YANKEE ATOMIC ELECTRIC COMPANY Telephone (413) 424-5261

YANKEE

49 Yankee Road, Rowe, Massachusetts 01367

September 1, 2006
BYR 2006-075

Massachusetts Department of Environmental Protection
DEP Western Region
436 Dwight Street
Suite 402
Springfield, MA 01103

Attention: Mr. David Howland

Subject: Groundwater Monitoring Plan to Support Closure under the Massachusetts Contingency Plan

Dear Mr. Howland:

Please find enclosed three (3) copies of the "*Groundwater Monitoring Plan to Support Closure under the Massachusetts Contingency Plan*" (GMP-MCP) for Department review, comment and/or approval. The GMP-MCP was prepared at the request of the Massachusetts Department of Environmental Protection (Department) and presents Yankee Atomic Electric Company's (YAEC's) proposed plans for groundwater monitoring necessary to support closure of the Yankee Nuclear Power Station (YNPS) site in Rowe, Massachusetts in accordance with the requirements of the Massachusetts Contingency Plan (MCP, 310 CMR 40.0000) for a Permanent Solution.

As you are aware, YAEC has prepared a separate plan, "*Groundwater Compliance Plan For License Termination Plan For The Yankee Nuclear Power Station*", (GMP-LTP) that outlines plans to conduct groundwater monitoring to satisfy Nuclear Regulatory Commission (NRC) requirements for License Termination. The GMP-LTP document is included as Appendix A of the GMP-MCP.

Should you have questions or require additional information, please contact us.

Sincerely,

YANKEE ATOMIC ELECTRIC COMPANY

Joseph R. Lynch

Joseph R. Lynch
Regulatory Affairs Manager

Attachment: Groundwater Monitoring Plan to Support Closure under the Massachusetts Contingency Plan

cc:

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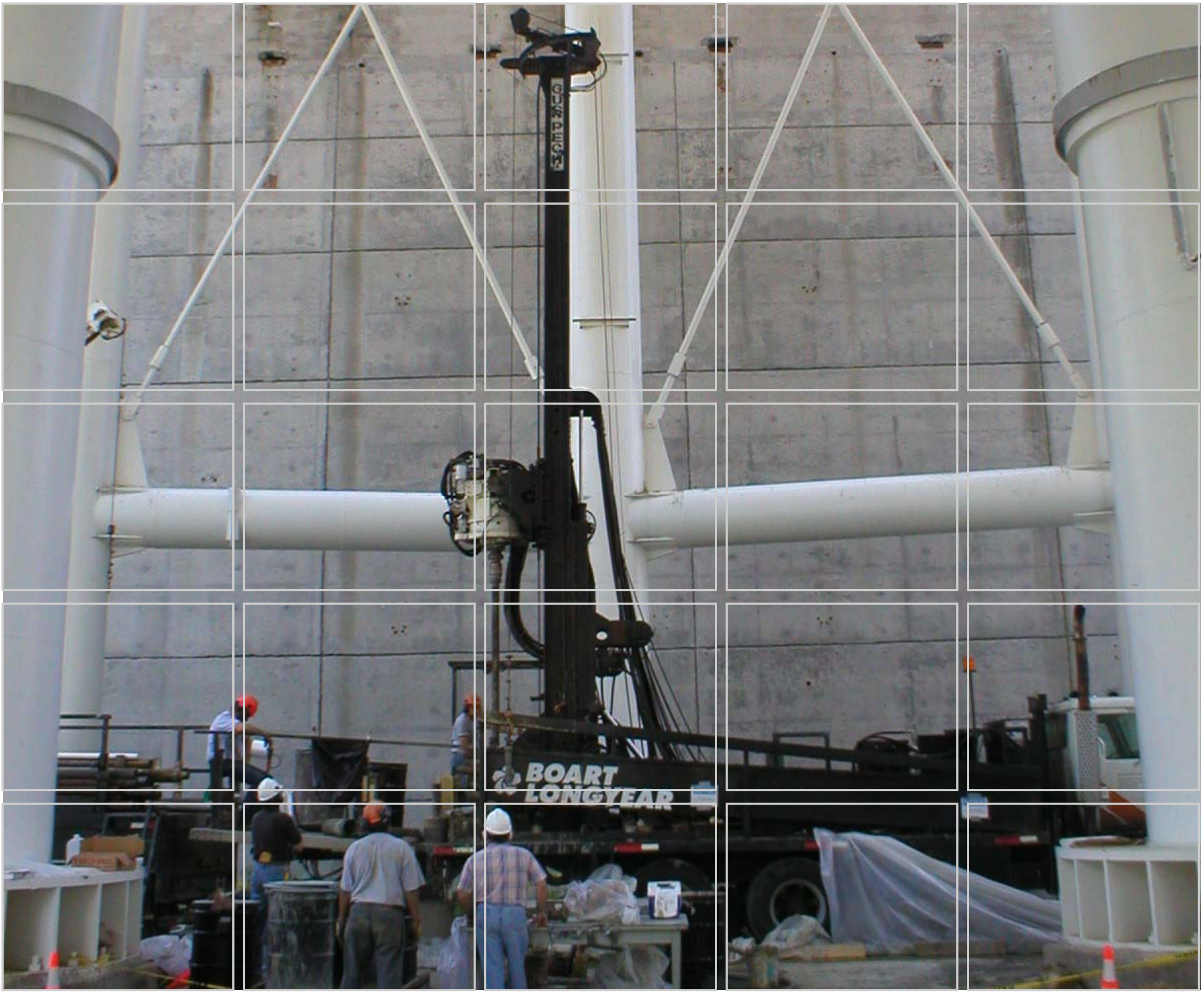

Groundwater Monitoring Plan to Support Closure under the Massachusetts Contingency Plan

Yankee Nuclear Power Station
Site Closure Project
Rowe, Massachusetts

1 September 2006

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Yankee Atomic Electric Company

Groundwater Monitoring Plan to Support Closure under the Massachusetts Contingency Plan

Yankee Nuclear Power Station
Site Closure Project
Rowe, Massachusetts

1 September 2006

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TABLES

FIGURES

APPENDICES

EXECUTIVE SUMMARY

Yankee Atomic Electric Company (YAEC) retained Environmental Resources Management (ERM) to prepare this *Groundwater Monitoring Plan to Support Closure under the Massachusetts Contingency Plan* (GMP-MCP) for the Yankee Nuclear Power Station (YNPS) located in Rowe, Massachusetts (the "site"). This GMP-MCP was prepared to support Massachusetts Department of Environmental Protection's (MA DEP's) review and approval of proposed plans for long-term groundwater monitoring at the YNPS. YAEC has prepared a separate plan, *Groundwater Compliance Plan For License Termination Plan For The Yankee Nuclear Power Station,* to outline plans to conduct groundwater monitoring to satisfy Nuclear Regulatory Commission (NRC) requirements (Appendix A).

A total of 78 groundwater monitoring wells have been installed at the site since 1977. Of those, 25 have been closed during the course of decommissioning activities. YAEC is installing three additional shallow monitoring wells to support site closure.

The GMP-MCP outlines plans for sampling groundwater for radiological parameters and Oil and/or Hazardous Materials (OHM). Groundwater sampling will be conducted at least annually. A more frequent sampling program may be implemented if deemed appropriate to facilitate site closure (e.g., sampling rounds could be conducted annually, semi-annually, or at a maximum frequency, quarterly).

Based on a review of historic data, tritium was the only radiological parameter carried forward in the GMP-MCP. Sampling will be performed at the one well (MW-107C) where tritium has been detected above the Maximum Contaminant Level (MCL), along with eight other wells where tritium has been detected at 25% of the MCL. Monitoring for tritium will be performed at least annually at MW-107C until results from four consecutive quarterly rounds completed over a one-year period are below the MCL. Monitoring will be performed at the other eight wells until monitoring is completed at MW-107C, or when the tritium concentration is less than 25% of the MCL for two consecutive sampling events.

Results of historic monitoring for OHM were compared to the Massachusetts Contingency Plan (MCP) Reportable Concentrations for Groundwater Category GW-1 (RCGW-1). Results indicate sporadic detections of OHM above RCGW-1 that were generally not repeatable, not associated with a release condition, or due to well integrity issues (e.g., polychlorinated biphenyl-containing paint chips found in damaged wells, glue used in above ground temporary risers during re-grading, etc.). Nonetheless, sampling for OHM constituents will be conducted at least annually at 19 monitoring wells. Monitoring will be conducted until the results of two consecutive sampling events demonstrate that OHM levels are below RCGW-1 Standards (or an alternative risk-based standard agreed to by YAEC and MA DEP).

1.0 PURPOSE & SCOPE

Yankee Atomic Electric Company (YAEC) retained Environmental Resources Management (ERM) to prepare this *Groundwater Monitoring Plan to Support Closure under the Massachusetts Contingency Plan* (GMP-MCP) for the Yankee Nuclear Power Station (YNPS) located in Rowe, Massachusetts (the "site") (Figure 1). This GMP-MCP was prepared to support Massachusetts Department of Environmental Protection's (MA DEP's) review and approval of proposed plans for long-term groundwater monitoring at the YNPS. This plan includes:

Section 2.0 Summary of Groundwater Monitoring at YNPS

A description of the history of groundwater monitoring, the existing well network, site geology and hydrogeology, and a brief summary of the known nature and extent and fate and transport of contaminants in site groundwater.

Section 3.0 Groundwater Regulatory Requirements & Proposed Compliance Plan

A brief summary of state and federal regulatory requirements governing groundwater monitoring, criteria for termination of monitoring and YAEC's proposed pathway to satisfy regulatory requirements.

Section 4.0 YNPS Proposed Groundwater Monitoring Plan

A summary of proposed monitoring locations, frequency, analytical parameters, quality assurance/quality control and reporting procedures.

YAEC has prepared a separate plan to outline groundwater monitoring that will be conducted to satisfy Nuclear Regulatory Commission (NRC) requirements. A copy of the *Groundwater Compliance Plan For License Termination Plan For The Yankee Nuclear Power Station* (GMP-LTP) is provided in Appendix A. In addition, monitoring of the former Southeast Construction Fill Area will be conducted to address the requirements of the Massachusetts Solid Waste Regulations, but is not addressed in this GMP-MCP.

2.0 SUMMARY OF GROUNDWATER MONITORING AT YNPS

2.1 HISTORY OF GROUNDWATER WELL MONITORING AT YNPS

Groundwater investigations began at YNPS in 1977 with the installation of the first monitoring well. Since 1977, a total of 78 monitoring wells have been installed. While 25 of these have been abandoned during site decommissioning, the remaining 53 support ongoing monitoring of site groundwater quality. A brief summary of primary well installation/abandonment events is provided below:

- Prior to 2003, 34 monitoring wells were installed at various times to investigate the shallow stratified drift aquifer.
- In 2003 and 2004, a comprehensive subsurface investigation program was initiated to evaluate groundwater quality deeper in the overburden beneath the shallow stratified drift deposits and into the underlying bedrock aquifer. This program included collection of continuous soil and rock cores and installation of 27 wells as a single, couplet or triplet monitoring point, including:
  - Four wells in the shallow stratified drift;
  - 13 wells in sand lenses interlayed within a lodgment till overlying the bedrock; and
  - 10 wells into the bedrock.
- In 2006, an additional 17 wells were installed to further define the extent of groundwater impact detected in previous events. This investigation focused on further characterization of groundwater quality in and around the Ion Exchange (IX) Pit and the Spent Fuel Pool (SFP) as the most significant suspected source of tritium in groundwater and the down-gradient extent of impact, including:
  - Nine wells in three well clusters to investigate the IX Pit (MW-110A, B, C, D), the SFP (MW-111A, B, C), and the Septic System Leachfield (MW-113A, B);

- Five shallow wells to bound the highest shallow tritium groundwater concentration (MW-101A, -102D, -104A, -107A, -109A);
- Two wells to investigate the highest deep tritium groundwater concentration (MW-107E, F); and
- One shallow well to investigate potential non-radiological impact down-gradient of the former Service Building (MW-105A).

Plant decommissioning activities necessitated the closure/abandonment of a total of 25 monitoring wells. These were generally older, shallow wells that were either damaged and of questionable integrity, duplicative of the current monitoring well network, or not worth maintaining during site re-grading, including:

- In July 2004, the following six wells were closed: B-1, CB-10, CB-11A, CW-11, CW-8, and MW-1.
- In November 2004, the following 16 wells were closed: CB-1, CB-12, CB-5, CB-7, CB-9, CFW-2, CFW-3, CFW-4, CFW-7, CW-3, CW-4, CW-5, MW-2, MW-5, MW-6, and OSR-1.
- In August 2005, the following three wells were closed: CB-2, CW-6, and CW-7.

Specifications for the remaining 53 monitoring wells are provided in Table 1. Well locations are displayed in Figure 2.

Additional wells are currently being installed which include two historic monitoring locations that were previously closed (CW-5 and MW-6) and two new monitoring locations (MW-112A and MW-104D) (Figure 2).

Since 2003, 12 comprehensive groundwater sampling events have been completed including analyses for both radiological and non-radiological contaminants. Characterization of groundwater quality for radiological contaminants is summarized in Table 3-4 of Appendix A. Characterization of groundwater for Oil and/or Hazardous Materials (OHM) included the following:

- Gasoline Range Organics (GRO) by GC, SW-846 Method 8015B;
- Diesel Range Organics (DRO) by GC, SW-846 Method 8015B;

- Extractable Petroleum Hydrocarbons (EPH), Volatile Petroleum Hydrocarbons (VPH), and target analytes by MADEP Methods MADEP-EPH-98-1 and MADEP-VPH-98-1;

- Semi-Volatile Organic Compounds (SVOCs) by GC/MS, SW-846 Method 8270C SVOCs, SIM analysis;

- Volatile Organic Compounds (VOCs) by GC/MS, SW-846 Method 8260B;

- Polychlorinated Biphenyls (PCBs) total and dissolved by GC, SW-846 Method 8082;

- Herbicides by GC, SW-846 Method 8151;

- Alcohols by FID Method ASTM D3695; and

- Priority Pollutant Metals (PP13), boron, and lithium by SW-846 Method 6010B.

2.2 *SUMMARY OF SITE GEOLOGY & HYDROGEOLOGY*

Results of subsurface investigations have resulted in the development of a Site Conceptual Model (SCM) that summarizes the site geology and hydrogeology. The SCM is described in detail in the GMP-LTP (Appendix A). The SCM describes the site as being comprised of the following four hydrogeologic units:

- Stratified Drift- a relatively permeable sand ranging in thickness from zero to 40 feet that contains the water table at depths ranging from 4 to 20 feet below ground surface in the central portion of the site.

- Glacial Till- a relatively impermeable mix of sand, silt and clay that is very dense and compact underlying the stratified drift. Till has been encountered from zero to 210 feet below ground surface across the site. Groundwater within this unit is confined/semi-confined to silty sand lenses that are up to a few feet in thickness and laterally discontinuous.

- Lake Deposits- an alternating sequence of fine silt and clay that is laminated (glaciolacustrine deposits) underlying the till at a depth of 100 feet below ground surface in the northern portion of the site.

- Bedrock- an albite gneiss encountered at depths ranging from zero to 210 feet below ground surface. The upper surface of the bedrock appears to be moderately fractured and capable of yielding a few gallons per minute.

The rate and direction of groundwater flow beneath the site varies depending on location and hydrogeologic unit, but is generally northwest to west toward the Deerfield River. The rate of flow is greatest in the shallow stratified drift. Groundwater flow in the underlying till, lake deposits and bedrock is subject to both confined and semi-confined flow conditions due to the dense and laterally heterogeneous nature of these units. Flow in these units is estimated to be substantially slower than the stratified drift, but is generally toward the Deerfield River. The Deerfield River is estimated to represent the western, down-gradient extent of groundwater flow, which eventually discharges to river surface water.

2.3 SUMMARY OF NATURE, EXTENT, TRANSPORT & FATE OF GROUNDWATER IMPACTS

2.3.1 Nature & Extent of Groundwater Impact

Tritium

A detailed review of site groundwater monitoring for radioactive contaminants is included in Appendix A. Results indicate that the only radiological contaminant of concern in groundwater is tritium. The primary source of tritium release appears to have been leakage of cooling water contained in the SFP/IX Pit, which was recently excavated and removed (2005/2006).

A tritium plume has been identified in the shallow stratified drift originating from beneath the former footprint of the plant and extending northwest/west toward the Deerfield River. The highest concentrations of tritium detected in this shallow plume are 16,900 pCi/L (based on April 2006 result at MW-101A) at the plant and decreasing to 7,620 pCi/L (at MW-106A in July 2006) near the Deerfield River. Tritium levels in this plume have been below the Environmental Protection Agency (EPA) Maximum Contaminant Level (MCL) for drinking water of 20,000 pCi/L.

Tritium has been confirmed at a concentration above the EPA MCL in only one monitoring well, MW-107C, located within a sand lens in the till just below the outwash. The highest level of tritium detected at MW-107C was 48,000 pCi/L in September 2003. The level of tritium in MW-107C has decreased to 36,600 pCi/L (July 2006). Detected impacts at all other wells remain below the EPA MCL.

The distribution of tritium in the shallow stratified drift is consistent with the advective flow of groundwater down-gradient to the northwest/west of the plant. Concentrations tend to decrease down-gradient due to dilution and dispersion with increasing distance from the plant. Tritium in the underlying till is limited to confined/semi-confined sand lenses that appear to be laterally discontinuous, thereby limiting down-gradient transport, dilution or dispersion and resulting in the tritium level remaining above the EPA MCL at one monitoring point (MW-107C).

OHM

Results of monitoring for OHM were compared to the Massachusetts Contingency Plan (MCP) Reportable Concentrations for Groundwater Category GW-1 (RCGW-1). Table 2 summarizes wells where target OHM were detected above RCGW-1. Results indicate sporadic detections of OHM above RCGW-1 Standards that were generally not repeatable, not associated with a potential site release condition, or were found to be associated to well integrity issues (e.g., polychlorinated biphenyls (PCBs) in groundwater within damaged wells where PCB-containing paint chips infiltrated with storm water, or volatile organic compounds (VOCs) found in wells where glue containing the same VOCs had been used to attach temporary risers pipes during re-grading).

At least one additional round of monitoring will be conducted to confirm site groundwater quality results for OHM prior to site closure. Locations confirming OHM below RCGW-1 would be excluded from further monitoring, while any above would continue to be monitored until at least two consecutive rounds demonstrate OHM below RCGW-1 Standards.

2.3.2 *Transport & Fate of Groundwater Impact*

Tritium is the primary contaminant of concern (COC) in site groundwater. All liquid sources of tritium release have been removed. A tritium plume exists in the relatively permeable upper stratified drift and flows to the west discharging to the Deerfield River. The highest concentrations of tritium in the shallow plume are below the EPA MCL. These levels are expected to continue to decrease via dilution, dispersion and radioactive decay (tritium half-life is approximately 12 years).

Tritium has been detected in the deeper confined/semi-confined sand lenses within the underlying till. Tritium concentrations in this unit have been found to exceed the EPA MCL at only one monitoring point (MW-107C). The laterally discontinuous, disconnected nature of these lenses within very tight till limits dilution or dispersion resulting in minimal dilution of tritium over time. While groundwater within these lenses may slowly migrate to surface water, it is likely that dilution, dispersion and radioactive decay of tritium will reduce the concentrations to negligible levels prior to discharge to surface water.

Groundwater down-gradient of MW-107C is not currently, and in the future is unlikely to be, used as a source of drinking water. Nevertheless, groundwater monitoring will be conducted in accordance with the GMP-LTP and the GMP-MCP to establish that tritium concentrations continue to decrease as expected below the EPA MCL.

3.0 GROUNDWATER REGULATORY REQUIREMENTS & PROPOSED COMPLIANCE PLAN

3.1 NUCLEAR REGULATORY COMMISSION REQUIREMENTS & COMPLIANCE PLAN

Nuclear Regulatory Commission (NRC) site closure requirements for groundwater are stipulated in the YNPS License Termination Plan (LTP), NRC License Amendment No. 158. The GMP-LTP identifies the following criteria that must be met to satisfy LTP License Amendment No. 158:

- Demonstration that site-generated radionuclides, with the exception of tritium, are not present in groundwater above the limits presented in LTP License Amendment No. 158.

- An evaluation to demonstrate that maximum concentration of tritium in a well capable of supplying a resident farmer does not exceed 20,000 pCi/L.

- An evaluation to demonstrate that tritium concentrations in down-gradient off-site wells are less than 20,000 pCi/L.

Compliance with these criteria will be based on five rounds of quarterly monitoring conducted beginning in the Spring of 2006 and ending in the Spring of 2007.

3.2 MASSACHUSETTS REQUIREMENTS & COMPLIANCE PLAN

Under the Massachusetts Contingency Plan (MCP) 310 CMR 40.0000 site closure must meet the performance standards of a Permanent Solution for a Class A Response Action Outcome (RAO) Statement, or a Temporary Solution for a Class C RAO, until a Permanent Solution is achieved. Performance standards for achievement of a Permanent Solution include:

- Demonstration that residual concentrations of OHM (including tritium) do not pose a condition of "significant risk." Using quantitative risk estimation protocols the MCP carcinogenic risk-based threshold is a risk of 1×10^{-5}. For tritium, if no other significant risk contributors exist, the risk threshold corresponds to an estimated concentration of 23,000 pCi/L using standard DEP default exposure assumptions (Appendix B).

- Demonstration that residual concentrations of OHM (including tritium) do not pose a condition of "significant risk" by complying with applicable or suitably analogous regulatory standards. For tritium this includes the EPA MCL of 20,000 pCi/L, which is adopted by Massachusetts under 310 CMR 22.09A.

YAEC anticipates that in 2007 a Permanent Solution as a Class A RAO-Partial (RAO-P) will be filed for the majority of the site that does not pose a "significant risk." YAEC anticipates that this will include areas where soil could pose a "significant risk", but where a deed restriction and/or Activity and Use Limitation (AUL) will be filed to prevent activities and uses that could result in adverse exposure. Therefore, YAEC anticipates that the majority of the site would be eligible for a Class A-3 RAO-P.

However, the presence of tritium, and/or other OHM in site groundwater, at concentrations exceeding an applicable or suitably analogous regulatory standard constitutes, by definition under the MCP, a condition of "significant risk" that prevents filing a Permanent Solution as a Class A RAO-P in those portions of the site. At this time, YAEC anticipates that the only groundwater condition remaining at the site that will meet the definition of a condition of "significant risk" will be the presence of tritium in groundwater at monitoring well MW-107C. If so, the Class A-3 RAO-P would exclude the area surrounding MW-107C where groundwater has the potential to exceed the drinking water standard. YAEC anticipates that the portion of the site to be excluded from the Permanent Solution would be eligible for a Temporary Solution as a Class C RAO-P, or transitioned into a Remedy Operation Status (ROS) in support of a Monitored Natural Attenuation (MNA) remedy for groundwater (described below). The exact boundaries of the RAO-P will be determined after additional groundwater monitoring is conducted and the cumulative risk assessment is completed.

YAEC intends to utilize MNA to address the residual tritium impacts in groundwater. Active abatement via groundwater pump and treat does not appear to be a viable option since:

1. Pumping extensive volumes of groundwater from the construction excavations during source removal had no significant effect on the levels of tritium in MW-107C. The groundwater was discharged to surface water under a National Pollution Discharge Elimination System permit for

construction dewatering. Hydraulic pump testing of MW-107C also resulted in minimal yield and no reduction in tritium concentrations. These results suggest that recovery via pumping is not feasible due to the very low yield of the sand lens in which this well screen is completed.

2. There is no available treatment technology for tritium in groundwater, either on or off-site. MA DEP has stated that discharge to surface water without treatment, as was done during the excavation activities, would not be an acceptable remedial alternative for the site.

3. Off-site disposal of large volumes of water would not be feasible from a risk-reduction/cost-benefit standpoint in considering that this would generate a costly waste stream and increase short-term risk.

There are two MCP regulatory filing options for addressing the portion of the site that will not be the subject of the Permanent Solution, including: 1) a Temporary Solution as a Class C-2 RAO-P; or 2) to file a ROS for MNA for groundwater. The bases for these alternatives are:

1. The infeasibility (considering risk reduction and cost-benefit) of abatement to achieve a Permanent Solution.

2. Site conditions would meet risk-based performance standards for a Temporary Solution including elimination of a "substantial hazard" (no risk in the short-term/several years, because there is no current exposure pathway as no one is drinking the water, but potential for long-term risk based on tritium remaining above an MCL and the potential for groundwater to be used as a future source of drinking water, since there are no alternate potable public water supplies in the vicinity of the site).

3. MNA is anticipated to result in the achievement of a Permanent Solution for the site.

Under a Class C-2 RAO-P or ROS, groundwater monitoring would continue for a period of five to ten years at which point natural attenuation and radioactive decay of tritium is anticipated to reduce the levels below the MCL. YAEC anticipates that a decision regarding a Class C-2 RAO-P or ROS filing will be reached following evaluation of groundwater monitoring results for the Spring 2007 event (completion of monitoring to support NRC requirements). Once it was demonstrated through additional groundwater monitoring that the levels of tritium are permanently reduced below the MCL, a Permanent Solution (Class A-3 RAO) will be filed for the remainder of the site and groundwater monitoring will be terminated.

4.0 YAEC'S PROPOSED GROUNDWATER MONITORING PLAN

4.1 RADIOLOGICAL GROUNDWATER MONITORING PLAN

Appendix A includes the GMP-LTP. This report includes the radiological groundwater monitoring plan that will be conducted in accordance with the License Termination Plan (LTP) and Nuclear Regulatory Commission (NRC) License Amendment No. 158. Quarterly groundwater sampling (with additional sampling for tritium at select wells) was proposed to begin in Spring 2006 and conclude no earlier than Spring 2007. Radiological sample parameter lists and QA/QC requirement are discussed in Appendix A.

To satisfy MCP requirements, at least annual monitoring for tritium will be conducted at selected well locations based on the following rationale:

1. MW-107C due to levels in excess of the MCL.
2. Additional wells where tritium had been detected at levels exceeding 25% of the MCL or greater than 5,000 pCi/L, including. The following wells meet this criterion based on a preliminary review of the data:

   - MW-107A, MW-107D, MW-107E, MW-107F
   - MW-101A
   - MW-102D
   - MW-106A (a down-gradient well)
   - MW-111C

Monitoring is expected to continue at least annually until the levels of tritium in MW-107C naturally decay permanently below the MCL. Once monitoring results indicate levels have decayed below the MCL, a permanent reduction in the levels of tritium in MW-107C will be established based on generating four consecutive quarterly monitoring rounds over a one-year period indicating tritium at levels below the MCL of 20,000 pCi/L.

Monitoring of tritium levels at each of the additional wells will continue until either: 1) titium concentrations from two consecutive sampling events are below 25% of the MCL or 5,000 pCi/L); or 2) tritium concentrations in MW-107C are consistently below the MCL (based on results from four consecutive quarterly monitoring events). In this manner the monitoring program can be pared down to focus efforts on those locations necessary to confirm compliance with MCP Response Action Performance Standards for a Permanent Solution. Groundwater monitoring will be terminated after achievement of a Permanent Solution as a Class A-3 RAO for the entire site.

The list of wells to be sampled for tritium will be re-evaluated based on the results of the quarterly sampling proposed in the GMP-LTP. Wells could be added to, or removed from, the above list of locations targeted for monitoring based on the criteria outlined above. In addition, a more frequent sampling program may be implemented if deemed appropriate to facilitate site closure using the above criteria (i.e., sampling rounds could be conducted annually, semi-annually or, at a minimum frequency, quarterly).

4.2 OHM GROUNDWATER MONITORING PLAN

Groundwater sampling and analysis of OHM parameters will be conducted in the Fall of 2006 at select monitoring well locations (Table 3 and Figure 2). The groundwater sampling event will focus on monitoring wells that have previously exceeded RCGW-1 Standards. Additionally, sampling will be conducted at replacement monitoring well locations that historically exceeded RCGW-1 Standards and were abandoned during decommissioning activities.

Analytical results from the Spring and Fall 2006 groundwater monitoring events will be evaluated to determine the need for future sampling. Groundwater monitoring will be conducted at select monitoring wells that continue to exceed RCGW-1 standards (or an alternative risk-based standard agreed to by YAEC and MA DEP). Monitoring will be conducted at least annually until the levels of OHM in groundwater are below RCGW-1 standards for two consecutive rounds at each individual well. As with the radiological sampling, a more frequent sampling program may be implemented if deemed appropriate to facilitate site closure using the above criteria (i.e., sampling could be conducted annually, semi-annually or quarterly).

Sampling proposed in Table 3 will be conducted in accordance with YAEC standard operating procedures and the *Quality Assurance Project Plan, Site Closure, Revision 2, Yankee Nuclear Power Station, Rowe, Massachusetts, Gradient, 20 December 2005*. The following Quality Assurance / Quality Control (QA/QC) samples will be collected during groundwater sampling activities for OHM parameters:

- Trip Blanks – One trip blank set for every 20 VOC, Alcohol or VPH samples or one trip blank set in every cooler used to ship VOC, Alcohol or VPH samples, whichever number is greater. Each VOA vial trip blank is filled with an aliquot of deionized water and sealed with Teflon septa. The trip blanks should be prepared and provided by the analytical laboratory.
- Temperature Blanks – One temperature blank per cooler. The temperature of the temperature blank will be measured upon receipt of the cooler at the laboratory.
- Equipment Rinsate Blank – The majority of groundwater samples will be collected using dedicated sampling equipment. However, where the depth to water is greater than 30 feet, a submersible pump will be used. A rinsate sample will be collected from the pump at a rate of one sample per 20 sampling locations. The rinsate blanks will be analyzed for the same parameters as the samples that were collected using the equipment.
- Field Duplicates – Field duplicates will be collected at the rate of one duplicate per 20 samples. Field duplicates will be submitted for the same analyses as the parent sample. Field duplicates should be submitted "blind" to the analytical laboratory.
- Matrix Spikes – Matrix spikes will be collected at the rate of one matrix spike and one matrix spike duplicate per 20 samples. Matrix spikes/matrix spikes duplicates will be analyzed for the same analyses as the actual sample. The monitoring well location for matrix spikes and matrix spike duplicates are identified to the analytical laboratory.

4.3 WELL CLOSURES

Monitoring wells that will not be included in the GMP-LTP or GMP-MCP will be decommissioned in-place within one year of termination of monitoring at each location.

Tables

Table 1
Summary of Monitoring Well Specifications
Yankee Nuclear Power Station
Rowe, MA

Monitoring Well ID	Date Completed	Well Location	Total Depth Drilled (feet)	Well Screen Length (feet)	Well Screen Interval (ft bg)	Geologic Unit at Screen Interval	Screen Sand Pack Interval (ft bg)	Diameter of Sand Pack (inches)	Bentonite Seal Interval (ft bg)	Cement Grout Seal Interval (ft bg)	Well Inside Diameter (in.)	Well Wall (PVC)	Well Screen Slot Size (in.)	8-Inch Steel Casing Interval (ft bg)
CB-3	29-Apr-93	Northeast of former Fire Tank	15	10	3 to 10	Stratified Drift	3 to 15	5.000	2 to 3	0 to 2	2.25	Schd 40	I/U	N/A
CB-4	5-May-93	Old septic leaching field	19	10	9 to 19	Stratified Drift	8 to 20	5.000	7 to 8	0 to 7	2.25	Schd 40	I/U	N/A
CB-6	13-Sep-94	Sherman dam embankment, south side; Sherman Spring area	25	10	15 to 25	Stratified Drift	14 to 26	5.000	12 to 14	0 to 12	2.25	Schd 40	I/U	N/A
CB-8	20-Sep-94	North of old PCA in outdoor rad storage area.	19	5	14 to 19	Till	13 to 19	5.000	11.5 to 13	0 to 11.5	2.25	Schd 40	I/U	N/A
CW-2	29-Apr-93	West of Safety Injection Tanks (RCA)	20	10	9 to 19	Stratified Drift	9 to 20	5.000	8 to 9	0 to 8	2.25	Schd 40	I/U	N/A
CW-10	8-Jun-98	North of Stores warehouse	30	15	15 to 30	Bedrock	14 to 30.5	4.000	13 to 14	0 to 13	2.00	Schd 40	0.010	N/A
CFW-1	13-Dec-99	Southeast construction fill area margin	8	5	3 to 8	Stratified Drift	2 to 8	4	1 to 2	0 to 1	2.00	Schd 40	0.010	N/A
CFW-5	14-Dec-99	Southeast construction fill area margin	5	5	1 to 5	Stratified Drift	0.5 to 5	5	0 to 0.5	1 to 0	2.00	Schd 40	0.010	N/A
CFW-6	14-Dec-99	Southeast construction fill area margin	6	5	1 to 6	Stratified Drift	0.5 to 6	5	0 to 0.5	0.5 to 0	2.00	Schd 40	0.010	N/A
MW-100A	5-Aug-03	Northern area of RCA	20	10	10 to 20	Stratified Drift	8.3 to 20	5.5	6.0 to 8.3	0 to 6.0	2.0	Schd 40	0.010	N/A
MW-100B	4-Aug-03	Northern area of RCA	43	10	32.9 to 42.9	Bedrock	31.0 to 43	4.625	28.0 to 31.0	0 to 28.0	2.0	Schd 40	0.010	N/A
MW-101A	11-Apr-06	South side of VC	23.5	5	18 to 23	Fill	16 to 23.5	5.5	13 to 16	0 to 13	2.0	Schd 40	0.010	0 to 10*
MW-101B	13-Aug-03	South side of VC	156	10	142 to 152	Bedrock	140.2 to 156	4.625	138.5 to 140.2	0 to 138.5	2.25	Schd 80	0.010	0 to 11.25
MW-101C	15-Aug-03	South side of VC	99	5	94 to 99	Sand and Silt	92.1 to 99	5.5	90.0 to 92.1	0 to 90.0	2.0	Schd 40	0.010	0 to 15.3
MW-102A	31-Jul-03	North Side of VC	39	5	33 to 38	Sand and Silt	31.0 to 39	5.5	29.0 to 31.0	0 to 29.0	2.0	Schd 40	0.010	N/A
MW-102B	24-Jul-03	North Side of VC	131.5	10	120.2 to 130.2	Bedrock	117.9 to 131.5	4.625	116.0 to 117.9	0 to 116.0	2.0	Schd 40	0.010	0 to 15
MW-102C	29-Jul-03	North Side of VC	99	5	94 to 99	Sand & Gravel	92.4 to 99	5.5	90.8 to 92.4	0 to 90.8	2.0	Schd 40	0.010	0 to 14.5
MW-102D	10-Feb-06	North Side of VC	22	10	11 to 21	Sand & Gravel	9 to 22	5.5	7 to 9	0 to 7	2.0	Schd 40	0.010	0 to 8
MW-103A	17-Jul-03	Northwest side of Security Center	26	10	15 to 25	Stratified Drift	13 to 26	5.5	11 to 13	0 to 11	2.0	Schd 40	0.010	N/A
MW-103B	10-Jul-03	Northwest side of Security Center	295	10	284.5 to 294.5	Bedrock	282 to 295	4.625	279 to 282	0 to 279	2.25	Schd 80	0.010	0 to 30
MW-103C	16-Jul-03	Northwest side of Security Center	125	10	115 to 125	Laminated Clay & Sand	112.3 to 125	5.5	110.5 to 112.3	0 to 110.5	2.0	Schd 40	0.010	N/A
MW-104A	6-Feb-06	Downgradient mid-plume location	27	10	10 to 20	Sand & Gravel	8 to 20	5.5	6 to 8	0 to 6	2.0	Schd 40	0.010	0 to 10
MW-104B	3-Sep-03	Downgradient mid-plume location	194.5	10	184 to 194	Bedrock	182 to 194.5	5.5: 182' to 187' 4.625: 187' to 194.5'	180 to 182	0 to 180	2.25	Schd 80	0.010	0 to 25
MW-104C	11-Sep-03	Downgradient mid-plume location	99	10	87 to 97	Laminated Silt & Sand	84.8 to 99	7.625	82.8 to 84.8	0 to 82.8	2.25	Schd 80	0.010	N/A
MW-105A	8-Feb-06	North of Service Building	25	10	10 to 20	Sand & Gravel	8 to 20	5.5	6 to 8	0 to 6	2.0	Schd 40	0.010	0 to 8
MW-105B	20-Aug-03	North of Service Building	75	10	64 to 74	Bedrock	61.8 to 75	4.625	59.6 to 61.8	0 to 59.6	2.0	Schd 40	0.010	0 to 25
MW-105C	21-Aug-03	North of Service Building	45	10	27 to 37	Silt and Sand	25.1 to 37	5.5	23.1 to 25.1	0 to 23.1	2.0	Schd 40	0.010	N/A
MW-106A	30-Aug-04	Downgradient portion of site near to Deerfield River	22	10	12 to 22	Sand & Gravel	9.5 to 22	7.625	7.5 to 9.5	0 to 7.5	2.0	Schd 40	0.010	N/A
MW-106B	27-Aug-04	Downgradient portion of site near to Deerfield River	265	10	251 to 261	Bedrock	249 to 265	4.625	230 to 249	0 to 230	2.25	Schd 80	0.010	N/A
MW-106C	8-Sep-04	Downgradient portion of site near to Deerfield River	95	5	90 to 95	Sand and Silt	86.5 to 95	5.5	80 to 86.5	0 to 80	2.0	Schd 40	0.010	0 to 25
MW-106D	14-Sep-04	Downgradient portion of site near to Deerfield River	155	10	144 to 154	Sand and Silt	142 to 154	5.5	132 to 142	0 to 132	2.25	Schd 80	0.010	0 to 25

Table 1
Summary of Monitoring Well Specifications
Yankee Nuclear Power Station
Rowe, MA

Monitoring Well ID	Date Completed	Well Location	Total Depth Drilled (feet)	Well Screen Length (feet)	Well Screen Interval (ft bg)	Geologic Unit at Screen Interval	Screen Sand Pack Interval (ft bg)	Diameter of Sand Pack (inches)	Bentonite Seal Interval (ft bg)	Cement Grout Seal Interval (ft bg)	Well Inside Diameter (in.)	Well Wall (PVC)	Well Screen Slot Size (in.)	8-Inch Steel Casing Interval (ft bg)
MW-107A	5-Apr-06	NE side of VC and NW of spent fuel pool	30	5	21 to 26	Sand & Gravel	19 to 26	5.5	16 to 19	0 to 16	2.00	Schd 40	0.010	0 to 9
MW-107B	17-Sep-03	NE side of VC and NW of spent fuel pool	110	10	99.7 to 109.7	Bedrock	97.8 to 109.7	4.625	96.0 to 97.8	0 to 96.0	2.25	Schd 80	0.010	0 to 12.5
MW-107C	19-Sep-03	NE side of VC and NW of spent fuel pool	32	5	27 to 32	Sand and Silt	25 to 32	5.5	23 to 25	0 to 23	2.0	Schd 40	0.010	N/A
MW-107D	24-Sep-03	NE side of VC and NW of spent fuel pool	81.2	5	75 to 80	Sand and Silt	73 to 81.2	5.5	71.1 to 73	0 to 71.1	2.0	Schd 40	0.010	N/A
MW-107E	15-May-06	NE side of VC and NW of spent fuel pool	70	5	52 to 57	Sand Lens in Till	50 to 59	5.5	46-50	0 to 46	2.0	Schd 40	0.010	0 to 32
MW-107F	23-May-06	NE side of VC and NW of spent fuel pool	57	5	49 to 54	Sand Lens in Till	47 to 55	5.5	40.5 to 47	0 to 40.5	2.0	Schd 40	0.010	0 to 25
MW-108A	17-Jul-04	Peninsula near Sherman Reservoir	25	10	14.7 to 24.7	Sand and Silt	10 to 25	5.5	6.1 to 10	0 to 6.1	2.0	Schd 40	0.010	N/A
MW-108B	16-Jul-04	Peninsula near Sherman Reservoir	215	10	205 to 215	Bedrock	202.5 to 215	5.5	197.5 to 202.5	0 to 197.5	2.25	Schd 80	0.010	0 to 26
MW-108C	8-Jul-04	Peninsula near Sherman Reservoir	170	5	60 to 65	Silty fine Sand	57 to 67	7.625	51-57&67-170	0 to 51	2.0	Schd 40	0.010	0 to 26
MW-109A	3-Feb-06	West side of Industrial Area	20	10	10 to 20	Sand & Gravel	8 to 20	5.5	4 to 8	0 to 4	2.0	Schd 40	0.010	0 to 8
MW-109B	2-Aug-04	West side of Industrial Area	190	10	180 to 190	Bedrock	177.5 to 190	4.625	175.5 to 177.5	0 to 175.5	2.25	Schd 80	0.010	0 to 20
MW-109C	9-Aug-04	West side of Industrial Area	55	5	49 to 54	Sand with Silt	46.8 to 55	5.5	42.5 to 46.8	0 to 42.5	2.0	Schd 40	0.010	N/A
MW-109D	6-Aug-04	West side of Industrial Area	113	5	88.7 to 93.7	Sand & Gravel	86 to 95	5.5	83-86&95-113	0 to 83	2.0	Schd 40	0.010	0 to 21
MW-110A	16-Feb-06	Adjacent to area of release associated with Ion exchange pit	31	5	25 to 30	Sand & Gravel	22 to 31	5.5	17 to 22	0 to 17	2.0	Schd 40	0.010	0 to 10
MW-110B	6-Mar-06	Adjacent to area of release associated with Ion exchange pit	110	10	100 to 110	Bedrock	98 to 110	4.625	93 to 98	0 to 93	2.0	Schd 40	0.010	0 to 38
MW-110C	20-Mar-06	Adjacent to area of release associated with Ion exchange pit	51	5	46 to 51	Sand Lens in Till	44 to 51	5.5	38 to 44	0 to 38	2.0	Schd 40	0.010	0 to 38
MW-110D	17-Mar-06	Adjacent to area of release associated with Ion exchange pit	88	5	83 to 88	Sand Lens in Till	81 to 88	5.5	75 to 81	0 to 75	2.0	Schd 40	0.010	0 to 33
MW-111A	30-Mar-06	Northeast side of SFP, downgradient of fuel transfer shute	23	5	18 to 23	Sand & Gravel	15.5 to 23	7.625	12 to 15.5	0 to 12	2.0	Schd 40	0.010	0 to 8
MW-111B	28-Mar-06	Northeast side of SFP, downgradient of fuel transfer shute	80	10	70 to 80	Bedrock	67 to 80	4.625	62 to 67	0 to 62	2.0	Schd 40	0.010	0 to 30
MW-111C	31-Mar-06	Northeast side of SFP, downgradient of fuel transfer shute	41	5	32 to 37	Sand Lens in Till	30 to 37	5.5	26 to 30	0 to 26	2.0	Schd 40	0.010	0 to 29
MW-113A	27-Apr-06	Northern portion of site adjacent to Deerfield River	25	10	15 to 25	Sand & Gravel	13 to 25	5.5	7.5 to13	0 to 7.5	2.0	Schd 40	0.010	0 to 8
MW-113C	26-Apr-06	Northern portion of site adjacent to Deerfield River	140	10	127 to 137	Sand and Silt	125 to 137	5.5	120 to 125	0 to 120	2.0	Schd 40	0.01	0 to 30

Notes:
Information from the "Groundwater Monitoring Plan to Support Yankee Nuclear Power Station License Termination Plan," dated June 2006, and ERM Reports
ft bg=feet below grade; N/A=not applicable; Schd=schedule; all wells completed with # 0 (medium) sand pack; SFP=Spent Fuel Pool
* = 6-inch diameter steel casing; I/U - Information Unavailable, TBC - To Be Constructed

Table 2
Summary of Contaminants in Groundwater
Yankee Nuclear Power Station
Rowe, MA

Monitoring Well ID	Historic Results Greater than RCGW-1	Elevated Tritium	MCP Groundwater Monitoring	Comment
CB-3	Antimony		No	Average of sample and duplicate below RCGW-1
CB-4	silver		No	Subsequent sampling below RCGW-1
CFW-3	antimony		No	Former SCFA monitoring addressed separately
CFW-7	bis(2-Ethylhexyl)phthalate		No	Former SCFA monitoring addressed separately
CW-5R	-		Yes	Replacement well to evaluate downgradient of former fuel oil tank
CW-10	bis(2-Ethylhexyl)phthalate		Yes	
MW-5	Polychlorinated Biphenyls		No	See MW-110A
MW-6R	Extractable Petroleum Hydrocarbons (C11-C22)		Yes	Replacement well to evaluate historic EPH concentrations
MW-101A	arsenic	X	Yes	
MW-101B	Extractable Petroleum Hydrocarbons (C11-C22)		Yes	
MW-101C	Volatile Petroleum Hydrocarbons (C5-C8), acetone		Yes	
MW-102C	lead		No	Subsequent sampling below RCGW-1
MW-102D	-	X	Yes	
MW-103B	lead, bis(2-Ethylhexyl)phthalate		No	Subsequent sampling below RCGW-1
MW-103C	acetone, arsenic, bis(2-Ethylhexyl)phthalate		No	Subsequent sampling below RCGW-1
MW-105B	bis(2-Ethylhexyl)phthalate		Yes	
MW-105C	1,1-Dichloroethylene, acetone		Yes	
MW-106A	-	X	Yes	
MW-107A	arsenic and silver	X	Yes	
MW-107B	Polychlorinated Biphenyls		Yes	
MW-107C	pentachlorophenol	X	Yes	Subsequent sampling below RCGW-1 for pentachlorophenol
MW-107D	Polychlorinated Biphenyls	X	Yes	
MW-107E	-	X	Yes	
MW-107F	-	X	Yes	Not yet sampled for OHM
MW-108B	bis(2-Ethylhexyl)phthalate, pentachlorophenol		No	Subsequent sampling below RCGW-1
MW-109B	pentachlorophenol		Yes	
MW-109C	pentachlorophenol		Yes	
MW-109D	pentachlorophenol		Yes	
MW-110A	-		Yes	Evaluate historic PCBs at MW-5
MW-110C	2-butanone (MEK)		Yes	
MW-111B	2-butanone (MEK)		Yes	
MW-111C	-	X	Yes	
MW-112A	-		Yes	New well downgradient of solvent usage area

Notes:
Non-Radiological Groundwater concentrations compared to Report Concentration (RCGW-1) standards
Elevated Tritium = Greater than 5,000 pCi/L based on a preliminary review of July 2006 data
- = sample results below RCGW-1 standards

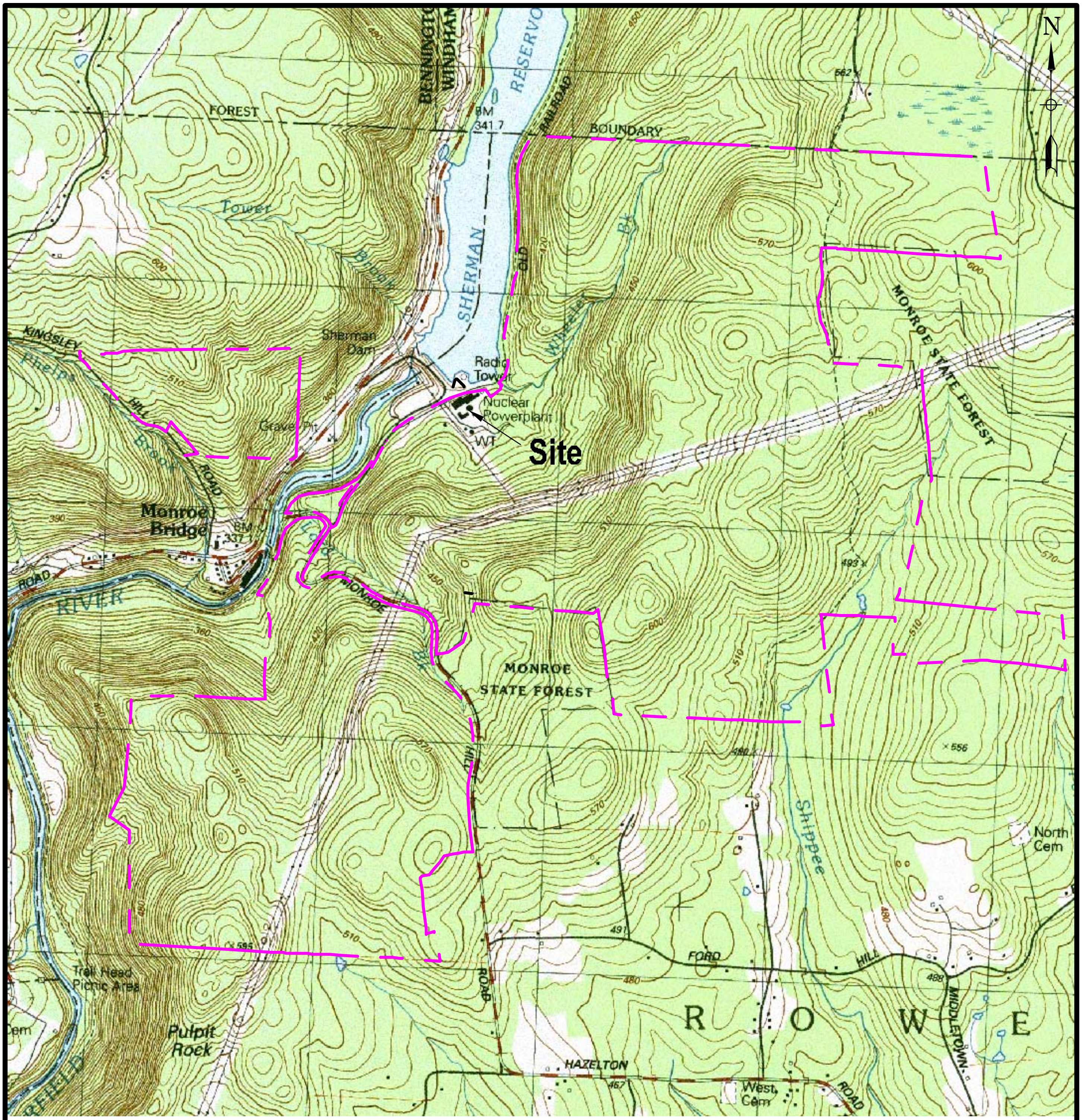
Table 3
MCP Groundwater Monitoring Parameters
Yankee Nuclear Power Station
Rowe, MA

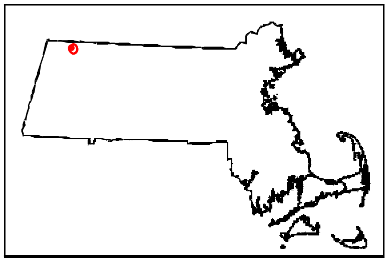
Well Designation	Sample ID	Status	Analytical Parameters							
			Tritium	OHM						
				VOC	SVOC	ALCOHOL	EPH	VPH	PP13 Metals plus Boron	Total PCBs
CW-5R	CW-5R	Proposed Replacement Well		X			X	X		
CW-10	CW-10	Existing			X					
MW-6R	MW-6R	Proposed Replacement Well		X			X			
MW-101A	MW-101A	Existing	X						X	
MW-101B	MW-101B	Existing					X			
MW-101C	MW-101C	Existing		X		X		X		
MW-102D	MW-102D	Existing	X							
MW-105B	MW-105B	Existing			X					
MW-105C	MW-105C	Existing		X				X		
MW-106A	MW-106A	Existing	X							
MW-107A	MW-107A	Existing	X						X	
MW-107B	MW-107B	Existing								X
MW-107C	MW-107C	Existing	X							
MW-107D	MW-107D	Existing	X							X
MW-107E	MW-107E	Existing	X							
MW-107F	MW-107F	Existing	X	X					X	
MW-109B	MW-109B	Existing			X					
MW-109C	MW-109C	Existing			X					
MW-109D	MW-109D	Existing			X					
MW-110A	MW-110A	Existing								X
MW-110C	MW-110C	Existing		X						
MW-111B	MW-111B	Existing		X						
MW-111C	MW-111C	Existing	X							
MW-112A	MW-112A	Proposed New Well		X[1]					X	

	Tritium	VOC	SVOC	ALCOHOL	EPH	VPH	PP13 Metals plus Boron	Total PCBs
Total Original Samples:	**9**	**8**	**5**	**1**	**3**	**3**	**4**	**3**
Total Duplicate Samples:	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Notes:
X[1] To be analyzed with Tentatively Identified Compounds (TICs)

Figures





YAEC Property Boundary

Scale 1:25,000

0.5 km 0 500 m

0.5 mi 0 1,000 ft

Figure 1 - Locus Map
Yankee Nuclear Power Station - Rowe, MA

ERM

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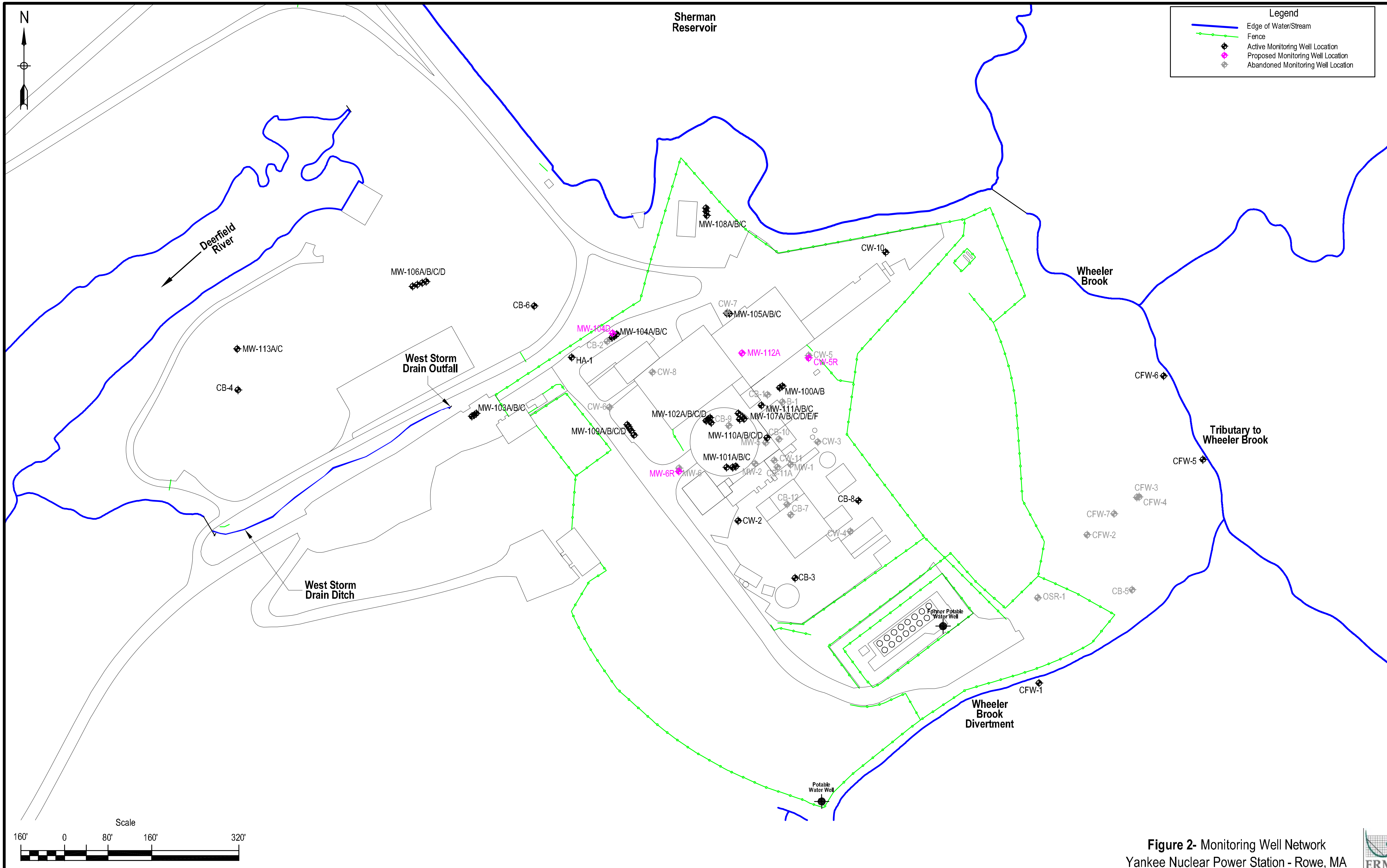

Figure 2- Monitoring Well Network
Yankee Nuclear Power Station - Rowe, MA

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Appendix A
Groundwater Monitoring Plan to Support Yankee Nuclear Power Station License Termination Plan, August 2006

Groundwater Compliance Plan for License Termination at Yankee Nuclear Power Station (YNPS)

Yankee Atomic Electric Company

August 2006

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1.0 Purpose

The purpose of the NRC Groundwater Compliance Plan (NRC-GCP) is to define how Yankee Atomic Electric Company (YAEC) will demonstrate that plant-related radioactivity in groundwater at Yankee Nuclear Power Station (YNPS) meets the license termination requirements defined in its License Termination Plan (LTP) (Reference 1a) and Nuclear Regulatory Commission (NRC) License Amendment No. 158 (Reference 1b). A separate request for license termination will be made based on data gathered in accordance with the NRC-GCP.

The NRC-GCP includes the following sections:

- Scope, Objectives, and Regulatory Criteria
- Groundwater Characterization
- Planned Groundwater Activities
- Quality Assurance
- Implementation Schedule and Deliverables

This Plan is based upon the hydrogeological characteristics of the YNPS site, as currently understood. The Plan will be used to validate these assumptions through additional investigations, such as aquifer testing and groundwater monitoring. Yankee expects that the results of these tests and investigations will support the current site conceptual model. If data obtained are contrary to the current understanding and assumptions, YAEC will review the Plan and make the necessary changes. Yankee will inform the NRC of changes made to the Plan before they are implemented.

2.0 Scope, Objectives and Regulatory Criteria

2.1 Scope

The scope of the NRC-GCP is limited to the portion of the YNPS site that either has historically exhibited plant-related groundwater contamination or may potentially exhibit plant-related groundwater contamination following decommissioning of plant facilities. The YNPS site is divided into the following functional areas (**Figure 2-1**):

- The Radiologically Controlled Area (RCA). The RCA is the approximately 4-acre parcel within the Industrial Area that contained radiological materials associated with plant operation.
- The Industrial Area (IA). The Industrial Area is the approximately 13-acre previously fenced portion of the site surrounding the RCA that contained industrial plant structures and operations (approximately 17 acres including the RCA).
- The Non-Industrial Area. The Non-Industrial Area is the remaining area on **Figure 1-1** that is not included in RCA or IA portion of the site, containing offices, roadways, fill areas, and undeveloped woodland. The portion of the property outside of the area defined on **Figure 1-1** has been released from the 10 CFR Part 50 license for YNPS site.

2.2 Objectives

The objectives of this plan are two-fold:

1) to define the method by which compliance with the LTP requirements and NRC license termination requirements will be achieved and
2) to define a process by which groundwater radiological conditions will be measured and documented during the monitoring period required for license termination.

2.3 LTP Regulatory Criteria

The following groundwater-related license termination criteria are required by the YNPS LTP and associated license amendment:

1) Demonstrate that the maximum concentration of well water available (based upon the well supply requirements assumed in LTP Section 6 for the resident farmer) is less than the EPA MCL for tritium (20,000 pCi/L) at the time of license termination (LTP Section 6.5).
2) Demonstrate that site-generated radionuclides, with the exception of tritium, are not present in groundwater above the action levels presented in NRC License Amendment

No. 158. YAEC must evaluate the need for site-specific groundwater DCGLs if groundwater radionuclides exceed these levels.

2.3.1 Resident Farmer Well Supply Requirements

LTP Section 6.5 states that the maximum concentration of well water available, based upon the well supply requirements assumed in Section 6 for the resident farmer, must be less than the EPA MCL for tritium (20,000 pCi/L) at the time of license termination. The well supply requirements for the resident farmer well are developed in LTP Appendix 6A. The median resident farmer well supply rate is 1,323 m^3/y (or 0.665 gpm) based on the range of well pumping rates calculated for YNPS.

In accordance with the guidance in NUREG/CR-6697, Attachment C, the resident farmer well pumping rate was based upon the sum of individual water needs. Those individual water needs, the value selected, and the basis for its selection are as follows:

- **Household use**. Assumed use of 374 m^3/yr. This value is based upon the domestic water use for a family of four (272 gal/d or 1.03 m^3/d) minus the contribution from drinking water, accounted for separately. The value of 272 gal/d was taken from U.S. Geological Survey Circular 1200, Estimated Use of Water in the United States in 1995, U.S. Department of the Interior, Government Printing Office, 1998. The document lists domestic freshwater use by state in Table 12, which for Massachusetts is 68 gal/d per person (272 gal/d for a household of four) for "self supplied" domestic water supplies.

- **Livestock use.** Assumed use of 76.7 m^3/yr. This value is based on information provided in NUREG/CR-6697, Development of Probabilistic RESRAD 6.0 and RESRAD-BUILD 3.0 Computer Codes, Table 2.1, and summing the values for water intake for meat livestock (50 L/d) and milk livestock (160 L/d).

- **Irrigation of vegetable plot.** Assumed use of 870 m^3/yr. The water requirement associated with irrigation of the resident farmer vegetable plot is based upon a site-specific irrigation rate, the assumed contamination fraction of food consumed (1.0), and the assumed sized of the vegetable plot associated with the resident farmer (2,000 m^2). Minimum and maximum values for the irrigation rate were calculated using site-specific distributions for the evapotranspiration rate, the precipitation rate, and the runoff coefficient (see LTP Appendix 6A, pp 6A-8 – 6A-13). The median value for the irrigation rate is 0.435 m/y. This value multiplied by the area being irrigated (2,000 m^2) resulted in 870 m^3/yr.

- **Irrigation of pasture land.** Assumed use of 0 m^3/y. Selection of this value is based upon information from the 1997 Census of Agriculture, Volume 1: Part 21, Chapter 1, as irrigation of pastureland is not a common practice in Massachusetts. In fact, only one farm in the Franklin County area claimed irrigation of pastureland.

- **Drinking water.** Assumed 1.9 m^3/yr. This value reflects the yearly intake of a four-person household consuming 478.5 L/yr (1.3 L/d) per person. 1.3 L/d is the median value listed for drinking water in Table 6.87 of NUREG/CR-5512, Volume 3, Residual Radioactive Contamination from Decommissioning, Parameter Analysis.

2.3.2 Limitations on Groundwater Radioactivity Excluding Tritium

License Amendment No. 158 limits the amount of radioactivity, other than tritium, that can be present in YNPS groundwater without YAEC reconsidering the need to calculate site-specific groundwater DCGLs. The license amendment established the following action levels for individual radionuclides in groundwater (additionally, the sum of the fractions for multiple radionuclides must be less than 2.0):

Radionuclide	Action Level per Radionuclide in pCi/L
Ag-108m	50
Am-241	0.5
C-14	200
Cm-243/244	0.50
Co-60	25
Cs-134	14
Cs-137	15
Eu-152	50
Eu-154	50
Eu-155	50
Fe-55	25
Nb-94	50
Ni-63	15
Pu-238	0.50
Pu-239/240	0.50
Pu-241	15
Sb-125	50
Sr-90	3
Tc-99	15

3.0 Groundwater Characterization

3.1 Summary Overview of YNPS Hydrogeologic Conceptual Model

A hydrogeologic Conceptual Site Model (CSM) has been developed for the YNPS based on both the regional geologic setting and on the hydrogeologic and chemical data collected at the site (Reference 2 and Reference 3). The hydrogeologic CSM developed for the YNPS describes a complex, multi-unit groundwater flow system. Four hydrogeologic units have been identified at the site:

1) a water table aquifer that occurs in stratified drift (glaciofluvial deposits),

2) a glacial till unit with multiple water-bearing sand lenses;

3) a glaciolacustrine unit with multiple water-bearing sand lenses; and

4) a bedrock aquifer.

In these four hydrogeologic units, groundwater occurs under unconfined, semi-confined, and confined conditions.

Geologic cross-section A-A' (**Figure 3-1**) illustrates the sequence of three surficial hydrogeologic units overlying bedrock (the orientation of the cross section at the YNPS site is shown in **Figure 3-2)**. Immediately below ground surface is a layer of stratified drift (glacio-fluvial) ranging in thickness from zero to about 40 feet, in which the water table aquifer exists. Beneath the stratified drift is a very dense till that includes lenses of water-bearing silty sand, which are a few feet thick and are interlayered within the till. The till ranges in thickness from zero to at least 210 feet.

Sand lenses within the till may be related to changes in ice margin position during late glacial stages. Short-term fluctuations in climate caused warming that may have spanned a period of a few years to a few decades. This resulted in a temporary stagnation or retreat in movement of the ice sheet and a net increase in melt water. This melt water deposited the relatively clean, well-sorted sand lenses into crevasses and ice channels within or on the margins of the glacier. As the climate reverted to colder temperatures, there occurred a net increase in snow accumulation and decrease in melt water. Under these conditions the ice front advanced, once again depositing lodgement till beneath its base and overriding the crevasse and ice-channel filling. Alternatively, portions of previously-deposited sand were incorporated into advancing ice and disseminated among more heterogeneous soil materials that were later laid down as till.

The process by which the sand lenses are believed to have been deposited suggests that they may be somewhat discontinuous and of limited extent. This stratigraphy has obvious implications for the transport of contaminants in groundwater and suggests that the thin, discrete sand lenses may not provide a mechanism for significant groundwater flow across the site. This judgement is based upon the poor correlation of water level measurements among sand lenses found in boreholes separated by more than a few hundred feet, as measured by installed pressure transducers and is supported by the distribution of tritium found within the sand lenses.

Tritium in these sand lenses has been detected at distances up to 350 feet down-gradient of the source area, and at depths up to 90 feet below the source area. In comparison, tritium in the shallow, glacio-fluvial soils has been detected across the complete down-gradient portion of the site (over 800 feet). Thus, the sand lenses are much less significant in the horizontal transmission of contaminants across the site, than the shallow, glacio-fluvial soils. There are a number of wells (e.g., MW-105B) that have measureable tritium in one aquifer but have no detectable tritium in a different aquifer (at a different elevation) in the ame area. This observation implies a lack of permeability or transmisstivity between layers.

A sequence of glacial lake deposits (glaciolacustrine sediments) underlies the till from the area north of the Radiologically Controlled Area (RCA) and extending north and west to the middle of the Deerfield River Valley (**Figure 3-1**). These lake deposits extend to the bedrock surface. This sequence is generally comprised of silt and clay, some of which is laminated. Sandy zones that are water-bearing are also found within the glaciolacustrine sediments. These sandy zones were likely formed during periods when stream flow into the lake was relatively high and coarser-grained sediment could be transported into the lake by the faster-flowing water.

The lake deposits are wedge-shaped in cross-section, being thickest toward the middle of the Deerfield River Valley, and thinning to the south where the lakeshore formerly existed (**Figure 3-1**). The sediments laid down in the lake were later buried by more than 100 feet of till and stratified drift.

The local bedrock is a dark gray, medium- to coarse-grained albite gneiss and occurs beneath the glaciolacustrine deposits (**Figure 3-1**). In addition to abundant 2 to 5 millimeter megacrystals of albite, two other predominant minerals form this rock, quartz and biotite. This is a metamorphic rock type that has been mapped by the United States Geological Survey as the Lower Cambrian Hoosac Formation (Reference 4). The monitoring wells recently installed in the bedrock indicate that the top few tens of feet of the rock are moderately fractured (Reference 1). The fractured rock comprises an aquifer that yields up to a few gallons per minute of water in some monitoring wells.

