMap_Peninsula.mxd NMoudry 4/12/2004

c04



CH2MHILL

FIGURE 2-4
GROUNDWATER MONITORING LOCATIONS AT THE LANDFILL AREA OF THE HADDAM NECK PLANT
HADDAM NECK, CT

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_4_2004\BaseMap_Landfill.mxd NMoudry 4/12/2004

C05

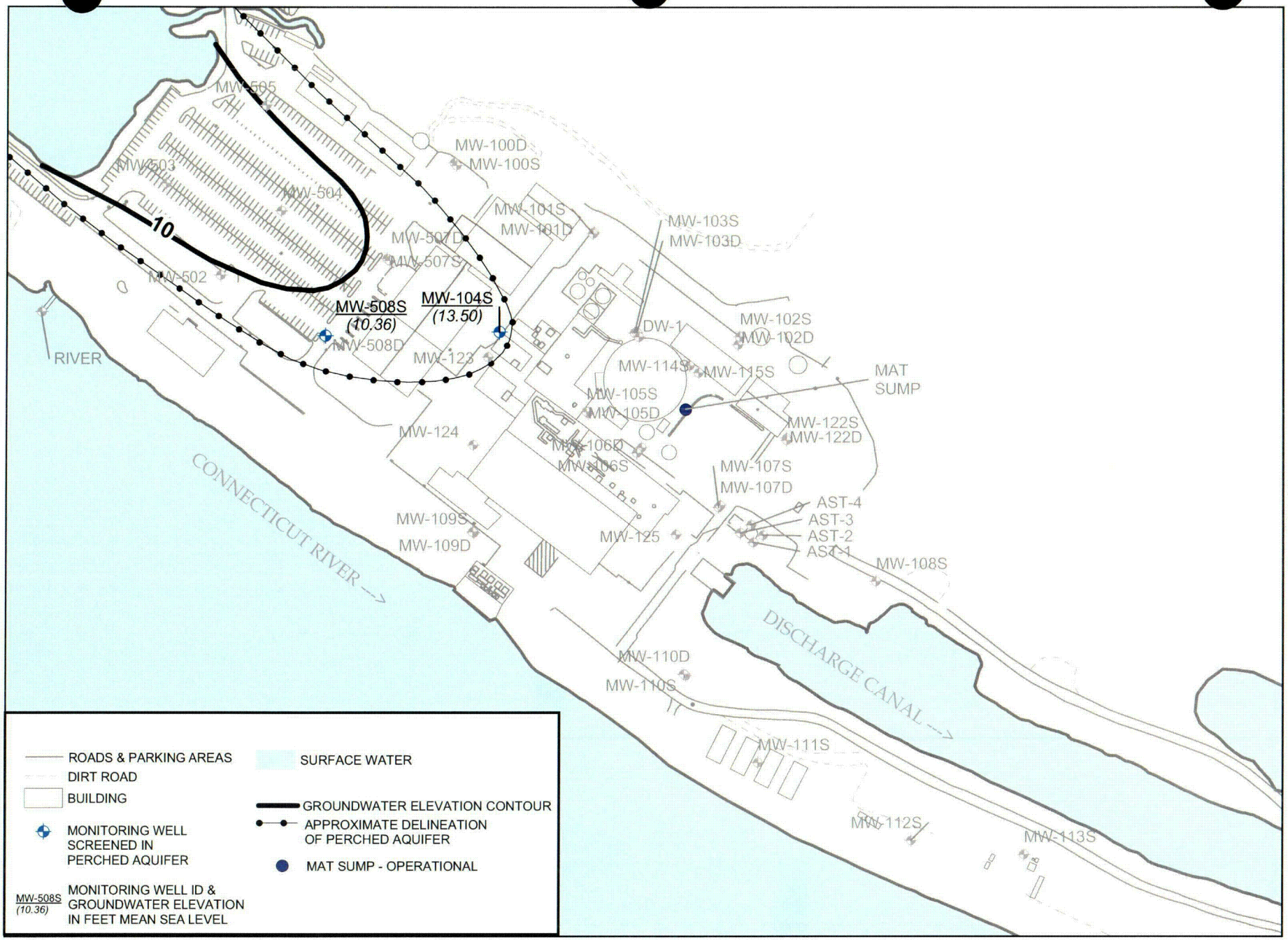


FIGURE 2-5

GROUNDWATER ELEVATION AND INFERRED CONTOURS AND FLOW DIRECTION IN THE PERCHED AQUIFER OF THE CONNECTICUT YANKEE HADDAN NECK PLANT AUGUST 22, 2004 11:15

HADDAM NECK, CT

CH2MHILL

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C06

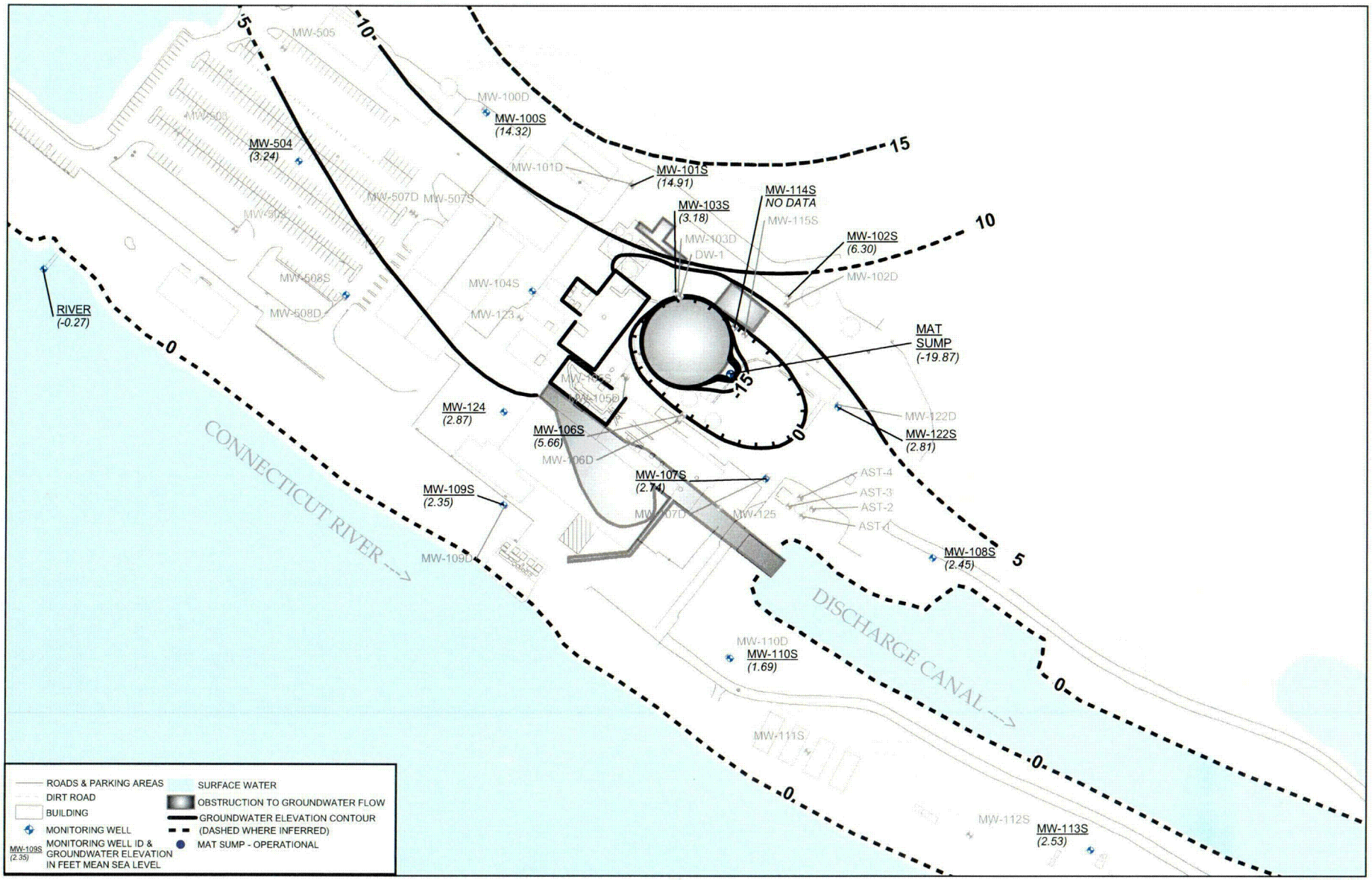
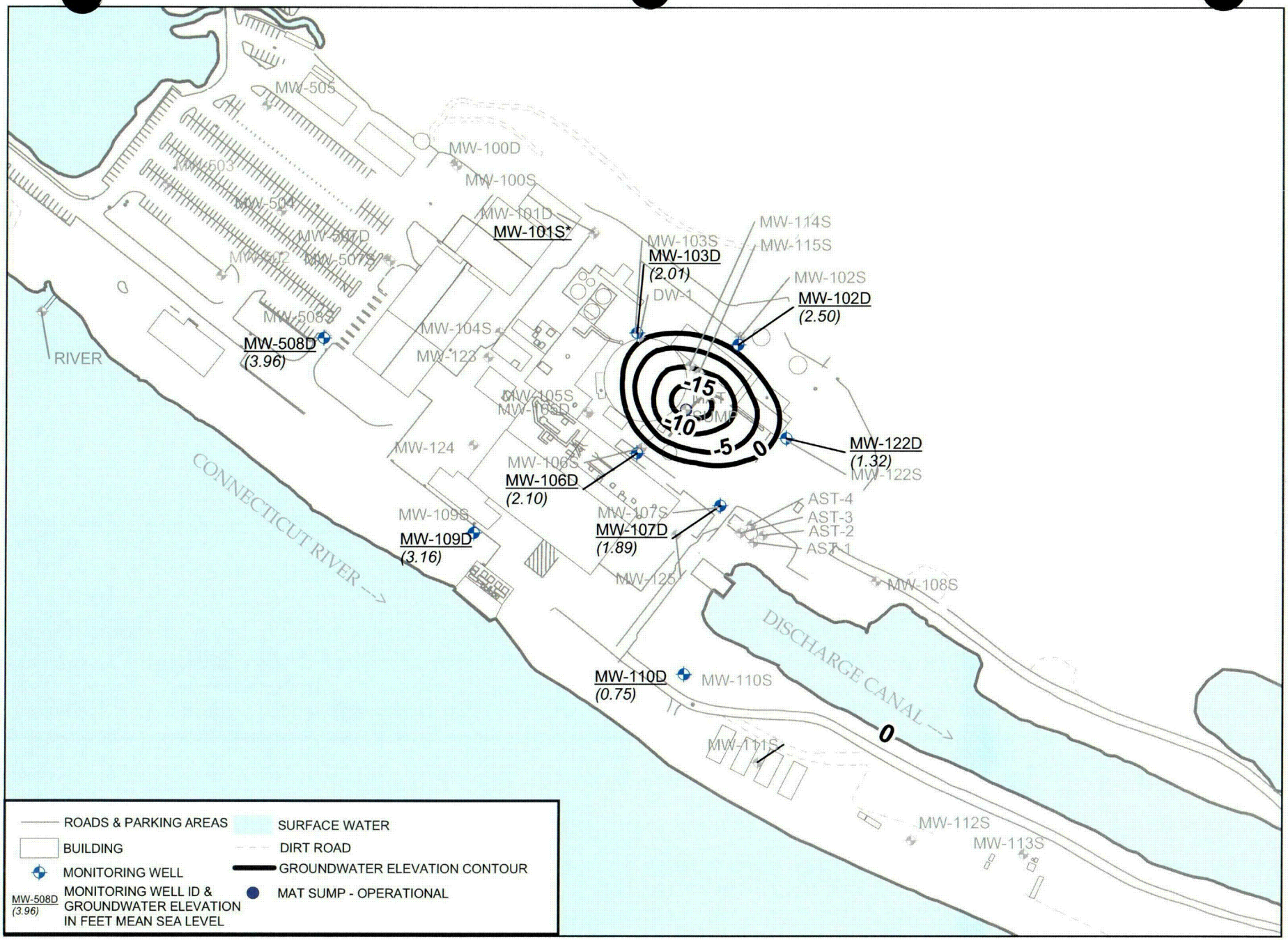


FIGURE 2-6
GROUNDWATER ELEVATION AND INFERRED CONTOURS AND FLOW DIRECTION IN THE UNCONFINED AQUIFER OF THE CONNECTICUT YANKEE HADDAN NECK PLANT AUGUST 22, 2004 11:15
HADDAM NECK, CT

CH2MHILL

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\Pot_Map_UNCONFINED_8_04.mxd JKelly 3/10/2005

C07



N

0 125 250 Feet

FIGURE 2-7

GROUNDWATER ELEVATION AND INFERRED CONTOURS AND FLOW DIRECTION IN THE CONFINED AQUIFER OF THE CONNECTICUT YANKEE HADDAN NECK PLANT AUGUST 22, 2004 11:15

HADDAM NECK, CT

CH2MHILL

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\Pot_Map_CONFINED_8_04.mxd JKelly 3/29/2005

C08

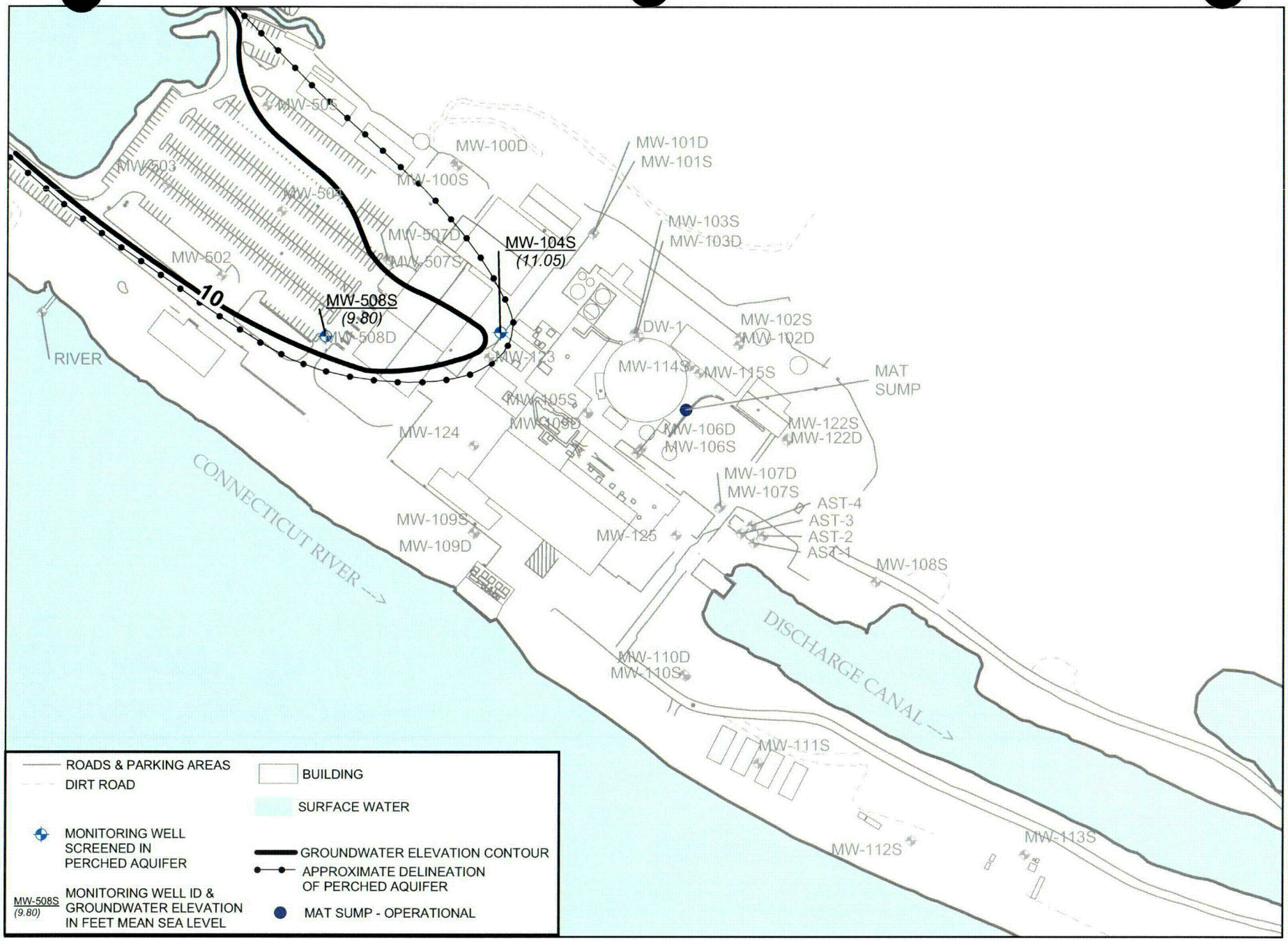


FIGURE 2-8

GROUNDWATER ELEVATION AND INFERRED CONTOURS AND FLOW DIRECTION IN THE PERCHED AQUIFER OF THE CONNECTICUT YANKEE HADDAN NECK PLANT DECEMBER 1, 2004 23:55

HADDAM NECK, CT

CH2MHILL

N

0 125 250 Feet

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\Pot_Map_PERCHED_12_04.mxd JKelly 3/29/2005

C09

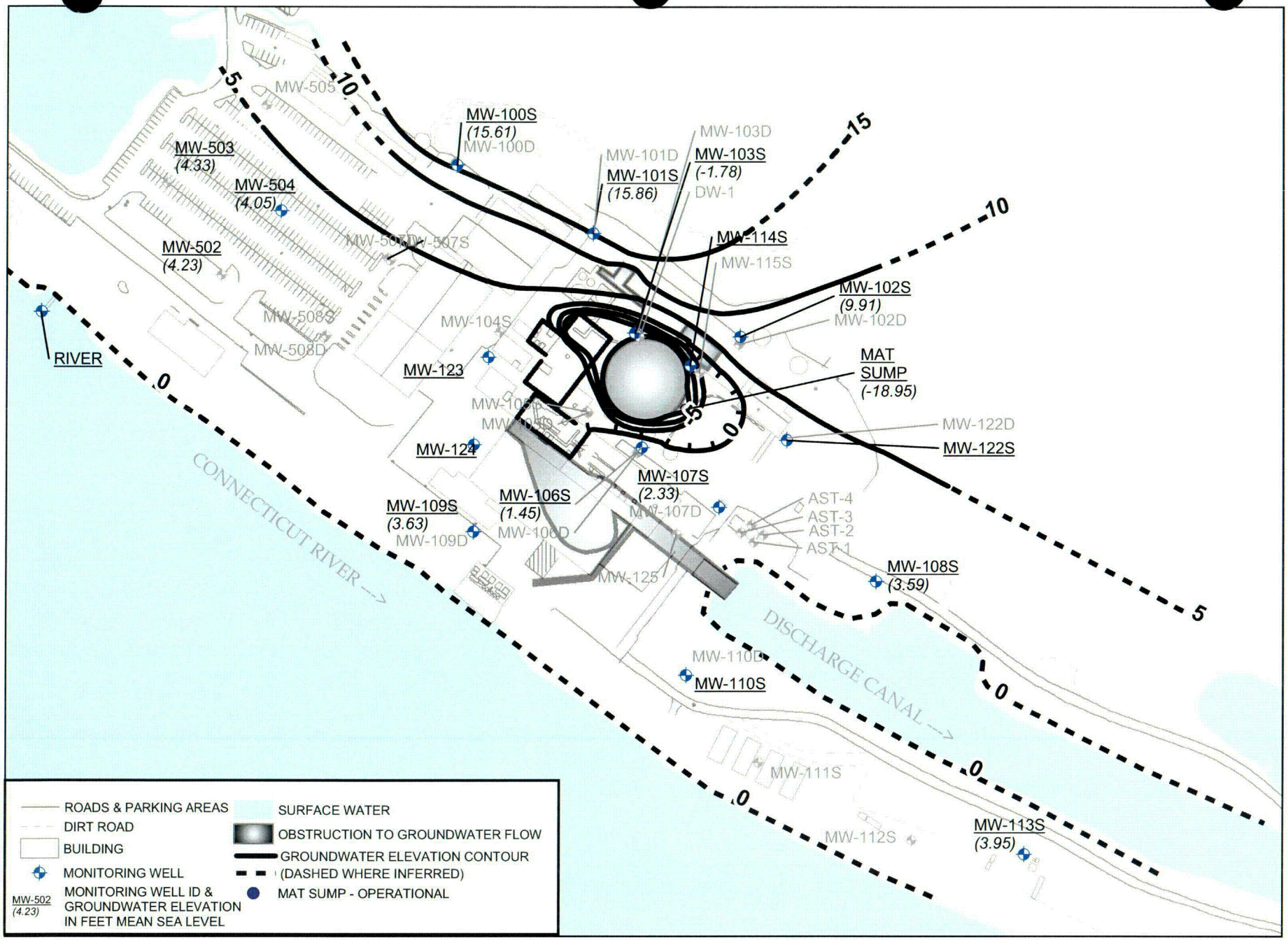


FIGURE 2-9
GROUNDWATER ELEVATION AND INFERRED CONTOURS AND FLOW DIRECTION IN THE UNCONFINED AQUIFER OF THE CONNECTICUT YANKEE HADDAN NECK PLANT DECEMBER 1, 2004 23:55
HADDAM NECK, CT

CH2MHILL

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C10

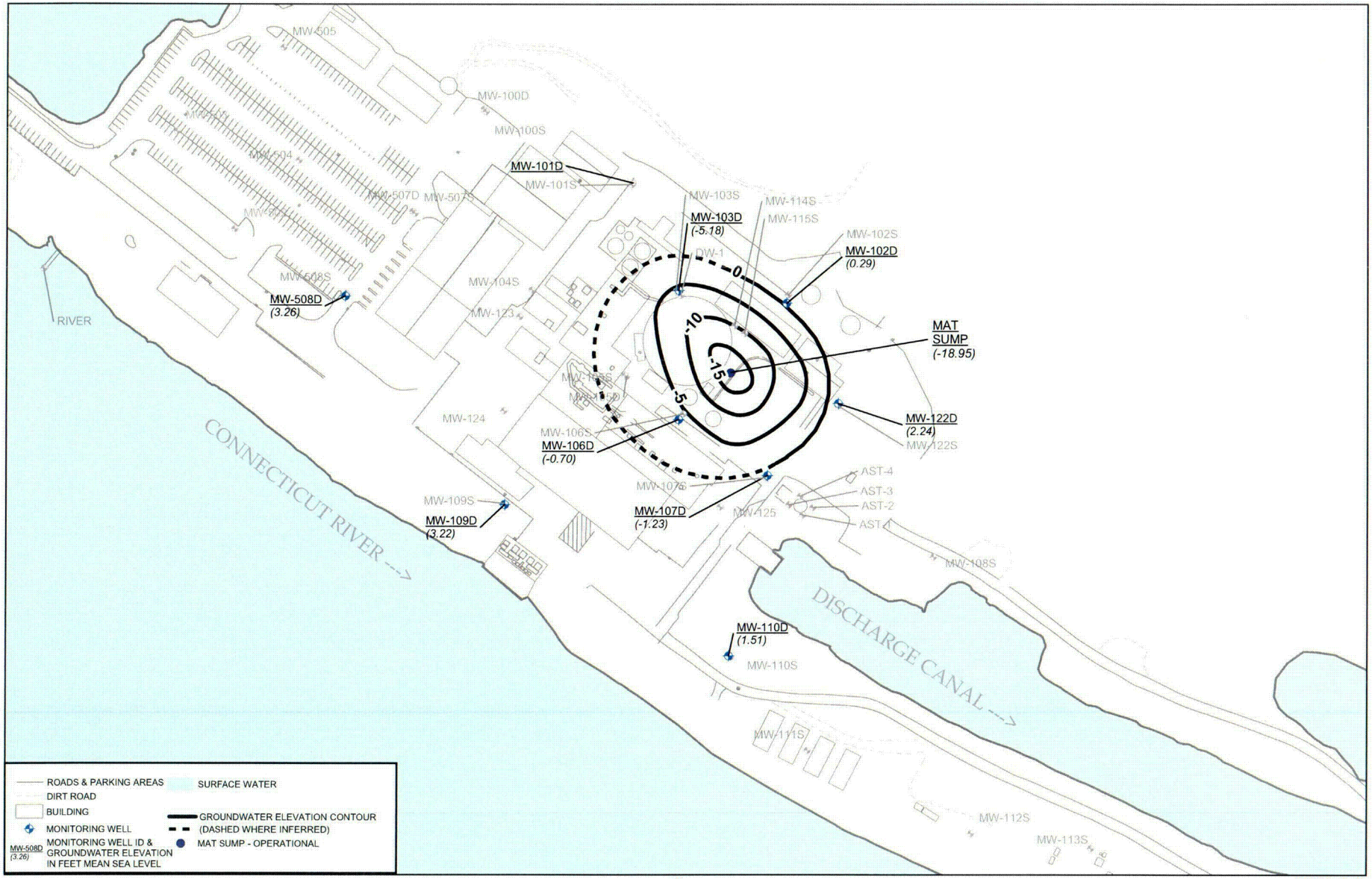

FIGURE 2-10
GROUNDWATER ELEVATION AND INFERRED CONTOURS AND FLOW DIRECTION IN THE CONFINED AQUIFER OF THE CONNECTICUT YANKEE HADDAN NECK PLANT DECEMBER 1, 2004 23:55
HADDAM NECK, CT

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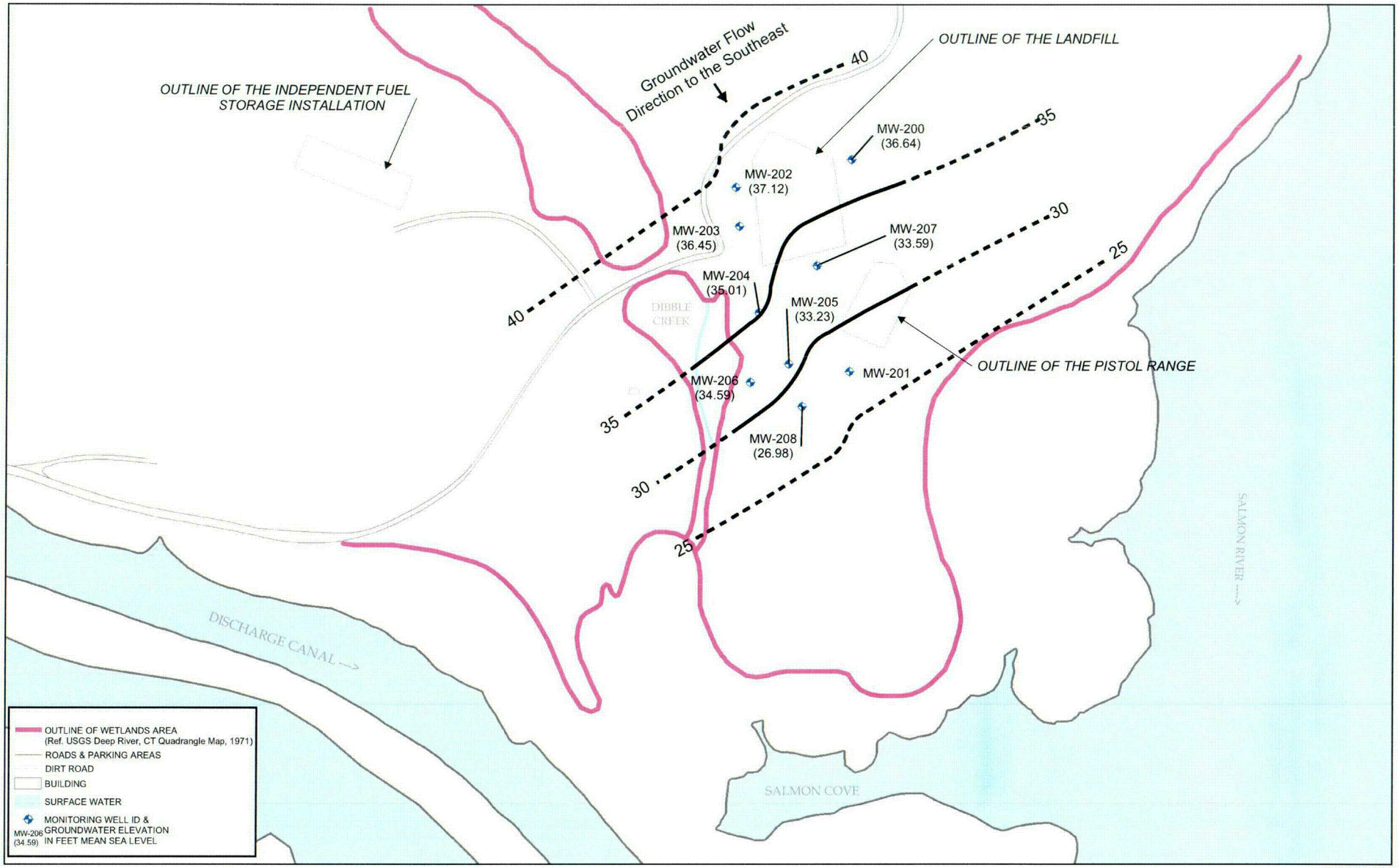
\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\Pot_Map_CONFINED_12_04.mxd JKelly 3/10/2005

C11



CH2MHILL

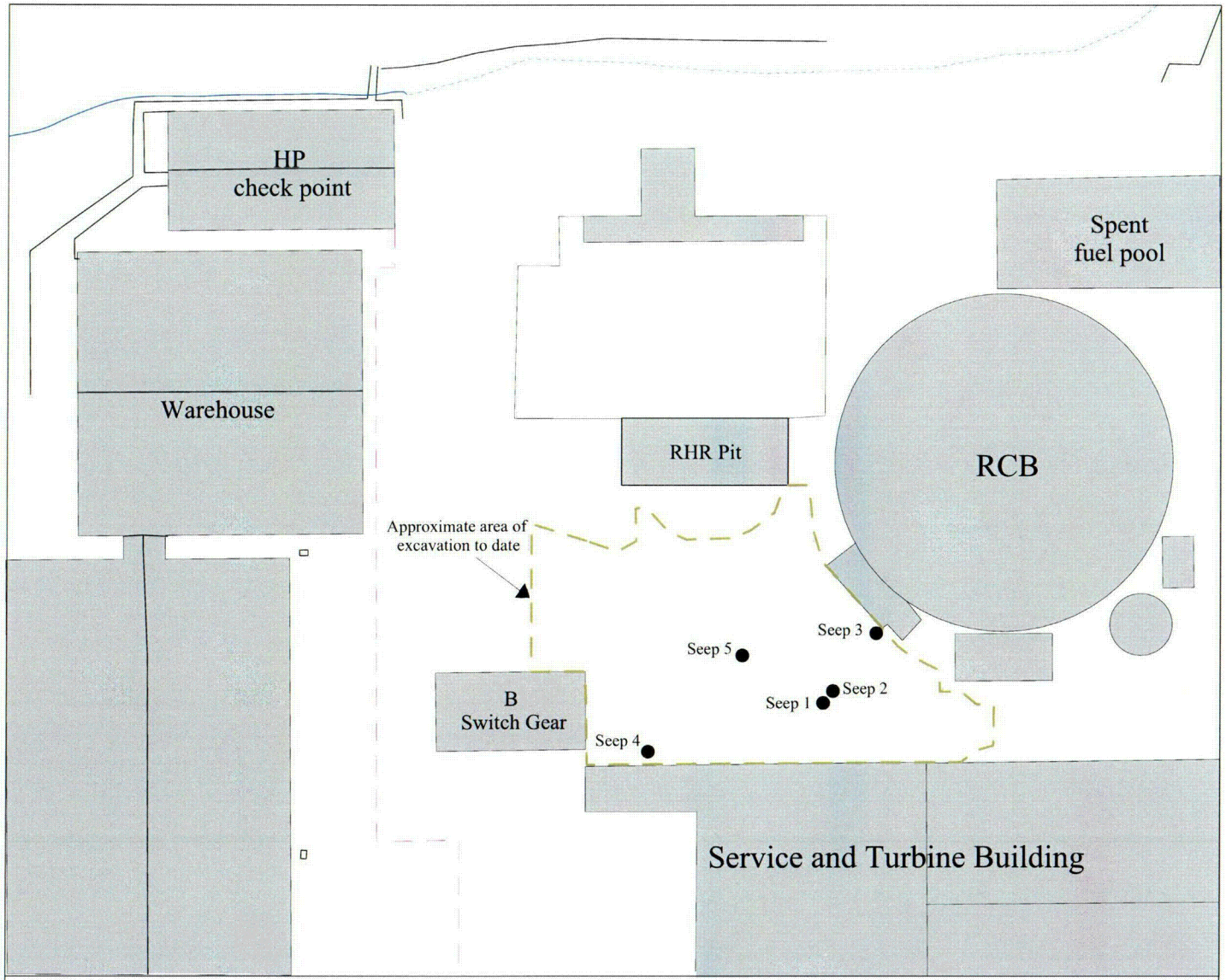
N

0 100 200 Feet

FIGURE 2-11
GROUNDWATER ELEVATIONS, INFERRED CONTOURS AND FLOW DIRECTION IN THE LANDFILL AREA, CONNECTICUT YANKEE HADDAM NECK PLANT DECEMBER, 2004
HADDAM NECK, CT

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\Pot_Map_Landfill_12_04.mxd JKelly 3/10/2005

C12



Approximate location of bedrock seeps

RCA fence line

Approximate area of excavation to date

Figure 2-12
Location of Groundwater Seeps in Exposed Bedrock

C13

Figure 2-13: Photographs of Seeps in Contaminated Soil Removal Area

C14

Figure 2-14: Photographs of Seeps in Contaminated Soil Removal Area

C15

Figure 5-1: Mn-54 Rank Order for September 2004

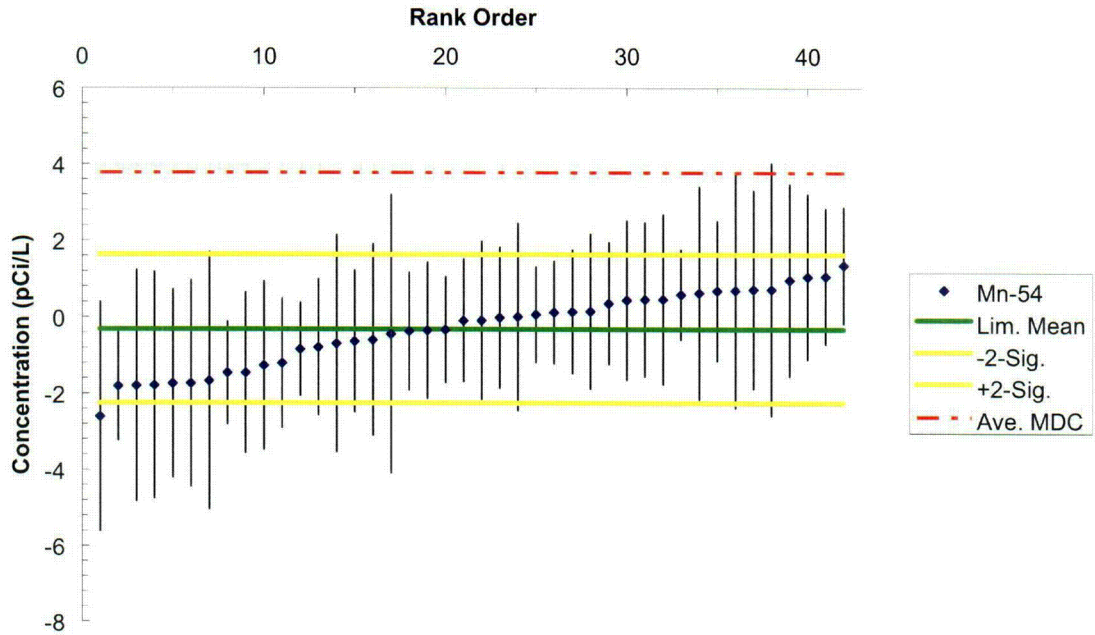
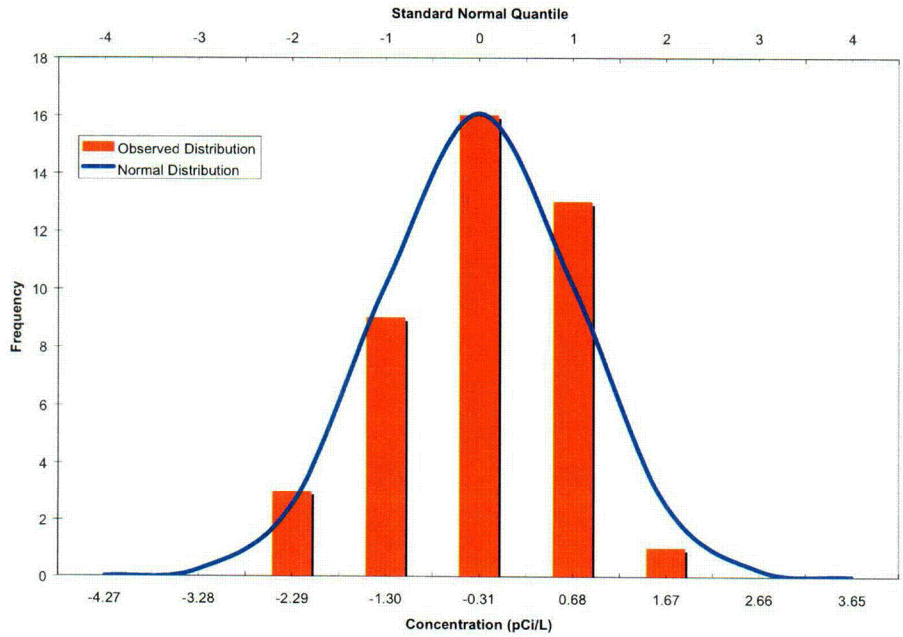


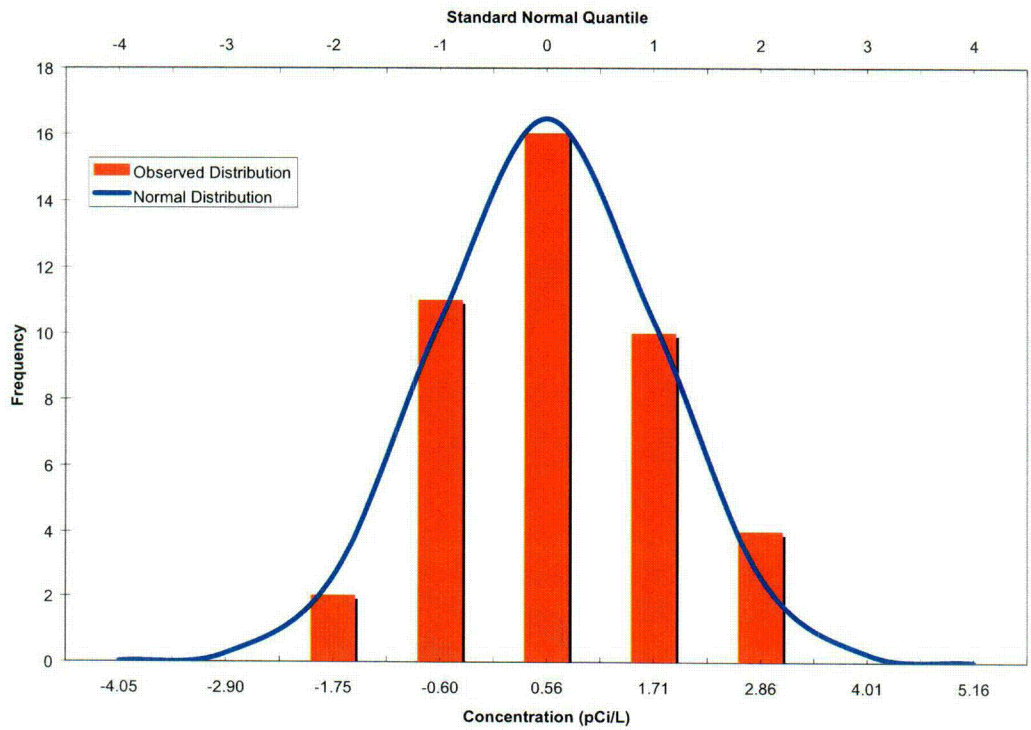
Figure 5-2: Mn-54 Normality Plot for September 2004



C16

Figure 5-3: Cs-137 Rank Order for September 2004

Figure 5-4: Cs-137 Normality Plot for September 2004



C17

Figure 5-5: Co-60 Rank Order for December 2004

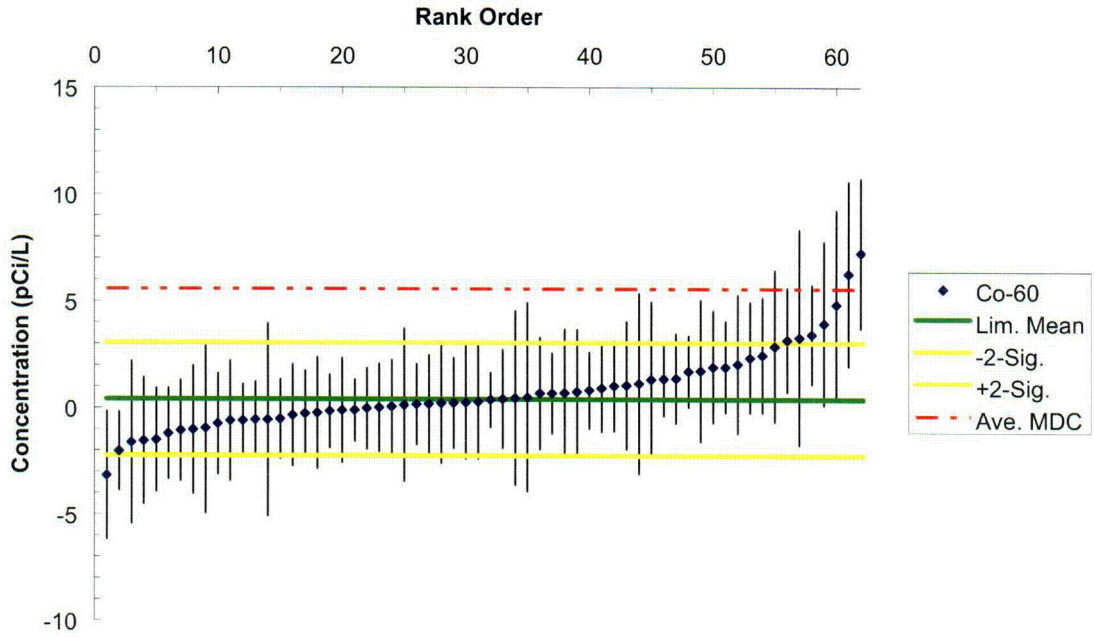
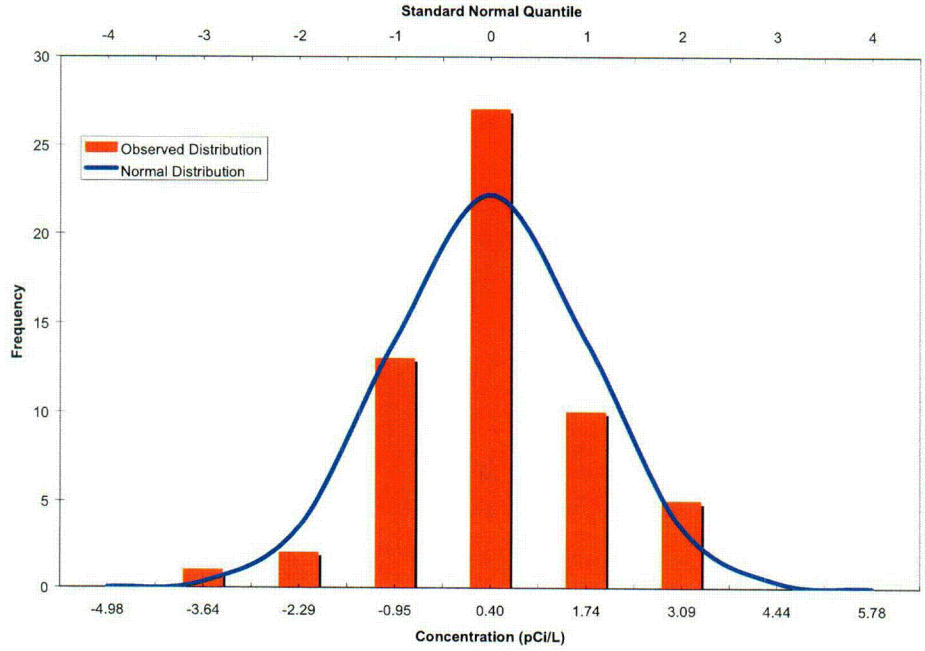


Figure 5-6: Co-60 Normality Plot for December 2004



C18

Figure 5-7: H-3 Rank Order for December 2004

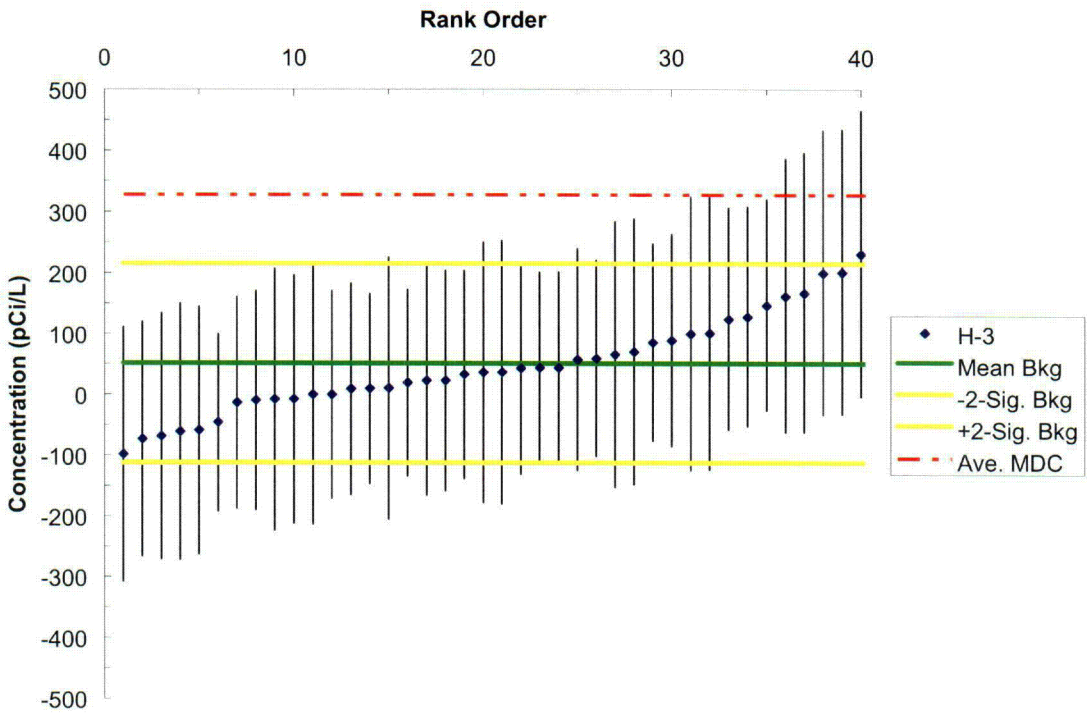
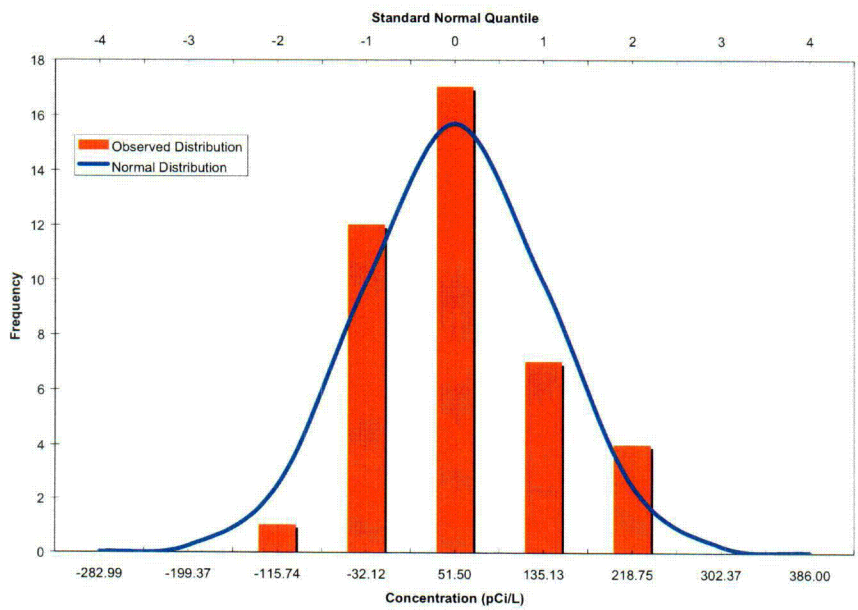


Figure 5-8: H-3 Normality Plot for December 2004



C19

Figure 5-9: Fe-55 Rank Order for June 2004

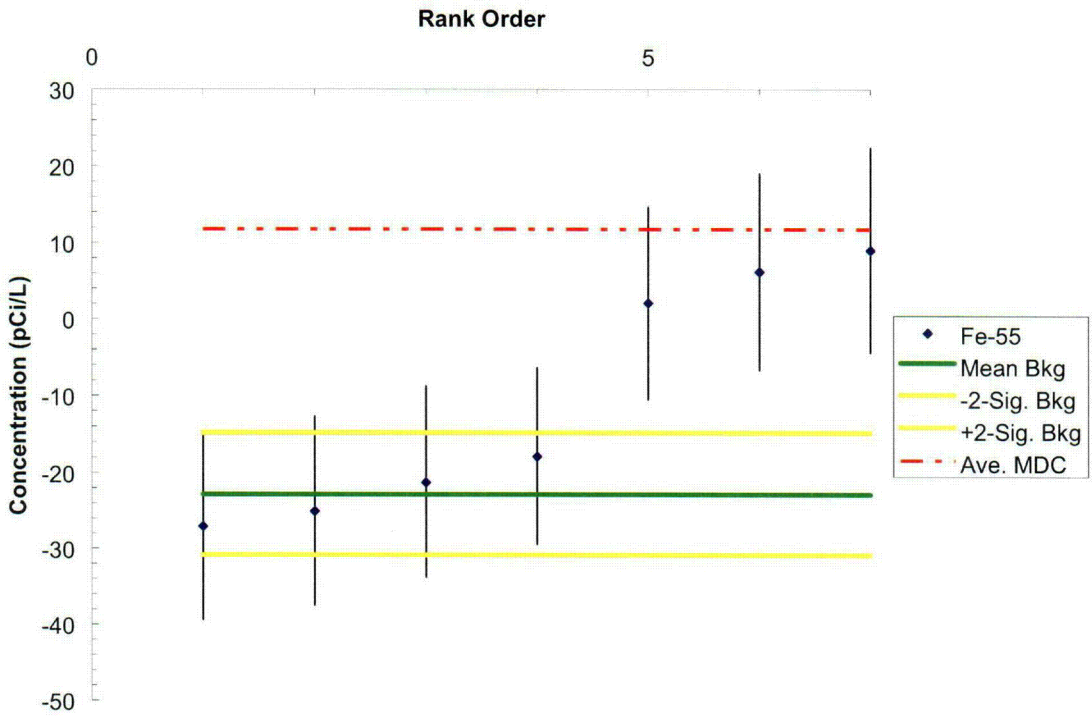
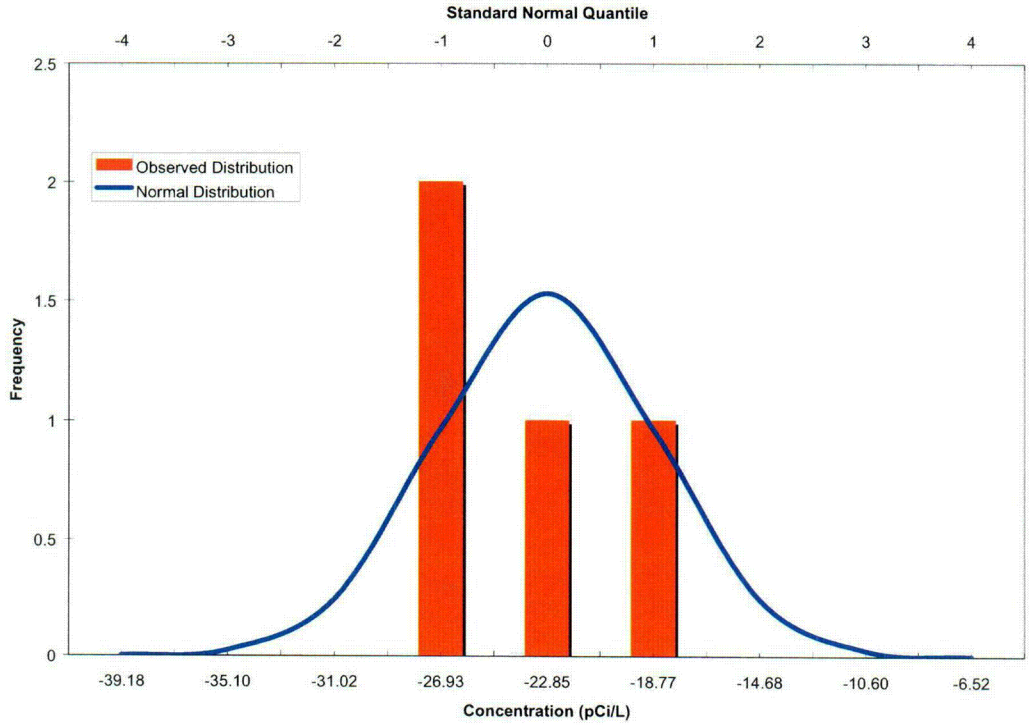


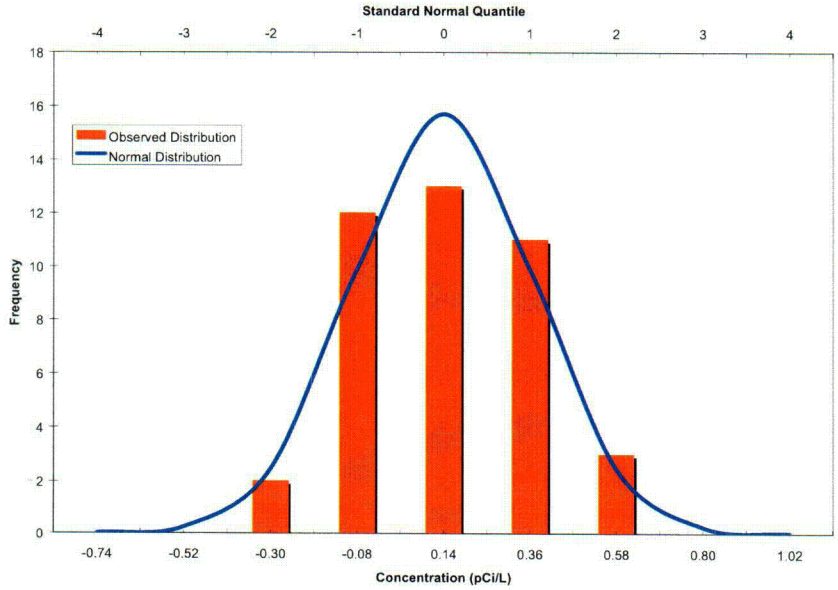
Figure 5-10: Fe-55 Normality Plot for June 2004



C20

Figure 5-11: Sr-90 Rank Order for December 2004

Figure 5-12: Sr-90 Normality Plot for December 2004



C21

Figure 5-13: Cm-242 Rank Order for December 2004

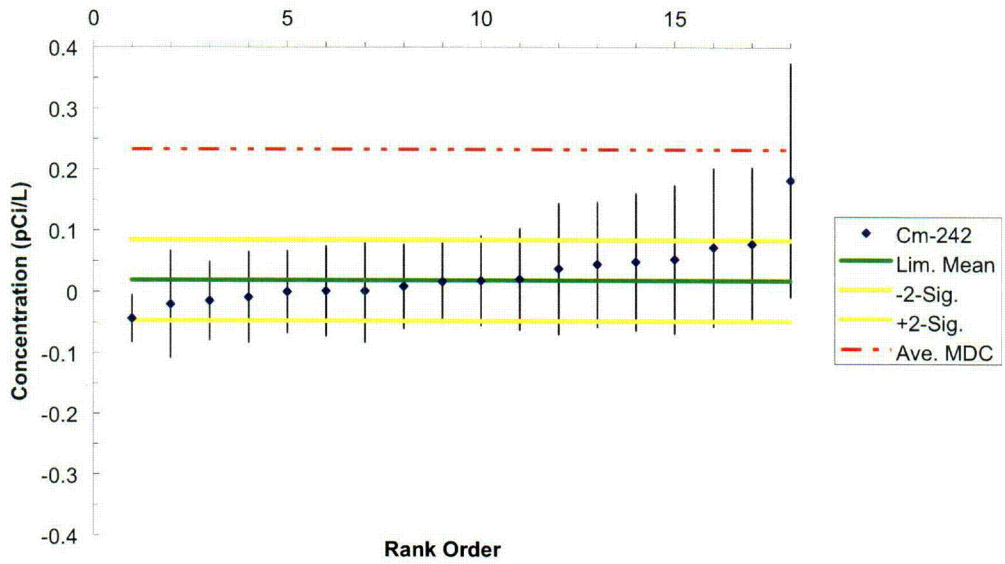
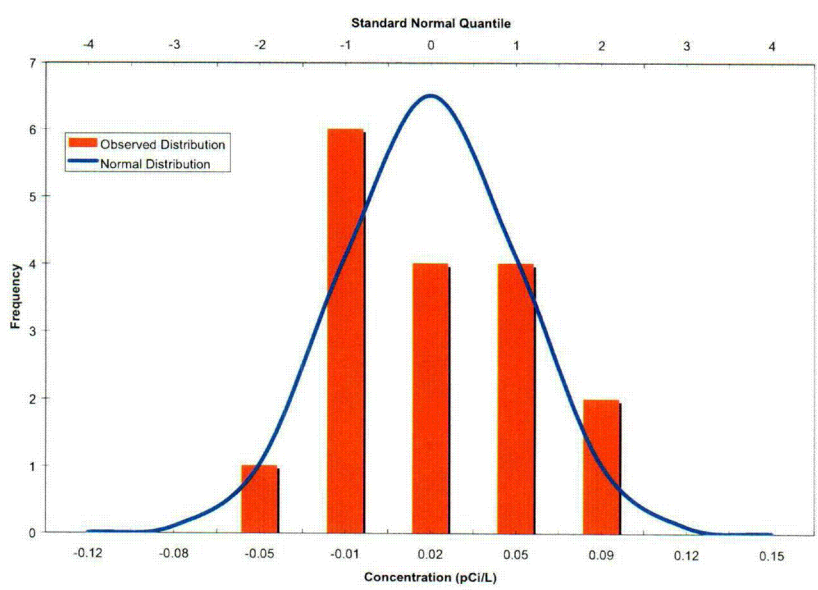


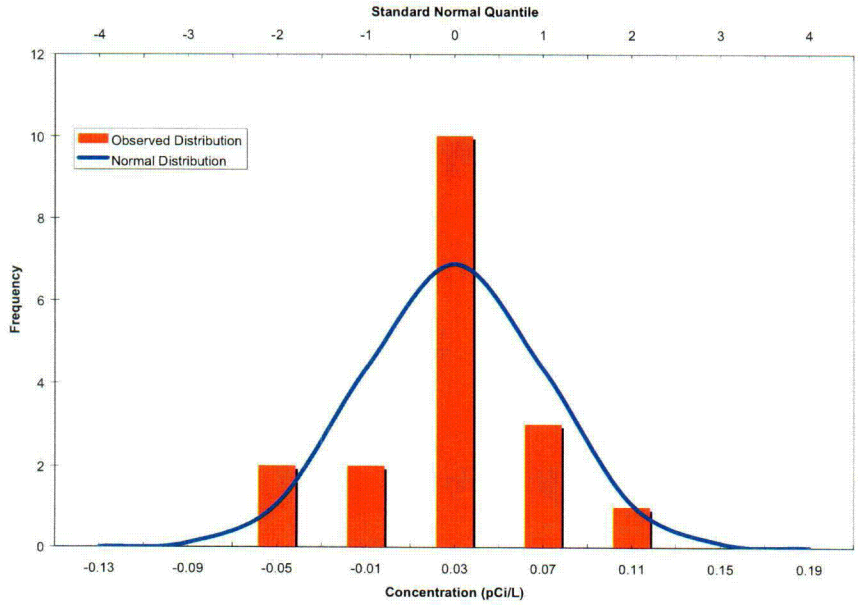
Figure 5-14: Cm-242 Normality Plot for December 2004



C22

Figure 5-15: Am-241 Rank Order for December 2004

Figure 5-16: Am-241 Normality Plot for December 2004



C23

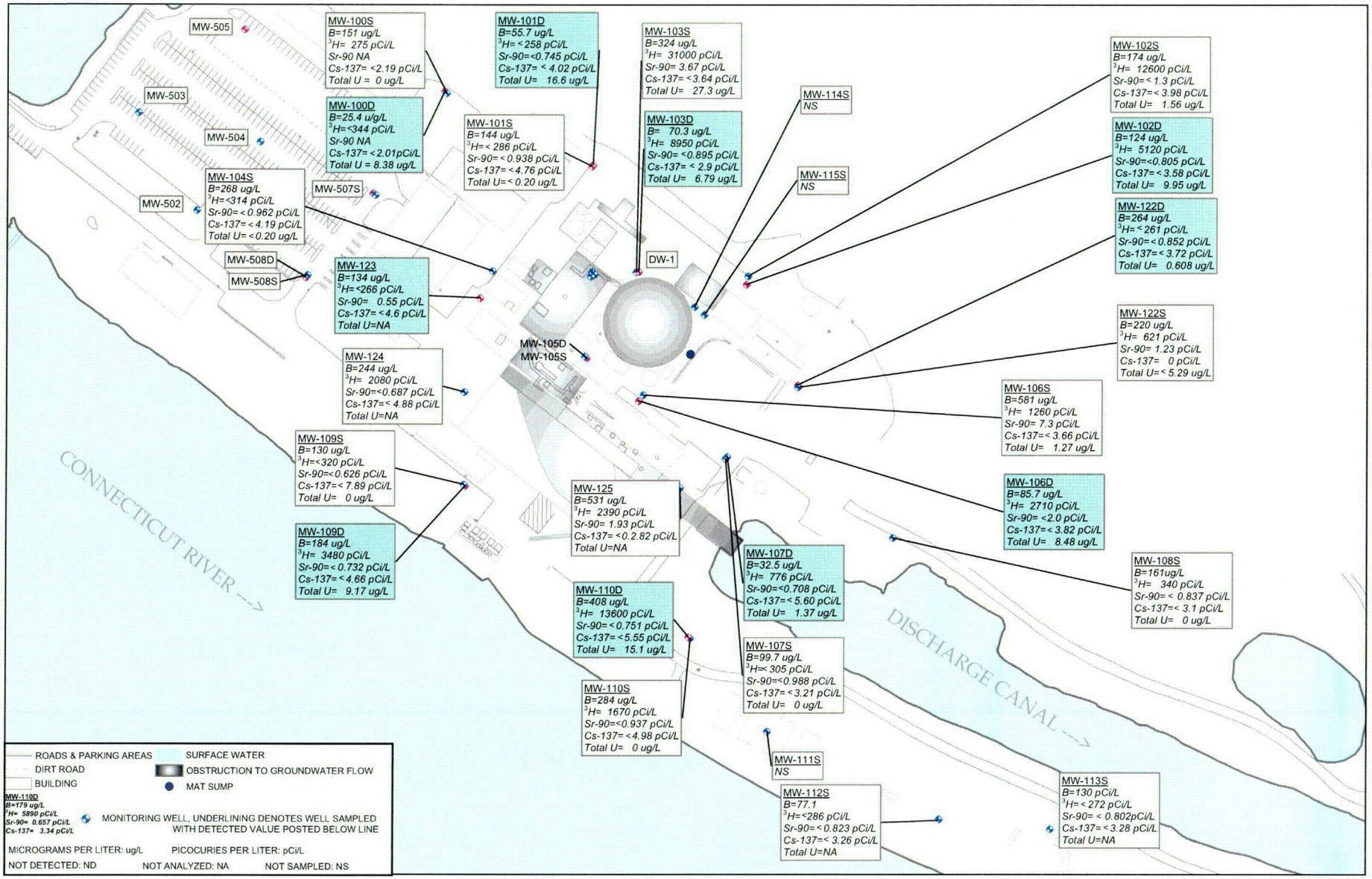


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FIGURE 6-1
DISTRIBUTION OF SELECTED SUBSTANCES OF CONCERN AT THE INDUSTRIAL AREA AND UPPER PENINSULA AREA OF THE CONNECTICUT YANKEE HADDAM NECK PLANT SEPTEMBER 2004
HADDAM NECK, CT