Groundwater equipotentials in the stratified drift from 2004 are shown in **Figure 3-3** and demonstrate a generally northwest flow direction in the shallow aquifer through the RCA, with a more westerly flow down-gradient of the RCA, toward the Deerfield River. A second flow path to the northeast and turning to the northwest is shown in the small sub-basin through which the tributary to Wheeler Brook flows, in the area of the Southeast Construction Fill Area (SCFA) (**Figure 3-3**).

Figure 3-4 shows the water level elevations that are used to interpret groundwater flow in sand lenses 30 to 100 feet deep within the till during 2004. As shown in **Figure 3-4,** a more westerly flow direction in the vicinity of the Vapor Container (VC) and SFP/IXP source area occurs relative to the shallow aquifer. However, the flow subsequently turns toward the northwest and follows a path similar to that in the shallow aquifer, toward the Deerfield River. A comparison of **Figure 3-3** with **Figure 3-4** shows that the water level elevations in the deeper sand lenses are generally 10 to 15 feet, and as much as 30 feet lower than in the shallow aquifer, indicating strong downward vertical gradients.

Groundwater equipotentials in the bedrock aquifer from 2004 are shown in **Figure 3-5**. The inferred flow direction shown in the bedrock aquifer is very similar to that found in the sand lenses 30 to 100 feet deep.

The Deerfield River is the discharge boundary for both surface water and groundwater for the entire watershed, acting as the definitive endpoint for groundwater flow paths in the hydrogeologic CSM for the YNPS.

3.2 Source Areas

Source areas at YNPS are described by two types: 1) primary release areas, where contaminants, consisting largely of radionuclides in aqueous coolant and other process solutions, were released to the ground under various circumstances; and 2) secondary source areas, consisting of surface and subsurface soils that were subsequently contaminated by the primary releases, either immediately on release, or due to down-gradient migration of contaminants in groundwater. Primary release and secondary source areas were remediated during demolition activities. The primary release areas for significant releases of radioactive materials are shown in **Figure 3-6** and are summarized in **Table 3-1**.

A significant source of tritium for groundwater at the site is the former Spent Fuel Pool (SFP) and Ion Exchange Pit (IXP). Most of the releases shown in **Table 3-1** consisted of small volumes that were promptly contained and removed; however two exceptions are noted. The first, documented in Abnormal Operating Report (AOR) 64-13, describes leakage from the IX Pit as a result of an operator failing to close the fill valve, after filling the IX Pit to its normal operating level. Water continued to flow into the pit from the Primary Water Storage Tank by gravity feed and subsequently seeped through the blacktop on the west side of the pit, at which time the operator noticed the water, diagnosed the cause, and closed the valve. The second is documented in a series of operating reports (Operating Report Nos. 44 - 53) that describe a leak at the construction joint at the common wall between the SFP and the IXP. Information indicates that the leak existed for about one year before it was successfully repaired in 1965. Additionally, YAEC belives the SFP leaked periodically before a steel liner was installed in 1979, based upon cracks observed in the pit's walls; however the amount of leakage was small and not discernable based on water levels changes and make-up rates. **Figure 3-7** is a cross-section of the west wall of the SFP/IXP complex, looking east, and shows the relation between the foundation of the SFP/IXP and the shallow stratigraphy in its vicinity.

A release of water contaminated with tritium at the IXP would have likely entered the stratified drift and flowed through the foundation backfill and into the top of the till. Tritium-contaminated water likely flowed through the permeable foundation backfill and was present in the fill surrounding the fuel transfer chute under the SFP, which is the lowest part of the structure. Microfractures or fossil ice wedges within the dense till likely allowed slow movement of the water downward and to the northwest, under the prevailing groundwater flow gradient. The resulting location is within a few feet of the sand lens identified in MW-107C, where the highest tritium concentration to date is found at YNPS.

This release mechanism and flow path resulted in the distribution of tritium observed in the monitoring well network. **Figure 3-7** illustrates the vertical proximity of the impacted sand lens in which MW-107C is completed at the northwest corner of the SFP (approximately 27 feet deep below original plant grade) and the bottom of the fuel transfer chute under the northeast corner of the SFP (approximately 24.5 feet deep). The vertical separation between these two features is about 2.5 feet, and, the vertical flow potential in this area of the site is downward from the shallow aquifer and backfill into the deeper sand lenses.

Per AOR 66-7, tritium concentration in water in the SFP was greater than 5,000,000 pCi/L. The water in the IXP had a similar concentration due to leaks in the ion exhange system and handling on ion exchange capsules. This concentration also would have been similar to that present in the IXP during the two events discussed above. Therefore, the tritium levels in the shallow aquifer were historically substantially higher than they are today. The concentration of tritium measured in Sherman Spring in 1965 was about 2,000,000 pCi/L (Reference 6) (**Figure 3-8**) and had decreased to less than 200 pCi/L by 1998. Current tritium concentrations in Sherman Spring are less than 3,000 pCi/L and decreasing. The higher tritium concentration reflects the uncovering of large areas of Industrial Area soils during decommissioning. The tritium concentration trend in the deeper hydrogeologic units is less certain, as monitoring of the deeper moniroing wells has only been conducted since 2003; however, all but one of the deeper monitornig wells (MW-107C) have tritium concentrations less than 20,000 pCi/L.

The process of natural attenuation (including dilution, dispersion and radioactive decay) has significantly reduced the tritium levels since the 1960's. The tritium levels are lower in the shallow aquifer because the higher hydraulic conductivity and more homogeneous flow domain in that unit have allowed more flushing and dilution compared to the deeper discontinuous sand lenses where flow is more restricted because the sands are interlayered within a low permeability till.

While the two significant release events appear to have contributed to much of the tritium in site groundwater, other sources of tritium have most likely contributed to other areas of observed tritium in site groundwater.

Decommissioning activities at YNPS have been ongoing for several years and the structures in the RCA and Industrial Area have been demolished and completely removed. Demolition activities have included excavation and removal of soil and concrete in the vicinity of the VC footprint, SFP/IXP, fuel transfer chute, radioactive waste warehouse, and various building slabs and foundations. The excavations of the VC, SFP/IXP, and fuel transfer area required dewatering as these structures were beneath the water table. These excavations resulted in significant soil removal in the historic tritium source areas at YNPS.

3.3 Groundwater Monitoring Well Network

The wells established at YNPS (depicted on **Figure 3-14**) provide a functional network to monitor contaminants in groundwater; provide bounding observations at the up-gradient, lateral, and down-gradient margins of the mapped tritium plume; and determine the vertical (i.e., between the ground surface and the lower extent of the plume) extent of contamination. A summary of the basis for monitoring locations and associated characteristics for each monitoring well are included in **Tables 3-2 and 3-3**, respectively, and well construction diagrams for the monitoring wells are presented in **Attachment 2**.

The monitoring well network includes wells that characterize groundwater up-gradient of the source areas, wells within and directly down-gradient of the source areas, monitoring wells that characterize groundwater on the lateral portions of the defined plume, and wells in the down-gradient plume areas. It also provides vertical profiling of the plume. In addition to monitoring wells included in the shallow water table aquifer within the stratified drift, deeper monitoring wells are screened in sand layers that occur in the till and glaciolacustrine deposits, and in the confined bedrock aquifer.

Monitoring well CFW-1 is up-gradient of the YNPS site, and provides information on up-gradient water quality within the stratified drift for the YNPS Industrial Area, ISFSI and construction fill area (**Figure 3-14**). Monitoring wells CB-3 and CB-8 are screened in shallow groundwater within the stratified drift and bound the up-gradient portion of the mapped tritium plume (**Figures 3-9 and 3-14**). Lateral plume boundaries are defined by the MW-109 and MW-103 well clusters on the southwest side and MW-100 and MW-108 well clusters on the northeast and northern sides of the plume, respectively (**Figures 3-9 and 3-14**).

The SFP/IXP source area is characterized by well clusters MW-101 and MW-102 on the southern and western portion of the source area and the MW-107 well cluster on the northern side of the SFP/IXP area (**Figure 3-14**). Monitoring well cluster MW-110 is located within the presumed release area associated with the IXP, and the MW-111 well cluster is located adjacent to the SFP fuel transfer chute.

The down-gradient plume area is monitored with the MW-106 and MW-113 well clusters and CB-4. The MW-113 well cluster and CB-4 are also down-gradient of a leach field that was used at the site.

Several monitoring wells are located within the mapped tritium plume including the MW-104 well cluster, CB-6, and the MW-105 well cluster. The MW-104 well cluster is located on the down-gradient side of the RCA within the central portion of the plume and CB-6 is further down-gradient also in the central portion of the mapped plume (**Figure 3-9 and 3-14**). The MW-105 well cluster is located within the northern portion of the plume in the down-gradient portion of the RCA. These monitoring wells will provide information regarding the change in tritium concentration down-gradient of the source area(s).

Monitoring wells are inspected regularly and maintained and repaired, as required. In the event a well becomes irreparably damaged, it will be replaced as soon as practical with a well completed in the same hydrogeologic unit in approximately the same functional location as the damaged well.

3.4 Contaminant Distribution in Groundwater

The distribution of groundwater contamination at the YNPS site has been monitored over the last several years by means of a quarterly sampling program. This monitoring program has shown that detectable concentrations of tritium are present in site groundwater. Low levels of Cs-137, Sr-90, and Co-60 have been identified sporadically during analysis of groundwater; however, these instances were investigated and found to be caused by one of three reasons:

1. Intrusion of surface water, which had been in contact with contaminated soil, into damaged well heads or roadboxes in adjacent areas.
2. False positive detections from expected statistical variations in laboratory analyses.
3. Improper onsite laboratory practices that introduced contamination into the sample being analyzed (e.g., lab cross contamination events).

The absence of radionuclides other than tritium in groundwater samples is consistent with soil-water partition coefficients (K_d) presented for these radionuclides in literature (Reference 5). The partition coefficients control the distribution of the radionuclides in groundwater as compounds with low K_d values are strongly partitioned to groundwater relative to soil and geologic material, while compounds with higher K_d values are more readily partitioned to the solid phase. The K_d value for tritium greatly favors its transport in the liquid phase (i.e., groundwater), while the K_d values of cobalt, strontium, and cesium favor their retention in the soil (Reference 5). Thus, the presence of tritium in site groundwater is consistent with the K_d values for this radionuclide.

A plume of tritium exists in the shallow stratified drift aquifer. In 2004, concentrations in this shallow plume ranged from non-detectable to about 5,000 pCi/L, with the highest concentrations located in the vicinity of the SFP/IXP complex. **Figure 3-9** depicts the shallow tritium plume in plan view based upon measurements in 2004. Generally, the shallow plume is aligned in the direction of shallow groundwater flow as shown in **Figure 3-3**.

Figure 3-10 depicts tritium concentrations from 2004 in deeper water-bearing sand lenses (at 30 to 100 feet) interlayered within the till and possibly extending into the glaciolacustrine deposits. This deeper zone of impact is smaller than the shallow plume but is more concentrated than the shallow plume, because of the restricted groundwater flow within the discontinuous, low-yielding sand lenses. Concentrations in the deeper zone of impact range from about 5,000 to approximately 37,000 pCi/L (based on May 2006 data in the low-yielding sand lens adjacent to the SFP/IXP complex).

Based upon available data, the shape of the impacted zone in these sand lenses is believed to be elongated, in a northerly direction. This orientation is not what might be expected when viewing the groundwater flow potential within these sands, as shown in **Figure 3-4**. However, this discrepancy is likely related to the heterogeneous nature of the multiple discrete sand lenses that are inter-layered, but not hydraulically connected, within a low permeability till, resulting in anisotropic flow along unpredictable contaminant flow paths. It is also possible that there were two separate source areas with an unmeasured zone of low or no contamination between them. Alternatively, contamination from the SFP/IXP may have been transmitted cross-gradient within utility trenches. Pumping tests, summarized in Attachment 1, were performed. Data obtained from this testing will help to resolve the hydraulic connectivity of the sand lenses and will provide additional insight to the fate and transport of tritium in the deeper sand layers.

The distribution of tritium in deeper sand lenses is illustrated in **Figures 3-11 and 3-12**. The cross-sections (A-A' and C-C') show tritium concentrations measured in screening samples collected in each sand lens encountered during drilling, as well as the results of tritium analyses of quarterly groundwater samples collected in 2004. Comparison of the two results indicates that where both screening samples and quarterly samples have been collected from the same sand lens, the quarterly sample results are generally comparable to or substantially less than the screening sample results. This relationship shows that the screening sample analyses are representative of the maximum concentration of tritium that is measured within a sand lens. This allows for characterization of the tritium distribution in a series of sand lenses in which screening data are available but no monitoring wells were located in these sand lenses.

Figure 3-11 illustrates tritium impacts in sand lenses 30 to 100 feet deep on cross-section A-A' during 2004. This figure shows that impacts within the deeper sand lenses appear to originate adjacent to the SFP/IXP complex and extend down-gradient in the direction of groundwater flow inferred in **Figure 3-4**, to a point somewhere beyond the MW-104 well cluster. **Figure 3-11** also illustrates the variations in subsurface geology and tritium groundwater concentrations. Several discrete sand lenses are present within the till and glaciolacustrine deposits and the sand lenses have concentrations of tritium ranging from over 40,000 pCi/L (about 37,000 pCi/L based on May 2006 data) in a shallow sand lens adjacent to the VC to approximately 6,500 pCi/L in deeper sand lenses beneath the VC. The hydraulic relationship among these sand lenses is being further assessed by groundwater characterization activities currently in progress (**Attachment 1**).

The cross-sections also illustrate the water level in each monitoring well and the inferred vertical flow potential that these water levels imply. Whether or not vertical flow occurs in the directions shown is dependent upon hydraulic connection between units. **Figure 3-11** shows a consistent downward flow potential from the shallow aquifer to the water-bearing sands 30 to 100 feet deep during each quarter of 2004. The downward groundwater gradient is consistent with the distribution of tritium in sand lenses beneath the VC area. The tritium concentration observed in the sand lenses beneath the VC decreases with depth of the sand lens (**Figure 3-11)**. This figure also shows a consistent upward flow potential from the bedrock to the deeper sand lenses in the central part of the site, near the VC. Conversely, the vertical flow potential is from the deeper sand lenses to the bedrock farther down-gradient, in the vicinity of the MW-104 well cluster.

Figure 3-12 also shows a consistent downward flow potential from the shallow aquifer to the deeper sand lenses during 2004 and also indicates an upward flow potential from the bedrock to the deeper sands in the central region of the site, but a reversal of this vertical flow potential in down-gradient areas such as the vicinity of monitoring well clusters MW-105, MW-108, and MW-103.

While quarterly sampling was conducted in 2003 and 2004, demolition activity associated with decommissioning precluded quarterly sampling in most of the industrial portion of the YNPS site in mid-2005. Several monitoring wells down-gradient of the RCA and Industrial Area were sampled in 2005 and early 2006, and tritium concentrations were observed to increase in several of the down-gradient monitoring wells and Sherman Spring (CB-4, SP-1, CB-6 and MW-106A) (Reference 7). The sample results for tritium in CB-6 from 2003 through early 2006 are shown in **Figure 3-13**. These results indicate a concentration below 1,000 pCi/L during 2003 and 2004 with a significant increase in tritium to levels in excess of 14,000 pCi/L in late 2005 and early

2006. These increases are most likely related to the removal of impervious surfaces and excavation activities associated with decommissioning, and the associated results indicate that the plume may have migrated in the down-gradient direction (northwest). Subsequent sampling has shown that these wells are trending downward.

4.0 LTP Compliance Demonstration

The planned activities for groundwater monitoring in support of license termination are described in this section and include the following elements:

- Groundwater sampling and analysis;
- Aquifer characterization;
- Resident farmer well tritium concentration demonstration;
- Data reports and deliverables; and
- Quality assurance requirements.

4.1 Groundwater Sampling and Analysis

Although the LTP specifies quarterly groundwater sampling and analysis, it does not specify the monitoring period required prior to license termination. A period consisting of at least five quarters (encompassing two spring seasons) of groundwater sampling beginning in the first quarter of 2006 will be completed prior to requesting license termination for the land areas outside of the ISFSI. The decision as to whether a longer period is needed will be based upon the tritium trends in the wells, the absence of other radionuclides, and the concentration of tritium calculated corresponding to the resident farmer well described in the LTP (see Section 4.3).

Future groundwater sampling of the existing groundwater well network will be planned and executed in a similar manner as previous quarterly groundwater monitoring events, including the use of a low flow sampling methodology. A sample plan will be prepared in accordance with AP-8601, "Ground and Well Water Monitoring Program for YNPS" (**Attachment 3**). Sample plans will specify the wells to be sampled, the analyses to be performed on the samples from each well, the number and type of containers to be filled with groundwater samples from each well, and the preservation and handling requirements for samples.

As discussed previously in the section on characterization, tritium has been the only plant-related radionuclide detected in groundwater. Groundwater samples collected during two of the quarterly sampling events will be analyzed for a complete suite of radionuclides, summarized in **Table 3-4**. The laboratory analytical program is partitioned into four analytical suites (**Table 3-4**). Suite A consists of gamma-emitting radionuclides, and Suite B includes tritium and gross alpha and gross beta. Suites C and D represent two sets of hard-to-detect (HTD) radionuclides. As summarized in **Table 3-5**, all four suites were analyzed in the recently completed spring 2006 quarterly sampling round, and a full-suite analytical program (A, B, C, and D) will be conducted in fall 2006. The analytical program for summer 2006 included tritium in all monitoring wells sampled and HTD radionuclides in selected wells.

Following sampling and analysis of groundwater in fall 2006, YAEC will evaluate eliminating the need for analysis of HTD radionuclides for each monitoring well. The purpose of the evaluation is to eliminate analyses for radionuclides that have not been detected historically in YNPS groundwater. The evaluation will also consider radionuclides potentially present in nearby soil or concrete. YAEC will discuss any revisions to the analytical suites with the NRC before they are implemented.

Prior to May 2006, turbid groundwater samples (i.e., samples with turbidity > 5 NTU) were preserved in the field and filtered at the laboratory prior to analysis. After the May 2006 sampling round, analyses will be completed on groundwater samples that have not been filtered in the field or at the laboratory prior to analysis. This change is consistent with Massachusetts Department of Environmental Protection expectations and removes the possibility that groundwater radionuclides may be removed inadvertently by filtration. YAEC does not expect there to be any difference between filtered and unfiltered results based on preliminary laboratory results, experience at other sites, and the prior practice of acidifying of samples to ensure that radionuclides were in solution prior to filtration. In May 2006 and July 2006, analyses of both unfiltered samples (for all wells) and filtered samples (for select wells) were conducted. Results are currently being evaluated.

YAEC will evaluate the tritium concentration trends for each monitoring well location using standard statistical tests. The trend analysis will include data from five quarterly sampling events taken between April 2006 and March 2007, supplemented with additional data collected since 2003. In the event of an increasing trend, the data will be evaluated to determine whether the trend significantly affects the maximum tritium concentration determined in the resident farmer well calculation (see Section 4.3) or results in a down-gradient offsite well exceeding 20,000 pCi/L. The results of this analysis could extend the duration of the required sampling period beyond the minimum of five quarters to establish an acceptable trend. Additional monitoring points will also be considered based on the data collected. Yankee will discuss extension of the monitoring period or changes to the monitoring well network with the NRC before making any modifications.

4.2 Aquifer Characterization

In addition to periodic groundwater sampling and analysis and to supplement prior aquifer characterization, YAEC conducted various tests to characterize aquifer hydraulic properties. These tests, summarized in Attachment 1, included a 24-hour pumping test to evaluate the hydraulic properties of sand lenses present in the till and glaciolacustrine deposits characteristic of the observations noted from MW-107 and additional short-term pumping tests to evaluate the interconnected nature of the sand lenses identified in the till and glaciolacustrine soils throughout the potential plume areas. These studies were conducted in June and July 2006. The results of these studies will be used to evaluate fate and transport of radionuclides in the sand lenses and support groundwater modeling for the YNPS site. The results of the tests will be documented in future groundwater reports (see Section 4.4).

YAEC expects the results of additional characterization and sampling to support the current site conceptual model. YAEC will evaluate the need for additional or different characterization tests, including additional monitoring wells, if the results are inconsistent with the current site conceptual model. YAEC will keep the NRC apprised new characterization data and will inform the NRC of decisions concerning the need for additional characterization.

4.3 Resident Farmer Demonstration

As discussed in Section 2.3 of this plan, YAEC will demonstrate that tritium would not exceed 20,000 pCi/L in any groundwater well with a yield equal to the well supply requirements documented in LTP Section 6 (0.665 gpm) based on a minimum of five quarters of groundwater sampling. This numerical demonstration will consider the capability of geologic formations and aquifers to supply water, trends of tritium concentration, and information from fate and transport modeling. If the maximum calculated tritium concentration at any location on site from a well with the resident farmer's yield exceeds 20,000 pCi/L, the sampling period will be extended beyond five quarters until an acceptable value is demonstrated,.

For example, the tritium concentration and yield of the aquifer monitored by MW-107C (location of the highest tritium concentration measured at YNPS) will be combined numerically with aquifers above or below that location to calculate the highest tritium concentration possible at a yield of 0.665 gpm. If the calculated tritium concentration is less than 20,000 pCi/L and there is a steady or decreasing tritium concentration trend, the demonstration will be acceptable. If the calculated value exceeds 20,000 pCi/L, YAEC will extend the sampling period beyond the minimum five quarters duration until the demonstration is acceptable.

4.4 Data Reporting and Deliverables

Several deliverables will be produced during the license-termination groundwater monitoring period and documented in quarterly groundwater summary letter reports, hydrogeologic reports, and final summary reports.

- <u>2006 Interim Groundwater Report.</u> This report will summarize ongoing data analyses from sampling rounds beginning in winter of 2005 through the supplemental tritium sampling in May 2006. In addition, this report will document the wells installed in spring 2006 including the synoptic water levels measurements. This report is planned for submittal to the NRC in early October 2006.
- <u>2006 Supplement to the Hydrogeological Report.</u> This report will summarize the data from groundwater sampling for summer 2006 through fall 2006 and include preliminary results from the pumping test. In addition, a summary of the preliminary numerical model for fate and transport will be provided. This report is planned for submittal to the NRC in November 2006.
- <u>Final Groundwater Condition Report</u>. This report will summarize the data from groundwater sampling for winter 2006 and any supplemental tritium sampling and previous monitoring results to confirm that closure criteria for license termination are being met. The report will document the development of the groundwater numerical model and will present any fate and transport analysis performed. Additionally the report will contain:
    - Validated laboratory results,

- Quarterly groundwater flow maps,
- Contour plots of data,
- Statistical trend analysis,
- Documentation and results of groundwater modeling,
- Fate and transport analysis, and
- Conclusions.

This report is planned to be submitted to the NRC in February 2007.

- Spring 2007 Groundwater Monitoring Summary Letter Report. A brief letter report will be submitted about 60 days after completion of the spring 2007 sampling event (planned for submittal in April 2007) and will summarize the following information:
  - Wells sampled in the previous quarterly monitoring event;
  - Validated laboratory results; and
  - Summary of any significant changes in concentration trends.
- License Termination Demonstration. The demonstration that the groundwater-related license termination criteria have been met will be included in the request for license termination for the site (excluding the ISFSI footprint area). This demonstration will include a summary of the groundwater tritium concentrations, confirmation that no other radionuclides have been detected in groundwater on site exceeding License Amendment No. 158 action levels, and that the tritium concentration in the resident farmer's well is less than EPA MCL (i.e., 20,000 pCi/L). The request is planned to be submitted in March 2007 following submittal of the Final Groundwater Condition Report. The spring 2007 samples results will be submitted in April 2007 as validation of the groundwater information presented in the License Termination Demonstration.

YAEC will continue to conduct periodic meetings with the NRC to discuss the results of sampling and analysis and groundwater characterization activities. In addition, if YAEC identifies significant changes in groundwater conditions or results from characterization that are not consistent with the current understanding of the hydrogeological conditions at the site, YAEC will brief the NRC on these conditions and changes to the NRC-GCP, prior to their implementation.

4.5 Quality Assurance Requirements

The YNPS Site Characterization and Site Release Quality Assurance Program Plan (QAPP) for Sample Data Quality (YNPS Procedure No. AP-9601) (**Attachment 4**) describes the methods for ensuring the quality of data collected in support of License Termination. The quality assurance requirements for sampling events and groundwater sampling are identified in "Ground and Well Water Monitoring Program for YNPS Site," YNPS Procedure No. AP-8601 and "Groundwater Level Measurement and Sample Collection in Observation Wells," YNPS Procedure No. DP-9745 (**Attachments 3 and 5**, respectively). The requirements for sample security and chain of custody are defined in YNPS Procedure No. DP-8123. All groundwater sample analyses will be performed by an off-site laboratory operating under a contractual scope of work consistent with the YNPS QAPP requirements necessary for the Groundwater Compliance Plan sample events.

While quarterly sampling was conducted in 2003 and 2004, demolition activity associated with decommissioning precluded quarterly sampling in most of the industrial portion of the YNPS site in mid-2005. Several monitoring wells down-gradient of the RCA and Industrial Area were sampled in 2005 and early 2006, and tritium concentrations were observed to increase in several of the down-gradient monitoring wells and Sherman Spring (CB-4, SP-1, CB-6 and MW-106A) (Reference 7). The sample results for tritium in CB-6 from 2003 through early 2006 are shown in **Figure 3-13**. These results indicate a concentration below 1,000 pCi/L during 2003 and 2004 with a significant increase in tritium to levels in excess of 14,000 pCi/L in late 2005 and early 2006. These increases are most likely related to the removal of impervious surfaces and excavation activities associated with decommissioning, and the associated results indicate that the plume may have migrated in the down-gradient direction (northwest). Subsequent sampling has shown that these wells are trending downward.

5.0 References

Reference 1a Yankee Atomic Electric Company 2004, License Termination Plan, Revision 1, September 2, 2004.

Reference 1b NRC Safety Evaluation Related to Amendment No. 158 to License No. DRP-3, July 28, 2005.

Reference 2 Yankee Atomic Electric Company 2004, Hydrogeologic Report of 2003 Supplemental Investigation, YA-REPT-00-004-04, March, 2004.

Reference 3 Yankee Atomic Electric Company 2005, Report of Continuing Hydrogeologic Investigations in 2004, YA-REPT-00-010-05, March, 2005.

Reference 4 United States Geological Survey 1967, Geologic Map of the Rowe Quadrangle, Franklin and Berkshire Counties, Massachusetts, and Bennington and Windham Counties, Vermont, 1967, by A.H. Chidester, N.L. Hatch, Jr., P.H. Osberg, S.A. Norton, and J.H. Hartshorn, Map GQ-642, Department of the Interior, United States Geological Survey.

Reference 5 United States Environmental Protection Agency 1999, Understanding Variation in Partition Coefficient, Kd, Values, Volume II: Review of Geochemistry and Available Kd Values for cadmium, Cesium, Chromium, Lead, Plutonium, Radon, Strontium, Thorium, Tritium, and Uranium, EPA 402-R-99-004B (August 1999).

Reference 6 Framatome ANP DE&S, 2003, Site Ground Water Data Collection for YNPS Decommissioning, DESD-TD-YR-02-001, Rev 1, February 2003.

Reference 7 Yankee Atomic Electric Company 2006, Summary Groundwater Report for the Yankee Nuclear Power Station – 2005, YA-RPT-00-004-06, January 2006.

Tables

Table 3-1
Summary of Unplanned Releases of Radioactive Material at YNPS

Yankee Nuclear Power Station
Rowe, Massachusetts

The following is a chronological summary of events that have occurred in the yard area inside the Radiologically Controlled Area (RCA), based on a review of Abnormal Occurrence Reports (AORs) and Plant Incident Reports (PIR). The location of each event is shown in Figure 3-6.

AOR 61-15: Radioactive Spill – On September 20, 1961 a container of main coolant was dropped on the asphalt in the Potentially Contaminated Area between the Primary Auxiliary Building and the Waste Disposal Building while being carried to the Radiochemistry Lab. The half liter sample contained approximately 35 μCi . The spill was absorbed using absorbent paper and the spill area decontaminated by mopping. Fixed contamination remaining was ~0.05 mr/hr at 1" from the pavement.
***Impacted Areas* NOL-02/ NOL-05**

AOR 63-12: Shield Tank Cavity Fill Water Spill – On September 18, 1963 while filling the shield tank cavity, a ½" sampling valve located over the ion exchange pit was inadvertently left open. A spill of approximately 10 gallons of water from the safety injection tank resulted. Part of this water ran off the deck of the pit and onto a section of the blacktop surface on the west side of the pit. The radiation level at the immediate spill area was 70-100 mr/hr measured at 1 inch. Contamination levels were 10^6 to 10^7 dpm for areas of several square inches. Run off water caused contamination levels of 20-60,000 dpm/ft^2. The area was decontaminated the following day.
***Impacted Areas* NOL-01/NOL-02**
***Impacted Structures* NSY-02**

AOR 63-17: De-watering Pump Packing Leakage – October 8, 1963. The leakage from the fuel chute de-watering pump is piped via a garden hose to a 30 gallon drum placed in a storm catch basin (ECB-005) located between the railroad tracks and the NE comer of the spent fuel pit. The bottom rim of the liarrel was very corroded and water was dripping from two or three rust hole locations. At the time there was 6"-8" of water in the barrel with activity of 6 x 10^{-5} μCi/ml. It was believed only minimal water was leaked to the storm system.
***Impacted Areas* OOL-01**
***Impacted Sub-surface Areas/Structures* – East Storm Drain System**

Table 3-1
Summary of Unplanned Releases of Radioactive Material at YNPS

Yankee Nuclear Power Station
Rowe, Massachusetts

AOR 64-08: Seal Water Tank Spill – On September 3, 1964 after filling the seal water tank, leaking shutdown cooling pump seals back-flowed into the tank causing it to overflow out the vent connection into the common relief valve discharge line and onto the Primary Auxiliary Building roof. An estimated 35 gallons of water containing a total of 270 µCi was spilled. A sample from the seal tank had gross activity of 2×10^{-3} µCi/ml. The puddle on the roof had 1×10^{-3} µCi/ml. The next day decontamination of the roof was begun. The roof drain system drains into the storm drain system via a sub-surface piping connection. A sample of the storm drain (WCB-009) showed 1×10^{-6} µCi/ml. The predominant isotopes were Co^{58}, Co^{60} and Mn^{54}. Service Water was diverted to the storm drain to dilute and flush the system.
ImpactedAreas – AUX-01 Roof and Roof Drain System
***Impacted Sub-surface Areas/Structures* – West Storm Drain System**

AOR 64-13: Leakage from Ion Exchange Pit – On October 3, 1964 after filling the ion exchange pit to its normal level, the operator forgot to close the fill valve. Water continued to flow into the pit from the Primary Water Storage Tank by gravity feed. Four hours later the operator noticed water seeping up through the blacktop on the west side of the pit, knew why and went to close the valve. Two days later the water on the blacktop was sampled. The liquid had a specific activity of 8×10^{-8} µCi/ml. It contained Ag^{110m} at 5×10^{-7} µCi/ml and Co^{60} at 1×10^{-6} µCi/ml, both below MPC. The blacktop was rinsed down with service water to the storm drain (ECB-005).

Operating Report Nos. 44 – 53: Leakage at SFP/IXP Common Wall: During early operations of the plant, the water level in the IX Pit was observed to slowly decrease over time, requiring addition of make-up water in order to maintain a minimum water level. The frequent need for make-up water indicated that a leak had developed in the IX Pit. The Operating Report No. 44, June 1964, identifies the leak. The leak, estimated to be approximately 2.5 gpm, was eventually found in the construction joint at the common wall between the SFP and the IXP and was successfully repaired in May 1965.
***Impacted Areas* NSY-02**

Table 3-1
Summary of Unplanned Releases of Radioactive Material at YNPS

Yankee Nuclear Power Station
Rowe, Massachusetts

AOR 66-7: Spent Fuel Pit Water Spill – On September 27, 1966 while doing shipping cask operations in the spent fuel pool, a 2" priming valve for the cooling and purification pump was left open. Later, when running the L.P.S.T makeup pump, water flowed through the left open priming valve and started filling the SFP. After a period of time the level in the pool approached the overflow point. By the time the Shift Supervisor realized the reason for the high level and closed the priming valve the water had just started overflowing. It was estimated that a total of 33 gallons of water ran out over the spent fuel pit exterior wall, over a small section of asphalt paving and into an immediately adjacent storm drain (. A £w gallons of this also leaked into the new fuel vault. A sample of spent fuel pool water taken immediately after the incident a gross activity of 3.2 x 10-5 μCi/ml. A sample taken four days previous to the occurrence indicated the gross activity to be 5.4 x 10-5 μCi/ml and tritium concentration of 5.4 x 10-3 μCi/ml. A continuous service water and intermittent fire-water flush of the east side culvert system (ECB-005) was initiated and continued for a 24 hour period. Sufficient dilution water (75,000 gallons) was added to the culvert to reduce the gross and tritium activity to 1.4 x 10-8 μCi/ml and 2.4 x 10-6 μCi/ml, respectively, when averaged over 24 hours. Samples of drainage water leaving the east side culvert were taken 24 and 42 hours afterwards and indicated gross levels of 2.0 x 10-9 μCi/ml (by outside lab) and <5 x 10-9 μCi/ml (by in-house) and tritium (after 24 hours) of 3.4 x 10-5 μCi/ml. This occurrence resulted in a total release of 4 μCi gross β-γ and 670 μCi of tritium activity.
***Impacted Areas* SFP-01 North external wall /NOL-01**
***Impacted Sub-surface Areas/Structures* East Storm Drain System internal and external to piping (backfrll between SFP-01 and ECB-005)**

AOR 66-8: Abnormal Activity in Storm Drain – On September 27, 1966 after the Spent Fuel Pit water spill, a water sample was taken from both east and west storm drain culverts, even though the spill was collected by the east side only. An average of two samples from the west side showed gross activity of 6.7 x 10^{-7} μCi/ml. Investigation slowed the activity was due to a leaky relief valve on the safety injection heating system being discharged into the PAB floor drain. The PAB floor drain was arranged to discharge through the PAB wall into WCB-009, an outside storm drain. It was estimated that no more than 8 gallons could have leaked from the relief valve during the previous 24 hour period. The relief valve was thought not to have been leaking on the previous day. Analysis of safety injection tank water showed gross activity of 3 x 10^{-5} μCi/ml and tritium activity of 1.1 x 10^{-1} μCi/ml. A sample collected 24 hours later and analyzed by an outside lab showed gross activity of 1.2 x 10^{-8} μCi/ml and tritium activity of 5.1 x 10^{-5} μCi/ml. This occurrence resulted in a total estimated release of 0.8 μCi gross β-γ and 3.32 mCi tritium.
Impacted Area – OOL-05/OOL-06

Table 3-1
Summary of Unplanned Releases of Radioactive Material at YNPS

Yankee Nuclear Power Station
Rowe, Massachusetts

Impacted Sub-surfaceAreaslStructures – West Storm Drain system

AOR 66-9: Plastic Garden Hose Failure – On November 1, 1966 during a routine drainage on the fuel chute pump discharge line, a plastic garden hose used for the draining burst and flowed into a storm drain served by the east culvert (ECB-005). The burst was caused by heat tracing which softened the line enough so that static pressure inside the line was sufficient to cause the hose to separate at the hose coupling. Approximately 10 gallons of 3.0×10^{-3} activity water (for a total of 113 μCi) was released. The spill area was hosed down with service water. The service water and a fire hose were left running all night at ~250 gpm for dilution of the culvert. The east culvert was sampled after the spill with results as follows:

	Activity (μCi/ml) – YAEC	Activity (μCi/ml) – ConRad
11/1/66@1930	4.4×10^{-6}	2×10^{-5}
@2145	1.99×10^{-7}	9.1×10^{-7}
@2300	3.18×10^{-7}	9.0×10^{-7}
11/2/66@0800	6.3×10^{-8}	2.3×10^{-7}
11/4/66@2200	1.4×10^{-8}	2.4×10^{-8}

Since the effects of dilution showed the spill was under control no further action was taken.
***Impacted Areas* – NOL-01/OOL-01**
***Impacted Sub-surface Areas/Structures* – East Storm Drain system**

AOR 68-1: Waste Holdup Tank Moat Spill – On January 16, 1968 approximately 200 gallons of water spilled from the activity dilution decay tank from a valve bonnet failure event caused by freezing. The spilled water had an activity of 6.87×10^{-4} μCi/ml (β-γ and 9.24×10^{-1} μCi/ml tritium. A total of 520 μCi R β-γ and 698 mCi tritium was spilled into the moat. Since the moat was kept isolated no release of activity to the storm drains occurred.
***Impacted Areas* –**
***Impacted Sub-surface Areas/Structures* – NSY-07**

PIR 75-7: Yard Area Contamination – On July 16, 1975 a contaminated area of ground was found near the ion exchange pit reading ~500,000 dpm. Over the next few days the entire site within the restricted area fence was surveyed. Fourteen areas, ten of which were in the clean area, were found to be contaminated >1000 dpm/100 cm^2. Most of this was cleaned up and the remaining was sealed in place using asphalt sealer and covered with clean soil. For more detail see 'Summary of Yard Decontamination Effort in 1975'.
***Impacted Areas* – NOL-01 through NOL-06**

Table 3-1
Summary of Unplanned Releases of Radioactive Material at YNPS

Yankee Nuclear Power Station
Rowe, Massachusetts

PIR 77-16: Service Building Radioactive Sump Transfer Line Puncture – On December 21, 1977 while conducting core borings inside the controlled area the boring bit inadvertently punctured the 2 ½" stainless steel line leading from the service building sump tanks to the primary auxiliary building. The sump line ran at a depth of 15 feet underground where the damage occurred and the boring depth was 61 ½ feet. The damage was not detected until the next day when the sump pump started and water issued from the borehole. The sump pump ran through two cycles resulting in 20 gallons of water discharged from the rupture. The water contained the following:

Radionuclide	Total Activity, μCi	Concentration, μCi/ml	Fraction of MPC
I^{131}	16.50	2.18×10^{-4}	3.63
I^{133}	2.76	3.65×10^{-5}	0.18
Cs^{134}	0.34	4.46×10^{-6}	0.01
Cs^{137}	0.50	6.67×10^{-6}	0.02
Co^{60}	0.58	7.69×10^{-6}	0.01

It was determined that no measurable levels of activity were released offsite or to the storm drain. The line was repaired and a sand and concrete casing poured around it. No mention was made of the leaked upon soil.
***Impacted Areas* – NOL-02**
***Impacted Sub-surface Areas/Structures* – Soils surrounding perforation and transfer line backfill**

PIR 80-9: Resin Spill – On August 6, 1980 while pumping resin to a cask a hose developed a pinhole leak. Pumping was stopped immediately. The failure of the hose allowed the release of several gallons of water and about one quart of resin. A 15 by 20 square foot area was contaminated. Radiation readings on the resin were up to 1 mrad/hr and the spilled liquid readings were up to several hundred thousand dpm/100 cm^2. Extensive decontamination was required including removal of some of the blacktop to ensure no release to the environment.
***Impacted Areas* – NOL-02/NSY-02**
***Impacted Sub-surface Areas/Structures* – South and East exterior walls of NSY-02. Also sub-slab area of NSY-02 (IX-pit) due to transfer by surface (decon/rain) water into cracks between asphalt and IX pit walls.**

Table 3-1
Summary of Unplanned Releases of Radioactive Material at YNPS

Yankee Nuclear Power Station
Rowe, Massachusetts

PIR 81-9: Contamination of Yard Area During Reactor Head Removal – On May 15, 1981 while removing the reactor head to the railroad car outside the VC the head made contact with the shield wall. No damage occurred and lowering to the car continued. Later when finished contaminated people and areas were found. Smearable levels on the railroad car plywood 15 feet east of the head read up to 200 mrad/hr beta. This was sealed by painting and covered in herculite. General levels on the blacktop were from 1000 to 500,000 dpm/100 cm^2 and covered an area of roughly 30 feet by 50 feet. The total activity released to the ground was ~250 μ Ci with ~10 μCi discharged to Sherman Pond. This was below 10 CFR 20 reporting requirements. The area was cleaned up but due to rainfall trace activity levels were detected in the east storm drains. The storm drain sumps were pumped out and cleaned to eliminate further contamination.
***Impacted Areas* – NOL-01/NOL-06/OOL-12/OOL-13**
***Impacted Sub-surface Areas/Structures* – BRT-01/in cracks and crevasses under VC Equipment Hatch and along rails/ties in OOL-12 and 00L-13**

PIR 84-16: Drain Pipe Failure – On September 10, 1984 work was commenced to remove the drain line between the Waste Storage Building and the PCA storage building. The line was 3 ½ feet below grade at the PCA storage building end. The joints in this pipe were degraded resulting in leakage into the soils surrounding the joints. Samples of the soil under the pipe showed the presence of Co^{60} and Cs^{137}. In the most contaminated area showed 50,000 dpm with a single hot spot of 29,300 pCi/gm Co^{60}. Average contamination at 2 feet below this joint was ~2100 pCi/gm. Average Cs^{137} levels were about 17 times less than the average Co^{60} levels. Since this area of the yard was paved there was little likelihood of water transport from the surface. The entire pipe and ~420 ft^3 of dirt and rock were removed as radwaste. The depth of the soil removed was typically from 5 to 9 feet below grade. The soil left at the bottom of the excavation contained Co-60 at a concentration of approximately 30 pCi/gm. Clean fill was brought in and all areas above the excavation were sealed under a concrete cap (New Radwaste Warehouse floor). For groundwater movement data see **PIR 84-16**.
***Impacted Areas* – WST-01/WST-02**
***Impacted Sub-surface Areas/Structures* – WST-02 at a depth of in excess of 9 feet below grade, activity remains in excess of DCGL. Partial remediation under 50.75g.**

Table 3-1
Summary of Unplanned Releases of Radioactive Material at YNPS

Yankee Nuclear Power Station
Rowe, Massachusetts

PIR 94-03 and PIR 94-09: Leakage from Frozen Fuel Chute Dewatering Line and NST Tell-tales –On February 17 & 18, 1994 a fuel chute dewatering line and a neutron shield tank telltale drain line ruptured due to freezing. Freezing was due to inadequate heat tracing and insulation. A 3.5 liter sample from the fuel chute line indicated 1000 ncpm. From the NST telltale line a sample indicated Co^{60} and Cs^{137}. The ground below showed no contamination. The area by the rail tracks and pumpback house also showed no contamination. The snow pile along the south side of the rails by the new fuel vault showed Co^{60}, Cs^{137} and Mn^{54}. All positive areas were sent to the rad drains and the areas de-posted.

***Impacted Area* – NOL-01**

Table 3-2
Monitoring Well Location Rationale
Yankee Nuclear Power Station, Rowe, Massachusetts

Monitoring Well	Location	Location Rationale	Radiological Results Summary(1)
CB-3	Northeast of former Fire Tank	Low level activity found in soil removed for fire tank foundation; decommissioning rad materials handeling area for upper RCA. Well is upgradient of mapped tritium plume in shallow groundwater	Non-detect for tritium
CB-4	Old septic leaching field for YNPS plant; downgradient of operating septic leach field.	Leach field received minor radioactivity in septage; downgradient of septic leach field. Well is also downgradient of mapped tritium plume in shallow groundwater.	Up to 3,000 pCi/L tritium detected
CB-6	Sherman dam embankment, south side; Sherman Spring area	Downgradient of RCA and monitors the downgradient portion of mapped tritium plume in shallow groundwater.	Up to 14,000 pCi/L tritium detected
CB-8	North of old PCA in outdoor rad storage area.	Outdoor rad storage area with elevated radioactivity in surface soils. Well is upgradient of mapped tritium plume in shallow groundwater	Non-detect for tritium
CW-10	North of Stores warehouse	Monitor groundwater downgradient of NE portion of Industrial Area and side gradient to mapped tritium plume	Non-detect for tritium
CFW-1	Southeast construction fill area margin	Upgradient of construction fill area and Industrial area of plant	Non-detect for tritium
CFW-5	Southeast construction fill area margin	Monitor groundwater adjacent to Wheeler Brook tributary	Non-detect for tritium
CFW-6	Southeast construction fill area margin	Monitor groundwater adjacent to Wheeler Brook tributary	Non-detect for tritium
MW-100A	Northern area of RCA	Monitor shallow groundwater on the northern side of mapped tritium plume within the RCA adjacent to source area of plume.	Non-detect for tritium
MW-100B	Northern area of RCA	Monitor bedrock groundwater on the northern side of mapped tritium plume withyin the RCA adjacent to source area of plume.	Non-detect for tritium
MW-101A	South side of VC	Monitor shallow groundwater on southwest side of SFP/IXP source area	New Well
MW-101B	South side of VC	Monitor bedrock on southwest side of SFP/IXP source area	Up to 1,000 pCi/L tritium detected
MW-101C	South side of VC	Monitor deep sand lens on southwest side of SFP/IXP source area	Non-detect for tritium
MW-102A	North Side of VC	Monitor mid-level sand lens on downgradient side of SFP/IXP source area	Up to 4,900 pCi/L tritium detected
MW-102B	North Side of VC	Monitor bedrock on downgradient side of SFP/IXP source area	Non-detect for tritium

Notes:
(1) Groundwater results through 2/2006

Table 3-2
Monitoring Well Location Rationale
Yankee Nuclear Power Station, Rowe, Massachusetts

Monitoring Well	Location	Location Rationale	Radiological Results Summary(1)
MW-102C	North Side of VC	Monitor deep sand lens on downgradient side of SFP/IXP source area	Up to 7,000 pCi/L tritium detected
MW-102D	North Side of VC	Monitor shallow groundwater on downgradient side of SFP/IXP source area	Up to 5,600 pCi/L tritium detected
MW-103A	Northwest side of Security Center	Monitor groundwater on NW extent of mapped tritium plume in stratified drift	Non-detect for tritium
MW-103B	Northwest side of Security Center	Monitor groundwater on the NW extent of shallow tritium plume in Bedrock aquifer	Non-detect for tritium
MW-103C	Northwest side of Security Center	Monitor groundwater on the NW extent of shallow tritium plume in mid-level sand lens	Non-detect for tritium
MW-104A	Downgradient mid-plume location	Monitor groundwater in stratified drift downgradient of RCA and within identified tritium plume.	Up to 3,000 pCi/L tritium detected
MW-104B	Downgradient mid-plume location	Monitor groundwater in bedrock downgradient of RCA and below identified tritium plume.	Non-detect for tritium
MW-104C	Downgradient mid-plume location	Monitor groundwater in mid-level sand lens downgradient of RCA and within identified tritium plume.	Up to 7,200 pCi/L tritium detected
MW-105A	North of Service Building	Monitoring groundwater in stratified drift on east side of tritium plume.	Non-detect for tritium
MW-105B	North of Service Building	Monitoring groundwater in bedrock on east side of tritium plume.	Up to 5,300 pCi/L tritium detected
MW-105C	North of Service Building	Monitoring groundwater in mid-level sand lens on east side of tritium	Up to 4,500 pCi/L tritium detected
MW-106A	Downgradient portion of site near to Deerfield River	Monitor groundater in downgradient area of mapped tritium plume in stratified drift/shallow groundwater.	Up to 13,000 pCi/L tritium detected
MW-106B	Downgradient portion of site near to Deerfield River	Monitor groundater downgradient of tritium plume in bedrock	Non-detect for tritium
MW-106C	Downgradient portion of site near to Deerfield River	Monitor groundater downgradient of tritium plume in sand lens in till unit	Non-detect for tritium
MW-106D	Downgradient portion of site near to Deerfield River	Monitor groundater downgradient of tritium plume in sand lens in glaciolacustrine unit	Non-detect for tritium
MW-107A	NE side of VC and NW of spent fuel pool	Monitor groundwater in stratified drift adjacent to SFP and IXP	Up to 7,500 pCi/L tritium detected
MW-107B	NE side of VC and NW of spent fuel pool	Monitor groundwater in bedrockadjacent to SFP and IXP	Non-detect for tritium
MW-107C	NE side of VC and NW of spent fuel pool	Monitor groundwater in shallow sand lens in till adjacent to SFP and IXP	Up to 48,000 pCi/L tritium detected
MW-107D	NE side of VC and NW of spent fuel pool	Monitor groundwater in deep sand lens in till adjacent to SFP and IXP	Up to 12,800 pCi/L tritium detected
MW-107E	NE side of VC and NW of spent fuel pool	Monitor groundwater in intermediate depth sand lens in till adjacent to SFP and IXP	New Well

Notes:
(1) Groundwater results through 2/2006

Table 3-2
Monitoring Well Location Rationale
Yankee Nuclear Power Station, Rowe, Massachusetts

Monitoring Well	Location	Location Rationale	Radiological Results Summary(1)
MW-107F	NE side of VC and NW of spent fuel pool	Monitor groundwater in intermediate depth sand lens in till adjacent to SFP and IXP	New Well
MW-108A	Peninsula near Sherman Reservoir	Monitor groundwater in stratified drift potentiallly discharging to Sherman Reservoir. Well also monitors lateral boundary of mapped tritium plume in shallow groundwater.	Non-detect for tritium
MW-108B	Peninsula near Sherman Reservoir	Monitor groundwater in bedrock adjacent to Sherman Reservoir	Non-detect for tritium
MW-108C	Peninsula near Sherman Reservoir	Monitor groundwater in mid-level sand lens adjacent to Sherman Reservoir	Non-detect for tritium
MW-109A	West side of Industrial Area	Monitoring groundwater in stratified drift on western lateral margin of mapped tritium plume in shallow groundwater.	Non-detect for tritium
MW-109B	West side of Industrial Area	Monitoring groundwater in bedrock on west margin of tritium plume	Non-detect for tritium
MW-109C	West side of Industrial Area	Monitoring groundwater in mid-level sand lens on west margin of tritium plume	Non-detect for tritium
MW-109D	West side of Industrial Area	Monitoring groundwater in deep sand lens on west margin of tritium plume	Non-detect for tritium
MW-110A	Adjacent to area of release associated with Ion exchange pit	Monitoring groundwater in stratified drift in area of historic release from ion exchange pit	Up to 7,700 pCi/L tritium detected
MW-110B	Adjacent to area of release associated with Ion exchange pit	Monitoring groundwater in bedrock in area of historic release from ion exchange pit	Non-detect for tritium
MW-110C	Adjacent to area of release associated with Ion exchange pit	Monitoring groundwater in mid-level sand lens in area of historic release from ion exchange pit	Non-detect for tritium
MW-110D	Adjacent to area of release associated with Ion exchange pit	Monitoring groundwater in deep sand lens in area of historic release from ion exchange pit	Non-detect for tritium
MW-111A	Northeast side of spent fuel pool, downgradient of fuel transfer shute	Monitor groundwater within permeable backfill adjacent to deepest portion of spent fuel pool transfer follower shute.	Up to 5,500 pCi/L tritium detected
MW-111B	Northeast side of spent fuel pool, downgradient of fuel transfer shute	Monitor groundwater within bedrock adjacent to deepest portion of spent fuel pool transfer follower shute.	Non-detect for tritium
MW-111C	Northeast side of spent fuel pool, downgradient of fuel transfer shute	Monitor groundwater within sand lens beneath deepest portion of spent fuel pool transfer follower shute.	Up to 2,400 pCi/L tritium detected

Notes:
(1) Groundwater results through 2/2006

Table 3-2
Monitoring Well Location Rationale
Yankee Nuclear Power Station, Rowe, Massachusetts

Monitoring Well	Location	Location Rationale	Radiological Results Summary(1)
MW-113A	Northern portion of site adjacent to Deerfield River	Monitor groundwater in stratified drift downgradient of old leachfield and mapped tritium plume in shallow groundwater	Non-detect for tritium
MW-113C	Northern portion of site adjacent to Deerfield River	Monitor groundwater in mid-level sand lens downgradient of old leachfield	Non-detect for tritium
Sherman Spring (SP-1)	Sherman dam embankment, south side	Groundwater discharge point, downgradient of RCA.	Historically (mid 1960s) 2.0E06 pCi/l tritium Recently 4700 pCi/l tritium
Plant Water Well	Soutwest corner of site, upgradient of industrial area	Potable water supply for the plant, in bedrock	Non-detect for tritium
Furlon House Water Well	West of site, at western end of Yankee Road	Potable water supply for the plant visitor center, in bedrock	Non-detect for tritium

Notes:
(1) Groundwater results through 2/2006

Table 3-3
Summary of Completion Details for Monitoring Wells Included in LTP Monitoring Plan
Yankee Nuclear Power Station, Rowe, Massachusetts

Well ID	Date Completed	Total Depth Drilled (feet)	Well Screen Length (feet)	Well Screen Interval (ft bg)	Geologic Unit at Screen Interval	Screen Sand Pack Interval (ft bg)	Diameter of Sand Pack (inches)	Bentonite Seal Interval (ft bg)	Cement Grout Seal Interval (ft bg)	Well Inside Dia. (in.)	Well Wall (PVC)	Well Screen Slot Size (in.)	8-Inch Steel Casing Interval (ft bg)
CB-3	29-Apr-93	15	10	3 to 10	Stratified Drift	3 to 15	5.000	2 to 3	0 to 2	2.25	Schd 40	I/U	N/A
CB-4	5-May-93	19	10	9 to 19	Stratified Drift	8 to 20	5.000	7 to 8	0 to 7	2.25	Schd 40	I/U	N/A
CB-6	13-Sep-94	25	10	15 to 25	Stratified Drift	14 to 26	5.000	12 to 14	0 to 12	2.25	Schd 40	I/U	N/A
CB-8	20-Sep-94	19	5	14 to 19	Till	13 to 19	5.000	11.5 to 13	0 to 11.5	2.25	Schd 40	I/U	N/A
CW-2	30-Apr-93	20	10	9 to 19	Stratified Drift	9 to 20	5.000	8 to 9	0 to 8	2.25	Schd 40	I/U	N/A
CW-10	8-Jun-98	30	15	15 to 30	Bedrock	14 to 30.5	4.000	13 to 14	0 to 13	2.00	Schd 40	0.010	N/A
CFW-1	13-Dec-99	8	5	3 to 8	Stratified Drift	2 to 8	4	1 to 2	0 to 1	2.00	Schd 40	0.010	N/A
CFW-5	14-Dec-99	5	5	1 to 5	Stratified Drift	0.5 to 5	5	0 to 0.5	1 to 0	2.00	Schd 40	0.010	N/A
CFW-6	14-Dec-99	6	5	1 to 6	Stratified Drift	0.5 to 6	5	0 to 0.5	0.5 to 0	2.00	Schd 40	0.010	N/A
MW-100A	5-Aug-03	20	10	10 to 20	Stratified Drift	8.3 to 20	5.5	6.0 to 8.3	0 to 6.0	2.0	Schd 40	0.010	N/A
MW-100B	4-Aug-03	43	10	32.9 to 42.9	Bedrock	31.0 to 43	4.625	28.0 to 31.0	0 to 28.0	2.0	Schd 40	0.010	N/A
MW-101A	11-Apr-06	23.5	5	18 to 23	Fill	16 to 23.5	5.5	13 to 16	0 to 13	2.0	Schd 40	0.010	0 to 10*
MW-101B	13-Aug-03	156	10	142 to 152	Bedrock	140.2 to 156	4.625	138.5 to 140.2	0 to 138.5	2.25	Schd 80	0.010	0 to 11.25
MW-101C	15-Aug-03	99	5	94 to 99	Sand and Silt	92.1 to 99	5.5	90.0 to 92.1	0 to 90.0	2.0	Schd 40	0.010	0 to 15.3
MW-102A	31-Jul-03	39	5	33 to 38	Sand and Silt	31.0 to 39	5.5	29.0 to 31.0	0 to 29.0	2.0	Schd 40	0.010	N/A
MW-102B	24-Jul-03	131.5	10	120.2 to 130.2	Bedrock	117.9 to 131.5	4.625	116.0 to 117.9	0 to 116.0	2.0	Schd 40	0.010	0 to 15
MW-102C	29-Jul-03	99	5	94 to 99	Sand & Gravel	92.4 to 99	5.5	90.8 to 92.4	0 to 90.8	2.0	Schd 40	0.010	0 to 14.5
MW-102D	10-Feb-06	22	10	11 to 21	Sand & Gravel	9 to 22	5.5	7 to 9	0 to 7	2.0	Schd 40	0.010	0 to 8
MW-103A	17-Jul-03	26	10	15 to 25	Stratified Drift	13 to 26	5.5	11 to 13	0 to 11	2.0	Schd 40	0.010	N/A
MW-103B	10-Jul-03	295	10	284.5 to 294.5	Bedrock	282 to 295	4.625	279 to 282	0 to 279	2.25	Schd 80	0.010	0 to 30
MW-103C	16-Jul-03	125	10	115 to 125	Laminated Clay & Sand	112.3 to 125	5.5	110.5 to 112.3	0 to 110.5	2.0	Schd 40	0.010	N/A
MW-104A	6-Feb-06	27	10	10 to 20	Sand & Gravel	8 to 20	5.5	6 to 8	0 to 6	2.0	Schd 40	0.010	0 to 10
MW-104B	3-Sep-03	194.5	10	184 to 194	Bedrock	182 to 194.5	5.5: 182' to 187' 4.625: 187' to 194.5'	180 to 182	0 to 180	2.25	Schd 80	0.010	0 to 25
MW-104C	11-Sep-03	99	10	87 to 97	Laminated Siit & Sand	84.8 to 99	7.625	82.8 to 84.8	0 to 82.8	2.25	Schd 80	0.010	N/A
MW-105A	8-Feb-06	25	10	10 to 20	Sand & Gravel	8 to 20	5.5	6 to 8	0 to 6	2.0	Schd 40	0.010	0 to 8
MW-105B	20-Aug-03	75	10	64 to 74	Bedrock	61.8 to 75	4.625	59.6 to 61.8	0 to 59.6	2.0	Schd 40	0.010	0 to 25
MW-105C	21-Aug-03	45	10	27 to 37	Silt and Sand	25.1 to 37	5.5	23.1 to 25.1	0 to 23.1	2.0	Schd 40	0.010	N/A

Table 3-3
Summary of Completion Details for Monitoring Wells Included in LTP Monitoring Plan
Yankee Nuclear Power Station, Rowe, Massachusetts

Well ID	Date Completed	Total Depth Drilled (feet)	Well Screen Length (feet)	Well Screen Interval (ft bg)	Geologic Unit at Screen Interval	Screen Sand Pack Interval (ft bg)	Diameter of Sand Pack (inches)	Bentonite Seal Interval (ft bg)	Cement Grout Seal Interval (ft bg)	Well Inside Dia. (in.)	Well Wall (PVC)	Well Screen Slot Size (in.)	8-Inch Steel Casing Interval (ft bg)
MW-106A	30-Aug-04	22	10	12 to 22	Sand & Gravel	9.5 to 22	7.625	7.5 to 9.5	0 to 7.5	2.0	Schd 40	0.010	N/A
MW-106B	27-Aug-04	265	10	251 to 261	Bedrock	249 to 265	4.625	230 to 249	0 to 230	2.25	Schd 80	0.010	N/A
MW-106C	8-Sep-04	95	5	90 to 95	Sand and Silt	86.5 to 95	5.5	80 to 86.5	0 to 80	2.0	Schd 40	0.010	0 to 25
MW-106D	14-Sep-04	155	10	144 to 154	Sand and Silt	142 to 154	5.5	132 to 142	0 to 132	2.25	Schd 80	0.010	0 to 25
MW-107A	5-Apr-06	30	5	21 to 26	Sand & Gravel	19 to 26	5.5	16 to 19	0 to 16	2.00	Schd 40	0.010	0 to 9
MW-107B	17-Sep-03	110	10	99.7 to 109.7	Bedrock	97.8 to 109.7	4.625	96.0 to 97.8	0 to 96.0	2.25	Schd 80	0.010	0 to 12.5
MW-107C	19-Sep-03	32	5	27 to 32	Sand and Silt	25 to 32	5.5	23 to 25	0 to 23	2.0	Schd 40	0.010	N/A
MW-107D	24-Sep-03	81.2	5	75 to 80	Sand and Silt	73 to 81.2	5.5	71.1 to 73	0 to 71.1	2.0	Schd 40	0.010	N/A
MW-107E	15-May-06	70	5	52 to 57	Sand Lens in Till	50 to 59	5.5	46-50	0 to 46	2.0	Schd 40	0.010	0 to 32
MW-107F	23-May-06	57	5	49 to 54	Sand Lens in Till	47 to 55	5.5	40.5 to 47	0 to 40.5	2.0	Schd 40	0.010	0 to 25
MW-108A	17-Jul-04	25	10	14.7 to 24.7	Sand and Silt	10 to 25	5.5	6.1 to 10	0 to 6.1	2.0	Schd 40	0.010	N/A
MW-108B	16-Jul-04	215	10	205 to 215	Bedrock	202.5 to 215	5.5	197.5 to 202.5	0 to 197.5	2.25	Schd 80	0.010	0 to 26
MW-108C	8-Jul-04	170	5	60 to 65	Silty fine Sand	57 to 67	7.625	51-57&67-170	0 to 51	2.0	Schd 40	0.010	0 to 26
MW-109A	3-Feb-06	20	10	10 to 20	Sand & Gravel	8 to 20	5.5	4 to 8	0 to 4	2.0	Schd 40	0.010	0 to 8
MW-109B	2-Aug-04	190	10	180 to 190	Bedrock	177.5 to 190	4.625	175.5 to 177.5	0 to 175.5	2.25	Schd 80	0.010	0 to 20
MW-109C	9-Aug-04	55	5	49 to 54	Sand with Silt	46.8 to 55	5.5	42.5 to 46.8	0 to 42.5	2.0	Schd 40	0.010	N/A
MW-109D	6-Aug-04	113	5	88.7 to 93.7	Sand & Gravel	86 to 95	5.5	83-86&95-113	0 to 83	2.0	Schd 40	0.010	0 to 21
MW-110A	16-Feb-06	31	5	25 to 30	Sand & Gravel	22 to 31	5.5	17 to 22	0 to 17	2.0	Schd 40	0.010	0 to 10
MW-110B	6-Mar-06	110	10	100 to 110	Bedrock	98 to 110	4.625	93 to 98	0 to 93	2.0	Schd 40	0.010	0 to 38
MW-110C	20-Mar-06	51	5	46 to 51	Sand Lens in Till	44 to 51	5.5	38 to 44	0 to 38	2.0	Schd 40	0.010	0 to 38
MW-110D	17-Mar-06	88	5	83 to 88	Sand Lens in Till	81 to 88	5.5	75 to 81	0 to 75	2.0	Schd 40	0.010	0 to 33
MW-111A	30-Mar-06	23	5	18 to 23	Sand & Gravel	15.5 to 23	7.625	12 to 15.5	0 to 12	2.0	Schd 40	0.010	0 to 8
MW-111B	28-Mar-06	80	10	70 to 80	Bedrock	67 to 80	4.625	62 to 67	0 to 62	2.0	Schd 40	0.010	0 to 30
MW-111C	31-Mar-06	41	5	32 to 37	Sand Lens in Till	30 to 37	5.5	26 to 30	0 to 26	2.0	Schd 40	0.010	0 to 29
MW-113A	27-Apr-06	25	10	15 to 25	Sand & Gravel	13 to 25	5.5	7.5 to13	0 to 7.5	2.0	Schd 40	0.010	0 to 8
MW-113C	26-Apr-06	140	10	127 to 137	Sand and Silt	125 to 137	5.5	120 to 125	0 to 120	2.0	Schd 40	0.01	0 to 30

Notes: ft bg=feet below grade; N/A=not applicable; Schd=schedule; all wells completed with # 0 (medium) sand pack

* = 6-inch diameter steel casing; I/U - Information Unavailable, TBC - To Be Constructed

Table 3-4
Summary of Laboratory Analysis for Quarterly Groundwater Sampling
Yankee Nuclear Power Station, Rowe, Massachusetts

Analyte		GEL Analytical Method	MDC (pCi/L)	MCL (pCi/L)	NRC (1) Threshold Level (pCi/L)
Suite	**Radionuclides (pCi/L)**				
A	Cobalt-60	GL-RAD-A-013 Rev 9	12	100	25
A	Cesium-134	GL-RAD-A-013 Rev 9	7	80	14
A	Cesium-137	GL-RAD-A-013 Rev 9	7	200	15
A	Niobium-94	GL-RAD-A-013 Rev 9	25	NA	50
A	Antimony-125	GL-RAD-A-013 Rev 9	25	300	50
A	Europium-152	GL-RAD-A-013 Rev 9	25	200	50
A	Europium-154	GL-RAD-A-013 Rev 9	25	60	50
A	Europium-155	GL-RAD-A-013 Rev 9	25	600	50
A	Silver-108m	GL-RAD-A-013 Rev 9	25	NA	50
B	Tritium	GL-RAD-A-002 Rev 9	500	20000	NA
B	Gross alpha/beta	GL-RAD-A-001	20	NA	NA
C	Strontium-90	GL-RAD-A-004 Rev 8	1	8	3
C	Carbon-14	GL-RAD-A-003 Rev 6	100	2000	200
C	Iron-55	GL-RAD-A-040 Rev 0	12	2000	25
C	Nickle-63	GL-RAD-A-022 Rev 6	7	50	15
C	Technicium-99	GL-RAD-A-005 Rev 11	7	900	15
D	Americium-241	GL-RAD-A-042 Rev 2	0.25	15	0.5
D	Plutonium-238	GL-RAD-A-042 Rev 2	0.25	15	0.5
D	Plutonium-239	GL-RAD-A-042 Rev 2	0.25	15	0.5
D	Plutonium-240	GL-RAD-A-042 Rev 2	0.25	15	0.5
D	Plutonium-241	GL-RAD-A-035 Rev 4	7	300	15
D	Curium-242	GL-RAD-A-042 Rev 2	0.25	15	NA
D	Curium-243	GL-RAD-A-042 Rev 2	0.25	15	0.5
D	Curium-244	GL-RAD-A-042 Rev 2	0.25	15	0.5

Notes:
NA - Not Available
MDC - Minimum Dectction Concentration
MCL Maximum Contaminant Level
GEL - General Engineering Laboratory - Contract laboratory for LTP groundwater program
(1) NRC License Amendment No. 158

Table 3-5
Summary of Laboratory Analytical Program for Spring, Summer, and Fall 2006 Quarterly Groundwater Sampling