C24

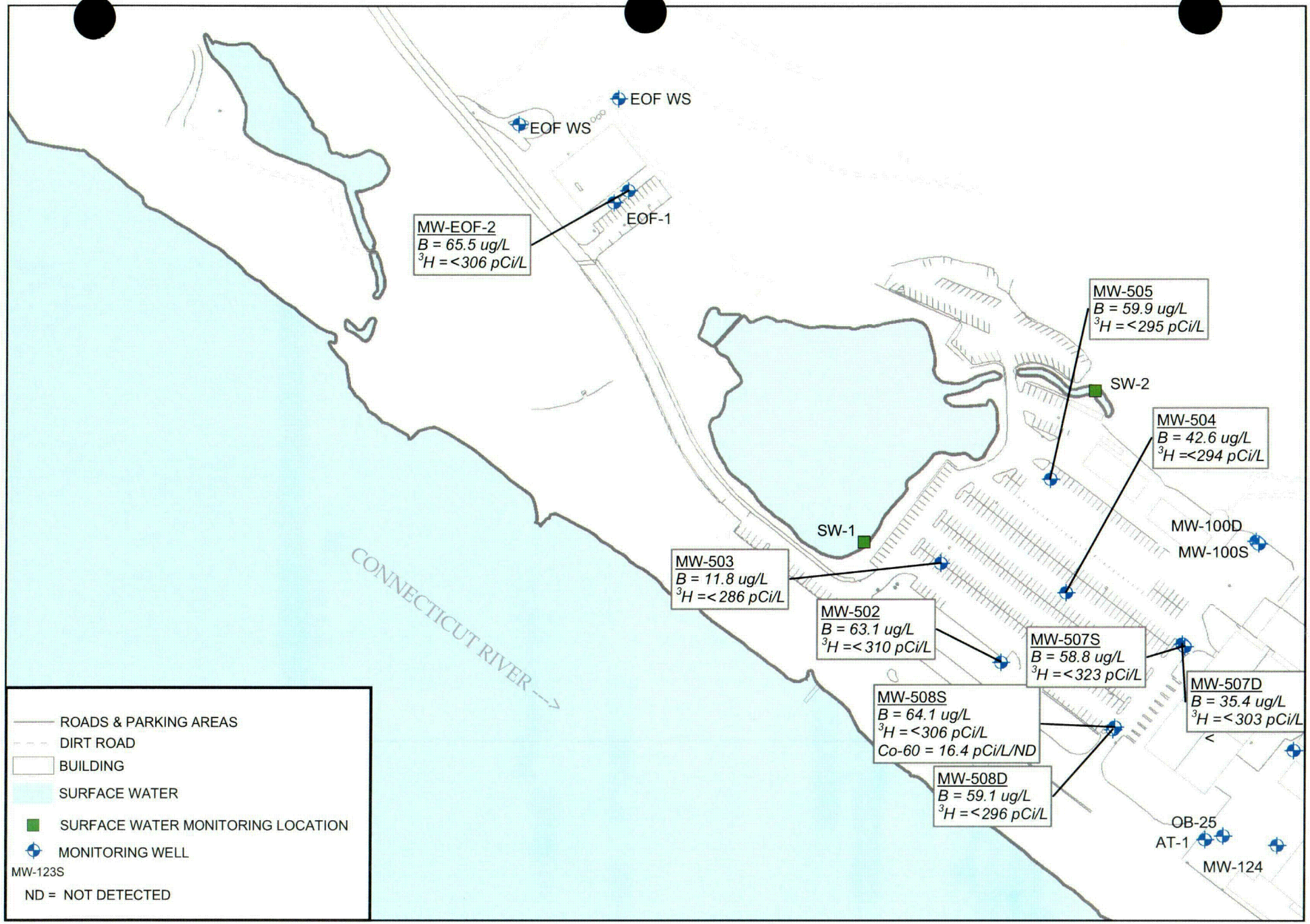

FIGURE 6-2

DISTRIBUTION OF SELECTED SUBSTANCES OF CONCERN AT THE EOF AND PARKING LOT AREA OF THE HADDAM NECK PLANT SEPTEMBER 2004

HADDAM NECK, CT

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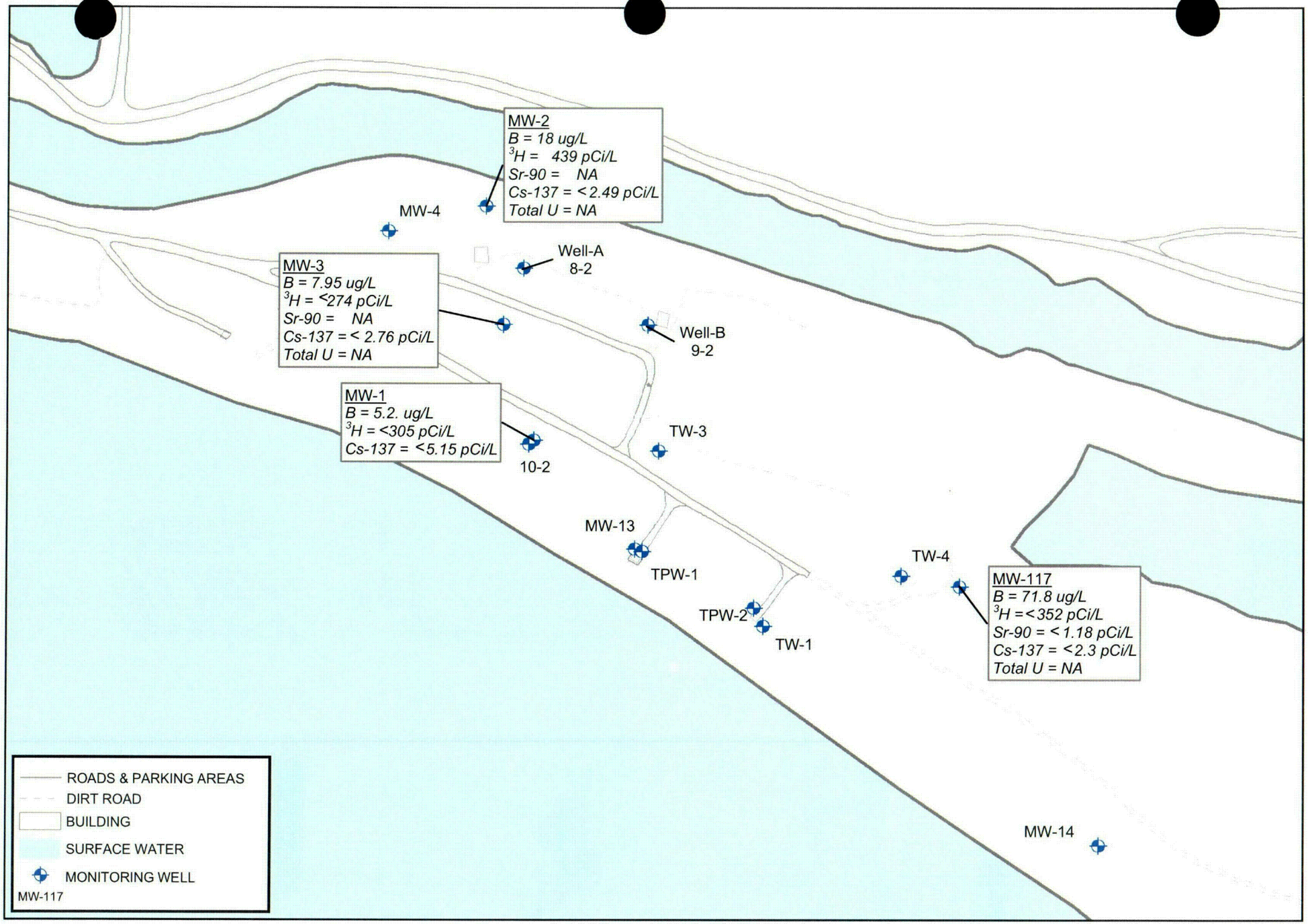
\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\SOC_EOF_ParkingLot_9_04.mxd JKelly 3/29/2005

C25



N

0 100 200 Feet

CH2MHILL

FIGURE 6-3
DISTRIBUTION OF SELECTED SUBSTANCES OF CONCERN AT THE PENINSULA AREA OF THE HADDAM NECK PLANT SEPTEMBER 2004
HADDAM NECK, CT

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C26

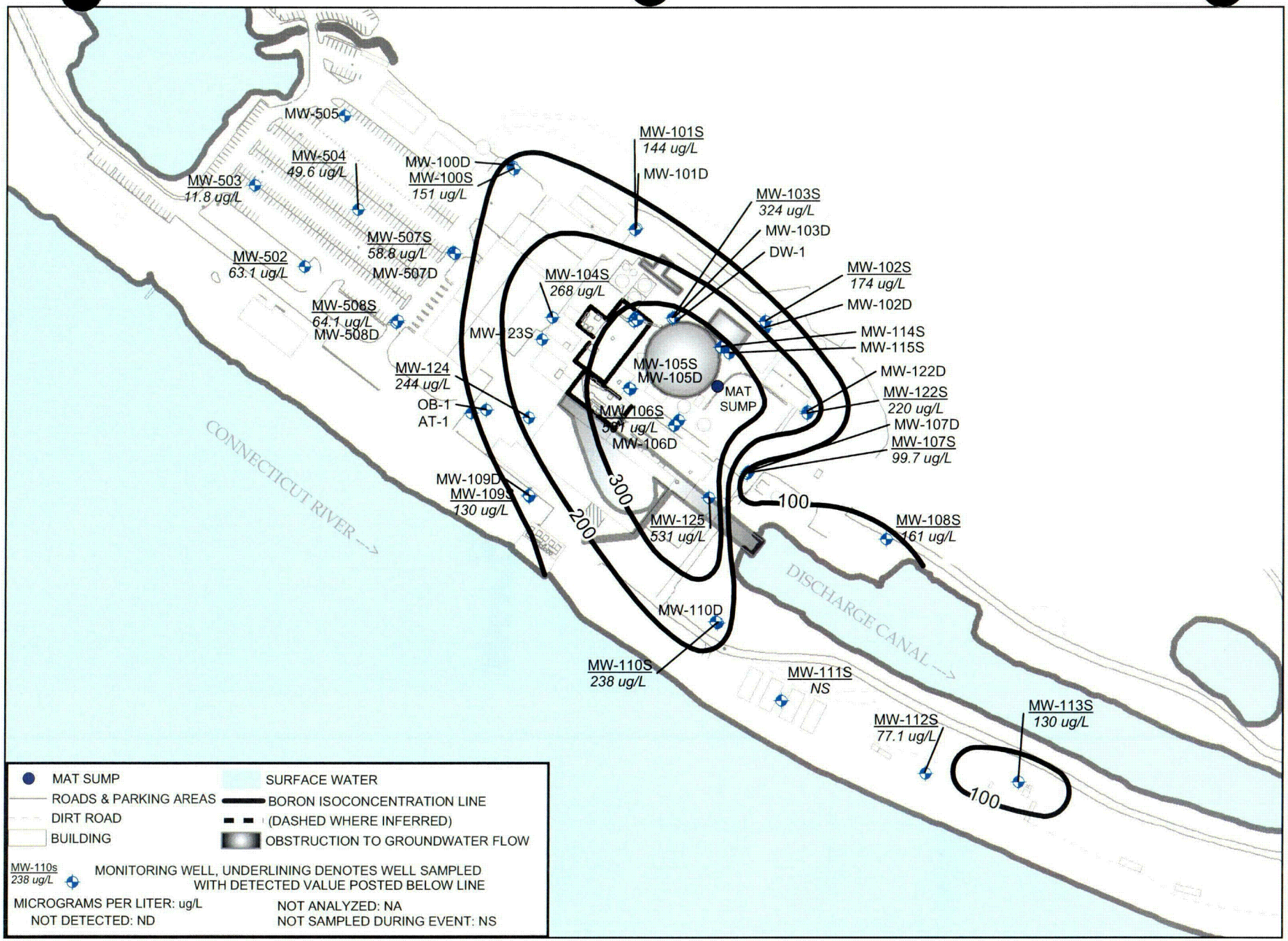

FIGURE 6-4
INFERRED DISTRIBUTION OF BORON (ug/L) IN THE UNCONFINED AQUIFER
AT THE INDUSTRIAL AREA AND UPPER PENINSULA AREA OF THE HADDAM NECK PLANT SEPTEMBER 2004
HADDAM NECK, CT

CH2MHILL

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C27

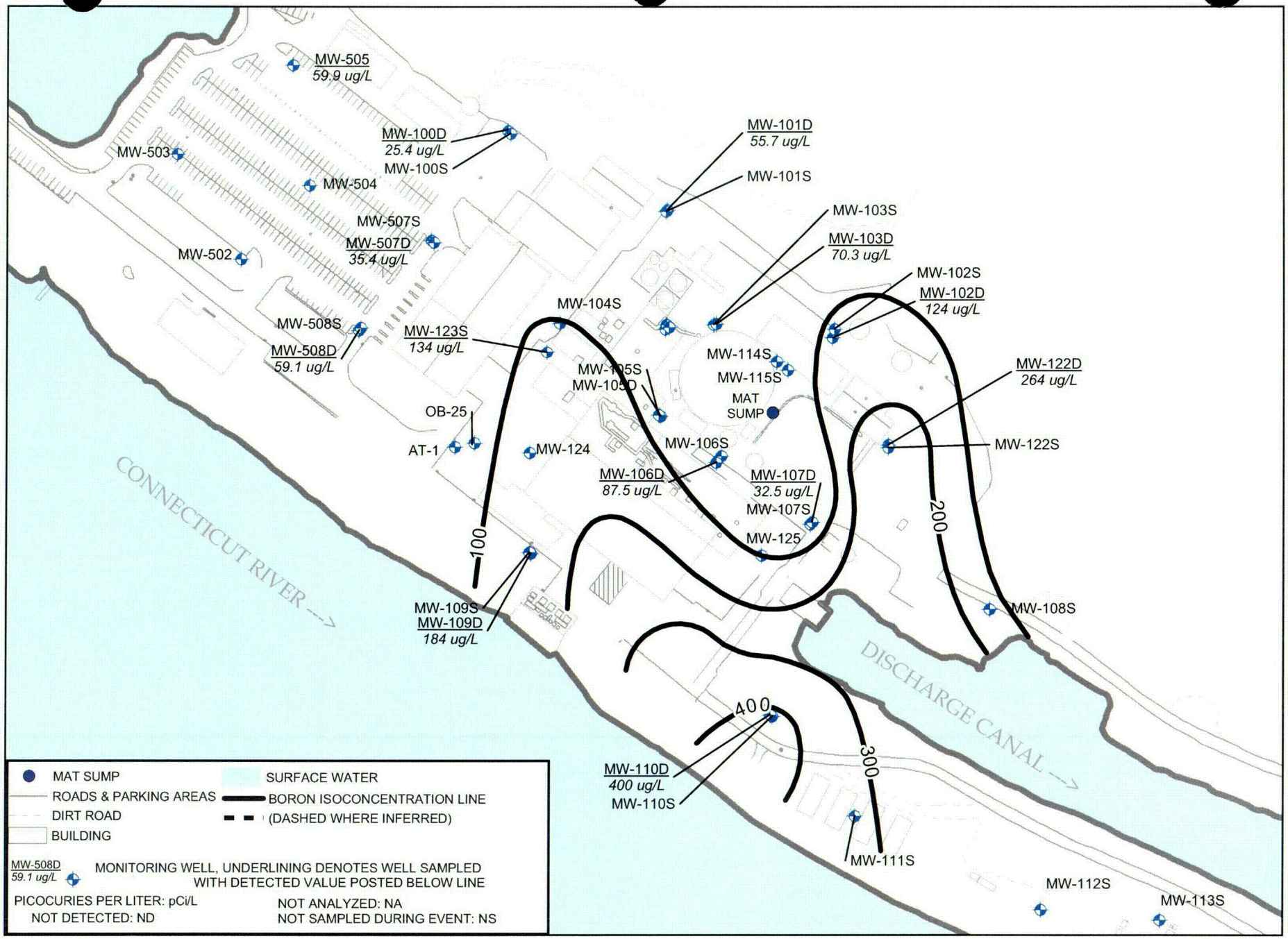

FIGURE 6-5
INFERRED DISTRIBUTION OF BORON (ug/L) IN THE CONFINED AQUIFER
AT THE INDUSTRIAL AREA AND UPPER PENINSULA AREA OF THE HADDAM NECK PLANT SEPTEMBER 2004
HADDAM NECK, CT

CH2MHILL

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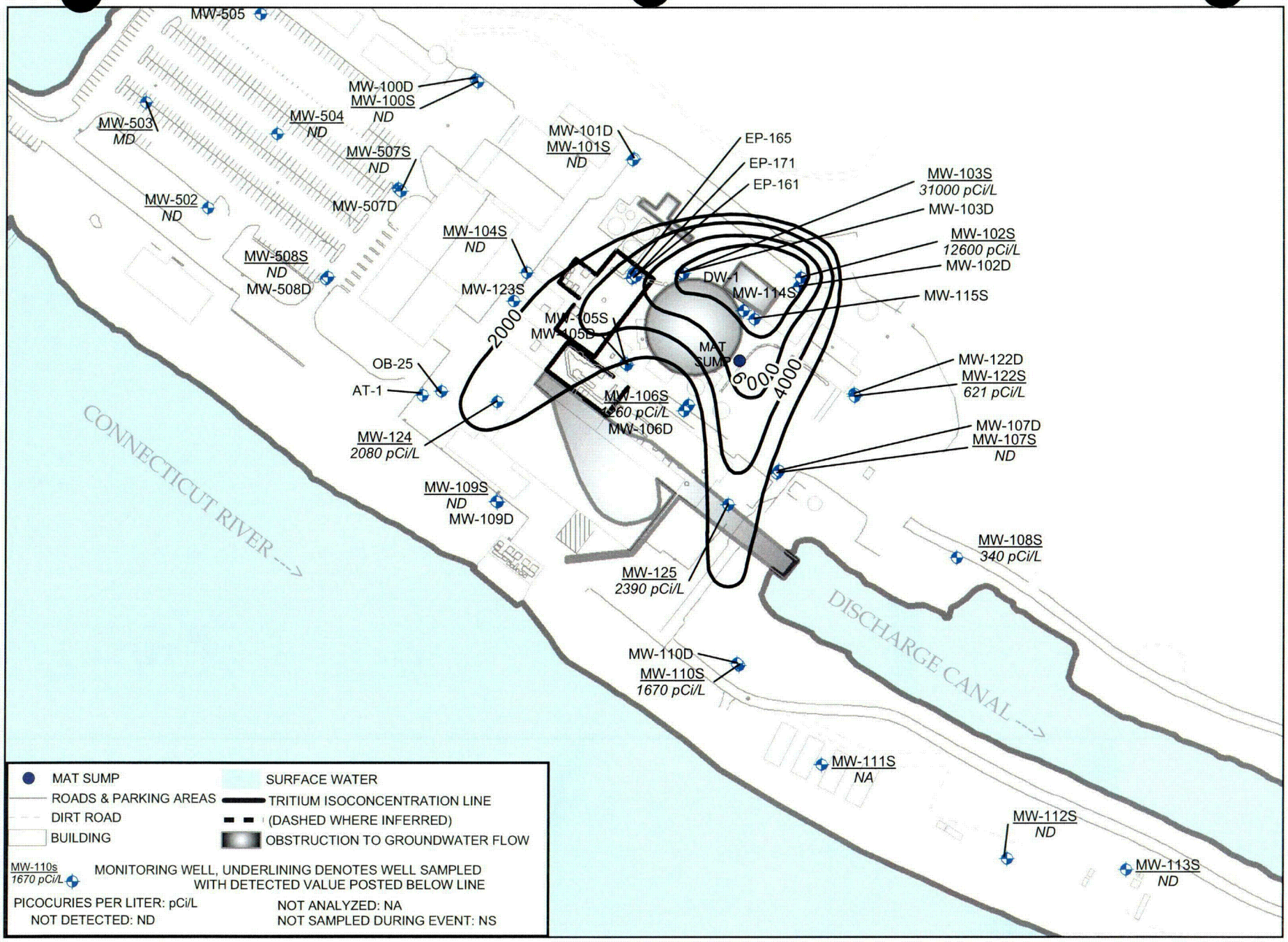
C28



N

0 100 200 Feet

CH2MHILL

FIGURE 6-6

INFERRED DISTRIBUTION OF TRITIUM (pCi/L) IN THE UNCONFINED AQUIFER
AT THE INDUSTRIAL AREA AND UPPER PENINSULA AREA OF THE HADDAM NECK PLANT SEPTEMBER 2004
HADDAM NECK, CT

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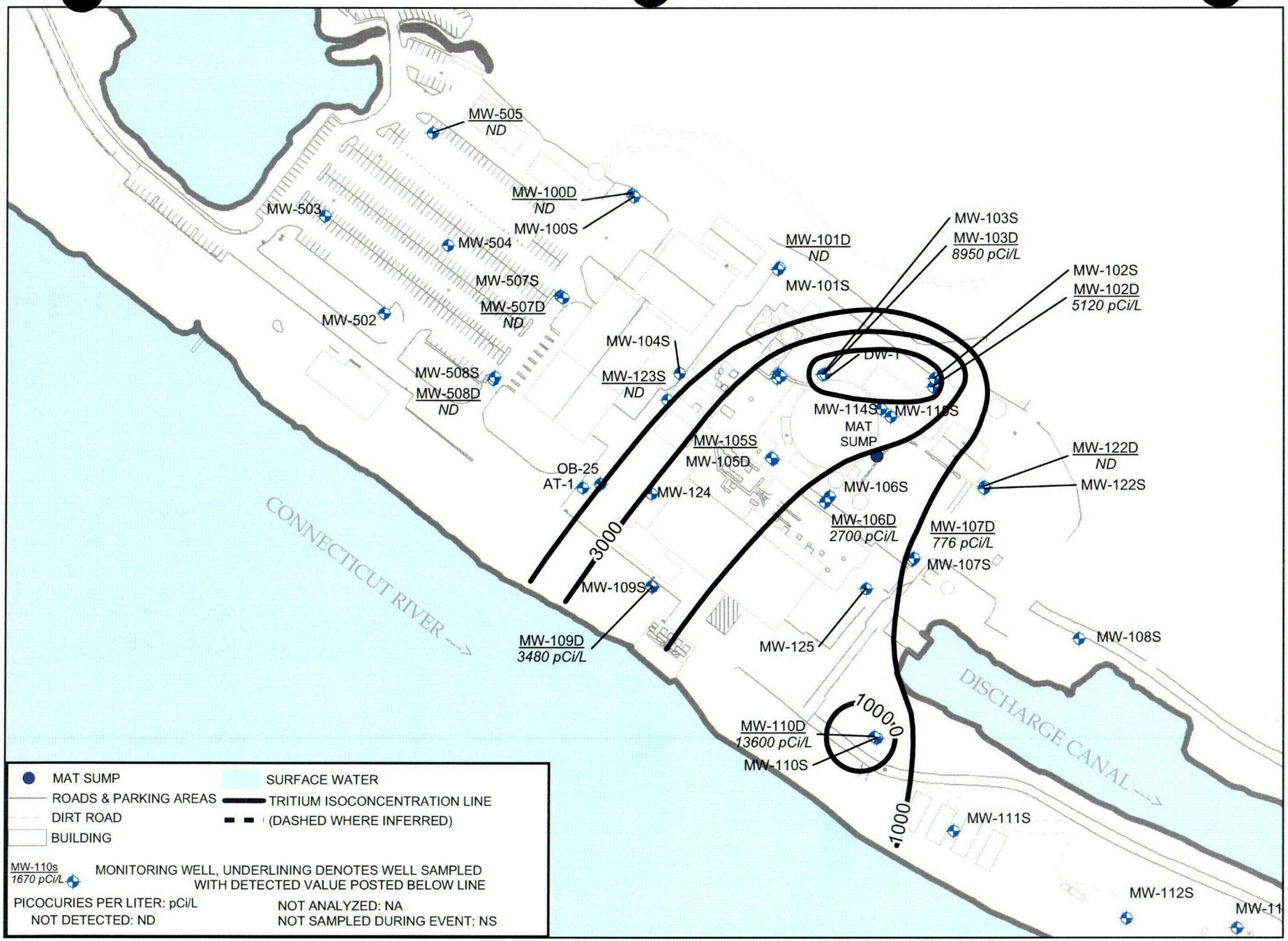
C29



N

0 100 200 Feet

FIGURE 6-7

INFERRED DISTRIBUTION OF TRITIUM (pCi/L) IN THE CONFINED AQUIFER
AT THE INDUSTRIAL AREA AND UPPER PENINSULA AREA OF THE HADDAM NECK PLANT SEPTEMBER 2004
HADDAM NECK, CT

CH2MHILL

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\Tritium_CONFINED_09_04.mxd JKelly 3/29/2005

C30

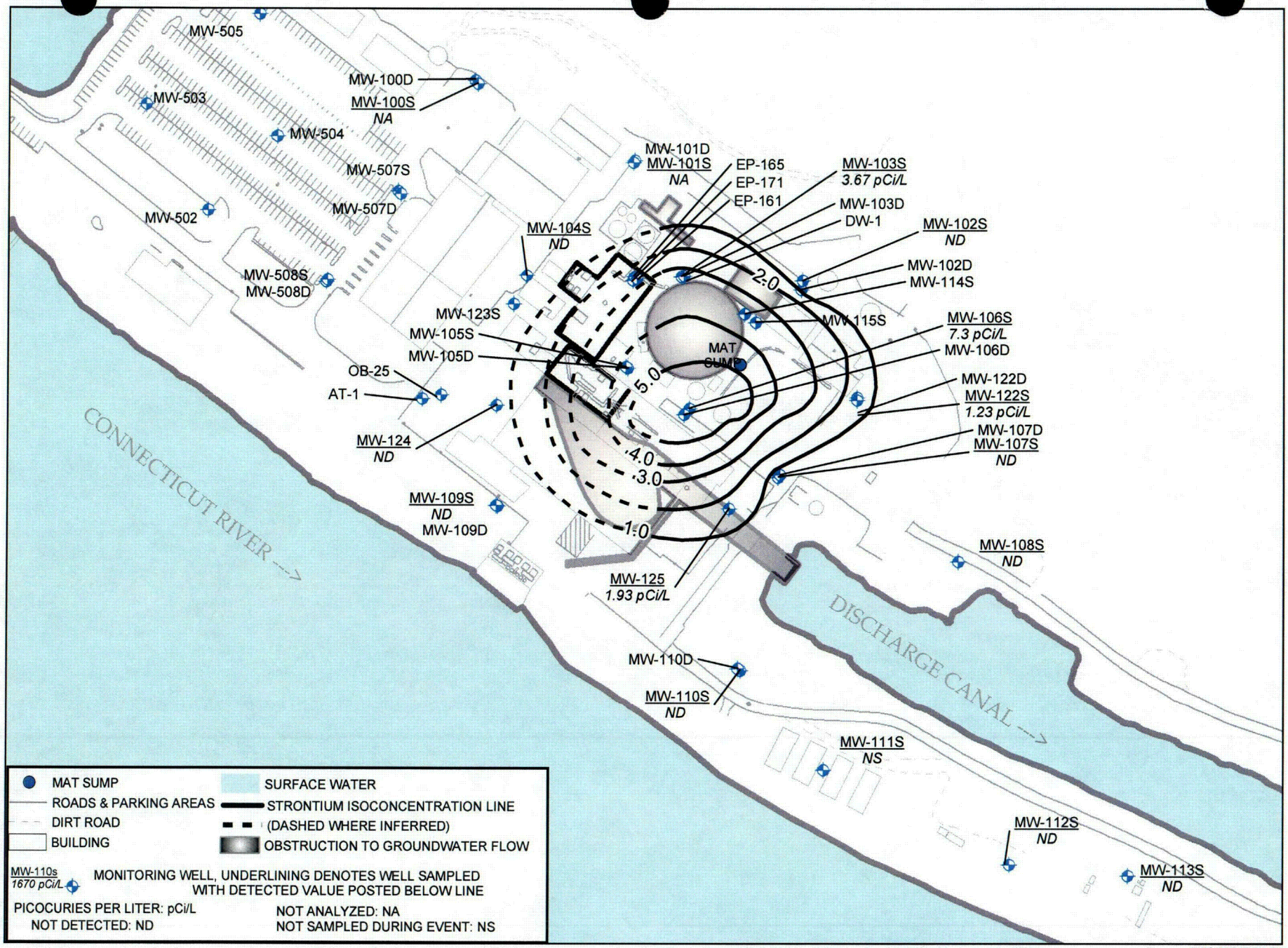


FIGURE 6-8

INFERRED DISTRIBUTION OF STRONTIUM-90 (pCi/L) IN THE UNCONFINED AQUIFER AT THE INDUSTRIAL AREA AND UPPER PENINSULA AREA OF THE HADDAM NECK PLANT SEPTEMBER 2004

HADDAM NECK, CT

N

0 125 250 Feet

CH2MHILL

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\Sr-90_UNCONFINED_09_04.mxd JKelly 3/30/2005