Yankee Nuclear Power Station, Rowe, Massachusetts

	Spring 2006				Summer 2006				Fall 2006			
Analytical Suite	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Well ID												
CB-3	X	X	X	X	X	X			X	X	X	X
CB-4	X	X	X	X	X	X			X	X	X	X
CB-6	X	X	X	X	X	X	X	X	X	X	X	X
CB-8	X	X	X	X	X	X			X	X	X	X
CW-10	X	X	X	X	X	X			X	X	X	X
CFW-1	X	X	X	X	X	X			X	X	X	X
CFW-5	X	X	X	X	X	X			X	X	X	X
CFW-6	X	X	X	X	X	X			X	X	X	X
MW-100A	X	X	X	X	X	X			X	X	X	X
MW-100B	X	X	X	X	X	X			X	X	X	X
MW-101A	X	X	X	X	X	X	X	X	X	X	X	X
MW-101B	X	X	X	X	X	X			X	X	X	X
MW-101C					X	X	X	X	X	X	X	X
MW-102A	X	X	X	X	X	X	X	X	X	X	X	X
MW-102B	X	X	X	X	X	X			X	X	X	X
MW-102C	X	X	X	X	X	X	X	X	X	X	X	X
MW-102D	X	X	X	X	X	X	X	X	X	X	X	X
MW-103A	X	X	X	X	X	X			X	X	X	X
MW-103B	X	X	X	X	X	X			X	X	X	X
MW-103C	X	X	X	X	X	X			X	X	X	X
MW-104A	X	X	X	X	X	X	X	X	X	X	X	X
MW-104B	X	X	X	X	X	X			X	X	X	X
MW-104C	X	X	X	X	X	X	X	X	X	X	X	X
MW-105A	X	X	X	X	X	X			X	X	X	X
MW-105B	X	X	X	X	X	X	X	X	X	X	X	X
MW-105C	X	X	X	X	X	X			X	X	X	X
MW-106A	X	X	X	X	X	X	X	X	X	X	X	X
MW-106B	X	X	X	X	X	X			X	X	X	X
MW-106C	X	X	X	X	X	X			X	X	X	X
MW-106D	X	X	X	X	X	X			X	X	X	X
MW-107A	X	X	X	X	X	X	X	X	X	X	X	X
MW-107B	X	X	X	X	X	X			X	X	X	X
MW-107C	X	X	X	X	X	X	X	X	X	X	X	X
MW-107D	X	X	X	X	X	X	X	X	X	X	X	X
MW-107E					X	X	X	X	X	X	X	X
MW-107F					X	X	X	X	X	X	X	X
MW-108A	X	X	X	X	X	X			X	X	X	X
MW-108B	X	X	X	X	X	X			X	X	X	X
MW-108C	X	X	X	X	X	X			X	X	X	X
MW-109A	X	X	X	X	X	X			X	X	X	X
MW-109B	X	X	X	X	X	X			X	X	X	X
MW-109C	X	X	X	X	X	X			X	X	X	X

Table 3-5
Summary of Laboratory Analytical Program for Spring, Summer, and Fall 2006 Quarterly Groundwater Sampling

Yankee Nuclear Power Station, Rowe, Massachusetts

	Spring 2006				Summer 2006				Fall 2006			
Analytical Suite	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
Well ID												
MW-109D	X	X	X	X	X	X			X	X	X	X
MW-110A	X	X	X	X	X	X	X	X	X	X	X	X
MW-110B	X	X	X	X	X	X			X	X	X	X
MW-110C	X	X	X	X	X	X			X	X	X	X
MW-110D	X	X	X	X	X	X			X	X	X	X
MW-111A	X	X	X	X	X	X	X	X	X	X	X	X
MW-111B	X	X	X	X	X	X			X	X	X	X
MW-111C	X	X	X	X	X	X			X	X	X	X
MW-113A					X	X	X	X	X	X	X	X
MW-113C					X	X	X	X	X	X	X	X
SP-1	X	X	X	X	X	X			X	X	X	X
Plant Water Well	X	X	X	X	X	X			X	X	X	X
Furlon House Water Well	X	X	X	X	X	X			X	X	X	X

Figures

Yankee Nuclear Power Station
Rowe, Massachusetts

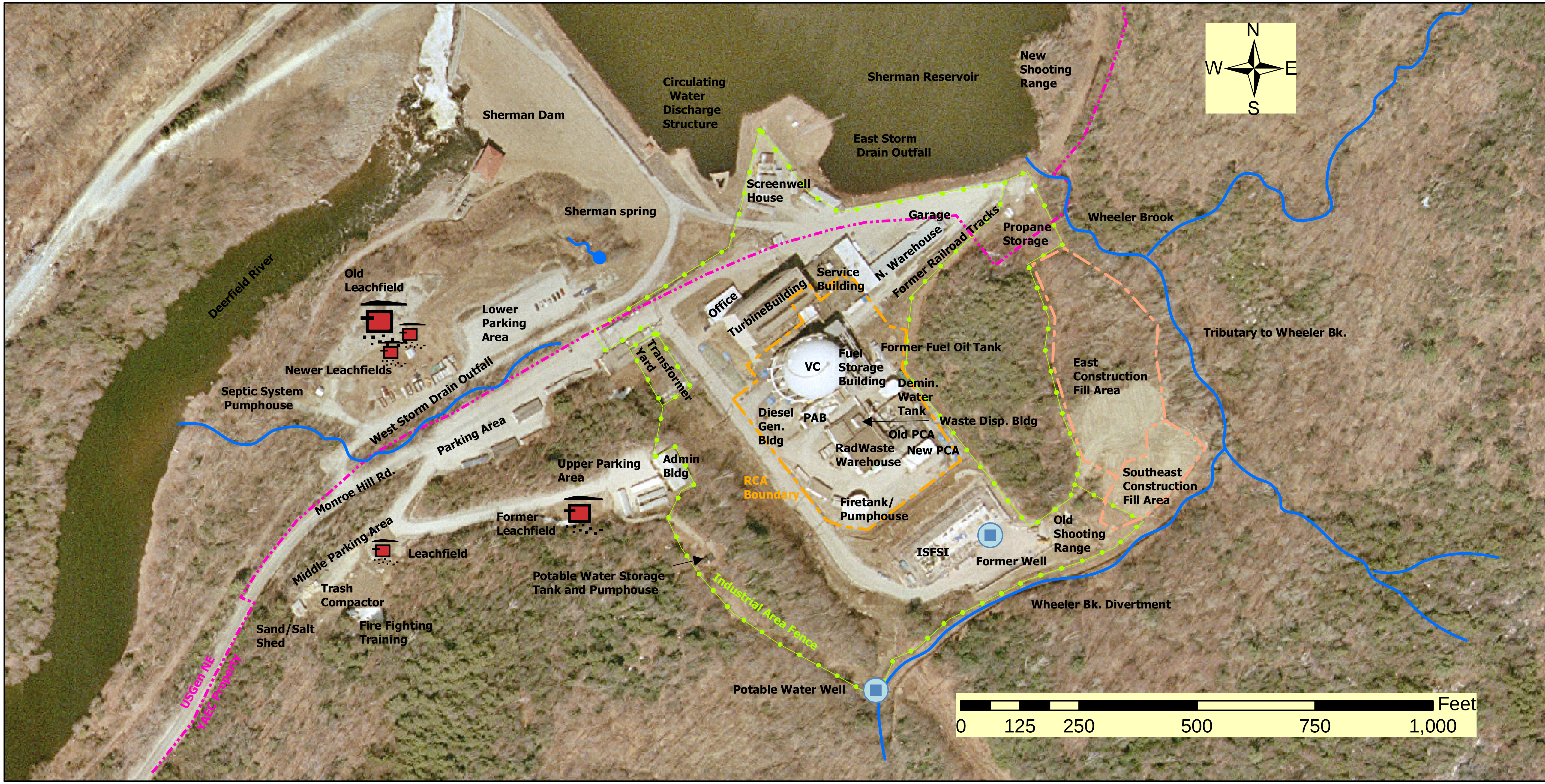
Aerial photos taken 4/15/97

6/9/06

Current 10 CFR Part 50
Licensed Site Boundary

Source: FSAR Figure 300-2

Figure 1-1



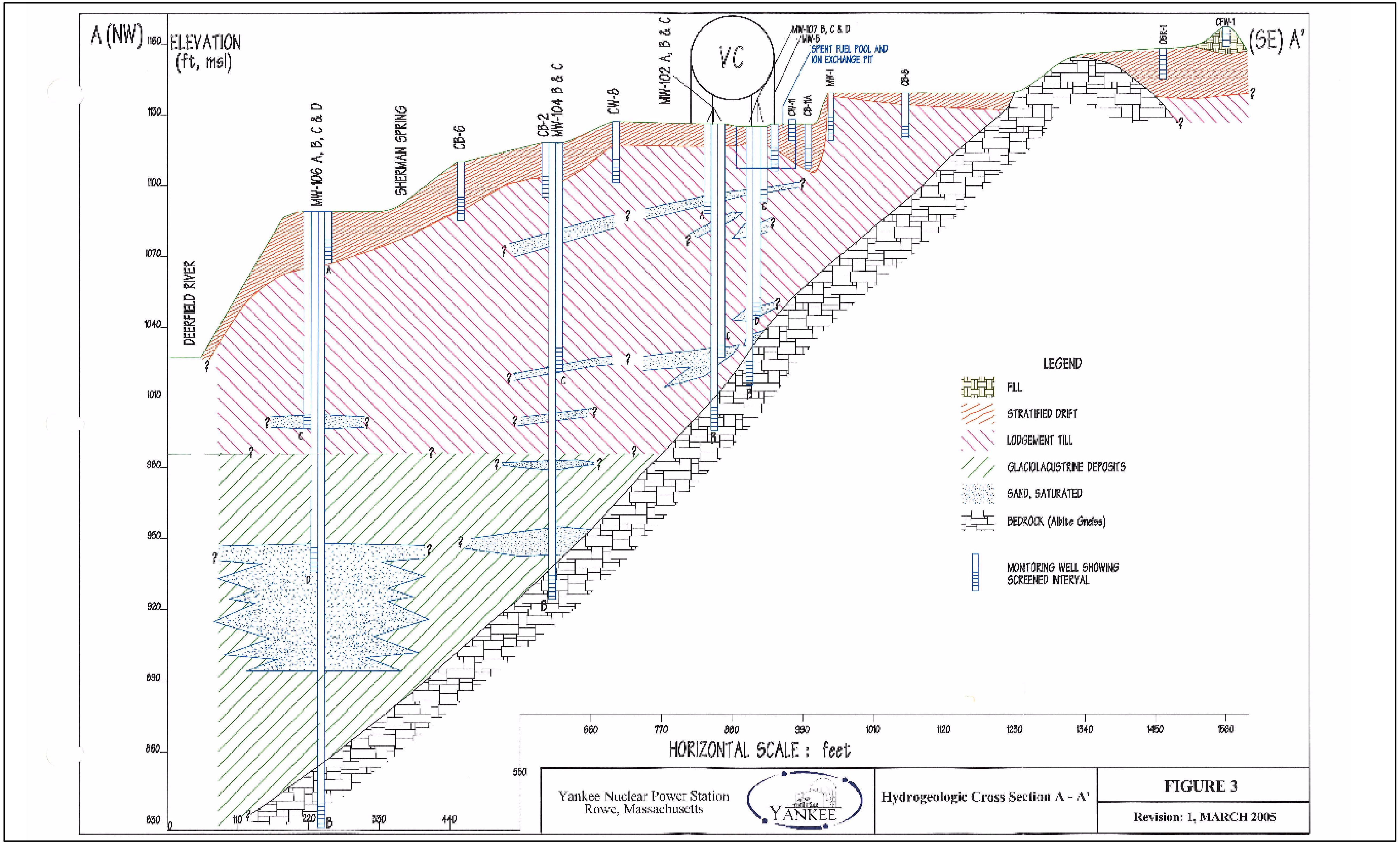
Yankee Nuclear Power Station
Rowe, Massachusetts

Aerial photos taken 4/15/97

YNPS Plant Site Map

6/8/06

Figure 2-1



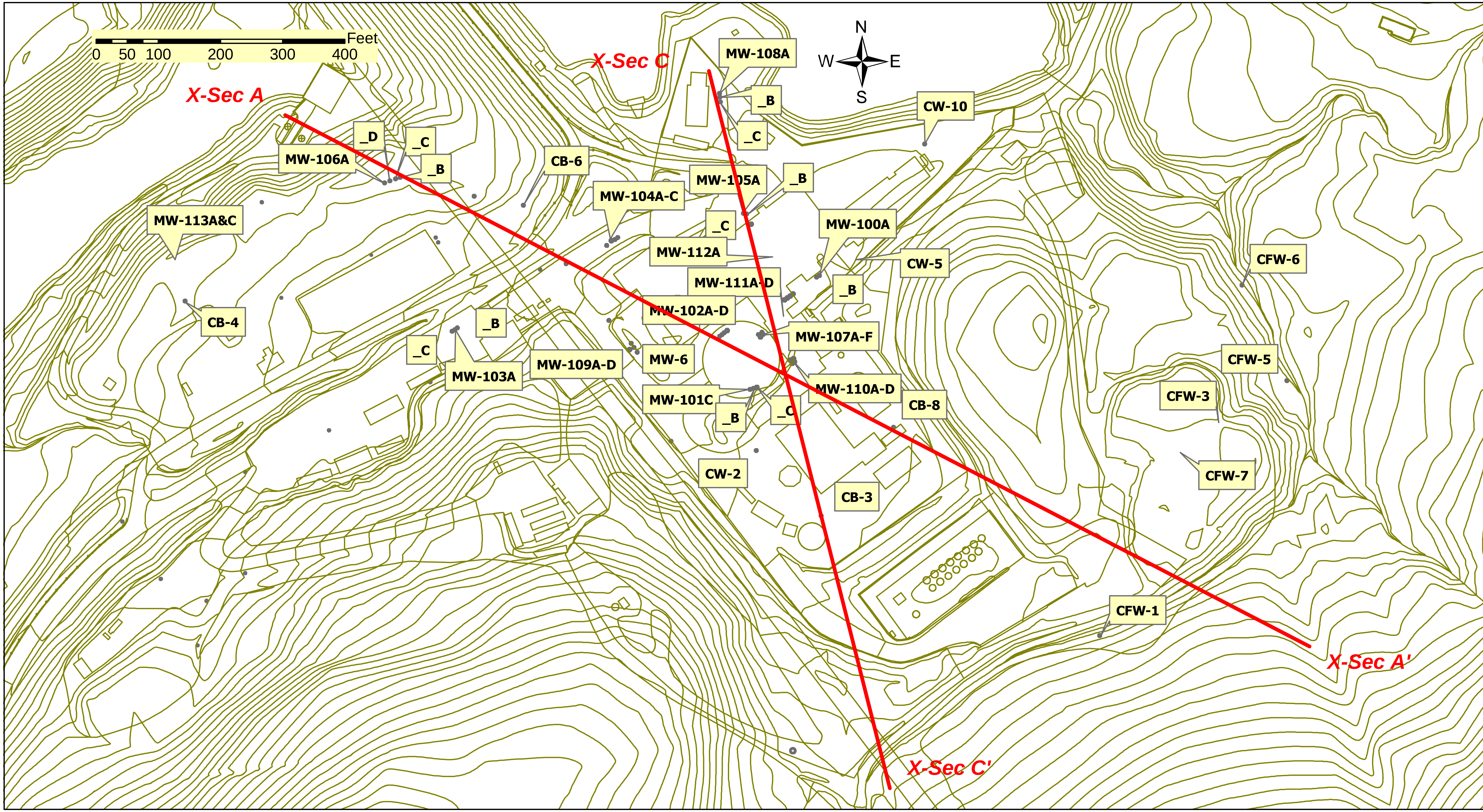
Yankee Nuclear Power Station
Rowe, Massachusetts

Geologic Cross Section A-A'

6/1/06

Source: YA-REPT-00-010-05

Figure 3-1

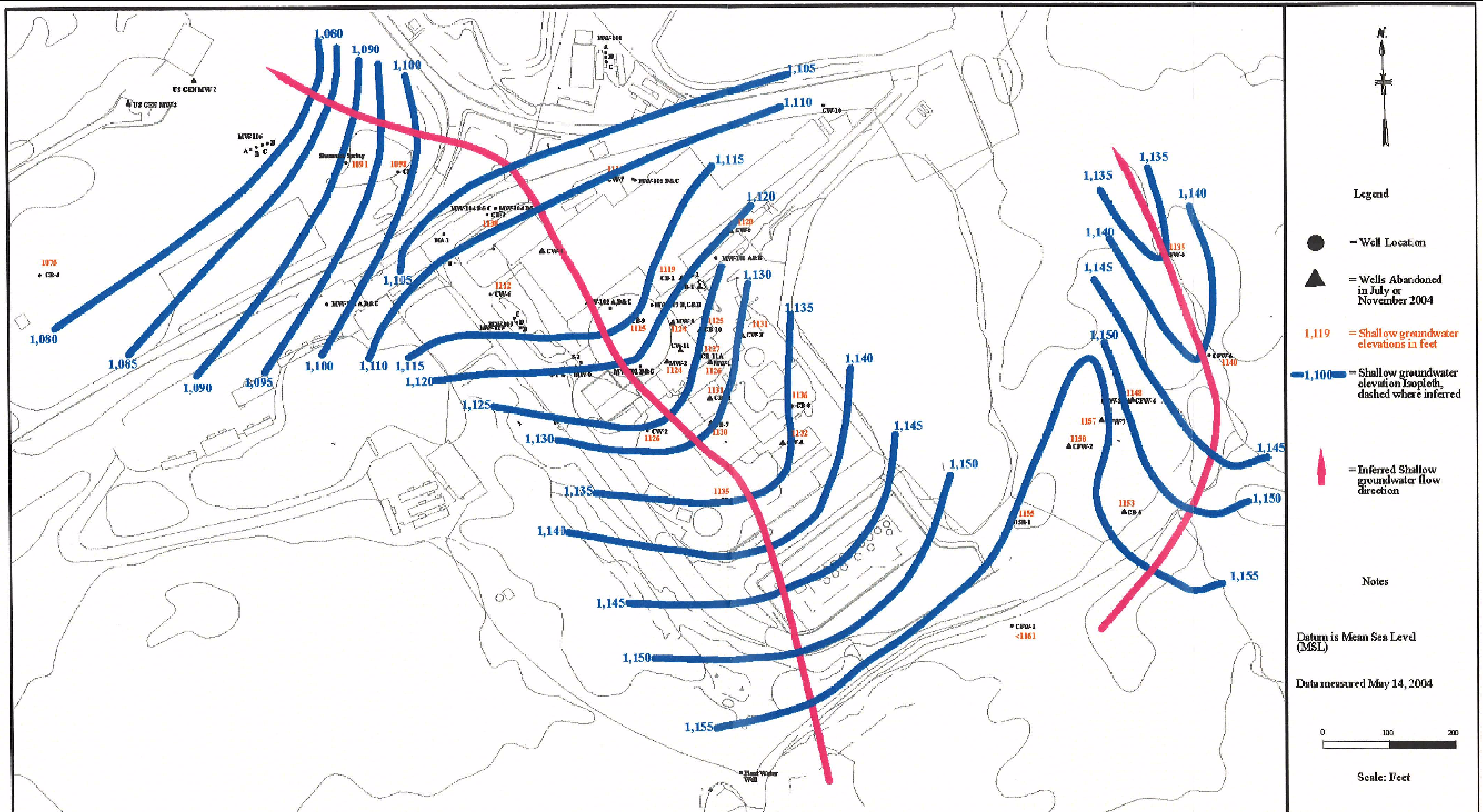


Yankee Nuclear Power Station
Rowe, Massachusetts

Plan View with X-Section Locations

6/1/06

Figure 3-2



Yankee Nuclear Power Station Rowe, Massachusetts	Ground Water Elevation in Shallow Aquifer May 14, 2004	Revision: 1, JAN 2005	Figure 21

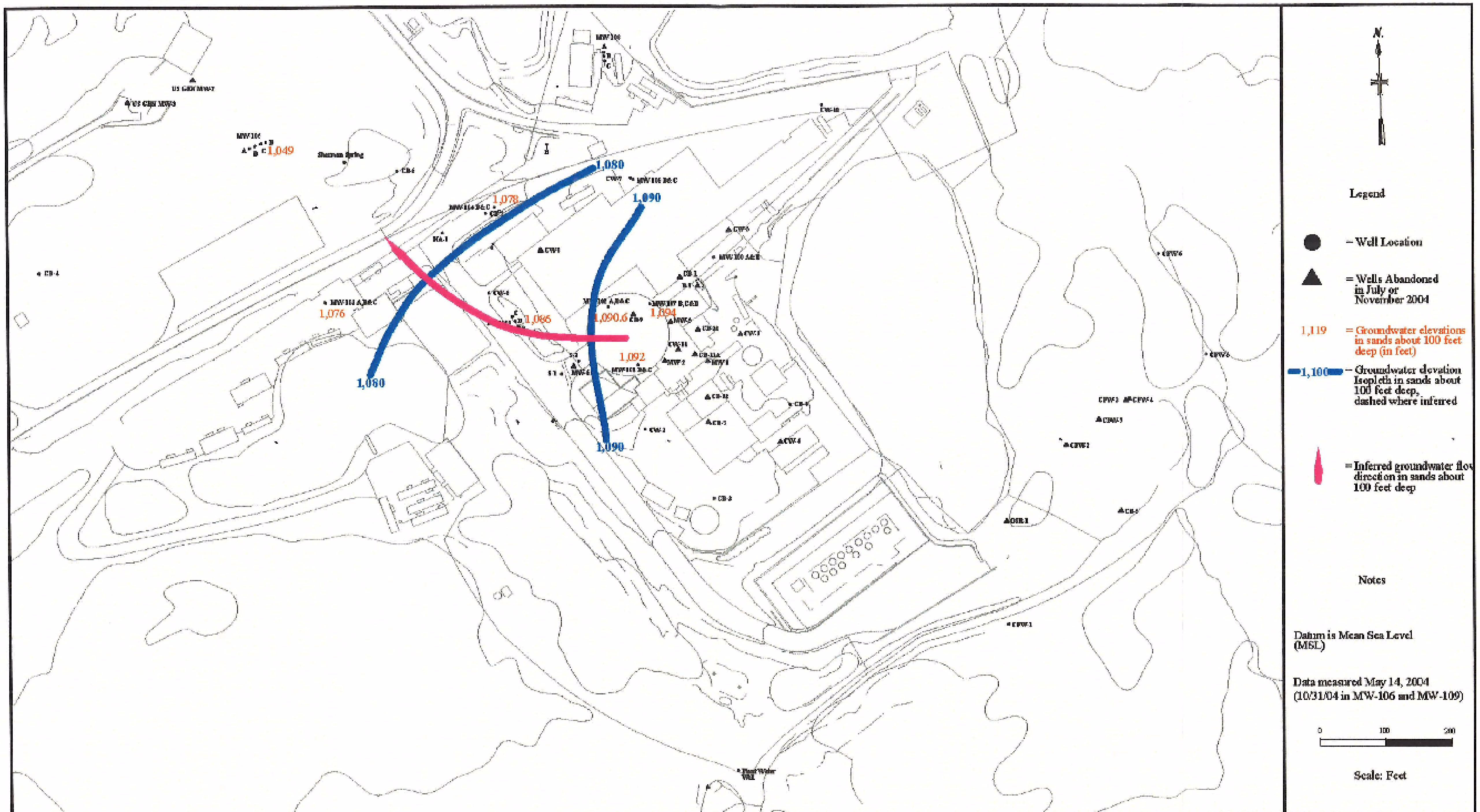
Yankee Nuclear Power Station
Rowe, Massachusetts

Inferred water elevation contours in shallow unconfined aquifer, YNPS, May 14, 2004

6/1/06

Source: ERM Phase II Report, 1/28/05

Figure 3-3



Yankee Nuclear Power Station Rowe, Massachusetts	Ground Water Elevation In Sands About 100 Feet Deep May 14, 2004	Revision: 1, JAN 2005	Figure 22

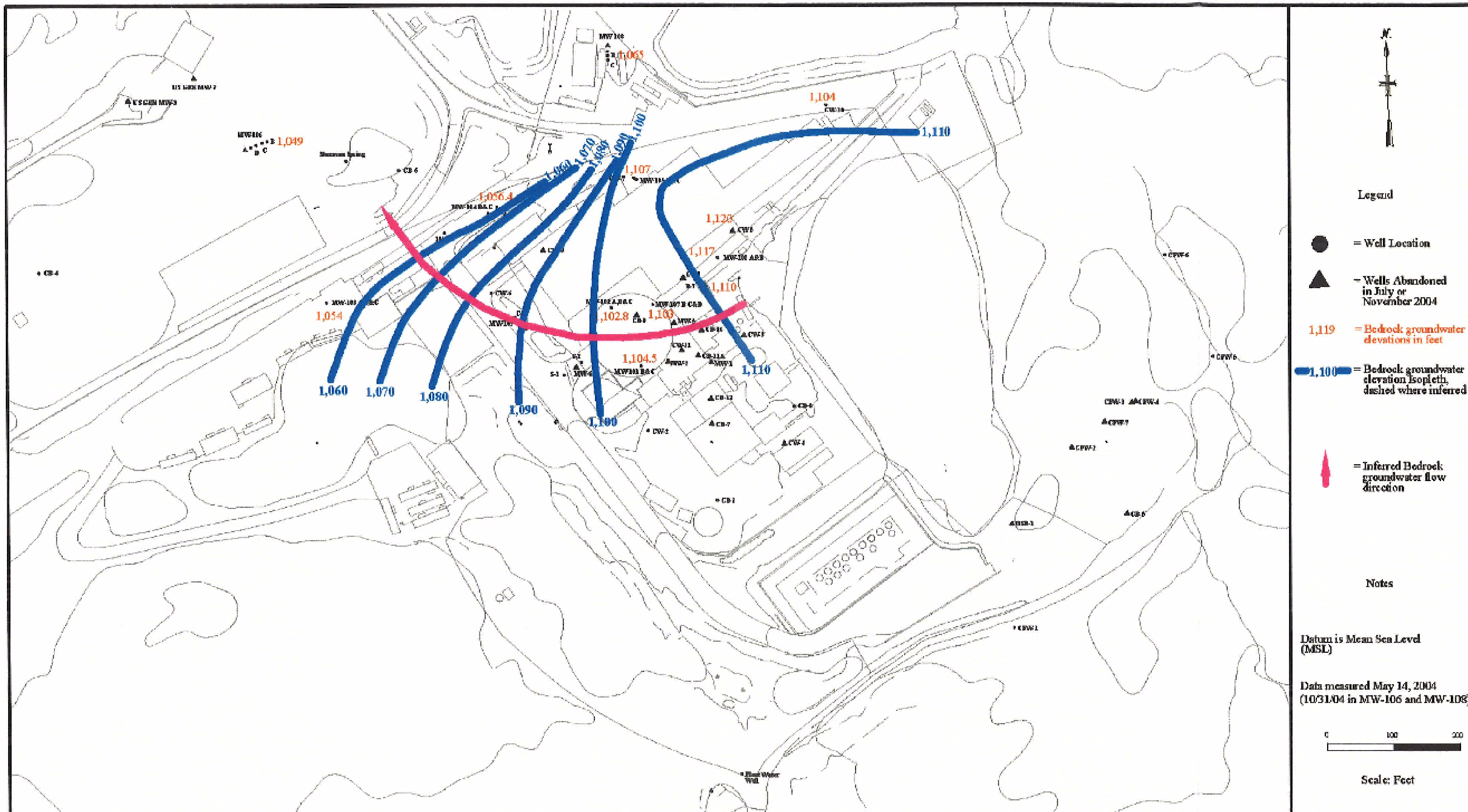
Yankee Nuclear Power Station
Rowe, Massachusetts

Inferred water elevation contours in sands 30 to 100 feet, YNPS, May 14, 2004

6/1/06

Source: ERM Phase II Report, 1/28/05

Figure 3-4



Yankee Nuclear Power Station Rowe, Massachusetts	Ground Water Elevations in the Bedrock Aquifer May 14, 2004	Revision: 1, JAN 2005	Figure 23

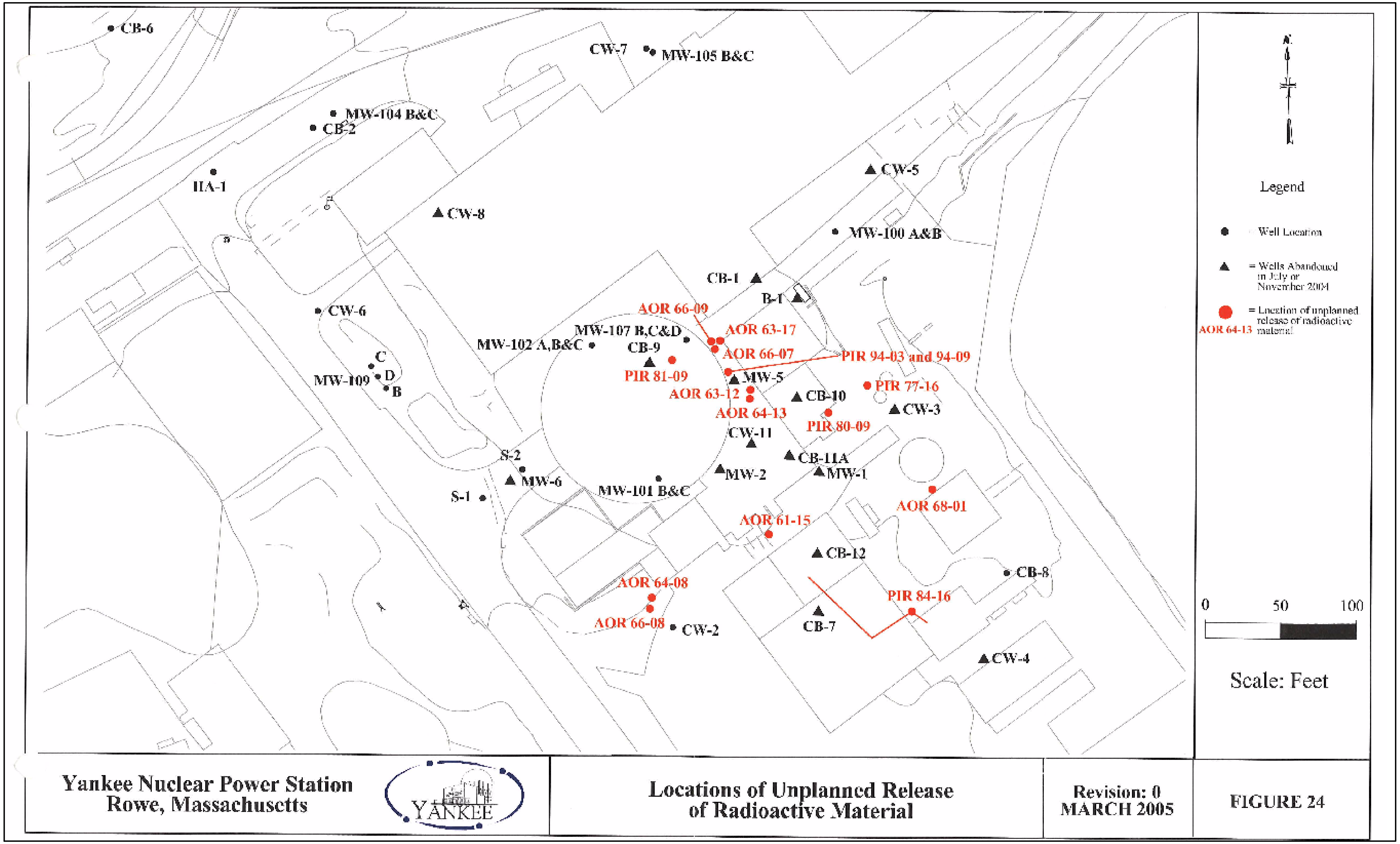
Yankee Nuclear Power Station
Rowe, Massachusetts

Inferred water elevation contours in bedrock, YNPS, May 14, 2004

6/1/06

Source: ERM Phase II Report, 1/28/05

Figure 3-5



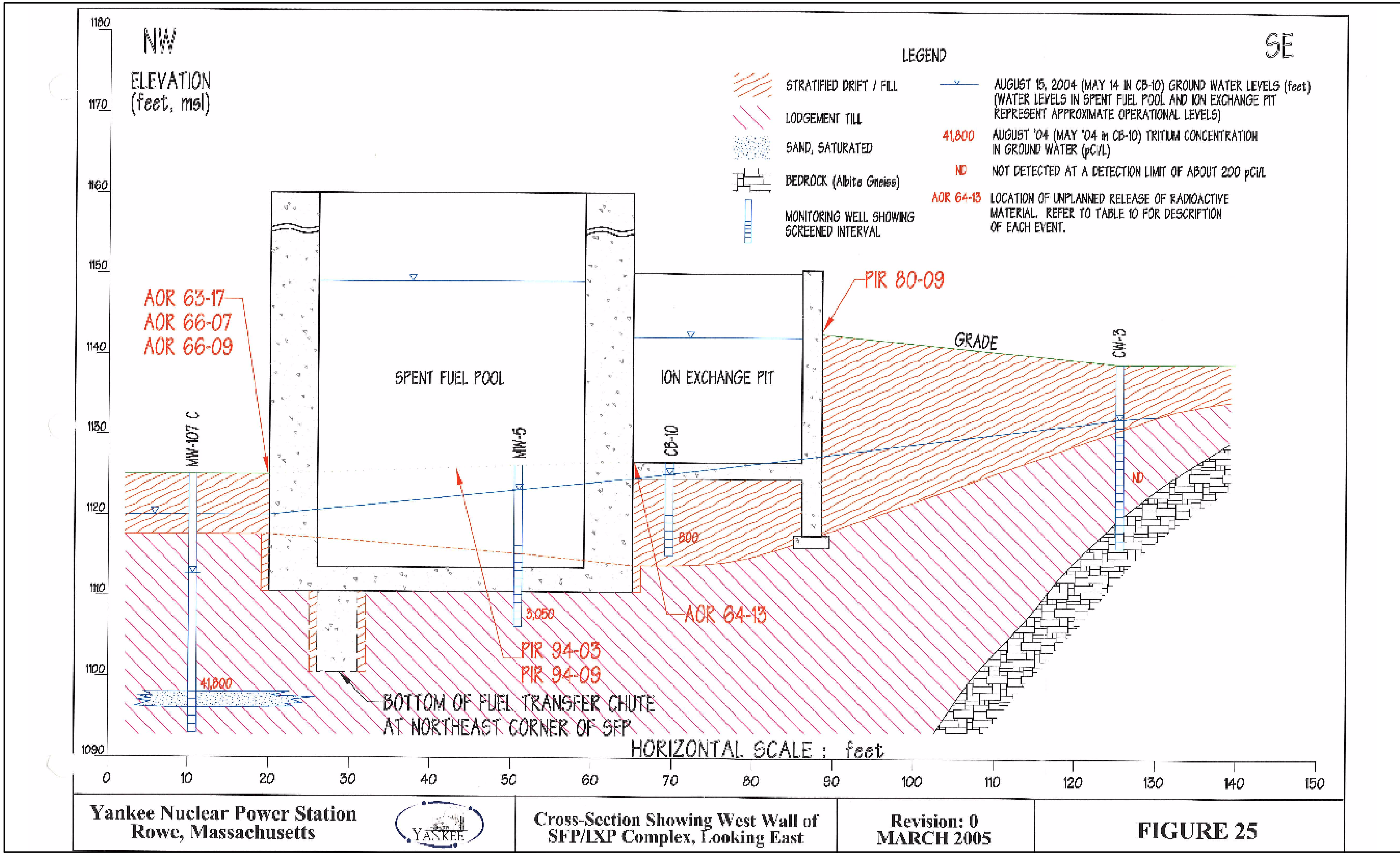
Yankee Nuclear Power Station
Rowe, Massachusetts

Location of Unplanned Release of Radioactive Material

6/1/06

Source: YA-REPT-00-010-05

Figure 3-6



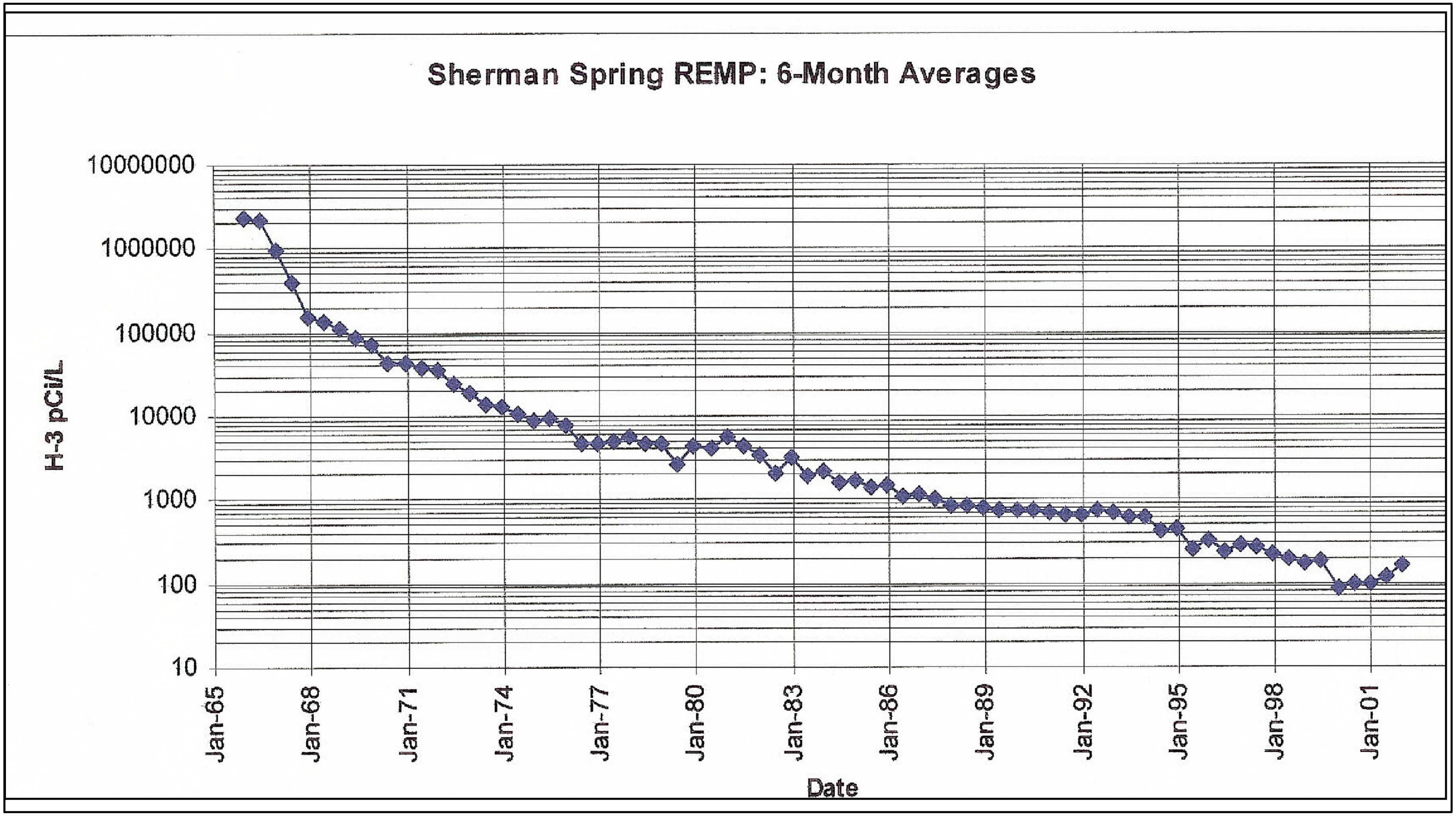
Yankee Nuclear Power Station
Rowe, Massachusetts

Cross-Section Showing the West Wall of the SPF/IXP Complex, Looking East

6/1/06

Source: YA-REPT-00-010-05

Figure 3-7



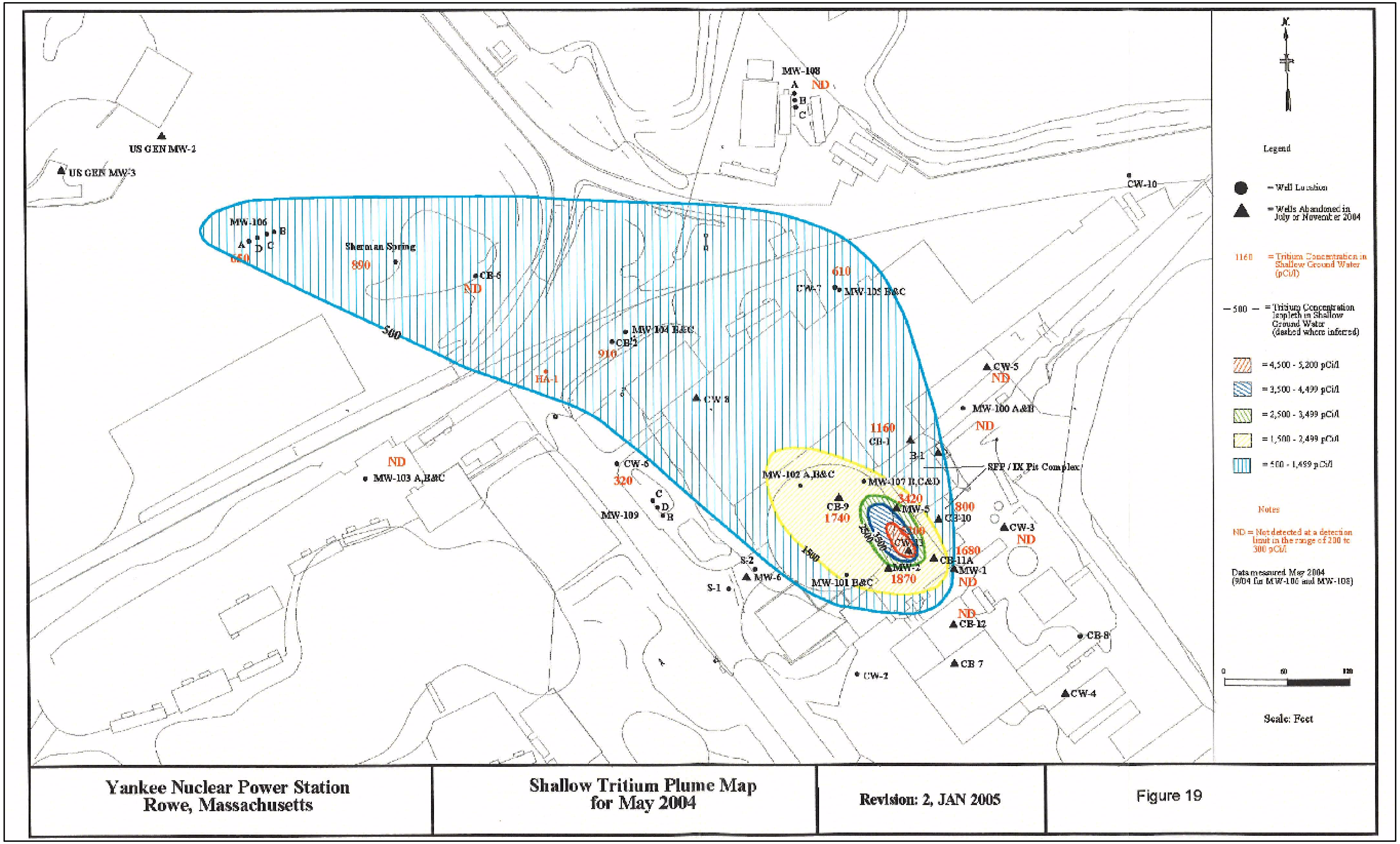
Yankee Nuclear Power Station Rowe, Massachusetts

Tritium in Sherman Spring 1965 through 2001

6/9/06

Source: DESD-TD-YR-02-001 Rev.0, Attachment 2, Page 2

Figure 3-8



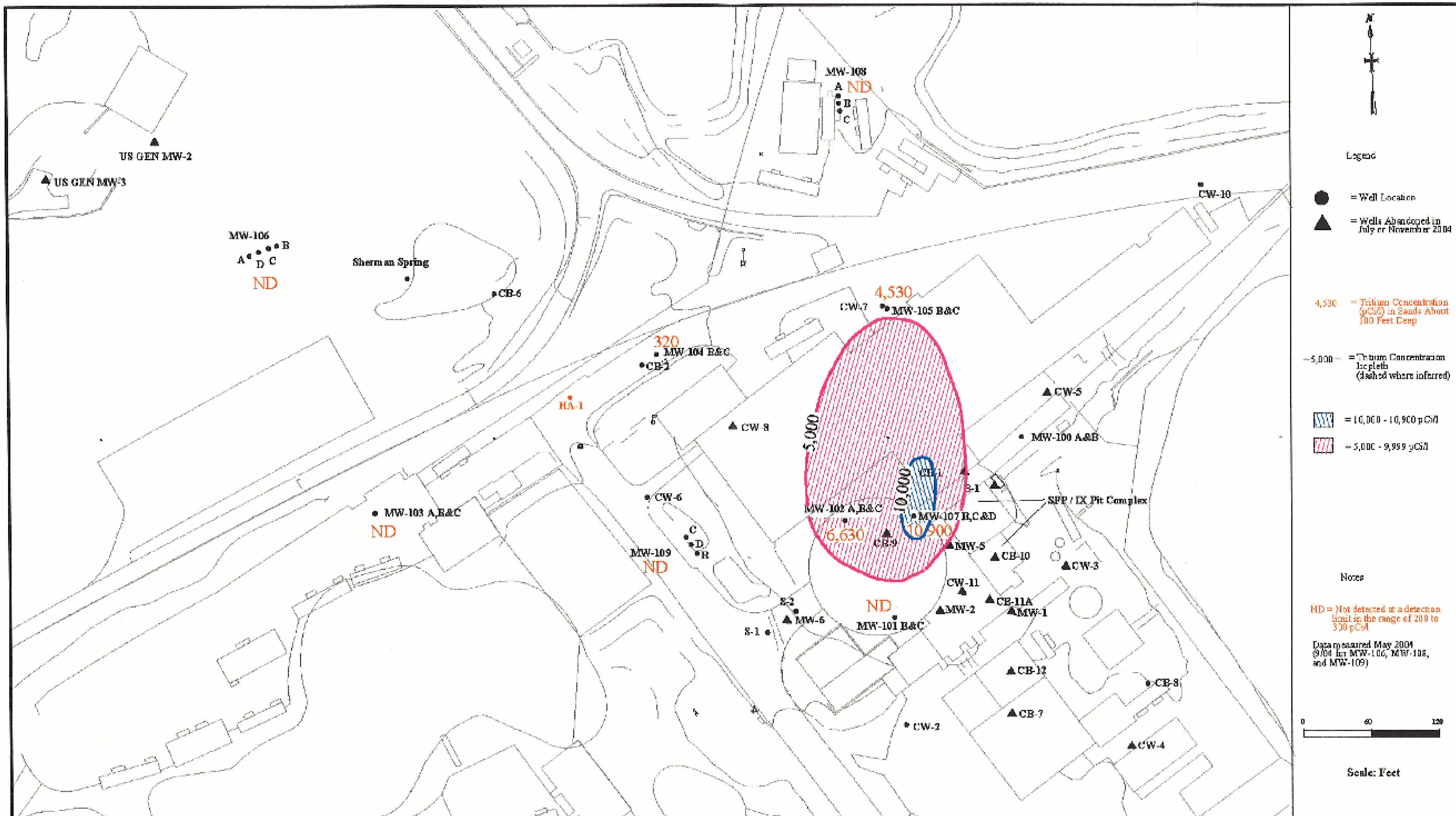
Yankee Nuclear Power Station
Rowe, Massachusetts

Shallow Tritium Plume Map for May 2004

6/1/06

Source: ERM Phase II Report, 1/28/05

Figure 3-9



Yankee Nuclear Power Station Rowe, Massachusetts	Tritium Plume in Sands About 100 Feet Deep May 2004	Revision: 2, JAN 2005	Figure 20

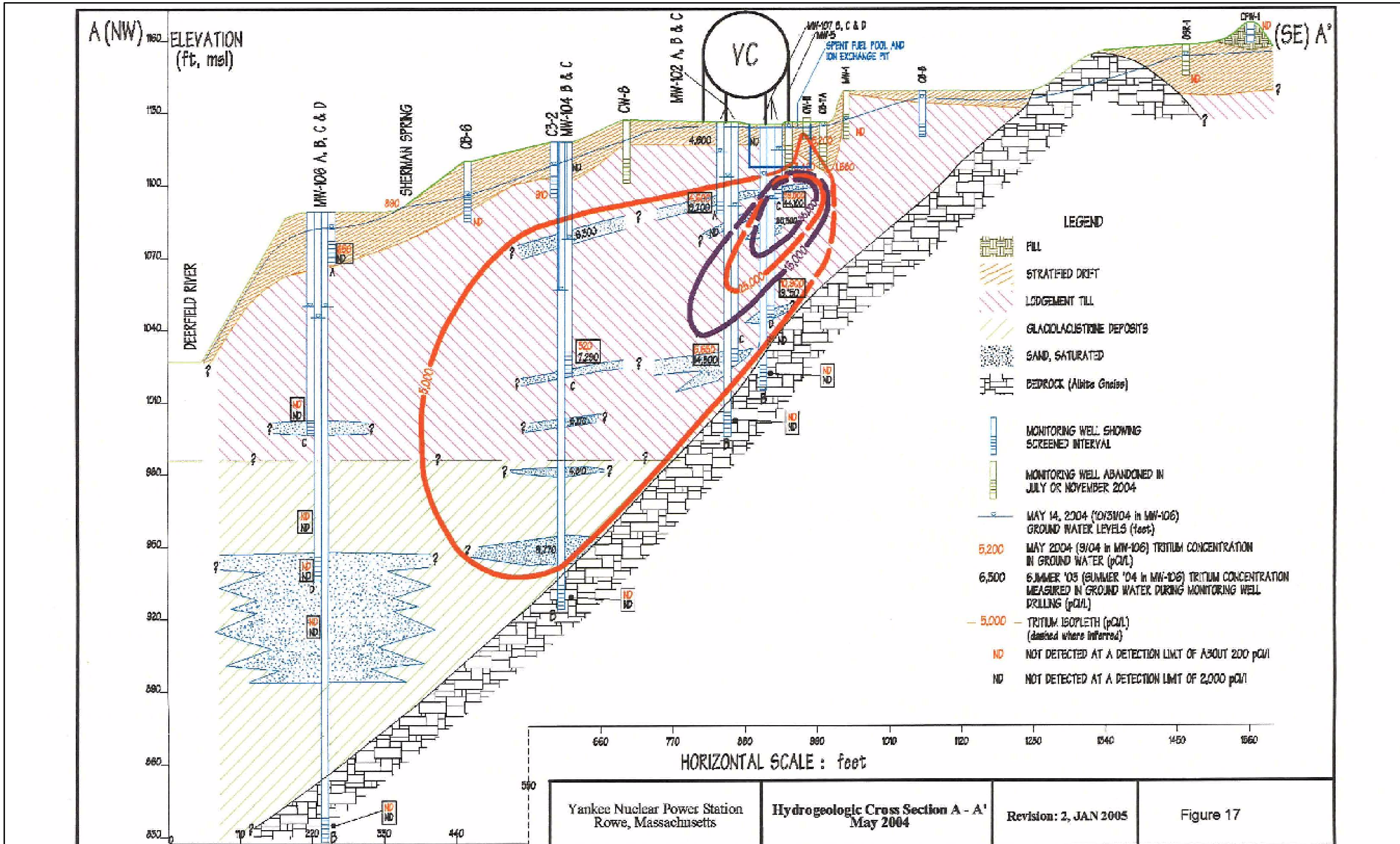
Yankee Nuclear Power Station
Rowe, Massachusetts

Tritium Plume in Sands
About 100 feet Deep
May 2004

6/1/06

Source: ERM Phase II Report, 1/28/05

Figure 3-10



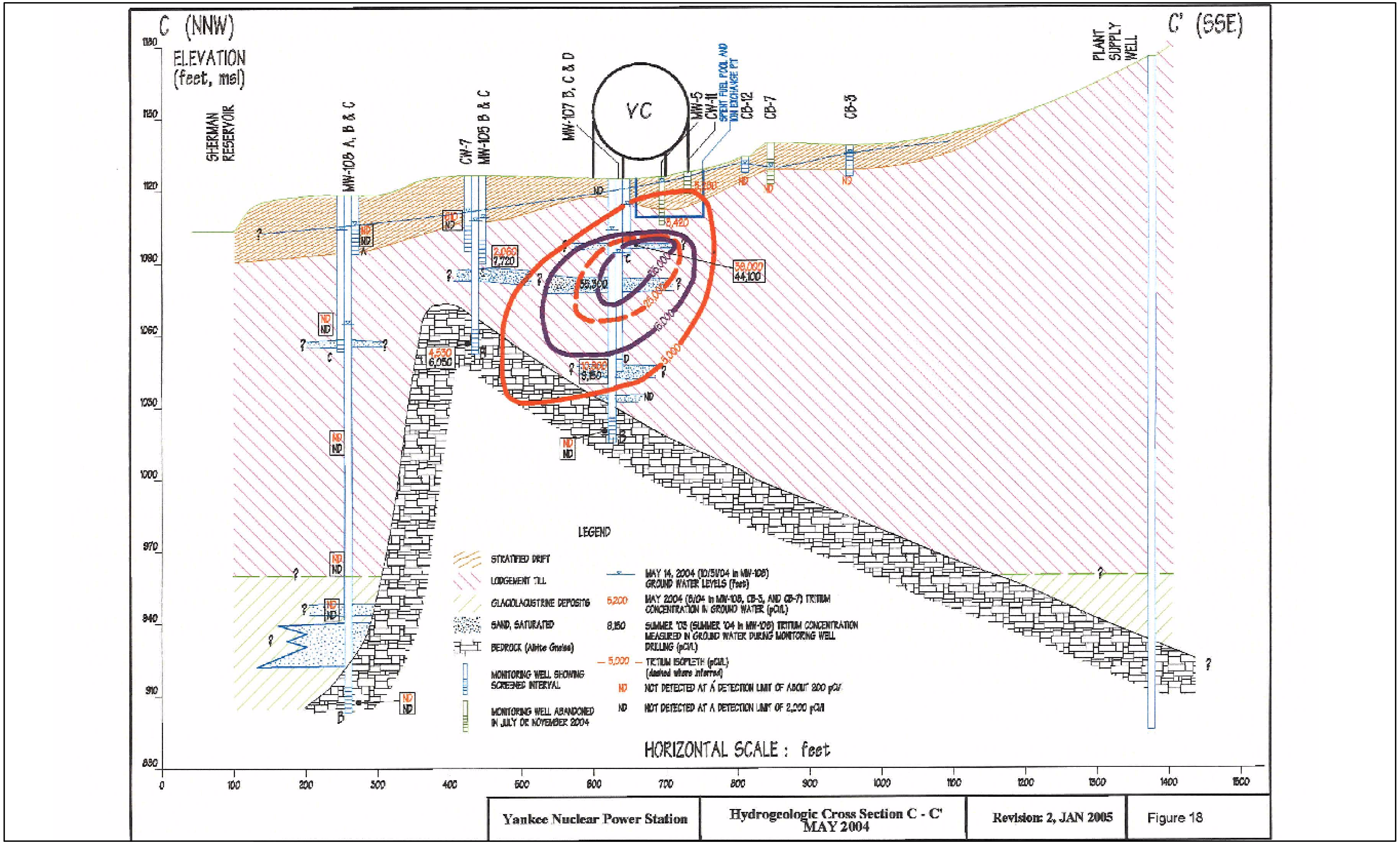
Yankee Nuclear Power Station
Rowe, Massachusetts

Hydrogeologic Cross-Section A-A' with Tritium During 2004

6/1/06

Source: ERM Phase II Report, 1/28/05

Figure 3-11



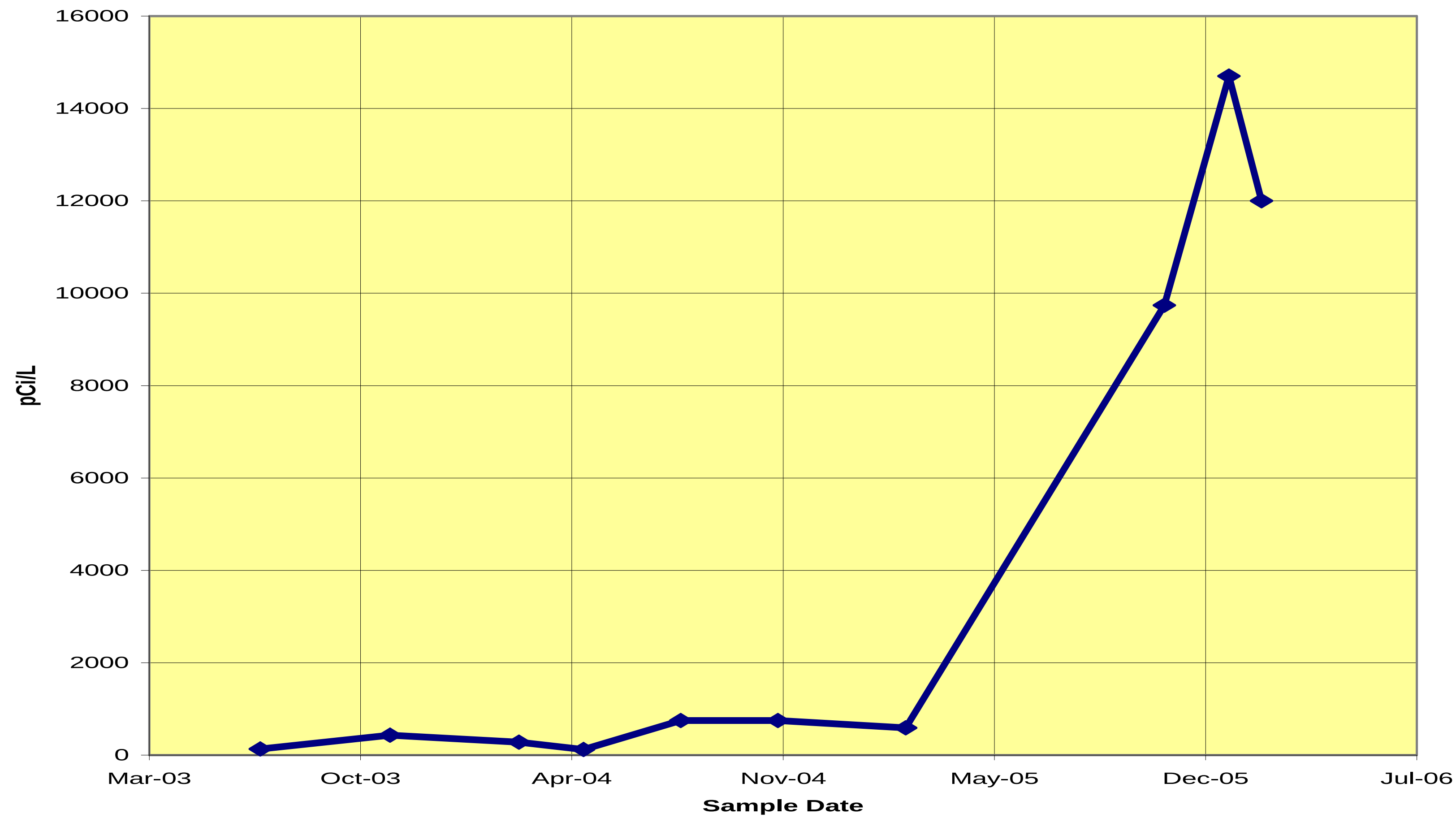
Yankee Nuclear Power Station
Rowe, Massachusetts

Hydrogeologic Cross-Section C-C' with Tritium During 2004

6/1/06

Source: ERM Phase II Report, 1/28/05

Figure 3-12

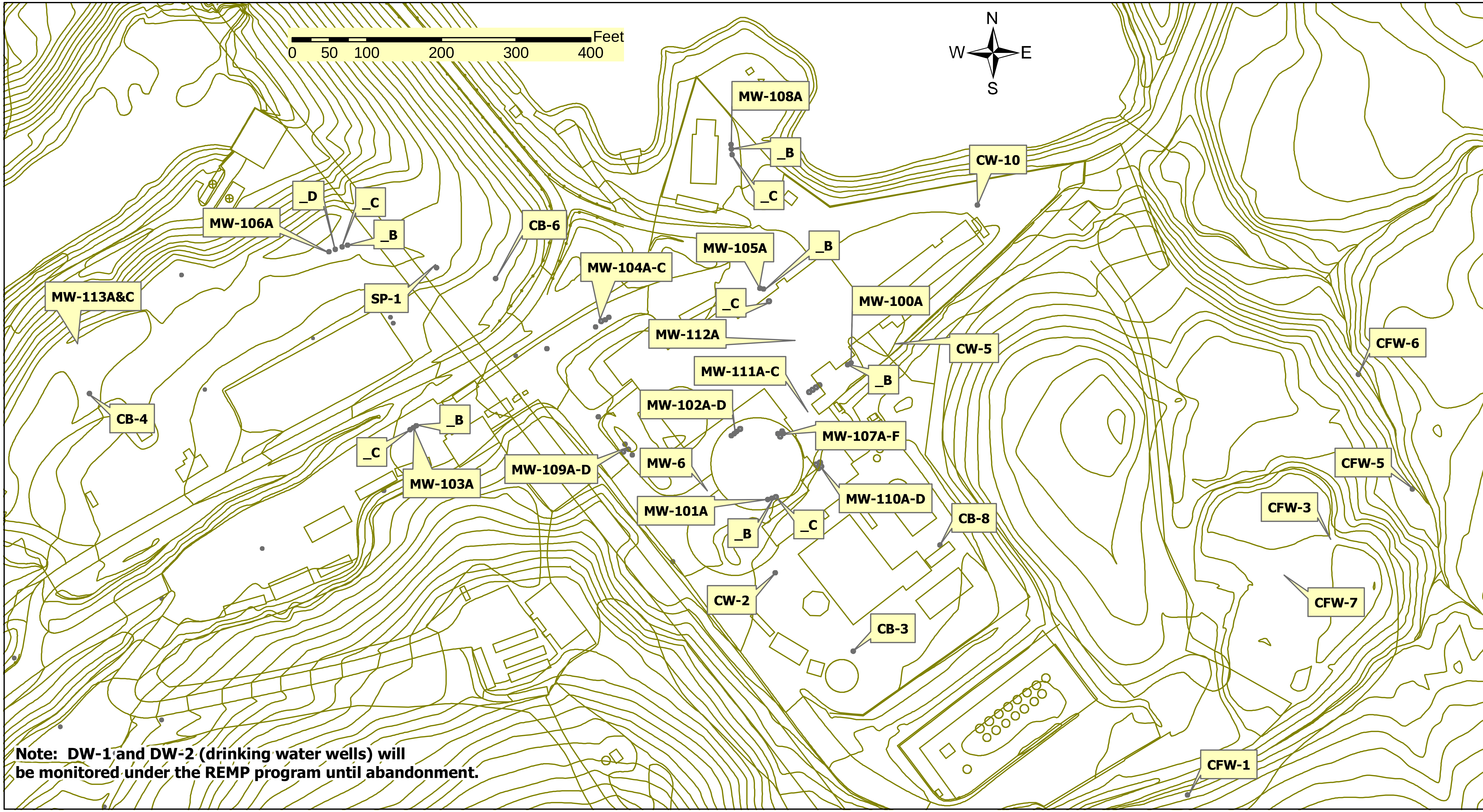


Yankee Nuclear Power Station Rowe, Massachusetts

Tritium Concentration in CB-6

6/1/06

Figure 3-13



Yankee Nuclear Power Station
Rowe, Massachusetts

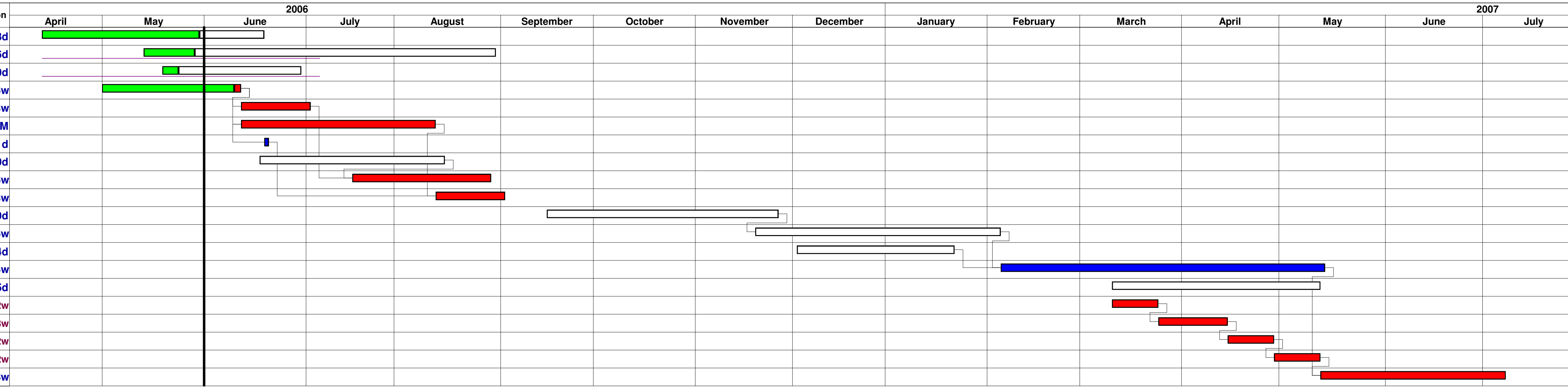
Monitoring Well Locations

6/1/06

Figure 3-14

Figure 4-1 License Termination Groundwater Monitoring Schedule

#	Task Name	Duration
1	Spring 2006 Quarterly Sampling	48d
5	Develop 3-D Groundwater Fate and Transport Model	76d
14	Develop Geologic and Chemistry Database	30d
18	Develop and submit Monitoring Plan to NRC	6w
19	Execute Final Characterization Plan after YAEC approval	3w
20	NRC Review of monitoring plan	2M
21	Meeting or Conference Call with NRC on Plan	1d
22	Summer 2006 Sampling	40d
26	2006 Supplemental Hydrogeologic Report	6w
27	Finalize Monitoring Plan after NRC comments	3w
29	Fall 2006 Sampling	50d
34	Final Groundwater Condition Summary Report	10.6w
37	Winter 2006 Sampling	34d
41	NRC Review of 2nd Half 2006 Monitoring Report	14w
42	Complete Supplemental Sampling	45d
43	Field Sampling	2w
44	Lab Analysis	3w
45	Data Validation	2w
46	Supplemental Groundwater Monitoring Report	2w
47	NRC Review of Supplemental Report and Release of LTP	8w



Default

Complete | Complete Milestone | Remaining | Remaining Milestone | Delay | Non-Resource | Baseline 1

Critical

Remaining | Remaining Milestone

6/1/06

Attachment 1
Final Aquifer Characterization of the YNPS Rowe Decommissioning Site

(Provided on enclosed CD)

Final Aquifer Characterization at the YNPS Rowe Decommissioning Site

The following assessment identifies data quality objectives (DQOs) for aquifer testing among the following monitoring wells at the YNPS site: MW-107C; MW-107D; MW-107E; MW-107F; MW-103C; MW-106C; MW-106D; MW-106B; MW-105B; MW-105C; MW-109C, MW-109D, MW-104B; and MW-104C. These wells are monitoring wells in geologic formations where it is important to estimate the hydraulic conductivity and connectivity with surrounding monitoring wells. This information is needed as part of the final fate and transport assessment for contaminants remaining in the groundwater at the site.

1. ***The Problem:*** The site stratigraphy consists of relatively permeable glaciofluvial deposits in the top 10 to 30 feet, underlain by glacial till that is quite thick in places and contains disseminated sand lenses; underlain by glaciolacustrine deposits that is locally quite thick with sand lenses. Total site soil thickness exceeds 260 feet in places. In addition to historical contamination within the glaciofluvial deposits of the "Sherman Spring" by tritium dating back to 1965, significantly elevated and sustained tritium concentrations have been observed in deep soils under the site and along the east side of the Deerfield River as part of decommissioning studies. The YNPS site has been explored with borings, seismic refraction studies, field mapping, and groundwater monitoring. The first soil boring and seismic exploration was performed in 1956 as part of the plant design. Additional field mapping, seismic refraction, testpitting, and soil borings were done in the period 1977-82. Fifteen monitoring wells were installed in 1993-94, and twenty more wells were added in the period 1997-99. Two more monitoring wells were added in 2001. Most of these initial monitoring wells were screened within the water table aquifer that occurs in the glaciofluvial deposits. To characterize deeper sand lenses within till and glaciolacustrine soils beneath the glaciofluvial deposits, thirteen additional well clusters were added in the period 2003-2006.