C31

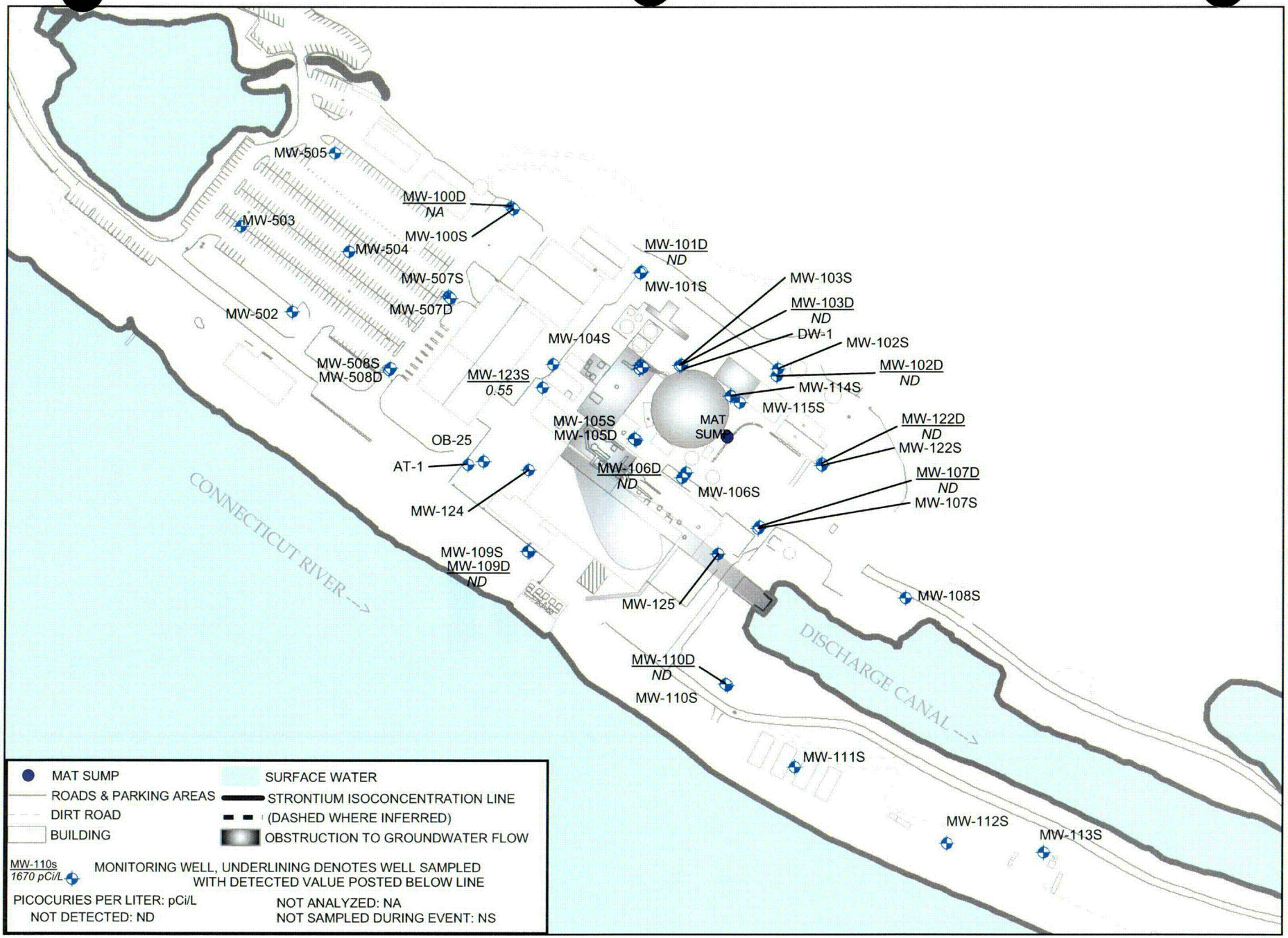


FIGURE 6-9

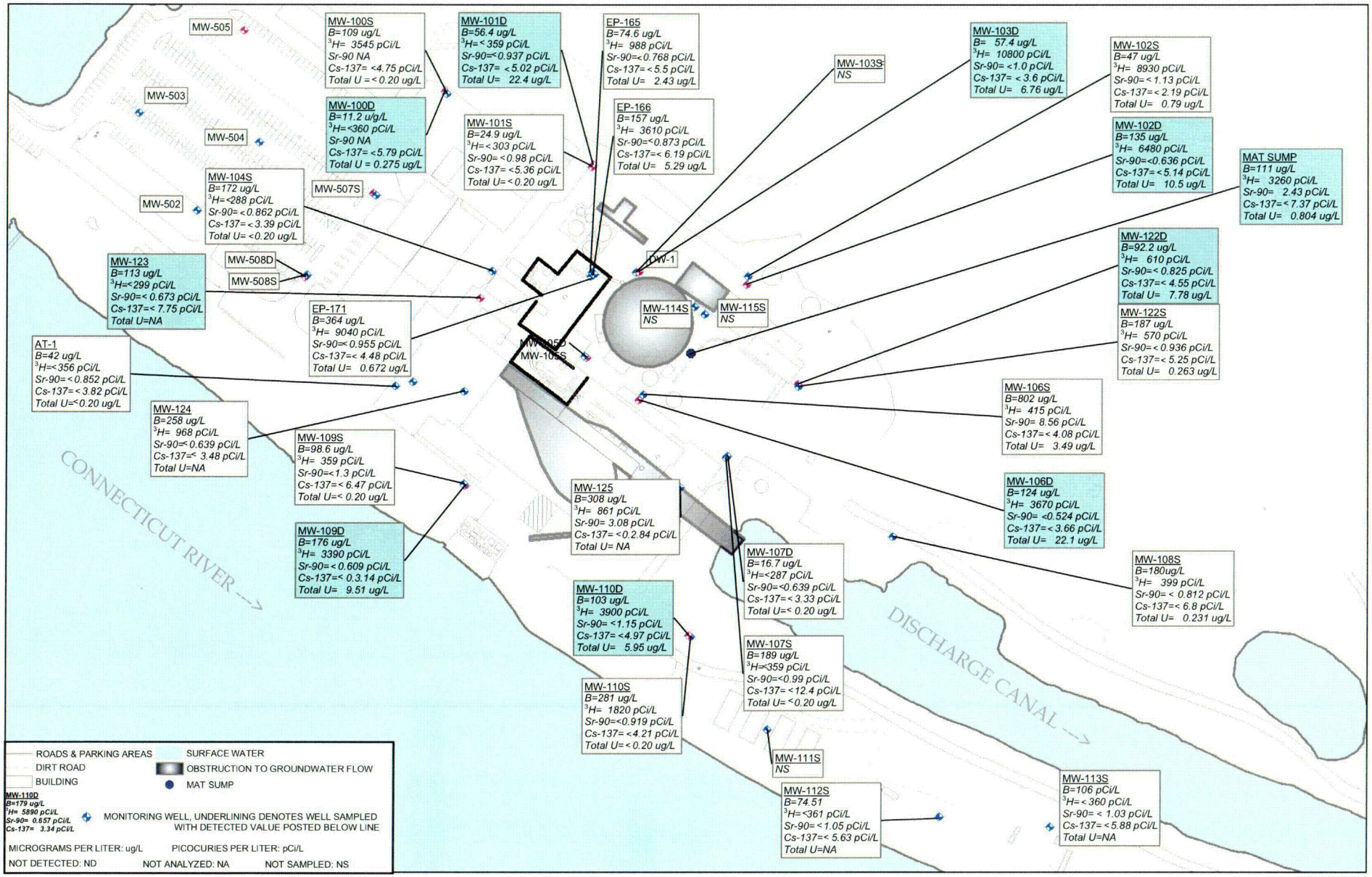
INFERRED DISTRIBUTION OF STRONTIUM-90 (pCi/L) IN THE CONFINED AQUIFER AT THE INDUSTRIAL AREA AND UPPER PENINSULA AREA OF THE HADDAM NECK PLANT SEPTEMBER 2004

HADDAM NECK, CT

CH2MHILL

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\Sr-90_CONFINED_09_04.mxd JKelly 3/30/2005

C32



CH2MHILL

FIGURE 6-10
DISTRIBUTION OF SELECTED SUBSTANCES OF CONCERN AT THE INDUSTRIAL AREA AND UPPER PENINSULA AREA OF THE CONNECTICUT YANKEE HADDAM NECK PLANT DECEMBER 2004
HADDAM NECK, CT

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\SOC_12_04.mxd JKelly 3/10/2005

C33

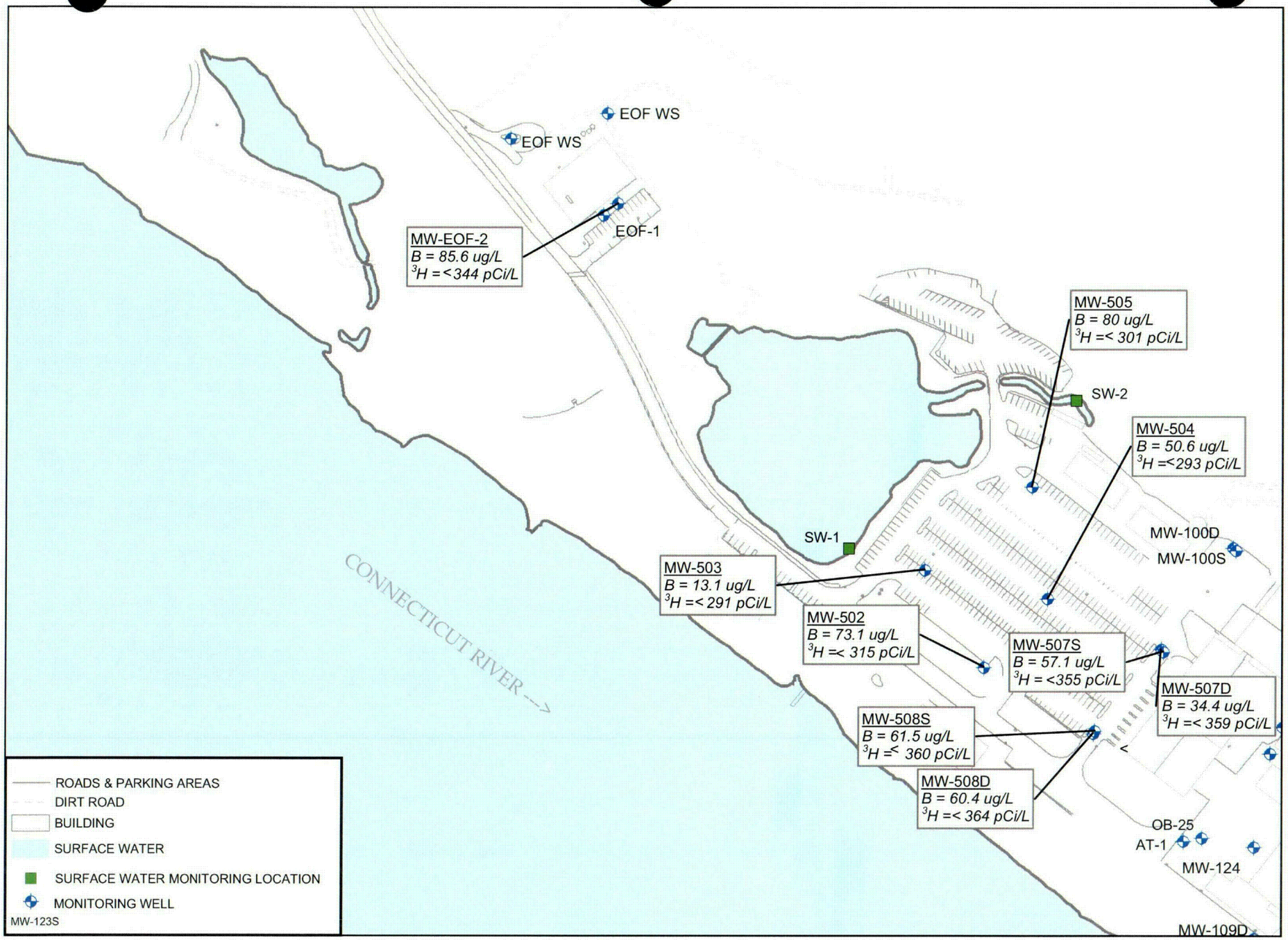
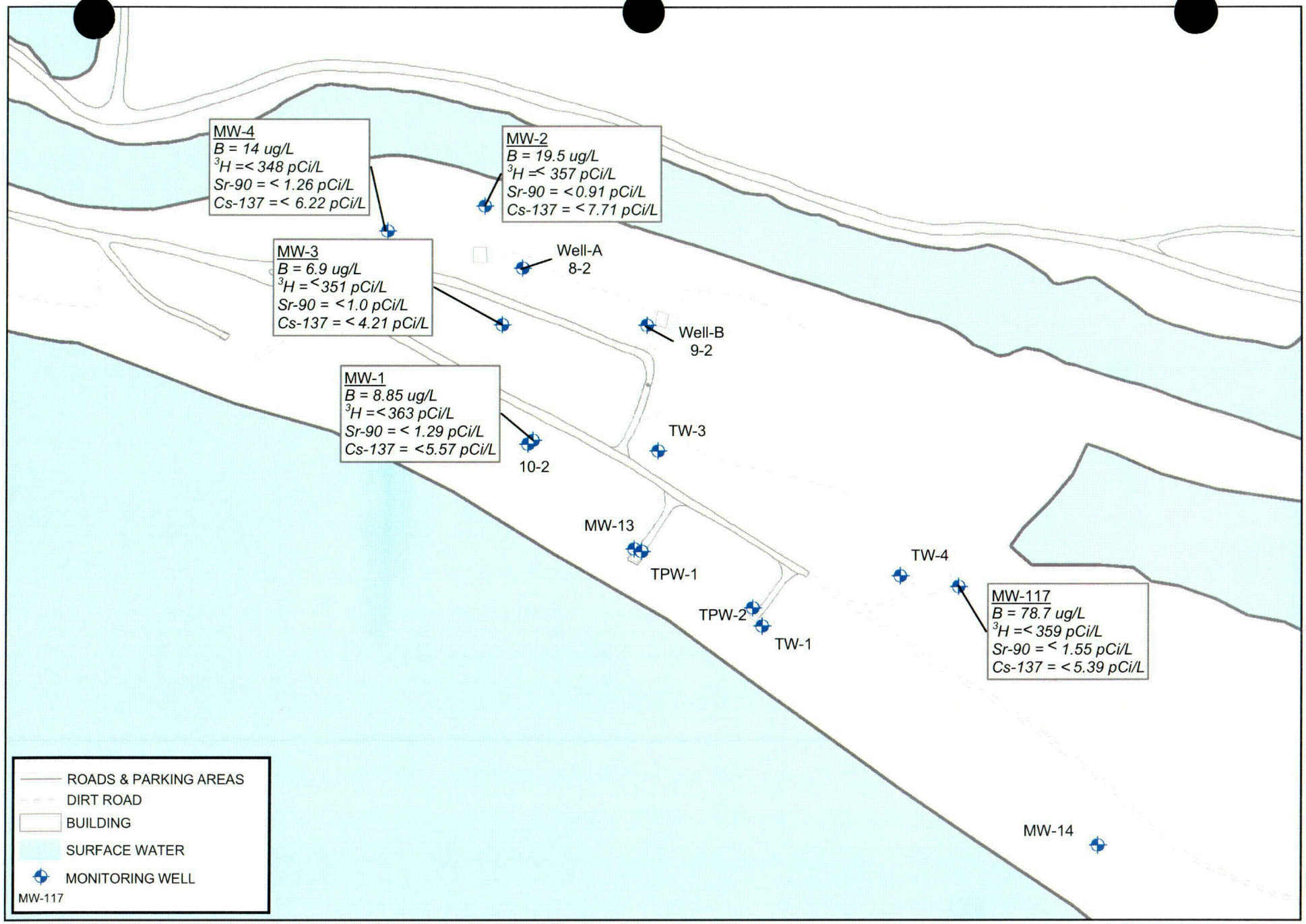


FIGURE 6-11
DISTRIBUTION OF SELECTED SUBSTANCES OF CONCERN AT THE EOF AND PARKING LOT AREA OF THE HADDAM NECK PLANT DECEMBER 2004
HADDAM NECK, CT

CH2MHILL

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\SOC_EOF_ParkingLot_12_04.mxd JKelly 3/30/2005

C34



N

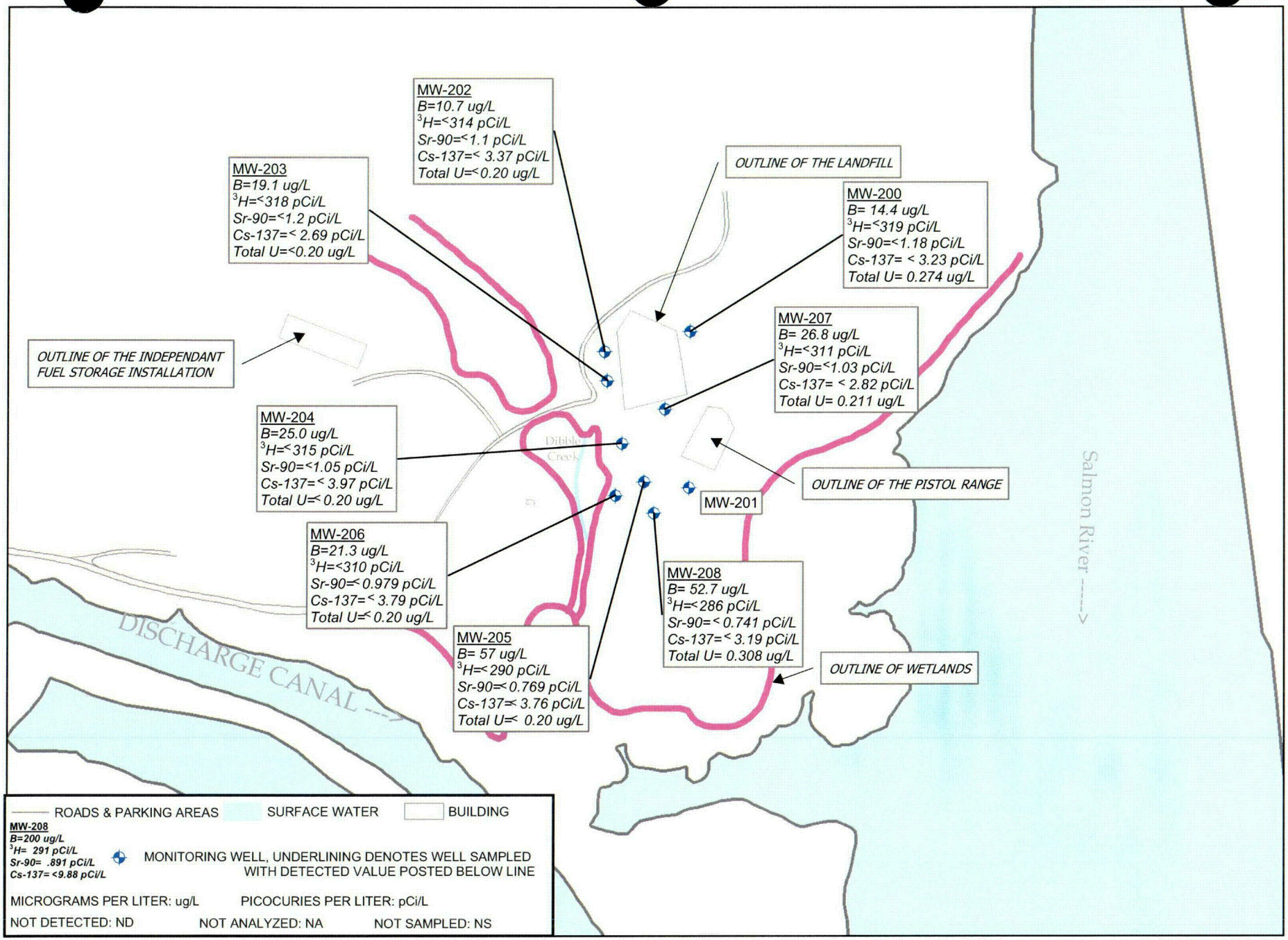
0 100 200 Feet

FIGURE 6-12
DISTRIBUTION OF SELECTED SUBSTANCES OF CONCERN AT THE PENINSULA AREA OF THE HADDAM NECK PLANT DECEMBER 2004
HADDAM NECK, CT

CH2MHILL

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\SOC_Peninsula_12_04.mxd JKelly 2/24/2005

C35



N

0 125 250 Feet

CH2MHILL

FIGURE 6-13
DISTRIBUTION OF SELECTED SUBSTANCES OF CONCERN AT THE LANDFILL AREA OF THE CONNECTICUT YANKEE HADDAM NECK PLANT DECEMBER 2004
HADDAM NECK, CT

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_4_2004\SOC_Landfill_12_04.mxd JKelly 3/8/2005

C36

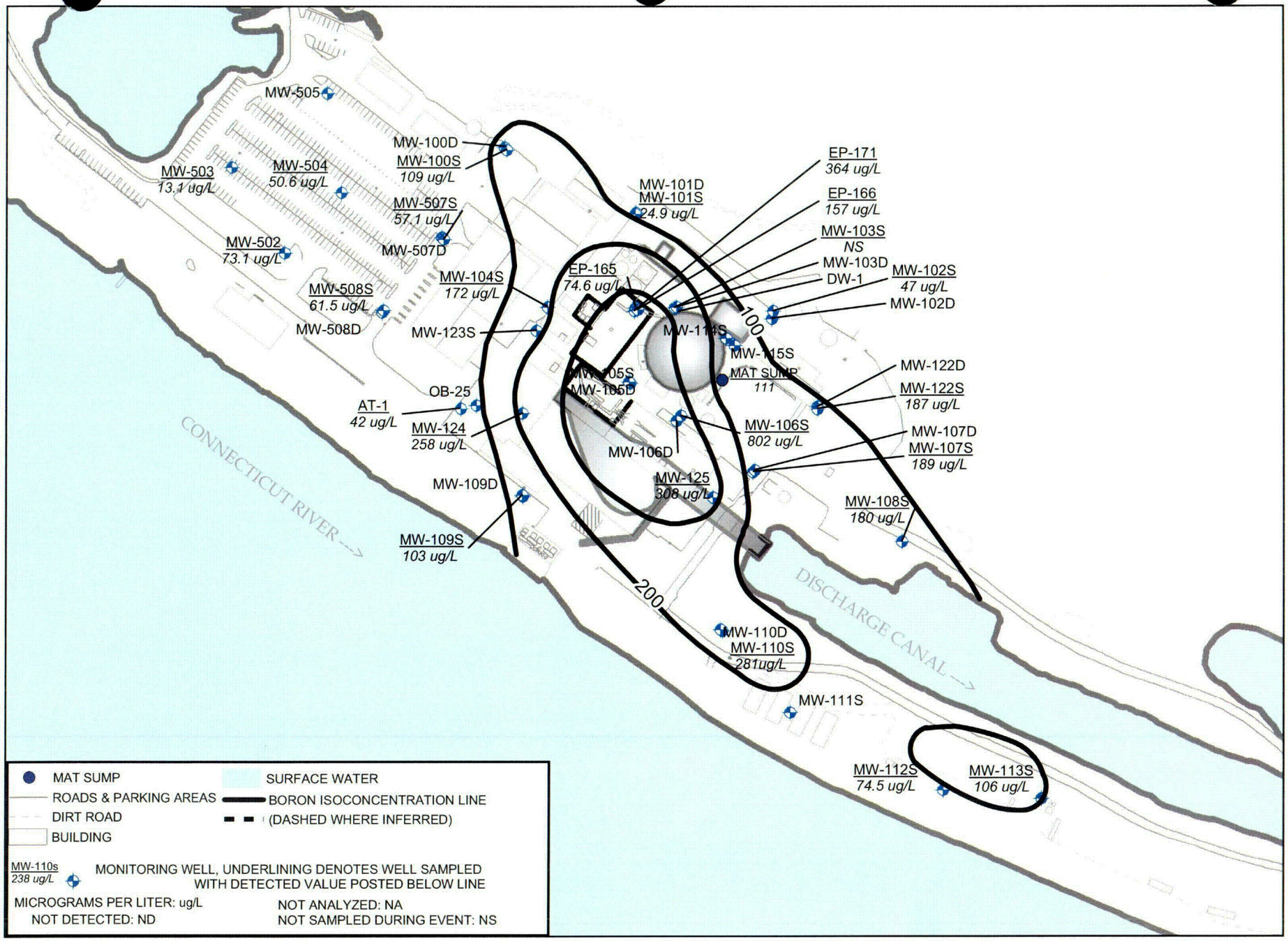


FIGURE 6-14
INFERRED DISTRIBUTION OF BORON (ug/L) IN THE UNCONFINED AQUIFER
AT THE INDUSTRIAL AREA AND UPPER PENINSULA AREA OF THE HADDAM NECK PLANT DECEMBER 2004
HADDAM NECK, CT

CH2MHILL

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\Boron_UNCONFINED_12_04.mxd JKelly 3/29/2005

C37

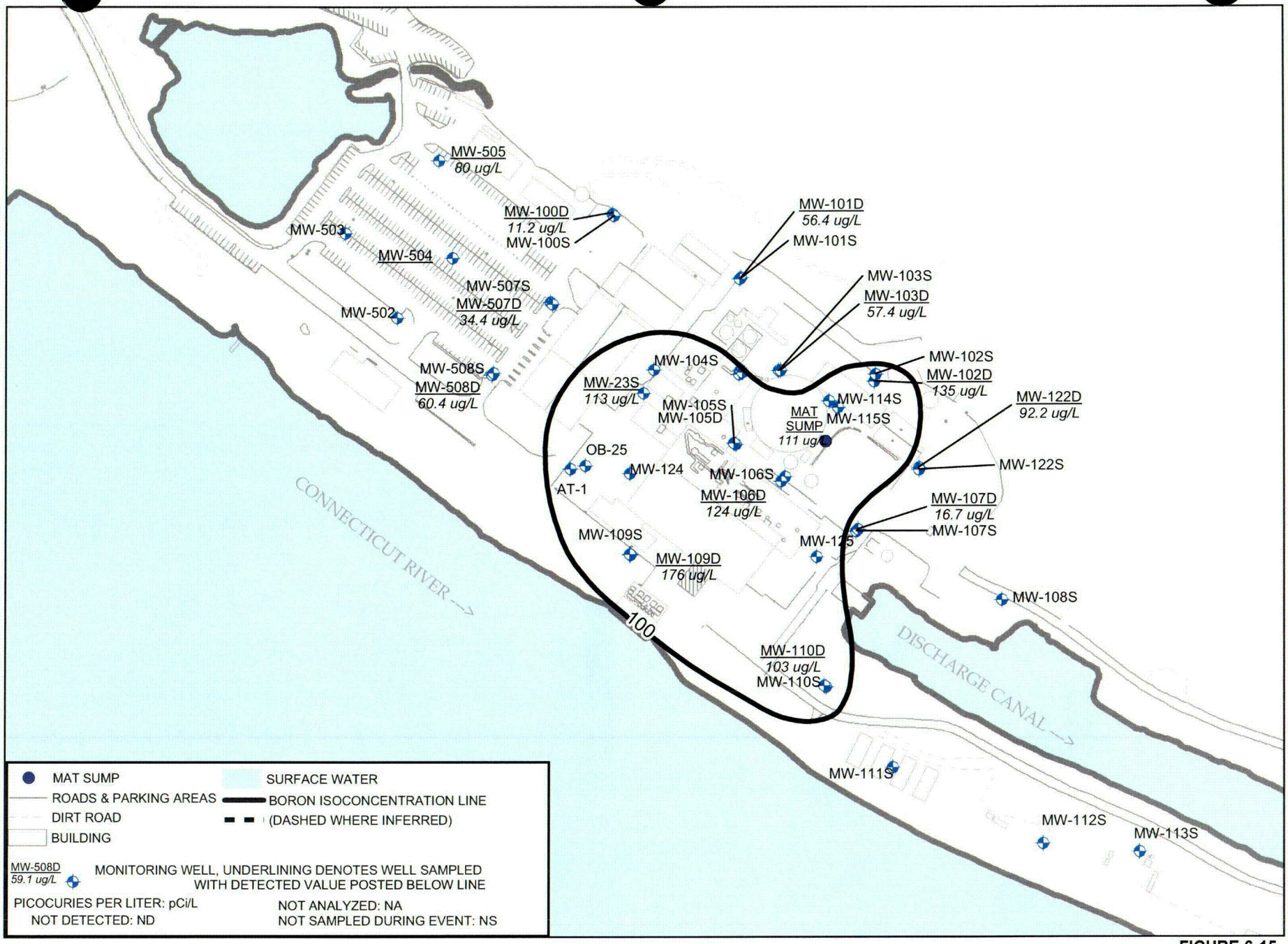


FIGURE 6-15

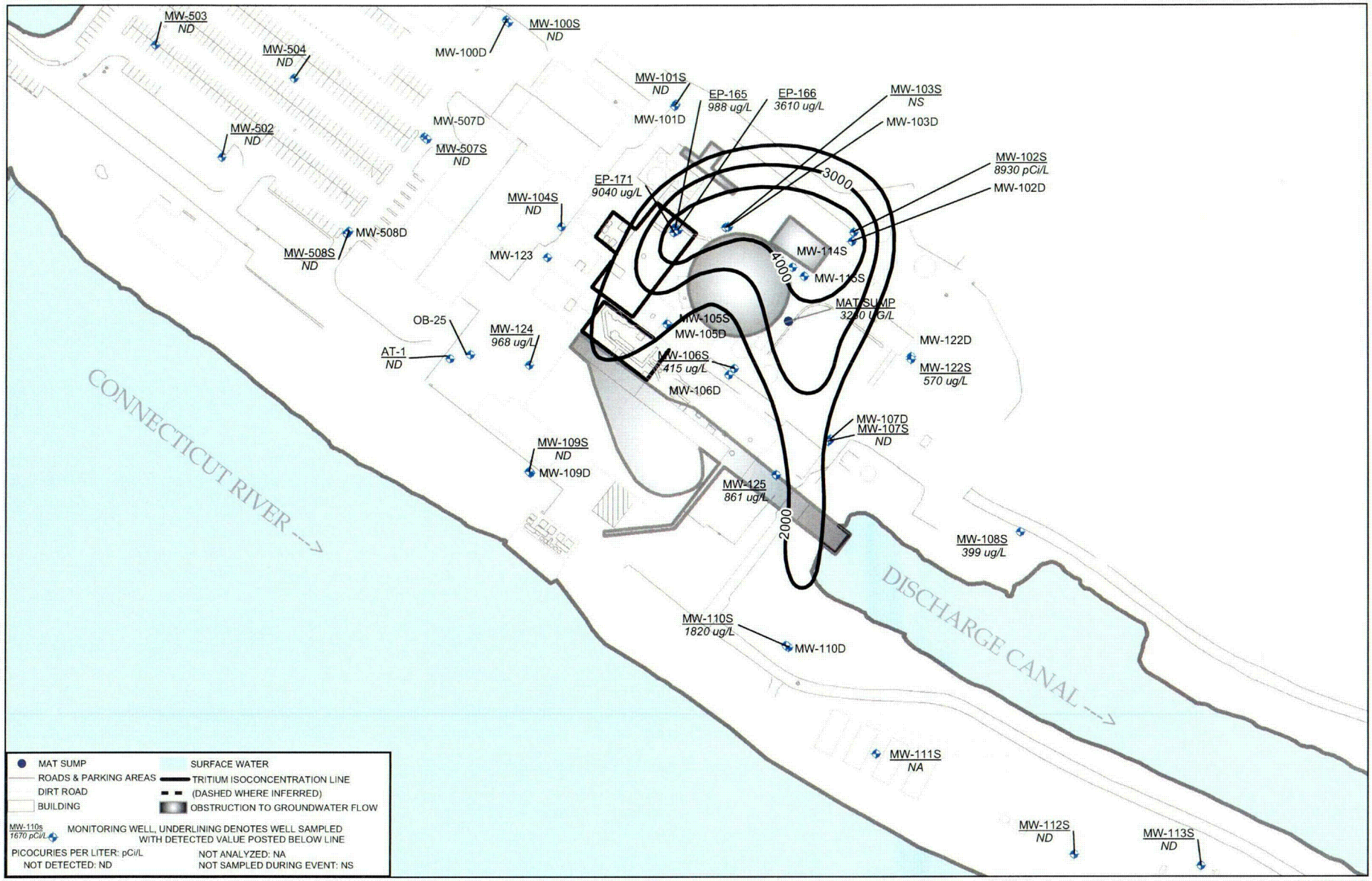
INFERRED DISTRIBUTION OF BORON (ug/L) IN THE CONFINED AQUIFER AT THE INDUSTRIAL AREA AND UPPER PENINSULA AREA OF THE HADDAM NECK PLANT DECEMBER 2004

HADDAM NECK, CT

CH2MHILL

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\Boron_CONFINED_12_04.mxd JKelly 3/29/2005

C38



N

0 100 200 Feet

FIGURE 6-16
INFERRED DISTRIBUTION OF TRITIUM (pCi/L) IN THE UNCONFINED AQUIFER
AT THE INDUSTRIAL AREA AND UPPER PENINSULA AREA OF THE HADDAM NECK PLANT DECEMBER 2004
HADDAM NECK, CT

CH2MHILL

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\Tritium_UNCONFINED_12_04.mxd JKelly 3/15/2005

C39

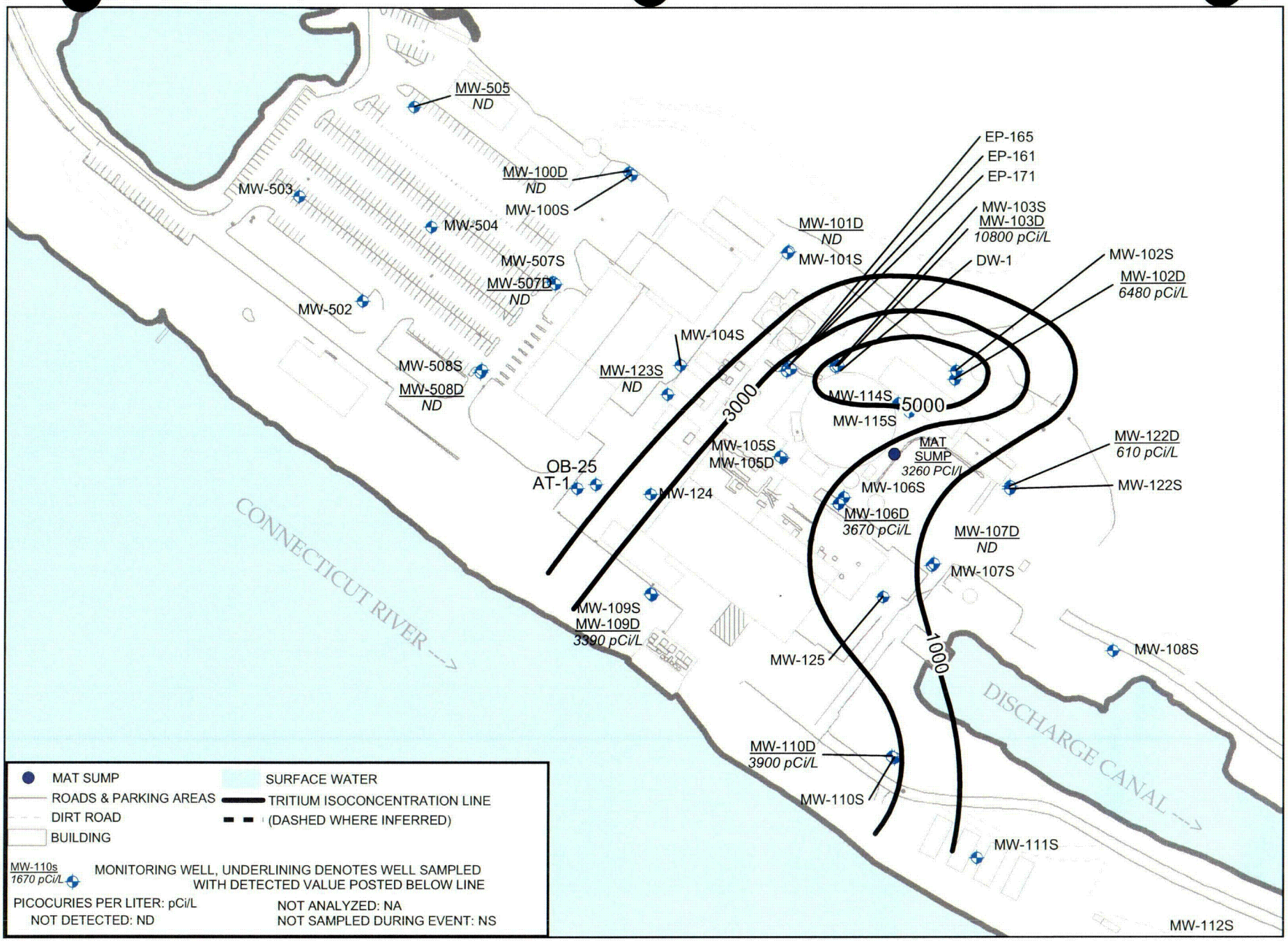


FIGURE 6-17

INFERRED DISTRIBUTION OF TRITIUM (pCi/L) IN THE CONFINED AQUIFER
AT THE INDUSTRIAL AREA AND UPPER PENINSULA AREA OF THE HADDAM NECK PLANT DECEMBER 2004
HADDAM NECK, CT

CH2MHILL

N

0 100 200 Feet

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\Tritium_CONFINED_12_04.mxd JKelly 3/30/2005

C40

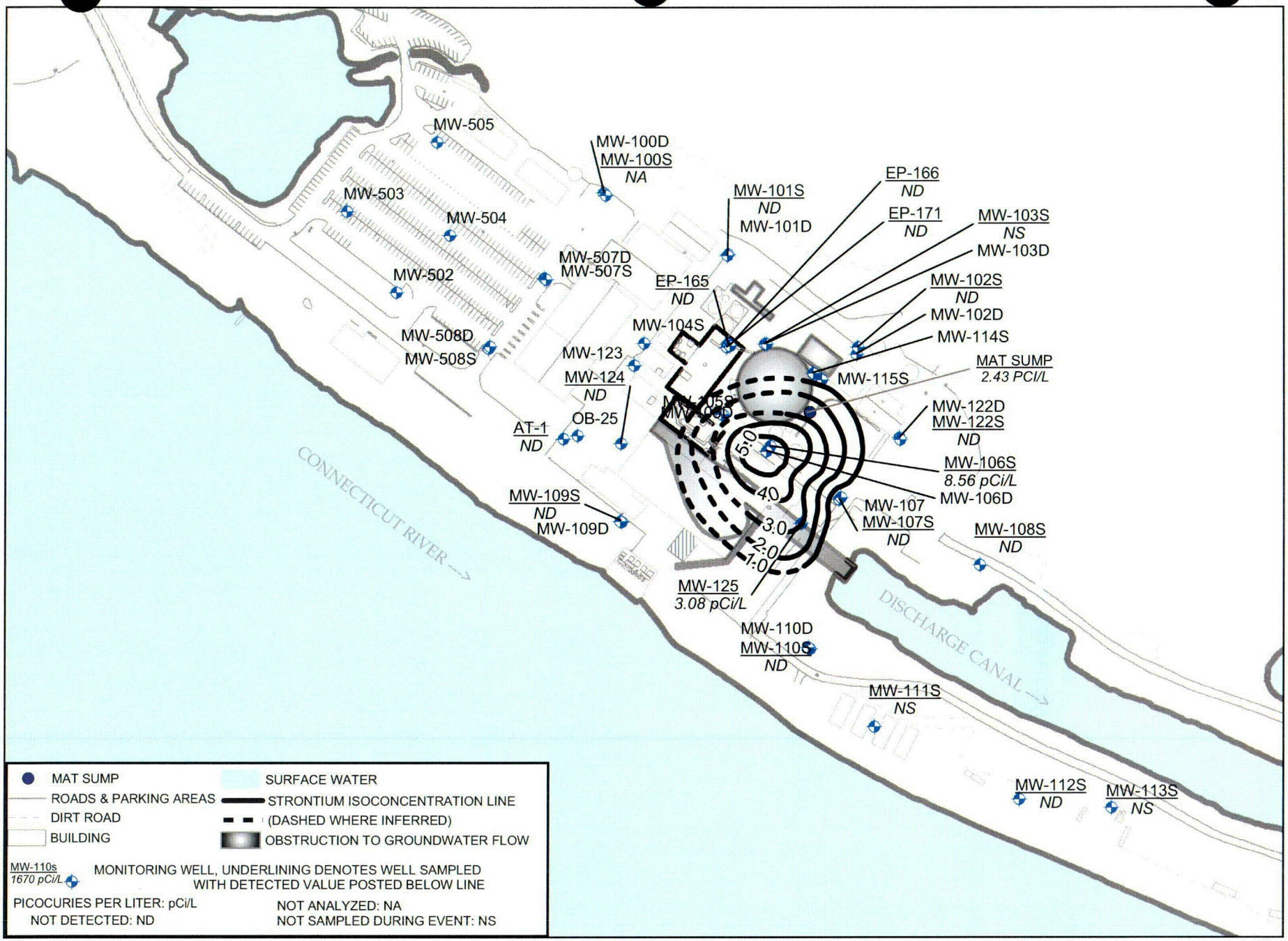


FIGURE 6-18
INFERRED DISTRIBUTION OF STRONTIUM-90 (pCi/L) IN THE UNCONFINED AQUIFER
AT THE INDUSTRIAL AREA AND UPPER PENINSULA AREA OF THE HADDAM NECK PLANT DECEMBER 2004
HADDAM NECK, CT

CH2MHILL

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\Sr-90_UNCONFINED_12_04.mxd JKelly 3/29/2005

C41

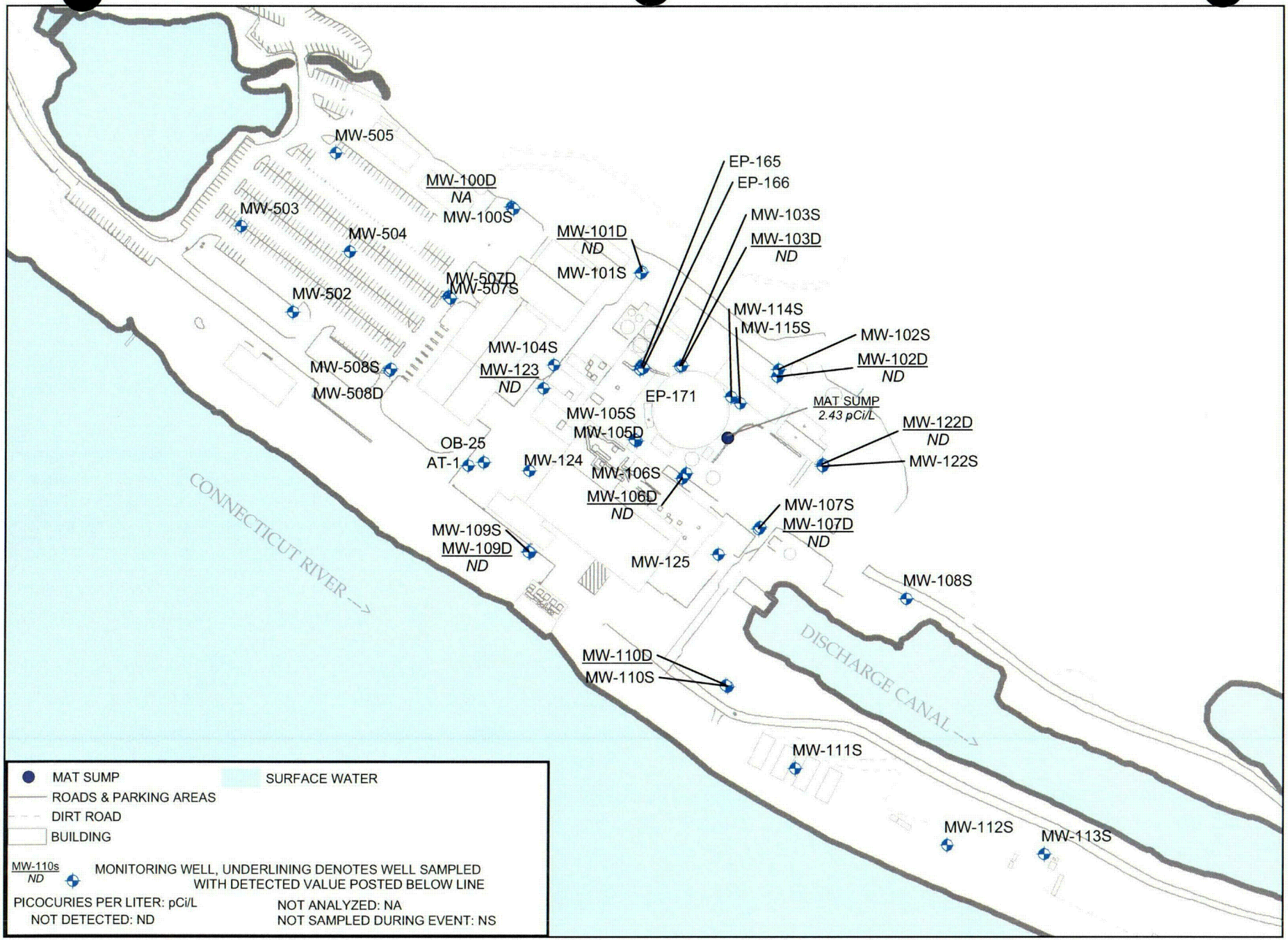


FIGURE 6-19

INFERRED DISTRIBUTION OF STRONTIUM-90 (pCi/L) IN THE CONFINED AQUIFER AT THE INDUSTRIAL AREA AND UPPER PENINSULA AREA OF THE HADDAM NECK PLANT DECEMBER 2004

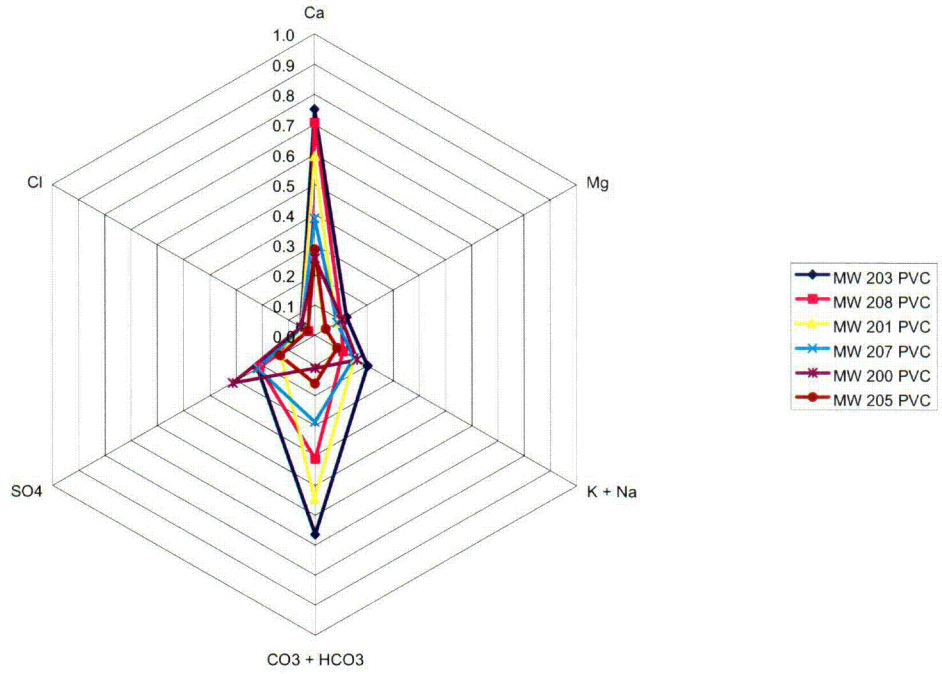
HADDAM NECK, CT

CH2MHILL

\\boomer\H\projects3\CT_Yankee\MXD\GW_Monitoring_Report_2_05\Sr-90_CONFINED_12_04.mxd JKelly 3/30/2005

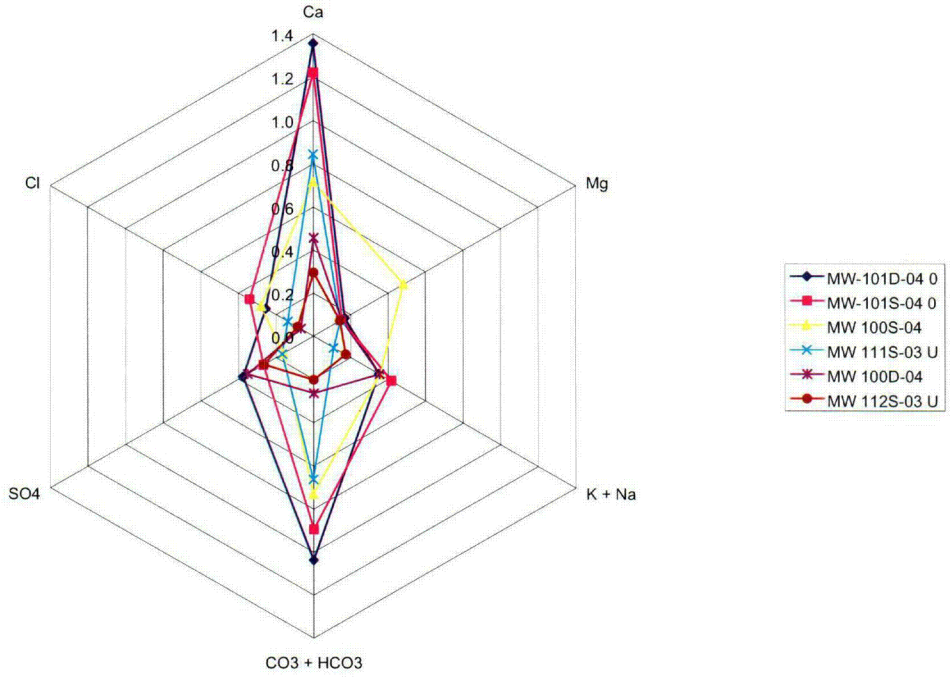
C42

Figure 6-20: Radar Plot of Geochemistry for Landfill Area Monitoring Wells



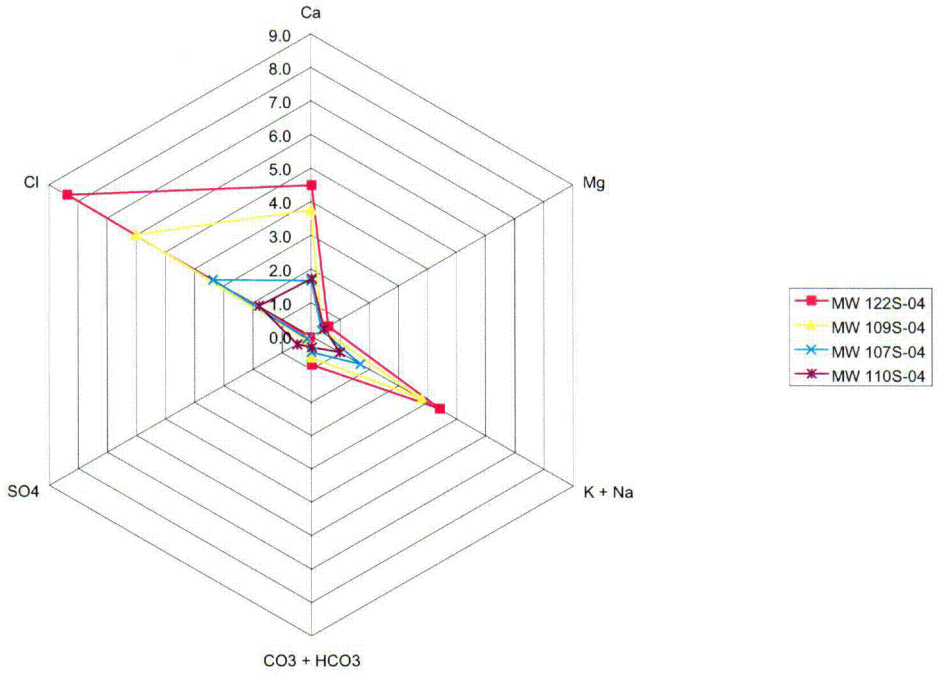
C43

Figure 6-21: Radar Plot of Geochemistry for Upgradient Monitoring Wells in the Industrial Area



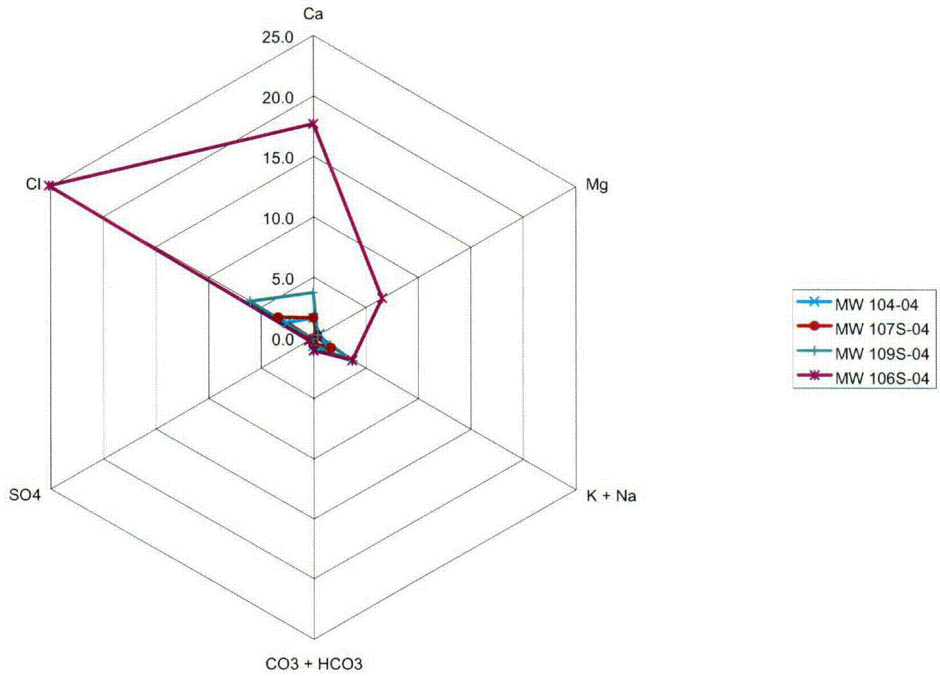
C44

Figure 6-22: Radar Plot of Geochemistry for Downgradient Monitoring Wells in the Industrial Area



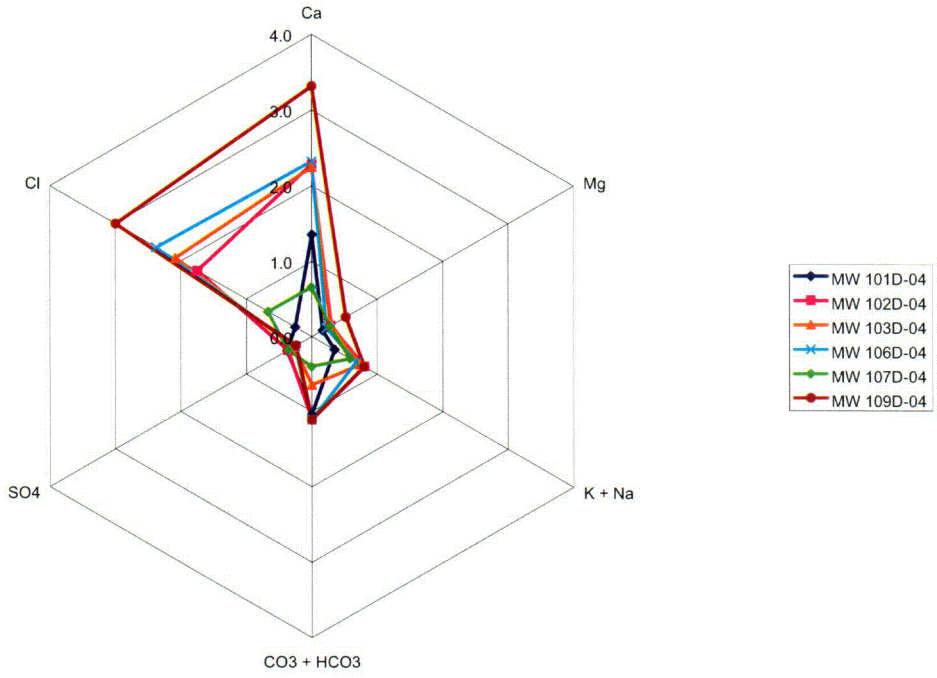
C45

Figure 6-23: Radar Plot of Geochemistry for Shallow Monitoring Wells in the Industrial Area



C46

Figure 6-24: Radar Plot of Geochemistry for Deep Monitoring Wells in the Industrial Area



C47

Figure 6-25: Boron Site-wide Concentration Box Plot

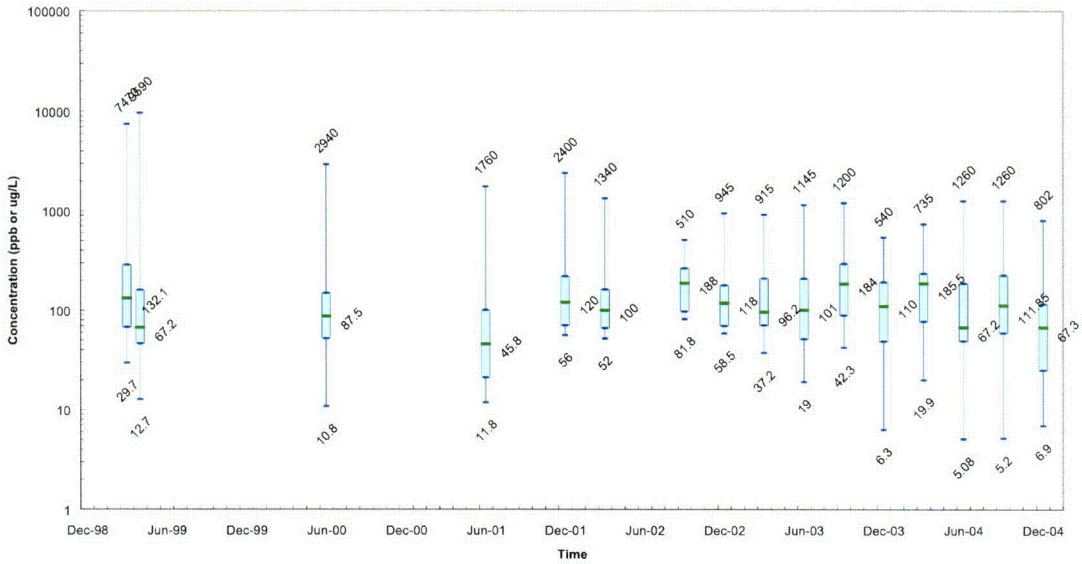
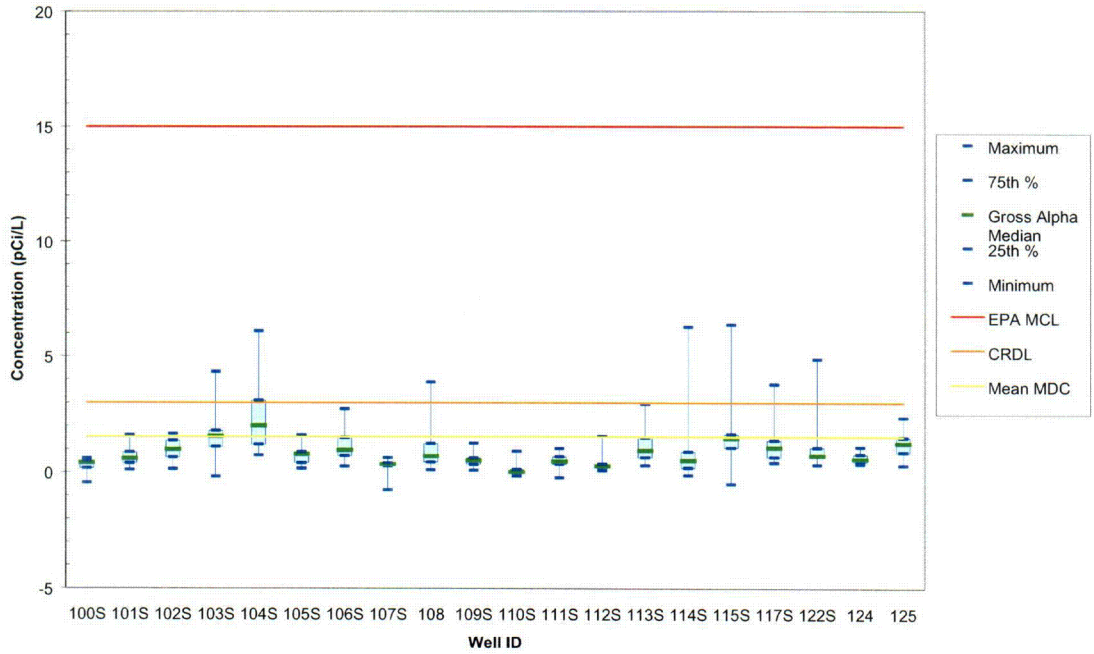


Figure 6-26: Box Plot of Gross Alpha Concentrations in Unconfined Aquifer



C48

Figure 6-27: Box Plot of Gross Alpha Concentrations in Confined Aquifier

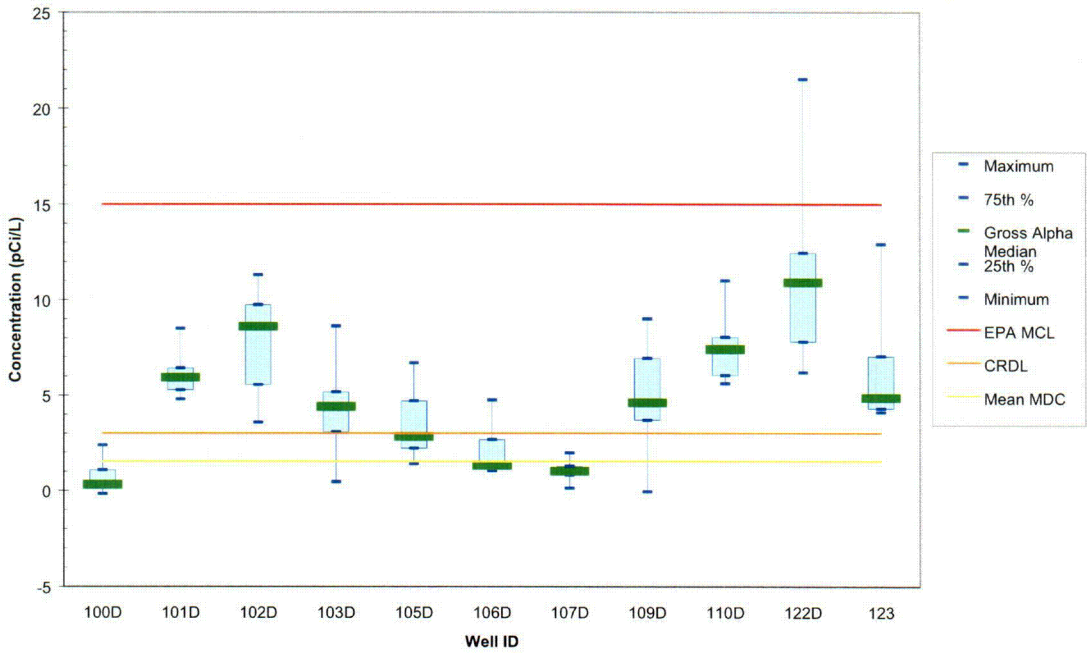
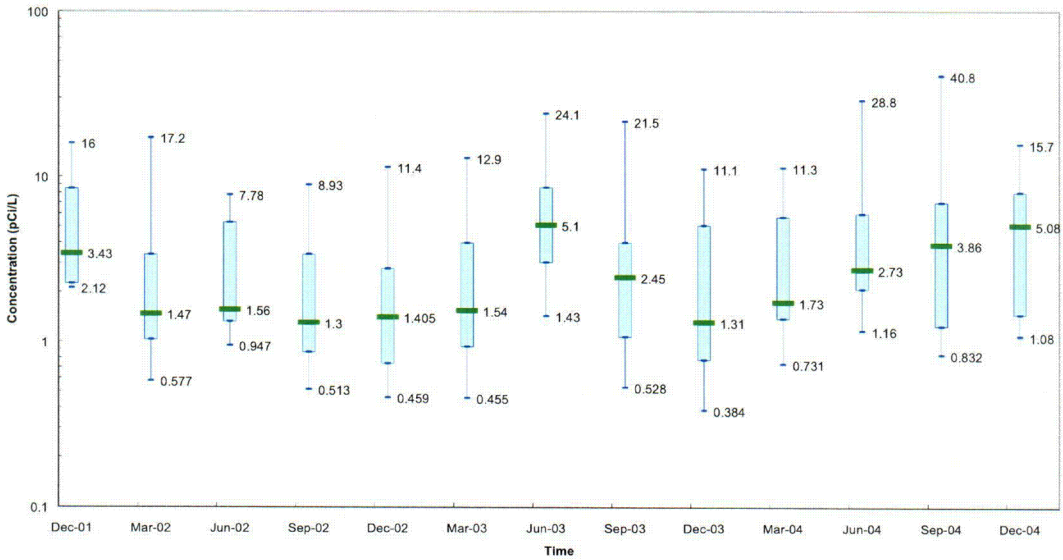


Figure 6-28: Gross Alpha Site-wide Concentration Box Plot



C49

Figure 6-29: Box Plot of Gross Beta Concentrations in Unconfined Aquifer

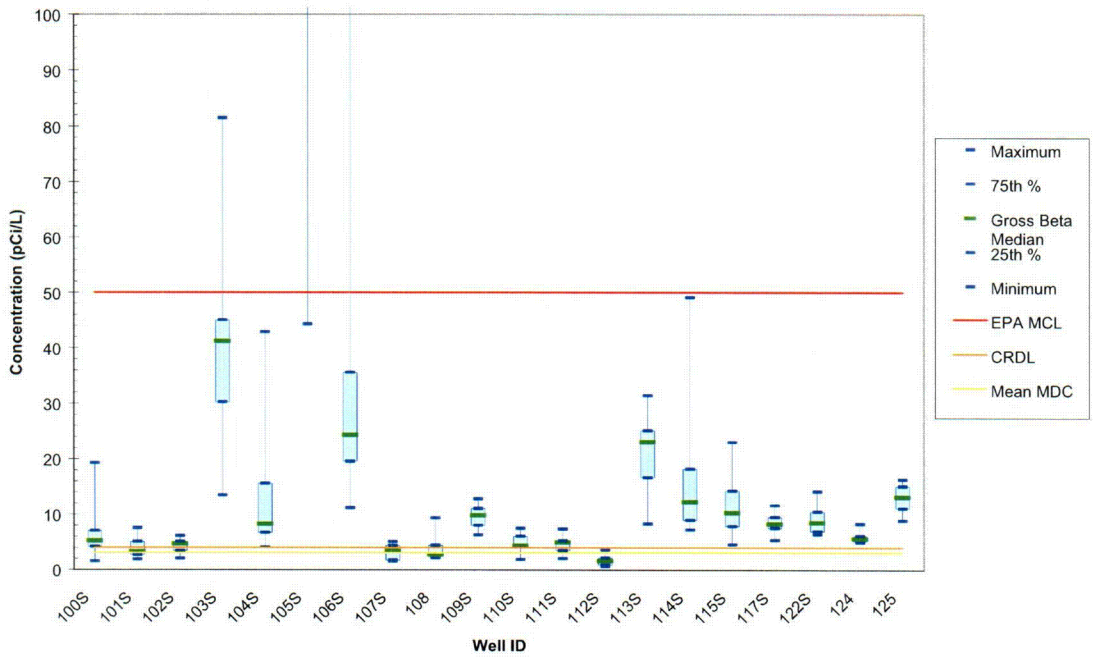
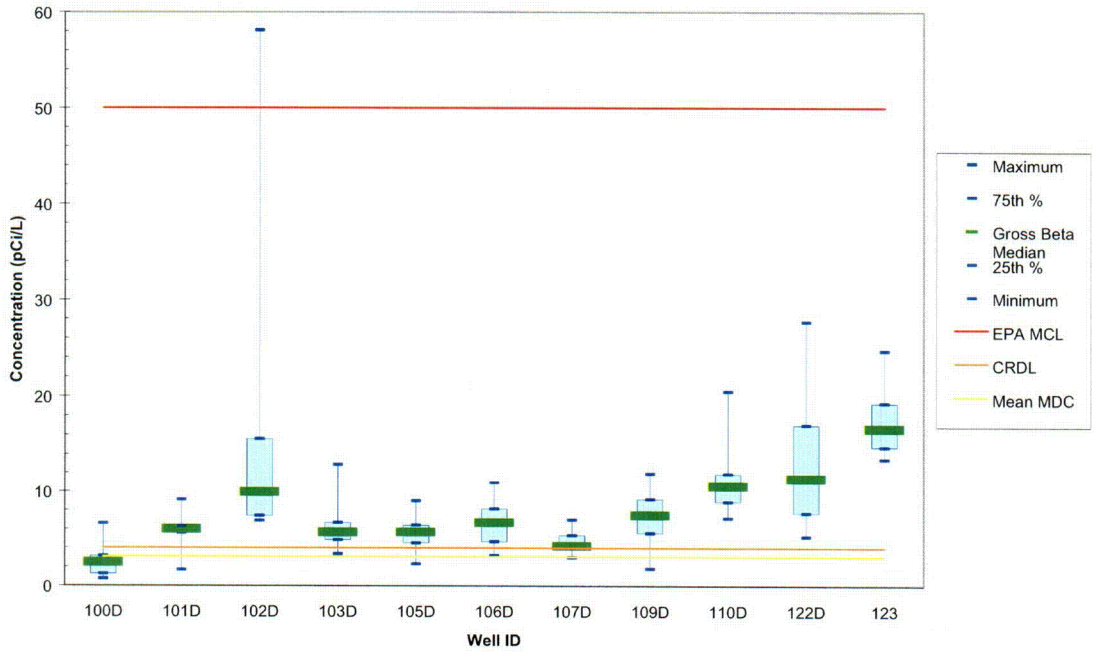