   The pathways and rate of downward and lateral transport of tritium through the glacial till and glaciolacustrine deposits are not known. On the basis of several years of observation of tritium concentrations at MW-107C, the rate of movement and/or dilution appears to be low. However, it is not known whether sand lenses within the two lower soil units are extensive enough to permit transport among monitoring well locations. For example, can MW-107C communicate with MW-105C, and can MW-102C communicate with MW-104C? To complete the development of the conceptual model of the site, information is needed on both the connectivity across the site and the hydraulic conductivity of the permeable sand lenses within the till and glaciolacustrine units.

   A related question is whether the soil zone monitored by MW-107C, which has been above the tritium EPA MCL for several years, is capable of supplying the "resident farmer", as postulated in the LTP, with sufficient water (0.665 gallons per minute median demand on a sustained basis). A pumping test on this well (and any additional well where MCL exceedences are identified) is needed in order to address this issue.

2. ***What Decision is Required?*** The decisions that are required are what tests to perform and in which wells to perform them to develop quantitative parameters for hydraulic conductivity

and storativity, and qualitative information on the general interconnectivity through permeable sand lenses detected at various monitoring well locations.

3. ***Inputs to the Decision*:** The types of testing to be performed and locations of these tests should provide the following information and satisfy the following criteria:

   a. The tests should enable the estimate of hydraulic conductivity and storativity in the immediate vicinity of the monitoring well.
   b. The tests should not disturb the integrity of the monitoring wells for their continuing use for water quality monitoring. Therefore, the geochemistry of the groundwater in the vicinity of the well should not be altered (e.g., by the introduction of foreign water).
   c. Discharge from the pumping of wells must be containerized for proper disposal or routed by piping to licensed discharged points.
   d. Water level perturbations due to pumping in a given monitoring well should be measured in surrounding monitoring wells with data loggers capable of measuring small water elevation changes at frequent intervals.
   e. The following YNPS SOPs should be followed: DP-9745; DP-9746; and DP-9747.

4. ***The Boundaries of the Decision*:** The decisions as to which wells to pump and which wells to monitor are based on the subsurface geological conditions at the site, the historic distribution of tritium in the soil and groundwater, and on our need to characterize soil and rock hydraulic response in the general downgradient direction from the industrial area of the site where historical releases occurred.

5. ***Decision Rules*:** The following decision rules apply to locating wells to be pumped and wells requiring water level monitoring during pumping of specified wells:
   a. The wells to be pumped must lie within 200 feet of a line between MW-107 and MW-106 where historical plant-derived tritium has generally been found.
   b. Wells located in the upper glaciofluvial deposit will be neither pumped nor monitored.
   c. The pumping period or water level perturbation range must be large enough to enable the calculation of hydraulic parameters and long enough to determine whether a local pocket of sand is being drained at a rate higher than the surrounding soil can recharge it to maintain the water level in the well.
   d. The well pump must be capable of operating below the normal limit of vacuum-operated pumps and have sufficient piping to be set up to 200 feet deep in the well.
   e. When a well of one cluster is pumped, all other levels except the A-level well (glaciofluvial deposit) will be monitored for water level change. As many as four other clusters of monitoring wells (one upgradient, one downgradient and one on each side-gradient) will be monitored of those wells in closest proximity.
   f. Water level measurement tolerance in monitored wells will be 0.01’. Water level measurement tolerance in pumped wells will be 0.1’.
   g. MW-107C and MW-107E or -F will each be pumped 24 hours, with a 24-hour recovery measurement period.

h. The rate of discharge from the pump shall be determined by a method such as timed discharge into a container of known volume or measuring flow through a totalizer having sufficient range to measure the expected range of flow. Since pumping volumes are expected to be small, discharge measurements should be done to an accuracy of 0.05 gallons per minute.

i. Data loggers must be established in wells to be monitored for at least 12 hours in advance of a drawdown test in order to establish any earth tide effects, barometric effects, or measure any change in water levels due to recharge, recession, or Sherman reservoir level change. This should also permit time for the water levels to equilibrate to the water displacement caused by the installation of the data loggers.

j. Barometric pressure shall be recorded with a barograph during the entire period of any data logging in the monitoring wells and be accurate to 0.05" of mercury.

k. After placing pumps and data loggers in wells, sufficient time should be provided before the start of a test to permit water levels to equilibrate after the displacement of water from the installation of the equipment in the wells. Generally the change rate should have decreased to less than 0.01' per hour.

6. ***<u>The Design for Obtaining Data</u>:*** The locations of the wells to be pumped and monitored are shown on Figure 1 of this Attachment. There will be two separate procedures for conducting the drawdown tests: one for MW-107C and MW-107E of -F; and one for all other wells to be pumped. (The decision as to whether MW-107E or MW-107F will be pumped will be made after the installation of MW-107F and review of the geologic log and tritium concentrations in any encountered sand lenses.) MW-107C and MW-107E of -F will be pumped with a procedure designed to sustain a nearly constant rate of discharge for 24 hours without uncovering the pump or well screen, then allow a 24-hour recovery period. Selected wells within the study area will be designated as observation wells and outfitted with a self-contained pressure transducer/data logger (i.e., InSitu MiniTroll™) to support measurement of groundwater head within the glacial till, glaciolacustrine, and bedrock aquifers.

Electronically measured water level readings will be recorded at a 2-second linear sampling interval in all monitoring wells for the background monitoring period, pumping and recovery phases. The transducer in the pumping well should be programmed to record every 4 seconds. Manual water level readings will be collected periodically (at approximately one (1) hour intervals) to validate operability/accuracy of the data logger/pressure transducer units during the pumping period. An InSitu BaroTroll™ unit or equivalent should measure barometric pressure.

6.1 MW-107C and MW-107E/F Capacity Tests

<u>This test will consist of the following steps:</u>

a. <u>Background monitoring:</u> A baseline measurement for 12 hours prior to pumping will be made of groundwater heads in the well to be pumped and in surrounding monitoring wells to identify any rhythmic/non-rhythmic external influences (i.e., pumping, barometric changes, precipitation, and diurnal earth tide effects).

b. <u>Step-drawdown test:</u> This will measure the well performance characteristics such as well efficiency, drawdown, and specific capacity over a range of discharge rates, and permit the selection of an optimum pumping rate for the 24-hour test. A bladder-type of pump is probably best suited to this work.

c. <u>Constant-rate pumping test:</u> A twenty-four (24)-hour constant discharge-rate will be maintained in MW-107C and in MW-107E or -F, if possible, to evaluate of aquifer characteristics such as transmissivity, storage properties, and hydraulic influence. A bladder-type pump is probably best suited to this work, given the expected specific capacity of the well.

d. <u>Recovery period:</u> Groundwater head data will be collected for 24 hours after pumping to support the evaluation of aquifer properties and the determination as to whether the pumped aquifer zone was limited in recharge capability.

<u>Step Test</u>

The step-drawdown test will be performed by extracting groundwater at four different flow rates: 0.02 gpm; 0.1 gpm; 0.4 gpm and 0.8 gpm. In the event that drawdown approaches the higher of two feet over the top of the pump intake or two feet over the top of the well screen, the step test should be terminated and recovery readings taken for 4 hours. Each pumping period should last sixty (60) minutes, for a total test time of two hundred-forty (240) minutes.

The groundwater extraction rate should be controlled with a ball valve and an electronic totalizer or other method of measuring or calculating instantaneous and cumulative discharge. The ball valve would be used for gross control of the flow, and minor adjustments of flow will be made with the pump control unit. Volume-based flow rates should be recorded periodically on a data form that includes flow meter readings, elapsed time, time interval, total period flow, calculated flow rate, and other observations related to flow. Care should be taken to closely monitor flow and to adjust the system so that constant rates are maintained to offset flow variations caused by (1) increased head due to greater drawdown and (2) power-source surge/creep caused by changes in power source efficiencies.

<u>Constant-Rate Test</u>

Prior to running the constant rate test on MW-107C or on MW-107E or -F, the results of the step-drawdown test would be evaluated to determine the sustainable rate for a 24-hour pumping test. The constant rate test will not be conducted prior to re-stabilization of water levels in the pumping and monitoring wells following the step test. If during the constant rate test the water level in the pumped well drops below the higher of two feet over the top of the pump intake or two feet over the top of the well screen, the constant rate test should be terminated and recovery readings taken for 24 hours. Data loggers should be installed in the monitoring wells as shown on Line 1 of Table 1 for MW-107D. However, when pumping MW-107C, low pressure range transducers should be installed in MW-107B, D, E, and F, and a high range pressure transducer in MW-107C. When pumping MW-107E or -F, low pressure range transducers should be installed in MW-107B, C, and D and a high range pressure transducer installed in MW-107E or -F.

It is imperative that all dataloggers be synchronized to the same time as closely as programming will permit prior to the start of the test.

6.2 Drawdown Tests on Selected Monitoring Wells

The wells identified in Table 1 will be subjected to rapid drawdown and recovery tests to evaluate connectivity with surrounding monitoring wells. The test will be conducted in each well to be pumped by inserting the pump into the well to an elevation no lower than 2 feet over the top of the well screen. A datalogger transducer with a sufficient pressure range to record dewatering of the well will also be lowered into the well. The transducer will be programmed to read at four second intervals. The well pump will be turned on and permitted to pump unrestricted at maximum rate until the water level either decreases to a level near the top of the pump or 1 hour has passed, whichever occurs first. Data loggers will record pressure recovery in each passive well at two second intervals for up to two hours following the shut-off of the pump or until the original static water level is achieved, whichever occurs first.

It is imperative that all dataloggers be synchronized to the same time as closely as programming will permit prior to the start of the test.

7. <u>Methods of Analysis</u>

Analysis and interpretation of the aquifer test data will follow accepted industry standards and methods. The raw data from the dataloggers will be downloaded and put into Excel spreadsheets that clearly identify each well for which the record was obtained, the date and time of the start of the record. Three time columns should be established on each record sheet in units of minutes: clock time; elapsed time from the time of the start of the drawdown test; and elapsed time from the shut-off of the pump and the start of recovery. Other manipulations and ratios may be made from these three measurements, depending on the type of analysis. Three head measurement columns should be established on each record sheet after correction of the transducers for barometric pressure and any other corrections necessary based on the field data checks of each transducers (these checks must be noted at the appropriate time on each sheet) in units of feet: elevation head throughout the period of the transducer record; drawdown in feet from the start of the pumping; and recovery in feet from the time of the shutoff of the pump. If the prior 12-hour data logger record, combined with coincident measurements of precipitation and reservoir level change suggest the need to correct data over the period of the test for obvious recharge, recession, barometric changes or earth tides, these changes will be made to the data if the changes would make a significant difference to the interpretation.

All corrected drawdown data will be plotted as log of drawdown versus log of time on log-log paper and the shape of each curve inspected to identify curve characteristics that might indicate whether boundary conditions were encountered, well storage is important, fracture flow is suggested, or some other physical phenomenon was causing the curve to deviate from the traditional Theis type curves.

The constant rate pumping tests would be analyzed by standard type curve matching procedures as described in Lohman, 1972. If fracture flow characteristics are suggested, then the analysis may occur as type curve matches according to the methods described in Gringarten and Witherspoon, 1972, Gringarten, 1982, or Karasaki, 1987. Recovery from the constant rate tests will be evaluated using a semi-log plot of residual drawdown as a function of the ratio of t/t' to determine if the curve is displaced, for example, by incomplete recovery due to the limited extent of the sand zone tested (method is described, for example, in Driscoll, 1986).

The analysis of the step-drawdown tests will be conducted using Kawecki, 1995.

The analysis of the rapid drawdown and recovery tests will be evaluated using methods typically used to evaluate slug tests, such as in Lohman, 1972, and the software AQTESOLV™.

All of the above methods have limitations due to the simplifying assumptions governing the boundary conditions, whether or not the aquifer is isotropic or homogeneous, and the like. Since a 3-dimensional groundwater model is being developed in parallel with the final site characterization, the model would be used to test the parameters calculated from the analytical methods.

In summary, best professional judgment will be applied to the review, test method selection, analysis, and interpretation of the aquifer test data. The values calculated from graphical and analytical analysis of the pumping tests will be tested in the 3-dimensional model, which will be capable of including non-homogeneity, anisotropy, layered systems, limited extent of sand layers, and the like.

List of References

Driscoll, F.G., 1986, *Groundwater and Wells*, 2nd edition, Johnson Filtration Systems Inc., St. Paul, Minnesota 55112, 1089 p. and plates

Gringarten, A.C. and P.A. Witherspoon, 1972, *A method of analyzing pumping test data from fractured aquifers*, in, Proceedings, Symposium on Percolation in Fissured Rock: Stuttgart, International Society of Rock Mechanics, Vol. 3, p. B1-B9

Gringarten, A.C., 1982, *Flow-test evaluation of fractured reservoirs*, in, Recent trends in hydrogeology, ed. by T.N. Narasimhan. Geol. Soc. of Am. Spec. Paper 189, p. 237-264

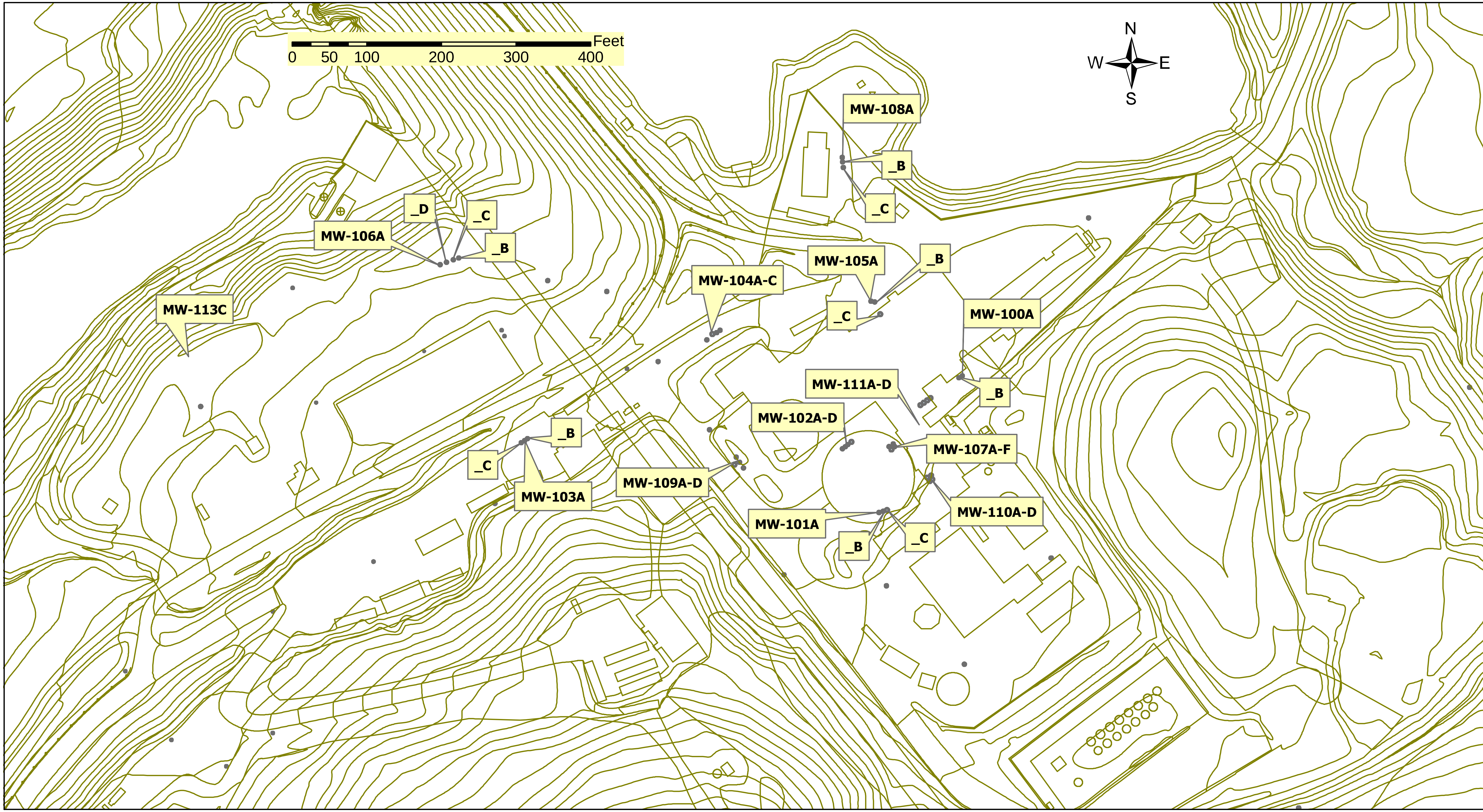
Karasaki, K., 1987, *Well test analysis in fractured media.* Ph.D. Thesis for Lawrence Berkeley Laboratory, University of California at Berkeley. Report LBL-21441 Rev., 239 p.

Kawecki, M.W., 1995, *Meaningful Interpretation of Step-Drawdown Tests*, Vol. 33, No. 1, Ground Water, Jan-Feb 1995

Lohman, S.W., 1972, *Ground-Water Hydraulics*, Geological Survey Professional Paper 708

Table 1
Schedule of Wells to be subjected to pressure transients
YNPS Rowe

Well Subjected to Rapid Drawdown and Recovery	Order of Testing	Mon. well	Mon. well	Mon. well	Mon. well	Mon. well	Mon. well	Mon. well	Mon. well	Mon. well	Mon. well	Mon. well	Mon. well	Mon. well	Mon. well
MW-107D	1	MW-107B	MW-107C	MW-107E	MW-107F	MW-101B	MW-101C	MW-102B	MW-102C	MW-102D	MW-111B	MW-111C	MW-110B	MW-110C	MW-110D
MW-106B	2	MW-106C	MW-106D	MW-113C	MW-103B	MW-103C	MW-104B	MW-104C							
MW-106C	3	MW-106B	MW-106D	MW-113C	MW-103B	MW-103C	MW-104B	MW-104C							
MW-106D	4	MW-106B	MW-106C	MW-113C	MW-103B	MW-103C	MW-104B	MW-104C							
MW-103C	5	MW-103B	MW-113C	MW-104B	MW-104C	MW-109B	MW-109C	MW-109D							
MW-104B	6	MW-104C	MW-109B	MW-109C	MW-109D	MW-105B	MW-105C	MW-108B	MW-108C	MW-102B	MW-102C	MW-102D			
MW-104C	7	MW-104B	MW-109B	MW-109C	MW-109D	MW-105B	MW-105C	MW-108B	MW-108C	MW-102B	MW-102C	MW-102D			
MW-105B	8	MW-105C	MW-108B	MW-108C	MW-102B	MW-102C	MW-102D	MW-100B	MW-111B	MW-111C					
MW-105C	9	MW-105B	MW-108B	MW-108C	MW-102B	MW-102C	MW-102D	MW-100B	MW-111B	MW-111C					
MW-109C	10	MW-109B	MW-109D	MW-101B	MW-101C	MW-102B	MW-102C	MW-102D	MW-107B	MW-107C	MW-107D	MW-107E	MW-107F		
MW-109D	11	MW-109B	MW-109C	MW-101B	MW-101C	MW-102B	MW-102C	MW-102D	MW-107B	MW-107C	MW-107D	MW-107E	MW-107F		



Yankee Nuclear Power Station
Rowe, Massachusetts

Monitoring Wells to be Used for
Pumping and Pressure Transient Testing

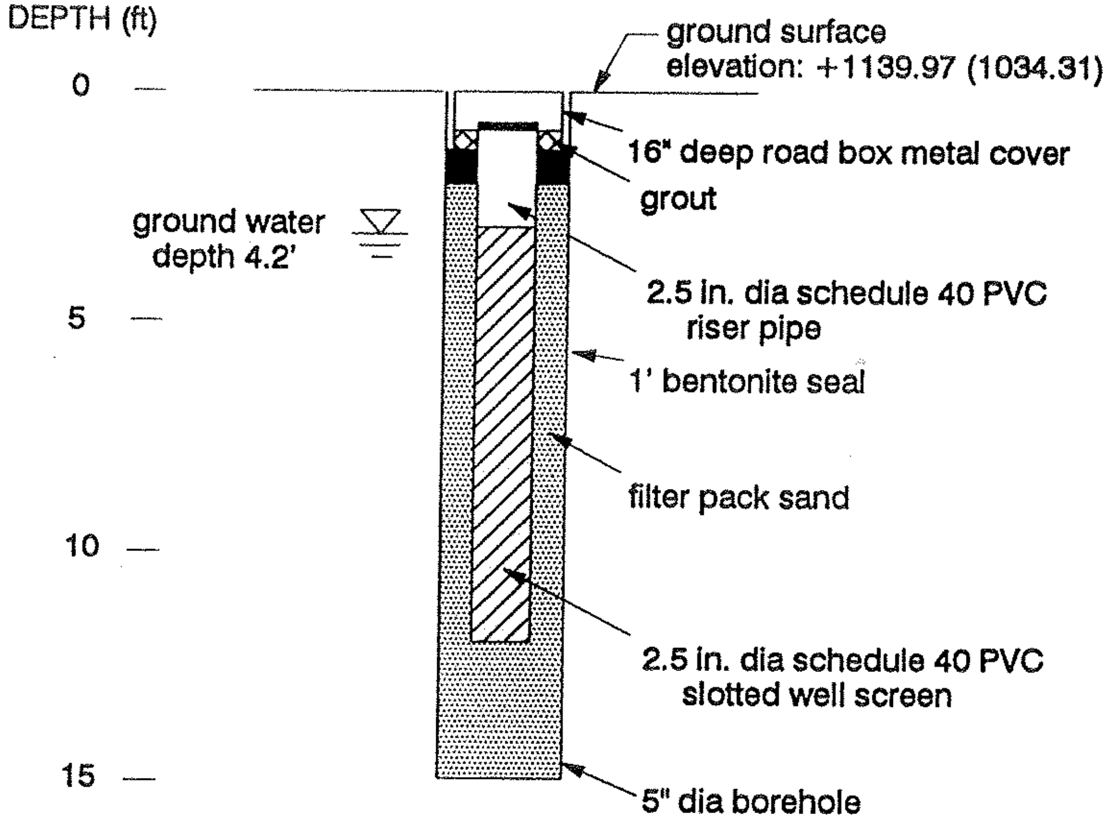
6/01/06

Attach. 1, Figure-1

Attachment 2
Monitoring Well Construction Diagrams

(Provided on enclosed CD)

SCHEMATIC FOR WELL INSTALLATION CB-3
E. of Fire Water Tank



Borehole depth: 15.0'
Bottom of well screen: 13.0'
Top of well screen: 3.0'
Top of filter sand: 5.0'
Top of bentonite seal: 2'
Installation date: 4/29/93

Sampled Subsurface Materials:
0-0.5' Asphalt
0.5-10' Silty Outwash
10-15' Till

Contractor: Guild Drilling
Engineer: Yankee Atomic

GUILD DRILLING CO., INC.

100 WATER STREET EAST PROVIDENCE, R I

SHEET 1 OF 1
DATE
HOLE NO. CB-3
LINE & STA.
OFFSET
SURF. ELEV.

TO Yankee Atomic Electric Company ADDRESS Bolton, Mass.
PROJECT NAME Borings & Wells for LOCATION Rowe, Mass.
REPORT SENT TO above / Radioactive PROJ. NO.
SAMPLES SENT TO Taken at Site / Contamination OUR JOB NO. 93-260

GROUND WATER OBSERVATIONS
At 3.3' (No casing) after Hours
At after Hours

	CASING	SAMPLER	CORE BAR.
Type	PW	S/S	
Size I.D.	5"	3"	
Hammer Wt	300#	300#	BIT
Hammer Fall	24"	30"	

	Date	Time
START	4/29/93	a.m. p.m.
COMPLETE	4/29/93	a.m. p.m.
TOTAL HRS.		

BORING FOREMAN G. Brouillette
INSPECTOR
SOILS ENGR.

LOCATION OF BORING

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	To 6-12	12-18	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE No.	Pen	Rec.
								0.17'	BLACKTOP			
		1'-2.5'	D	10	10	10	Wet		Brown fine to medium SAND	1	18"	16"
							Medium		Gravel, Cobbles, some			
		2.5'-4'	D	11	14	16	Dense		Silt	2	18"	3"
		4'-6'	D	9	9	9	"			3	24"	3"
				5								
		6'-8'	D	3	10	23	Dense		"	4	24"	24"
				31								
		8'-10'	D	10	28	34	Very		"	5	24"	16"
				52			Dense					
		10'-10.7'	D	50	80/3"		"		"	6	9"	4"
		12'-13.1'	D	27	37	80/2"			"	7	14"	9"
		14'-15'	D	35	37	80/0"		15.0'		8	12"	9"

Bottom of Boring 15.0'

Installed (2.5" PVC) Well at 13.0'

10' Screen
5' Riser
3 Bags of Filter Sand
12.5# Bentonite Chips
1/2 Bag of Cement
One Large Road Box

GROUND SURFACE TO 10' USED PW "CASING: THEN Open Well

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density
0-10 Loose
10-30 Med. Dense
30-50 Dense
50 + Very Dense

Cohesive Consistency
0-4 Soft
4-8 M/Stiff
8-15 Stiff
15-30 V-Stiff
30 + Hard

SUMMARY:
Earth Boring 15'
Rock Coring
Samples 8

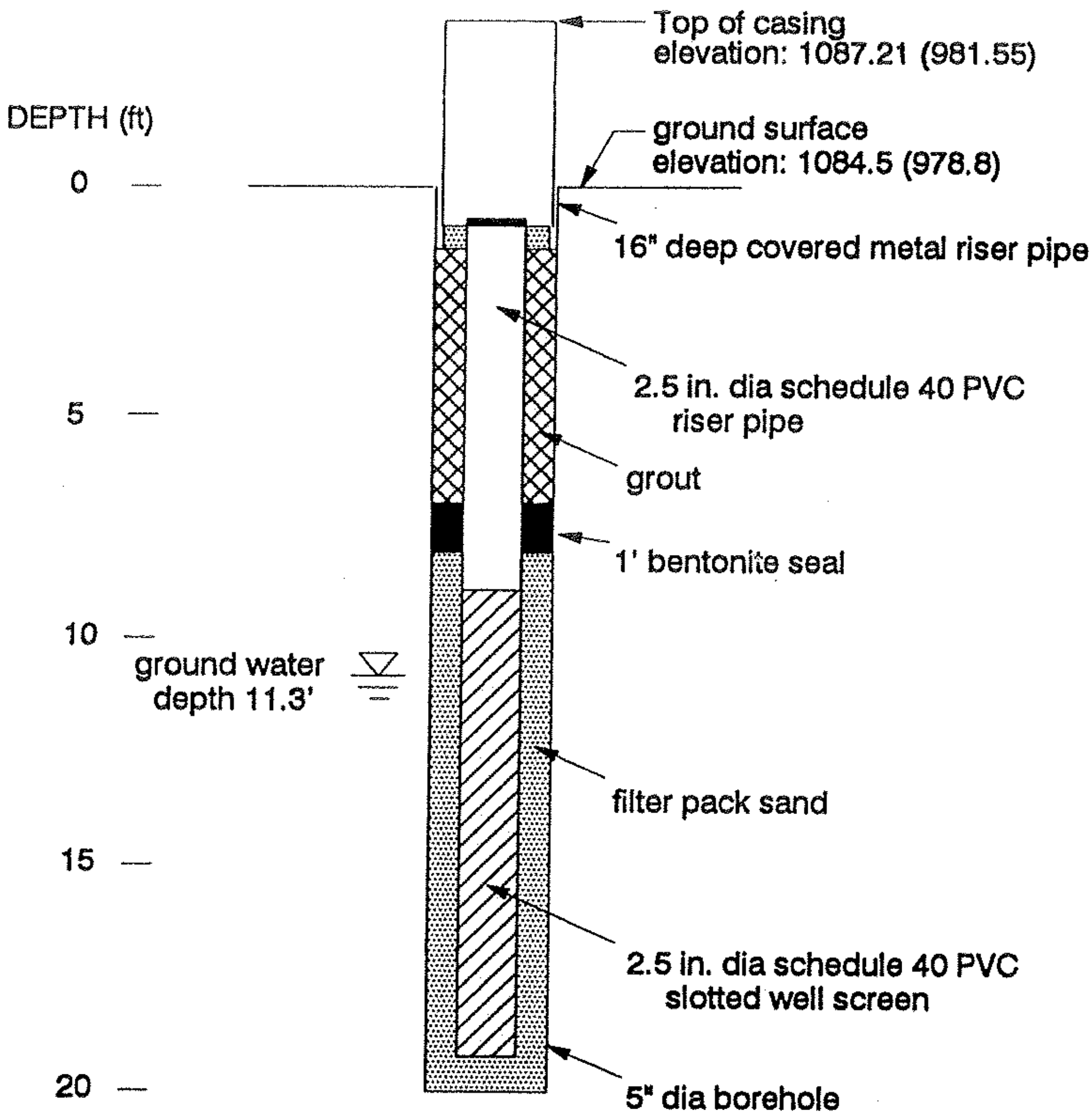
HOLE NO CB-3

Project VYNPS Scoping		Boring No. CB-3	
Driller Guild Drilling: G. Brouillette		Page 1 of 1	
Logged by F.X. Bellini		Date(s) 4/29/93	
Elevation	Depth 15'	Ground Water Depth 4'2"	
Location E. of Fire Water Tank			

DEPTH (ft)	SAMPLE CONDITION			GRAPHIC LOG		SAMPLE DESCRIPTION
0	S1: Casing sample: asphalt clogs casings Recov ~50%					Asphalt ~6"
	S2A S2B S2C	10-10-10 16"/18"				Brown fine-grained sand with gravel up to 2" and v. little fines.
	S3	11-14-16 8"/18"				Sim. to S2.
5	S4	9-9-9-5 3"/24"	3" rock in nose of spoon is only recovery			
	S5A S5B S5C	3-10-23-31 21"/24"				Soft silt lens w/gravel at top, otherwise similar to S2.
	S6A S6B S6C	10-28-34-52 16"/24"				Silt, fine sand and fine to coarse gravel
10	S7	50-80/3" 4"/9"				Sim. to S6
	S8	27-37-80/2" 9"/14"				Sim. to S6.
	Drilled through boulder				Boulder	
	S9	35-37-80/0" 9"/12"				Sim. to S6.
15						Bottom of Boring, 15'

YANKEE

SCHEMATIC FOR WELL INSTALLATION CB-4
Old Septic Leaching Field



Borehole depth: 20.0'
Bottom of well screen: 19.0'
Top of well screen: 9.0'
Top of filter sand: 8.0'
Top of bentonite seal: 7.0'
Installation date: 5/4-5/93

Sampled Subsurface Materials:
0-0.5' Asphalt
0-2' Fill
2'-7'Sand
7'-9' Gravel
9-13' Sand
13-15' Gravel
15-20' Alluvium

Contractor: Guild Drilling
Engineer: Yankee Atomic

GUILD DRILLING CO., INC.

100 WATER STREET EAST PROVIDENCE, R I

SHEET 1 OF 1
DATE
HOLE NO. CB-4
LINE & STA.
OFFSET
SURF. ELEV.

TO Yankee Atomic Electric Company ADDRESS Bolton, Mass.
PROJECT NAME Borings & Wells for LOCATION Rowe, Mass.
REPORT SENT TO above / Radioactive PROJ. NO.
SAMPLES SENT TO Taken at Site / Contamination OUR JOB NO. 93-260

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR
At 9.0' after ___ Hours in Casing	Type	PW	S/S	
	Size I.D.	5"	3"	
At ___ after ___ Hours	Hammer Wt	300#	300#	BIT
	Hammer Fall	24"	24"	

	Date	Time
START	5/4/93	a.m. p.m.
COMPLETE	5/5/93	a.m. p.m.
TOTAL HRS.		
BORING FOREMAN	G. Brouillette	
INSPECTOR		
SOILS ENGR.		

LOCATION OF BORING

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE No.	Pen	Rec.
		0'-2'	D	12	16	12	Medium		Brown fine to medium SAND	1	24"	8"
				11			Dense		and Gravel, some Cobbles			
		2'-4'	D	8	5	8	"			2	24"	18"
				13				4.0'				
		4'-6'	D	5	5	8	"		Brn. fine to med. SAND &	3	24"	10"
				4					Gravel, some Cobbles, some			
		6'-8'	D	5	5	9	"	7.0'	organic Silt mixed	4	24"	13"
				13				8.0'	PEASTONE			
		8'-9'	D	45	51		Very	9.0'	COBBLE	5	12"	0"
		9'-11'	D	20	15	10	Dense		Brown fine to medium	6	24"	24"
				10			M.Dens.		SAND			
		11'-13'	D	3	4	5	Loose			7	24"	8"
				6				13.0'				
		13'-14'	D	14	13		Medium	14.0'	COBBLE	8	12"	0"
		14'-16'	D	45	65	40	Dense		BOULDER	9	24"	24"
				42								
		16'-18'	D	10	10	14	Medium		Brown fine to medium SAND	10	24"	13"
				25			Dense		and Gravel, Silt, some			
		18'-20'	D	50	100	30	Very		Cobbles & Boulders	11	24"	12"
				36			Dense	20.0'				
									Bottom of Boring 20.0'			
									Installed (2.5" PVC Well)			
									at 19'			
									10' Screen			
									10' Riser			
									5 Bags of Filter Sand			
									25# Bentonite			
									4 Bags of Cement			
									One Guard Pipe (4")			

GROUND SURFACE TO 20.0' USED PW "CASING: THEN Installed Well

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140 lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency			
0-10	Loose	0-4	Soft	30 +	Hard
10-30	Med. Dense	4-8	M/Stiff		
30-50	Dense	8-15	Stiff		
50 +	Very Dense	15-30	V-Stiff		

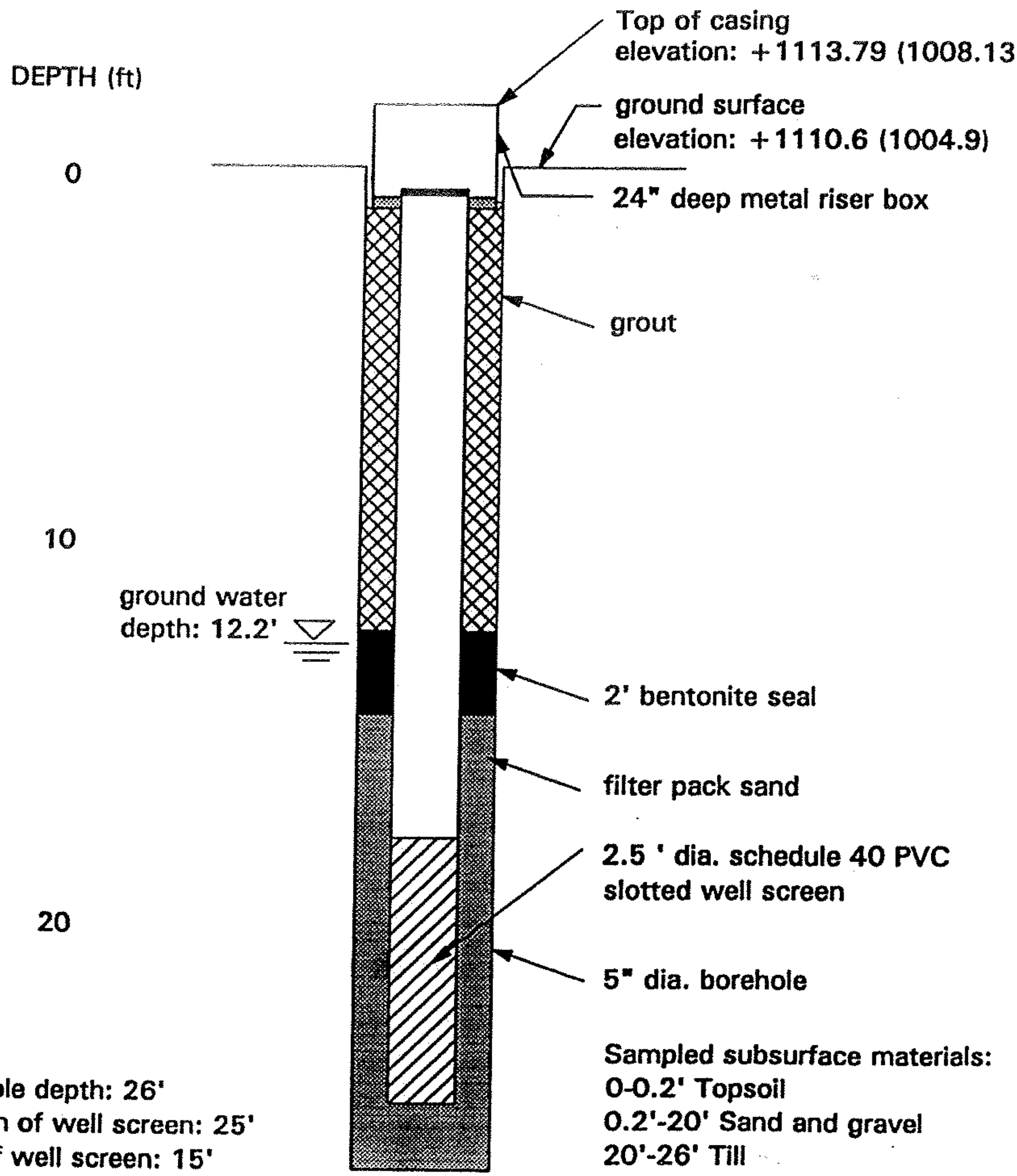
SUMMARY:
Earth Boring 20'
Rock Coring
Samples 11
HOLE NO CB-4

Project YNPS Springs	Boring No. CB-4
Driller Guild Drilling · G. Brouillette	Page 1 of 1
Logged by F.X. Bellini	Date(s) 5/4-5/93
Elevation ____ Depth 20'	Ground Water Depth 11'3"
Location S.W. corner of old Leaching Field	

DEPTH (ft)	Sample	SAMPLE CONDITION		GRAPHIC LOG	SAMPLE DESCRIPTION
0	S1	12-16-12-11 6"/24" Large rock in nose of spoon			Brown fine-grained sand with gravel up to 3". No fines.
	S2A	8-5-8-13 18"/24"			Sim. to S1.
	S2B				Dark gray fine-grained sand. Odorless. Contains organics?
	S3A	5-5-4-3 10"/24"			Sim. to S1.
5	S3B				
	S4A	5-5-9-13 13"/24"			Sim to S1 with organics and gravel at bottom.
	S4B				Fine to coarse gravel with minor sand. No fines.
	S5	45-51 0"/12"	Lost drill water return.		Sim. to S4B? Gravel lens?
10	S6A	20-15-10-10 24"/24"			Brown, fine to medium-grained sand, trace of gravel, no fines
	S6B		Regained drill water return.		
	S7A	3-4-5-6 24"/24"			Sim to S6.
	S7B				
	S8	14-11 0"/12"	Lost drill water return	Gravel? Cobbles	
15	S9A	45-65-40-42 18"/24"	Regained drill water return		Gravel, some v. wx with coarse to fine-grained sand, little fines.
	S9B				Wx rock: black schist, friable fine to medium grained sand.
	S10A	10-10-14-25 13"/24"			Gravel with coarse to fine sand (lens?), becoming fine to coarse-grained sand with gravel. Alluvium?
	S10B				
	S11A	50-100-30-36 12"/24"			Sim. to S10. Alluvium?
	S11B				
20					Bottom of Boring, 20'

SCHEMATIC FOR WELL INSTALLATION CB-6

Southeast of Sherman Dam



Borehole depth: 26'
Bottom of well screen: 25'
Top of well screen: 15'
Top of filter sand: 14'
Top of bentonite seal: 12'

Sampled subsurface materials:
0-0.2' Topsoil
0.2'-20' Sand and gravel
20'-26' Till

Contractor: Guild Drilling
Engineer: Yankee Atomic
Installation date: 9/13/94

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 1 OF 1

TO Yankee Atomic Electric Co.
PROJECT NAME M. Wells Outside & Inside
REPORT SENT TO above

ADDRESS Bolton, Mass.
LOCATION Rowe, Mass.
OUR JOB NO. 95-74

HOLE NO. CB-6
PROJ. NO.
SURF. ELEV.

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR.		DATE
13.5' after ___ Hours	Type	PW	S/S		Start	9/12/94
	Size I.D.	5"	3"		Complete	9/13/94
At 12.2' after ___ Hours	Hammer Wt.	300#	300#	BIT	Boring Foreman	G. Brouillette
In Well 9/13/94 AM	Hammer Fall	24"	30"		Inspector/Engr.	

LOCATION OF BORING

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	SAMPLE No.	Pen"	Rec."
		0.0-2.0	D	15	20	29			Topsoil	1	24	8
						30		0.5	Brown fine to medium SAND, Gravel & Silt			
5		4.0-5.5	D	8	10	12				2	18	6
									Boulders			
10		9.0-10.0	D	8	100					3	12	4
									10' to 12' - Boulders			
		12.0-14.0	D	28	30	18				4	24	21
						19						
		14.0-15.5	D	37	39	58				5	18	18
20		19.0-21.0	D	36	40	70				6	24	19
						31						
25		24.0-26.0	D	24	16	23				7	24	19
						25						
								26.0	Bottom of Boring 26'			

Installed 2-1/2" PVC Well at 25'
10' Slotted - 18' Solid
5 Bags of Sand
5 Bags of Cement
1/2 Bag of Bentonite Chips
One 4" Guard Pipe & Cap

...ND SURFACE TO 24' USED PW CASING: THEN

Sample Type
D=Drive C=Cored W=Washed
UP=Fixed Piston UT=Shelby Tube
TP=Test Pit A=Auger
OE = Open End Rod

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb. Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency	
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M./Stiff	
30-50	Dense	8-15	Stiff	

SUMMARY:
Earth Boring 26'
Rock Coring
Samples 7

HOLE NO. CB-6

Project VNRS Decommissioning

Driller Guild Drilling; G. Brouillette

Logged by F.X. Bellini

Date(s) 9/12/94

Elevation +1113.79 Depth 26' Ground Water Depth 14'8"

Location SE of Sherman Dam

Boring No. CB-6

DEPTH (ft)	SAMPLE CONDITION	Blow Count	Recov, "	GRAPHIC LOG		SAMPLE DESCRIPTION
0	S-1	15-20-29-30	8		Topsoil	Brown silt, some sand and gravel with 1½ in. of topsoil at surface
					Cobbles, Boulder(s)?	
4	S-2	8-10-12	6		Lost grout.	Similar to S-1 with 3-4 in cobble
8	S-3	8-100	4			Brown fine-grained silty sand with coarse gravel and cobbles.
					Boulders, Cobbles	
12	S-4	28-30-18-19	21			Brown, fine-grained, silty sand with gravel and some medium-grained sand and decomposed rock.
	S-5	37-39-58	18			Gray-brown fine to medium-grained silty sand: decomposed rock. Dry, powdery with some coarse-grained sand. Similar to soil in CB-4. Decomposition appears to have occurred in-place: rock fabric is obvious.
16						
20	S-6	36-40-70-31	19			
21						

Continued on Page 2 of 2

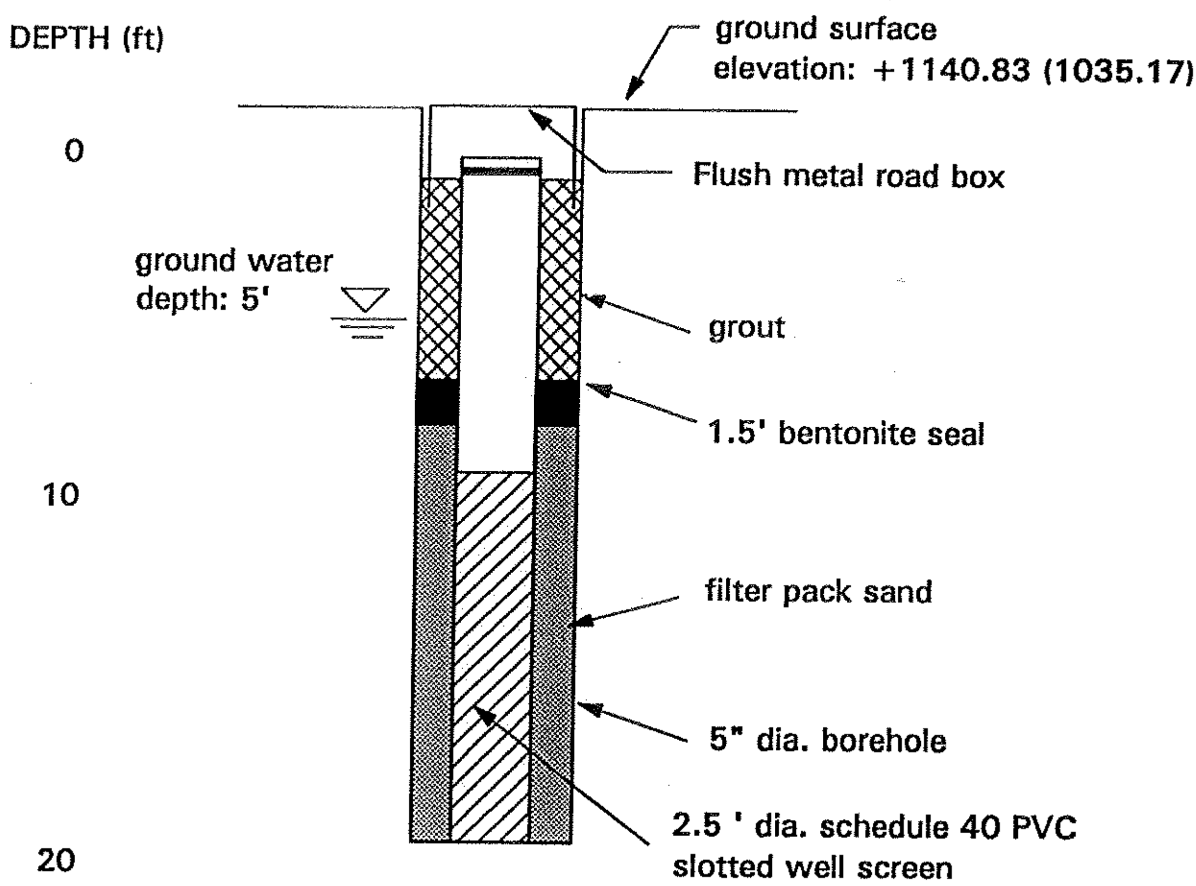
YANKEE

Project YNPS Decommissioning	Boring No. CB-6
Driller Guild Drilling: G. Brouillette	Page 2 of 2
Logged by FX Bellini	Date(s) 9/12/94
Elevation +1113.79 Depth 26'	Ground Water Depth 14' 8"
Location SE of Sherman Dam	

DEPTH (ft)	SAMPLE CONDITION			GRAPHIC LOG	SAMPLE DESCRIPTION
21					
22					Approx top of Till
24					Till. Brown silt with gravel and little sand. Matrix has moderate to slow reaction to shaking test
	S-7	24-16-23-25	19		
26					Bottom of Boring

SCHEMATIC FOR WELL INSTALLATION CB-8

Rad Storage Area Behing Old PCA



Well depth: 19'
Bottom of well screen: 19'
Top of well screen: 14'
Top of filter sand: 13'
Top of bentonite seal: 11.5'

Sampled subsurface materials:
0-.5' Asphalt
0.5'-3' Sand fill (till?)
3'-19' Till

Contractor: Guild Drilling
Engineer: Yankee Atomic
Installation date: 9/20/94

GUILD DRILLING CO., INC.
100 WATER STREET • EAST PROVIDENCE, R.I.

SHEET 1 OF 1

Yankee Atomic Electric Co.	ADDRESS Bolton, Mass.	HOLE NO. CB-8
PROJECT NAME M. Wells Outside & Inside	LOCATION Rowe, Mass.	PROJ. NO.
REPORT SENT TO above	OUR JOB NO. 95-74	SURF. ELEV.

GROUND WATER OBSERVATIONS

At 5.0' after ___ Hours 9/20/94 AM

At ___ after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	PW-HW	S/S	
Size I.D.	5" 4"	3"	
Hammer Wt.	300#	300#	BIT
Hammer Fall	24"	24"	

	DATE
Start	9/19/94
Complete	9/20/94
Boring Foreman	G. Brouillette
Inspector/Engr.	

LOCATION OF BORING

Depth	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler From 0-6	6-12	To 12-18	Moisture Density or Consist.	Strata Change Elev./Depth	SOIL OR ROCK IDENTIFICATION Remarks include color, gradation, type of soil etc. Rock-color, type, condition, hardness, drilling time, seams, etc.	SAMPLE No.	Pen"	Rec."
		0.0-0.5	D						Black Top	1	6	6
		0.5-2.0	D	10	16	21		0.5	Brown fine to medium SAND & Gravel, some silt	2	18	10
		2.0-4.0	D	14	10	19				3	24	17
						21						
5		4.0-6.0	D	29	40	29				4	24	17
						33						
		6.0-8.0	D	19	44	28				5	24	23
						45						
		8.0-10.0	D	16	25	46				6	24	18
10						49						
		10.0-12.0	D	22	36	48				7	24	23
						53						
		12.0-12.8	D	28	100/3"				(Boulder)	8	9	3
		14.0-15.5	D	20	69	100				9	18	15
		16.0-17.0	D	25	100					10	12	9
								19.0	Bottom of Boring 19'			

Installed 2-1/2" PVC Well at 19'
10' Slotted - 10' Solid
4 Bags of Sand
2 Bags of Cement
1/3 Bag of Bentonite Chips
One Large Road Box

GROUND SURFACE TO 9' USED PW CASING: THEN HW to 14' - Open

Sample Type
D=Drive C=Cored W=Washed
UP=Fixed Piston UT=Shelby Tube
TP=Test Pit A=Auger
OE = Open End Rod
300# hammer

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140 lb. Wt x 30" fall on 2" O.D. Sampler

Cohesionless	Density	Cohesive	Consistency	
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M./Stiff	
30-50	Dense	8-15	Stiff	
50 +	Very Dense	15-30	V-Stiff	

SUMMARY:
Earth Boring 19'
Rock Coring
Samples 10

HOLE NO. CB-8

Project	YNPS Decommissioning	Boring No.	CB-8
Driller	Guild Drilling: Brouillette	Page	1 of 1
Logged by	F.X. Bellini	Date(s)	9/19-20/94
Elevation	+1140.83 Depth 19'	Ground Water Depth	4'5"
Location	Rad Storage Area Behind Old PCA		

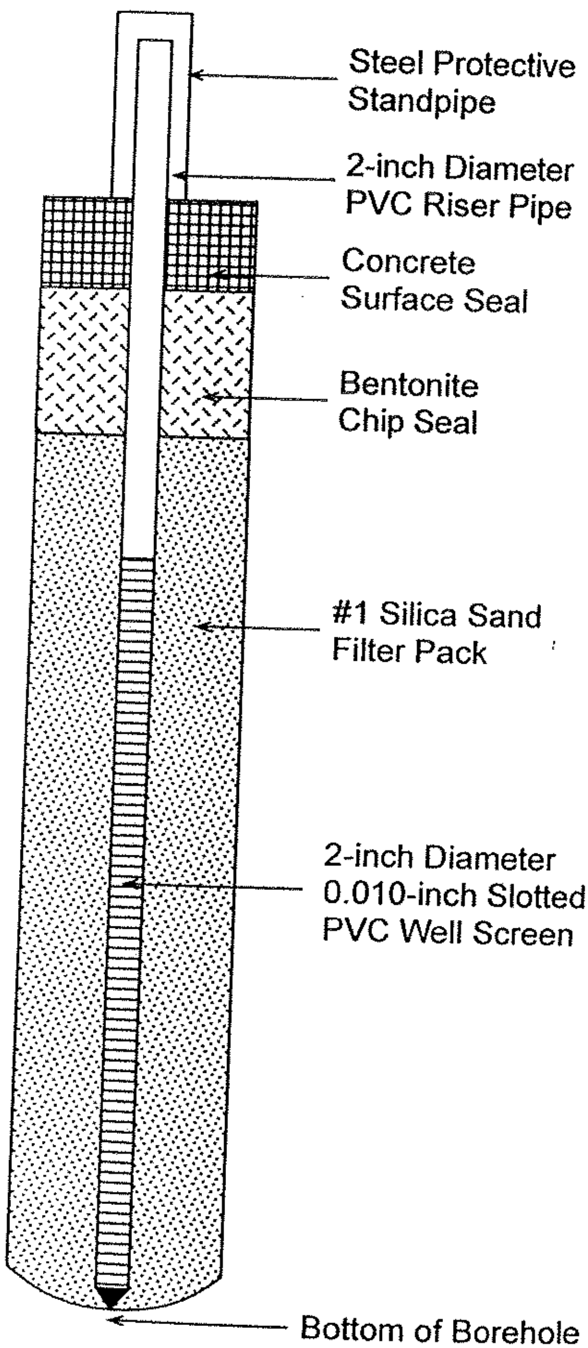
DEPTH (ft)	SAMPLE CONDITION	Blow Count	Recovery,"	GRAPHIC LOG		SAMPLE DESCRIPTION
0	S-1		6			Asphalt, 6" (two layers?)
	S-2	10-16-21	10			Brown gravelly, sandy silt Till.
	S-3	14-10-19-21	17			Sim. to S-2 with a little coarse sand
4	S-4	29-40-29-33	17			Sim to S-3
	S-5	19-44-28-45	23			Sim. to S-3, but with little gravel. Some softer, fine-gr. sandy lenses to ½ in thick have mod. to slow reaction to shaking test.
8	S-6	16-25-46-49	18		½" layer f-gr sand	Sim. to S-3
	S-7	22-36-48-53	23			Sim to S-3 with gravel to 4".
12	S-8	28-100/3"	3		Boulder	Very f-gr silty sand, brown, gravelly with little coarse sand. Till, but coarse matrix
14	S-9	20-69-100	15			Sim. to S-8
16	S-10	25-100	9			
17						

Bottom of Boring

YANKEE

Monitoring Well Construction Schematic For CFW-1

PROJECT NAME	Yankee Atomic, SCFA ISA
LOCATION	Rowe, MA
CLIENT	Duke Engineering and Services
CONTRACTOR	Geosearch
OBSERVED BY	Ryan Bagley
DATE	13 December 1999



Monitoring Well Construction Details

Well No.	Total Depth	Screen Interval	Sand Pack Interval
CFW-1	8 ft	3-8 ft	2-8 ft

ERM

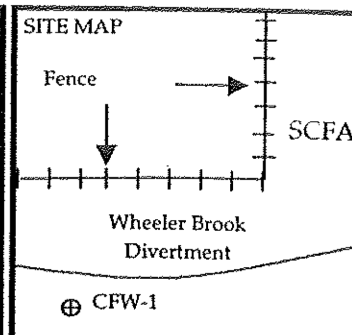
DRILLING LOG for Well #: CFW-1

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Project:	Yankee Rowe	Project Number:	468.06
Client:	Duke Engineering & Services	Logged by:	Peter A. Lawrence
Drilling Co:	Geosearch, Inc.	Driller:	Rodney Kaddy
Date Started:	13-Dec-99	Date Finished:	13-Dec-99
Location:	Rowe, Massachusetts	Drilling Method:	Tripod/Slide Hammer

Screen Diam:	2"	Length:	5'	Slot Size:	0.01"
Casing Diam:	2"	Length:	3'	Type:	PVC
Boring Depth:	8'	Well Depth:	8'	Boring Diam.:	5"/4"
Surface Elev.:	Not Measured	MP:	Not Measured	Depth to GW:	5'
		MP Elev.:	Not Measured	Depth to BR:	Not Measured

SITE MAP



Notes:

Depth	Well Log	Stratigraphic Unit Designation	Blowcounts per 6 inches	Recovery	Split Spoon Description/Soil Classification	Sample # & Depth	Headspace PID Screen (ppm)	Lab Sample # & Analyses
0-2		SAND			Brown medium to fine SAND, little Silt and coarse Gravel, loose, poorly sorted, moist to wet.	S-1 0'-2'	0.0	
5-7		SAND & SILT	6,8 6,7	11"	Brown fine SAND and SILT with interbedded Gravel, trace iron staining, dense, poorly sorted, saturated.	S-2 5'-7'	0.0	
7-8		SAND & SILT	5,7 7,6	10"	Brown fine SAND and SILT, dense, well sorted, saturated.	S-3 7'-8'	0.0	

Well Construction Details:

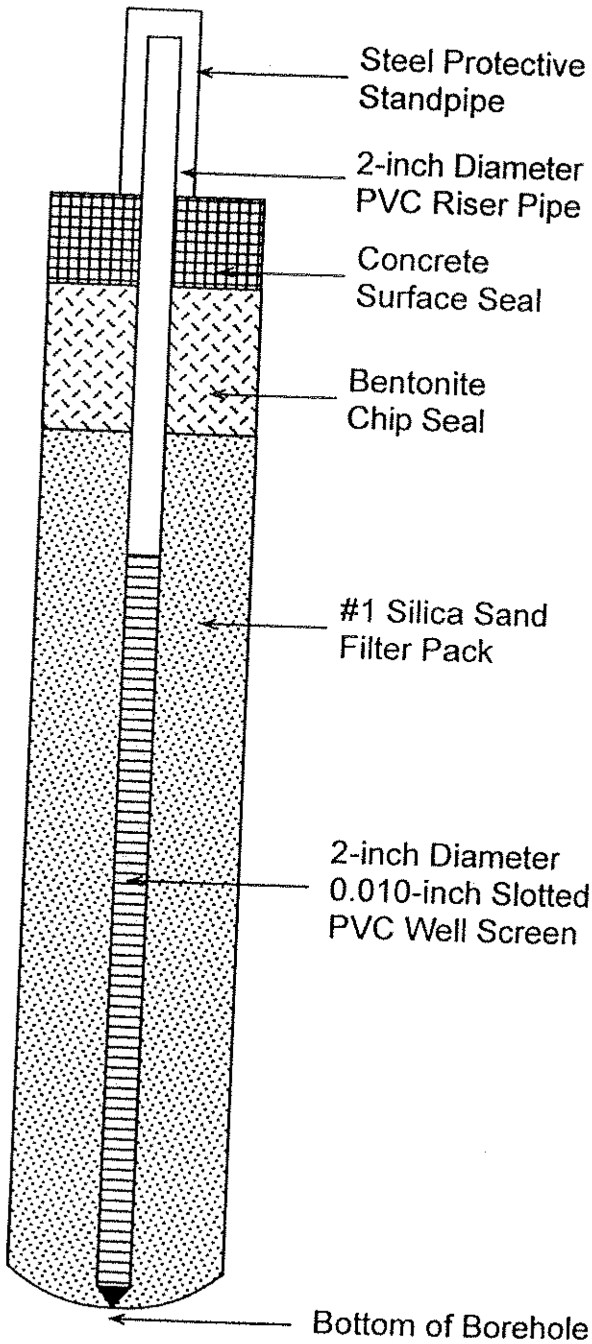
0'-1'	Concrete surface seal
1'-2'	Bentonite chip seal
2'-8'	#1 Silica sand filter pack
3'-8'	0.010" slotted PVC well screen
8'	Bottom of boring

Key to Well Construction

Sandpack · Well Screen · Grout · Bentonite Seal · Cement

Monitoring Well Construction Schematic For CFW-5

PROJECT NAME	Yankee Atomic, SCFA ISA
LOCATION	Rowe, MA
CLIENT	Duke Engineering and Services
CONTRACTOR	Geosearch
OBSERVED BY	Ryan Bagley
DATE	14 December 1999



Monitoring Well Construction Details

Well No.	Total Depth	Screen Interval	Sand Pack Interval
CFW-5	5 ft	1-5 ft	.5-5 ft

ERM

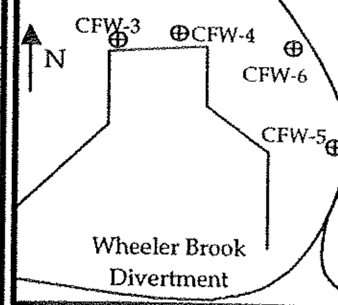
DRILLING LOG for Well #: CFW-5

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Project:	Yankee Rowe	Project Number:	468.06
Client:	Duke Engineering & Services	Logged by:	Peter A. Lawrence
Drilling Co:	Geosearch, Inc.	Driller:	Rodney Kaddy
Date Started:	14-Dec-99	Date Finished:	15-Dec-99
Location:	Rowe, Massachusetts	Drilling Method:	Tripod/ Slide Hammer

Screen Diam:	2"	Length:	5'	Slot Size:	0.01"
Casing Diam:	2"	Length:	2'	Type:	PVC
Boring Depth:	5'	Well Depth:	5'	Boring Diam.:	5"
Surface Elev.:	Not Measured	MP:	Not Measured	Depth to GW:	1.4'
		MP Elev.:	Not Measured	Depth to BR:	Not Measured

SITE PLAN



Notes:

Depth	Well Log	Stratigraphic Unit Designation	Blowcounts per 6 inches	Recovery	Split Spoon Description/Soil Classification	Sample # & Depth	Headspace PID Screen (ppm)	Lab Sample # & Analyses
0-2		SAND			Brown medium SAND with interbedded organic material, some Peat, loose, poorly sorted, moist.	S-1 0'-2'	0.0	
3-5		SAND & SILT			Brown fine SAND and SILT, interbedded coarse to medium Gravel, dense, poorly sorted, saturated.	S-2 3'-5'	0.0	

Depth scale: 1 2 3 4 5 6 7 8 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25

Well Construction Details:

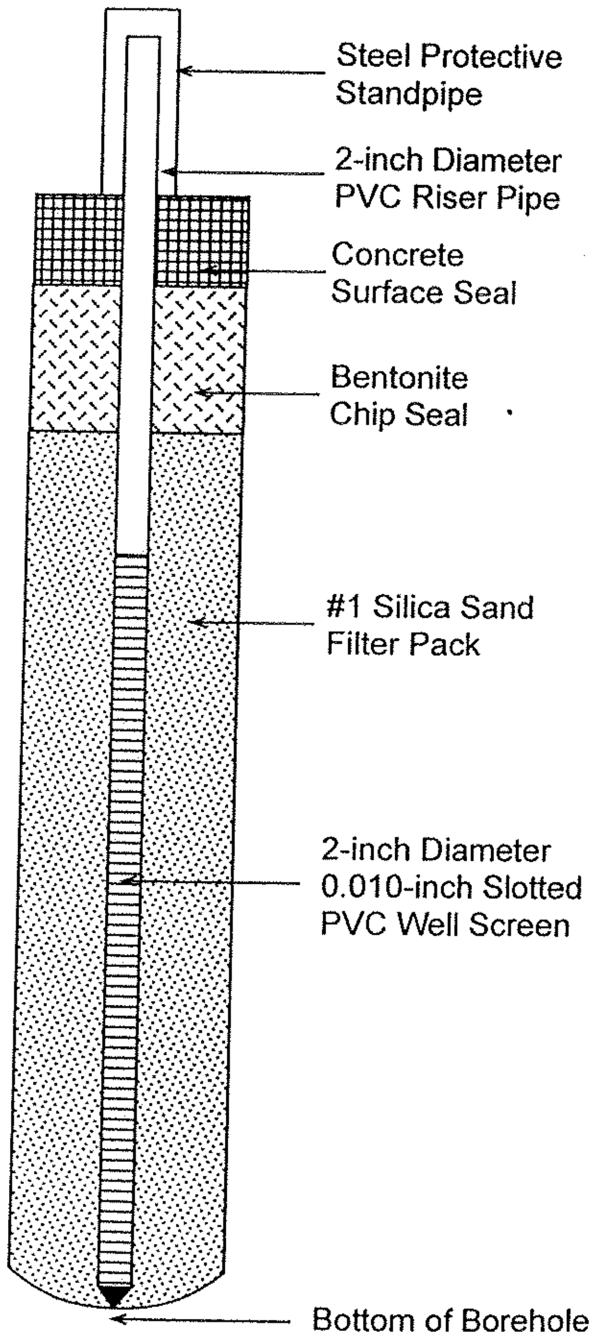
1'-0'	Concrete surface seal
0'-0.5'	Bentonite chip seal
0.5'-5'	#1 silica sand filter pack
0.5'-5'	0.010" slotted PVC well screen
5'	Bottom of boring

Key to Well Construction

Sandpack — Well Screen — Grout
Bentonite Seal — Cement

Monitoring Well Construction Schematic For CFW-6

PROJECT NAME	Yankee Atomic, SCFA ISA
LOCATION	Rowe, MA
CLIENT	Duke Engineering and Services
CONTRACTOR	Geosearch
OBSERVED BY	Ryan Bagley
DATE	14 December 1999



Monitoring Well Construction Details

Well No.	Total Depth	Screen Interval	Sand Pack Interval
CFW-4	6 ft	1-6 ft	.5-6 ft

ERM

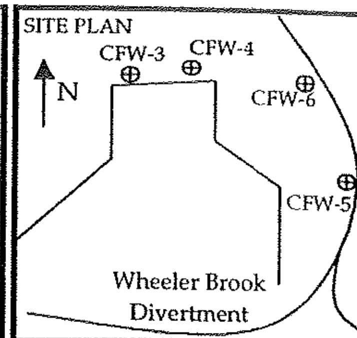
DRILLING LOG for Well #: CFW-6

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Project:	Yankee Rowe	Project Number:	468.06
Client:	Duke Engineering & Services	Logged by:	Peter A. Lawrence
Drilling Co:	Geosearch, Inc.	Driller:	Rodney Kaddy
Date Started:	14-Dec-99	Date Finished:	14-Dec-99
Location:	Rowe, Massachusetts	Drilling Method:	Tripod/ Slide Hammer

Screen Diam:	2"	Length:	5'	Slot Size:	0.01"
Casing Diam:	2"	Length:	1'	Type:	PVC
Boring Depth:	6'	Well Depth:	6'	Boring Diam.:	5"
Surface Elev.:	Not Measured	MP:	Not Measured	Depth to GW:	3.2'
		MP Elev.:	Not Measured	Depth to BR:	Not Measured

SITE PLAN



Notes:

Depth	Well Log	Stratigraphic Unit Designation	Blowcounts per 6 inches	Recovery	Split Spoon Description/Soil Classification	Sample # & Depth	Headspace PID Screen (ppm)	Lab Sample # & Analyses
0-2		SAND			Brown coarse to medium SAND, some coarse to medium Gravel, loose, poorly sorted, damp.	S-1 0'-2'	0.0	
5-6		SAND			Gray/brown coarse SAND, some coarse to medium Gravel (TILL), dense, poorly sorted, saturated.	S-2 5'-6'	0.0	

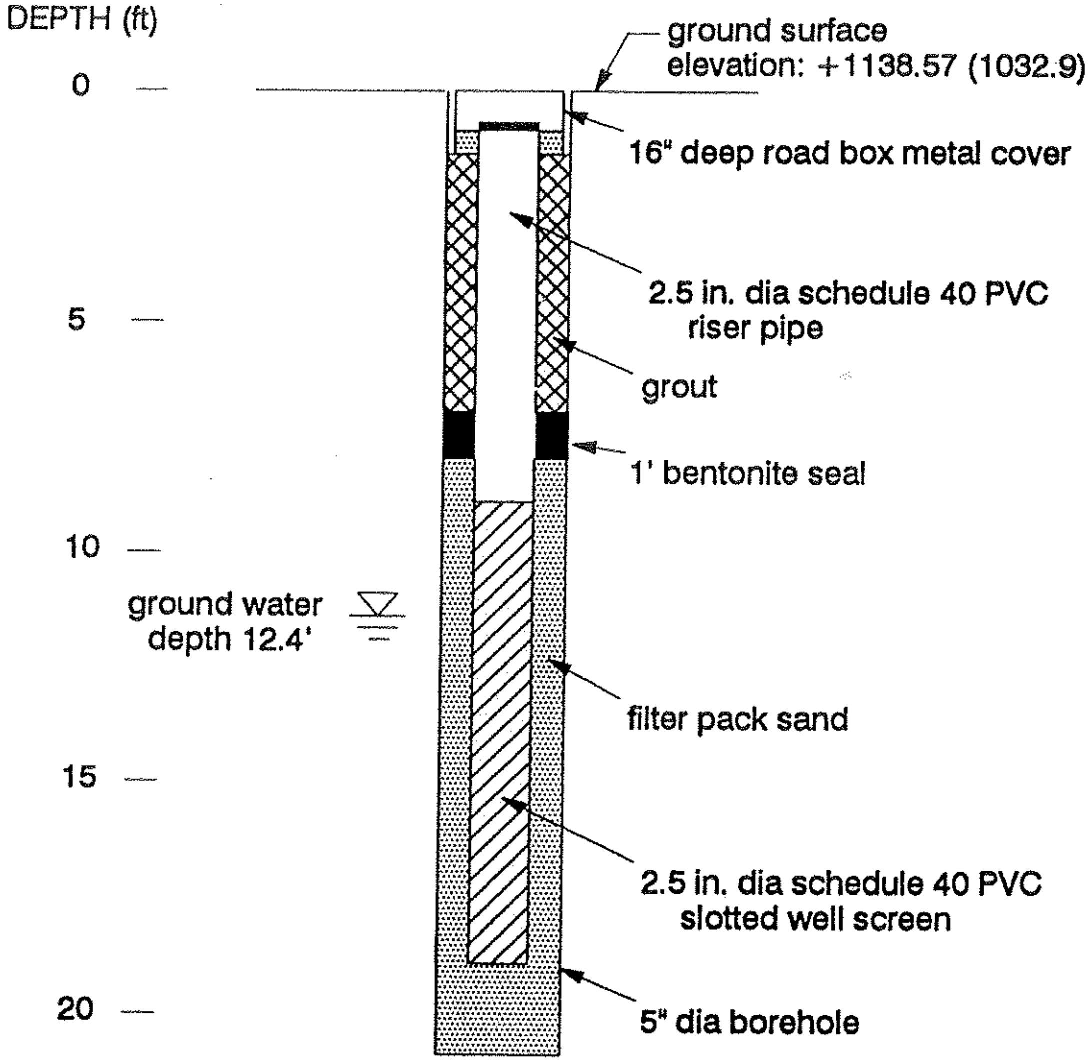
Well Construction Details:

0.5'-0'	Concrete surface seal
0'-0.5'	Bentonite chip seal
0.5'-6'	#1 Silica sand filter pack
1'-6'	0.010" Slotted PVC well screen
6'	Bottom of boring

Key to Well Construction

Sandpack — Well Screen — Grout
Bentonite Seal — Cement

SCHEMATIC FOR WELL INSTALLATION CW-2
N. of old SI Tank



Borehole depth: 21.0'
Bottom of well screen: 20.0'
Top of well screen: 9.0'
Top of filter sand: 9.0'
Top of bentonite seal: 8.0'
Installation date: 4/29/93

Inferred Subsurface Materials:
0-0.5' Asphalt
0.5-15' Fill/Outwash
15'-21' Till

Contractor: Guild Drilling
Engineer: Yankee Atomic

GUILD DRILLING CO., INC.