Figure 6-30: Box Plot of Gross Beta Concentrations in Confined Aquifer



C50

Figure 6-31: Gross Beta Site-wide Concentration Box Plot

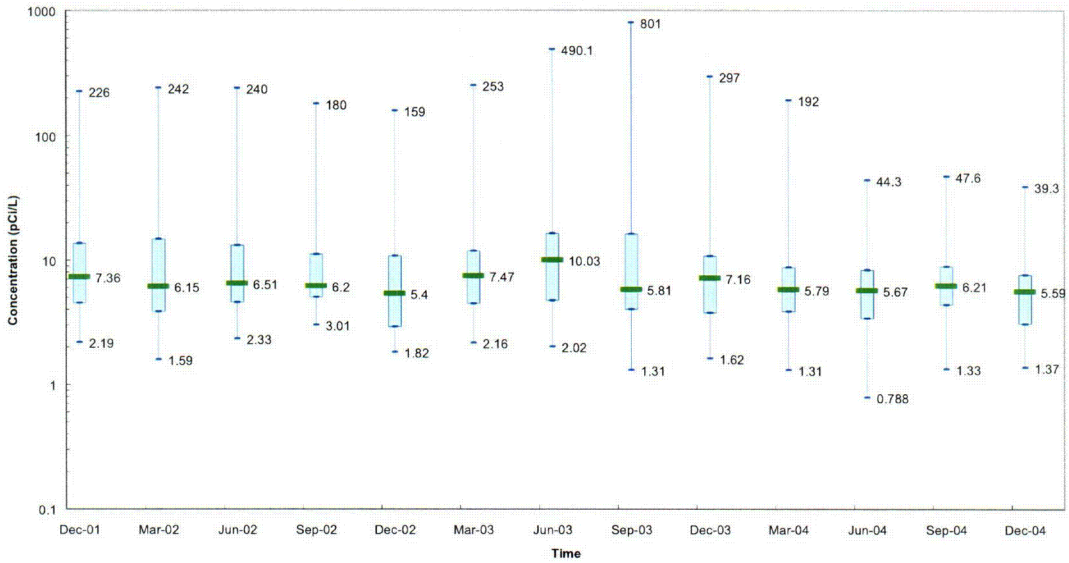
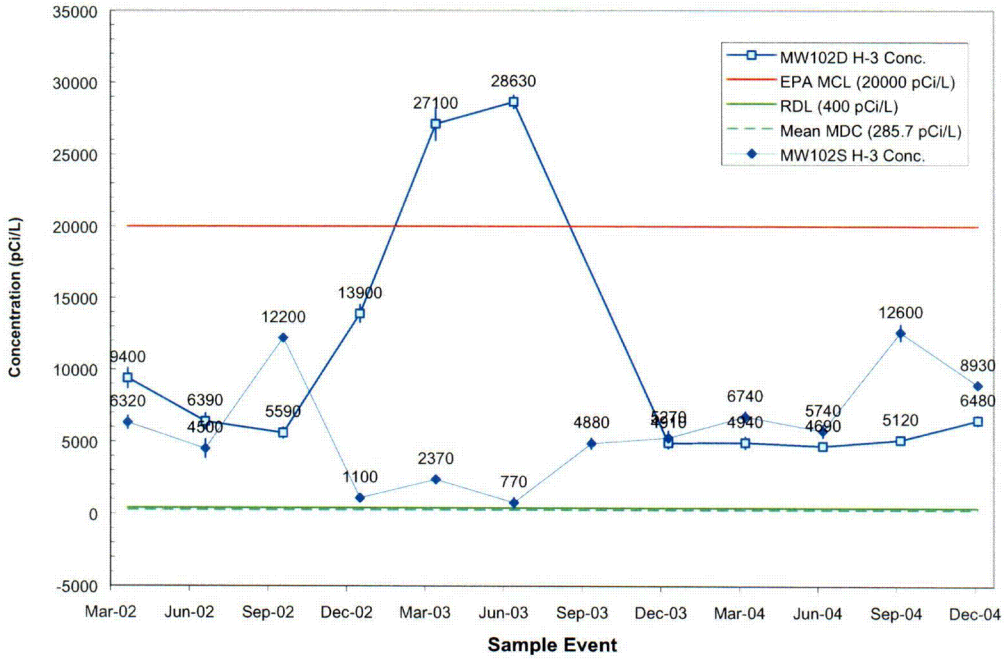


Figure 6-32: H-3 Concentration Trend at Cluster Well MW102



C51

Figure 6-33: H-3 Concentration Trend at Cluster Well MW103

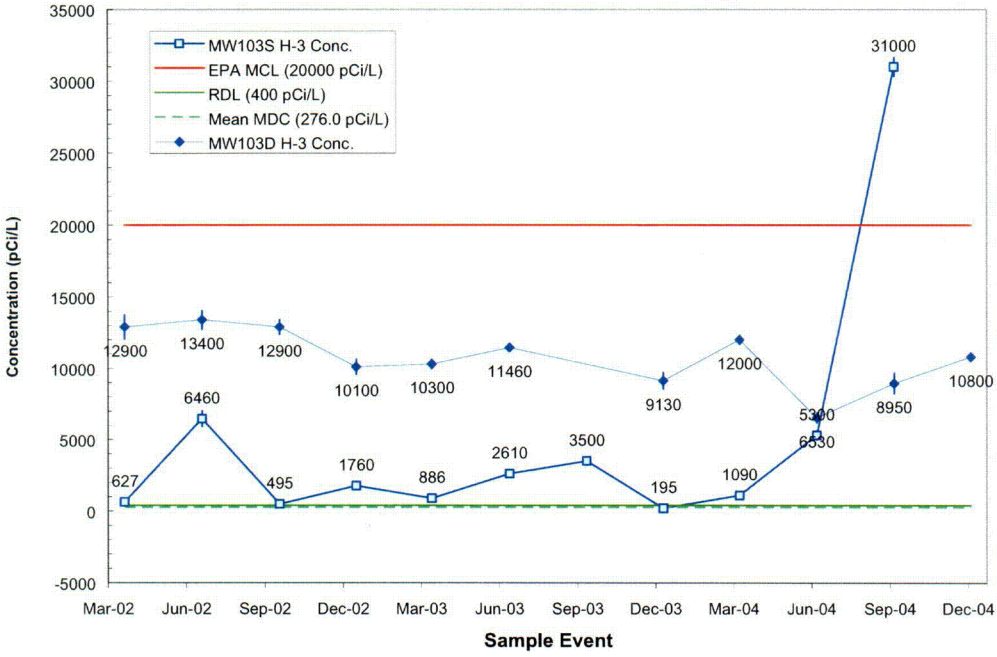
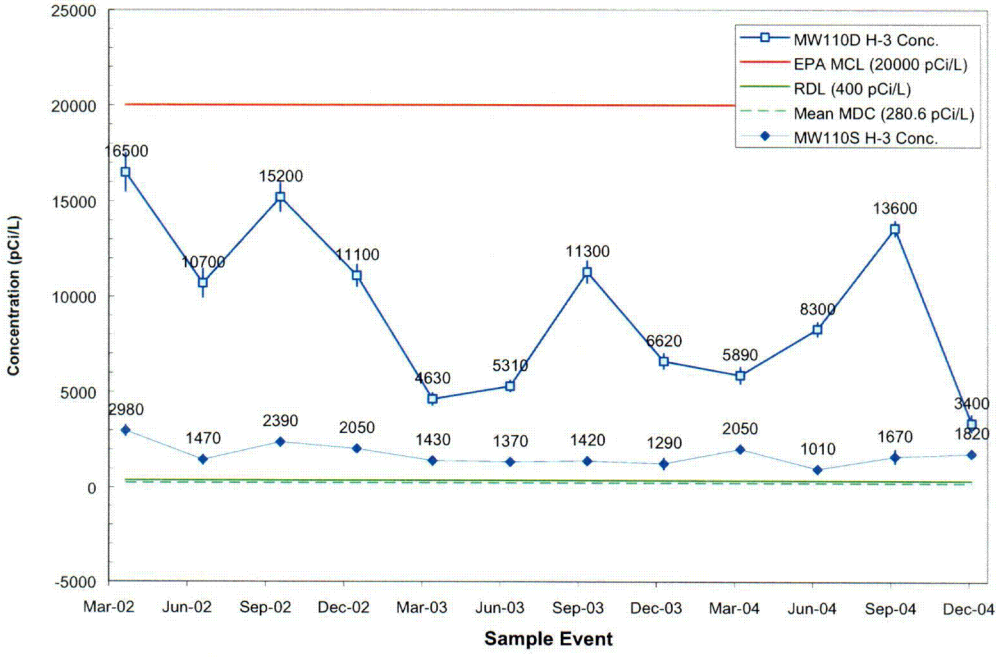


Figure 6-34: H-3 Concentration Trend at Cluster Well MW110



C52

Figure 6-35: H-3 Concentration Trend at Cluster Well MW105

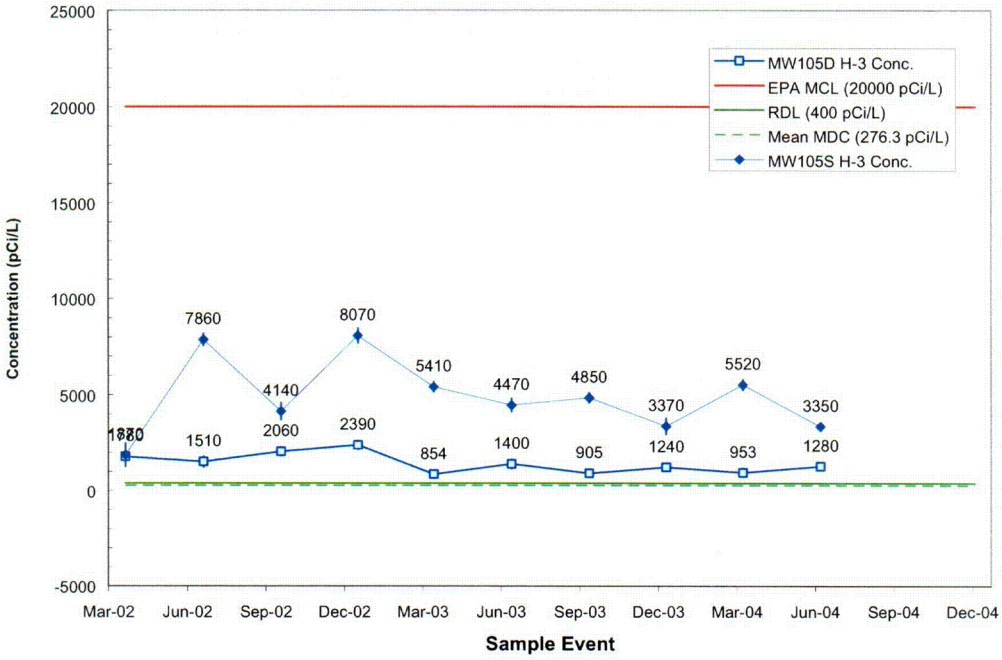
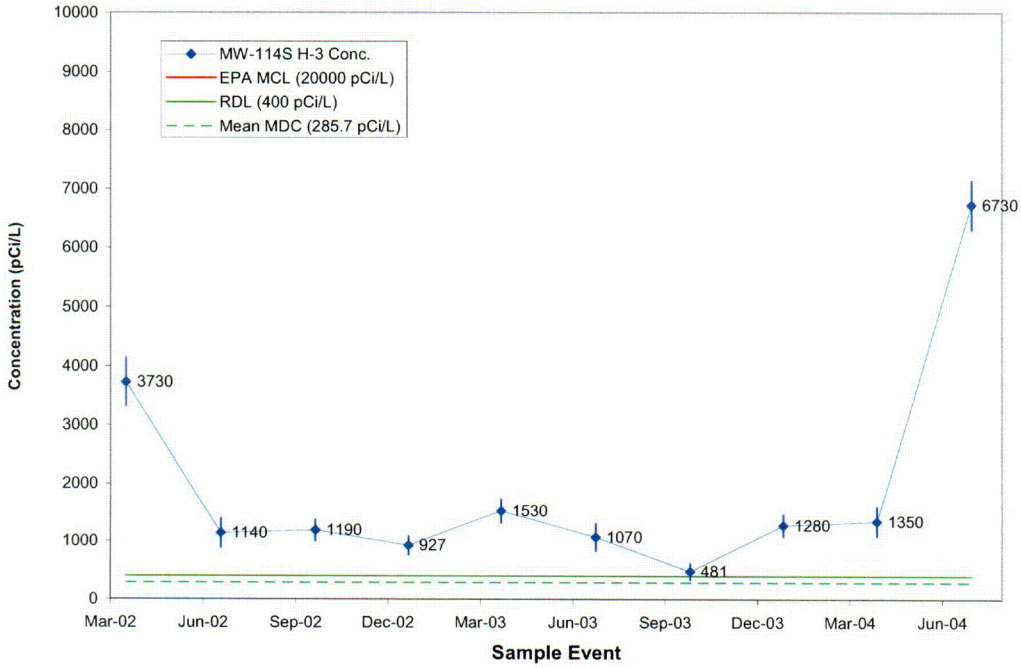


Figure 6-36: H-3 Concentration Trend at Well MW114S



C53

Figure 6-37: Box Plot of H-3 Concentrations in Unconfined Aquifer

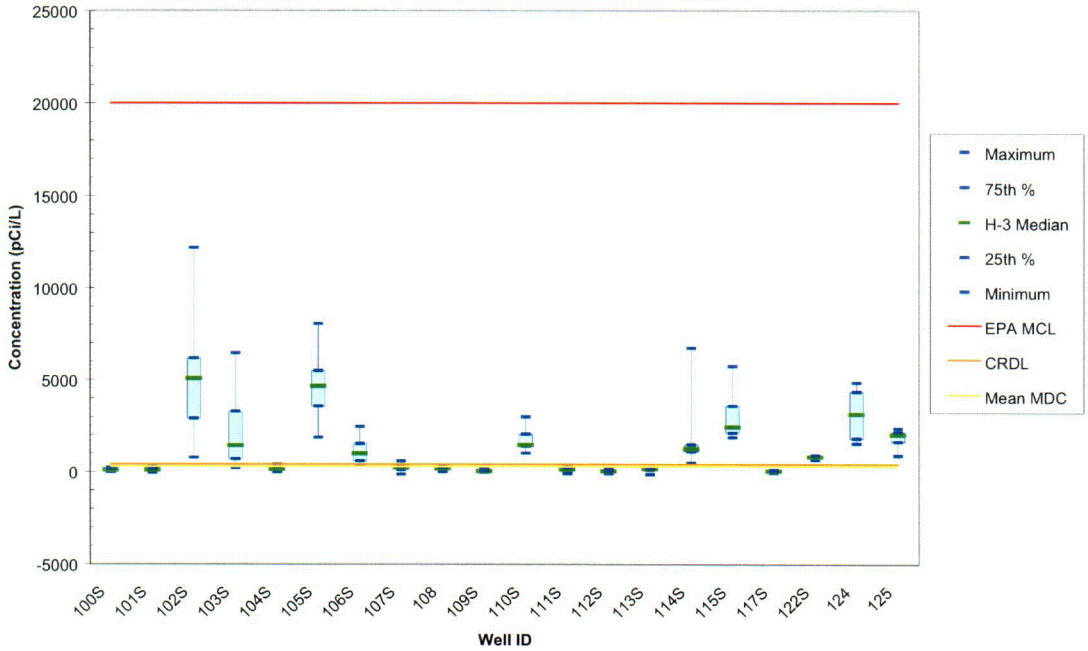
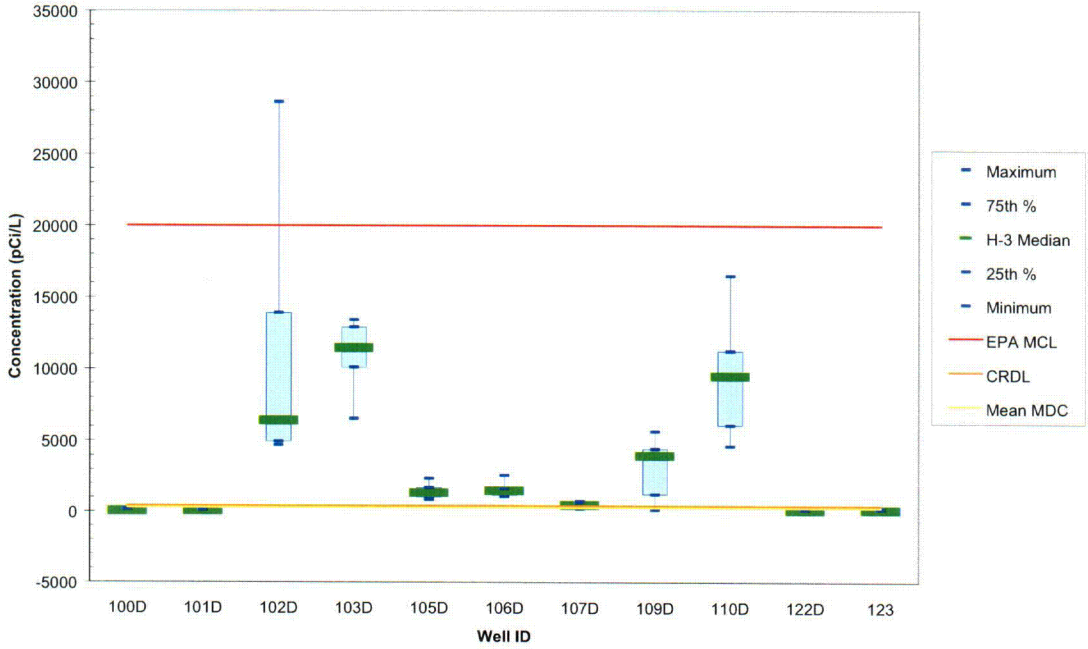


Figure 6-38: Box Plot of H-3 Concentrations in Confined Aquifer



C54

Figure 6-39: H-3 Site-wide Concentration Box Plot

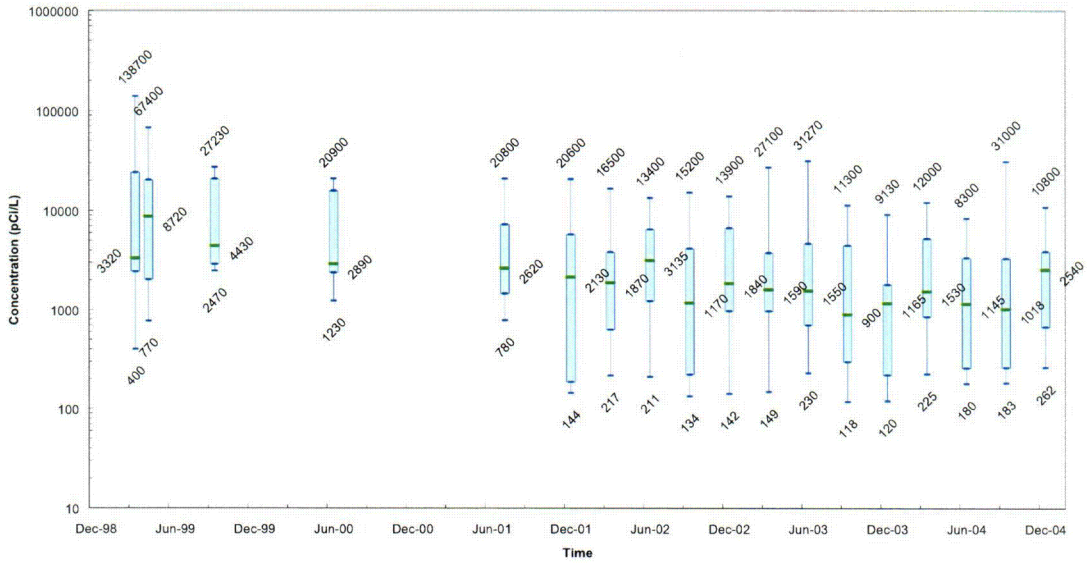
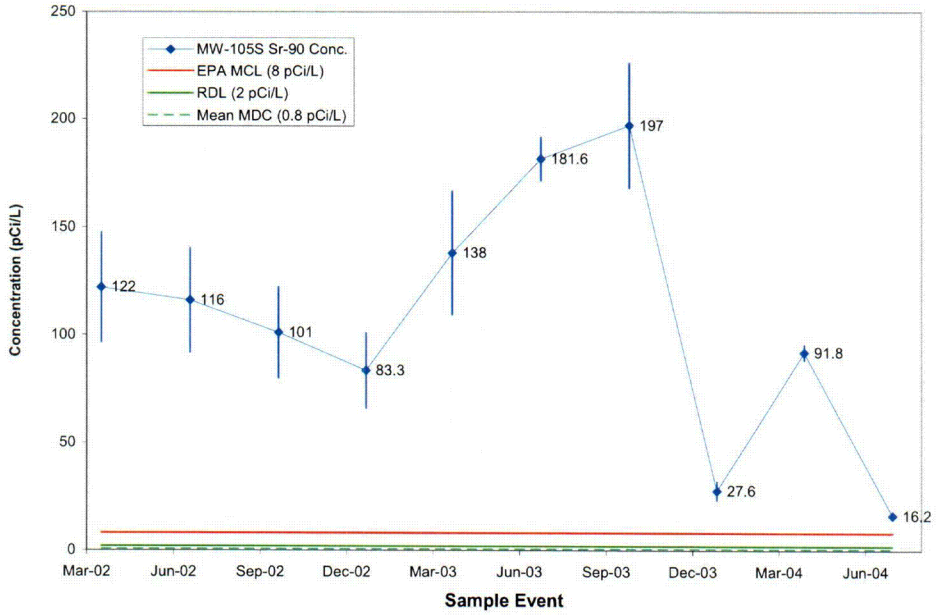


Figure 6-40: Sr-90 Concentration Trend at Well MW105S



C55

Figure 6-41: Sr-90 Concentration Trend at Cluster Well MW106

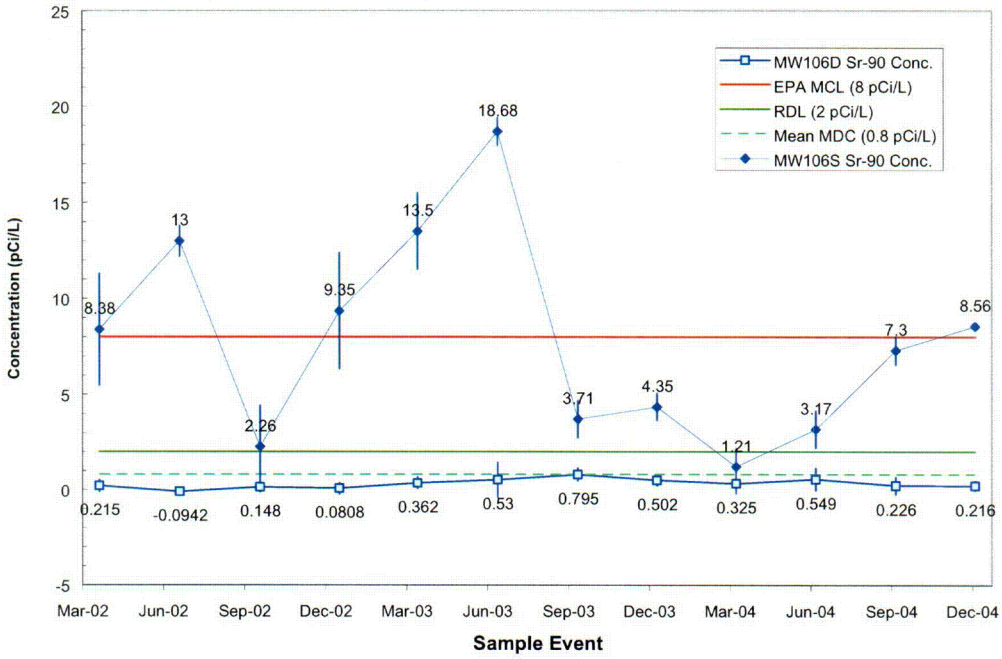
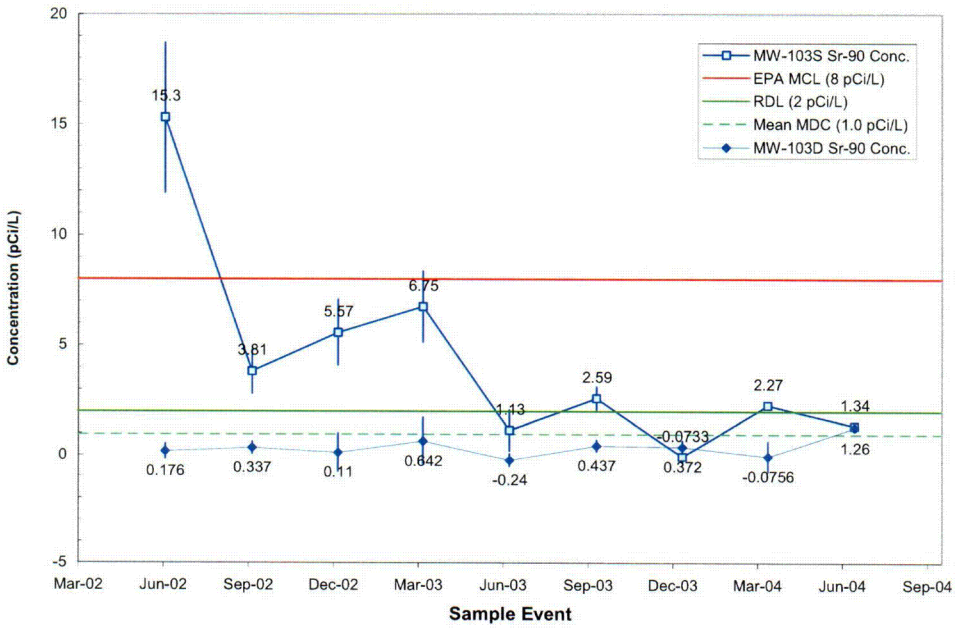


Figure 6-42: Sr-90 Concentration Trend at Cluster Well MW103



c56

Figure 6-43: Sr-90 Concentration Trend at Well MW104S

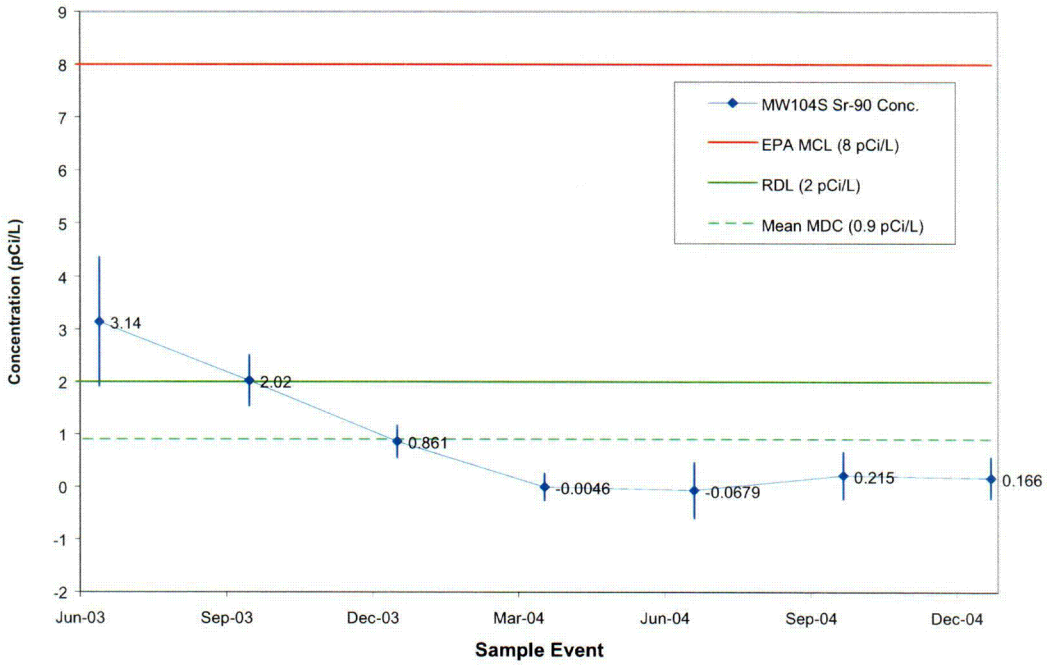
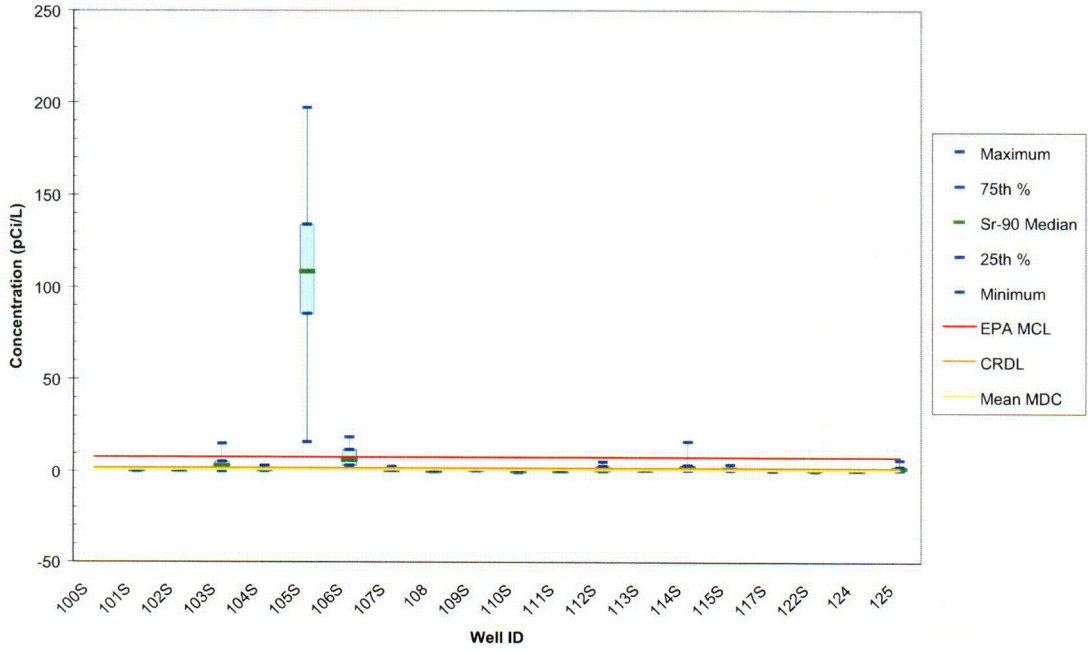


Figure 6-44: Box Plot of Sr-90 Concentrations in Unconfined Aquifer



C57

Figure 6-45: Box Plot of Sr-90 in Unconfined Aquifer (Expanded View)

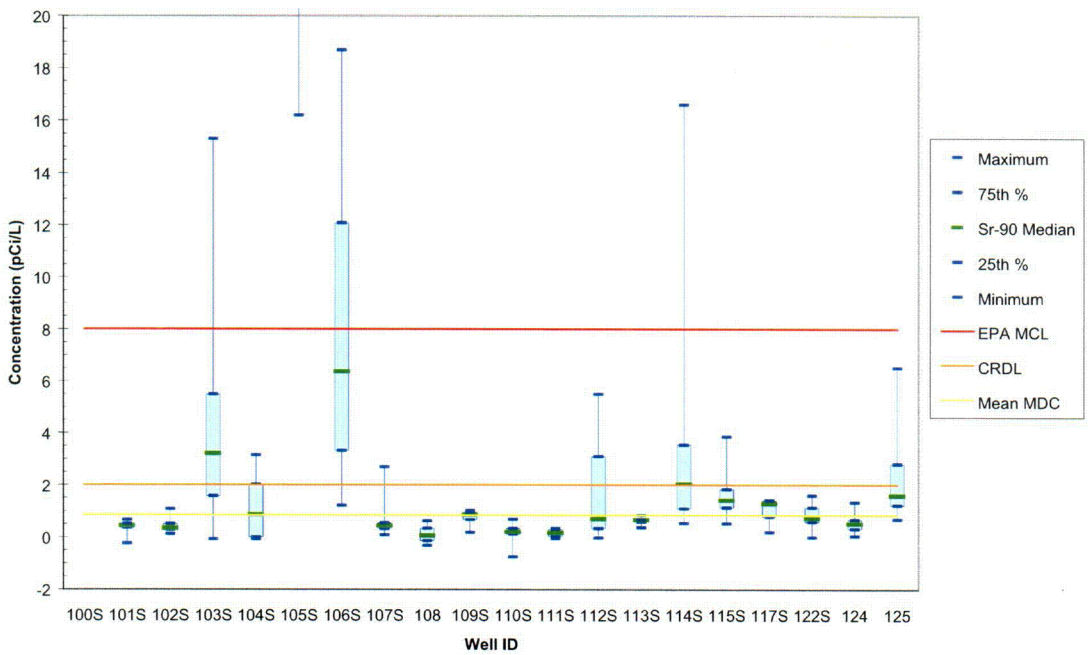
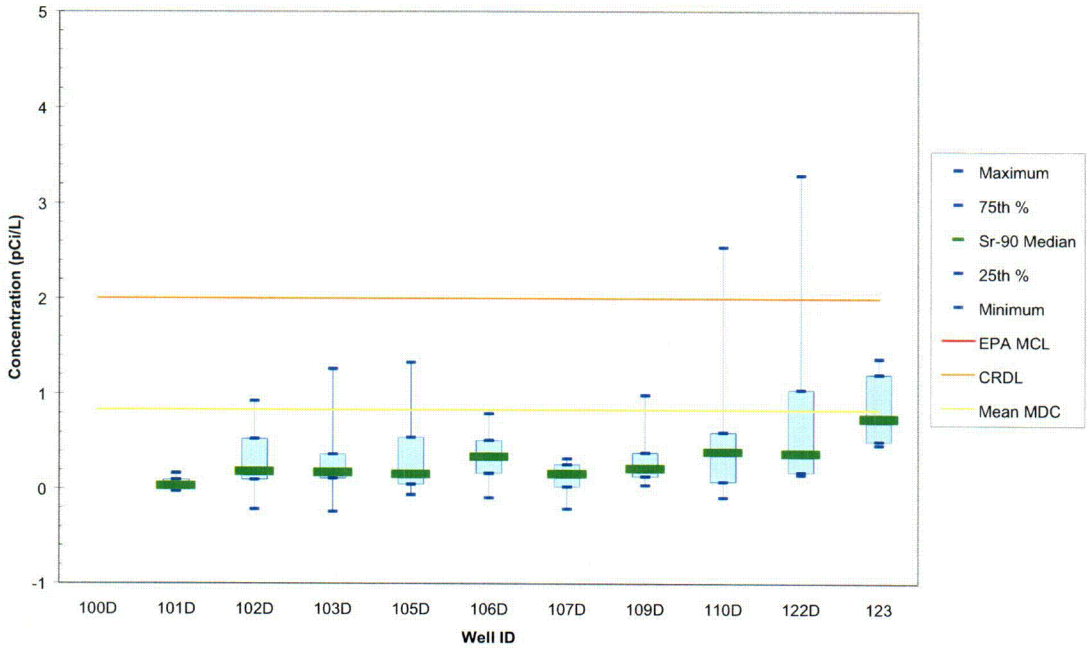


Figure 6-46: Box Plot of Sr-90 Concentrations in Confined Aquifer



C58

Figure 6-47: Sr-90 Site-wide Concentration Box Plot

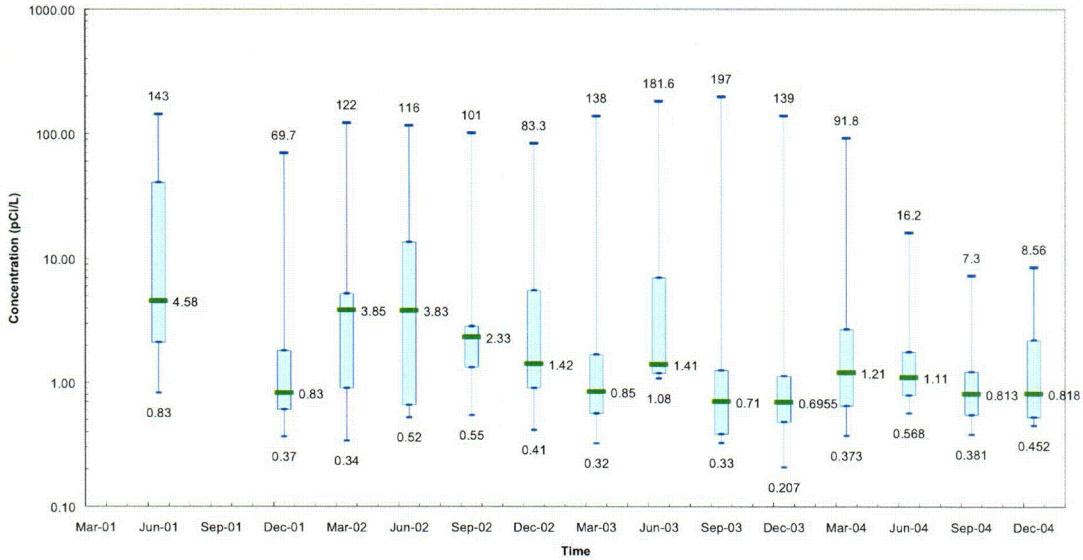
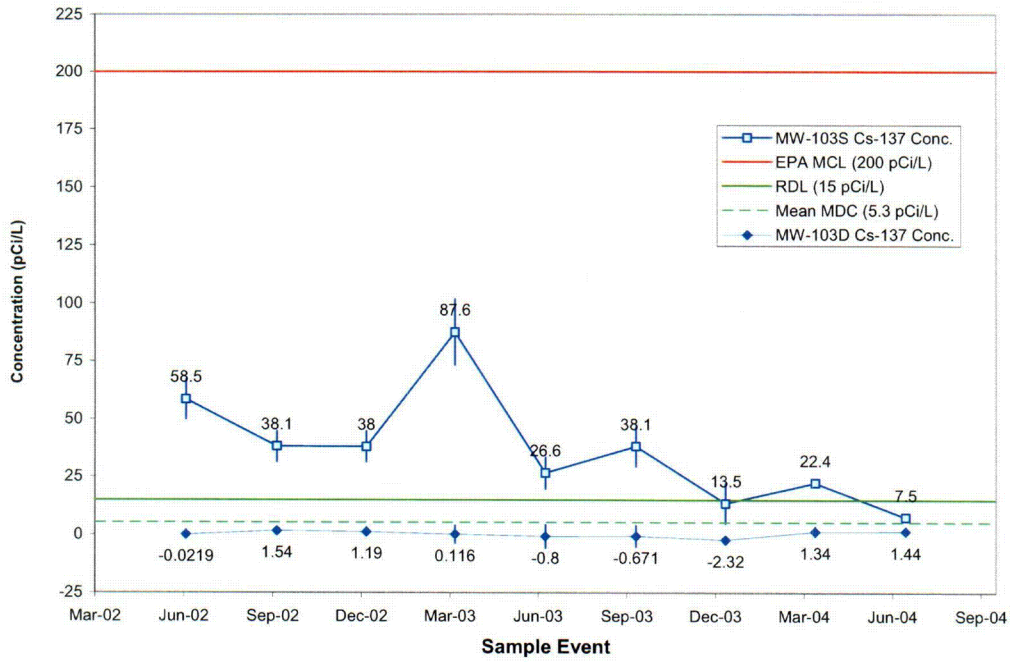


Figure 6-48: Cs-137 Concentration Trend at Cluster Well MW103



C59

Figure 6-49: Cs-137 Concentration Trend at Well MW115S

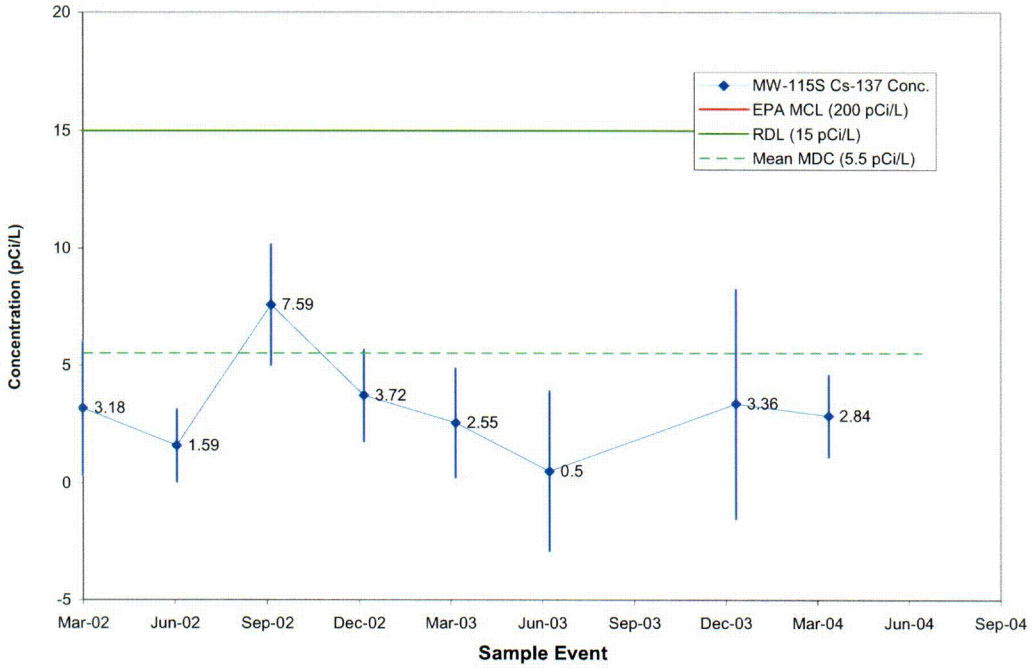
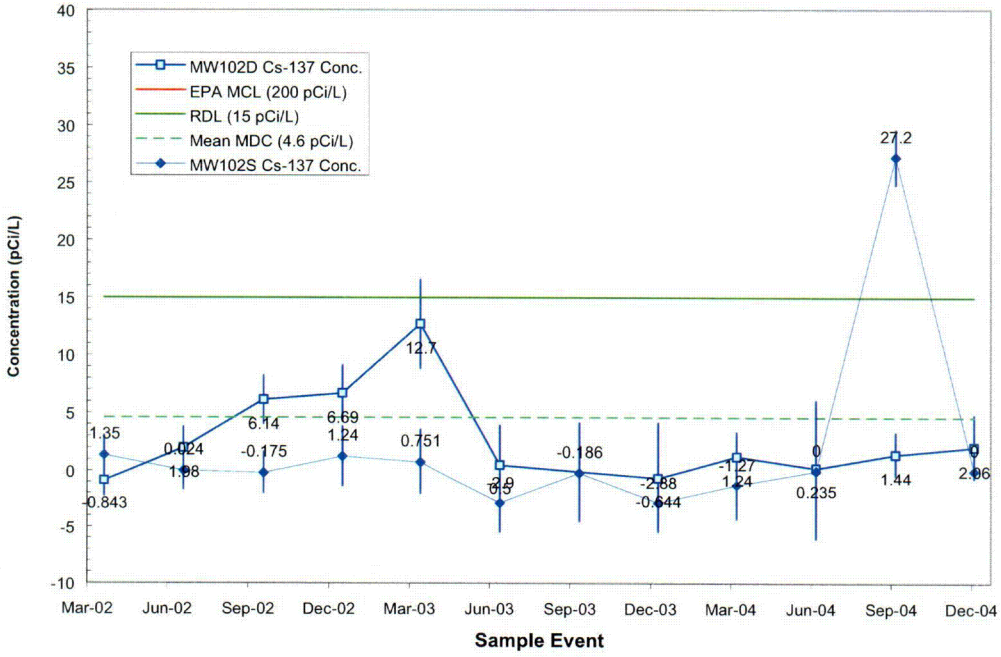


Figure 6-50: Cs-137 Concentration Trend at Cluster Well MW102



C60

Figure 6-51: Box Plot of Cs-137 Concentrations in Unconfined Aquifer

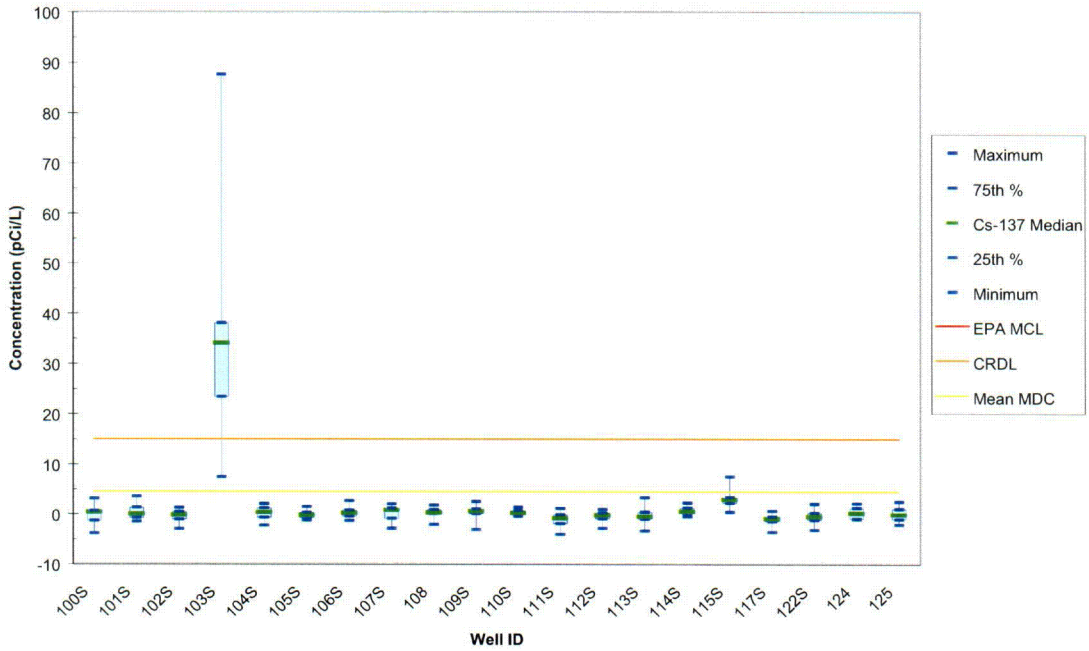
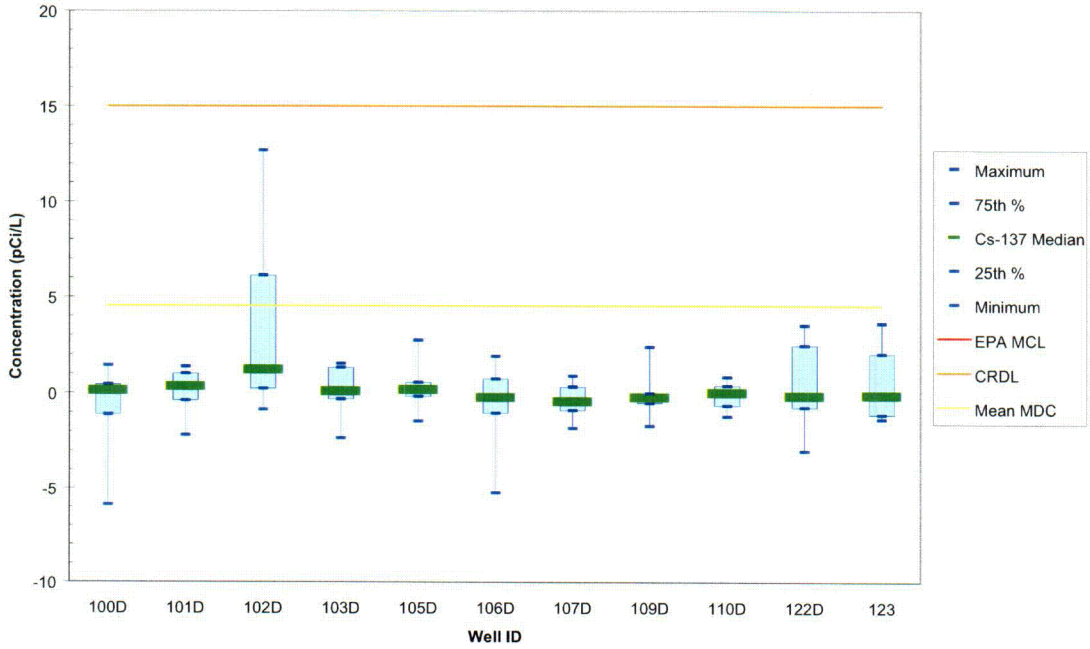


Figure 6-52: Box Plot of Cs-137 Concentrations in Confined Aquifer



C(6)

Figure 6-53: Box Plot of Am-241 Concentrations in Unconfined Aquifer

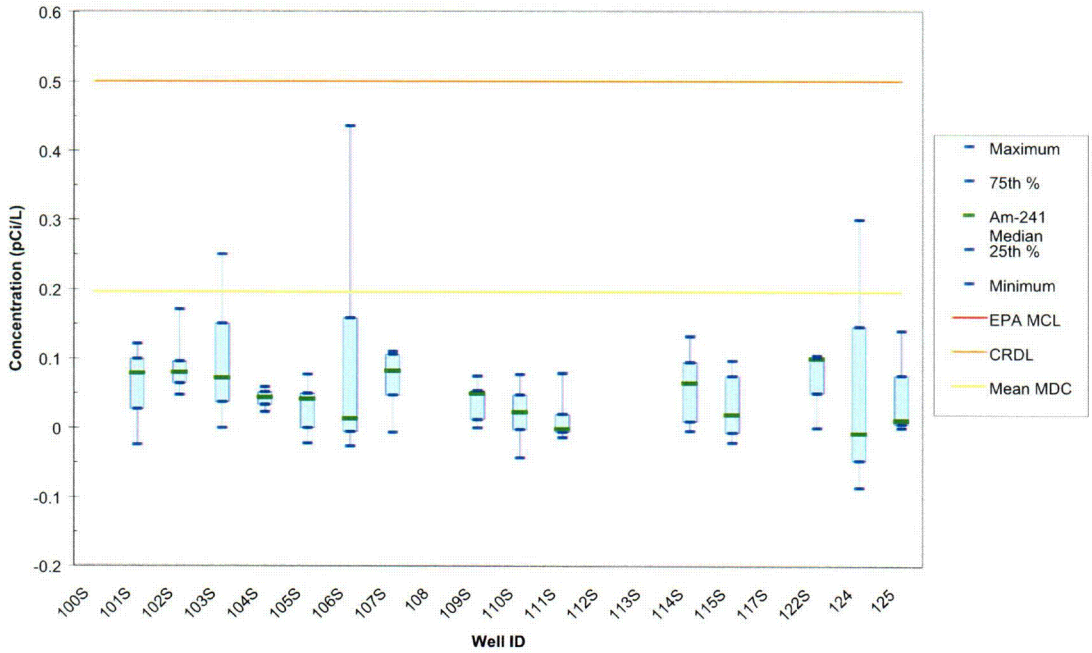
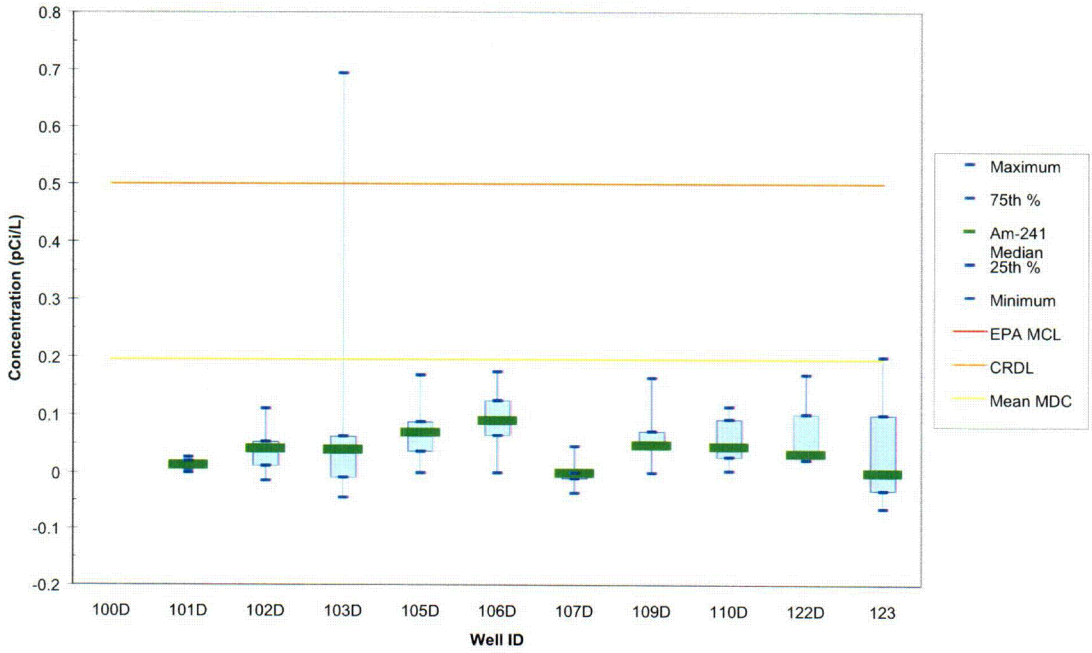


Figure 6-54: Box Plot of Am-241 Concentration in Confined Aquifer



C62

Figure 6-55: Sr-90/Y-90 + Cs-137 versus Gross Beta

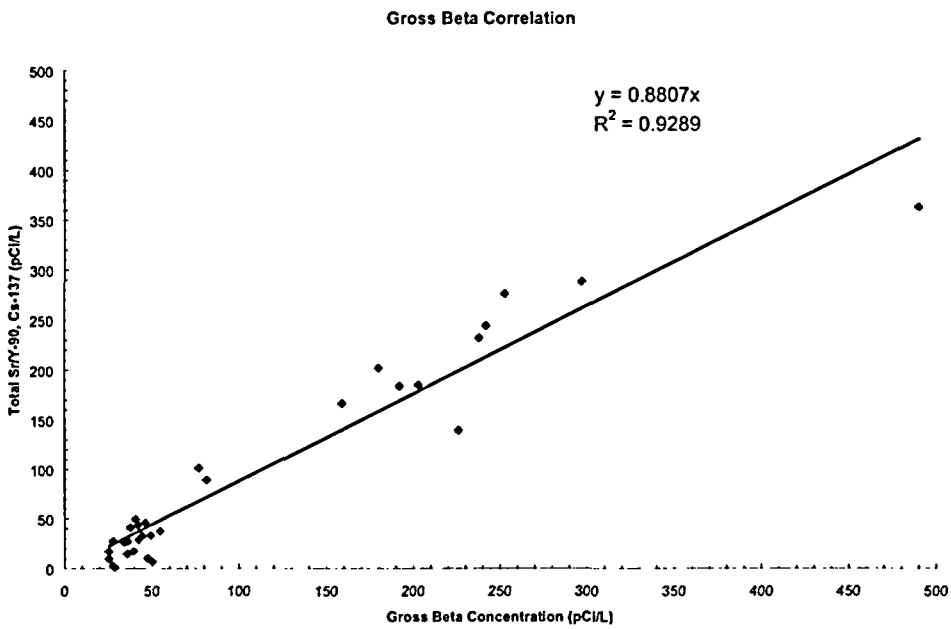


Figure 6-56: Total Uranium vs Gross Alpha

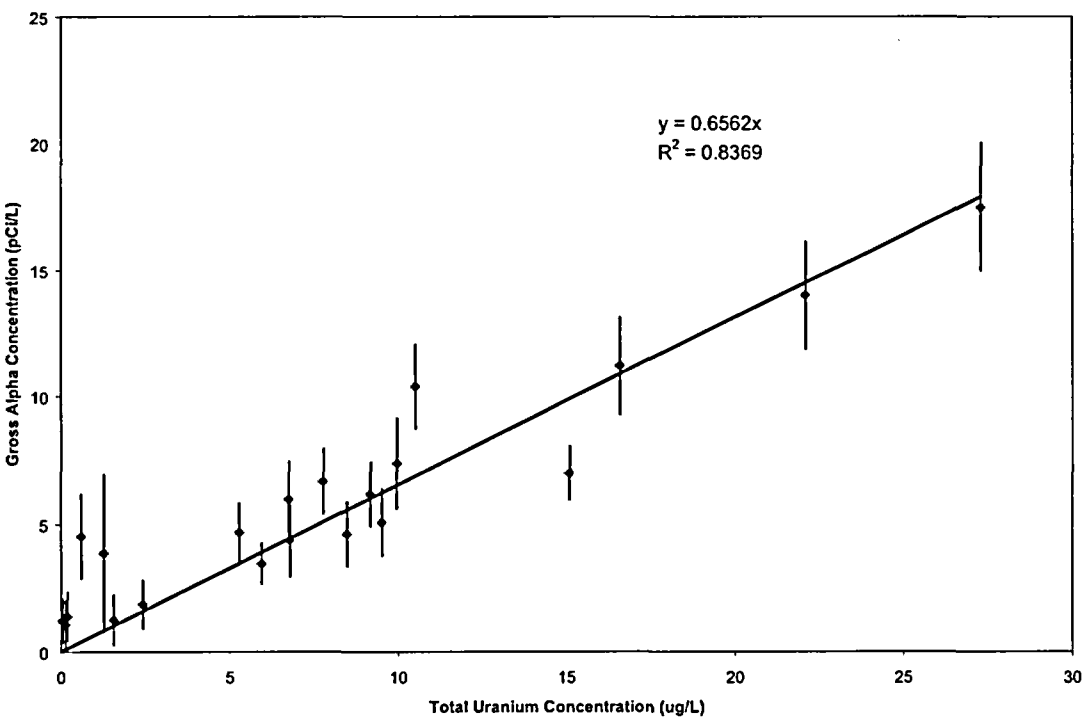


Figure 6-57: Total Uranium vs Gross Alpha

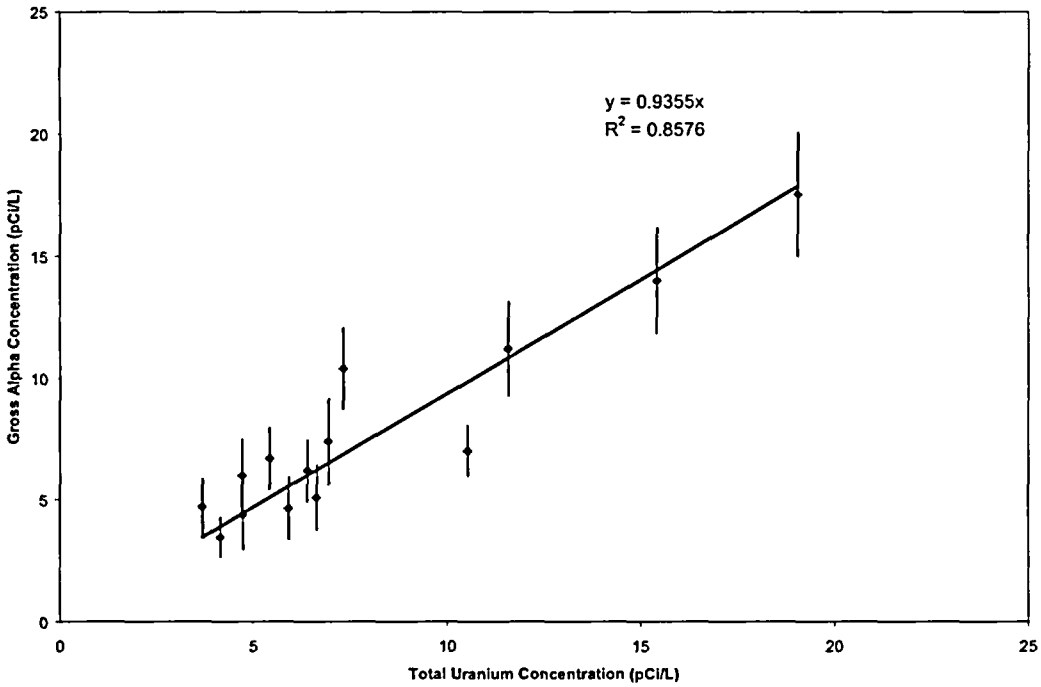


Figure 6-58: K-40 (K ion) versus Gross Beta

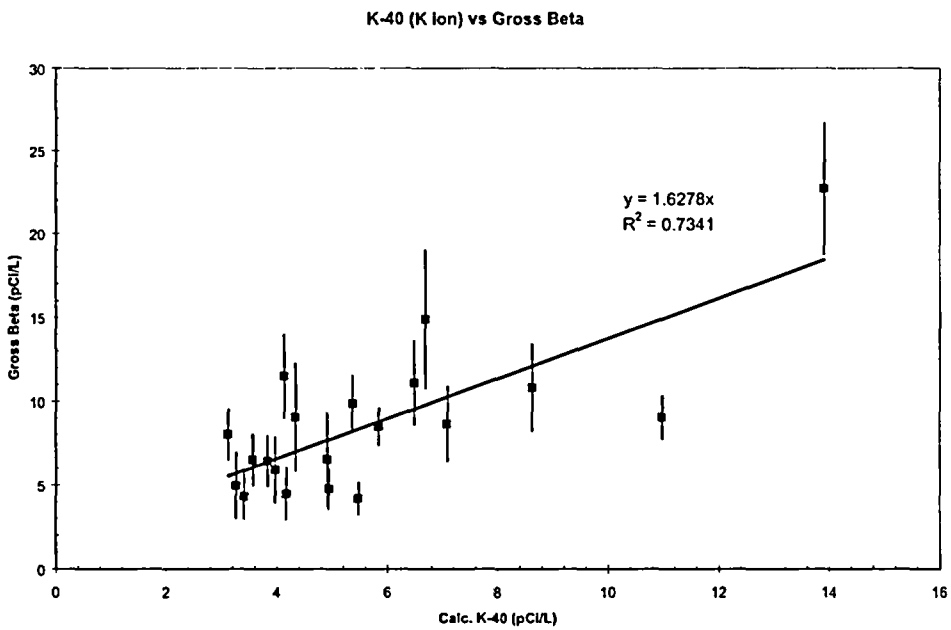
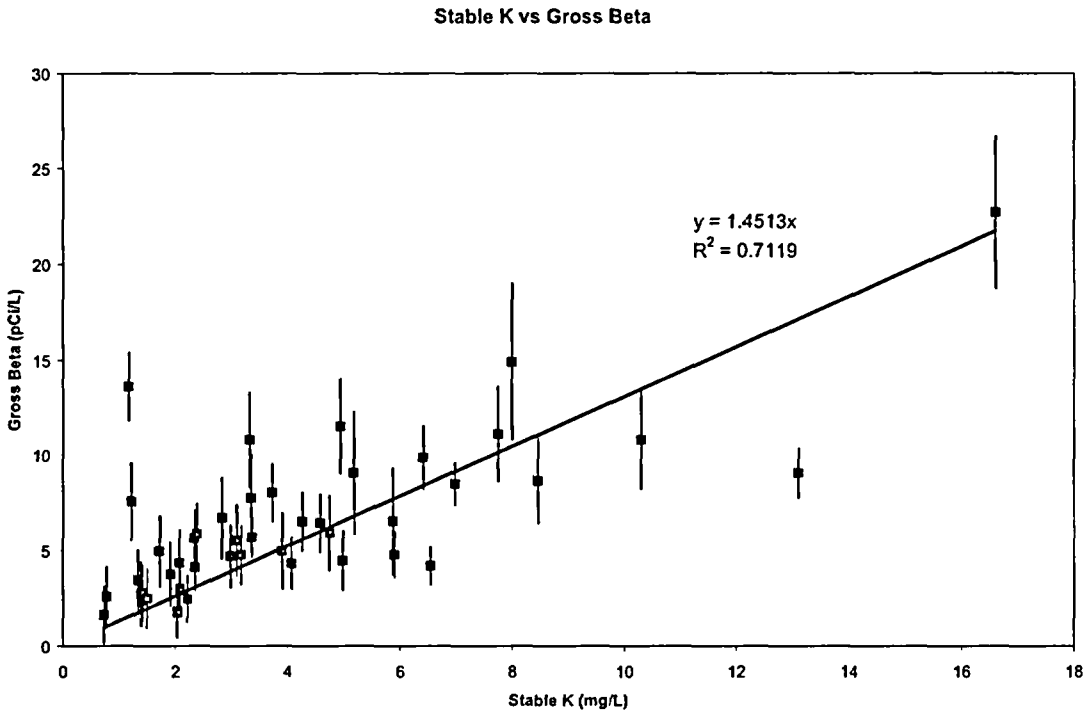


Figure 6-59: Stable K versus Gross Beta



Appendix A

Procedure 5.3-1

SEP 2 9 2003

June 5, 2003

CONNECTICUT YANKEE ATOMIC POWER COMPANY

DECOMMISSIONING PROCEDURE

CONTROLLED

SAFETY

GROUND WATER LEVEL MEASUREMENT AND SAMPLE COLLECTION IN MONITORING WELLS (RPM 5.3-1)

24265-000-GPP-GGGR-R5300-003 Rev# CY-001

To Be Completed By Preparer				
ACP 1.2-2.42 and ACP 1.2-2.92 Assessments				
10CFR50.59 SCREEN REQUIRED?	X	YES		NO
10CFR50.59 EVALUATION REQUIRED (NO. N/A)		YES	X	NO
10CFR72.48 SCREEN REQUIRED?		YES	X	NO
10CFR72.48 EVALUATION REQUIRED (NO. N/A)		YES	X	NO
PORC/INDEPENDENT REVIEW REQUIRED?		YES	X	NO
OPERATOR REVIEW		YES	X	NO

Preparer: Garv Seckinger Date: 9/22/03

Reviewer Section

Dept. Review: Signature: 9-29-03 Date:

Nuclear Safety Review: Signature: Date:

Approval Section

Dept. Manager Signature / Date 9/29/03

PORC Chairman
Signature: N/A

PORC Mtg. No. N/A	PORC Date: N/A	Effective Date: 9-29-03

1.0 OBJECTIVE

To describe the methods for measurement of ground water levels and collection of representative samples of ground water from monitoring wells.