100 WATER STREET EAST PROVIDENCE, R I

SHEET 1 OF 1
DATE
HOLE NO. CW-2
LINE & STA.
OFFSET
SURF. ELEV.

TO Yankee Atomic Electric Company
PROJECT NAME Borings & Wells for
REPORT SENT TO above / Radioactive
SAMPLES SENT TO Taken at Site / Contamination

ADDRESS Bolton, Mass.
LOCATION Rowe, Mass.
PROJ. NO.
OUR JOB NO. 93-260

GROUND WATER OBSERVATIONS
At 8.5' 4/30/93 AM after ___ Hours
10' PW
At ___ after ___ Hours

	CASING	SAMPLER	CORE BAR.
Type	PW		
Size I.D.	5"		
Hammer Wt	300#		BIT
Hammer Fall	24"		

	Date	Time
START	4/29/93	a.m. p.m.
COMPLETE	4/30/93	a.m. p.m.
TOTAL HRS.		

BORING FOREMAN G. Brouillette
INSPECTOR
SOILS ENGR.

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler 0-6	6-12	12-18	Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE No.	Pen	Rec
									Drove PW to 19.0'			
								20.0'				
									Bottom of Boring 20.0' Installed (2.5') PVC Well at 19.0' 10' Screen 10' Riser 5 Bags of Filter Sand 12.5'# Bentonite Chips 2 Bags of Cement One Road Box			

GROUND SURFACE TO 19.0' USED PW "CASING: THEN Installed Well

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test

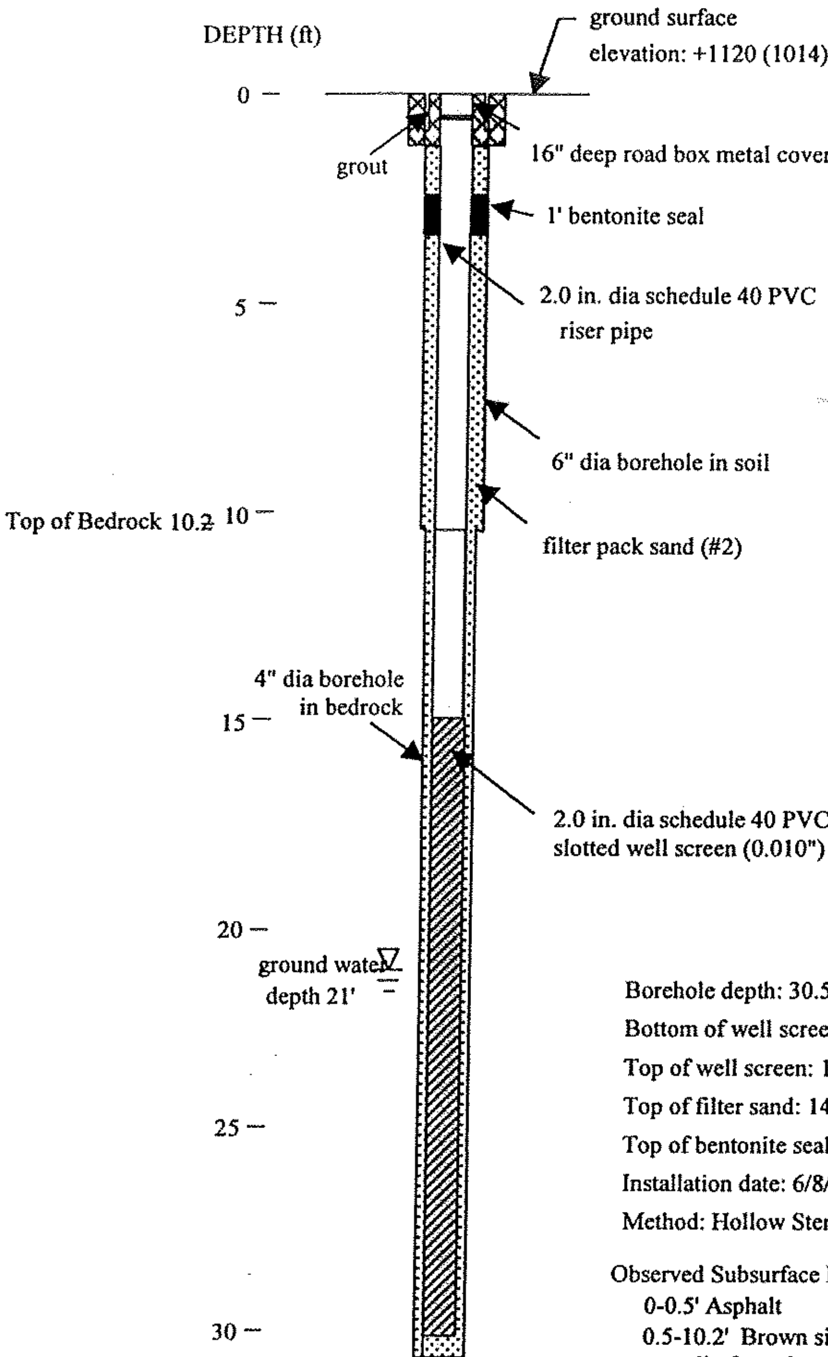
Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%

140 lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density		Cohesive Consistency		
0-10	Loose	0-4	Soft	30 + Hard
10-30	Med. Dense	4-8	M/Stiff	
30-50	Dense	8-15	Stiff	

SUMMARY: 20
Earth Boring
Rock Coring
Samples -0

SCHEMATIC FOR WELL INSTALLATION CW-10
N. of Former Gasoline UST Location



Borehole depth: 30.5'
Bottom of well screen: 30.0'
Top of well screen: 15.0'
Top of filter sand: 14.0'
Top of bentonite seal: 13'
Installation date: 6/8/98
Method: Hollow Stem Auger

Observed Subsurface Materials:
0-0.5' Asphalt
0.5-10.2' Brown silty gravelly f. sand
10.2-30.5' Bedrock: dry to 23,' where fractures occur

Contractor: Geosearch
Engineer: Duke Engineering & Services

CW-10 no soil log

DRILLING LOG for Well #: MW-100A

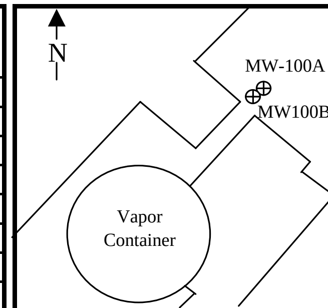
ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Project:	Yankee L.T.P.	Project Number:	2107.01
Client:	Yankee Atomic Electric Company	Logged by:	Michael Horesh
Drilling Co:	D.L. Maher	Driller:	Bill Zammow
Date Started:	5-Aug-03	Date Finished:	5-Aug-03
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic

Screen Diam:	2"	Length:	10'	Slot Size:	0.010"
Casing Diam:	2"	Length:	10'	Type:	Schedule 40, 2" PVC
Boring Depth:	20'	Well Depth:	20'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	8.55'

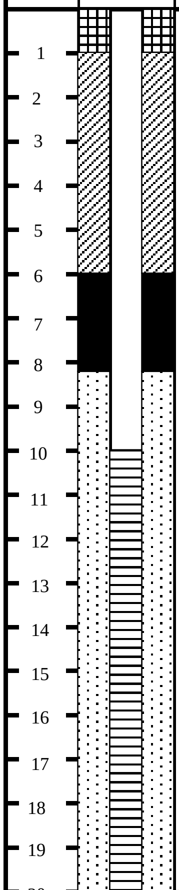
On-Site GW Analysis: H-3, Co-60, Cs-134, Cs-137

Off-Site Non-radiological Laboratory: Northeast Laboratories



Notes: DTW measured on 11-Sep-03

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses



Well Construction Details:

0-1' : Cement, Protective Flushmount Roadbox
1'-6': Portland Cement/Bentonite Grout
6'-8.3': Bentonite Chip Seal
8.3'-20': #0 Silica Sand Filter Pack
0-10': Sched. 40 2" PVC Riser
10'-20': Sched. 40 2" PVC Screen
20': Bottom of Boring

Bottom of Boring at 20' bgs

Key to Well Construction

Sandpack
Bentonite Seal
Well Screen
Cement
Grout

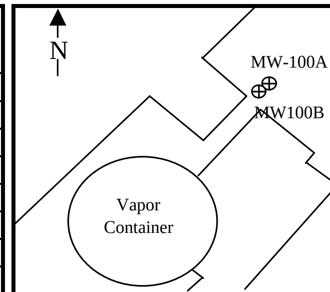
DRILLING LOG for Well #: MW-100B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Project:	Yankee L.T.P.	Project Number:	2107.01
Client:	Yankee Atomic Electric Company	Logged by:	Michael Horesh
Drilling Co:	D.L. Maher	Driller:	Bill Zammow, Oiden Gonzales
Date Started:	1-Aug-03	Date Finished:	5-Aug-03
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic

Screen Diam:	2"	Length:	10'	Slot Size:	0.010"
Casing Diam:	2"	Length:	32.9'	Type:	Schedule 40, 2" PVC
Boring Depth:	42.9'	Well Depth:	42.9'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	9.38'

On-Site GW Analyses: H-3, Co-60, Cs-134, Cs-137
Off-Site Non-radiological Laboratory: Northeast Laboratories



Notes: DTW measured on 9/11/03

Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
0-2	SILT	2'	2'	Brown, loose to medium loose, poorly sorted SILT, some Clay, some to little Gravel, Cobbles, Boulders; dry.	0-2'	0.0	
2-5	SAND	3'	3'	Brown to Orange-Brown, loose, poorly sorted SAND, little Cobbles/Gravel, some to little Boulders; dry.	2'-5'	0.0	
5-10.5	SAND	5.5'	5.5'	Brown to Orange-Brown, loose, poorly sorted SAND, little Gravel, Cobbles, little Boulders (4-8" diameter); dry. 1/2" black layer at~4' (suggests fill).	5'-10.5'	0.0	
10.5-11.5	BOULDER	1'	1'	Gnessic Boulder (13" diameter).	10.5'-11.5'	NA	
11.5-12.5	BOULDER	1'	1'	Gray Gneissic Boulder, broken-up pulverized sections.	11.5'-12.5'	NA	
12.5-16	SAND	3.5'	3.5'	Brown, loose, poorly sorted SAND, some Silt, little Clay, little Cobbles, Boulders; dry, wet at bottom.	12.5'-16'	0.0	
16-21	SAND	5'	5'	Brown to Dark Gray, medium loose to dense fine to coarse SAND and Silt, some Clay, little Cobbles, little Boulders; grading downwards to coarser Sand with higher frequency of Cobbles at bottom of interval; wet.	16'-21'	0.0	**GW-1** VOC-8260B
21-23	SILT	2'	2'	Brown to Gray-Brown, dense, moderately well sorted SILT, little Gravel/Pebbles, trace Cobbles, trace Clay; dry.	21'-23'	0.6[1]	
23-24	SILT	1'	1'	Brown to Gray-Brown, dense, moderately well sorted SILT, little to trace Gravel/Pebbles, little Boulders; dry to moist.	23'-24'	1.2	
24.5-25	BOULDER	0.5'	0.5'	Black to Dark Gray-Light Gray gneissic rock/some pulverized material; dry.	24.5'-25'	NA	

NOTES:
[1] Similar or equal to background levels
*Results of on-Site radiological screening <MDL unless otherwise noted
NA= Not Applicable

Key to Well Construction
Sandpack — Well Screen — Grout — Bentonite Seal — Cement

DRILLING LOG for Well #: MW-100B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Boring Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
26–27		SAND	2'	1.5'	**0-1':** Broken-up gneiss boulder, quartz Cobbles **1'-1.5':** Brown, loose, poorly sorted SAND, some Gravel/Cobbles; dry.	25'-27'	0.0	
28–29		GNEISSIC ROCK	2'	2'	Light Gray, loose, well sorted pulverized rock (rock at tip of core barrel, top of bedrock at 27.5' bgs).	27'-29'	NA	
30–43		BEDROCK	14'	12'	Black and White, strongly foliated gneiss with albite veins dipping at ~30^{o} from horizontal; fracture surfaces bear discolored (reddish-brown) weathering rind; middle core highly fractured (noted by drillers by varying penetration rates) and highly broken-up; large fracture zone at 42'-43' along quartzite zone--moderate discoloration; other fracture zones at 29', 32', 40'.	29'-43'	NA	**GW-2** VOC-8260B

Bottom of Boring at 42.9' bgs.

Well Construction Details:

0-1' : Cement, Protective Flushmount Roadbox
1'-28': Portland Cement/Bentonite Grout
28'-31': Bentonite Chip Seal
31'-42.9': #0 Silica Sand Filter Pack
0'-32.9': Sched. 40 2" PVC Riser
32.9'-42.9': Sched. 40 2" PVC Screen
42.9': Bottom of Boring

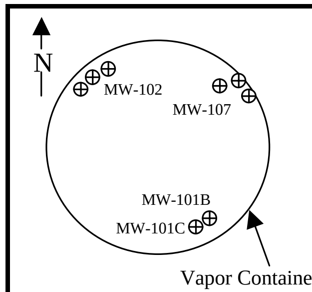
NOTES:
*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-101B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Project:	Yankee L.T.P.	Project Number:	2107.01
Client:	Yankee Atomic Electric Company	Logged by:	Michael Horesh/Eugene Gabay
Drilling Co:	D.L. Maher	Driller:	Chris Huther, Bill Zammow
Date Started:	06-Aug-03	Date Finished:	13-Aug-03
Location:	Rowe, Massachusetts	Drilling Method:	RotoSonic

Screen Diam:	2.5"	Length:	10'	Slot Size:	0.010"
Casing Diam:	2.5"	Length:	142'	Type:	Schedule 80, 2.5" PVC
Boring Depth:	156'	Well Depth:	152'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	20.68'
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site Non-radiological Laboratory:	Northeastern Laboratories		



Notes: DTW measured on 12-Sep-03

Depth	Well Log	Stratigraphy	Penetration	Recovery	Split Spoon Description/Soil Classification	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
0–5		SAND & GRAVEL	5'	2.5'	Brown to Dark Brown, loose, poorly sorted coarse SAND and GRAVEL, little Gravel at top 1' of interval, little Cobbles, little to trace Boulders; moist.	0-5'	0.0	
5–8		SILT	3'	3'	**0-1':** Brown to Dark Brown, medium loose, moderately well sorted SILT, some to little fine Sand, some to little Pebbles, trace Clay; moist to wet. **1'-3':** Brown-Gray, medium dense, moderately well to poorly sorted, SILT and Clay, trace Gravel, trace Pebbles; dry.	5'-8'	0.0	
8–9.5		BOULDER	1.5'	1.5'	Light Gray to Gray Boulder-broken into multiple pieces.	8'-9.5'	0.0	
9.5–11.5		SILT & CLAY	2'	2'	Brown to Gray Brown, dense to very dense, poorly sorted, broken-up CLAY, SILT, some Pebbles, some to little Boulders, trace Gravel.	9.5'-11.5'	N/A	
11.5–15		SAND & SILT	3.5'	3.5'	Brown to Dark Gray-Brown, loose, poorly sorted, medium SAND and SILT, little to some Cobbles, some Gravel, little Boulder; moist.	11.5'-15'	0.0	**GW-1** VOC 8260B
15–20		SILT & CLAY	5'	4.9'	Brown to Gray Brown, dense to very dense, poorly sorted SILT and CLAY, some to little, fine to medium angular Gravel, little Cobbles; moist to dry.	15'-20'	0.0	
20–24		SILT	4'	4'	Gray to Dark Gray-Brown, poorly sorted, very dense SILT, some Clay, little, fine to medium angular Gravel/Cobbles, trace Boulder; dry.	20'-24'	0.0	
24–25								

*Results of on-Site radiological screening <MDL unless otherwise note

N/A=Not Applicable

Key to Well Construction

Sandpack | Bentonite Seal | Well Screen | Cement | Grout

Depth	Stratigraphy	Penetration	Recovery	Split Spoon Description/Soil Classification	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
26–28	SILT & CLAY	4'	4'	Light Gray to Brown, very dense, poorly sorted SILT and CLAY, some Sand, little Gravel/Cobbles/Pebbles; dry.	24'-28'	0.0	
28–35	SILT	7'	7'	**0-1':** Black gneissic boulder with foliated quartz **1'-5':** Gray-Brown, dense, poorly sorted SILT and CLAY, little angular Pebbles/Gravel/Cobbles; dry. **5'-7':** Brown, dense to very dense, poorly sorted SILT and SAND, little to trace Clay; little Gravel/Pebbles/Cobbles; dry.	28'-35'	0.0	
35–45	SILT	10'	10'	**0-2':** Brown, poorly sorted, medium dense to medium loose, fine to medium SAND, little Pebbles/Cobbles; wet. **2'-10':** Gray to Gray-Brown, very dense, poorly sorted SILT, some CLAY, little Gravel, Pebbles (*Boulder at6'-7'), trace Cobbles; dry.	35'-45'	0.0	**GW-2** VOC 8260B
45–52	SILT	7'	7'	**0-3.5':** Dark Gray-Brown, dense, poorly sorted SILT, some fine to medium Sand, little Clay, little Cobbles, Gravel, Pebbles; moist. **3.5'-7':** Light Brown, very dense, poorly sorted SILT, some to little Sand, little Clay, little Pebbles/Cobbles, dry.	45'-52'	0.0	
52–57	SILT	5'	5'	Dark Gray to Dark Brown, very dense, poorly sorted SILT, some Clay, some to little Gravel, little Pebbles, traced Cobbles; dry.	52'-57'	0.0	
57–61	SILT	4'	4'	Brown to Dark Brown to Dark Gray-Brown, very dense, poorly sorted SILT, some Clay, some Gravel/Pebbles, trace Cobbles; dry.	57'-61'	0.0	
61–65	SILT	4'	4'	**0-2':** Brown medium dense, poorly sorted SAND and SILT, some Pebbles, trace Cobbles, some to little Gravel; dry to moist. **2'-4':** Brown, well sorted, dense SILT, some to little Sand, some to little Clay, minor indications of varves; moist.	61'-65'	0.0	**GW-3** VOC 8260B

*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-101B

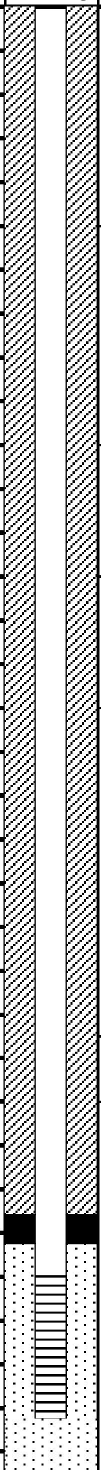
ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Stratigraphy	Penetration	Recovery	Split Spoon Description/Soil Classification	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
65-70	CLAY	5'	5'	**0-1':** Gray, Silty Till, some Gravel; moist. **1'-5':** Gray, very dense, silty Clay, some Cobbles/Boulders; dry.	65'-70'	0.0	
70-73	CLAY	5'	3'	Gray, very dense, Silty Clay, some Cobbles/Boulders; dry.	70'-73'	0.0	
73-77.5	SAND & SILT	4.5'	4.5'	Brown to gray-brown, dense to very dense, moderately well sorted fine Sand and Silt, little Clay, some to little Gravel, little Pebbles, trace Cobbles; moist.	73'-77.5'	0.0	
77.5-84	SAND	6.5'	6.5'	**0-2':** Brown fine to coarse, well sorted loose SAND; wet. **2'-4':** Olive, very fine SAND and Silt, poorly sorted, dense; wet. **4'-6.5':** Olive Silt, very dense and fine subangular Gravel, unsorted, 2-5mm stringers of fine Sand; moist.	77.5'-84'	0.0	**GW-4** VOC-8260B
84-85							
85-92	SILT	7'	7'	**0-2':** Brown-Gray, medium loose to medium dense, coarse to fine SAND and SILT, some angular Gravel; wet. **2'-5.5':** Dark Gray-Blue, very dense, poorly sorted varved SILT, some Clay, some fine to angular Gravel; moist. **5.5'-7':** Varved Silt and Clay with 1-3mm gray Sand interbeds, trace fine Gravel, dense; moist.	85'-92'	0.0	**GW-5** VOC 8260B
92-95	SAND	3'	3'	**0-1':** Gray, loose, well sorted coarse SAND, some Gravel; moist to wet. **1'-3':** Gray, very coarse to coarse SAND, some Gravel some Cobbles; moist to wet.	92'-95'	0.0	
95-103	SAND & SILT	8'	8'	**1-3':** Gray-Blue, poorly sorted, dense fine SAND and SILT, some angular Gravel, some Cobbles; moist. **3'-8':** Gray-Blue, poorly sorted, very dense fine SAND and SILT, some angular Gravel and Cobbles, little Boulders; moist.	95'-103'	0.0	
103-105				SEE NEXT PAGE FOR LOGGING DETAILS			

*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-101B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116



Depth	Well Log	Stratigraphy	Penetration	Recovery	Split Spoon Description/Soil Classification	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
106, 107, 108, 109, 110		SAND & SILT	7'	7'	**0-4':** Brown-Gray, very dense fine SAND and SILT, little Cobbles; moist. **4'-10':** Gray varved Silt and Clay with some Sand, dense, fine to coarse angular Gravel, moderately well sorted; wet.	103'-110'	0.0	
111, 112, 113, 114, 115		SAND	5'	5'	Brown to Gray, medium loose to medium dense, well sorted fine to medium SAND; wet.	110'-115'	0.0	
116, 117, 118		SAND	3'	3'	Brown, loose, medium to fine SAND, little Gravel; wet.	115'-118'	0.0	
119, 120, 121		SILT	3'	3'	Brown to Gray, dense SILT, some Clay, some Boulders; dry.	118'-121'	0.0	**GW-6** VOC-8260B
122, 123, 124, 125, 126, 127, 128		SAND & SILT	7.5'	7.5'	**0-2':** Brown, dense, poorly sorted medium SAND and SILT, some angular Pebbles; wet. **2'-5':** Brown, loose coarse to fine SAND, some Silt, some angular Gravel, some Cobbles, wet. **5'-7.5':** Brown, dense, fine SAND and SILT, some Cobbles, , some angular Gravel, moist to wet.	121'-128.5'	0.0	
129, 130		SAND & SILT	1.5'	1.5'	**0-0.5':** Brown to orange-brown, medium dense, fine to coarse SAND and SILT, some Gravel/Cobbles; wet. **0.5'-2':** Weathered Schist Boulder.	128.5'-130'	0.0	**GW-7** VOC-8260B
133, 136, 139, 142, 145, 148, 151, 154, 157		BEDROCK	25'	18.5'	**0-10':** Black to Dark Gray albite gneiss; highly broken-up/fractured (RQD<5%); reddish-brownish discoloration on rock surfaces (142'). **10'-13.5':** Black to Dark Gray albite Gneiss, higher competency (RQD>95%), higher incidence of quartz, strongly foliated. **13.5'-18.5':** Black to dark Gray albite Gneiss, strongly foliated, moderately competent (RQD >90%); some schistose zones--mostly gneissic.	130'-156'	0.0	**GW-8** VOC-8260B

Well Construction Details:

0-1': Cement, Protective Flushmount Roadbox
1'-138.2': Portland Cement/Bentonite Grout
138.2'-140.2': Bentonite Chip Seal
140.2'-156': #0 Silica Sand Filter Pack
0-142': Sched. 80 2.5" PVC Riser
142'-152': 0.010" Sched. 80 2.5" PVC Screen
156': Bottom of Boring
0-11.5': 8" Steel Casing Grouted in Place

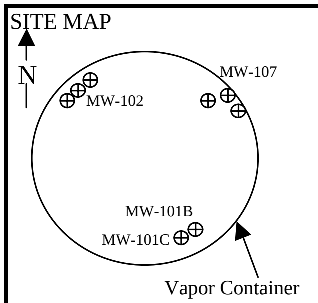
*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-101C

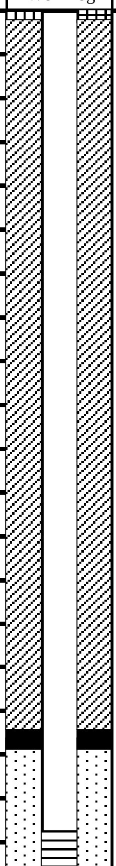
ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Project:	Yankee L.T.P.	Project Number:	2107.01		
Client:	Yankee Atomic Electric Company	Logged by:	Michael Horesh		
Drilling Co.:	D.L. Maher	Driller:	Bill Zammow		
Date Started:	13-Aug-03	Date Finished:	15-Aug-03		
Location:	Rowe, Massachuestts	Drilling Method:	Rotosonic		
Screen Diam.:	2.0"	Length:	5'	Slot Size:	0.010"
Casing Diam.:	2.0"	Length:	94'	Type:	Schedule 40, 2" PVC
Boring Depth.:	99'	Well Depth:	99'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	34.20'
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site Non-radiological Laboratory:	Northeast Laboratories		

SITE MAP



Notes: DTW measured on 12-Sep-03

Depth	Well Log	Stratigraphy	Penetration	Recovery	Split Spoon Description/Soil Classification	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses
5–100					**Well Construction Details:** 0-1': Cement, Protective Flushmount Roadbox 1'-90': Portland Cement/Bentonite Grout 90'-92.1': Bentonite Chip Seal 92.1'-99': #0 Silica Sand Filter Pack 0-94': Sched. 40 2" PVC Riser 94'-99': 0.010" Sched. 40 2" PVC Screen 99': Bottom of Boring			**GW-1** VOC-8260B

Bottom of Boring at 99' bgs

*Results of on-Site radiological activity <MDL unless otherwise noted

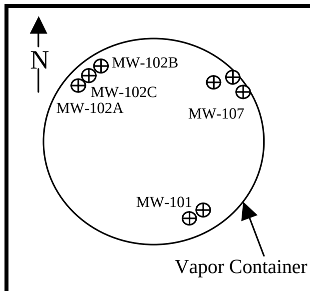
Key to Well Construction

Sandpack
Bentonite Seal
Well Screen
Cement
Grout

DRILLING LOG for Well #: MW-102A

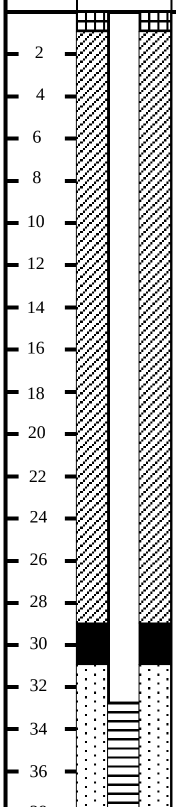
ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Project:	Yankee L.T.P.	Project Number:	2107.01		
Client:	Yankee Atomic Electric Company	Logged by:	Michael Horesh		
Drilling Co:	D.L. Maher	Driller:	Bill Zammow		
Date Started:	30-Jul-03	Date Finished:	31-Jul-03		
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic		
Screen Diam:	2"	Length:	5'	Slot Size:	0.010"
Casing Diam:	2"	Length:	33'	Type:	Schedule 40, 2" PVC
Boring Depth:	38'	Well Depth:	38'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	13.7'
On-Site GW Analysis:	H-3, Co-60, Cs-134, Cs-137	Off-Site Non-radiological Laboratory:	Northeast Laboratories		



Notes: DTW measured on 18-Aug-03

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses



Well Construction Details:

0-1': Cement, Protective Flushmount Roadbox
1'-29': Portland Cement/Bentonite Grout
29'-31': Bentonite Chip Seal
31'-38': #0 Silica Sand Filter Pack
0-33': Sched. 40 2" PVC Riser
33'-38': 0.010" Sched. 40 2" PVC Screen
38': Bottom of Boring

Bottom of Boring at 38' bgs

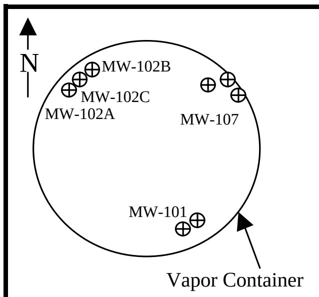
Key to Well Construction

Sandpack
Bentonite Seal
Well Screen
Cement
Grout

Vapor Container

DRILLING LOG for Well #: MW-102B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116



Project:	Yankee L.T.P.	Project Number:	2107.01
Client:	Yankee Atomic Electric Company	Logged by:	Michael Horesh
Drilling Co:	D.L. Maher	Driller:	Bill Zammow, Oiden Gonzales
Date Started:	17-Jul-03	Date Finished:	24-Jul-03
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic

Screen Diam:	2"	Length:	10'	Slot Size:	0.010"
Casing Diam:	2"	Length:	120.2'	Type:	Schedule 40 PVC
Boring Depth:	131.5'	Well Depth:	130.2'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	23.6'
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site Non-radiological Laboratory:	Northeastern Laboratories		

Notes: DTW measured on 18-Aug-03

Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
0–5	SAND & GRAVEL	5'	5'	**0-2':** Brown, loose to medium loose, poorly sorted medium to fine SAND, trace Gravel, little Pebbles, little Cobbles; moist. **2'-5':** Brown to Dark Brown, medium dense, poorly sorted rounded Cobbles, some Gravel, little Pebbles, little Silt; moist to very moist.	0-5'	0.0	
5–10	SAND	5'	5'	**0-2':** Brown to Dark Brown, loose, poorly sorted medium to coarse SAND, little Gravel, little Pebbles, trace to little Cobbles; moist. **2'-4.5':** Brown to Dark Brown, medium dense, poorly sorted, medium to coarse SAND, little to rounded Pebbles, little to some rounded Cobbles, trace Gravel; wet at ~7' **4.5'-5':** Brown, dense, poorly sorted SAND and SILT, Cobbles; moist to dry.	5'-10'	0.0	
10–15	COBBLES/ PEBBLES/ GRAVEL/SAND/ SILT	5'	5'	**0-0.5':** Brown, medium dense to dense, poorly sorted angular to rounded SAND, SILT, angular GRAVEL, COBBLES; moist. **0.5'-5':** Gray, very dense, poorly sorted, CLAY, SILT, PEBBLES, COBBLES; large Boulders at base of interval; dry.	10'-15'	0.0	**GW-1** VOC-8260B H-3=4,370 pCi/L
15–20	CLAY	5'	2.5'	Dark Brown, very dense, poorly sorted CLAY, some Cobbles, Boulders; very dry.	15'-20'	6.3[1]	
20–25	SILT & CLAY	5'	3.6'	Gray to Gray-Brown, very dense, poorly sorted SILT and CLAY, some rounded Cobbles and Boulders, fine to coarse Sand; dry.	20'-25'	6.1[1]	

NOTES:
[1] : Higher FID hits attributed to melted poly sleeve
*Results of on-Site radiological screening <MDL unless otherwise noted

Key to Well Construction
Sandpack
Bentonite Seal
Grout
Cement
Well Screen

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
26–30		SILT	5'	4.8'	Green-Gray to Gray-Brown, very dense, poorly sorted SILT, some to little Clay, some fine Sand, little rounded Pebbles, little Gravel; dry.	25'-30'	3.9[1]	
31–35		SAND & SILT	5'	4'	**0'-2':** Green-Gray to Dark Brown, very dense, poorly sorted SILT, some Clay, trace Gravel, trace Pebbles. **2'-4':** Dark Gray-Brown, loose, well sorted coarse SAND, little rounded Pebbles, trace Gravel; moist to wet.	30'-35'	0.0	**GW-2** VOC-8260B H-3=8,700 pCi/L
36–38		GNEISSIC BOULDERS	5'	2.5'	Light Gray, loose, poorly sorted Clay and crushed/broken Boulders (gneiss); dry.	35'-38'	0.0	
39–42		SILT	4'	4'	Dark Brown to Dark Gray-Brown, very dense to dense, poorly sorted SILT, little Gravel, little Pebbles, little Clay; dry (Top 2' slightly coarser with some wet Sand).	38'-42'	0.0	
43–48		SILT & CLAY	6'	6'	**0-2':** Brown Gray, medium dense to dense SILT and CLAY, some Gravel/Pebbles; moist. **2'-2.5':** Brown-Gray, medium loose, well sorted, coarse Sand, little Clay, little Silt; wet. **2.5'-6':** Blue-Gray, very dense, poorly sorted SILT and CLAY, some Gravel, some to little Cobbles, some to little Pebbles; dry.	42'-48'	0.0	**GW-3** VOC-8260B
49–53		SILT & CLAY	5'	5'	Dark Gray to Brown, very dense, poorly sorted SILT and CLAY, some to little angular to rounded Pebbles, trace rounded Cobbles; dry.	48'-53'	0.0	
54–56		SILT	3'	3'	Dark Gray to Brown, very dense, poorly sorted SILT, some Clay, some to little rounded Pebbles and Cobbles, trace to little angular Cobbles; dry.	53'-56'	0.0	
57–59		SILT	3'	3'	Dark Brown to Dark Gray, dense to very dense SILT, some Clay, little to trace rounded Pebbles, Cobbles; dry (moist at 56'-7' of interval).	56'-59'	0.0	
60–61		SILT & CLAY	2'	2'	Dark Brown to Dark Gray, medium dense to dense, poorly sorted SILT and CLAY, little angular Gravel, Pebbles, little angular to rounded Cobbles; moist.	59'-61'	0.0	
62		SILT	1'	1'	Dark Gray-Brown, dense, well sorted SILT, little to some Clay, little Gravel; moist to dry.	61'-62'	0.0	
63–65		SILT & CLAY	3'	3'	Dark Gray-Brown, medium dense, well sorted SILT and CLAY, trace Gravel, trace Pebbles, trace Boulder; dry.	62'-65'	0.0	

NOTES:
[1]: Higher FID hits attributed to melted poly sleeve
*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-102B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
66 67 68 69		VARVED SILT & CLAY	4'	4'	**0-1.5':** Dark Brown, medium dense, well sorted varved SILT and CLAY, little Gravel **1.5'-3':** Gray to Dark Brown SILT and CLAY, little Gravel, little Pebbles/Boulders. **3'-4':** Dark Gray to Dark Brown SILT and CLAY, little fine Sand lenses (varves), moderately plastic unit.	65'-69'	0.0	
70		SILT	1'	1'	Brown to Dark Brown, medium dense, poorly sorted SILT, some Clay, little angular Gravel/Pebbles; moist	69'-70'	1.1[2]	
71 72		VARVED SILT & CLAY	2.5'	2.5'	Dark Brown to Dark Gray, dense, well sorted SILT and CLAY, some to little dark Gray medium Sand varves throughout section; moist.	70'-72.5'	0.9[2]	
73 74		SILT	2'	2'	Dark Brown, dense to very dense, poorly sorted SILT, some Clay, little angular Gravel, Pebbles; moist.	72.5'-74.5'	1.1[2]	
75 76 77 78 79 80		SILT	5.5'	3.5'	Dark Brown, medium loose to loose, moderately well sorted SILT, little to trace angular Gravel/Pebbles, trace Clay; moist to wet	74.5'-80'	1.2[2]	
81 82 83 84 85		SILT	5'	4.5'	**0-1':** Dark Brown, medium loose to loose, moderately to poorly sorted SILT, little angular Gravel/Pebbles, trace Clay, moist to wet. **1'-4':** Dark Brown, dense, moderately well sorted SILT, little Gravel/Pebbles, trace Clay, moist. **4'-4.':** Medium Gray to Dark Gray -Brown, very dense, poorly sorted SILT and Clay, some to little Cobbles and Boulders; dry.	80'-85'	1.4[2]	
86		SILT	1'	1'	Brown, dense to very dense, poorly sorted SILT, some fine Sand, some to little Boulders/Cobbles; moist to dry.	85'-86'	6.3[1]	
87 88		SILT	2'	1.9'	Brown to Gray, very dense, poorly sorted SILT, some Clay, some rounded Boulders/Cobbles; dry.	86'-88'	4.9[1]	**MW-102B: 90'** VOC (low, med.), Total Solids, TPH-GRO, TPH-DRO, PCB's, SVOC, PP13 Metals
89 90		SILT & BOULDER	2'	2'	**0-1':** Brown, medium loose to medium dense, poorly sorted SILT, some Clay, some round Cobbles, trace Gravel **1'-2':** Light Gray Boulder (albite gneiss)--pulverized.	88'-90'	**7.1**	
91 92 93 94 95		SILT & BOULDERS	5'	5'	Dark Gray-Blue, very dense, poorly sorted SILT, some to little Clay, some angular Gravel, Pebbles, little to trace Cobbles; quartzite Boulder 2' into section (4" diameter); albite gneiss Boulder at bottom of section (8" diameter); dry.[3]	90'-95'	0.7	
96 97 98 99 100		SAND, SILT & CLAY	5'	5'	**0-3':** Brown to Brown Gray, loose, moderately well-sorted, coarse to medium SAND, little angular Pebbles, trace Clay, moist to wet. **3'-5':** Dark Gray, very dense, poorly sorted SILT and CLAY, some angular Cobbles/Pebbles; dry.	95'-100'	2.4	**GW-4** VOC-8260B H-3= 14,800 pCi/L
101 102 103 104 105		SAND & SILT	5'	2.5'	**0-1.5':** Gray to dark Gray-Brown, loose, moderately poorly sorted SILT, little rounded Pebbles, Cobbles, little Boulders; wet. **1.5'-2.5':** Brown to Gray-Brown, loose, well sorted, coarse SAND, little to trace Clay, trace angular Cobbles; wet.	100'-105'	4.1	

NOTES:

[1]: Higher FID hits attributed to melted poly sleeve

[2]: Similar or equal to background levels

[3]: Eberline Frisker yielded reading of ~250 cpm--further analysis attributed activity to naturally-occurring Actinium-228

*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-102B

ERM
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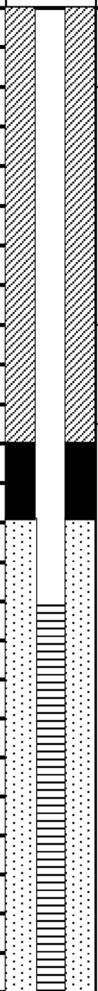
Boston, MA 02116



Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
106–107	SILT & CLAY	2'	1.8'	Brown, medium dense to dense, poorly sorted SILT and CLAY, some to little Gravel and Pebbles, little to trace Cobble; moist.	105'-107'	NR	
107–113	SILT & CLAY	6'	6'	**0-1':** Dark Gray, very dense, poorly sorted SILT and CLAY, some angular Gravel, Pebbles, little Cobbles. **1'-6':** Dark Gray to Brown, dense to broken-up loose, poorly sorted SILT and CLAY, some Pebbles, some to little Boulders @ 111', 112', 113'; moist to dry.	107'-113'	2.7	
113–115.5	SILT & CLAY	2.5'	2.5'	**0-1':** Dark Gray, very dense, poorly sorted SILT and CLAY, some angular Pebbles, little Cobbles; moist to dry. **1'-2.5':** Dark Gray to Dark Brown, dense (broken-up), poorly sorted SILT, little Clay, some Pebbles, Cobbles; moist to dry.	113'-115.5'	0.2	
115.5–130.2	BEDROCK	16'	11.5'	Black to light gray-white, coarse-grained albite gneiss; moderately to strongly foliated; fracture zone at upper 1.5' of section; fracture zone with yellowish discoloration at 5.5'-7.5'; some pieces exhibit natural fractures within competent bedrock. Large quartz cobble at 1' with large albite crystals; quartz veins within bedrock dip at ~30° from horizontal.	115.5'-131.5'	NR	**GW-5** VOC-8260B

Bottom of Boring at 130.2' bgs

Well Construction Details:

0-1': Cement, Protective Flushmount Roadbox
1'-116': Portland Cement/Bentonite Grout
116'-117.9': Bentonite Chip Seal
117.9'-130.2': #0 Silica Sand Filter Pack
0-120.2': Sched. 40 2" PVC Riser
120.2'-130.2': 0.010" Sched. 40 2" PVC Screen
130.2': Bottom of Boring
0-15': 8" Steel Casing Grouted in Place

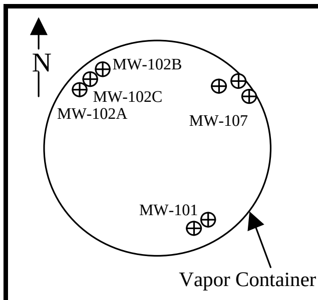
*Results of on-Site radiological screening <MDL unless otherwise noted

NR = Not Recorded

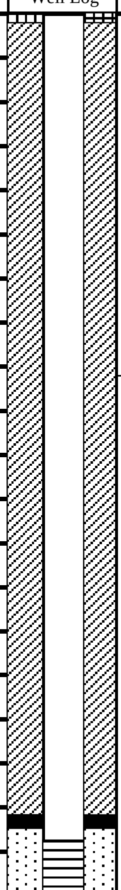
DRILLING LOG for Well #: MW-102C

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Project:	Yankee L.T.P.	Project Number:	2107.01		
Client:	Yankee Atomic Electric Company	Logged by:	Michael Horesh		
Drilling Co:	D.L. Maher	Driller:	Bill Zammow		
Date Started:	25-Jul-03	Date Finished:	30-Jul-03		
Location:	Rowe, Massachuestts	Drilling Method:	Rotosonic		
Screen Diam:	2"	Length:	5'	Slot Size:	0.010"
Casing Diam:	2"	Length:	94'	Type:	Schedule 40, 2" PVC
Boring Depth:	99'	Well Depth:	99'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	35.8'
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site Non-radiological Laboratory:	Northeast Laboratories		



Notes: DTW measured on 18-Aug-03

Depth	Well Log	Stratigraphy	Penetration	Recovery	Split Spoon Description/Soil Classification	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses
0–41						41		**GW-1** VOC-8260B H-3=6,040 pCi/L
41–100					**Well Construction Details:** 0-1': Cement, Protective Flushmount Roadbox 1'-91': Portland Cement/Bentonite Grout 91'-92.5': Bentonite Chip Seal 92.5'-99': #0 Silica Sand Filter Pack 0-94': Sched. 40 2" PVC Riser 94'-99': 0.010" Sched. 40 2" PVC Screen 99': Bottom of Boring			

Bottom of Boring at 99' bgs

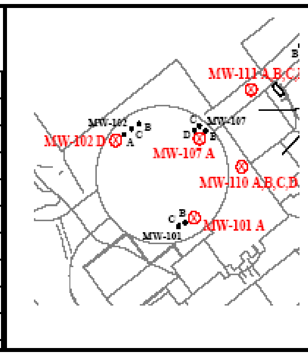
*Results of on-Site radiological activity <MDL unless otherwise noted

Key to Well Construction

Sandpack — Well Screen — Grout
Bentonite Seal — Cement

GEOLOGIST'S LOG for Well #: MW-102D

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:			
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott		
Drilling Co:	Boart Longyear	Driller:	Roy Buckenberger / Mike Hansen		
Date Started:	10-Feb-06	Date Finished:	10-Feb-06		
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic		
Screen Diam:	2 inches	Length:	10 feet	Slot Size:	0.010 inch
Casing Diam:	2 inches	Length:	11 feet	Type:	Schedule 40 PVC
Boring Depth:	22 feet	Well Depth:	21 feet	Boring Diam.:	10" telescoping to 5½"
Surface Elev.:	1133.8 feet NAVD '88	MP:	Ground Surface	Depth to GW:	23.45 feet from PVC
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	PVC Casing Extension Above Grade: 8.1 feet			on April 18, 2006

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	Ground Water Sample No.*
1–5			5'	5'	Fill, dark brown, consisting of silt and sand, f. to c.; some gravel, f. to c., and cobbles; trace roots and wood, trace Mirafi cloth; unsorted, moist, loose.	0-5'	
6–10			5'	5'	Fill, dark brown, consisting of silt and sand, f. to c.; some gravel, f. to c., and cobbles; trace roots and wood, trace Mirafi cloth; unsorted, moist, loose.	5-10'	
11–15			5'	5'	10-14': Fill, dark brown, consisting of silt and sand, f. to c.; some gravel, f. to c., and cobbles; trace roots and wood, trace Mirafi cloth; unsorted, loose, wet at 12'. 14-15': Sand, brown, f. to c. and gravel, rounded, f. to c., some silt, few cobbles, loose, wet.	10-15'	GW-1: H-3=5,560 pCi/L
16–22			7'	7'	15-20': Sand, brown, f. to c. and gravel, rounded, f. to c., some silt, few cobbles, dense, wet. 20-22': Till consisting of olive green-gray silt, little clay and f. sand, f. to c. angular gravel, tr. fist-sized cobbles of garnet schist, unsorted, very dense, moist.	15-22'	
23–26					End of Boring at 22 feet		

NOTES:
*Results of on-site radiological screening <MDL unless otherwise noted

Key to Well Construction

Sandpack; Well Screen; Cement/Bentonite Grout; Bentonite Seal; Cement/Bentonite Grout and 8-inch Steel Casing

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	Ground Water Sample No.*

Monitoring Well Construction Details

0-8.3': 8-inch Steel Casing Extension Above Grade

0-8': Cement/Bentonite Grout and 8-inch Steel Casing Below Grade

0-7': Cement/Bentonite Grout

7-9': Bentonite Chip Seal

9-22': # 0 (medium) Silica Sand Filter Pack

0-11': Schedule 40, 2-inch PVC Well Riser

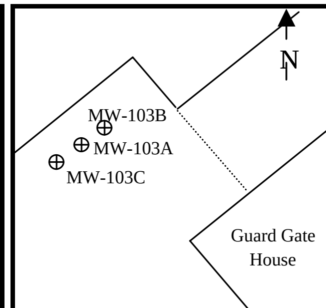
11-21': Schedule 40, 2-inch PVC, 0.010-inch Slot Well Screen

22': Bottom of Boring

*Results of on-site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-103A

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116



Project:	Yankee L.T.P.	Project Number:	2107.01
Client:	Yankee Atomic Electric Company	Logged by:	Michael Horesh
Drilling Co:	D.L. Maher	Driller:	Oiden Gonzales
Date Started:	16-Jul-03	Date Finished:	16-Jul-03
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic

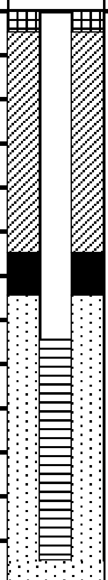
Screen Diam:	2"	Length:	10'	Slot Size:	0.010"
Casing Diam:	2"	Length:	15'	Type:	Schedule 40 PVC
Boring Depth:	26'	Well Depth:	25'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	18.58'

On-Site GW Analyses: H-3, Co-60, Cs-134, Cs-137
Off-Site Non-radiological Laboratory: Northeastern Laboratories

Notes: GW measured on 8-Sep-03

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) spoon/HS	Lab Sample # & Analyses

2
4
6
8
10
12
14
16
18
20
22
24
26



Well Construction Details:

0-1': Cement, Protective Flushmount Roadbox
1'-11': Portland Cement/Bentonite Grout
11'-13': Bentonite Chip Seal
13'-26': #0 Silica Sand Filter Pack
1-15': Sched. 40 2" PVC Riser
15'-25': 0.010" Sched. 40 2" PVC Screen
26': Bottom of Boring

Bottom of Boring at 26' bgs

*Results of on-Site radiological activity <MDL unless otherwise noted

Key to Well Construction

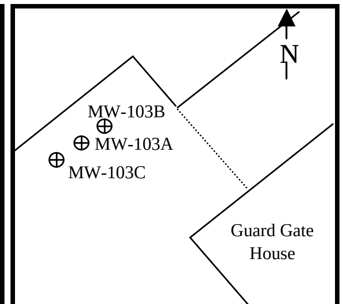
- Sandpack
- Bentonite Seal
- Well Screen
- Cement
- Grout

DRILLING LOG for Well #: MW-103B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Project:	Yankee L.T.P.	Project Number:	2107.01
Client:	Yankee Atomic Electric Company	Logged by:	Michael Horesh
Drilling Co:	D.L. Maher	Driller:	Bill Zammow, Oiden Gonzales
Date Started:	9-Jun-03	Date Finished:	9-Jul-03
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic

Screen Diam:	2.5"	Length:	10'	Slot Size:	0.010"
Casing Diam:	2.5"	Length:	284.5'	Type:	Schedule 80 PVC
Boring Depth:	294.5'	Well Depth:	294.5'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	37.90'
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site Non-radiological Laboratory:	Northeastern Laboratories		



Notes: DTW measured on 9-Sep-03

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
1–5		SAND & GRAVEL	5'	4.9'	**0-1.3':** Brown to Orange Brown, loose, poorly sorted coarse SAND and GRAVEL, little Pebbles, trace Cobbles/Boulders;dry. **1.3'-4.9':** Brown to Red Brown, loose, poorly sorted coarse SAND (mica), little Pebbles, trace Cobbles/Boulders; dry.	0-5'	0.5	
6–15		SAND	10'	9.5'	Dark Brown to Gray Brown, loose, poorly sorted, coarse to fine SAND, some rounded Cobbles/Boulders, little rounded Pebbles; Dark Brown banded interval from 1.8'-2.0', Gray-Tan interval w/ Pebbles and Boulders from 3.8'-4.0'; dry.	5'-15'	0.0	
16–25		SAND	10'	5.5'	**0-2.5':** Brown to Orange Brown, loose, moderately well-sorted coarse to medium SAND, some rounded Pebbles, trace rounded Boulders, Clay, dry. **2.5'-3.5':** Light Brown to Gray, loose, poorly sorted fine to medium SAND, little rounded Gravel, some rounded Boulders, trace Pebbles, moist. **3.5'-5.5':** Brown to Orange Brown, loose, moderately well-sorted coarse to medium SAND, some to little rounded Pebbles, wet.	15'-25'	0.0	

NOTES:
*Results of on-Site radiological screening <MDL unless otherwise noted

Key to Well Construction
Sandpack, Well Screen, Grout, Bentonite Seal, Cement

DRILLING LOG for Well #: MW-103B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Boring Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
26 27 28 29		SAND, SILT & CLAY	4.0'	4'	**0-1':** Light Tan to Yellow tan, dense, poorly sorted SILT, SAND and rounded Pebbles, Cobbles; dry. **1'-4':** Gray-Brown to Brown, dense, poorly sorted, SAND, CLAY, SILT and rounded Gravel, Pebbles and Cobbles; dry to moist.	25'-29'	0.0	**GW-1** VOC-8260B
30 31 32		SAND, SILT & PEBBLES	3.0'	2.8'	**0-8", 2-2.8':** Brown to Red Brown, very dense, poorly sorted SILT, SAND, PEBBLES, trace rounded Boulder;dry. **0.8'-2.0':** Light Gray, medium dense medium SAND, little Pebbles/Cobbles, trace Boulders; dry.	29'-32'	0.0	
33 34 35		SAND & SILT	3.0'	2.0'	Brown to Red Brown, loose to dense, poorly sorted SAND and SILT, some to little rounded Pebbles, rounded Boulders; dry.	32'-35'	0.0	
36 37 38 39		SAND & SILT	4.0'	3.8'	Dark Gray-Brown, very dense, moderately well sorted fine SAND and SILT, little to trace rounded Cobbles/Pebbles, semi-rounded schist Boulder at base of interval; dry.	35'-39'	2.2[1]	
40 41		SAND & SILT	2.0'	2.0'	Dark Gray-Brown to Red-Brown, very dense, poorly sorted SILT and fine to coarse SAND, rounded schist Pebbles w/ talc, garnet; some zones of yellowish-reddish oxidation; moist.	39'-41'	0.0	
42 43 44 45		SAND & SILT	4.0'	4.0'	**0-0.5':** Dark Brown, medium dense, well sorted fine SAND, trace rounded Gravel/Pebbles; moist. **0.5'-2.8':** Dark Brown to Dark Gray, very dense, well sorted SILT, trace rounded Pebbles; dry. **2.8'-4.0':** Dark Brown, medium loose, well sorted medium to coarse SAND, trace Gravel, little Pebbles; wet	41'-45'	0.0	
46 47 48 49		SAND & SILT	4.0'	3.0'	**0-2.4':** Dark Gray-Brown to Dark Brown, dense to very dense, moderately well sorted SILT and fine SAND, some coarse SAND, little Pebbles, trace Cobbles; dry. **2.4'-3.0':** Light Tan to Greenish Brown, very dense SILT and fine SAND, some to little rounded Talc Cobbles, little Pebbles/Boulders; dry.	45'-49'	0.0	
50 51		SAND & SILT	2.0'	2.0'	Medium Brown to Reddish Brown, very dense, moderately well sorted SILT and SAND, trace rounded Gravel, gneissic-schist broken-up/massive Boulder; dry.	49'-51'	0.0	
52 53 54 55		SAND & SILT	4.0'	4.0'	**0-3.5':** Dark Gray Brown to Yellowish Brown very dense, well to poorly sorted SILT and fine SAND, some rounded Pebbles, rounded gneissic-schist Boulder; dry. **3.5'-4.0':** Dark Gray-Brown, very dense, moderately well sorted fine SAND and SILT, little rounded schist Pebbles and Cobbles; dry.	51'-55'	0.0	
56 57 58		SAND & SILT	3.0'	3.0'	Gray-Brown to Green, very dense to dense, poorly sorted fine SAND and SILT, some to little rounded schist Cobbles, trace to little Clay, trace medium Sand, trace Gravel/Pebbles; dry.	55'-58'	0.0	
59								
60 61 62 63 64 65		SAND & SILT	6.0'	6.0'	Dark Gray-Brown, very dense to dense, very well sorted, interbedded (1/16"-1/8") medium to very fine SAND and SILT; wet.	59'-65'	0.0	**GW-2** VOC-8260B

NOTES:

[1]: Headspace reading not repeatable

*Results of on-Site radiological screening <MDL unless otherwise noted

Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
66–68	SILT	3.0'	3.0'	Dark Brown to Dark Reddish-Brown, very dense, moderately well sorted SILT, little highly-oxidized Talc Pebbles/Cobbles, some to little fine Sand; moist.	65'-68'	0.0	
69–71	SAND & SILT	3.0'	2.8'	Brown-Green-Gray, very dense, well sorted fine SAND and SILT, trace rounded schist Cobbles, little rounded Gravel; dry.	68'-71'	0.0	
72–75	SAND & SILT	4.0'	4.0'	Orange-Brown to dark Gray Brown, very dense, poorly sorted fine SAND and SILT, some rounded schist Cobbles/Pebbles, trace Clay, little rounded schist Boulders; dry.	71'-75'	0.0	
76–78	SILT	3.0'	3.0'	Dark Gray-Brown, very dense to dense, well sorted SILT, little fine Sand, little to trace rounded Pebbles, multiple zones of yellowish staining, trace angular to rounded Gravel; moist.	75'-78'	0.0	
79–81	SILT	3.0'	3.0'	Dark Gray-Brown, very dense, well sorted SILT, some fine Sand some Clay, little rounded Talc, Cobbles; moist.	78'-81'	0.0	
82–83	SILT	2.0'	2.0'	Dark Brown-Gray, dense to very dense, well sorted SILT, little rounded Pebbles--large orange-yellow quartzite boulder at bottom of interval; dry.	81'-83'	0.0	
84–85	SAND	2.0'	2.0'	Dark Brown-Gray, very dense, moderately well sorted fine SAND, some Silt, little to some Boulders, trace Clay; dry.	83'-85'	0.0	
86–88	SAND & SILT	3.0'	3.0'	Dark Brown, very dense, moderately well sorted SAND, some SILT, some Talc Pebbles/Cobbles, some whitish-yellowish discoloration at bottom of interval; dry.	85'-88'	0.0	
89–92	SAND & SILT	4.0'	4.0'	Dark Brown-Gray, very dense, poorly sorted very fine SAND and SILT, some rounded Pebbles, little rounded Cobbles; dry.	88'-92'	0.0	
93–95	SAND & SILT	4.0'	2.8'	**0-2.2':** Brown to Dark Brown, medium dense, well sorted SILT, little Clay, little Pebbles, trace Gravel. **2.2'-2.8'**: Brown to gray brown fine SAND, some Silt, little rounded Cobbles, trace Gravel/Pebbles; dry.	92'-95'	0.0	
96–100	SAND & SILT	5.0'	5.0'	Dark Brown to Gray Brown fine, very dense, moderately well sorted. SAND and SILT, some medium SAND, little rounded Pebbles, little to trace Cobbles; dry.	95'-100'	0.0	
101–105	SILT	5.0'	3.5'	Dark Brown to Gray Brown, medium dense to dense, poorly sorted SILT, some Clay, little angular Gravel, little angular Boulders; Orange rind in 4" Sand zone; dry.	100'-105'	3.2	**GW-3** VOC-8260B H-3=1,900 pCi/L

NOTES:
*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-103B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
106–110		CLAY	5'	5'	Medium Brown and Dark Gray dense, well sorted CLAY, some Silt, some fine Sand (micas); medium stiff; miost (varves).	105'-110'	1.3[2]	
110–115		CLAY	5'	5'	Brown to Bluish-Green Gray, dense, well sorted CLAY, some Silt, trace Sand (mica) stringers, medium stiff; moist to wet (varves).	110'-115'	1.7[2]	
115–125		CLAY	10'	10'	Bluish-Green Gray, very stiff, well sorted CLAY and very fine micaceous SAND (varves)	115'-125'	2.0[2]	
125–135		CLAY	10'	10'	Brown to Dark Brown, very stiff, well sorted CLAY with Dark Gray to Gray micaceous very fine Sand interbeds (varves--1mm to several cm in thickness); wet.	125'-135'	1.4[2]	
135–145		CLAY	10'	10'	Brown to Dark Brown, stiff to very stiff, well sorted CLAY, trace Gray Clay with Dark Gray very fine micaceous Sand varves; trace Gravel (Talc?); wet.	135'-145'	2.0[2]	

NOTES:

[2]: Similar or equal to background levels

*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-103B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
146–149	CLAY	4.0'	3.8'	Brown to Dark Brown, very stiff CLAY with some Silt, grading downward to Clay and Gravel, grading downward into Clay/Sand/Cobbles/Gravel; wet.	145'-149'	0.0	
150–155	CLAY	6.0'	5.5'	**0-1':** Gray Brown, very dense SILT, some fine to medium subangular Gravel, little fine to medium Sand; moist. **1'-6':** Brown to Gray Brown, dense, moderately well sorted CLAY with little micaceous Sand varves (no grain size greater than medium Sand).	149'-155'	0.2	**GW-4** VOC-8260B
156–160	CLAY	5.0'	5.0'	Brown to Dark Brown, dense, moderately well sorted to well sorted Clay with medium to coarse Sand varves, interval coarsening downwards, oxidized Talc (?) Cobble; bottom 6" consists of fine Sand, trace Silt; wet.	155'-160'	1.1[2]	
161–165	SILT	5.0'	4.5'	Dark Brown to Dark Brown-Gray, medium dense, poorly sorted SILT and some Clay, some to little angular, fine to coarse Gravel little Pebbles; wet.	160'-165'	0.6	
166–170	SAND	5.0'	5.0'	Dark Brown-Gray, dense to medium dense, poorly sorted medium to fine SAND, little rounded Pebbles, trace rounded Cobble, little Silt (at top of interval).	165'-170'	2.0	**GW-5** VOC-8260B
171–185	SAND	15.0'	15.0'	**0-5':** Dark Brown to medium Gray, medium dense to loose, well sorted fine SAND and Silt, trace Clay; wet. **5'-10':** Dark Brown to medium Gray, medium dense to loose, well sorted medium to fine SAND, trace Silt; wet. **10'-15':** Dark Brown to medium Gray, medium dense, well sorted SILT, some to little fine Sand, trace Clay; wet.	170'-185'	2.0[1,2]	**GW-6** VOC-8260B

NOTES:

[1]: Headspace reading not repeatable

[2]: Similar or equal to background levels

*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-103B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
186–194		SAND	9.0'	9.0'	Gray-Brown, medium loose to medium dense, well sorted coarse to fine SAND, little fine SAND and Silt--grades downward at 7' to Silt and Clay, trace fine SAND; wet.	185'-194'	1.9	
194–195		SAND	1.0'	1.0'	Gray-Brown, medium loose, well sorted fine SAND; wet.	194'-195'	2.2	
195–215		SAND & SILT	20'	20'	**0-7':** Gray-Brown, medium loose, well sorted medium SAND, some fine Sand, little to trace coarse Sand; wet. **7'-11':** Brown to Dark Gray Brown, very stiff, well sorted Clay, little gray Silty interbeds (varves), trace angular Pebbles, little to trace angular Gravel; wet. **11'-17.5':** Brown to Dark Gray Brown, medium dense, well sorted SILT, some fine SAND, little to some Clay; wet. **17.5'-20':** Brown to Dark Gray Brown, medium dense to medium loose, well sorted fine SAND grading downwards to medium SAND; wet.	195'-215'	N/A	
215–225		SAND	15'	15'	**215'-218':** Dark Gray Brown, medium dense to medium loose, well sorted coarse to fine SAND fining downwards to Clay, some Silt; wet. **218'-224':** Dark Gray Brown, medium dense, well sorted fine SAND and Silt; wet. **224'-228':** Dark Gray Brown, well sorted, medium loose, medium to fine SAND, little Silt; wet. **228'-230'**: Dark Gray to Brown, dense, well sorted Silt, some Clay with Gray fine SAND interbeds (varves); wet.	215'-230'	0.0	

NOTES:
*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-103B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
226–230					SEE PREVIOUS PAGE FOR LOGGING DETAILS			
230–245		SAND & SILT	20'	15'	**0-7':** Gray to Dark Gray-Brown, medium loose, well sorted fine SAND and SILT; wet. **7'-9':** Gray to Dark Gray-Brown, stiff, well sorted Clay, little Silt varves; moist. **9'-15':** Gray to Dark Gray-Brown, medium dense to medium loose, well sorted fine SAND and SILT, grading into dominantly Clay with Silt varves; moist.	230'-245'	0.0	
245–265		SILT & CLAY	20'	20'	**0-7':** Dark to Medium Gray-Brown, medium dense, well sorted SILT, some CLAY. **7'-13':** Medium Gray-Brown, dense, well sorted SILT and CLAY, little very fine Sand varves, trace Gravel, trace rounded Pebbles, angular Gravel (unit shears along very fine SAND and SILT beds). **13'-18':** Medium Gray-Brown, dense, well sorted SILT and CLAY, little very fine Sand. **18'-20':** Medium Gray-Brown, dense, well sorted SILT and CLAY, trace very fine Sand and Silt varves.	245'-265'	0.0	

NOTES:
*Results of on-Site radiological sceening <MDL unless otherwise noted

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
266	SAND & SILT	1'	1	Medium Brown, medium dense, well sorted SILT, some Clay, coarsening downward to coarse to fine SAND, trace Silt.	265'-267'	2.5	
267–270	SCHIST BOULDER	4'	4'	**0-1.5':** Weathered Black gneissic-schist boulder, large, potentially albite crystals. **1.5-4':** Highly weathered, Black, Tan, Orange, Brown Schist with trace lodged rounded Pebbles, some Gravel, weathered to coarse Sand-sized grains.	267'-271'	2.0	
271–274	SAND	3.5'	3.5'	Dark Brown-Gray, medium dense, moderately well-sorted, coarse SAND, some Silt and Clay, cored boulder (gneissic) at 2.5'-3.5', trace rounded cobbles at base of interval; wet.	271'-274'	1.7	
275–276	BOULDERS	2'	2'	**0-0.5':** Multi-colored, loose, poorly sorted SAND & GRAVEL and medium dense fine Sand and Silt **0.5'-2':** Very Gray to Black weathered Schistic-Gneiss Boulders.	275'-277'	3.5[2]	**GW-7** (Sample too Silty for Submittal)
277–278	BOULDERS	2'	1.5'	Very Dark Gray to Black weathered Cobbles to Boulders.	277'-279'	0.0	
279	SILT	1'	1'	Dark Gray to Dark Gray Brown, poorly sorted, dense SILT, little to some Clay, some rounded Cobbles, trace Gravel, trace Pebbles.	279'-280'	0.0	
280–295	BEDROCK	15'	15'	Black to Light Gray/White Gneiss, strongly foliated, some associated Talc (Garnet?), horneblende, mica, foliation at ~35° to horizontal; competent rock with several drillers' breaks, few natural fractures.	280'-295'	N/A	**GW-8** VOC-8260B

Bottom of Boring at 294.5' bgs

Well Construction Details:

0-1': Cement, Protective Flushmount Roadbox
1'-279': Portland Cement/Bentonite Grout
279'-282': Bentonite Chip Seal
282'-295': #0 Silica Sand Filter Pack
0-284.5': Sched. 80 2.5" PVC Riser
284.5'-294.5': 0.010" Sched. 80 2.5" PVC Screen
294.5': Bottom of Boring
0-30': 8" Steel Casing Grouted in Place

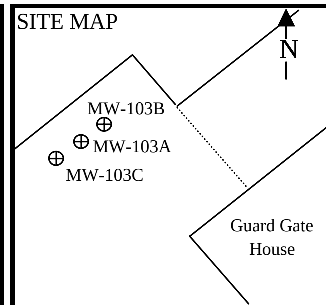
NOTES:
[2]: Similar or equal to background levels
*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-103C

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Project:	Yankee L.T.P.			Project Number:	2107.01
Client:	Yankee Atomic Electric Company			Logged by:	Michael Horesh
Drilling Co:	D.L. Maher			Driller:	Bill Zammow
Date Started:	11-Jun-03			Date Finished:	16-Jul-03
Location:	Rowe, Massachusetts			Drilling Method:	Rotosonic
Screen Diam:	2"	Length:	10'	Slot Size:	0.010"
Casing Diam:	2"	Length:	115'	Type:	Schedule 40 PVC
Boring Depth:	125'	Well Depth:	125'	Boring Diam.:	5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	76.80'
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site Non-radiological Laboratory		Northeastern Laboratories	

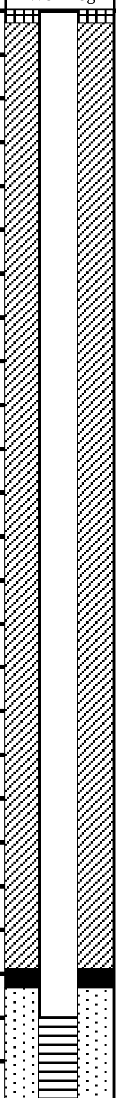
SITE MAP



Notes: DTW measured on 17-Jul-03

Depth	Well Log	Stratigraphy	Penetration	Recovery	Split Spoon Description/Soil Classification	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses

Depth scale: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85, 90, 95, 100, 105, 110, 115, 120, 125



Well Construction Details:

0-1': Cement, Protective Flushmount Roadbox
1'-110.5': Portland Cement/Bentonite Grout
110.5'-112.3': Bentonite Chip Seal
112.3'-125': #0 Silica Sand Filter Pack
0-115': Sched. 40 2" PVC Riser
115'-125': 0.010" Sched. 40 2" PVC Screen
125': Bottom of Boring

Lab Sample # & Analyses: **65' bgs** **GW-1** VOC-8260B

Bottom of Boring at 125' bgs

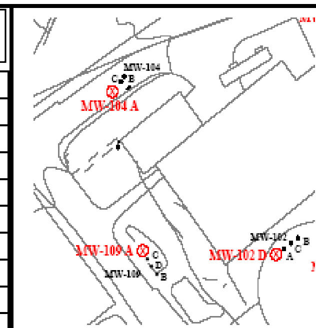
*Results of on-Site radiological activity <MDL unless otherwise noted

Key to Well Construction

- Sandpack
- Bentonite Seal
- Well Screen
- Cement
- Grout

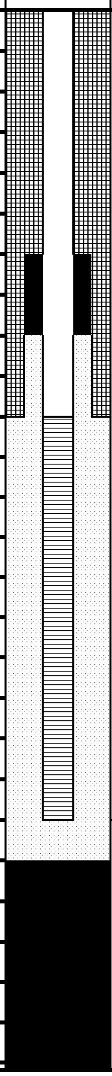
GEOLOGIST'S LOG for Well #: MW-104A

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:	
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott
Drilling Co:	Boart Longyear	Driller:	Roy Buckenberger / Mike Hansen
Date Started:	6-Feb-06	Date Finished:	6-Feb-06
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic

Screen Diam:	2 inches	Length:	10 feet	Slot Size:	0.010 inch
Casing Diam:	2 inches	Length:	10 feet	Type:	Schedule 40 PVC
Boring Depth:	20 feet	Well Depth:	20 feet	Boring Diam.:	10" telescoping to 5½"
Surface Elev.:	1118.5 feet NAVD '88	MP:	Ground Surface	Depth to GW:	8.50 feet from PVC
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	PVC Stick Up Above Ground: 0 feet			on April 18, 2006



Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	Ground Water Sample No.*
1–5		Sand & Gravel	5'	5'	Sand, brown, f. to c. and gravel, f. to c., subangular; some silt; loose, dry.	0-5'	
5–10			5'	5'	Sand, brown, f. to c. and gravel, f. to c., subangular; some silt; loose, moist. Advance 10" drill casing to 10', install 8" permanent steel casing to 10', cement grout annular space and withdraw 10" drill casing.	5-10'	
10–15			5'	5'	Sand, brown, f. to c. and gravel, f. to c., subangular; some silt; loose, wet.	10-15'	GW-1: H-3=8,070 pCi/L
15–22		Sand & Gravel (to 20); Till (below 20)	7'	7'	15-20': Sand, brown, f. to c. and gravel, f. to c., subangular; some silt; loose, wet. Sand and gravel with gray clay from 17 to 17.5'. 20-22': Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, weathered gneiss cobbles, unsorted, very dense, dry.	15-22'	
22–26		Till	5'	5'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry.	22-27'	

NOTES:
*Results of on-site radiological screening <MDL unless otherwise noted

Key to Well Construction

Sandpack — Well Screen — Cement/Bentonite Grout
Bentonite Seal — Cement/Bentonite Grout and 8-inch Steel Casing

DRILLING LOG for Well #:	MW-104A	Yankee Nuclear Power Station, Rowe, MA	Page 2 of 2

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	Ground Water Sample No.*
27		Till	5'	5'	See Previous Page	22-27'	

Bottom of Boring at 27'

Well Construction Details:

0-1': Concrete, Flushmount Roadbox
0.5-10': 8" Steel Casing Cement/Bentonite-Grouted in Place
1-6': Cement/Bentonite Grout
6-8': Bentonite Chip Seal
8-21': #0 (medium) Silica Sand Filter Pack
0-10': Schedule 40 2" PVC Riser
10-20': Schedule 40 2" PVC, 0.010"-Slot Screen
21-27': Bentonite Chip Seal
27': Bottom of Boring

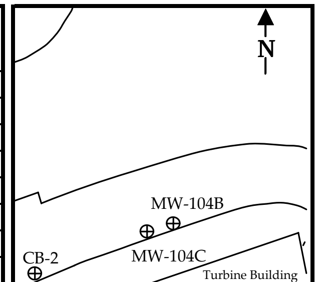
*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-104B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Project:	Yankee L.T.P.	Project Number:	2107.01
Client:	Yankee Atomic Electric Company	Logged by:	Michael Horesh
Drilling Co:	D.L. Maher	Driller:	Bill Zammow, Oiden Gonzales
Date Started:	22-Aug-03	Date Finished:	04-Sep-03
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic

Screen Diam:	2.5"	Length:	10'	Slot Size:	0.010"
Casing Diam:	2.5"	Length:	184'	Type:	Schedule 80 PVC
Boring Depth:	194.5'	Well Depth:	194'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	23.60'
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site Non-radiological Laboratory:	Northeastern Laboratories		



Notes: DTW measured on 18-Aug-03

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
1 2		SAND & GRAVEL	2'	2'	Brown to Dark Brown, loose, moderately sorted medium SAND and fine to coarse, well rounded GRAVEL, some to little rounded Pebbles, little to trace rounded Boulders, Cobbles, trace angular Gravel; dry.	0-2'	2.4[1]	
3 4 5		SAND & GRAVEL	3'	3'	Brown to Dark Brown, loose to moderately loose, poorly sorted medium SAND and fine to coarse, well rounded GRAVEL, some to little rounded Pebbles, Cobbles, trace to little Silt, trace Clay; moist (beginning at ~3' bgs).	2'-5'	0.6[1]	
6 7 8 9 10 11 12 13 14 15		SAND & GRAVEL	10'	10'	**0-5':** Brown-Orange Brown, loose, poorly sorted medium to coarse SAND, some angular Gravel/Pebbles, little rounded Cobbles; moist. **5'-7':** Brown to Dark Gray-Brown, loose, poorly sorted, medium to coarse SAND, some angular Gravel/Pebbles, little rounded Cobbles;moist **7'-10':** Brown to Dark Orange Brown, loose, poorly sorted, medium to coarse SAND, little angular Gravel, some rounded Cobbles, little to trace Clay; moist to wet (wet at ~14.5')	5'-15'	0.0	
16 17 18 19 20		SAND & GRAVEL	5'	5'	**0-2'**: Dark Brown to Reddish Brown, loose to moderately loose, poorly sorted medium to coarse SAND and fine to coarse GRAVEL, some rounded to angular Pebbles/Cobbles, trace to little Silt Clay **2'-5'**: Dark Gray Brown, medium dense, fine to coarse SAND, little to some Clay, trace Boulders, Cobbles; dry.	15'-20'	0.0	
21 22 23 24 25		SILT	5'	5'	**0-2.5'**: Dark Gray Brown, very dense, moderately sorted SILT, some to little Clay, little rounded Pebbles, little rounded schist Cobble; dry. **2.5'-5.0'**: Dark Gray Brown, very dense, poorly sorted SILT, some Clay, some angular rounded Pebbles, little Boulder; dry.	20'-25'	0.0	**GW-1** VOC-8260B

NOTES:
1 : Similar or equal to background levels
*Results of on-Site radiological screening <MDL unless otherwise noted

Key to Well Construction
Sandpack
Bentonite Seal
Well Screen
Cement
Grout

DRILLING LOG for Well #: MW-104B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Well	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
26–29		SILT	4'	4'	Bluish Gray, dense to very dense, moderately well sorted SILT, little Clay, little to trace Gravel, trace Pebbles; dry.	25'-29'	0.0	
29–32		SAND	3'	3'	**0-1'**: Gray-Brown, dense, well sorted Silt, trace coarse SAND, trace Gravel/Pebbles (angular); moist. **1'-3'**: Gray-Gray Brown, medium dense, well sorted fine SAND, trace Silt; moist.	29'-32'	0.0	
32–34		SAND & SILT	2'	2'	Dark Brown to Gray, medium dense, well sorted fine SAND and SILT, little to trace angular Pebbles, trace Gravel; moist.	32'-34'	0.0	
34–35		SILT	1'	1'	Brown to Gray Brown, medium dense, poorly sorted SILT, some fine Sand, little Pebbles/Gravel; moist (boulder at tip of core).	34'-35'	0.2	
35–43		SAND	8'	8'	**0-3'**: Brown to Gray, medium dense, poorly sorted fine SAND and Silt, some to little Pebbles, little angular Gravel, little to trace Cobbles; moist (dry boulder at 37'). **3'-8'**: Brown, medium loose, well sorted medium SAND, trace Cobbles, trace Silt; wet.	35'-43'	0.0	**GW-2** VOC-8260B H-3=6,270 pCi/L
43–50		SAND & SILT	7'	7'	**0-1'**: Brown, loose, well sorted coarse SAND; wet. **1'-2'**: Brown, very dense, moderately sorted SILT, little angular Gravel; moist. **2'-5'**: Brown, medium dense to medium loose, poorly sorted SAND, GRAVEL, PEBBLES, SILT, trace Clay; dry. **5'-7'**: Brown to Gray Brown, very dense, poorly sorted SILT, Cobbles, some to little Clay, little medium SAND; dry.	43'-50'	0.0	
50–55		SILT	5'	5'	**0-2.5'**: Gray to Dark Gray-Blue, very dense, poorly sorted SILT, some angular Cobbles, some to little Clay, little Gravel; dry. **2.5'-5'**: Gray-Blue to Dark Gray, very dense, poorly sorted SILT, some Clay, little angular Pebbles/Gravel, minor indications of varving; dry.	50'-55'	0.0	
55–59		SAND & SILT	4'	5'	Dark Gray-Brown to Gray, medium dense to dense, poorly sorted fine SAND and SILT, some to little Clay, some angular Gravel/Pebbles; moist to dry.	55'-59'	0.0	
59–65		SILT & CLAY	6'	6'	**0-5'**: Dark Brown-Gray, dense to very dense, poorly sorted SILT and CLAY, some to little angular to rounded Gravel, trace Pebbles, dry to moist. **5'-6'**: Brown to dark Brown fine Sand and SILT, trace Gravel, trace Pebbles; moist.	59'-65'	0.9	

NOTES:
*Results of on-Site radiological screening <MDL unless otherwise notec

DRILLING LOG for Well #:	MW-104B	ERM 399 Boylston Street, 6th Floor Boston, MA 02116	Page 3 of 6

Depth	Boring Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
66–69		SILT & CLAY	4'	4'	Dark Brown to dark Brown-Gray, medium dense to dense, well to moderately well sorted SILT and CLAY, little to trace angular Gravel/Pebbles, trace Cobbles, varved intervals throughout; moist (LACUSTRINE?).	65'-69'	2.2	
69–70		SILT	1'	1'	Dark Brown, medium dense, poorly sorted SILT, some Clay, some to little angular Pebbles/Gravel, trace fine Sand, some varving, moist.	69'-70'	0.0	
70–72		SILT	2'	2'	Dark Brown, dense to very dense, poorly sorted SILT, some Clay, some Gravel/Pebbles (angular), trace Cobbles; moist.	70'-72'	0.0	
72–75		SILT and CLAY	3'	3'	**0-1.5':** Medium Brown, very dense, poorly sorted SILT and CLAY, little angular Gravel/Pebbles; dry. **1.5'-3':** Pulverized boulder (black gneissic schist); dry.	72'-75'	0.0	
75–80		SILT	5'	5'	Dark Gray-Brown to Gray, medium dense, poorly sorted SILT, some Clay, little fine Sand, some to little angular Gravel/Pebbles; moist to dry.	75'-80'	0.0	
80–85		SILT	5'	5'	Dark Brown to Dark Brown-Gray, dense, poorly sorted SILT, some to little fine Sand, little angular Gravel/Pebbles, trace Cobbles, little to trace Clay; dry to moist.	80'-85'	0.0	
85–90		SILT	5'	5'	Dark Brown, medium dense, poorly sorted SILT , little Clay, little fine Sand, little Pebbles, trace Cobbles; moist to dry.	85'-90'	0.6	
90–95		SILT	5'	4.5'	**0-2.5':** Dark Brown to dark Gray-Brown, medium dense, poorly sorted SILT, little Clay, little angular Gravel/rounded Pebbles; dry. **2.5'-4':** Dark Brown, loose to medium loose, moderately sorted SILT, some to little Clay, trace Gravel; moist to wet. **4'-4.5':** Brown to Dark Brown, dense, poorly sorted SILT, little fine Sand, little Cobbles, little Pebbles/Gravel; dry.	90'-95'	0.6	
95–104		SILT	9'	9'	**0-1':** Brown, well sorted, loose medium SAND and SILT, trace Gravel/Pebbles/Cobbles, little Clay; wet. **1'-3':** Brown, moderately well sorted, medium dense SILT, some Clay with varved Sandy interbeds; moist. **3'-9':** Brown, poorly sorted, dense SILT, some Cobbles, some Gravel/Pebbles, little Clay, little to trace Sand; dry.	95'-104'	0.0	**GW-3** VOC-8260B H-3=7,290 pCi/L
104–105								

NOTES:

*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-104B

Depth	Well Log	Well Log	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
106, 107, 108, 109, 110, 111, 112, 113, 114		SILT & CLAY	11'	7.5'	Brown to dark Gray-Brown, dense, well sorted SILT and CLAY with Sandy varves throughout section; dry (LACUSTRINE?)	104'-115'	0.0	
115, 116, 117, 118, 119, 120, 121, 122		SILT	8'	10'	**0-3.5':** Dark Brown to Dark Gray Brown, loose to medium loose, moderately well sorted coarse SAND, fining downwards into fine SAND, little Silt, little to trace Clay; wet. **3.5'-7':** Dark Gray-Brown, dense to very dense SILT, some Clay little angular Gravel, fining downwards into dense, till-like unit with little Pebbles/Gravel; dry. **7-10':** Dark Gray-Brown SILT and CLAY with little Sandy varves; dry.	115'-123'	0.0	**GW-4** VOC-8260B H-3=6,170 pCi/L
123, 124, 125		SILT	3'	3'	**0-0.5'**: Quartzite Boulder **0.5'-2.5'**: Dark Brown to dark Gray-Brown, medium dense to dense, poorly sorted SILT, litt angular Gravel/Pebbles, little fine Sand, little Clay, moist (varved interval at bottom 0.5'). **2'-3'**: Gray to light Gray, dense, poorly sorted SILT, some Pebbles, little Clay; dry.	123'-126'	1.2	
126, 127, 128, 129, 130		SILT	4'	4'	Dark Brown-Gray, very dense, poorly sorted SILT, some Clay, little rounded Gravel/Pebbles, minor indications of stratification; dry.	126'-131'	0.0	
131, 132, 133, 134		SILT	4'	4'	**0-3':** Dark Brown-Gray, medium dense, moderately sorted SILT, little Clay, little Gravel, little Pebbles; dry. **3'-4':** Brown, dense, poorly sorted SILT and Boulder, little Gravel/Pebbles; dry.	131'-135'	2.1	
135								
136, 137, 138, 139		SILT	5	5	**0-3':** Dark Gray-Brown, medium loose, well to moderately sorted SILT, some medium Sand, little rounded Gravel/Pebbles, trace Boulders; moist to wet at top of interval, dry at bottom. **3'-5':** Dark Gray-Brown, very dense SILT and fine angular GRAVEL, unsorted, little angular Cobbles; dry.	136'-139.5'	4.1	**GW-5** VOC-8260B H-3=4,810 pCi/L
140								
141, 142, 143, 144, 145		SILT	4'	4'	Dark Brown-Gray, dense, well sorted SILT, some to little fine Sand, little Clay, minor indications of stratification throughout interval, trace angular Gravel/Pebbles, varving more pronounced at bottom of interval; dry to moist (TRANSITION ZONE?)	141'-145'	0.0	

*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-104B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
146 147 148 149 150 151 152		SAND & SILT	7.5'	7.5'	Gray-Brown to Brown, medium dense to dense, well sorted fine SAND and SILT with some varving throughout the section, some to little Clay, trace Gravel; dry.	145'-152.5'	0.0	
153 154 155 156		SILT	4'	4'	Brown-Gray, medium dense, poorly sorted SILT, little to trace Clay, little Gravel/Pebbles, little Cobble (at 157.5'); dry.	152.5'-156.5'	4.1	
157 158 159 160 161 162 163		SILT	7'	5'	Dark Gray-Brown, medium dense to medium loose, poorly sorted SILT, little angular Gravel/Pebbles, trace fine Sand, trace to little Clay; dry (NOT TILL).	156.5'-163.5'	0	
164 165 166 167 168 169 170 171 172 173 174		SAND	11.5'	11.5'	**0-3.5'**: Brown, loose, fine SAND and SILT, little Gravel; saturated. **3.5'-6'**: Brown, loose, poorly sorted coarse SAND, some Silt, little Cobbles, some to little Pebbles; wet. **6'-11.5'**: Brown, medium dense to medium loose, well sorted Silt, some to little fine Sand, fining downwards; wet.	163.5'-175'	**5.4**	**MW-104B: 163'- 175' , MW-104B: 176'-179'** VOC (low, med.), Total Solids, TPH-GRO, TPH-DRO, PCB's, SVOC, PP13 Metals **GW-6** VOC-8260B H-3=8,770 pCi/L
175		SAND & SILT	1'	1'	Dark Brown-Gray, dense, poorly sorted fine SAND and SILT, some roundec Gravel/Pebbles; moist.	175'-176'	4.1	
176 177 178 179		SAND & SILT	4'	3.5'	**0-3'**: Dark Gray, well sorted, loose, fine SAND and SILT, little Clay, trace angular Gravel, saturated. **3'-3.5'**: Dark Gray, loose to dense, poorly sorted fine SAND and SILT, some weathered gneissic Cobbles; wet.	176'-180'	7.0[1]	
180 181 182 183 184 185		BEDROCK	14.5'	11.5'	Light Gray Gneiss; moderately foliated; metamorphic grade appears to increase with depth; fracture zones at 194.5', 183'-184' and 181' bgs (reddish discoloration); RQD for entire section ~75%; more highly fractured between 184'-192' (RQD=40%); foliation dips ~30^{o} below horizontal.	180'-185'	N/A	

NOTES:

[1] Higher FID hits attributed to melted poly sleeve

*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-104B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
186-190					See Previous Page for Bedrock Core Description			**GW-7** VOC-8260B
191-195								

Bottom of Boring at 194.5' bgs

Well Construction Details:

0-1': Cement, Protective Flushmount Roadbox
1'-180': Portland Cement/Bentonite Grout
180'-182': Bentonite Chip Seal
182'-194.5': #0 Silica Sand Filter Pack
0-184: Sched. 80 2.5" PVC Riser
184'-194': 0.010" Sched. 80 2.5" PVC Screen
194.5': Bottom of Boring
0-25': 8" Steel Casing Grouted in Place

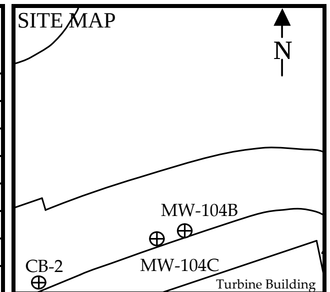
NOTES:
*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-104C

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

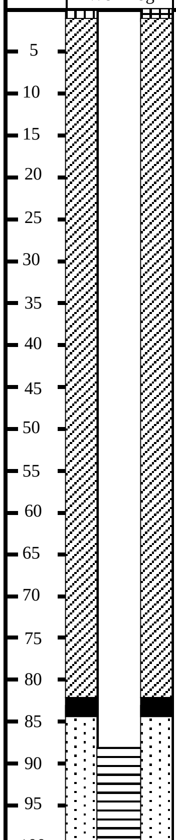
Project:	Yankee L.T.P.	Project Number:	2107.01		
Client:	Yankee Atomic Electric Company	Logged by:	Michael Horesh		
Drilling Co.:	D.L. Maher	Driller:	Bill Zammow		
Date Started:	5-Sep-03	Date Finished:	10-Sep-03		
Location:	Rowe, Massachuestts	Drilling Method:	Rotosonic		
Screen Diam.:	2.5"	Length:	10'	Slot Size:	0.010"
Casing Diam.:	2.5"	Length:	87'	Type:	Schedule 40, 2" PVC
Boring Depth.:	97'	Well Depth:	97'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	NR
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site Non-radiological Laboratory:	Northeast Laboratories		

SITE MAP



Notes:

Depth	Well Log	Stratigraphy	Penetration	Recovery	Split Spoon Description/Soil Classification	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses



Well Construction Details:

0-1': Cement, Protective Flushmount Roadbox
1'-82.8': Portland Cement/Bentonite Grout
82.8'-84.8': Bentonite Chip Seal
84.8'-97': #0 Silica Sand Filter Pack
0-87': Sched. 40 2" PVC Riser
87'-97': 0.010" Sched. 40 2" PVC Screen
97': Bottom of Boring

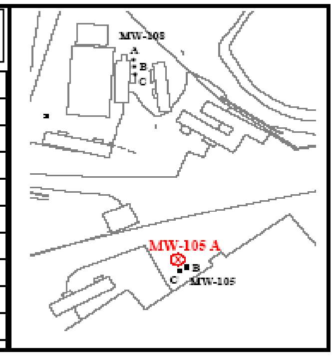
Bottom of Boring at 97' bgs

Key to Well Construction

Sandpack
Bentonite Seal
Well Screen
Cement
Grout

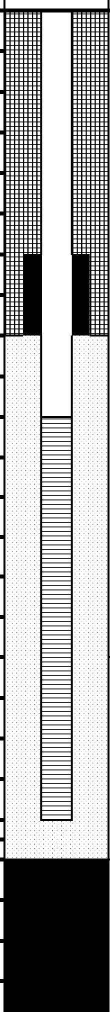
GEOLOGIST'S LOG for Well #: MW-105A

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:	
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott
Drilling Co:	Boart Longyear	Driller:	Roy Buckenberger / Mike Hansen
Date Started:	8-Feb-06	Date Finished:	8-Feb-06
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic

Screen Diam:	2 inches	Length:	10 feet	Slot Size:	0.010 inch
Casing Diam:	2 inches	Length:	10 feet	Type:	Schedule 40 PVC
Boring Depth:	25 feet	Well Depth:	20 feet	Boring Diam.:	10" telescoping to 5½"
Surface Elev.:	1126.9 feet NAVD '88	MP:	Ground Surface	Depth to GW:	25.95 feet from PVC
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	PVC Casing Extension Above Grade: 9.9 feet			on April 18, 2006

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	Ground Water Sample No.*
1 2 3 4 5		Sand & Gravel	5'	5'	0-0.67': Concrete floor slab of former Service Building. 0.67-5': Sand, brown, f. to c., some gravel, f. to c., subangular, some silt, few fist-sized cobbles, loose, dry.	0-5'	
6 7 8 9 10			5'	5'	Sand, brown, f. to c., some gravel, f. to c., subangular, some silt, few fist-sized cobbles, loose, dry. Advance 10" drill casing to 8', install 8" permanent steel casing to 8', cement/bentonite grout annular space and withdraw 10" drill casing.	5-10'	
11 12 13 14 15 16			6'	6'	Sand, brown, f. to c., some gravel, f. to c., subangular, some silt, few fist-sized cobbles, loose, dry; moist on bottom. On boulder at 16'.	10-16'	GW-1: H-3<2,000 pCi/L
17		Boulder	1'	1'	Schist boulder, pulverized by drill.	16-17'	
18 19			2'	2'	Schist boulder, pulverized by drill.	17-19'	
20			1.5'	1.5'	Schist boulder, pulverized by drill.	19-20.5'	
21 22 23 24 25		Till	4.5'	4.5'	Through boulder at 21'. 21-25': Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry.	20.5-25'	
26					End of Boring at 25 feet		

NOTES:
*Results of on-site radiological screening <MDL unless otherwise noted

Key to Well Construction

Sandpack — Bentonite Seal — Well Screen — Cement/Bentonite Grout — Cement/Bentonite Grout and 8-inch Steel Casing

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	Ground Water Sample No.*

Monitoring Well Construction Details

0-10.3': 8-inch Steel Casing Extension Above Grade

0-8': Cement/Bentonite Grout and 8-inch Steel Casing Below Grade

0-6': Cement/Bentonite Grout

6-8': Bentonite Chip Seal

8-21': # 0 (medium) Silica Sand Filter Pack

0-10': Schedule 40, 2-inch PVC Well Riser

10-20': Schedule 40, 2-inch PVC, 0.010-inch Slot Well Screen

21-25': Bentonite Chip Seal

25': Bottom of Boring

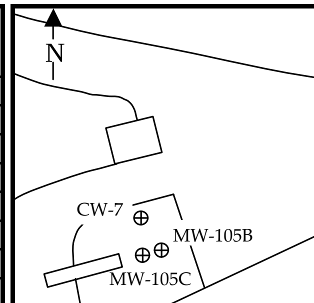
*Results of on-site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-105B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Project:	Yankee L.T.P.	Project Number:	2107.01
Client:	Yankee Atomic Electric Company	Logged by:	Horesh, Regan, Picard
Drilling Co:	D.L. Maher	Driller:	Bill Zammow
Date Started:	18-Jun-03	Date Finished:	20-Aug-03
Location:	Rowe, Massachusetts	Drilling Method:	RotoSonic

Screen Diam:	2"	Length:	10'	Slot Size:	0.010"
Casing Diam:	2"	Length:	64'	Type:	Schedule 40, 2" PVC
Boring Depth:	75'	Well Depth:	74'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	20.49'
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site Non-radiological Laboratory:	Northeastern Laboratories		



Notes: DTW measured on 9-Sep-03

Depth	Well Log	Stratigraphy	Penetration	Recovery	Split Spoon Description/Soil Classification	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
1 2 3 4 5		SAND	5'	5'	Dark brown to brown, loose, poorly sorted medium SAND, some coarse Sand, some fine to coarse rounded Gravel, little Cobbles; dry.	0-5'	0.0	
6 7 8 9 10 11 12		SAND	7'	7'	Brown to orange-brown, loose, poorly sorted medium to coarse SAND, some fine to coarse fine to coarse subangular to angular Gravel, some Cobbles; dry.	5'-12'	0.0	
13 14 15		SAND	3'	3'	Brown to dark brown, loose, poorly sorted medium to coarse SAND, little angular to subangular Gravel, some rounded Cobbles, little rounded fine Gravel; dry.	12'-15'	0.0	
16 17 18 19 20		SAND	5'	5'	Brown to dark brown, loose, poorly sorted coarse SAND, some to little medium Sand, trace Silt, little Clay, little to some Cobbles, Note: top of denser material (till?) at 19', water table at 16.5'; moist.	15'-20'	0.0	
21 22 23 24 25		SILT & CLAY	5'	4'11"	Dark brown to gray-brown, dense, poorly sorted CLAY and SILT, some rounded fine Gravel, little rounded Cobbles; dry.	20'-25'	0.8	**GW-1** VOC-8260B

*Results of on-Site radiological screening <MDL unless otherwise note Key to Well Construction

Sandpack | Well Screen | Grout
Bentonite Seal | Cement

DRILLING LOG for Well #: MW-105B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Well Log	Stratigraphy	Penetration	Recovery	Split Spoon Description/Soil Classification	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
26, 27, 28, 29, 30		SILT & CLAY	5'	5'	**0-3':** Olive, very dense, greenish-gray SILT with CLAY, some to little angular Cobbles; moist. **3'-5':** Dark brown to gray-brown, dense, poorly sorted SILT, some to little Clay, some rounded fine Gravel, little rounded Pebbles/Cobbles; moist.	25'-30'	0.0	
31, 32, 33, 34, 35		SILT & CLAY	5'	5'	Dark brown to gray-brown, very dense, poorly sorted SILT, some to little Clay, little rounded Pebbles, trace Gravel/Cobble; dry.	30'-35'	0.0	
36, 37, 38, 39		BOULDER/SILT	4'	4'	**0-2.5':** Boulder (Albite gneiss) grindings and dust. **2.5-4':** Olive greenish-gray, dense, SILT with Clay and angular Cobbles, trace fine Sand; moist.	35'-39'	0.0	
40, 41, 42, 43, 44		NR	5'	0'	No recovery (core barrel is wet; presume loose, saturated sand)	39'-44'	NA	**GW-2** VOC-8260B H-3=7,720 pCi/L
45, 46, 47, 48, 49		SILT	5'	5'	**0-5':** Greenish gray, very dense, moderately well sorted SILT, little Clay and angular Cobbles, little to trace coarse Gravel; dry.	44'-49'	0.0	
50		SILT	1'	1'	Greenish gray, very dense, moderately well sorted SILT, little Clay, little coarse Gravel, trace fine Sand (1" at 49'); dry.	49'-50'	0.0	
51, 52, 53, 54, 55		SILT	5'	5'	Greenish gray, very dense, moderately well sorted SILT, little Clay and angular Cobbles, little coarse Gravel; dry.	50'-55'	0.0	
56, 57, 58		BOULDER	3'	5'	**0-2':** Very dense, poorly sorted SILT, some to little Clay, some Gravel/Pebbles, trace Cobbles; dry. **2'-3':** Pulverized Bedrock.	55'-58'	0.0	
59, 60, 61		BEDROCK	3'	3'	Bedrock	58'-61'	0.0	
62, 63, 64, 65			14'	11.5'	SEE FOLLOWING PAGE FOR LOGGING DETAILS	61'-75'	0.0	

*Results of on-Site radiological screening <MDL unless otherwise noted

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Well Log	Stratigraphy	Penetration	Recovery	Split Spoon Description/Soil Classification	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
66–75		BEDROCK	14'	11.5'	Albite Gneiss Bedrock, foliation dips at ~35o to horizontal, rust colored fractures at 64', 65' 66.5', 70'-71', and 74'-75'	61'-75'	0.0	**GW-3** VOC-8260B H-3=6,030 pCi/L

Bottom of Boring at 75' bgs.

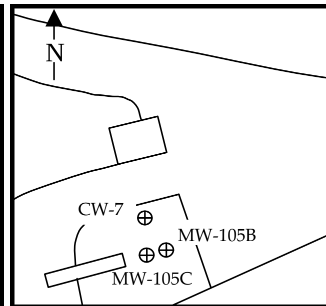
<u>Well Construction Details:</u>

0-1': Cement, Protective Flushmount Roadbox
1'-59.7': Portland Cement/Bentonite Grout
59.7'-61.8': Bentonite Chip Seal
61.8'-75': #0 Silica Sand Filter Pack
0-64': Sched. 40 2" PVC Riser
64'-75': 0.010" Sched. 40 2" PVC Screen
75': Bottom of Boring
0-25': 8" Steel Casing Grouted in Place

*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-105C

ERM
ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

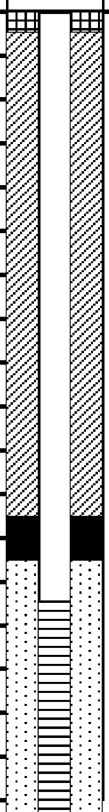


Project:	Yankee L.T.P.	Project Number:	2107.01		
Client:	Yankee Atomic Electric Company	Logged by:	Michael Horesh		
Drilling Co:	D.L. Maher	Driller:	Bill Zammow		
Date Started:	18-Jun-03	Date Finished:	20-Aug-03		
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic		
Screen Diam:	2"	Length:	10'	Slot Size:	0.010"
Casing Diam:	2"	Length:	27'	Type:	Schedule 40, 2" PVC
Boring Depth:	37'	Well Depth:	37'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	17.56'
On-Site GW Analysis:	H-3, Co-60, Cs-134, Cs-137	Off-Site Non-radiological Laboratory:	Northeast Laboratories		

Notes: DTW measured on 08-Sep-03

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses

Depth: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38



Well Construction Details:

0-1': Cement, Protective Flushmount Roadbox
1'-23.1: Portland Cement/Bentonite Grout
23.1'-25.1': Bentonite Chip Seal
25.1'-37': #0 Silica Sand Filter Pack
0-27': Sched. 40 2" PVC Riser
27'-37': 0.010" Sched. 40 2" PVC Screen
37': Bottom of Boring

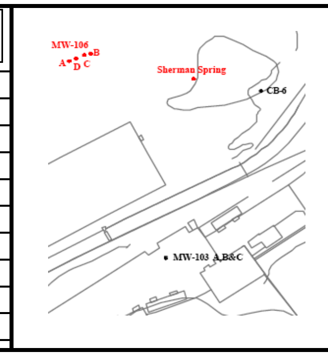
Bottom of Boring at 37' bgs

Key to Well Construction

Sandpack
Bentonite Seal
Well Screen
Cement
Grout

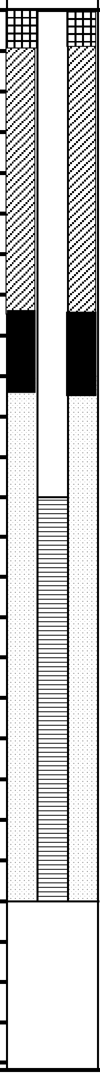
GEOLOGIST'S LOG for Well #: MW-106A

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:			
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott		
Drilling Co:	D.L. Maher	Driller:	Roy Buckenberger		
Date Started:	August 30, 2004	Date Finished:	August 30, 2004		
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic		
Screen Diam:	2 inches	Length:	10 feet	Slot Size:	0.010 inch
Casing Diam:	2 inches	Length:	12 feet	Type:	Schedule 40, 2-inch PVC
Boring Depth:	22 feet	Well Depth:	22 feet	Boring Diam.:	7⅝ inches
Surface Elev.:	1089.2 feet MSL	MP:	Ground Surface	Depth to GW:	6.60 feet from PVC
On-Site GW Analyses:	None	Off-Site GW Analyses:	None		on October 31, 2004

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*



Depth: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26

See log of MW-106B for description of sediment and ground water samples.

Well Construction Details

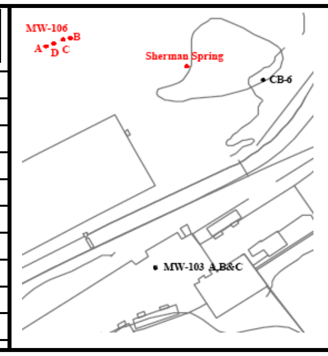
0-1': Concrete and Flushmount Roadbox
1-7.5': Portland Cement/Bentonite Grout
7.5-9.5': Bentonite Chip Seal
9.5-22': #0 Silica Sand Filter Pack
0-12': Schedule 40, 2" Diameter PVC Riser
12-22': Schedule 40, 2" Diameter, 0.010-Slot PVC Screen
22': Bottom of Boring

Key to Well Construction

Sandpack
Bentonite Seal
Well Screen
Concrete and Flushmount Roadbox
Cement/Bentonite Grout

GEOLOGIST'S LOG for Well #: MW-106B

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:	
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott
Drilling Co:	D.L. Maher	Driller:	Roy Buckenberger
Date Started:	August 12, 2004	Date Finished:	August 27, 2004
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic

Screen Diam:	2½ inches	Length:	10 feet	Slot Size:	0.010 inch
Casing Diam:	2½ inches	Length:	251 feet	Type:	Schedule 80, 2½-inch PVC
Boring Depth:	265 feet	Well Depth:	261 feet	Boring Diam.:	5½ inches
Surface Elev.:	1088.9 feet MSL	MP:	Ground Surface	Depth to GW:	39.00 feet from PVC
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site GW Analyses: VOCs by 8260B			on October 31, 2004

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
1, 2, 3, 4, 5		Stratified Drift	5 '	4 '	0-2': Sand, brown, fine to coarse, and dark brown organic silt, little medium to coarse subrounded gravel, unsorted, medium dense, damp. 2-2.5': Sand, gray, fine, well sorted, medium dense, damp. 2.5-5': Sand and gravel, brown to orange (in oxidized zones), fine to coarse, angular, little silt, unsorted, medium dense, damp.	0 to 5 '	0.0	
6, 7, 8, 9, 10, 11, 12, 13, 14, 15		Stratified Drift	10'	7'	6-7': Albite gneiss boulder 7-11': Silt, gray-brown, with fine to medium sand and subangular gravel, unsorted, moderately dense, damp. 11-12': Schist boulder, oxidized orange, severely weathered, loose, mostly sand. 12-13': Same as 7-11', with 4" cobble at 13'. 13-15': Sand and gravel, brown, fine to coarse, subround, little silt, unsorted, loose, wet.	5-15'	0.0	GW-1 H-3=650 pCi/L
16, 17, 18, 19, 20, 21, 22, 23, 24, 25		Stratified Drift / Till	10'	7'	15-17': Same as above, with 4" cobble at 17'. 17-20': Silt, brown, with fine to coarse subround gravel, little sand, unsorted, dense, moist; increasing clay content with depth. One fist-sized cobble. 20-22': Sand and gravel, brown, fine to coarse, unsorted, loose, wet. 22-25': Till consisting of silt, olive, with fine to coarse angular gravel, little sand, trace clay, unsorted, very dense, damp. Advanced 10" drill casing to 25' and pressure grouted with bentonite slurry to seal off aquifer.	15-25'	0.0	
26		Till	5'	3'	See next page.	25-30'	0.0	

NOTES:
*Results of on-site radiological screening <MDL unless otherwise noted

Key to Well Construction

Sandpack · Well Screen · Cement/Bentonite Grout
Bentonite Seal · Concrete and Flushmount Roadbox

GEOLOGIST'S LOG for Well No.: MW-106B

Yankee Nuclear Power Station, Rowe, MA

Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
Till	5'	3'	Till consisting of silt, olive, clay and fine to coarse angular gravel, trace sand, unsorted, very dense, damp.	25-30'	0.0	
Till	5'	2'	Till consisting of silt, olive, clay and fine to coarse angular gravel, trace sand, unsorted, very dense, damp.	30-35'	0.0	
Till	5'	5'	Till consisting of silt, olive, clay and fine to coarse angular gravel, trace sand, unsorted, very dense, damp.	35-40'	0.0	
Till	3'	3'	Same as above, with few fist-sized cobbles.	40-43'	0.0	
Till	2'	2'	Same as above, with few fist-sized cobbles.	43-45'	0.0	
Till	4'	3'	Same as above, with few fist-sized cobbles.	45-49'	0.0	
Till	2'	2'	Till consisting of silt, olive, clay and fine to coarse angular gravel, trace sand, few fist-sized cobbles, unsorted, extremely dense, dry.	49-51'	0.0	
Till	4'	3'	Till consisting of silt, olive, clay and fine to coarse angular gravel, trace sand, few fist-sized cobbles, unsorted, extremely dense, dry.	51-55'	0.0	
Till	4'	3.5'	Till consisting of silt, olive, clay and fine to coarse angular gravel, trace sand, few fist-sized cobbles, unsorted, extremely dense, dry.	55-59'	0.0	
Till	3'	3'	Till consisting of silt, olive, clay and fine to coarse angular gravel, trace sand, few fist-sized cobbles, unsorted, extremely dense, dry. One talc fragment.	59-62'	0.0	
Till	3'	3'	Till consisting of silt, olive, clay and fine to coarse angular gravel, trace sand, few fist-sized cobbles, unsorted, extremely dense, dry.	62-65'	0.0	
Till	2'	2'	See next page.	65-67'	0.0	

*Results of on-site radiological screening <MDL unless otherwise noted

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
67		Till	2'	2'	Same as above.	65-67'	0.0	
68-69			2'	2'	Till consisting of silt, olive, clay and fine to coarse angular gravel, trace sand, few fist-sized cobbles, unsorted, extremely dense, dry.	67-69'	0.0	
70-72			3'	3'	Same as above. Two-inch seam of silt, clay and fine sand at 71.5 feet.	69-72'	0.0	
73-75			3'	3'	Till consisting of silt, olive, clay and fine to coarse angular gravel, trace sand, few fist-sized cobbles, unsorted, extremely dense, dry.	72-75'	0.0	
76-80			5'	5'	75-77': Same as above, with increasing clay content and finer-grained gravel. 77-80': Laminated silty clay, olive, with 2 to 5-mm very fine sand lamellae at ~2 to 5-cm intervals, more sand at bottom; very stiff, damp.	75-80'	0.0	
81-83			3'	3'	Till consisting of silty clay, olive, with fine subangular gravel, little medium to coarse gravel, trace fine to medium sand, unsorted, very stiff, damp.	80-83'	0.0	
84-85		Boulder	2'	2'	83-83.5': Same as above 83.5-85': Albite gneiss boulder	83-85'	0.0	
86			1'	1'	Same albite gneiss boulder	85-86'	0.0	
87			1	1'	86-86.5': Same albite gneiss boulder.	86-87'	0.0	
88-90		Till	3'	3'	86.5-89': Sand, fine to medium, well sorted, loose, saturated. 20 feet of rods are wet. 89-90': Albite gneiss boulder.	87-90'	0.0	GW-2 H-3<300 pCi/L
91-93			3'	3'	90-91.5': Same as 80-83'. 91.5-92.5': Sand, f. to m., little silt, loose, saturated. 92.5-93': Albite gneiss boulder.	90-93'	0.0	
94-95			2'	2'	Till consisting of silt, olive, clay and fine to coarse angular gravel, trace sand, few fist-sized cobbles, unsorted, very dense, damp.	93-95'	0.0	
96-103			8'	8'	Advanced 7⅝" drill casing to 95' and pressure grouted with bentonite slurry to seal off aquifer above. 95-103': Till consisting of clay, olive, silt and fine to medium subangular gravel, some coarse gravel and fist-sized cobbles, trace sand, unsorted, very stiff, moist.	95-103'	0.0	
104-106		Glaciolacustrine Sequence	7'	7'	Laminated silt and clay, olive, some fine to medium subangular gravel in bottom 6", stiff, damp, very plastic.	103-110'	0.0	

*Results of on-site radiological screening <MDL unless otherwise noted

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
107-110		Glaciolacustrine Sequence	7'	7'	Laminated silt and clay, olive, some fine to medium subangular gravel in bottom 6", stiff, damp, very plastic.	103-110'	0.0	
110-115		Glaciolacustrine Sequence	5'	5'	Same as above, (disturbed); rate of drilling slowed at 111', apparently because we were pushing a boulder. Retrieved no sample on the first attempt and reentered the hole to recover the sample.	110-115'	0	
115-123		Glaciolacustrine Sequence	8'	8'	Laminated silt and clay, olive, with 1-mm lamellae of gray, very fine, micaceous sand; trace medium to coarse gravel; more gravel at bottom 6", wet.	115-123'	0.0	GW-3 H-3<300 pCi/L
123-128		Glaciolacustrine Sequence	5'	5'	Collected sample in 5' long by 3½" diameter translucent Lexan liner. Material is same as above. Advanced 7⅝" drill casing to 125' and pressure grouted with bentonite slurry to seal off aquifer.	123-128'	0.0	GW-3 H-3<300 pCi/L
128-135		Glaciolacustrine Sequence	7'	4'	128-130': Same laminated silty clay, olive, trace fist-sized cobbles. 130-131': Sand, fine, with silt, olive, firm, saturated. 131-132': Same as 128-130'. 132-135': Sample dropped out: probable sand, saturated (4 rods wet). Advanced 7⅝" drill casing to 135'.	128-135'	0.0	GW-4 H-3<300 pCi/L (130-135)
135-137		Till ?	2'	2'	Clayey silt, olive, with fine to medium subangular gravel, few fist-sized cobbles, unsorted, dense, moist.	135-137'	0.0	
137-139		Boulder	2'	0.5'	Albite gneiss boulder.	137-139'	0.0	
139-141		Till ?	2'	2'	Clayey silt, olive, with fine to medium subangular gravel, few fist-sized cobbles, unsorted, dense, moist.	139-141'	0.0	
141-146		Glaciolacustrine Sequence	14'	8'	No recovery on first attempt: heaving sand - 30' heaved into the casing. Reentered the hole to retrieve sample: Sand, very fine, micaceous, and silt, olive, trace coarse gravel, loose, saturated. 6" hard zone at 153'.	141-155'	0	GW-5 H-3<300 pCi/L

*Results of on-site radiological screening <MDL unless otherwise noted

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
147–155		Glaciolacustrine Sequence	14'	8'	No recovery on first attempt: heaving sand - 30' heaved into the casing. Reentered the hole to retrieve sample: Sand, very fine, micaceous, and silt, olive, trace coarse gravel, loose, saturated. 6" hard zone at 153'. Advanced 7⅝" drill casing to 155' and pressure grouted with bentonite slurry to seal off aquifer above.	141-155'	0.0	GW-5 H-3<300 pCi/L
155–165			10'	10'	155-158.5': Sand, olive, fine, with fine to coarse subround gravel, some silt, unsorted, medium dense, saturated. 158.5-163.5': Sand, olive, fine to coarse, with fine to coarse subround gravel, some silt, unsorted, medium dense, saturated. 163.5-165': Laminated silty clay, olive, very stiff, damp. One 1-mm very fine gray sand lamella.	155-165'	0.0	
165–175			10'	10'	Advanced 7⅝" drill casing to 165' and pressure grouted with bentonite slurry to seal off aquifer. 165-172': No recovery on first attempt; 120' of rods are wet. Reentered the hole to retrieve sample: 10' of sand heaved into the casing. Sample description: Sand, brown, medium to very coarse, and fine to medium gravel; little silt, loose, saturated. 172-173': Silt, olive, stiff, saturated. 173-175': Sand, brown, fine, little silt, medium dense, saturated.	165-175'	0.0	GW-6 H-3<300 pCi/L
175–185			10'	10'	Advanced 5½" drill casing to 175'. Did not pressure grout because there is no confining unit to key into. 175-185': Laminated sand, very fine, and silt, olive, some clay, stiff, saturated.	175-185'	0.0	
185–186			10'	10'	See next page.	185-195'	0.0	

*Results of on-site radiological screening <MDL unless otherwise noted

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
187–195		Glaciolacustrine Sequence	10'	10'	Laminated sand, very fine, and silt, olive, some clay, stiff, saturated.	185-195'	0.0	
195–205			10'	10'	195-199': Clay, olive, some silt, medium soft, moist. 199-203': Sand, very fine, and silt, olive, some clay, medium soft, wet. 203-205': Laminated clay with silt, olive, stiff, moist.	195-205'	0.0	
205–225			20'	20'	205-211': Laminated silt with clay, olive, trace very fine sand, stiff, moist. 211-215': Laminated silt with clay, olive, some very fine sand, stiff, moist. 215-225': Laminated silt with clay, olive, some very fine sand, stiff, moist.	205-225'	0.0	
225–226			8'	6'	See next page.	225-233'	0.0	

*Results of on-site radiological screening <MDL unless otherwise noted

GEOLOGIST'S LOG for Well No.: MW-106B

Yankee Nuclear Power Station, Rowe, MA

Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.
227–233	Glaciolacustrine Sequence	8'	6'	Advanced 5½" drill casing to 225' and pressure grouted with bentonite slurry to seal off aquifers above. 225-230': Laminated silt with clay, olive, some very fine sand, stiff, moist. 230-232': Same as above, little fine gravel. 232-233': Gravel, f. to c., angular; some silt and clay, loose, wet. 6" albite gneiss cobble at bottom.	225-233'	0.0	
233–245	Bedrock	12'	9'	Albite gneiss bedrock, coarse grained, foliation (bands of quartz) dips at 30º. One 6.5'-stick and one 2.5'-stick of core recovered from the 233-242' interval (only one fracture). Interval from 242-245' very broken up - only coarse gravel-sized fragments recovered (several natural fractures).	233-245'	0.0	
245–255		10'	7'	Albite gneiss bedrock, coarse granular texture; rich in biotite and muscovite; few small garnets; quartz stringers form foliation dipping 30°; ¼" albite grains; 3.4' solid stick of core from 248.8' to 252.2'; natural break at 254' with silt in-filling.	245-255'	0	
255–265		10'	10.6'	Same albite gneiss as above. Natural break at 260'. Collected GW-7 from well, after sand pack and bentonite seal were placed.	255-265'	0	GW-7 H-3<300 pCi/L
265–266				End of boring at 265'.			

*Results of on-Site radiological screening <MDL unless otherwise noted

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*

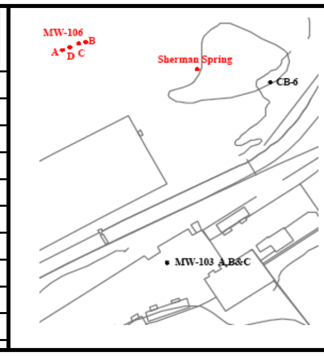
Well Construction Details

0-1': Concrete and Flushmount Roadbox
1-230': Portland Cement/Bentonite Grout
230-249': Bentonite Chip Seal
249-265': #0 Silica Sand Filter Pack
0-251': Schedule 80, 2½" Diameter PVC Riser
251-261': Schedule 80, 2½" Diameter, 0.010-Slot PVC Screen
265': Bottom of Boring

*Results of on-site radiological screening <MDL unless otherwise noted

GEOLOGIST'S LOG for Well #: MW-106C

Yankee Nuclear Power Station
Rowe, Massachusetts

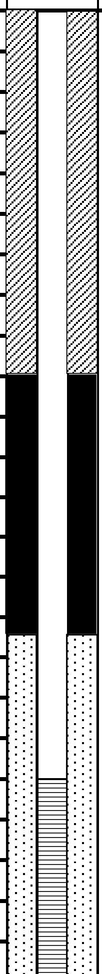


Project:	Yankee Ground Water Investigation	Project Number:	
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott
Drilling Co:	D.L. Maher	Driller:	Roy Buckenberger
Date Started:	August 30, 2004	Date Finished:	September 8, 2004
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic

Screen Diam:	2 inches	Length:	5 feet	Slot Size:	0.010 inch
Casing Diam:	2 inches	Length:	90 feet	Type:	Schedule 40, 2-inch PVC
Boring Depth:	95 feet	Well Depth:	95 feet	Boring Diam.:	5½ inches
Surface Elev.:	1089.0 feet MSL	MP:	Ground Surface	Depth to GW:	38.90 feet from PVC
On-Site GW Analyses:	None	Off-Site GW Analyses: None			on October 31, 2004

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*

Depth: 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97



See log of MW-106B for description of sediments and ground water samples

Well Construction Details

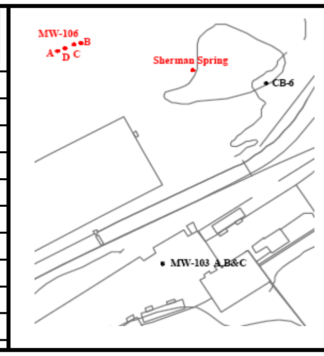
0-1': Concrete and Flushmount Roadbox
1-80': Portland Cement/Bentonite Grout
80-86.5': Bentonite Chip Seal
86.5-95': #0 Silica Sand Filter Pack
0-90': Schedule 40, 2" Diameter PVC Riser
90-95': Schedule 40, 2" Diameter, 0.010-Slot PVC Screen
95': Bottom of Boring
0-25': 8" Steel Casing Cement/Bentonite Grouted in Place

Key to Well Construction

Sandpack
Bentonite Seal
Well Screen
Concrete and Flushmount Roadbox
Cement/Bentonite Grout

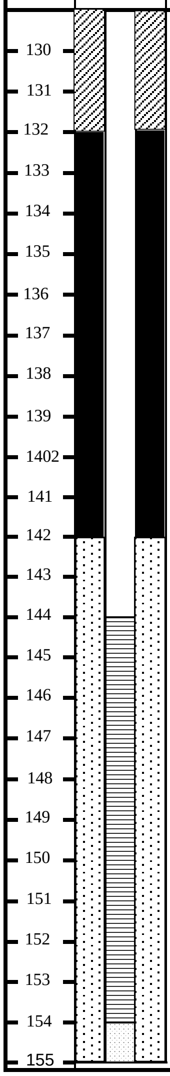
GEOLOGIST'S LOG for Well #: MW-106D

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:			
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott		
Drilling Co:	D.L. Maher	Driller:	Roy Buckenberger		
Date Started:	September 8, 2004	Date Finished:	September 14, 2004		
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic		
Screen Diam:	2½ inches	Length:	10 feet	Slot Size:	0.010 inch
Casing Diam:	2½ inches	Length:	144 feet	Type:	Schedule 80, 2½-inch PVC
Boring Depth:	155 feet	Well Depth:	154 feet	Boring Diam.:	5½ inches
Surface Elev.:	1089.1 feet MSL	MP:	Ground Surface	Depth to GW:	43.70 feet from PVC
On-Site GW Analyses:	None	Off-Site GW Analyses: None			on October 31, 2004

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*



See log of MW-106B for description of sediments and ground water samples

Well Construction Details

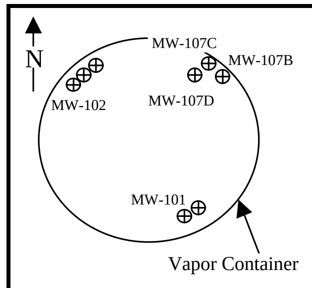
0-1': Concrete and Flushmount Roadbox
1-132': Portland Cement/Bentonite Grout
132-142': Bentonite Chip Seal
142-155': #0 Silica Sand Filter Pack
0-144': Schedule 80, 2½" Diameter PVC Riser
144-154': Schedule 80, 2½" Diameter, 0.010-Slot PVC Screen
155': Bottom of Boring
0-25': 8" Steel Casing Cement/Bentonite Grouted in Place

Key to Well Construction

Sandpack
Bentonite Seal
Well Screen
Concrete and Flushmount Roadbox
Cement/Bentonite Grout

DRILLING LOG for Well #: MW-107B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116



Project:	Yankee L.T.P.	Project Number:	2107.01
Client:	Yankee Atomic Electric Company	Logged by:	D. Scott, E. Gabbay
Drilling Co:	D.L. Maher	Driller:	Bill Zammow
Date Started:	12-Sep-03	Date Finished:	17-Sep-03
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic

Screen Diam:	2.5"	Length:	10'	Slot Size:	0.010"
Casing Diam:	2.5"	Length:	99.7'	Type:	Schedule 80, 2.5" PVC
Boring Depth:	109.7'	Well Depth:	109.7'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	NR
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site Non-radiological Laboratory:	Northeastern Laboratories		

Notes:

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
1–5		SAND & GRAVEL	5'	5'	Brown, loose, rounded, poorly sorted fine to coarse SAND and GRAVEL, little Silt; wet (2.5')	0-5'	NR	
6–10		SAND	5'	5'	**0-1':** Brown, medium dense, poorly sorted fine to coarse SAND and GRAVEL, little Silt; wet. **1'-2.5':** Olive to dark brown, medium dense, poorly sorted fine to coarse SAND and GRAVEL, little Silt; wet. **2.5'-5':** Light brown, very dense, poorly sorted very fine SAND and SILT, trace coarse subangular Gravel; dry.	5'-10'	NR	
11–12								
13–15		SAND & SILT	5'	2.5'	**0-1':** Olive, medium dense, sorted, interbedded very fine SAND and SILT, trace coarse Gravel; wet. **1'-2.5':** Olive, very dense, poorly sorted SILT, some fine to coarse subangular Gravel, trace fine Sand; dry.	12.5'-15'	NR	
16–18		SILT	3'	3'	Olive, very dense, poorly sorted SILT with fine to coarse subangular Gravel, trace very fine Sand; dry.	15'-18'	NR	
19–20		SILT	2.5'	2.5'	Olive, very dense, poorly sorted SILT with fine to coarse subangular Gravel, trace very fine Sand; dry.	18'-20.5'	NR	
21–23		SILT	2.5'	2.5'	Olive, very dense, poorly sorted SILT with fine to coarse subangular Gravel, trace very fine Sand; damp.	20.5'-23'	NR	
24–25		SILT	4'	4'	**0-3':** Olive, very dense, poorly sorted SILT with fine to coarse subangular Gravel, trace very fine Sand; dry.	23'-27'	NR	

NOTES:
*Results of on-Site radiological screening <MDL unless otherwise noted

Key to Well Construction

Sandpack	Well Screen	Grout
Bentonite Seal	Cement	

DRILLING LOG for Well #: MW-107B

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
26–27	SAND & SILT	4'	4'	**3'-4':** Olive, very dense, sorted, interlayered very fine SAND and SILT, trace fine subangular Gravel; damp.	23'-27'	NR	
27–32	SAND & SILT	5'	5'	**0-2':** Olive, dense, sorted, interbedded very fine to fine SAND and SILT, trace fine subangular gravel; wet. **2'-5':** Olive, very dense, poorly sorted SILT with fine to coarse subangular Gravel, trace very fine Sand; dry.	27'-32'	NR	**GW-1** VOC-8260B H-3= 44,100 pCi/L
32–41	BOULDER & SILT	9'	9'	**0-1':** Albite Gneiss Boulder **1'-3.5':** Olive, very dense, poorly sorted SILT with fine to coarse subangular Gravel, trace very fine Sand; dry. **3.5'-9':** Olive, very dense, poorly sorted SILT, fine to coarse subangular Gravel, trace very fine Sand; dry.	32'-33'	NR	
41–45	SAND & GRAVEL	4'	4'	Olive, medium dense, unsorted, fine to coarse rounded SAND and GRAVEL , some SILT, few fist sized rounded Cobbles; wet.	41'-45'	NR	**GW-2** VOC-8260B H-3= 34,200 pCi/L
45–49	SAND & GRAVEL	4'	4'	**0-2':** Olive, loose, unsorted coarse to fine SAND, little coarse to medium subrounded Gravel, trace Silt; wet. 2'-4**':** Olive, very dense, unsorted, SILT and subangular fine GRAVEL, some fist-sized Cobbles, trace fine Sand, trace Clay; dry.	47'-49'	NR	
49–50	SAND & SILT	1'	1'	Olive, very dense, SILT and unsorted fine GRAVEL, some fist-sized Cobbles, trace fine Sand/Clay; dry.	49'-50'	NR	
50–55	SILT	5'	5'	**0'-3':** Olive, very dense, unsorted SILT and fine angular GRAVEL, some Clay, some coarse to medium subangular Gravel, trace Sand, trace Cobbles; damp. **3'-5':** Olive, unsorted, stiff, varved SILT and gray CLAY, some fine angular, unsorted Gravel; damp.	50'-55'	NR	
55–61	SILT	4.5'	4.5'	0-1.5': Olive, unsorted, stiff varved SILT and gray CLAY, some fine angular, unsorted Gravel; damp. 1.5'-4.5': Olive, very dense, unsorted SILT and fine angular GRAVEL, some Clay, some coarse to medium subangular Gravel, trace Sand, trace Cobbles; damp.	55'-61'	NR	
61–62	BOULDER	1'	1'	Albite Gneiss, with 1/8" garnet x'tals	61'-62'	NR	
62–65	BOULDER	3'	3'	Garnetiferous albite gneiss	62'-65'	NR	

NOTES:
*Results of on-Site radiological screening <MDL unless otherwise noted

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
66					See previous page for description			
67		SILT AND CLAY	1'	1'	Olive, dense, unsorted SILT and fine angular GRAVEL, some Clay, some medium subangular Gravel, trace Sand, trace Cobbles; damp.	66.5'-67.5'	NR	
68 69 70		BOULDER	2.5'	2.5'	Pulverized rock + 8" of Albite Gneiss.	67.5'-70'	NR	
71 72 73 74 75			5'	1.5'	(BLOW-IN FROM ABOVE)	70'-75'	NR	
76 77 78 79 80 81		GRAVEL & SILT	6'	6'	**0-2.5':** Olive, very dense, unsorted, fine angular Gravel and SILT, trace coarse to medium Gravel, trace Clay; damp. **2.5'-6':** Brown, medium dense, sorted medium to fine SAND, little coarse to medium subangular Gravel, trace Silt; wet.	75'-81'	NR	**GW-3** VOC-8260B H-3=6,740 pCi/L
82 83		SAND	2'	2'	**0-1.5':** Olive, medium sorted, medium dense fine SAND, some coarse to fine subangular Gravel, some Silt; wet. **1.5'-2':** Brown, medium dense, unsorted Silt and severely weathered schist; dry.	81'-83'	NR	
84 85		BOULDER	2'	2'	**0-0.5':** Brown, loose, unsorted Silt and severely weathered schist; dry. **0.5'-2':** Pulverized albite gneiss, little brown Silt, severely weathered micaceous schist.	83'-85'	0.0	
86		BOULDER	1.5'	1.5'	**0-0.2':** Albite gneiss Cobble. **0.2'-1.2':** Dark Brown, loose, stratified SILT (infill?); dry. 1.2'-1.5': Albite gneiss.	85'-86.5'	3.5	
87 88 89 90		BOULDER & SILT	3.5'	3'	**0-2.5':** Brown, dense micaceous SILT; dry. **2.5'-3':** Albite gneiss Cobble **2.5'-3':** Brown, loose, micaceous SILT with weathered micaceous schist fragments; dry.	86.5'-90'	0.0	
91		GRAVEL/SAND/SILT	1'	1'	**0'-0.5':** Olive, loose, well sorted fine to medium SAND; Silt; wet. **0.5'-1':** Olive, dense, unsorted SILT and GRAVEL (pulverized schist).	90'-91'	NR	**GW-4** VOC-8260B
92 93		SAND	2'	2'	**0-1.5':** Olive, medium dense, well sorted fine to medium SAND, trace Silt; wet. **1.5'-2':** Olive, loose, unsorted medium to fine SAND, and fine subangular Gravel, trace Silt; wet.	91'-93'	NR	
94		GRAVEL & SILT	1'	1'	**0-0.5':** Olive, dense, unsorted SILT and fine subangular GRAVEL; damp. **0.5'-1':** Pulerized albite gneiss.	93'-94'	NR	
95 96 97 98 99 100 101 102 103 104 105		BEDROCK	16'	16'	Albite Gneiss, only 3 machine breaks, coarse-grained foliation (defined by 1/4" layers of albite dips at ~30o), few small garnets (1/8"); fracture zones at 109'-110' and 105'-106'.	94'-110'	NR	**GW-5** VOC-8260B

NOTES:
*Results of on-Site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #:	MW-107B	ERM 399 Boylston Street, 6th Floor Boston, MA 02116	Page 4 of 4

Depth	Boring Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Lab Sample # & Analyses*
106								
107					SEE PREVIOUS PAGE FOR LOGGING DETAILS			**GW-5** VOC-8260B
108								
109								
110								

Bottom of Boring at 109.7' bgs.

Well Construction Details:

0-1': Cement, Protective Flushmount Roadbox
1'-96': Portland Cement/Bentonite Grout
96'-97.8': Bentonite Chip Seal
97.8'-109.7': #0 Silica Sand Filter Pack
0-99.7': Sched. 80 2.5" PVC Riser
99.7'-109.7': 0.010" Sched. 80 2" PVC Screen
109.7': Bottom of Boring
0-12.5': 8" Steel Casing Grouted in Place

NOTES:
*Results of on-Site radiological screening <MDL unless otherwise noted

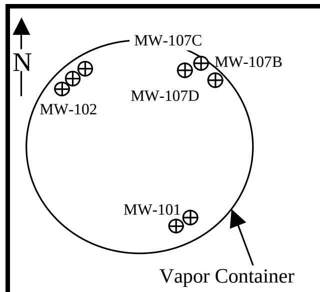
DRILLING LOG for Well #: MW-107C

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

Project:	Yankee L.T.P.	Project Number:	2107.01
Client:	Yankee Atomic Electric Company	Logged by:	Michael Horesh
Drilling Co:	D.L. Maher	Driller:	Oiden Gonzales
Date Started:	18-Sep-03	Date Finished:	19-Sep-03
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic

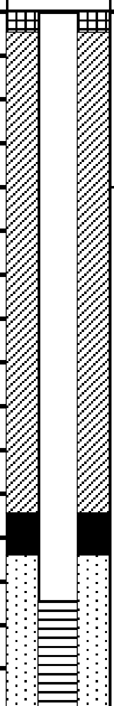
Screen Diam:	2"	Length:	5'	Slot Size:	0.010"
Casing Diam:	2"	Length:	27'	Type:	Schedule 40, 2" PVC
Boring Depth:	32'	Well Depth:	32'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	NR

On-Site GW Analyses: H-3, Co-60, Cs-134, Cs-137 Off-Site Non-radiological Laboratory: Northeastern Laboratories



Notes:

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) spoon/HS	Lab Sample # & Analyses
2, 4, 6, 8								**8'** **GW-1** VOC-8260B
10–32					**Well Construction Details:** 0-1': Cement, Protective Flushmount Roadbox; 1'-23': Portland Cement/Bentonite Grout; 23'-25': Bentonite Chip Seal; 25'-32': #0 Silica Sand Filter Pack; 1'-27': Sched. 40 2" PVC Riser; 27'-32': 0.010" Sched. 40 2" PVC Screen; 32': Bottom of Boring			
					Bottom of Boring at 32' bgs			



*Results of on-Site radiological activity <MDL unless otherwise noted

Key to Well Construction

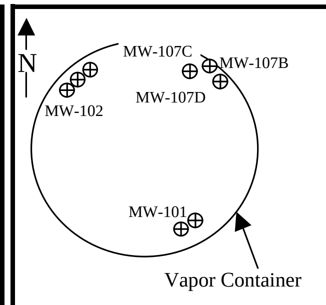
Sandpack; Bentonite Seal; Well Screen; Cement; Grout

ERM
399 Boylston Street, 6th Floor
Boston, MA 02116

DRILLING LOG for Well #: MW-107D

Project:	Yankee L.T.P.		Project Number:	2107.01	
Client:	Yankee Atomic Electric Company		Logged by:	Michael Horesh	
Drilling Co:	D.L. Maher		Driller:	Oiden Gonzales	
Date Started:	20-Sep-03		Date Finished:	23-Sep-03	
Location:	Rowe, Massachusetts		Drilling Method:	Rotosonic	
Screen Diam:	2"	Length:	5'	Slot Size:	0.010"
Casing Diam:	2"	Length:	76.2'	Type:	Schedule 40, 2" PVC
Boring Depth:	81.2'	Well Depth:	81.2'	Boring Diam.:	5.5"
Surface Elev.:	NR	MP:	Ground Surface	Depth to GW:	NR

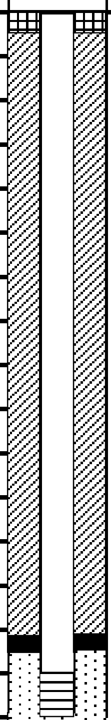
On-Site GW Analyses: H-3, Co-60, Cs-134, Cs-137 Off-Site GW Analytical Laboratory: Northeastern Laboratories



Notes:

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) spoon/HS	Lab Sample # & Analyses

Depth: 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 65, 70, 75, 80, 85



Well Construction Details:

0-1': Cement, Protective Flushmount Roadbox
1'-71.1': Portland Cement/Bentonite Grout
71.1'-73': Bentonite Chip Seal
73'-81.2': #0 Silica Sand Filter Pack
1-75': Sched. 40 2" PVC Riser
75'-80': 0.010" Sched. 40 2" PVC Screen
81.2': Bottom of Boring

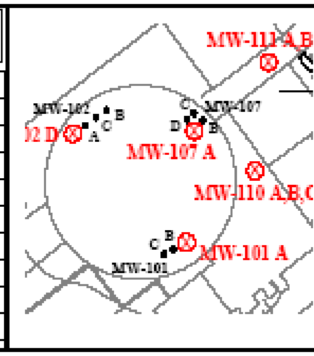
Bottom of Boring at 81.2' bgs

Key to Well Construction

Sandpack
Bentonite Seal
Well Screen
Cement
Grout

GEOLOGIST'S LOG for Well #: MW-107E

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:	
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott
Drilling Co:	Boart Longyear	Driller:	Mike Hansen
Date Started:	5-May-06	Date Finished:	15-May-06
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic

Screen Diam:	2 inches	Length:	5 feet	Slot Size:	0.010 inch
Casing Diam:	2 inches	Length:	52 feet	Type:	Schedule 40, PVC
Boring Depth:	70 feet	Well Depth:	57 feet	Boring Diam.:	10" telescoping to 5½"
Surface Elev.:	1135.1 feet NAVD '88	MP:	Ground Surface	Depth to GW:	
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site GW Analyses: none			

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	Ground Water Sample No.*
1–5		Fill	5'	No Sample (see MW-107A)	Fill, dark brown, consisting of silt and sand, f. to c.; some gravel, f. to c., and cobbles; trace roots and wood, trace Mirafi cloth; unsorted, damp, loose.	0-5'	
6–15			10'	No Sample (see MW-107A)	Fill, dark brown, consisting of silt and sand, f. to c.; some gravel, f. to c., and cobbles; trace roots and wood, trace Mirafi cloth; unsorted, moist, loose.	5-15'	
16–25			10'	No Sample (see MW-107A)	Fill, dark brown, consisting of silt and sand, f. to c.; some gravel, f. to c., and cobbles; trace roots and wood, trace Mirafi cloth; unsorted, wet, loose.	15-25'	
26			5'	4'	See next page.	25-30'	

NOTES:
*Results of on-site radiological screening <MDL unless otherwise noted

Key to Well Construction

Sandpack
Bentonite Seal
Well Screen
Cement/Bentonite Grout and 8-inch Steel Casing
Cement/Bentonite Grout

Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth (feet)	Ground Water Sample No.*
27-32	Fill; Till	7'	6'	25-28': Fill consisting of silt, dark brown, f. to c. sand and f. to c. gravel, unsorted, loose, wet. 28-32': Till consisting of olive green-gray silt, little clay and f. sand, f. to c. angular gravel, tr. Fist-sized cobbles of garnet schist, unsorted, very dense, damp.	25-32'	
32-35	Till; Sand and Silt	3'	2.5'	Advance 10-inch drill casing to 32', install 8-inch permanent casing, cement grout annular space and withdraw 10-inch casing. 32-34.5': Till, as above, dry. Driller reports drilling got soft at very bottom of sample run.	32-35'	
35-40	Till	5'	5.5'	34.5-35': Sand, f. to m. and silt, gray-green, unsorted, m. loose, wet. Borehole has ~1' water and collapsed ~1'. Attempted to bail GW sample, but not enough water coming in. 35-40': Till as in 32-34.5', dry; except for 1-inch seam of fine sand and gray-green silt, damp, at 37.5 to 37.6'. Advance 7 5/8-inch drill casing to 40' and pressure grout to seal off water.	35-40'	
40-45	Sand; Sand and Silt	5'	5'	40-40.5': Sand, vc., some f. gravel, tr. Silt, olive-gray, unsorted, loose, wet. 40.5-44.5': Sand, f. and silt, olive-gray, unsorted, moderately dense, wet; few cobbles @ 42.5-43'. 44.5-45': Till, very dense, dry, as in 32-34.5'. 8' of water in the borehole. Bail GW-1, advance 7 5/8" drill casing to 45' and pressure grout to seal off water.	40-45'	GW-1: H-3=15,200 pCi/L
45-50	Till; Silt and Sand	5'	5'	45-49.5': Till, more fine-grained than above, consisting of silt and f. angular gravel; little clay, tr cobbles, unsorted, dense, damp. 49.5-50': Silt and f. sand, olive-gray, unsorted, mod dense, moist.	45-50'	
50-55	Till; Sand and Gravel; Till	5'	5'	50-52': Till consisting of silt, olive-gray, some f. to c. sand and f. to c. angular gravel, little clay, tr cobbles, unsorted, dense, dry. 52-52.5': Sand, f. to c. and c. angular gravel, unsorted, loose, wet. 52.5-55': Till consisting of silt, olive-gray, some f. to c. sand and f. to c. angular gravel, little clay, tr cobbles, unsorted, dense, dry.	50-55'	GW-2: H-3=4,600 pCi/L
55-60	Silt and Sand; Till	5'	5'	55-57': Silt and f. sand, with f. angular gravel, little c. gravel, unsorted, dense, moist. 57-60': Till consisting of silt, olive-gray, some f. to c. sand and f. to c. angular gravel, little clay, tr cobbles, unsorted, dense, dry. Water entering the borehole: bail GW-2, and advance 5 1/2-inch drill casing to 60'.	55-60'	
60-65	Till	5'	4.5'	60-64': Till consisting of silt, olive-gray, some f. to c. sand and f. to c. angular gravel, little clay, tr cobbles, unsorted, very dense, dry. 1-inch f. sand layer @ 62', moist. 64-65': Clay, olive green, very stiff, some f. to m. angular gravel.	60-65'	
65-66		5'	5'	See next page.	65-70'	

*Results of on-site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-107E

Yankee Nuclear Power Station, Rowe, MA

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	Ground Water Sample No.*
67 68 69 70		Till	5'	5'	Till consisting of clay and silt, olive green, some f. to c. sand and f. to c. angular gravel, tr cobbles, unsorted, very dense, dry (more clay-rich than higher up in the section).	65-70'	

Bottom of Boring at 70'

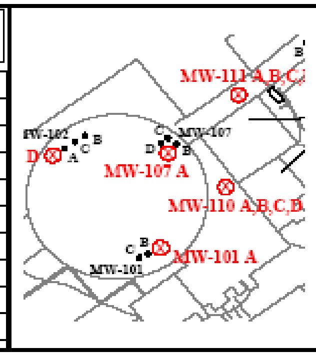
Well Construction Details:

0-32': Cement/Bentonite Grout and 8-inch Steel Casing
0-46': Portland Cement/Bentonite Grout
46-50': Bentonite Chip Seal
50-59': #0 (medium) Silica Sand Filter Pack
0-52': Schedule 40 2" PVC Riser
52'-57': Schedule 40 2" PVC, 0.010"-Slot Screen
59-70': Bentonite Chip Seal
70': Bottom of Boring

*Results of on-Site radiological screening <MDL unless otherwise noted

GEOLOGIST'S LOG for Well #: MW-107F

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:			
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott		
Drilling Co:	Boart Longyear	Driller:	Mike Hansen		
Date Started:	17-May-06	Date Finished:	23-May-06		
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic		
Screen Diam:	2 inches	Length:	5 feet	Slot Size:	0.010 inch
Casing Diam:	2 inches	Length:	49 feet	Type:	Schedule 40 PVC
Boring Depth:	57 feet	Well Depth:	54 feet	Boring Diam.:	10" telescoping to 5½"
Surface Elev.:	1135.1 feet NAVD '88	MP:	Ground Surface	Depth to GW:	
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site GW Analyses: none			

Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	Ground Water Sample No.*
1–5	Fill	5'	4'	Fill, dark brown, consisting of silt and sand, f. to c.; some gravel, f. to c., and cobbles; trace roots and wood, trace Mirafi cloth; unsorted, loose, wet.	0-5'	
5–15	Fill	10'	6.5'	Fill, dark brown, consisting of silt and sand, f. to c.; some gravel, f. to c., and cobbles; trace roots and wood, trace Mirafi cloth; unsorted, loose, wet.	5-15'	
15–21	Fill (to 20'); Till	6'	4'	15-20': Fill, dark brown, consisting of silt and sand, f. to c.; some gravel, f. to c., and cobbles; trace roots and wood, trace Mirafi cloth; unsorted, loose, wet. 20-21': Till consisting of olive-gray silt and f. sand and f. to c. angular gravel, little clay, tr cobbles, unsorted, very dense, dry.	15-21'	
21–25	Till	4'	4'	Till consisting of olive-gray silt and f. sand and f. to c. angular gravel, little clay, tr cobbles, unsorted, very dense, dry.	21-25'	
25–26	Till	5'	5'	See next page.	25-30'	

NOTES:
*Results of on-site radiological screening <MDL unless otherwise noted

Key to Well Construction

- Sandpack
- Bentonite Seal
- Well Screen
- Cement/Bentonite Grout
- Cement/Bentonite Grout and 8-inch Steel Casing

DRILLING LOG for Well No.:	MW-107F	Yankee Nuclear Power Station, Rowe, MA	

Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth (feet)	Ground Water Sample No.*
27, 28, 29	Till	5'	5'	Till consisting of olive-gray silt and f. sand and f. to c. angular gravel, little clay, tr cobbles, unsorted, very dense, dry. Soil core is very hot due to friction from drill action on very dense till.	25-30'	
30, 31, 32, 33	Till	4'	4'	Same as above. 1-inch f. sand seam at 32.5'. 3 inches of vf silty sand at bottom of sample, dry.	30-34'	
34, 35, 36, 37, 38	Till / Sand / Till	5'	5'	34-35.5': Boulder. 35.5-36.5': Till, as at 25-30'. 36.5-38': Sand, brown, c. at top, grading to f. at bottom, loose, wet. Borehole collapsed to 37'. 38-39': Till, as at 25-30'.	34-39'	GW-1: H3=44,800 pCi/L
39, 40	Till	1'	1'	39-40': Till as above. Collect GW-1, advance 7 5/8" drill casing to 40' and pressure grout.	39-40'	
41, 42, 43, 44	Till	5'	5'	Till consisting of olive-gray silt and f. sand and f. to c. angular gravel, little clay, tr cobbles, unsorted, very dense, damp. 4-inch layer of silt @ 44-44.3', moist.	40-45'	
45, 46, 47, 48, 49	Till	5'	5'	Till consisting of olive-gray silt and f. sand and f. to c. angular gravel, little clay, tr cobbles, unsorted, very dense, dry.	45-50'	
50, 51, 52, 53, 54	Sand and Gravel / Till	5'	5'	50-52': Sand, f. to m. with subangular gravel, f. to c., little silt, unsorted, dense, wet. 10' of water in the borehole. 52-55': Till consisting of olive-gray silt and f. sand and f. to c. angular gravel, little clay, tr cobbles, unsorted, very dense, damp.	50-55'	GW-2: H-3=8,790 pCi/L
55, 56	Till	2'	2'	Till consisting of olive-gray silt and f. sand and f. to c. angular gravel, little clay, tr cobbles, unsorted, very dense, dry.	55-57'	
57, 58, 59, 60, 61, 62, 63, 64, 65, 66				End of Boring at 57'		

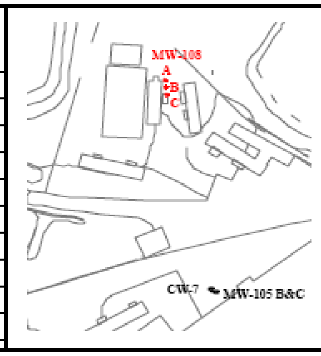
Well Construction Details

0-25':	Cement/Bentonite Grout and 8-inch Steel Casing
0-40.5':	Portland Cement/Bentonite Grout
40.5'-47':	Bentonite Chip Seal
47-55':	#0 (medium) Silica Sand Filter Pack
0-49':	Schedule 40 2" PVC Riser
49-54':	Schedule 40 2" PVC, 0.010"-Slot Screen
55-57':	Bentonite Chip Seal

*Results of on-site radiological screening <MDL unless otherwise noted

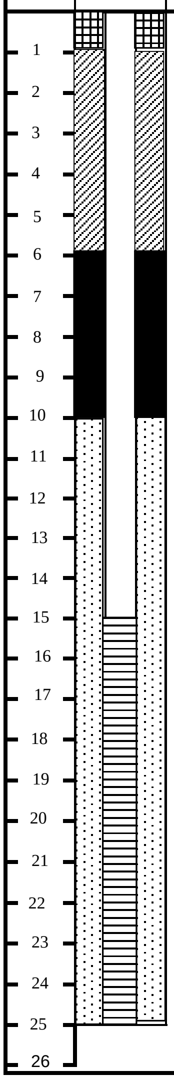
GEOLOGIST'S LOG for Well #: MW-108A

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:			
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott		
Drilling Co:	D.L. Maher	Driller:	Roy Buckenberger		
Date Started:	July 16, 2004	Date Finished:	July 16, 2004		
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic		
Screen Diam:	2 inches	Length:	10 feet	Slot Size:	0.010 inch
Casing Diam:	2 inches	Length:	15 feet	Type:	Schedule 40, 2-inch PVC
Boring Depth:	25 feet	Well Depth:	25 feet	Boring Diam.:	5½ inches
Surface Elev.:	1118.4 feet MSL	MP:	Ground Surface	Depth to GW:	12.31 feet from PVC
On-Site GW Analyses:	None	Off-Site GW Analyses: None			on October 31, 2004

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*



See log of MW-108B for description of sediment and ground water samples.

Well Construction Details:

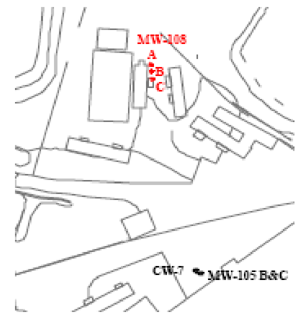
0-1': Concrete and Flushmount Roadbox
1'-6.1': Portland Cement/Bentonite Grout
6.1'-10': Bentonite Chip Seal
10'-25': #0 Silica Sand Filter Pack
0-15': Schedule 40 2" PVC Riser
15'-25': Schedule 40 2" PVC, 0.010-Slot Screen
25': Bottom of Boring

Key to Well Construction

Sandpack
Bentonite Seal
Well Screen
Concrete and Flushmount Roadbox
Cement/Bentonite Grout

GEOLOGIST'S LOG for Well #: MW-108B

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:			
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott		
Drilling Co:	D.L. Maher	Driller:	Roy Buckenberger		
Date Started:	July 8, 2004	Date Finished:	July 15, 2004		
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic		
Screen Diam:	2½ inches	Length:	10 feet	Slot Size:	0.010 inch
Casing Diam:	2½ inches	Length:	205 feet	Type:	Schedule 80, 2½-inch PVC
Boring Depth:	215 feet	Well Depth:	215 feet	Boring Diam.:	5½ inches
Surface Elev.:	1118.5 feet MSL	MP:	Ground Surface	Depth to GW:	53.43 feet from PVC
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site GW Analyses: VOCs by 8260B			on October 31, 2004

Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
Fill	5'	4'	Fill consisting of sand, brown, fine to medium, and fine to coarse subround gravel, some cobbles, some silt, unsorted, loose, dry.	0-5'	0.0	
Fill	2'	2'	Sand, brown, fine to coarse, little medium to coarse gravel, some silt, unsorted, loose, wet at 7'.	5-7'	0.0	
Fill	3'	3'	Sand, brown, fine, some silt, trace fine gravel, rounded, unsorted, loose, wet.	7-10'	0.0	
Fill	5'	4'	Sand, brown to gray-green, fine and gravel, fine to coarse, some silt, unsorted, medium dense, wet.	10-15'	0.0	GW-1 H-3<300 pCi/L
Stratified Drift	3'	3'	Silt, dark brown, organic and sand, very fine, trace fine to medium subangular gravel, unsorted, loose, wet.	15-18'	100	
Stratified Drift	2'	2'	Same as above, but gray-green.	18-20'	0.0	
Stratified Drift / Till	5'	5'	20-21': Sand, brown, med. to very coarse and gravel, f. to c., rounded, trace silt, unsorted, medium dense, wet. 21-24': Silt, gray-brown and sand, very fine, some subangular fine to medium gravel, few cobles, unsorted, dense, moist. 24-25': Till: silt, brown, some f. to c. sand, subangular f. to c. gravel, few cobbles, unsorted, very dense, dry.	20-25'	0.0	
Till	1'	1'	Same as 24-25'.	25-26'	0.0	

Depth scale (feet): 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26

NOTES:
*Results of on-site radiological screening <MDL unless otherwise noted

Key to Well Construction

- Sandpack
- Bentonite Seal
- Well Screen
- Concrete and Flushmount Roadbox
- Cement/Bentonite Grout

GEOLOGIST'S LOG for Well No.: MW-108B

Yankee Nuclear Power Station, Rowe, MA

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
27–29		Till	3'	3'	Advanced 8" permanent steel casing to 26' and cement grouted to seal off aquifer above. 26-29': Silt, olive brown and very fine sand, some angular decomposed schist-m. to c. gravel-sized, unsorted, very dense, dry. Very tough drilling.	26-29'	0.0	
30–32		Till	3'	2'	29-30': Same as above. 30-32': Albite gneiss boulder: pulverized by drill, with up to cobble-sized fragments, dry.	29-32'	0.0	
33–35		Till	3'	3'	Silt, olive brown and fine sand, some angular fine to medium gravel, trace coarse gravel, unsorted, very dense, dry.	32-35'	0.0	
36–38		Till	3'	3'	35-36.5': Same as above, but moist; slightly more sandy. 36.5-38': Same as 32-35', dry.	35-38'	0.0	
39–41		Till	3'	3'	Silt, olive brown with very fine sand and fine to coarse angular gravel, few angular quartz cobbles and garnetiferous schist fragments, unsorted, very dense, dry.	38-41'	0.0	
42–45		Till	4'	4'	Same as above. No recovery on the first attempt. Reentered the hole to retrieve the sample. As a result, the sample was highly disturbed.	41-45'	0.0	
46–49		Till	4'	4'	45-48': Silt, olive and fine sand, some fine to coarse angular gravel, unsorted, very dense, damp. 48-49': Same as above; slightly more sand at top and wet, but only damp at bottom.	45-49'	0.0	
50–51		Till	2'	2'	Silt, olive, with very fine sand, some fine to medium subangular gravel, unsorted, very dense, damp.	49-51'	0.0	
52–53		Till	2'	2'	Same as above, but dry with few chlorite schist and albite gneiss cobbles.	51-53'	0.0	
54–55		Till	2'	2'	53-54.5': Albite gneiss boulder. 54.5-55': Same as 49-51', dry.	53-55'	0.0	
56–58		Till	3'	3'	Same as 51-53', damp.	55-58'	0.0	
59–60		Till	2'	2'	Same as 49-51', dry.	58-60'	0.0	
61–63		Till	3'	3'	60-61.5': Same as above, damp; one 2" medium sand lense in middle, wet. 61.5-63': Sand, fine with silt, olive, unsorted, loose, saturated. Bottom 3" in top of albite gneiss boulder.	60-63'	0.0	GW-2 H-3<300 pCi/L
64		Boulder	1.5	0.5	Albite gneiss boulder.	63-64.5'	0.0	
65–66		Boulder	10.5	0.5	Advanced 5½" drill casing to 65'. See next page.	64.5-75'	0.0	

*Results of on-site radiological screening <MDL unless otherwise noted

GEOLOGIST'S LOG for Well No.: MW-108B

Yankee Nuclear Power Station, Rowe, MA

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
67–75		Till	10.5'	0.5'	Cored with water because we thought we were in bedrock. Broke through the boulder at 66'; all fine-grained material was washed from the sample below the boulder by the coring water. Only subround cobbles of albite gneiss, garnet gneiss and marble remained in the sample. The coring water return was very silty and gray-green; not gray as if we had been cutting through the albite gneiss bedrock.	64.5-75'	0.0	
75–80		Till	5'	7'	Two feet in top of sampler is wash from 65-75': medium to very coarse sand and medium to coarse subround gravel. 75-80': Silt, olive green and clay, with fine angular gravel, some medium gravel, unsorted, very dense, damp. Few cobbles in bottom 1 foot of sample.	75-80'	0.0	
80–85		Till	5'	5'	Advanced 7⅝" drill casing to 79' and pressure grouted with bentonite slurry to seal off aquifer above. 80-85': Extremely dense till consisting of silt, olive, little clay and fine to coarse angular gravel, some fine sand, unsorted, dry. Gravel is comprised of granite gneiss and chlorite schist.	80-85'	0.0	
85–90		Till	5'	5'	Same as above.	85-90'	0.0	
90–95		Till	5'	5'	Same as above.	90-95'	0.0	
95–100		Till	5'	5'	Silt, olive, with fine angular gravel, little medium to coarse gravel, trace clay, unsorted, very dense, dry. Faint bedding near bottom defined by 1-2mm light gray clay lamellae at 5-10 cm intervals within gravely silt matrix.	95-100'	0.0	
100–105		Till	5'	5'	Same as above, no layering. Top of sample is wet but water is probably what was trapped above a grout plug between the 5½" and 7⅝" drill casings, which was released when the 5½" casing was advanced after the 95-100' sample was collected. Although the water is probably not from the formation, we will sample it anyway, as a precaution.	100-105'	0.0	GW-3 H-3<300 pCi/L
105–106		Till	5'	5'	105-106': Albite gneiss boulder.	105-110'	0.0	

*Results of on-site radiological screening <MDL unless otherwise noted

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
107–110		Till	5'	5'	Advanced 5½" drill casing to 105' and pressure grouted with bentonite slurry to seal off possible aquifer above. 106-110': Silt, olive, with clay and fine angular gravel, little coarse gravel, unsorted, very dense, damp.	105-110'	0.0	
111–115			5'	5'	Clay, olive, with fine angular gravel, trace coarse subangular garnet schist gravel, one talc clast, unsorted, unlayered, hard, damp. This interval drilled easier than above.	110-115'	0.0	
116–125			10'	10'	Clay, olive, with fine angular gravel. Few 1-2 mm very fine gray sand lamellae at 124' and one 1" very coarse brown sand layer with small cobbles at 115'.	115-125'	0.0	
126–132			7'	7'	Silt, olive, with clay and fine to coarse angular gravel, unsorted, very dense, no layering, damp. 4" schist cobble at bottom.	125-132'	0.0	
133–135			3'	3'	Same as above, some gneiss and schist cobbles.	132-135'	0.0	
136–138			3'	3'	Silt, olive, and fine to coarse angular gravel, trace clay, unsorted, very dense, dry; 4" anorthosite cobble at bottom.	135-138'	0.0	
139–145			7'	7'	Same as above. No imbrication of gravel.	138-145'	0.0	
146			4'	3'	145-147': Same as above.	145-149'	0.0	

*Results of on-site radiological screening <MDL unless otherwise noted

GEOLOGIST'S LOG for Well No.:	MW-108B	Yankee Nuclear Power Station, Rowe, MA	Page 5 of 6

Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
Till / Boulder	4'	3'	147-149': Albite gneiss boulder (mostly pulverized by drill).	145-149'	0.0	
Till	6'	0.75	Cored with water, believing we were in bedrock. Broke through the boulder at 150'. All fine-grained material below the boulder was washed from the sample by the coring water. Only subround cobbles of gneiss and schist remained in the sample. The coring water return was very silty and gray-green; not gray as if we had been cutting through the albite gneiss bedrock.	149-155'	0.0	
Till	2'	4.5'	Top 2.5' of sample is slough: very coarse sand and gravel from which the fines were washed while coring 149-155'. 155-157': Same silt and f. to c. angular gravel as above.	155-157'	0.0	
Till / Glaciolacustrine Sequence	8'	8'	Silt, olive, some clay, with fine to medium angular gravel, trace cobbles, unsorted, very dense, damp. Few fine sand lamellae (1-2 mm) at 163-164'; moist in sandy zone, remaining sample damp to dry. After sitting overnight, the hole had 80' of water. The water-bearing zone is likely 163-164', or possibly a sand that was washed out while coring 149-155'. After collecting ground water sample GW-4, advanced 5½" drill casing to 165' and pressure grouted with bentonite slurry to seal off aquifer.	157-165'	0.0	GW-4 H-3<300 pCi/L
Glaciolacustrine Sequence	5'	3'	165-166': albite gneiss boulder. 166-170': Cored with water from 165-170', believing we were on bedrock. Broke through the boulder at 166'. Most fine-grained material below the boulder was washed from the sample by the coring water. Only subrounded cobbles of gneiss and quartzite remained, with thumbnail-sized clumps of olive clay.	165-170'	0.0	
Glaciolacustrine Sequence	8'	8'	170-174': Sand, fine to medium, trace silt, olive, loose, saturated. Upon reentering the hole to advance, the sand had heaved 20'. 174-175': Sand, f. to m. and silt, olive, dense, moist. 175-178': Silt, olive, with fine angular gravel, little medium to coarse gravel, trace clay, unsorted, very dense, dry. After collecting ground water sample GW-5, advanced 5½" drill casing to 175' and pressure grouted with bentonite slurry to seal off aquifer.	170-178'	0.0	GW-5 H-3<300 pCi/L
Glaciolacustrine Sequence	7'	5.5'	Sand, very fine, with silt, olive, little clay, well sorted, medium dense, saturated. 40' of rods are wet. Upon reentering the hole, sand had heaved 25' into the casing, which was at 175'.	178-185'	0.0	
Glaciolacustrine Sequence	4'	4'	See next page.	185-189'	0.0	

Depth scale: 147 148 149 150 151 152 153 154 155 156 157 158 159 160 161 162 163 164 165 166 167 168 169 170 171 172 173 174 175 176 177 178 179 180 181 182 183 184 185 186

*Results of on-site radiological screening <MDL unless otherwise noted

GEOLOGIST'S LOG for Well No.: MW-108B

Yankee Nuclear Power Station, Rowe, MA

Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
187-189	Glaciolacustrine Sequence	4'	4'	Same as above, some medium to coarse sand at 185-186'. Faint 1-2 mm lamellae visible. On rock at bottom of sampler.	185-189'	0.0	
189-195	Boulder Glaciolacustrine Sequence	6'	6'	189-194': Albite gneiss boulder. 194-195': Same very fine sand as at 178-185'.	189-195'	0.0	
195-205	Glaciolacustrine Sequence Bedrock	10	6'	195-196': Same as above. 196-205': Albite gneiss bedrock, coarse grained, with ¼" albite megacrystals. Several machine breaks, but at least 3 natural fractures with iron staining at 201', 202.5' and 203.5'. Bottom 6" of sample very quartz rich.	195-205'	0.0	
205-215	Bedrock	10'	8.5'	Albite gneiss bedrock. Iron-stained (natural) fractures at 206.5', 209.5' and 211.5'. Collected ground water sample GW-6 after completing well and purging approximately 80 gallons of water.	205-215'	0.0	GW-6 H-3<300 pCi/L

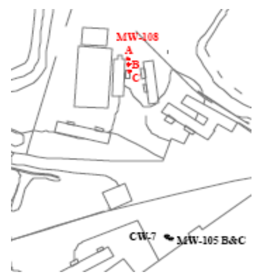
Well Construction Details:

0-1': Concrete and Flushmount Roadbox
1'-197.5': Portland Cement/Bentonite Grout
197.5'-202.5': Bentonite Chip Seal
202.5'-215': #0 Silica Sand Filter Pack
0-205': Schedule 80 2.5" PVC Riser
205'-215': Schedule 80 2.5" PVC, 0.010-Slot Screen
215': Bottom of Boring
0-26': 8" Steel Casing Cement/Bentonite-Grouted in Place

*Results of on-site radiological screening <MDL unless otherwise noted

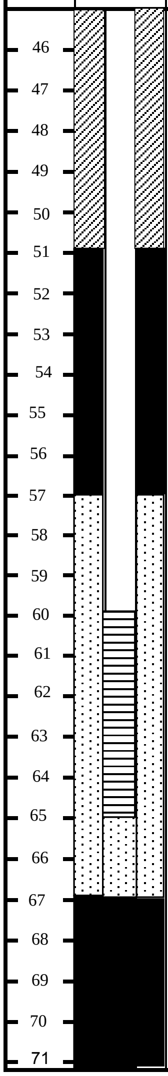
GEOLOGIST'S LOG for Well #: MW-108C

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:			
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott		
Drilling Co:	D.L. Maher	Driller:	Bill Zamow (6/23-6/25), Roy Buckenberger (6/28-7/7)		
Date Started:	June 23, 2004	Date Finished:	July 7, 2004		
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic		
Screen Diam:	2 inches	Length:	5 feet	Slot Size:	0.010 inch
Casing Diam:	2 inches	Length:	60 feet	Type:	Schedule 40, 2-inch PVC
Boring Depth:	170 feet (see note below)	Well Depth:	65 feet	Boring Diam.:	7⅝ inches
Surface Elev.:	1118.7 feet MSL	MP:	Ground Surface	Depth to GW:	14.20 feet from PVC
On-Site GW Analyses:	None	Off-Site GW Analyses: None			on October 31, 2004

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*



See log of MW-108B for description of sediment and ground water samples.

Well Construction Details:

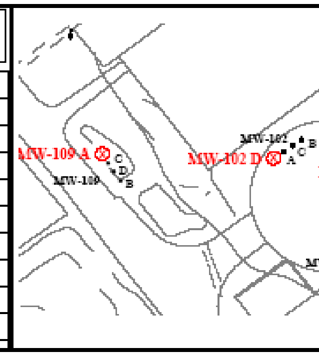
0-1': Concrete and Flushmount Roadbox
1'-51': Portland Cement/Bentonite Grout
51'-57': Bentonite Chip Seal
57'-67': #0 Silica Sand Filter Pack
0-60': Schedule 40 2" PVC Riser
60'-65': Schedule 40 2" PVC, 0.010-Slot Screen
170': Bottom of Boring (filled to 67' with bentonite chips)
0-26': 8" Steel Casing Cement/Bentonite-Grouted in Place

Key to Well Construction

Sandpack
Bentonite Seal
Well Screen
Concrete and Flushmount Roadbox
Cement/Bentonite Grout

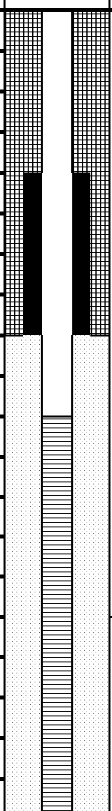
GEOLOGIST'S LOG for Well #: MW-109A

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:	
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott
Drilling Co:	Boart Longyear	Driller:	Roy Buckenberger/Mike Hansen
Date Started:	3-Feb-06	Date Finished:	3-Feb-06
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic

Screen Diam:	2 inches	Length:	10 feet	Slot Size:	0.010 inch
Casing Diam:	2 inches	Length:	10 feet	Type:	Schedule 40 PVC
Boring Depth:	20 feet	Well Depth:	20 feet	Boring Diam.:	10" telescoping to 5½"
Surface Elev.:	1124.1 feet NAVD '88	MP:	Ground Surface	Depth to GW:	12.41 feet from PVC
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	PVC Casing Extension Above Grade: 3.9 feet			on April 18, 2006



Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	Ground Water Sample No.*
1–5		Sand & Gravel	5'	5'	Sand, brown, f. to vc. and gravel, f. to c., subangular; some silt; loose. Stormwater is entering the borehole because of heavy rain. Unable to identify moisture content of sample.	0-5'	
6–10			5'	5'	Sand, brown, f. to vc. and gravel, f. to c., subangular; some silt; loose. Stormwater is entering the borehole because of heavy rain. Unable to identify moisture content of sample. Advance 10" drill casing to 8', install 8" permanent steel casing to 8', cement grout annular space and withdraw 10" drill casing.	5-10'	
11–15			5'	5'	10-12': Sand, brown, m. to c.; little silt, moist. 12-15': Sand, brown, f. to vc. and gravel, f. to c., subangular, some silt, loose, wet.	10-15'	GW-1: H-3<2,000 pCi/L
16–20		Till	5'	4'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, damp.	15-20'	

Depth: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26

Bottom of Borehole at 20'

Well Construction Details

0-4.1': 8-inch Steel Casing Extension Above Grade 0-
8': Cement/Bentonite Grout and 8-inch Steel Casing
0-4' Cement/Bentonite Grout 4-8':
Bentonite Chip Seal
8-20': # 0 (medium) Silica Sand Filter Pack
0-10': Schedule 40 2" PVC Well Riser
10-20': Schedule 40 2" PVC, 0.010-Slot Well Screen

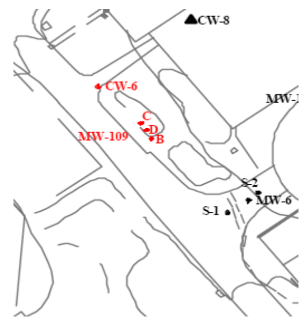
NOTES:
*Results of on-site radiological screening <MDL unless otherwise noted

Key to Well Construction

⬚	Sandpack	☰	Well Screen	▨	Cement/Bentonite Grout
■	Bentonite Seal	▦	Cement/Bentonite Grout and 8-inch Steel Casing		

GEOLOGIST'S LOG for Well #: MW-109B

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:			
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott (0-20') and Mike Ravella (20-190')		
Drilling Co:	D.L. Maher	Driller:	Roy Buckenberger		
Date Started:	July 20, 2004	Date Finished:	August 2, 2004		
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic		
Screen Diam:	2½ inches	Length:	10 feet	Slot Size:	0.010 inch
Casing Diam:	2½ inches	Length:	180 feet	Type:	Schedule 80, 2½-inch PVC
Boring Depth:	190 feet	Well Depth:	190 feet	Boring Diam.:	5½ inches
Surface Elev.:	1124.6 feet MSL	MP:	Ground Surface	Depth to GW:	28.70 feet from PVC
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site GW Analyses: VOCs by 8260B			on October 31, 2004

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
1–4		Fill	4'	1'	Fill consisting of silt, brown and fine to coarse sand, some fine to coarse subangular gravel, one fist-sized cobble, unsorted, loose, dry.	0-4'	0.0	
4–5		Fill	1'	1'	Boulder: rusty-weathering gneiss.	4-5'	0.0	
5–11		Fill (to 8'); Stratified Drift	6'	6'	5-6': Same boulder; rusty-weathering gneiss. 6-8': Fill, same as 0-4'; dark brown oxidized zone at 8'. 8-11': Sand, fine to medium and rounded fine to coarse gravel, with brown silt, few cobbles, unsorted, loose, dry.	5-11'	0.0	
11–12		Stratified Drift	1'	1'	Boulder: albite gneiss.	11-12'	0.0	GW-1 H-3< 300 pCi/L
12–15		Stratified Drift	3'	2.5'	12-13.5': Same boulder. 13.5-15': Silt, brown and fine to coarse angular gravel, little fine to medium sand, unsorted, loose, wet.	12-15'	0.0	
15–20		Till	5'	5'	Till consisting of silt, olive, some fine to coarse sand and fine to coarse subangular gravel, trace clay, unsorted, very dense, damp. Advanced permanent 8" steel casing to 20' and cement grouted.	15-20'	0.0	
20–25		Till	5'	4'	Grayish Brown (5YR3/2) Gravely Silt: mostly silt, some gravel, little clay, poorly sorted, hard, damp, poor plasticity. (Till).	20-25'	0.0	
25–26		Till	4'	3.5'	See next page.	25-29'	0.0	

NOTES:
*Results of on-site radiological screening <MDL unless otherwise noted

Key to Well Construction

Sandpack | Well Screen | Cement/Bentonite Grout
Bentonite Seal | Concrete and Flushmount Roadbox

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
27–29		Till	4'	3.5'	25-26':Grayish Brown (5YR3/2) Clayey Silt: mostly silt, some clay, some gravel; moderately soft, moist, some plasticity. 26-28.5': Grayish Brown (5YR3/2) Gravelly Silt: mostly silt, some gravel, poorly sorted, hard, damp to dry, poor plasticity. (Till).	25-29'	0.0	
29–35		Till	6'	6'	Same as above, no laminations thus far to this depth. Higher clay content at 4'. (Till).	29-35'	0.0	
35–40		Till	5'	5'	Grayish Brown (5YR3/2) Clayey Silt: mostly silt, some clay, some gravel, unsorted, hard, damp to dry, some plasticity. Note: higher clay content than above. (Till).	35-40'	0.0	
40–45		Till	5'	5'	Grayish Olive (10Y4/2) Clayey Silt: mostly silt, some clay, little gravel, hard, dry, little plasticity. Note: 6" cobble at 43.5', less clay and mostly silt at 44'. (Till).	40-45'	0.0	
45–53		Till	8'	8'	Grayish Olive (10Y4/2) Fine Sandy Silt: mostly silt, some fine sand, little clay, some laminations, hard, damp to moist, low plasticity. Note: silty fine sand from 51-52', moist. Hole produces water, with water level about 47'. (Silt / Till).	45-53'	0.0	GW-2 H-3< 300 pCi/L
53–57		Till	4'	2'	Grayish Olive (10Y4/2) Silt: mostly silt, little fine sand, little clay, firm, damp to dry, low plasticity. (Silt / Till).	53-57'	0.0	
57–60		Till	3'	3'	57-58': Same as above, but medium soft, damp. 58-60': Grayish Brown (5YR3/2) Silt: mostly silt, little gravel, hard, dry, no plasticity. (Till).	57-60'	0.0	
60–65		Till	5'	5'	Advanced 7⅝" drill casing to 60' and pressure grouted with bentonite slurry to seal off above aquifer. 60-65': Grayish Brown (5YR3/2) Gravelly Silt: mostly silt, some to little gravel, little clay, hard, dry, no plasticity. (Till).	60-65'	0.0	
65–66		Till	2'	2'	Same as above. (Till).	65-67'	0.0	

*Results of on-site radiological screening <MDL unless otherwise noted

Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
65-67	Till	2'	2'	Same as above. (Till).	65-67'	0.0	
67-70	Till	3'	3'	Same as above. (Till).	67-70'	0.0	
70-74	Till (70-72); Silty Sand (72-73); Till (73-74)	4'	4'	70-72': Same as above. (Till). 72-73':Grayish Brown (5YR3/2) Silty Sand: fine sand, some silt, little clay, unsorted, med. soft, moist.(Sand). 73-74': Grayish Brown (5YR3/2) Clayey Silt: silt, some clay and gravel, very stiff, moist, poor plasticity. (Till).	70-74'	0.0	
74-80	Till	6'	6'	Grayish Brown (5YR3/2) Clayey Sandy Silt: mostly silt and clay, some fine sand and little gravel, poorly laminated, stiff, damp to moist, poor plasticity. (Till).	74-80'	0.0	
80-85	Till	5'	5'	Grayish Brown (5YR3/2) Silty Clay: mostly clay, some silt, little gravel, very little fine sand, poorly laminated, stiff, damp, poor plasticity. (Till).	80-85'	0.0	
85-90	Till	5'	3'	Same as above. (Till).	85-90'	0.0	
90-100	Silty Sand (90-97); Clayey Silt (97-98); Silty Sand (98-99); Clayey Silt (99-100)	10'	10'	90-93': Dark Yellowish Brown (10YR4/2) Silty Sand: mostly fine to coarse sand, little silt and little cobbles, poorly sorted, loose, wet. (Sand). 93-97': Grayish Brown (5YR3/2) Silty Sand: mostly fine to coarse sand, little gravel and little clay, poorly sorted, medium dense, moist. (Sandy Till). 97-98': Grayish Brown (5YR3/2) Clayey Silt: silt, some clay, little gravel, very stiff, moist, poor plasticity. (Clay Till). 98-99': Grayish Brown (5YR3/2) Silty Sand: fine to medium sand, some silt and little cobbles, poorly sorted, loose, wet. 99-100': Same as 97-98'. (Clay Till).	90-100'	0.0	GW-3 H-3<300 pCi/L
100-105	Till	5'	5'	Grayish Brown (5YR3/2) Clayey Silt: silt, some clay, little gravel, very stiff, damp, poor plasticity. (Clay till). Advanced 7⅝" drill casing to 105' and pressure grouted with bentonite slurry to seal off aquifer above.	100-105'	0.0	
105-106	Glaciolacustrine	5'	5'	See next page.	105-110'	0.0	

*Results of on-site radiological screening <MDL unless otherwise noted

GEOLOGIST'S LOG for Well No.: MW-109B

Yankee Nuclear Power Station, Rowe, MA

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
107–110		Glaciolacustrine Sequence	5'	5'	Grayish Brown (5YR3/2) Silty Clay: mostly clay, some silt, little gravel, little sand, laminated, stiff, damp, moderate plasticity. (Glaciolacustrine Deposits).	105-110'	0.0	
111–120			10'	10'	Grayish Brown (5YR3/2) Fine Sandy Silty Clay: mostly clay with thin layers of fine sand and silt, little gravel, well laminated, soft, moist to wet, moderate plasticity. (Glaciolacustrine Deposits).	110-120'	0.0	
121–125			5'	5'	Same as above. (Glaciolacustrine Deposits). Approximately 3 inches of fine to medium sand and a cobble at 120'. The hole has continued to produce water slightly since 105'. These sediments will be cased off when a confining unit is encountered.	120-125'	0.0	GW-4 H-3=460 pCi/L
126–130			5'	5'	Collected sample in 3.5" by 5' long translucent Lexan liner. Appears to be the same material as above, possibly with more sand.	125-130'	0.0	
131–136		Sand	15'	15'	130-136': Light Olive Gray (5Y5/2) Sand: fine to medium subrounded sand, well sorted, homogenous structure, weak cementation, wet. (Sand).	130-145'	0.0	
137–145		Till ?			136-145': Grayish Brown (5YR3/2) Silty Clay: mostly clay, some silt, little gravel / cobbles, stiff, not laminated, damp, poor to moderate plasticity. (Till). Note: sand lense from 137.5 to 138'. Advanced 5½" drill casing to 145' and pressure grouted with bentonite slurry to seal off aquifer above.			
146		Glaciolacustrine	10'	10'	145-147': Grayish Brown (5YR3/2) Fine Sandy Silt:	145-155'	0.0	

*Results of on-site radiological screening <MDL unless otherwise noted

GEOLOGIST'S LOG for Well No.: MW-109B

Yankee Nuclear Power Station, Rowe, MA

Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*
147–155	Glasciolacustrine Sequence	10'	10'	145-147': Mostly silt, some fine sand, little gravel, not laminated, soft, damp, no plasticity. 147-155': Grayish Brown (5YR3/2) Silt: mostly silt, little clay, not laminated, firm, damp, no plasticity.	145-155'	0.0	
155–165	Glasciolacustrine Sequence	10'	10'	155-156': Grayish Brown (5YR3/2) silt: mostly silt, little clay, not laminated, firm, moist, poor plasticity. 156-157': Grayish Brown (5YR3/2) Sand: fine to medium sand, some silt, poorly sorted, loose, wet. 157-158': Same as 155-156', but soft and wet. 158-159': Same as 156-157'. 159-164.5': Same as 155-156', but very little clay. Rods are wet. 164.5-165': Same as 155-156', but very little clay and dry.	155-165'	0.0	GW-5 H-3=880 pCi/L
165–175	Glasciolacustrine Sequence (to 174); Bedrock (174–175)	10'	10'	165-171': Grayish Brown (5YR3/2) Silt: mostly silt, little to no clay, firm, not laminated, moist to wet, poor plasticity (Silt). 171-174': Same as above, but some clay. 174-175': Crushed weathered rock, dry (cobble or bedrock).	165-175'	0.0	
175–186	Bedrock	15'	10'	Advanced 5½" drill casing to 175'. Cored competent rock from 175-190': biotitic albite gneiss. Natural fractures at 173' and 173.5' (iron staining on 173' fracture). Remaining fractures appear to be machine breaks. Missing 5' of sample is probably due to washed out fractured material. Collected GW-6 from well after sand pack and bentonite seal were placed.	175-190'	0.0	GW-6 H-3<300 pCi/L

*Results of on-site radiological screening <MDL unless otherwise noted

GEOLOGIST'S LOG for Well No.:	MW-109B	Yankee Nuclear Power Station, Rowe, MA	Page 6 of 6

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.
187 188 189 190		Bedrock	15'	10'	Cored competent rock from 175-190': biotitic albite gneiss. Natural fractures at 173' and 173.5' (iron staining on 173' fracture). Remaining fractures appear to be machine breaks. Missing 5' of sample is probably due to washed out fractured material.	175-190'	0.0	GW-6 H-3<300 pCi/L

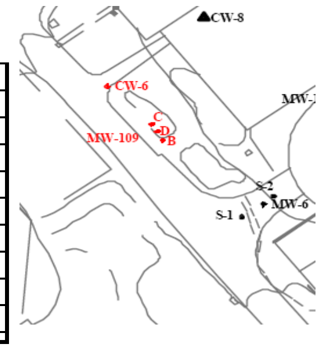
Well Construction Details:

0-1': Concrete and Flushmount Roadbox
1'-175.5': Portland Cement/Bentonite Grout
175.5'-177.5': Bentonite Chip Seal
177.5'-190': #0 Silica Sand Filter Pack
0-180': Schedule 80 2.5" PVC Riser
180'-190': 0.010" Schedule 80 2.5" PVC Screen
190': Bottom of Boring
0-20': 8" Steel Casing Cement/Bentonite-Grouted in Place

*Results of on-Site radiological screening <MDL unless otherwise noted

GEOLOGIST'S LOG for Well #: MW-109C

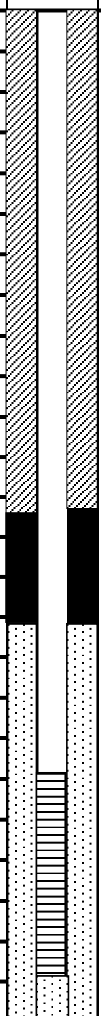
Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:			
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott		
Drilling Co:	D.L. Maher	Driller:	Roy Buckenberger		
Date Started:	August 6, 2004	Date Finished:	August 9, 2004		
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic		
Screen Diam:	2 inches	Length:	5 feet	Slot Size:	0.010 inch
Casing Diam:	2 inches	Length:	49 feet	Type:	Schedule 40, 2-inch PVC
Boring Depth:	55 feet	Well Depth:	54 feet	Boring Diam.:	5½ inches
Surface Elev.:	1124.2 feet MSL	MP:	Ground Surface	Depth to GW:	15.28 feet from PVC
On-Site GW Analyses:	None	Off-Site GW Analyses: None			on October 31, 2004

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*

Depth: 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56



See log of MW-109B for description of sediment and ground water samples.

Well Construction Details:

0-1': Concrete and Flushmount Roadbox
1'-42.5': Portland Cement/Bentonite Grout
42.5'-46.8': Bentonite Chip Seal
46.8'-55': #0 Silica Sand Filter Pack
0-49': Schedule 40 2" PVC Riser
49'-54': 0.010" Schedule 40 2" PVC Screen
55': Bottom of Boring

Key to Well Construction

Sandpack
Bentonite Seal
Well Screen
Concrete and Flushmount Roadbox
Cement/Bentonite Grout

GEOLOGIST'S LOG for Well No.: MW-109B

Yankee Nuclear Power Station, Rowe, MA

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.
187 188 189 190		Bedrock	15'	10'	Cored competent rock from 175-190': biotitic albite gneiss. Natural fractures at 173' and 173.5' (iron staining on 173' fracture). Remaining fractures appear to be machine breaks. Missing 5' of sample is probably due to washed out fractured material.	175-190'	0.0	GW-6

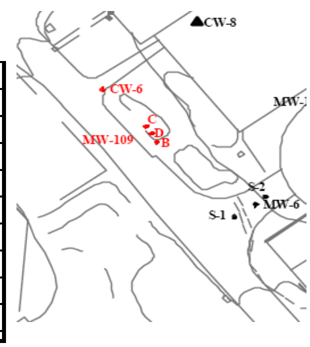
Well Construction Details:

0-1': Concrete and Flushmount Roadbox
1'-175.5': Portland Cement/Bentonite Grout
175.5'-177.5': Bentonite Chip Seal
177.5'-190': #0 Silica Sand Filter Pack
0-180': Schedule 80 2.5" PVC Riser
180'-190': 0.010" Schedule 80 2.5" PVC Screen
190': Bottom of Boring
0-20': 8" Steel Casing Cement/Bentonite-Grouted in Place

*Results of on-Site radiological screening <MDL unless otherwise noted

GEOLOGIST'S LOG for Well #: MW-109D

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:			
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott		
Drilling Co:	D.L. Maher	Driller:	Roy Buckenberger		
Date Started:	August 2, 2004	Date Finished:	August 6, 2004		
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic		
Screen Diam:	2 inches	Length:	5 feet	Slot Size:	0.010 inch
Casing Diam:	2 inches	Length:	88.7 feet	Type:	Schedule 40, 2-inch PVC
Boring Depth:	113 feet	Well Depth:	93.7 feet	Boring Diam.:	5½ inches
Surface Elev.:	1124.2 feet MSL	MP:	Ground Surface	Depth to GW:	37.87 feet from PVC
On-Site GW Analyses:	None	Off-Site GW Analyses: None			on October 31, 2004

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.*

77
78
79
80
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95
96
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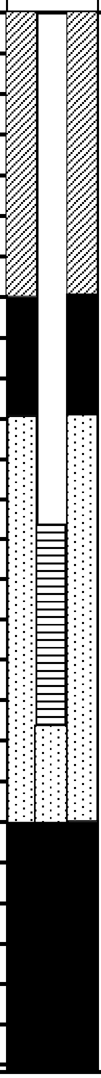
102



See log of MW-109B for description of sediment and ground water samples.

Well Construction Details:

0-1': Concrete and Flushmount Roadbox
1'-83': Portland Cement/Bentonite Grout
83'-86': Bentonite Chip Seal
86'-96': #0 Silica Sand Filter Pack
0-88.7': Schedule 40 2" PVC Riser
88.7'-93.7': 0.010" Schedule 40 2" PVC Screen
113': Bottom of Boring (filled to 96 feet with bentonite chips)
0-21': 8" Steel Casing Cement/Bentonite-Grouted in Place

Key to Well Construction

Sandpack
Bentonite Seal
Well Screen
Concrete and Flushmount Roadbox
Cement/Bentonite Grout

GEOLOGIST'S LOG for Well No.: MW-109B

Yankee Nuclear Power Station, Rowe, MA

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	FID Conc. (ppm) HS	Ground Water Sample No.
187 188 189 190		Bedrock	15'	10'	Cored competent rock from 175-190': biotitic albite gneiss. Natural fractures at 173' and 173.5' (iron staining on 173' fracture). Remaining fractures appear to be machine breaks. Missing 5' of sample is probably due to washed out fractured material.	175-190'	0.0	GW-6

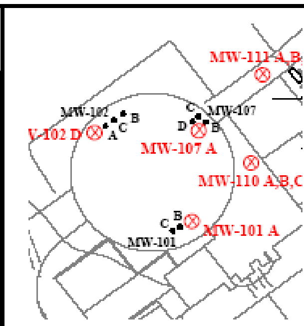
Well Construction Details:

0-1': Concrete and Flushmount Roadbox
1'-175.5': Portland Cement/Bentonite Grout
175.5'-177.5': Bentonite Chip Seal
177.5'-190': #0 Silica Sand Filter Pack
0-180': Schedule 80 2.5" PVC Riser
180'-190': 0.010" Schedule 80 2.5" PVC Screen
190': Bottom of Boring
0-20': 8" Steel Casing Cement/Bentonite-Grouted in Place

*Results of on-Site radiological screening <MDL unless otherwise noted

GEOLOGIST'S LOG for Well #: MW-110B

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:	
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott
Drilling Co:	Boart Longyear	Driller:	Roy Buckenberger / Mike Hansen
Date Started:	20-Feb-06	Date Finished:	6-Mar-06
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic

Screen Diam:	2 inches	Length:	10 feet	Slot Size:	0.010 inch
Casing Diam:	2 inches	Length:	100	Type:	Schedule 40 PVC
Boring Depth:	110 feet	Well Depth:	110	Boring Diam.:	10" telescoping to 4"
Surface Elev.:	1138.2 feet NAVD '88	MP:	Ground Surface	Depth to GW:	39.42 feet from PVC
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site GW Analyses: none			on April 18, 2006

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth (feet)	Ground Water Sample No.*
1–12		Fill	12'	12'	Fill, dark brown, consisting of silt and sand, f. to c.; some gravel, f. to c., and cobbles; trace roots and wood, trace Mirafi cloth; unsorted, wet, loose.	0 to 12'	
12–15			3'	3'	Same as Above	12 to 15'	
15–25			10'	10'	Same as Above	15 to 25'	
25–26			10'	10'	See Next Page	25 to 35'	

NOTES:
*Results of on-site radiological screening <MDL unless otherwise noted

Key to Well Construction

Sandpack
Bentonite Seal
Well Screen
Cement/Bentonite Grout
Cement/Bentonite Grout and 8-inch Steel Casing

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth (feet)	Ground Water Sample No.*
27–31.5		Fill	10'	10'	25-31.5': Fill, dark brown, consisting of silt and sand, f. to c.; some gravel, f. to c., and cobbles; trace roots and wood, trace Mirafi cloth; unsorted, wet, loose.	25 to 35'	
31.5–33		Sand & Gravel			31.5-33': Sand, brown, f. to m. and f. to c. gravel, some silt, unsorted, medium dense, wet.		
33–35		Till			33-35': Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, damp.		
35–38			3'	3'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry. Advance 10-inch drill casing to 38', install 8-inch permanent casing, cement grout annular space and remove 10-inch casing.	35-38'	
38–40			2'	2'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry.	38-40'	
40–45			5'	5'	Same as Above	40-45'	
45–48			5'	5'	45-48': Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, dense, dry.	45-50'	
48–50		Sand & Gravel			48-50': Sand, brown, m. to vc., some f. to m. subround gravel, unsorted, subloose, wet.		GW-1: H-3 <2,000 pCi/L
50–52		Till	2'	2'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry. Advance 7 5/8-inch drill casing to 52' and pressure grout.	50-52'	
52–53			8'	8'	52-53': Till, very dense, dry.	52-60'	
53–55		Sand & Silt			53-55': Sand, m. to c., some silt, gray-green, unsorted, loose, wet.		GW-2: H-3 <2,000 pCi/L
55–60		Till			55-60': Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry. Advance 5 1/2-inch drill casing to 58' and pressure grout.		
60–64			4'	4'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, several fist-sized cobbles, unsorted, very dense, dry. On boulder at 64'	60-64'	
64–66			6'	6'	See next page.	64-70'	

*Results of on-site radiological screening <MDL unless otherwise noted

Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth (feet)	Ground Water Sample No.*
67–70	Till	6'	6'	Till, very dense, dry. Two or three 2 to 3-foot boulders encountered in this interval (very tough drilling). Ten feet of water in the borehole. Pounding on the boulders apparently caused the grout seal at 58' to fail. Advance 5 1/2-inch drill casing to 65' and pressure grout.	64-70'	
70–72	Till	2'	2'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, some fist-sized cobbles, unsorted, very dense, dry.	70-72'	
72–78	Till	6'	6'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, some fist-sized cobbles, unsorted, very dense, dry. Slightly more sandy at bottom of sample.	72-78'	
78–84	Till (78–81); Sand & Gravel (81–83); Till (83–84)	6'	6'	78-81': Same as above. 81-83': Sand, brown, f. to c. and gravel, f. to c., subround, unsorted, loose, wet. 83-84': Till consisting of silt, olive-gray, with f. angular gravel, some sand, f., some clay, unsorted, very dense, damp.	78-84'	GW-3: H-3 <2,000 pCi/L
84–94	Till (84–88); Sand & Silt (88–88.5); Till (88.5–92); Sand & Silt (92–94)	10'	8'	Advance 5 1/2-inch drill casing to 84' and pressure grout. 84-85.5': Boulder 85.5-88': Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, some fist-sized cobbles, unsorted, very dense, dry. 88-88.5': Sand, brown, m. to c., some silt, unsorted, loose, wet. 88.5-92': Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, some fist-sized cobbles, unsorted, very dense, dry. Weathered schist cobble at 92'. 92-94': Sand, gray and silt, trace f. to m. subangular gravel, unsorted, m. dense, wet. Fragments of weathered schist in bottom 0.5'.	84-94'	GW-4: H-3 <2,000 pCi/L
94–95.5	Sand & Silt (94–95); Till (95–95.5)	1.5	0.5	94-95': Same as above. Advance 5 1/2-inch casing to 95' and grout. 95-95.5': Till, as above, very dense, damp.	94-95.5'	
95.5–100	Bedrock	4.5'	3'	Albite gneiss, coarse grained, few 2 to 3mm garnets; foliation formed by white, 2 to 5mm thick feldspar-rich layers dips ~ 30 degrees. Soft zone from 96.5 to 97.5'. Many machine breaks caused by reentering borehole after failed attempt to retrieve core.	95.5-100'	
100–106	Bedrock	10'	10'	Albite gneiss, coarse grained, few 2 to 3mm garnets; foliation formed by white, 2 to 5mm thick feldspar-rich layers dips ~ 30 degrees. Iron-stained fracture at 101'. Another natural fracture in quartz-rich zone with small vugs at 109'. Core is mostly broken into 0.5 to 1-foot machine-broken pieces. One 2.5-foot intact piece from 101 to 103.5 feet.	100-110'	GW-5: H-3 <2,000 pCi/L

*Results of on-site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #:	MW-110B	Yankee Nuclear Power Station, Rowe, MA	Page 4 of 4

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth (feet)	Ground Water Sample No.*
107 108 109 110		Bedrock	10'	10'	See previous page.	100-110'	GW-5: H-3 <2,000 pCi/L

End of Boring at 110'

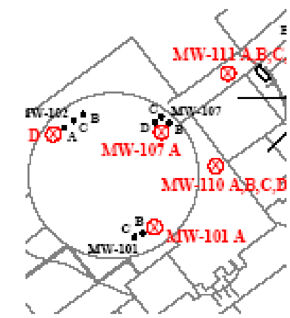
Well Construction Details:

0-38': Cement/Bentonite Grout and 8-inch Steel Casing
0-93': Portland Cement/Bentonite Grout
93-98': Bentonite Chip Seal
98-110': #0 (medium) Silica Sand Filter Pack
0-100': Schedule 40, 2" PVC Riser
100-110': Schedule 40, 2" PVC, 0.010"-Slot Screen
110': Bottom of Boring

*Results of on-Site radiological screening <MDL unless otherwise noted

GEOLOGIST'S LOG for Well #: MW-111B

Yankee Nuclear Power Station
Rowe, Massachusetts



Project:	Yankee Ground Water Investigation	Project Number:			
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott		
Drilling Co:	Boart Longyear	Driller:	Roy Buckenberger / Mike Hansen		
Date Started:	21-Mar-06	Date Finished:	28-Mar-06		
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic		
Screen Diam:	2 inches	Length:	10 feet	Slot Size:	0.010 inch
Casing Diam:	2 inches	Length:	70 feet	Type:	Schedule 40, PVC
Boring Depth:	80 feet	Well Depth:	80 feet	Boring Diam.:	10" telescoping to 4"
Surface Elev.:	1138.2 feet NAVD '88	MP:	Ground Surface	Depth to GW:	35.25 feet from PVC
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site GW Analyses: none			on April 18, 2006

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	Ground Water Sample No.*
1–5		Fill	5'	5'	Fill, dark brown, consisting of silt and sand, f. to c.; some gravel, f. to c., and cobbles; trace roots and wood, trace Mirafi cloth; unsorted, dry, loose.	0-5'	
6–15		Fill	10'	4'	Fill, dark brown, consisting of silt and sand, f. to c.; some gravel, f. to c., and cobbles; trace roots and wood, trace Mirafi cloth; unsorted, dry to wet, loose.	5-15'	
16–25		Fill	10'	10'	Fill, dark brown, consisting of silt and sand, f. to c.; some gravel, f. to c., and cobbles; trace roots and wood, trace Mirafi cloth; unsorted, dry to wet, loose.	15-25'	
26		Till	3'	3'	See next page.	25-28'	

NOTES:
*Results of on-site radiological screening <MDL unless otherwise noted

Sandpack | Well Screen | Cement/Bentonite Grout
Bentonite Seal | Cement/Bentonite Grout and 8-inch Steel Casing

Stratigraphy	Penetration	Recovery	Soil Core Description	Depth (feet)	Ground Water Sample No.*
Till	3'	3'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry.	25-28'	
Till	2'	2'	Same as Above	28-30'	
Till	5'	4'	Advance 10-inch drill casing to 30'. Install 8-inch permanent casing to 30', cement grout annular space and remove 10-inch casing. Same as Above	30-35'	
Silty Sand Till Silty Sand	5'	5'	35-57': Sand, brown, f. to m., little silt, unsorted, m. dense, wet. 37-39.75': Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry. 39.75-40': Silt, gray-brown and sand, f., unsorted, m. dense, damp.	35-40'	GW-1 H-3=2,360 pCi/L GW-2: H-3<2,000
Till	5'	7'	Advance 7 5/8 drill casing to 38' and pressure grout. Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry. Boulder 43-44.5'.	40-45'	
Till	5'	7'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry.	45-50'	
Till	5'	7'	Same as above, few 6-inch boulders.	50-55'	
Till	5'	7'	Same as above. Several feet of water in the borehole, probably from a small sand seam that was missed around 40'. Water has been following the drill down the hole since then (note 2' of slough in each sample since 40'). Collect GW-2, advance 5 1/2-inch drill casing to 55' and pressure grout.	55-60'	
Till Silty Sand Bedrock	5'	5'	60-63.6': Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry. 63.6-64': Silt and sand, f. to m., moist. 64-65': Rock, pulverized, possible top of bedrock.	60-65'	GW-3: H-3<2,000 pCi/L
Bedrock	1'	1'	V. hard drilling. Probable bedrock. Will drill with water to core Rx.	65-66'	

*Results of on-site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well #: MW-111B

Yankee Nuclear Power Station, Rowe, MA

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	Ground Water Sample No.*
67-80		Bedrock	14'	8.5'	Albite gneiss, m. to c.-grained with 2 to 5mm megacrystals of albite. Other predominant minerals are quartz and biotite. Quartz and albite layers 3 to 5mm thick form foliation dipping ~ 30 degrees. Drilling is soft to ~73'. No return of coring water until ~73' due to fractures taking water. Only two 1-foot pieces of intact core. Most of core is machine-broken into 6-inch or less pieces. One iron-stained natural fracture at 79'; other possible natural fractures at 71, 77 and 78 feet.	66-80'	GW-4: H-3<2,000 pCi/L

End of Boring at 80 feet

Well Construction Details:

0-30': Cement/Bentonite Grout and 8-inch Steel Casing
0-62': Portland Cement/Bentonite Grout
62-67': Bentonite Chip Seal
67-80': #0 (medium) Silica Sand Filter Pack
0-70': Schedule 40 2" PVC Riser
70-80': Schedule 40 2" PVC, 0.010"-Slot Screen
80': Bottom of Boring

*Results of on-Site radiological screening <MDL unless otherwise noted

GEOLOGIST'S LOG for Well #: MW-113C

Yankee Nuclear Power Station
Rowe, Massachusetts

Project:	Yankee Ground Water Investigation	Project Number:			
Client:	Yankee Atomic Electric Company	Logged by:	Dave Scott		
Drilling Co:	Boart Longyear	Driller:	Mike Hansen		
Date Started:	11-Apr-06	Date Finished:	26-Apr-06		
Location:	Rowe, Massachusetts	Drilling Method:	Rotosonic		
Screen Diam:	2 inches	Length:	10 feet	Slot Size:	0.010 inch
Casing Diam:	2 inches	Length:	127 feet	Type:	Schedule 40, PVC
Boring Depth:	140 feet	Well Depth:	137 feet	Boring Diam.:	10" telescoping to 5½"
Surface Elev.:		MP:	Ground Surface	Depth to GW:	
On-Site GW Analyses:	H-3, Co-60, Cs-134, Cs-137	Off-Site GW Analyses: none			

Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	Ground Water Sample No.*
Sandy Loam (0-2'); Septic System Leachfield ? (2-9.5')	5'	4'	0-2': Sand, brown, f. to m. and silt, with organic material. 2-5': Sand, brown, f. to m. and gravel, m. to c., subangular, with silt, unsorted, loose, dry, no odor.	0-5'	
Septic System Leachfield ?	5'	5'	5-7.5': Sand, brown, f. to m. and gravel, m., subangular, with silt, unsorted, loose, dry, no odor. 7.5-8.5': Sand, lt. brown, m. to c., well sorted, loose, moist, no odor. 8.5-9.5': Gravel, m. to c., well sorted, loose, wet, no odor. 9.5-10': Sand, dk. brown, f., tr. m. gravel & silt, unsorted, loose, wet, no odor.	5-10'	
Sand & Gravel	5'	5'	Sand, f. to vc., lt. brown, and gravel, f. to c., subround, tr. Silt, tr. Cobbles, poorly sorted, loose, damp, no odor.	10-15'	
Sand & Gravel	5'	5'	15-18': Gravel, f. to c., subround to round, trace c. to vc. sand, poorly sorted, loose, wet, no odor. 18-19': Sand, brown, f. to m., some silt, with m. to c. gravel, poorly sorted, loose, moist, no odor. 19-20': Sand, brown, c. to vc, well sorted, loose, wet, no odor.	15-20'	
Sand & Gravel	5'	5'	20-22': Sand, vc., some m. to c. subround gravel, tr. Silt, poorly sorted, loose, wet. 22-24': Sand, gray, f., and c. angular gravel and silt, unsorted, m. dense, wet. 24-25': Sand, brown, f. to c. and gravel, f. to m., subround, with silt, unsorted, loose, wet.	20-25'	GW-1: H-3 <2,000 pCi/L
Sand & Gravel	5'	5'	See next page.	25-30'	

NOTES:
*Results of on-site radiological screening <MDL unless otherwise noted

Key to Well Construction

Sandpack; Well Screen; Cement/Bentonite Grout; Bentonite Seal; Cement/Bentonite Grout and 8-inch Steel Casing

DRILLING LOG for Well No.:	MW-113C	Yankee Nuclear Power Station, Rowe, MA	Page 2 of 5

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth (feet)	Ground Water Sample No.*
27–30		Sand & Gravel / Till	5'	5'	25-27': Same as 24-25'. 27-30': Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry.	25-30'	
30–35		Till	5'	5'	Advance 10-inch drill casing to 30', install 8-inch permanent casing, cement grout the annular space and withdraw the 10-inch casing. 30-35': Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry.	30-35'	
35–40		Till	5'	5'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry.	35-40'	
40–45		Till	5'	5'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry.	40-45'	
45–50		Till	5'	5'	45-47': Till consisting of silt, olive-gray, with f. to c. angular gravel, more clay than above, unsorted, very dense, damp. 47-50': Till, same as 40-45', dry, but damp at 50'.	45-50'	GW-2: H-3<2,000 pCi/L
50–55		Till	5'	5'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry. 52-53' is more clay-rich. Little water at the top of the sample, coming from 50'. Water enters the borehole very slowly (0.6' in 7 minutes). Collect GW-2, advance 5 1/2-inch drill casing to 55' and pressure grout to seal off the water-bearing zone.	50-55'	
55–60		Till	5'	5'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry.	55-60'	
60–65		Till	5'	5'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry. Sample is very hot due to friction from drill action on extremely dense till.	60-65'	
65–66		Till	5'	5'	See next page.	65-70'	

*Results of on-site radiological screening <MDL unless otherwise noted

DRILLING LOG for Well No.:	**MW-113C**	Yankee Nuclear Power Station, Rowe, MA	Page 3 of 5

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth (feet)	Ground Water Sample No.*
67–70		Till	5'	5'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry. Sample is very hot due to friction from drill action on extremely dense till.	65-70'	
70–75		Till (to 73); Silty Clay (73–78)	5'	5'	70-73': Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry. 73-75': Silty clay, olive-gray, very stiff, with vf. Sand in 1-2mm lamellae; trace f. to m. angular gravel, increasing clay content with depth, damp.	70-75'	
75–80		Silty Clay (to 78); Till	5'	5'	75-78': Same as 73 to 75'; very clayey on top, more silty with depth. 78-80': Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry.	75-80'	
80–85		Till	5'	5'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry.	80-85'	
85–90		Till	5'	5'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry.	85-90'	
90–95		Till	5'	5'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry.	90-95'	
95–100		Till	5'	5'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry.	95-100'	
100–105		Till; Sand (103–103.25); Till	5'	5'	100-103': Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, dry. 103-103.25': Sand, m., medium dense, moist. 103.25-105': Same as 100-103'.	100-105'	GW-3: H-3<2,000 pCi/L
105–106		Till	5'	5'	See next page.	105-110'	

*Results of on-site radiological screening <MDL unless otherwise noted

Depth	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	Ground Water Sample No.*
105-110	Till	5'	5'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, moist. The borehole sat open from 95' overnight and 28' of water entered by morning from sand at 103'. Collect ground water sample GW-3.	105-110'	
110-115	Till	5'	5'	Till consisting of silt, olive-gray, with f. to c. angular gravel, some sand, f. to m., some clay, trace cobbles, unsorted, very dense, moist. Moisture is probably from water from 103' sitting in the hole all night. Advance 5 1/2-inch drill casing to 115' and pressure grout to seal off water.	110-115'	
115-120	Till (115-117); Glaciolacustrine Silt and Clay (117-)	5'	5'	115-117': Till with more clay than above. Clay and silt, olive green, laminated, very stiff, tr. Sand, f. and f. angular gravel, moist.	115-120'	
120-125	Glaciolacustrine Silt and Clay	5'	5'	Clay and silt, olive green, laminated, very stiff, tr. Sand, f. and f. angular gravel, moist.	120-125'	
125-135	Glaciolacustrine Silt and Clay (-128); Glaciolacustrine Sand (128-135)	10'	10'	125-128': Clay and silt, olive green, laminated, very stiff, tr. Sand, f. and f. angular gravel, moist. 128-135': Sand, gray-green, f. to m. and silt, tr. Gravel, m. to c., unsorted, dense, wet. 53' of water came into the borehole overnight. Collect ground water sample GW-4 and advance 5 1/2-inch drill casing to 135'.	125-135'	GW-4: H-3<2,000 pCi/L
135-140	Till	5'	1'	Till consisting of silt, olive-gray, with sand, f. to m. and f. to c. angular gravel, some clay, trace cobbles, unsorted, very dense, dry. Drilled very hard.	135-140'	

End of Boring at 140 feet

*Results of on-site radiological screening <MDL unless otherwise noted

Depth	Well Log	Stratigraphy	Penetration	Recovery	Soil Core Description	Depth	Ground Water Sample No.*

Well Construction Details

0-30': Cement/Bentonite Grout and 8-inch Steel Casing
0-120': Portland Cement/Bentonite Grout
120-125': Bentonite Chip Seal
125-140': # 0 (medium) Silica Sand Filter Pack
0-127': Schedule 40, 2" PVC Riser
127-137': Schedule 40, 2" PVC, 0.010"-Slot Screen
140': Bottom of Boring

*Results of on-site radiological screening <MDL unless otherwise noted

Attachment 3

Ground and Well Water Monitoring

Program for YNPS Site (AP-8601)

(Provided on enclosed CD)

GROUND AND WELL WATER MONITORING PROGRAM FOR THE YANKEE NUCLEAR POWER STATION SITE

SCOPE

This procedure outlines the overall program for the collection of radiological ground and well water samples to support decommissioning activities at the Yankee Nuclear Power Station (YNPS) site. The procedures, which support this document, implement the sampling, analysis, quality and record keeping procedures for the program are listed in the Reference Section.