2.0 REQUISITES

Representative samples of ground water must be collected from monitoring wells and analyzed in order to demonstrate compliance as described in the Ground Water Monitoring Program (GWMP) and to meet the requirements of the License Termination Plan, Revision 1, August, 2002.

3.0 INSTRUCTIONS

3.1 Equipment and Materials

3.1.1 IF performing synoptic, or individual, water level monitoring, THEN OBTAIN the following equipment, as necessary:

- map of well and surface water gauging locations
- key(s) for all well locks
- 9/16", or ½" socket with drive for removing curb box covers
- sampling procedure, field log book and/or forms for documenting data and comments (Attachment A)
- electronic water level meter
- clean cloth or paper towels
- polyethylene sheet
- one gallon of de-ionized or distilled water, or spray bottle containing such
- garbage bag for trash

3.1.2 IF performing water sampling, THEN OBTAIN the following equipment, as necessary:

- map of well and surface water gauging locations
- key(s) for all well locks
- polyethylene sheet
- 9/16", or ½" socket with drive for removing curb box covers
- sampling procedure, field log book and/or forms for documenting data and comments (Attachment B)
- stainless steel, polyethylene or Teflon bailer (one per well)

- variable speed electric drill with pump attachment, peristaltic pump, bladder pump, and/or submersible pump
- portable generator and extension cord and/or 12 VDC car or marine battery
- Air compressor or nitrogen gas (for use with bladder pump)
- nylon string (enough for the total depth of well(s) to be sampled)
- de-ionized or distilled water
- electronic water level meter
- clean cloth or paper towels
- sample bottles – one set per well
- sample labels
- trip blank (water sample issued from the volatile organic compound (VOC) analytical lab) for VOC analysis, if required
- custody seals
- preservatives, if required (see Attachment C)
- containers to hold the purged ground water
- cooler(s) with "blue ice" packs for storing samples, if sample cooling is required
- decontamination supplies(e.g., non-phosphate detergent, tubes, etc.)
- packing materials
- leather work gloves
- zip-lock bags
- latex, and/or nitrile gloves – two pairs per well
- indelible marker (Sharpie or equivalent)
- garbage bag for trash
- roll of aluminum foil
- pump tubing (1/4 to 3/8-inch ID)
- silica tubing (1/8-inch ID;for use with peristaltic pump)
- hose clamps
- 15/16" socket with drive if using 55 gallon drums for containing purge water
- knife or scissors
- measuring container
- individual pH, temperature, conductivity and turbidity meters or an Horiba, or equivalent, combination meter, if necessary
- 0.45 micron ground water filters (one per well if sampling for dissolved metals)
- chain(s)-of-custody
- flow-through-cell for field parameter measurements, if necessary

NOTE

Peristaltic pumps shall not be used when collecting samples for VOCs analysis. Peristaltic pumps also have limited lift capacity and are ineffective where the depth to water exceeds 20 feet.

3.2 Connecticut River Level Determination

NOTE

Because the Connecticut River water level fluctuates with the tides, obtain a water level from the boat dock ramp reference location at the time of synoptic ground water level measurements.

3.2.1 OBTAIN the surface water level of the Connecticut River, by the designated elevation benchmark whenever water level measurements are taken in association with synoptic measurements.

a. Connecticut River benchmark is located on the south side of the boardwalk leading to the dock adjacent to the Information Center.
b. Synoptic water level measurements are recorded on Attachment A.

3.3 Synoptic Measurements of Depth to Ground Water Surface

3.3.1 OBSERVE the area surrounding the well and the well itself and NOTE the existence of any unusual conditions, e.g., ground staining from possible oil or gasoline spills or damage to the well.

3.3.2 IF any unusual condition exists, DO NOT proceed with that well.

- DESCRIBE the condition(s) in the comments section of Attachment A.
- NOTIFY Final Status Survey supervision.

3.3.3 CONTINUE if no unusual conditions exist.

NOTE

Personnel performing sampling should exercise caution to prevent cross-contamination whenever the potential for coming into contact with ground water exists (i.e., well purging, sample collection).

CAUTION

Due to fluctuation of hydraulic gradients, the air inside the well may have become pressurized. Approximately two hours before sampling or ground water level measurements are to take place, loosen the applicable well caps to relieve any built up pressure. Exercise caution when removing well covers.

3.3.4 OPEN the well cover and UNCAP the monitoring well, exercising care not to introduce any foreign material into the well. Note any unusual odors, sounds or difficulty opening the well. If the wellhead is submerged with water, remove standing water from within the curb box to a level below the top of the well. Put removed water into a container if required. Record observations on the Synoptic Water Level Measurement Data Sheet (Attachment A) or Ground Water Monitoring Well Data Log provided in Attachment B, as appropriate.

3.3.5 TURN the electric water level meter on and test the operational status by either placing the end of the probe in clean water or by use of the probe test system.

NOTE

The measurement should be taken at the notch filed on the top of the PVC pipe. The notch may or may not also be marked with an indelible marker.

3.3.6 Slowly LOWER the probe into the well and CONTINUE lowering until the tone sound indicates that contact with the water has been achieved.

3.3.7 REPEAT raising and lowering the probe via the cable using slight movements and keeping your head and face away from the well head, while listening to the indicator, until the water level surface in the well can be determined to the nearest 0.01 feet from the top of the PVC riser.

3.3.8 RECORD the well number, depth to ground water surface, and the start and finish times if synoptic measurements were taken on Attachment A.

3.3.9 As the cable is withdrawn from the well, WIPE down the cable and probe using a clean damp cloth, or paper towel(s).

NOTE

The well shall not be sampled if any liquid, other than water, is present on the water level meter probe. A note of the condition shall be made on Attachment A and the well shall be closed and locked. The probe shall not be used again until it is decontaminated.

3.3.10 PLACE the probe into the probe holder of the meter to prevent it from becoming contaminated. At no time shall the probe and/or cable come in contact with the ground surface.

3.3.11 IF sampling is not to be completed, THEN CLOSE and LOCK the well.

3.3.12 SECURE the area.

3.4 Purging the Ground Water to Prepare for Sample Collection

3.4.1 IF directed by Health Physics, SPREAD a clean, unused polyethylene sheet on the ground and RETAIN the bailer, nylon string, pump, tubing, battery, electronic water level meter and sample bottles, as appropriate, on the sheet during sampling.

3.4.2 MEASURE the depth to ground water surface as described in Section 3.3, and RECORD on Attachment B.

NOTE

The well may be purged using a dedicated bailer, bladder, peristaltic, submersible, or Waterra-style pump. The bailer must be wrapped in plastic prior to use and new string attached.

3.4.3 RECORD the ground water field parameters on Attachment B.

NOTE

The purged water and decontamination fluids generated from wells inside the Industrial Area MUST be disposed of under the direction of the Health Physics or Chemistry. Fluids generated from wells outside the Industrial Area will be either contained for disposal or discharged at the location under the direction of the Health Physics or Chemistry.

3.4.4 LABEL the purge water container(s) with the date, well number and the words "Monitoring Well Purge Water" where required

3.4.5 ARRANGE for transport of purge water container(s) to designated staging area when sampling is completed.

3.4.6 Equipment

Section 3.1.2 details the equipment needed for low flow purging/sampling, as necessary.

3.4.7 Preliminary Site Activities

If the well casing does not have a reference point (usually a V-cut or mark on the well casing), make one. Describe its location and record the date of the mark in the logbook.

A water level measurement must be performed before any purging or sampling activities begin as presented in Section 3.3.

3.4.8 Procedure for Low Flow Purging

The following procedure will be followed during low flow sampling events:

3.4.8.1 Install Pump or Tubing

LOWER pump, safety cable, tubing, electrical lines, and air lines SLOWLY (to minimize disturbance) into the well to the midpoint of the zone to be sampled.

NOTE

If possible, keep the pump or tubing intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well. Collection of turbidity-free water samples may be especially difficult if there is two feet or less of standing water in the well.

NOTE

When using a peristaltic pump, dedicated tubing shall be lowered to the requisite sample depth and suspended below the well cap at the completion of sampling for future sampling events. Care shall be taken to limit movement of the tubing to minimize mobilization of particulates.

3.4.8.2 Measure Water Level

BEFORE starting pump, MEASURE the water level to verify the water displacement has returned to the approximate initial water table level as presented in Section 3.3. Record data on Attachment B.

3.4.8.3 Purge Well

START the pump at its lowest speed setting and SLOWLY increase the speed until discharge occurs. Check the water level (Section3.3). ADJUST the pump speed so that there is little or no water level drawdown (less than 0.3 feet). If the minimal drawdown achieved exceeds 0.3 feet, but remains stable, continue purging until indicator field parameters stabilize.

MONITOR and RECORD the water level and pumping rate every three to five minutes (or as appropriate) during purging and record on Attachment B.

NOTE

Flow rate ADJUSTMENTS are best made in the first fifteen minutes of pumping to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" as pump flow adjustments are made.

NOTE

Measure the pumping rate by directing the pump discharge into a graduated beaker and timing the rate at which it fills.

NOTE

Do not allow the water level to fall to the pump intake level (if the static water level is above the well screen, avoid lowering the water level into the screen).

3.4.8.4 Low Recharge Wells

IF the recharge rate of the well is lower than extraction rate capabilities of currently manufactured pumps, or bailing, and the well is essentially dewatered during purging, THEN the well should be sampled as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all anticipated sampling. Remove the pump, if used, close and vent the well, periodically monitor the recharge rate of the monitoring well (perhaps several hours, or days) and samples may then be collected even though the indicator field parameters have not stabilized pursuant to Section 3.5.

3.4.8.5 Monitor Indicator Field Parameters

During well purging, MONITOR indicator field parameters (i.e., turbidity, temperature, specific conductance, pH, oxidation-reduction potential (Eh), dissolved oxygen (DO), water level) every three to five minutes (or less frequently, if appropriate). Note: during the early phase of purging, emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments. Purging is considered complete and sampling may begin when all the indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken at three (3) to five (5) minute intervals, are within the following limits:

Turbidity (10% for values greater than 1 NTU);
DO (10%);
Specific conductance (3%);
Temperature (3%)
pH (± 0.1 standard unit); and
Oxidation-Reduction potential/ Eh (+/- 10 mv)

NOTE

If the field parameters are outside of the above limits, CONTACT the ESCS. The ESCS may direct sample collection upon discussion with the field sampling team and/or prior historical knowledge of a specific monitoring well.

3.4.8.6 Flow-Through-Cell

OBTAIN measurements with a flow-through-cell. Transparent flow-through cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. If a flow-through-cell cannot be used, partially fill a container with purge water and submerge field parameter measuring devices into the container. Turbidity measurements may also be measured using a separate meter through a by-pass assembly before the purge water enters the flow-through-cell. Section 3.5.4 illustrates a typical flow-through-cell.

3.5 Collection of Ground Water Samples

NOTE

Samples must be obtained using a new polyethylene bailer, dedicated tubing with peristaltic pump, bladder pump, or a submersible pump. With the exception of the dedicated tubing and peristaltic pump, all pumps will be decontaminated using the steps in Section 3.6 of this procedure.
Not all wells may require sample collection. Sampling needs shall be determined by Final Status Survey supervision at the direction of the client and/or stakeholder(s).

NOTE

Personnel performing sampling shall wear new latex or nitrile gloves while collecting samples and not touch the inside surfaces of sample containers or caps. If caps fall on the ground during sampling, a new sample container or cap must be used.

NOTE

Information regarding typical sample containers, volumes and preservatives are discussed in Attachment C of this procedure. The proper type and amount of sample preservative shall be present in each container prior to filling.

NOTE

Some environmental samples are required to be stored at 4 to 6 degrees Celsius. A plastic cooler with ice packs shall be used as the sample carrier. Care must be taken to ensure the samples are chilled, but not frozen by maintaining separation between ice packs and environmental samples. Radiological ground water samples are not required to be chilled.

NOTE

Please review Attachment D – Low Flow Purging and Sampling Annotations for additional specific information.

3.5.1 SELECT the sample containers to be filled.

3.5.2 UNCAP and fill only one container at a time.

NOTE

Treat all samples and equipment as contaminated until analyses prove otherwise.

3.5.3 IDENTIFY each sample container with the sample identification number, date and time of sample collection, analysis requested and preservatives if any. Fill in the information on the label or container with a water-proof indelible pen <u>before</u> sample collection. Identify the sample as follows:

MWXXX(*)-YYQQ-XXX

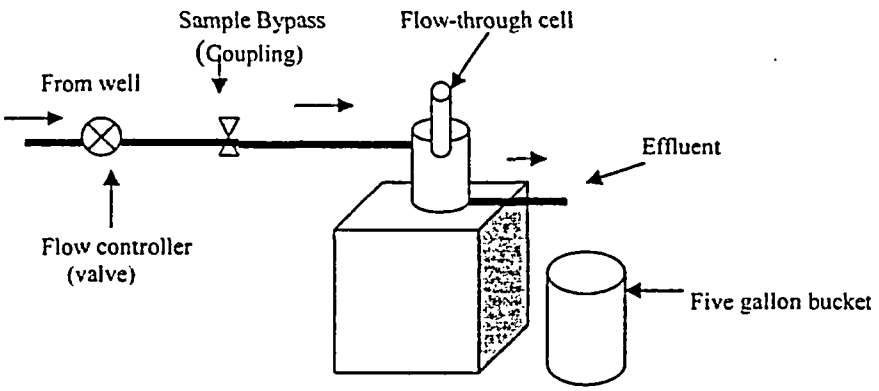
Where: MWXXX indicates monitoring well number where the sample originated.
* indicates a further optional alphanumeric descriptor
YYQQ indicates sample date (year/quarter)
XXX indicates the number of times the well was sampled during the quarter (e.g., each sampling event or group of

samples collected from a well for a given GWSEP would have the same number.

3.5.4 Low Flow Sampling

Water samples for laboratory analyses MUST be collected before water has passed through the flow-through-cell (use a by-pass assembly or disconnect cell to obtain sample). A by-pass assembly must be placed upstream of effluent tube and flow-through cell (refer to figure below) to avoid sample off gassing due to pressure changes.

Typical Flow-Through Cell Plumbing



VOC sample aliquots should be collected before those for other analytical parameters and put directly into pre-preserved sample containers. The VOC vial should be tilted on an angle as it is filled. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

3.5.5 Bailer Sampling

3.5.5.1 Slowly LOWER the bailer into the well and allow it to fill.

3.5.5.2 Slowly WITHDRAW the bailer by the nylon string, coiling the string on the plastic sheet, or drape over hand, so it does not come into contact with the ground.

3.5.5.3 WHEN the bailer has been retrieved, EMPTY the bailer such that the contents enter the sample container.

3.5.5.4 REPEAT above steps until desired sample volume is obtained.

3.5.6 Add preservative, as required by analytical methods, to samples immediately after they are collected if the sample containers are not pre-preserved. Check analytical methods (e. g. EPA SW-846, Drinking Water methods, etc.) for additional information on preservation.

3.5.7 Samples of ground water should be collected in the following order, if necessary, after pre-sampling protocols specified in section 3.4.8.5 have been met:

1. Volatile organic compounds (VOCs);
2. Semivolatile organic compounds (SVOCs);
3. Unfiltered inorganic compounds; (metals)
4. Filtered inorganic compound, if required
5. PCBs
6. Pesticides
7. Herbicides
8. Cyanide
9. Radiological constituents

NOTE

If, at any time, a duplicate sample is required, then use one of the extra sets of sample bottles to collect the second sample and label it as a duplicate. The location and designation of the duplicate shall be noted on Attachment B.

3.5.8 Samples collected for Volatile Organic Compounds (VOC) analyses.

NOTE

Samples collected for volatile organic compounds must be devoid of air bubbles and the sample must not be aerated during sample collection.

1. ENSURE the preservative is in the VOC container prior to sampling.

2. Slowly FILL the container from a steady flow of water from the bailer or pump.

3. FILL and CAP the container TURN the container upside down and ENSURE that no bubbles are present in the sample container.

4. TAP the container lightly on your hand to dislodge any bubbles.

5. IF any bubbles are observed, THEN OPEN the container and slowly add more water.

3.5.8.1 Samples collected for other analyses

1. FILL the preserved containers, leaving a small amount of air space, directly from the bailer or pump tubing.

2. ADD preservative, if necessary.

3. CAP the container(s).

3.5.9 INITIATE a Chain-of-Custody form.

a. ENSURE the Chain-of-Custody form remains with the sample.

3.5.10 When all samples for the well have been collected, REMOVE the bailer and/or pump and tubing from the well.

a. PLACE the cap back onto the well and CLOSE the lock and road box, if applicable.
b. Dispose of, or STORE, sampling materials in a separate place.

3.5.11 IF rinsate samples are required to be collected pursuant to the sampling plan, OBTAIN rinsate samples from the pump to demonstrate the efficiency of the decontamination method.

a. PERFORM decontamination of pump as presented in Section 3.6.
b. PUMP de-ionized water through the tubing into appropriate container(s) for analyses using the pump that has been decontaminated.
c. LABEL and MANAGE the rinsate samples per Sections 3.5.1 – 3.5.8, with the exception that they are not processed through the flow-through-cell and are labeled as "rinsate" samples in place of "Well Number".

3.5.12 At the end of the sampling period, BRING the samples to the designated storage location.

a. RELINQUISH samples via the Chain-of-Custody form.

3.5.13 START a new Attachment B for each monitoring well sampled and COMPLETE the sections for the well sampled.

a. FORWARD Attachment B pages to the Environmental Site Closure Supervisor.

b. INCLUDE a copy of the Chain-of-Custody form, blanks and other samples in the shipment of samples to the analytical laboratory.

c. PLACE sample containers into a shipping container, cool to 4°C with ice packs, if necessary. Pad the samples with bubble wrap, styrofoam and/or vermiculite packing as necessary.

3.6 Decontamination

3.6.1 DISPOSE of single-use bailers, tubing and rope/string used for ground water sampling after each use in radwaste trash receptacle, as appropriate.

3.6.2 DECONTAMINATE the field meter and field parameter probes, and measuring beaker before sampling each well.

a. FILL a spray bottle with de-ionized water and alconox soap, or equivalent.
b. SPRAY the probes and measuring container(s) with the soap solution.
c. RINSE the probes and measuring container(s) with de-ionized water from a second spray bottle.
d. COLLECT the rinse water if required
e. STAGE the probes in the equipment storage container.

3.6.3 DECONTAMINATE sampling pump in the field prior to sampling each well following one of these procedures:

Method 1

a. FILL one PVC tube with a mixture of alconox soap, or equivalent, and de-ionized water.
b. FILL a second PVC tube with distilled water.
c. PLACE pump in first tube and set discharge tubing so it flows back into the tube.
d. RUN pump so the solution goes through the pump and back into the PVC tube for several minutes.

e. REMOVE pump from first tube and wipe with clean cloth or paper towel(s).
f. PLACE pump into second tube and repeat steps c and d above.
g. REMOVE pump from second tube and wipe down with clean cloth or paper towel(s).
h. COLLECT the rinse water into container(s), if required
i. PLACE pump in pump stand holder.

Method 2 (For use with bladder pumps)

a. WASH external components of the pump (also wash tubing and air line if not dedicating these to individual wells) with alconox soap solution and rinse with de-ionized water as pump is withdrawn from the well.

b. WIPE external components down with clean cloth or paper towel(s).

c. PUMP a dilute mixture of alconox soap, or equivalent, and de-ionized water through the bladder pump using a peristaltic pump.

d. RUN pump so the solution goes through the pump for several minutes and discharge into waste container.

e. RINSE by pumping a volume of de-ionized water through the pump using the persistaltic pump and discharge into waste container.

f. COLLECT the rinse waters into waste container(s), if required.

g. PLACE pump in pump stand holder.

3.7 Sample Collection and Handling Controls

NOTE

Care must be taken to avoid potential cross contamination of environmental samples and sample containers. Sample containers, coolers, and sampling equipment must never be stored near gasoline, solvents, or other equipment and /or fluids that may present a source of contamination.

3.7.1 Trip Blanks

NOTE

Trip blanks are required for aqueous sampling events for which VOC analyses will be performed. Trip blank samples are used to document potential cross contamination of samples due to container contamination, and/or induction of contamination during sampling and transport of containers from the laboratory into the field and then shipment back to the analytical laboratory.

NOTE

Trip blanks consist of a set of sample bottles filled at the laboratory with laboratory-grade water. These sample bottles accompany the empty sampling containers, supplied by the laboratory, to the site, into the field during the sampling sent, and then back to the laboratory. Trip blanks will be analyzed for volatile organic compounds (VOCs).

a. The specific GWSEP will DETERMINE the number of trip blank samples required for the monitoring event. <u>One trip blank is required for each day VOC sample containers are transported from the site to the analytical laboratory</u>. If no VOC samples are collected on a given day, then a trip blank is not required to be included in the shipping container. Likewise, if multiple samples are collected in a given day and several shipping containers are used, place all VOC samples into one shipping container and then only one trip blank is required.

NOTE

Trip Blank bottles are never to be opened in the field. Trip blank samples should be chilled (e.g. maintained in a cool to 4°C condition) only after the accompanying sample containers have been filled and are prepared for off-site shipment.

3.7.2 Duplicate Samples

Field duplicate samples, if required by the GWSEP, are two separate samples taken from the same source and are used to determine data repeatability based on field conditions.

Duplicate samples are collected by alternately filling the environmental sample container and the duplicate sample container. Duplicate samples should be preserved and handled in the same manner as environmental samples. Duplicate samples shall be analyzed for the same parameters as the associated environmental samples.

NOTE

Selection of duplicate samples shall be biased toward locations that have indicated, or are suspected, of being the most heavily impacted with the analyte(s) of interest and will be detailed within the specific ground water sampling plan for a particular sampling event.

4.0 ATTACHMENTS

4.1 Attachment A – Synoptic Water Level Measurement Data Sheet

4.2 Attachment B – Ground Water Monitoring Well Data Logs

4.3 Attachment C – Typical Sample Containers, Volumes, Preservatives and Holding Times for Various Analyses

4.4 Attachment D – Low Flow Purging and Sampling Annotations

5.0 SUMMARY OF CHANGES

Section/Paragraph	Change	Reason
3.1	Added various pump types	More flexibility
3.4	Added ability to pour sample, decon fluid to ground. Added alternate turbidity measurement method.	If allowed by Chem Waste Permit. More flexibility
ALL		Revised minor typos, title, name changes

ATTACHMENT A – Synoptic Water Level Measurement Data Sheet

Summary of Depth-to-Water Measurements

Monitoring Well Location and Identification	Depth to Water in Feet From TIC
MW-100D	
MW-100S	
MW-101D	
MW-101S	
MW-102D	
MW-102S	
MW-103D	
MW-103S	
MW-104S	
MW-105D	
MW-105S	
MW-106D	
MW-106S	
MW-107D	
MW-107S	
MW-108S	
MW-109D	
MW-109S	
MW-110D	
MW-110S	
MW-114S	
MW-115S	
AST-1	
MW-111S	
MW-112S	
MW-113S	
MW-117S	
MW-13	
TW-1	
EOF-2	
MW-200	
MW-201	
MW-202	
MW-203	
MW-204	
MW-205	
MW-206	
MW-207	
Boat Dock	

TIC: Top of Inner Casing

Date:______________

Time Started:______________

Time Finished:______________

Prepared By:______________

Field Observations/Comment Section:

ATTACHMENT B - Ground Water Monitoring Well Data Log

Monitoring Well ID:_____ Date:_____ Static Water Level: _____ Name: _____

Pump Set Depth: _____ All Depths Are Feet Below Top Of Inner Casing (TIC)

TIME (military)	Frequency (cycles/sec)	Discharge Rate (mL/min)	Cum. Purge Volume (gallons)	DTW (feet)	Field Parameters					
					Turbidity (NTU)	DO (mg/L)	Eh (mv)	pH (S.U.)	Specific Conductance (us/cm)	Temperature (degree C)

Instrument Model/Serial Number(s): _____ Calibration Date(s): _____

ATTACHMENT C

Typical Sample Containers, Volumes, Preservatives and Holding Times for Various Analyses

Analytical Suite	Volume/Sample Container	Preservative	Holding Time
Volatile Organic Compounds	(2) 40 ml. glass vial	Acidified to pH <2 with VOC grade Hydrochloric acid (HCL) Keep at 4 °C	14 days
Metals	500 ml polyethylene	Acidified with reagent grade nitric acid (HNO_3) to pH <2	6 months (except Hg which is 28 days)
Cyanide	1 liter, polyethylene	NaOH added to pH >12	14 days
Herbicides	1 liter, amber glass	Keep at 4°C	7 day pre-extraction 40 day post-extraction
Pesticides	1 liter, amber glass	4° C	7 day pre-extraction 40 day post-extraction
PCBs	1 liter, amber glass	4° C	7 day pre-extraction 40 day post-extraction
SVOCs	1 liter, amber glass	4° C	7 day pre-extraction 40 day post-extraction

ATTACHMENT C

Typical Sample Containers, Volumes, and Preservatives for Various Analyses

Radionuclide	Ground Water Concentration Equivalent to 1 mrem/yr[1]	EPA Drinking Water MCL (pCi/l)	Required MDC[2] (pCi/l)	Analysis Category
H-3	26080	20000	400	LSC
C-14	360	2000	200	LSC
Mn-54	968	300	50	Gamma
Fe-55	2616	2000	25	LSC
Co-60	46	100	25	Gamma
Ni-63	1260	50	15	LSC
Nb-94	270	-	50	Gamma
Ag-108m	170	-	50	Gamma
Eu-152	293	60	50	Gamma
Eu-154	202	200	50	Gamma
Eu-155	1300	600	50	Gamma
Sr-90	10	8	2	LSC
Tc-99	1056	900	15	LSC
Cs-134	14	20000	14	Gamma
Cs-137	17	20	15	Gamma
Pu-238	0.60	15	0.50	Alpha
Pu-239	0.54	15	0.50	Alpha
Pu-241	28.40	-	15	LSC
Am-241	0.53	15	0.50	Alpha
Cm-243	0.78	15	0.50	Alpha

Summary	Preservative	Container
Gross Alpha/Beta	Nitric acid pH<2 (5 ml)	1 liter HDPE
Gamma Isotopic	Nitric acid pH<2 (20 ml)	4 liter HDPE
Hard to Detects		
Alpha Isotopic	Nitric acid pH<2 (20 ml)	4 liter HDPE
H-3	None	250 ml glass
C-14	None (no headspace air)	250 ml glass
Fe-55	Nitric acid pH<2 (20 ml)	4 liter HDPE
Ni-63	Nitric acid pH<2 (20 ml)	4 liter HDPE
Sr-90	Nitric acid pH<2 (20 ml)	4 liter HDPE
Tc-99	Nitric acid pH<2 (20 ml)	4 liter HDPE
Pu-241	Nitric acid pH<2 (20 ml)	4 liter HDPE

(1) These values are derived from the LTP Ground Water DCGLs
(2) MDC = Minimum Detectable Concentration to meet the DQO

* For the purpose of attaining analyte sensitivities required to demonstrate compliance with the License Termination Plan (LTP) DCGLs or Water Quality Standards (WQS), a generic DQO is an acceptable approach to ensure quality data since numerous levels of quality assurance are built into analytical laboratory performance and chain of custody requirements.

Attachment D
Low Flow Purging and Sampling Annotations

Purpose of Low Flow Ground Water Sampling

The purpose of low flow (low stress) purging and sampling is to collect ground water samples that are representative of ground water quality under approximate natural flow conditions. The presence and concentration of dissolved organic and inorganic pollutants as well as the pollutants associated with mobile particulates are most accurately revealed through low flow sampling. Low flow sampling techniques minimize stress on the aquifer by utilizing low pumping rates that result in minimal water level drawdowns.

Presence of NAPLs

Check newly constructed wells for the presence of light non-aqueous phase liquids (LNAPLs) or dense non-aqueous phase liquids (DNAPLs) with a product level interface probe before the initial sampling round. Low flow sampling may be an inappropriate method for sampling ground water with non-aqueous phase liquids (NAPLs). Procedures for the collection of LNAPL and DNAPL samples are not addressed in this Procedure.

Measurement and Cleaning of the Flow-Through-Cell

Transparent flow-through cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell and may also cause an under-estimation of turbidity values measured after the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning, and continue monitoring activities.

Additional Control of Discharge Flow

During purging and sampling, the tubing should remain filled with water to minimize possible changes in water chemistry upon contact with the atmosphere. It is recommended that ¼ -inch or 3/8-inch (inside diameter) tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use one of the following procedures to collect samples: (1) add clamp, connector or valve to constrict sampling end of tubing; (2) insert small diameter tubing into water filled portion of pump tubing allowing the end to protrude beyond the end of the pump tubing, collect sample from small diameter tubing; (3) collect non-VOC samples first, then increase flow rate slightly until the water completely fills the tubing, collect VOC sample and record new drawdown, flow rate and new indicator field parameter values on Attachment B.

6.0 BASIS

6.1 "Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM)" (NUREG-1575) recommends that as part of the decommissioning process, a suitable monitoring well network be set up to sample ground water for possible contamination.