ENCLOSURES

AP-8601 - Pgs. 1-8
Attachment A - Pgs. 1-2
Attachment B - Pg. 1
Attachment C - Pg. 1
Attachment D – Pg. 1
Attachment E – Pg. 1
APF-8601.1 - Pg. 1

REFERENCES

1. DP-9745, "Ground Water Level Measurement and Sample Collection in Observation Wells"
2. AP-9601, "Yankee Nuclear Power Station Site Characterization and Site Release Quality Assurance Program Plan (QAPP) for sample Data Quality"
3. DP-8602, "Ground Water Monitoring Well Drilling and Completion"
4. DP-8603, "Radiochemical Data Quality Assessment"
5. 10CFR20 Subpart E, "Radiological Criteria for Licensing Termination"
6. NYR 2005-030, "Yankee Nuclear Power Station – Issuance of Amendment No. 158 Re: License Termination Plan" dated July 28, 2005

DISCUSSION

10CFR20 Subpart E requires that the total annual dose from site activities in the future be less than 25 mrem/yr from the sum of all potential uptake pathways. Analysis of the site groundwater through the use of monitoring and observation wells will help characterize the final condition of that medium. It is important that a standard set of protocols be established so that the Data Quality Objectives (DQO) will be met for all sampling and analysis activities.

The License Termination Project (LTP) Team has discussed extensively the suite of radionuclides that are important to the monitoring process at the plant site. They have decided upon the radionuclides identified in Attachments A and B, based on the probability of their (measurable) presence and potential dose consequence.

PRECAUTIONS

Changes to this procedure and its referenced implementation procedures must be made in accordance with the LTP and documented on Att. C. Any changes which alter the sample collection, sample analysis or data analysis, must be evaluated prior to changing these procedures to establish a connection to historical data (see Enclosure APF- 8601.1).

EQUIPMENT AND MATERIALS

N/A

PROCEDURE

A. Roles and Responsibilities

1. Program Oversight.

   a. The YNPS Radiation Protection Manager or designee will have overall responsibility for program oversight, including:

      - Approval of budget expenditures
      - Designation of appropriate personnel qualified to review data and propose program changes.
      - Approval of Sampling events.
      - Approval of vendor selection for sampling and analytical services.
      - Final approval of program changes

2. Sample Collection Scheduling.

   a. The YNPS Radiation Protection Manager or designee shall be responsible for coordinating the sampling events.

   b. The Radiation Protection Manager or designee will schedule all sampling events with the contractor selected for this task.

   c. A list of the wells to be sampled shall be first approved by the Radiation Protection Manager or designee and then communicated, in writing, to the vendor. This shall be part of the sampling package documentation.

3. Program Changes

Changes to programs or procedures shall be initiated by the YNPS Radiation Protection Manager or designee, and approved by the Radiation Protection Manager or designee and documented on Att. C. Changes may result from the following conditions as well as others:

- Significant changes in radioactivity levels of the wells
- Appearance of new radionuclides in the monitoring program.
- Significant physical changes to the site geology or site contour.

It is also significant to note that deselection of wells or radionuclides should be part of the monitoring process. If sufficient historical data indicates that certain wells or radionuclides indicate less than quantifiable radioactivity, they may be deselected using APF-8601.1.

4. Sample Collection Activities

The Radiation Protection Manager or designee shall designate YNPS site personnel to have direct oversight of:

a. The sampling events and any necessary escort functions for contract personnel.

b. Proper packaging, preservation, labeling, and shipment of the samples to the contract laboratory.

c. Return of all chain of custody forms and verification that all samples were received intact.

The Radiation Protection Manager or designee shall also coordinate with the Site Environmental Supervisor:

a. All non-radiological analyses required by sampling procedures

b. Verify purge time requirements or immediate analysis required prior to the samples being shipped to the analytical contract laboratory.

c. Disposal of all wastewater and chemicals associated with the sampling events.

5. Data Validation and Verification

a. The Radiation Protection Manager or designee shall designate a qualified individual to perform these functions. A qualified person is defined as one who has at least 5 years experience in radiochemistry or radiation protection, and has a bachelors degree in a related scientific field, or equivalent experience dealing with radiochemistry calculations.

b. Procedure DP-8603 shall be used for documentation of the verification and validation activities of all parameters related to radiological sample analysis.

c. The verification and validation activities shall be independent of those activities performed by the contract laboratory for sample analysis.

6. Report Generation

   a. The Radiation Protection Manager or designee shall have the responsibility for generation of any report that will be subject to regulatory review.

   b. Final approval of the report will be the responsibility of the Radiation Protection Manager or designee.

B. Schedule for Sampling and Analysis

1. At a minimum, the routine sampling and analysis frequency will be as specified in Attachment A for each of the wells. Additional sampling rounds may be conducted as necessary to address specific, identified needs.

2. Chemical separation of radionuclides in radiochemical samples should be initiated as soon as practicable after sampling, but should begin within three weeks of the sampling event.

3. If evaluation of data trends identifies unexpected changes (as described in B.4) selected monitoring wells may be resampled. Resampling and analysis shall occur as soon as practical after discovery of the need to resample.

4. It is anticipated that radioactivity levels in the monitoring wells will decrease over time. However, the following data changes may indicate an unexpected change in groundwater conditions.

   - A sample location normally showing < MDC activity shows activity level significantly greater than the MDC. Significantly is identified as >3 MDC for the time of analysis.
   - A sample location showing a steady downward trend shows a sudden increase or decrease in the projected value by greater than 20%. Projected values may be determined by best-fit extrapolation of the existing curve shape.

   Such changes may require program changes to the sampling and analysis frequency for the affected well and any down gradient wells. This evaluation is recorded on APF-8601.1, and approved by the Radiation Protection Manager or designee.

5. Samples which are lost, or "analytical blunders" to sole samples, should be replaced with a new sample, taken as close in time to the subject sample, if possible.

6. The initial data set for the purposes of this program shall be the first one following program approval. However, the results of the initial data set should be compared to the site historical data prior to making any changes to the sampling or analysis schedules.

C. Data Quality Objectives

1. The contract laboratory shall achieve the required method uncertainty for each radionuclide shall be as listed in Attachment B.

2. Each batch of samples shall, as an average, achieve the required method uncertainty for each analyte. [For example, a batch of samples analyzed for ^{241}Am would have an average method uncertainty ≤ 0.5 pCi/L]

3. The method MDC shall be as listed in Attachment B.

4. All results greater than $2.33\sigma_{counts}$ are to be evaluated to determine if they are part of the overall background distribution or positive activity.

5. Acceptance criteria on QC samples per sample and radionuclide are identified in DP-8603.

6. Maximum batch size is 20 (exclusive of QC samples).

7. Each batch will contain a duplicate, matrix spike, blank and laboratory control sample (LCS).

8. Matrix spikes and LCS will be performed for all hard-to-detect radionuclides except: ^{242}Cm, $^{243/244}$Cm and $^{239/240}$Pu. Matrix spikes and LCS for gamma spectrometry analysis shall have at least two gamma emitters in different energy ranges.

9. Typical yields for tracers or carriers are identified in Attachment D.

10. Laboratory control sample concentrations should be targeted at the concentrations identified as the Action Level in Attachment B.

11. Matrix spike concentrations should be targeted at the concentrations identified in Attachment E.

12. Each batch of sample analyses will have one calculation per analytical counting method verified (i.e., one for gamma spectrometry, one for alpha spectrometry, one for liquid scintillation, one for gas proportional counting).

D. Analytical Laboratory Requirements

1. Quality Assurance Program (QAP)

   The contract analytical laboratory shall have a QAP that meets the requirements of USNRC Regulatory Guide 4.15-1979, and ANSI/ASQC E4-1994, for all aspects of the work that they perform for the YNPS Groundwater Monitoring Program.

2. Procedures

   Analytical procedures shall be written using the guidance of an accepted standards organization such as ASTM, ANSI, ISO, etc., or a recognized reference such as MARSSIM or MARLAP (when first issued).

   Examples of such standards are:

40 CFR Ch. I, Part 141.25	Analytical Methods for Radioactivity
EML Procedures Manual(formerly HASL-300)	Environmental Measurements Laboratory Procedures Manual, 28th Edition, February 1997
EPA 520/5-84-006, 1984	Eastern Environmental Radiation Facility Radiochemistry Procedures Manual
EPA-600/4-80-032, 1980	Prescribed Procedures for Measurement of Radioactivity in Drinking Water,
EPA R4-73-014, 1973	Procedures for Radiochemical Analysis of Nuclear Reactor Aqueous Solutions,
EMSL-LV-0539-17, 1979	Radiochemical Analytical Procedures for Analysis of Environmental Samples,

E. Training Requirements

1. Personnel performing sampling shall have been trained in accordance with the procedure in force at the time of training. The training shall include on-the-job-training style instruction as well as procedural review with a knowledgeable individual.

2. Personnel shall have been deemed qualified for procedural use, following successful procedure use by an evaluator (usually previously qualified personnel or a designee of the Radiation Protection Manager).

3. Qualification may occur by the following processes:

   a. Through the training process

   b. Documented historical experience of at least three years using the procedures involved or equivalent.

   c. Development of the procedure as the subject matter expert (SME).

   d. Documented training from another organization using equivalent procedures.

4. All personnel involved in the monitoring program shall review approved procedure changes prior to their using the procedures.

5. All vendor personnel performing analysis or sampling with the monitoring program procedures shall be qualified in accordance with the vendors QAP.

6. All training shall be appropriately documented in retrievable records maintained by the vendor or onsite in accordance with approved procedures.

F. Documentation Package Requirements for Sampling and Analysis

1. Each sampling event will normally take samples for multiple wells.

2. Each sampling event will include the following forms, at a minimum:

   - Attachment A – One copy of the page in force at the date of sampling.

   - Form DPF-9745.4, "Ground Water Sampling Field Log" will be completed for each well. Attached to this form will be a data sheet from the laboratory, which includes the measurements made for each sample parameter and values for the blank, QC and any splits, spikes, or duplicates identified for that sampling event.

   - Original Chain of Custody Forms that have accompanied the samples to the analytical laboratory.

3. In the event that a sample is lost or not analyzed appropriately, or any of the conditions described in A.3 above have occurred, the data package will also include the appropriate number of copies of APF-8601.1 from this procedure.

4. The Analytical Laboratory report shall include as a minimum:
   - The values of all radionuclides stated in pCi/L
   - The total propagated uncertainty (TPU) of the individual results in pCi/L
   - The MDC for each analyte
   - The value of the QC and its target value for the batches reported
   - The value of the Blank for each of the analyses
   - The values for spike samples shall be reported, with a recovery percentage
   - Any irregularities in sample processing
   - Reproductions of the data sheets, which show sample count times, sample mass, carrier or tracer mass, and yield, or any other data necessary to reproduce analytical calculations.

Attachment A

Radiological Groundwater Sampling Plan at YNPS

Lab Batch ID # ____________________

Well ID	Frequency	Suites
CB-3	Semi-Annually	ABCD
CB-4	Quarterly	ABCD
CB-6	Quarterly	ABCD
CB-8	Semi-Annually	ABCD
CFW-1	Quarterly	ABCD
CFW-5	Quarterly	B
CFW-6	Quarterly	B
CW-10	Semi-Annually	B
DW-1	Quarterly	ABCD
DW-2	Quarterly	ABCD
MW-100A	Quarterly	ABCD
MW-100B	Quarterly	ABCD
MW-101A	Quarterly	ABCD
MW-101B	Quarterly	ABCD
MW-101C	Quarterly	ABCD
MW-102A	Quarterly	ABCD
MW-102B	Quarterly	ABCD
MW-102C	Quarterly	ABCD
MW-102D	Quarterly	ABCD
MW-103A	Quarterly	ABCD
MW-103B	Quarterly	ABCD
MW-103C	Quarterly	ABCD
MW-104A	Quarterly	ABCD
MW-104B	Quarterly	ABCD
MW-104C	Quarterly	ABCD
MW-105A	Quarterly	ABCD
MW-105B	Quarterly	ABCD
MW-105C	Quarterly	ABCD
MW-106A	Quarterly	ABCD
MW-106B	Quarterly	ABCD
MW-106C	Quarterly	ABCD
MW-106D	Quarterly	ABCD
MW-107A	Quarterly	ABCD
MW-107B	Quarterly	ABCD
MW-107C	Quarterly	ABCD
MW-107D	Quarterly	ABCD
MW-107E	Quarterly	ABCD
MW-107F	Quarterly	ABCD
MW-108A	Quarterly	ABCD
MW-108B	Quarterly	ABCD
MW-108C	Quarterly	ABCD
MW-109A	Quarterly	ABCD
MW-109B	Quarterly	ABCD
MW-109C	Quarterly	ABCD
MW-109D	Quarterly	ABCD
MW-110A	Quarterly	ABCD

Well ID	Frequency	Suites
MW-110B	Quarterly	ABCD
MW-110C	Quarterly	ABCD
MW-110D	Quarterly	ABCD
MW-111A	Quarterly	ABCD
MW-111B	Quarterly	ABCD
MW-111C	Quarterly	ABCD
MW-111D	Quarterly	ABCD
MW-113A	Quarterly	ABCD
MW-113C	Quarterly	ABCD
SP-1	Quarterly	ABCD

NOTES: Use DP-9745 to perform low-flow sampling. DP-9745 contains the non-radiological parameters that must be established prior to sampling.

The suites listed in the table are typical. The actual suites for analysis should be in accordance with the sampling plan.

Analytical Parameter Suites:

A. Gamma (including: ^{60}Co, $^{134/137}$Cs, ^{94}Nb, ^{125}Sb, $^{152/154/155}$Eu, ^{108m}Ag).
B. Tritium, Gross Alpha/Beta
C. ^{14}C, ^{55}Fe, ^{63}Ni, ^{90}Sr, ^{99}Tc
D. ^{241}Am, ^{238}Pu, $^{240/239}$Pu, ^{241}Pu, ^{242}Cm, $^{243/244}$Cm,

The following are typical volumes that are collected per well each time the well is sampled. Also noted is the amount and type of preservative. The actual volumes collected per well and preserved are in accordance with the sampling plan. This sheet should be used to aid in tracking during each quarterly sampling event.

NOTE :

1. 1 gallon jugs have a nominal volume of 4 liters.

2. Duplicates and Matrix Spikes are taken for samples which require all four analytical suites.

3. For each Duplicate, three 1 gallon jugs are required: 2 preserved and one unpreserved as they are for the regular samples.

4. For each Matrix Spike, three 1 gallon jugs are required: 2 preserved and one unpreserved as they are for the regular samples

Attachment B

Required MDC, Required Method Uncertainty (U_{MR}), and Action Level Values for Analytes in Groundwater

Analyte	^{3}H	^{63}Ni	^{99}Tc	^{55}Fe	^{90}Sr	^{14}C	^{241}Am	^{238}Pu	$^{239+240}Pu$	^{241}Pu	$^{243+244}Cm$
Action Level[2] pCi/L	2,000	15	15	25	3	200	0.5	0.5	0.5	15	0.5
MDC, pCi/L	500	7	7	12	1	100	0.25	0.25	0.25	7	0.25
Required Method Uncertainty[1], pCi/L	500	2.7	2.7	4.3	0.70	33	0.083	0.083	0.083	2.7	0.083

Analyte	^{60}Co	^{137}Cs	^{134}Cs	^{94}Nb	^{108m}Ag	^{152}Eu	^{154}Eu	^{155}Eu	^{125}Sb
Action Level[2]	25	15	14	50	50	50	50	50	50
MDC, pCi/L	12	7	7	25	25	25	25	25	25
Required Method Uncertainty[1], pCi/L	4.3	2.7	2.3	8.3	8.3	8.3	8.3	8.3	8.3

[1] U_{MR}, Required Method Uncertainty = {Action Level – MDC]/3 for radionuclides other than ^{3}H

[2] The action level is a site-specific values, less than the MCL, which provides additional assurance that doses from drinking water would be less than the standard allowed. Above the action level, consideration would be given for additional action. With the exception of ^{3}H, the action levels are those values given in License Amendment 158, associated with the License Termination Plan. For ^{3}H, the action level is one-tenth of the associated Maximum Contaminant Level, as defined by EPA implementation guidance for radionuclides (EPA 816-F-00-002), of 20,000 pCi/l.

Attachment C

Justification for Procedure Change

Note: Above and beyond the requirements of AP-0001 the following guidance must be followed to ensure any change made to this procedure does not affect the DQO, Sample Integrity, Sample Validity, Reproducibility of Sampling, or Data obtained.

I. Procedure Number___________ Procedural Step(s) Changed___________

Date Required ___________

II. Identify the type of procedure change being made:

☐ Administrative change (no technical details of procedure have changed)

☐ Change of Analytical Method

☐ Change of Procedural Steps

☐ Change of Detection Limits

☐ Other: Describe____

III. Description of Change

____
____
____
____
____

IV. Does the Change Negatively Effect:

• The DQOs	YES	NO
• The Sample Integrity or Validity	YES	NO
• The Reproducibility of Sampling or Data	YES	NO

If any of the answers above is "YES", write a justification for the change, and have an independent technical review performed before processing the change through the existing change program.

If all answers above are "NO", process the change through the existing change program.

V. Approval

Radiation Protection Manager or designee________________________________

Date___________

Attachment D

Minimum Acceptable Yields for Radionuclides

Matrix	^{14}C	^{55}Fe	^{63}Ni	^{238}Pu	^{90}Sr	^{99}Tc	^{241}Am	^{241}Pu
Groundwater	35%	75%	75%	50%	60%	40%	60%	60%

Attachment E

Matrix Spike Approximate Concentrations in pCi/L

Analyte	Spike (pCi/L)
^{3}H	3000
^{63}Ni	100
^{99}Tc	50
^{55}Fe	150
^{90}Sr	25
^{14}C	300
^{241}Am	5
^{238}Pu	5
^{241}Pu	60
^{60}Co	30
^{137}Cs	30
GA	50
GB	50

Groundwater Resample and Reanalysis Report

Date___________ Analyst___________________

Sample Identification_____________ Analyte(s)_________________

The following incident(s) has occurred:

☐ The identified sample has been lost.

☐ The identified sample did not have _________ analysis performed.

☐ The value of _______ exceeded 20% of the projected value of the analyte from the historical trend.

☐ The value of __________ has exceeded 3 times the MDC, and the previous sample had been < MDC.

☐ Other(Explain)____

____

The following remedial action(s) are recommended:

____

____

____

____

____

____

Remedial Actions Approved:

YNPS Radiation Protection Manager or designee ______________________Date________

Actions Completed:

Analyst____ Date/ Time________

Attachment 4
YNPS Site Characterization and Site Release Quality Assurance Program Plan (AP-9601)
(Provided on enclosed CD)

YANKEE NUCLEAR POWER STATION SITE CHARACTERIZATION AND SITE RELEASE QUALITY ASSURANCE PROGRAM PLAN (QAPP) FOR SAMPLE DATA QUALITY

SCOPE

This procedure describes methods for ensuring the quality of data collected in support of site characterization activities. This QAPP has been prepared for use by YNPS staff and contractors who perform sampling and analytical services, to ensure that data are scientifically valid and defensible. Included are measurements for contamination in media such as surface soils, asphalt, sub-surface soils, sub-floor soils, sediments, ground water, and surface water. It also applies to measurements for contamination in plant Structures, Systems and Components (SSCs) such as piping, pumps, tanks, roofs, concrete and building structures.

ENCLOSURES

AP-9601 Pgs. 1-2
Appendix A - QAPP - Pgs. 1-17

REFERENCES

1. DP-8123, "Sample Security and Chain of Custody"
2. AP-8122, "Subsurface Soil Sampling and Monitoring Well Installation"
3. DP-8120, "Collection of Site Characterization and Site Release Samples"
4. DP-9017, "Review of PCB Sampling and Analytical Results"
5. DP-9454, "Collection of Samples from Painted Surfaces"
6. DP-9455, "Collection of PCB Wipe and Concrete Samples"
7. 310 CMR 40, Massachusetts Contingency Plan
8. 40 CFR
9. AP-8601, "Ground and Well Water Monitoring Program for the Yankee Nuclear Power Station Site"
10. DP-8603, "Radiochemical Data Quality Assessment"
11. Quality Assurance Project Plan, Site Closure, Yankee Nuclear Power Station, Rowe, MA; QAPP-YNPS-001, prepared by Gradient Corp, December 20, 2005.

DISCUSSION

The purpose of this Quality Assurance Program Plan (QAPP) is to specify the policies, organization, objectives, and Quality Assurance/Quality Control (QA/QC) activities used to achieve the data quality requirements for sampling in support of the Yankee Rowe Decommissioning (D&D) project. The elements of this procedure provide guidance for both the radiochemical and non-radiochemical analyses. Some sections of the procedure are divided appropriately due to the differing nature of data requirements in these areas. Additional procedures are cited in the reference section which provide additional details about data quality and assessment. Information in these lower tier documents will be more specific and shall be used as the most appropriate means of assessing data quality. These specifications are used to assess and control measurement errors that may enter the system at various phases of the project during sampling, sample preparation, and subsequent analysis. This QAPP is designed to ensure that samples are collected, transported, analyzed and reported in a consistent manner and that the quality of the resulting data is consistent with project objectives. Samples being obtained for non-radiological (Environmental) Site Closure shall use the QAPP (Reference 11) developed for environmental media analysis.

PRECAUTIONS

This QAPP does not apply to sampling for worker exposure control at YNPS.

PROCEDURE

Samples shall be obtained in conformance with Appendix A.

FINAL CONDITION

Samples have been collected, delivered, analyzed and reported in accordance with the quality assurance elements discussed in Appendix A.

Yankee Nuclear Power Station
Site Characterization Quality Assurance Program Plan for Sample Data Quality

Table of Contents

1.0 Introduction

The purpose of this Quality Assurance Program Plan (QAPP) is to specify the policies, organization, objectives, and Quality Assurance/Quality Control (QA/QC) activities used to achieve the data quality requirements for sampling in support of the Yankee Rowe Decommissioning (D&D) project. These specifications are used to assess and control measurement errors that may enter the system at various phases of the project during sampling, sample preparation, and subsequent analysis. This QAPP is designed to ensure the samples are collected, transported, analyzed and reported in a consistent manner and that the quality of the resulting data is consistent with project objectives.

1.1 Scope

This procedure describes methods for ensuring the quality of data collected in support of site characterization and site release activities. This QAPP has been prepared for use by YNPS staff and contractors who perform sampling and analytical services, to ensure that data are scientifically valid and defensible. Included are measurements for contamination in media such as surface soils, asphalt, sub-surface soils, sub-floor soils, sediments, ground water, and surface water. It also applies to measurements for contamination in plant Structures, Systems and Components (SSCs) such as piping, pumps, tanks, roofs, concrete and building structures.

1.2 Applicability

This QAPP applies to sampling activities for contaminants including sampling and evaluations associated with plants structures, systems, components and environmental media. In the case where approved quality procedures are developed for specific activities, those activity-specific procedures shall supersede the requirements in this QAPP.

Data collected prior to approval and issuance of this QAPP may be used in future decision making given such data is qualified as appropriate and valid for its intended use by the review of a qualified individual.

1.3 Using the QAPP

This QAPP addresses activities performed by project management staff, the field sampling team, and the analytical laboratory. The QAPP is not intended to provide a cookbook approach to data quality. Rather, it describes programmatic requirements of an acceptable data quality management system.

Many of the detailed implementation issues, such as task specific procedures, calculation of sample sizes and the associated QC requirements, are not prescribed in the QAPP. Users of this QAPP should consult appropriate Plant procedures and references for detailed guidance on these issues, including regulatory agencies and standards organizations. For non-radiological site closure activities QAPP-YNPS-001 (Reference 11) must also be utilized which more fully describe the program and procedures to be followed. These documents ensure compliance with both the United States Environmental Protection Agency (USEPA) Region 1 and the Massachusetts Department of Environmental Protection (MA DEP) Quality Assurance guidelines.

2.0 Project Description

The Yankee Nuclear Power Station (YNPS), located in Rowe, Massachusetts, was the first nuclear power plant built in New England and the third in the United States. Construction of the plant was completed in 1960 and it permanently ceased operation in February 1992. In December 1993, Yankee submitted its Decommissioning Plan to the Nuclear Regulatory Commission (NRC). In February 1995, after more than a year of review, the NRC approved the Plan.

Throughout this effort, significant amounts of data have been generated related to plant systems, structures and components as well as environmental media. This data has primarily been used to assess the presence or absence of contamination to guide decontamination and remediation efforts. In the final stages of the project, data will be collected to support the release of the site.

3.0 Project Organization and Responsibility

All individuals involved in the collection of samples at YNPS have responsibilities within the QA program, as well as responsibility for the quality of work that is performed under their control. YAEC Management is responsible for approving the program. A QA representative is responsible for independent review and oversight of the QAPP program. Specific responsibilities applicable to the QAPP are described below.

YNPS Director of Decommissioning

The Director of Decommissioning is responsible for the onsite oversight of the project organization and its function.

Director of Site Closure (DSC)

The DSC is responsible for all characterization efforts and ensures that staff is adequately trained and procedures are followed. The DSC has the following responsibilities:

- Approve work plans.
- Review and approve corrective actions.

The DSC or appropriate designee shall also act as the QC Officer and be responsible for oversight of data quality assurance with the following responsibilities:

- Assure that laboratory audits are performed periodically.
- Assure data quality reviews are performed.

Environmental Manager (EM)/Radiation Protection Manager (RPM)

The EM/RPM or appropriate designee is responsible for tracking samples and review of all analytical data. Data review may be contracted out under the supervision of the EM/RPM. The EM/RPM has the following responsibilities:

- Prepare work plans.
- Oversee field staff.
- Ensure all chain-of-custody forms are completed and managed according to YNPS procedures.
- Track the status of all samples from collection through data review.
- Review data packages and data quality.
- Initiate corrective actions.
- Identify deviations from approved work plans and procedures.
- Complete corrective actions.

3.1 Project Planning

Adequate project planning is a key element in meeting data quality needs. During the planning phase of a sampling project, project management should identify the decisions that will be supported by the data collection activities. Sampling activities shall be performed after adequate work plans have been developed and approved.

Development and approval of work plans will be commensurate with the project objectives and required data quality.

4.0 Laboratory Quality Program and Data Quality

Data quality is influenced by activities conducted both in the field and in the laboratory. For laboratory activities, the laboratory shall have a QA program.

4.1 Method Detection Limits and Instrumentation Calibration

4.1.1 Method Detection Limits

a. Non-Radiochemical Analyses

The method detection limit (MDL) is the minimum concentration of a substance that can be measured and reported with a certain degree of confidence that its concentration is greater than the appropriate background of the measurement. The degree of confidence is 99 percent based on a double sided confidence interval. The laboratory shall establish MDLs for each method, matrix, and analyte germane to each project. The laboratory shall revalidate these MDLs in accordance with the laboratory QA program.

b. Radiochemical Analyses

The method used to report detectable amounts of radionuclides shall use the critical level concept. It is defined as the minimum value of the response variable (or the measured analyte concentration) required giving confidence that a positive amount of analyte is present in the material analyzed. For radiochemical analyses the most important contributor to the critical level will be the background counts and the count times posed for background and sample. The critical level will be assessed with a α =0.01. The investigative level will be assessed with a α =0.05. The investigative level is a lower level of detection with less confidence, but more sensitivity. Results between the investigative and critical levels should be considered "flags" for further investigation, but not positive results in the absence of further investigation.

4.1.2 Instrument Calibration

Analytical instruments shall be calibrated in accordance with the approved analytical methods of the contractor laboratories. All results reported shall be within the calibration range. For radiochemical analytes analytical instrument results shall be evaluated using DP-8603, "Radiochemical Data Quality Assessment".

The laboratory shall maintain records of standard preparation or purchase and instrument calibration. Records shall unambiguously trace the preparation of standards and their use in calibration and quantification of sample results. Calibration standards shall be traceable to standard materials.

The initial calibration shall be checked at the frequency specified in the analytical method using materials prepared independently of the calibration standards. Analytical instruments shall be calibrated in accordance with the manufacturer's recommendations and/or the applicable analytical methods. Any deviations from the recommended procedures or intervals must be documented and approved by a qualified individual. Calibration procedures shall be written and controlled for all instruments and equipment used in the measurement process. When available, calibration standards shall be NIST traceable. Records of calibration and instrument calibration shall be maintained.

Non-Radiochemical Analyses

Analytes shall be measured below the value of the highest calibration standard. Samples whose initial measured values exceed the highest calibration standard shall be diluted to bring the sample within the calibration range. The dilution corrected initial value and the dilution factor will be reported and the MDL value will be adjusted appropriately. All results reported shall be obtained from samples (or their dilutions) measured within the calibration range. All calibrations criteria shall satisfy, at a minimum, SW-846[1] requirements or equivalent. The initial calibration shall be checked at the frequency specified in the method using materials prepared independently of the calibration standards. [11]

Radiochemical Analyses

Instruments used for measurement of radionuclides shall be calibrated using the guidance of

- ANSI N42.14, "Calibration and Used of Germanium Spectrometers for the Measurement of Gamma-Ray Emission Rates of Radionuclides"
- ASTM D3084, "Practice for Alpha Spectrometry of Water"
- ASTM D1890, "Test method for Beta Particle Radioactivity of Water"
- ASTM D1943, "Standard Test Method for Alpha Particle Radioactivity of Water"

Analyses performed using other instruments shall be calibrated and used as described under the Non-Radiochemical Analyses section.

4.2 Quality Control Elements

This section presents QC requirements relevant to analysis of samples that may be specified in work plans for analytical activities for fixed-base, mobile, and field laboratories. The purpose of this QC program is to produce data of known quality that satisfy the project objectives and that meet or exceed the requirements of the standard methods of analysis. This program provides a mechanism for ongoing control and evaluation of data quality measurements through the use of QC materials.

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1. USEPA 1983, U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Test Methods for Evaluating Solid Waste, SW-846. 3rd Edition, Washington, D.C.

Non-Radiochemical Analyses

Laboratory QC samples (e.g., blanks and laboratory process control samples) shall be included in the preparation batch with the field samples. An analytical batch is a number of samples (typically 20 samples as a default value but exceptions can be defined in the work plan) that are similar in composition (matrix) and that are extracted or digested at the same time and with the same lot of reagents. Matrix spikes and matrix spike duplicates count as samples, but are not counted in determining the batch size.[11]

Radiochemical Analyses

Laboratory QC samples shall be prepared by the contract analytical laboratory. QC samples shall be included in the analytical batch of samples processed (not to exceed 20 samples), the QC samples not counted in the 20 per batch. Sample spikes and duplicates are counted as part of the sample batch. Sample spikes are prepared by the contract laboratory with the radionuclide(s) specified in the Statement Of Work (SOW) or contract, Sample duplicates are taken in the field, and have no sample markings that would identify it as a duplicate of another sample. Additional details for radiochemical quality control elements are included in procedure DP-8603, Radiochemical Data Quality Assessment.

4.3 Quality Control Procedures

4.3.1 Holding Time Compliance

All sample preparation and analysis shall be completed within the method-required holding times. The holding time begins at the time of sample collection. Some methods have more than one holding time requirement corresponding to different stages of the analytical process.

4.3.2 Standard Materials for Instrument Calibrations

Standard materials, including second source materials, used in calibration and to prepare QC samples shall be traceable to National Institute of Standards and Technology (NIST), EPA, or other equivalent approved source, if available. If NIST or EPA standard material is not available, the laboratory will use other suitable material as appropriate traceable to a known recognized standard. The laboratory record will maintain a copy of the certificate of analysis or assay of the standard material.

For analytical standards, the expiration dates for ampulated solutions shall not exceed the manufacturer's expiration date. Expiration dates for laboratory-prepared stock and diluted standards shall be no later than the expiration date of the stock solution or material or the date calculated from the holding time allowed by the applicable analytical method, whichever comes first. Expiration dates for pure chemicals shall be established by the laboratory and be based on chemical stability, possibility of contamination, and storage conditions and manufacturers recommendations (if applicable).

Expired standard materials shall be either revalidated prior to use or discarded. Revalidation may be performed through assignment of a true value and error window statistically derived from replicate analyses of the material as compared to an unexpired standard. For usability, the revalidated value must be within five percent of the original value. The laboratory shall label standard and QC materials with expiration dates.

5.0 Field Operations and Data Quality

5.1 Sampling Procedures

All data collection activities shall adhere to approved YNPS project sampling procedures. The YNPS D&D project shall treat these as controlled documents as specified in YNPS procedure AP-0221, Plant Records Management. The following procedures have been specifically approved for the collection of samples:

DP-9745	Groundwater Level Measurement and Sample Collection in Observation Wells
DP-8120	Collection of Site Characterization and Site Release Samples
AP-8122	Subsurface Soil Sampling and Monitoring Well Installation
DP-8124	Collection of Pond Sediment Samples for Site Characterization
DP-9454	Collection of Samples from Painted Surfaces
DP-9455	Collection of PCB Wipe and Concrete Samples

5.2 Sample Custody

All data collection activities shall adhere to the YNPS sample custody procedure, DP-8123, Sample Security and Chain of Custody.

5.3 Field Documentation

Field logbooks permanently bound, logs and forms from specific procedures, provide a daily handwritten record of all field activities at an investigation site and are the primary records for all sampling activities. All documentation will become part of the permanent project file and be maintained in accordance with YNPS procedure AP-0221, Plant Records Management.

6.0 Data Reduction, Review, Verification, Reporting, and Validation

The data reduction, review, reporting, and validation procedures described in this section will ensure; (1) complete documentation is maintained, (2) transcription and data reduction errors are minimized, (3) the data are reviewed and documented, and (4) the reported results are qualified if necessary. Laboratory data reduction and verification procedures are required to ensure the overall objectives of analysis and reporting meet method and project specifications.

6.1 Analytical Laboratory Requirements

Soil/sediment samples shall have results reported on a dry weight basis. The sample percent moisture result used to convert the measured values (wet weight) to the reported values (dry weight) will be included for all soil/sediment samples. MDLs shall also be adjusted for dry weight.

In each laboratory analytical section, the analyst performing the tests shall review the data. After the analyst's review has been completed, 100 percent of the data shall be reviewed independently by a senior analyst or by the supervisor of the respective analytical section. Records of the review will be maintained as well as the results of the review including necessary corrections of the analyst's results or re-analysis of the samples. Reasons for the changes or re-analysis will be included.

These requirements must appear in the SOW agreed to by the analytical laboratory.

6.2 Project Review Requirements

The analytical results and supporting data must be verified for project plan compliance by the environmental department, contractor or designated alternate. Deviations (nonconformance) from the project plan or lab procedural specifications shall be evaluated as to their effect on data quality, validity and usability. The data shall be validated through the detailed review of the raw analytical data during periodic laboratory assessments / audits and desk audits, through the successful performance related to the internal lab batch QC samples, YNPS submitted field QC samples and external third party measurement QA programs. Any invalidated data shall be so designated.

Data Quality Assessment for Radiochemical Analyses shall be performed using DP-8603.

The Environmental Manager (EM)/Radiation Protection Manager (RPM) or appropriate designee shall determine if the data quality objectives have been met.

7.0 Data / Records Management

7.1 Electronic Data Reports

Information generated from the work activities may be recorded in an electronic data management system. [11]

7.2 Archiving

Hard copy and electronic data shall be archived in project files and on electronic media (microfilm) as decommissioning records with retention until license termination.

7.3 Project Data Flow and Transfer

The data flow from the laboratory and field to the project staff and data users shall be sufficiently documented to ensure the data are properly tracked, reviewed, and validated for use.

7.4 Record Keeping

7.4.1 Analytical Laboratories

All analytical laboratories utilized in the project shall maintain electronic and/or hard copy records sufficient to recreate each analytical event conducted pursuant to YNPS requirements.

7.4.2 Field Operations

The D&D project shall maintain records pertinent to field operation according to the approved YNPS records management system (AP-0221). Records subject to this requirement include:

(1) All Site and Field Logbooks and Procedural forms;

(2) Chain of custody forms or sample submission forms;

(3) All analytical reports from onsite and offsite laboratories;

(4) Corrective action reports;

(5) Field sampling work plans.

8.0 Training

Training shall be provided to all project personnel to ensure compliance with the health and safety plan and technical competence in performing the work effort. Documentation of this training shall be maintained in the records of the YNPS D&D project (AP-0221). This documentation shall include training requirements for each project position relative to data collection and management.

9.0 Program Audits

Audits shall be performed as independent assessments of program adequacy and adherence to operational procedures and protocols. Audit results will be used to evaluate the ability of an analytical contractor to (1) produce data that fulfill the objectives established for the program, (2) comply with the QC criteria, and (3) identify any areas requiring corrective action.

9.1 Laboratory Program Audits

A laboratory audit shall be performed if previous audit reports indicate that corrective actions are outstanding, a recent audit has not been conducted, or quality concerns have arisen based upon the use of that laboratory for other projects. Audits of contract analytical laboratories shall be performed once every five years or more frequently for cause as indicated in this section. The laboratory audit results will be used to review laboratory operation and ensure the technical procedures and documentation are in place and operating to provide data that fulfill the project objectives and to ensure outstanding corrective actions have been addressed.

Critical items for a laboratory or field systems audit include:

(1) sample custody procedures,
(2) calibration procedures and documentation,
(3) completeness of data forms, notebooks, and other reporting requirements,
(4) data review and validation procedures,
(5) data storage, filing, and record keeping procedures,
(6) QC procedures, tolerances, and documentation,
(7) operating conditions of facilities and equipment,
(8) documentation of training and maintenance activities,
(9) corrective action program,
(10) internal and external QC results,
(11) analytical procedures

After each on-site audit, a debriefing session will be held for all participants to discuss the preliminary audit results. The auditor will then complete the audit evaluation and submit an audit report to the Laboratory Manager and the YNPS Director of Site Closure including observations of the deficiencies and the necessary recommendations for corrective actions.

9.2 Field Operations Audits

A field operations audit is an on-site, qualitative review of the sampling or analytical system to ensure that the activity is being performed in compliance with the QAPP specifications. Sampling and field procedures shall be audited at a minimum frequency of 2 yrs. by the YNPS Quality Assurance Department or appropriate designee. Audits may also be subcontracted to a third party Quality Assurance vendor.

Critical items for a field operations audit include:

(1) completeness of documentation in field logbooks and sampling data sheets,
(2) organization and minimization of potential contamination sources while in the field,
(3) proper sample collection, storage, and transportation procedures,
(4) compliance with established chain of custody and transfer procedures,
(5) operating conditions of facilities and equipment,
(6) documentation of training and maintenance activities, and
(7) sampling procedures.

After each on-site audit, a debriefing session will be held for all participants to discuss the preliminary audit results. The auditor will then complete the audit evaluation and submit an audit report to the YNPS Director of Site Closure including observations of the deficiencies and the necessary recommendations for corrective actions.

10.0 Non-conformance Reporting and Corrective Actions

At the discretion of the Environmental Manager/Radiation Protection Manager, the YAEC Condition Reporting Program, as defined in AD-07, shall be used to report and evaluate adverse conditions potentially affecting data quality and to track corrective actions through completion.

ATTACHMENT 1 **Data Quality Elements** (Non Radiochemical Analyses) [11]

Precision

Precision measures the reproducibility of measurements. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions. Analytical precision is the measurement of the variability associated with duplicate (two) or replicate (more than two) analyses.

Total precision is the measurement of the variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate or replicate field samples which allows evaluation of sampling variability introduced by field operations.

Field duplicate samples shall be analyzed to assess field precision. Matrix spike and duplicate matrix spike samples and laboratory duplicate samples shall be analyzed to assess analytical precision.

Accuracy

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and systemic error. It therefore reflects the total error associated with a measurement. A sample measurement is considered accurate when the value reported for QC samples does not differ from the true value or known concentration of the laboratory control sample, standard or matrix spike, respectively.

Representativeness

Objectives for representativeness are defined for each sampling and analysis task and are a function of the project objectives. Representativeness shall be achieved through use of the standard field, sampling, and analytical procedures. Representativeness is also determined by appropriate program design, with consideration of elements such as proper well locations, drilling and installation procedures, and sampling locations.

ATTACHMENT 2 **QUALITY CONTROL ELEMENTS** (Non-Radiochemical Analyses) [11]

This attachment contains definitions and requirements for quality control samples. These control samples have been organized into field samples and laboratory samples. The use and frequency of control samples should be related to the data quality objectives.

Field Samples

Ambient Blank

The ambient blank consists of reagent grade water poured into a volatile organic compound (VOC) vial at the sampling site (in the same vicinity as the associated samples). An ambient blank is handled like a sample and transported to the laboratory for analysis. Ambient blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes.

Ambient blanks are used to assess the potential introduction of contaminants from ambient sources (e.g., contaminated sampling containers, active runways, engine test cells, gasoline motors in operation, etc.) to the samples during sample collection.

The frequency of collection for ambient blanks is specified in the work plan. Ambient blanks shall be collected downwind of possible VOC sources.

Equipment Blank

An equipment blank is a sample of reagent grade water poured into or over or pumped through the sampling device, collected in a sample container, and transported to the laboratory for analysis.
Equipment blanks are used to assess the effectiveness of equipment decontamination procedures.

The frequency of collection for equipment blanks is specified in the work plan. Equipment blanks shall be collected immediately after the equipment has been decontaminated. The blank shall be analyzed for all laboratory analyses requested for the samples collected at the site.

Trip Blank

The trip blank consists of a VOC sample vial filled in the laboratory with reagent grade water, transported to the sampling site, handled like a sample and returned to the laboratory for analysis. Trip blanks are not opened in the field. Trip blanks are prepared only when VOC samples are taken and are analyzed only for VOC analytes.

Trip blanks are used to assess the potential introduction of contaminants from sample containers or during transportation and storage prior to analysis.

One trip blank shall accompany each cooler of samples sent to the laboratory for analysis of VOCs or as specified in the work plan.

Field Blanks

Field blanks will be collected from sources of water used during field sampling events that may come in contact with samples, or sampling equipment, and have a possible impact on sample results. Field blanks are collected from water used as the final rinse in equipment decontamination, water used to prepare equipment rinse blanks, or water used in drilling activities. Field blanks will be collected at a rate of one per source for each sampling event.

Field blanks consist of samples made by filling appropriate sample bottles from the source location where water is obtained for use in the field.

For dissolved metals, a separate field blank must be collected that will be either field or laboratory filtered prior to analyses. This filtered water blank will be obtained by processing the designated blank-source water through the field filter-apparatus and then preserving and handling this blank-water sample in the same way as field-filtered metals samples. For every 20 samples collected for dissolved metals, a filtered-blank must be generated.

Temperature Blanks

Temperature blanks will consist of a water filled container provided by the laboratory that will be shipped to the off-site laboratory with each cooler of samples submitted for laboratory analyses. During sample receipt, the sample custodian will measure the temperatures in the blank to determine the status of sample preservation during shipment to the laboratory. The preservation goal for the samples is to maintain temperatures at 4°C ± 2°C. If the cooler temperature is outside this range (i.e., above 6°C), the laboratory will contact the client for guidance as to whether to proceed with analyses.

Field Replicates

A field replicate sample is a second sample collected at the same location as the original sample. Replicate samples are collected simultaneously or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field such that they cannot be identified (blind replicate) as replicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field replicate samples prior to the beginning of sample collection.

Replicate sample results are used to assess precision of the sample collection process. It assumes there is no variability between two closely located samples. Precision of soil samples to be analyzed for VOCs is assessed from collocated samples because the compositing process required to obtain uniform samples could result in loss of the compounds of interest.

The frequency of collection for field replicates is specified in the work plan.

Field Duplicates

A field duplicate sample, also called a split, is a single sample divided into two equal parts for analysis. The sample containers are assigned an identification number in the field such that they cannot be identified as duplicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field duplicate samples prior to the beginning of sample collection.

Duplicate sample results are used to assess precision of the field sample processing operation. It assumes there is no imprecision introduced by laboratory processes such as sub-sampling, preparation, analysis, and data reduction.

The frequency of collection for field duplicates is specified in the work plan.

Laboratory Samples

Matrix Spike/Matrix Spike Duplicate

A matrix spike (MS) and matrix spike duplicate (MSD) are aliquots of sample spiked with known concentrations of all analytes specified in the work plan on a method-specific basis. The spiking occurs prior to sample preparation and analysis. The MS and MSD shall be spiked at a level less than or equal to the midpoint of the calibration curve for each analyte.

The MS/MSD is used to document the bias of a method due to sample matrix.

If required, a minimum of one MS and one MSD sample shall be analyzed for every 20 YNPS samples or as specified in the work plan.

The performance of the MS and MSD is evaluated against the QC acceptance limits.

Surrogates

Surrogates are organic compounds that are similar to the target analyte(s) in chemical composition and behavior in the analytical process, but that are not normally found in samples.

Surrogates are used to evaluate accuracy, method performance, and extraction efficiency.

Surrogates shall be added to samples, controls, and blanks, in accordance with the method requirements.

Internal Standards

Internal standards (ISs) are measured amounts of certain compounds added after preparation or extraction of a sample.

They are used in an IS calibration method to correct sample results affected by column injection losses, purging losses, or viscosity effects.

ISs shall be added to samples, controls, and blanks, in accordance with the method requirements. The use of internal standards to correct measured sample values shall not be performed on a routine basis. It shall only be used when required by the approved method or as otherwise specified in the work plan.

Interference Check Sample

The interference check sample (ICS), used in inductively coupled plasma (ICP) analyses only, contains both interfering and analyte elements of known concentrations.

The ICS is used to verify background and inter element correction factors. The ICS is run at the beginning and end of each run sequence.

When the interference check sample results are outside of the acceptance limits stated in the method, corrective action shall be performed.

Method Blank

A method blank is an analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank shall be carried through the complete sample preparation and analytical procedure.

The method blank is used to document contamination resulting from the analytical process.

A method blank shall be included in every analytical batch or as specified in the work plan.

QUALITY CONTROL ELEMENTS

QUALITY CONTROL METHOD	PREPARATION	MINIMUM FREQUENCY	QC ELEMENT ASSESSED
Field Samples			
Ambient Blank	Reagent grade water in VOC vials in field at sample site	Work Plan specified	Potential ambient contaminants (VOC only)
Equipment Blank	Reagent grade water in field following sampler decontamination	Work Plan specified	Equipment decontamination effectiveness
Trip Blank	Reagent grade water in lab in VOC vials, transported to field	One sample / VOC cooler	Potential contaminants prior to analysis
Field Replicate	Second sample collected in field at location of original	Work Plan specified	Precision of sample collection process
Field Duplicate	Split of single sample in field	Work Plan specified	Precision of field sample processing
Field Blank	Source Water during field sampling	Work Plan specified	Effectiveness is decon of equipment or Rinse blank
Temperature Blank	Reagent grade water from laboratory to off-site lab.	Work Plan specified	Sample Preservation during shipment
Laboratory Samples			
Matrix Spike / Spike Duplicate	Sample spiked with known concentration	According to method requirements	Bias of method due to sample matrix
Surrogates	Added organic cmpd similar to target analytes	According to method requirements	Accuracy, method performance, and extraction efficiency
Internal Standards	Measured amounts added after sample preparation or extraction	According to method requirements	To correct for column losses, purging losses or viscosity effects

QUALITY CONTROL METHOD	PREPARATION	MINIMUM FREQUENCY	QC ELEMENT ASSESSED
Interference Check Sample	Inductively Plasma Analysis (ICP) with interfering and analytes of know conc.	According to method requirements	Background and inter-element correction factors
Method Blank	All analytes added to reagent free matrix in same proportions	According to method requirements	Contamination resulting from analytical process

Attachment 5
Groundwater Level Measurement and Sample Collection in Observation Wells (DP-9745)
(Provided on enclosed CD)

Proc. No. DP-9745
Rev. No. 17
Issue Date 06/2006
Review Date 05/2008

GROUND WATER LEVEL MEASUREMENT AND SAMPLE COLLECTION IN OBSERVATION WELLS

SCOPE

This procedure describes methods for measurement of ground water levels and collection of ground water samples in monitoring wells. Synoptic measurements of ground water levels may be taken independently from sampling. Samples are intended to be analyzed for radiological and/or nonradiological constituents. The method of sampling described in this procedure is low-flow sampling. The objective of low-flow sampling is to collect a representative groundwater sample while minimizing the amount of purge water generated. It also produces a low turbidity sample. The low-flow sample technique involves pumping the groundwater at a low flow rate through a flow cell where water quality parameters are monitored until they stabilize, after which a groundwater sample is collected for laboratory analysis. All samples are subject to documentation for transfer to a testing lab as detailed in Reference 1.

ENCLOSURES

DP-9745 Pgs. 1-2
DPF-9745.1 - Pgs. 1-2
DPF-9745.2 - Pg. 1
DPF-9745.3 - Pg. 1
DPF-9745.4 - Pgs. 1-4
DPF-9745.5 - Pg. 1
Attachment A - Pgs. 1-5

REFERENCES

1. DP-8123, "Sample Security and Chain of Custody"
2. AP-8122, "Subsurface Soil Sampling and Monitoring Well Installation"
3. DP-8120, "Collection of Site Characterization and Site Release Samples"
4. AP-9601, "Yankee Nuclear Power Station Site Characterization and Site Release Quality Assurance Program Plan (QAPP) for Sample Data Quality"
5. ERM New England Low Flow SOP Rev. 2003
6. ASTM D4448,"Sampling Groundwater Monitoring Wells"
7. ASTM D5903,"Planning and Preparing for a Groundwater Sampling Event"

DISCUSSION

Typical well construction is shown in DPF-9745.2 (figure 1). Measurements of water levels may be done independently of sampling; however, such level measurements are also required as a preliminary step in well sampling and usually conducted in a single synoptic round in as short a time period as practical before sampling commences.

Ground water sampling is conducted periodically (usually quarterly), as required for study purposes. Wells may be added to or removed from those measured or sampled as investigations continue.

NOTE: All weather paper should be used for groundwater data collection.

PRECAUTIONS

1. As listed in Attachment A.

EQUIPMENT AND MATERIALS

1. As listed in Attachment A.

PROCEDURE

1. Use Attachment A for Low Flow sampling.

2. Proper sample containers and preservatives.

   Prior to sampling, contact the laboratory which will analyze the samples to determine the appropriate sample containers, the necessary volume of sample media that must be collected, and any required preservation methods. Also determine the holding times for each sample to be collected to ensure that samples are not held beyond their prescribed time period prior to analysis. Typical sample containers, volumes, preservation methods, and holding times are provided in Appendix A of DP-8120.

   See Attachments A and B for requirements for ^{14}C sample preservation during storage between sampling and analysis.

FINAL CONDITIONS

1. As per Attachment A.

May 2006 Depths to Screens in Monitoring Wells

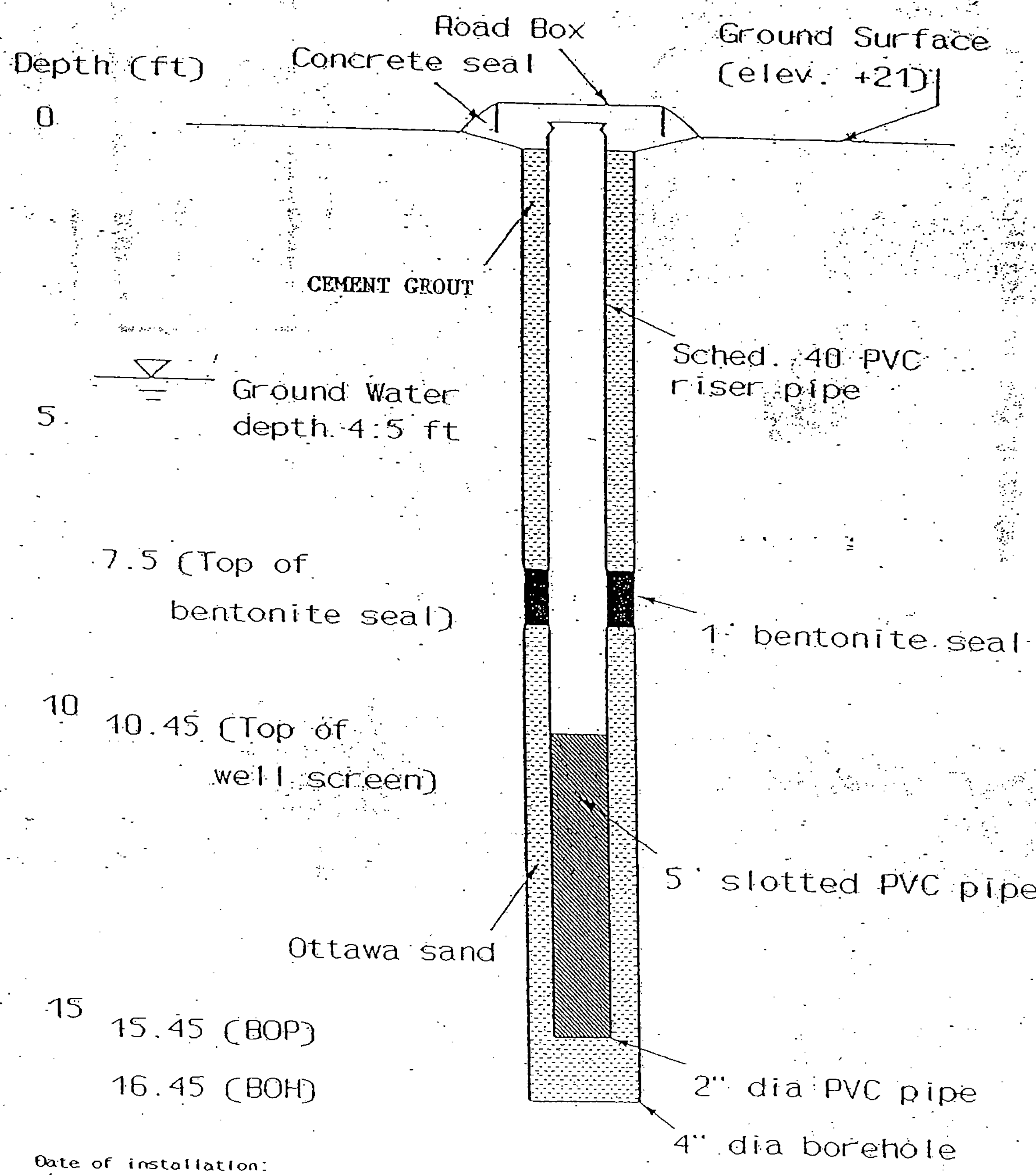
Yankee Nuclear Power Station
Rowe, Massachusetts

Well No.	Original Depth to Top of Screen From Top of PVC (feet)	Original Top of PVC Elevation (feet, NAVD '88)	May 2006 Top of PVC Elevation (feet, NAVD '88)	May 2006 Depth to Top of Screen From Top of PVC (feet)	Screen Length (feet)	May 2006 Depth to Middle of Screen From Top of PVC (feet)
CB-3	3	1138.62	1138.62	3.00	10	8
CB-4	9	1085.61	1085.61	9.00	10	14
CB-6	18	1112.06	1112.06	18.00	10	23
CB-8	14	1139.14	1139.14	14.00	5	16.5
CFW-1		1168.69	1168.69			
CFW-5		1143.93	1143.93			
CFW-6		1140.07	1140.07			
CW-10	15	1124.53	1128.71	19.18	15	26.68
MW-100A	10	1125.10	1134.48	19.38	10	24.38
MW-100B	32.9	1125.06	1134.07	41.91	10	46.91
MW-101A	NA		1146.13	26.13	5	28.63
MW-101B	142	1125.68	1145.52	161.84	10	166.84
MW-101C	94	1125.43	1145.78	114.35	5	116.85
MW-102A	33	1125.62	1139.28	46.66	5	49.16
MW-102B	120.2	1125.67	1139.82	134.35	10	139.35
MW-102C	94	1125.55	1139.12	107.57	5	110.07
MW-102D	NA		1141.91	19.11	10	24.11
MW-103A	15	1110.65	1110.65	15.00	10	20
MW-103B	284.5	1110.92	1110.92	284.50	10	289.5
MW-103C	115	1110.59	1110.59	115.00	10	120
MW-104A	NA		1118.17	10.00	10	15
MW-104B	184	1117.75	1117.75	184.00	10	189
MW-104C	87	1118.17	1118.17	87.00	10	92
MW-105A	NA		1136.80	19.90	10	24.9
MW-105B	64	1126.29	1135.74	73.45	10	78.45
MW-105C	27	1126.22	1136.86	37.64	10	42.64
MW-106A	12	1088.49	1088.49	12.00	10	17
MW-106B	251	1088.14	1088.14	251.00	10	256
MW-106C	90	1088.30	1088.30	90.00	5	92.5
MW-106D	144	1088.66	1088.66	144.00	10	149
MW-107A	NA		1140.07	25.97	5	28.47
MW-107B	99.7	1124.58	1140.00	115.12	10	120.12
MW-107C	27	1124.65	1139.69	42.04	5	44.54
MW-107D	75	1124.68	1139.18	89.50	5	92
MW-107E	NA			52 ***	5	54.5
MW-107F	NA			49 ***	5	51.5
MW-108A	14.7	1118.00	1118.00	14.70	10	19.7
MW-108B	205	1118.18	1118.18	205.00	10	210
MW-108C	60	1118.26	1118.26	60.00	5	62.5
MW-109A	NA		1127.99	13.89	10	18.89
MW-109B	180	1123.70	1128.19	184.49	10	189.49

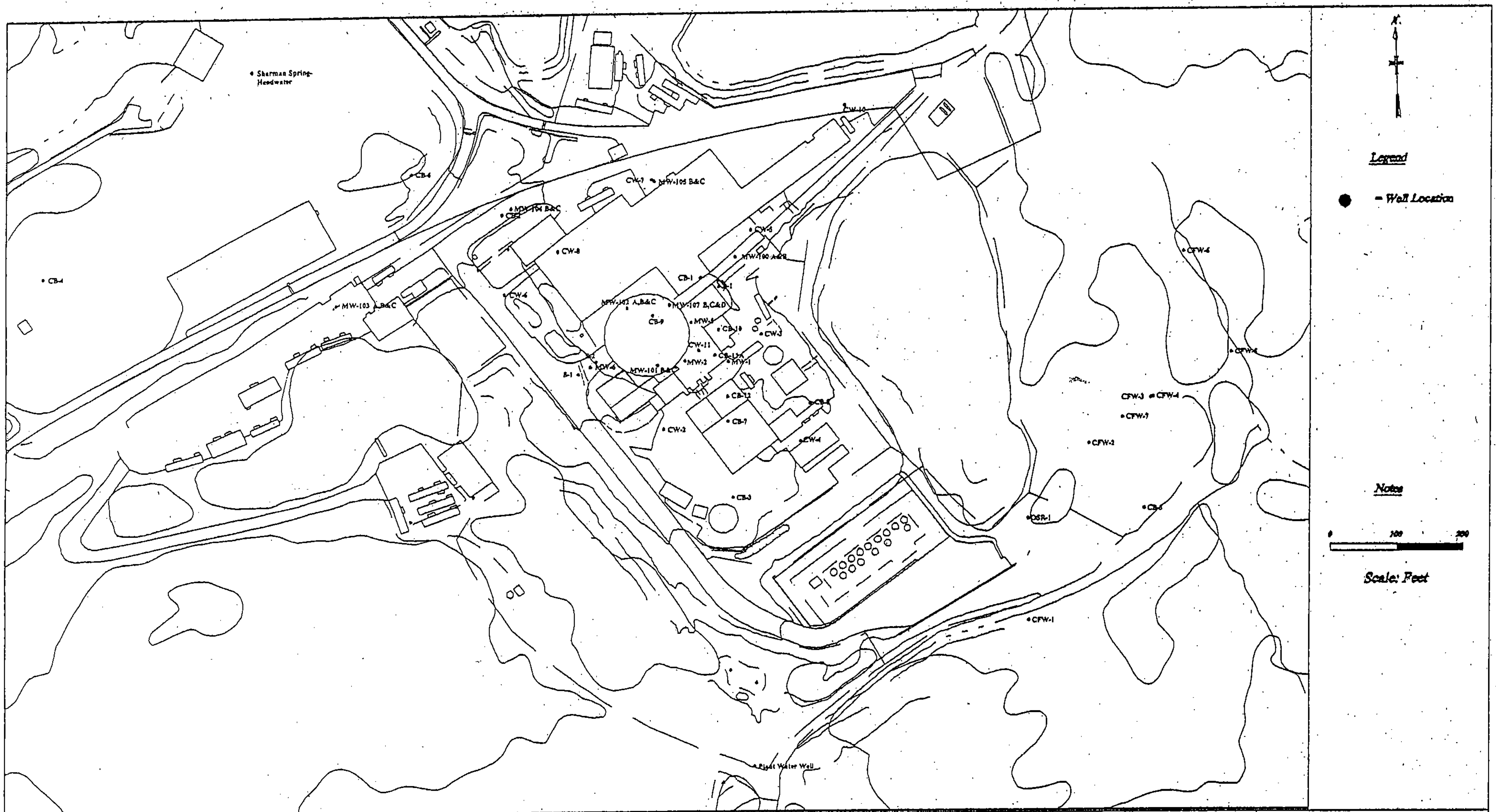
MW-109C	49	1123.40	1127.68	53.28	5	55.78
MW-109D	88.7	1123.38	1127.71	93.03	5	95.53
MW-110A	NA		1143.38	29.98	5	32.48
MW-110B	NA		1143.40	105.20	10	110.2
MW-110C	NA			46 ***	5	48.5
MW-110D	NA			83 ***	5	85.5
MW-111A	NA		1141.02	24.22	5	26.72
MW-111B	NA		1141.75	75.95	10	80.95
MW-111C	NA		1140.59	37.79	5	40.29
MW-113A	NA			15 ***	10	20
MW-113C	NA			127 ***	10	132

*** : Depth from grade

Figure 1.
Typical Detail of Observation Well



Date of installation:
Contractor:



Yankee Atomic Power Company *Existing Monitoring Wells*	YANKEE	*Date: January 2004* *Revision: 5*	*Figure: 2*

Appendix B
Tritium Risk-Based Concentration in Drinking Water

Attachment B

Tritium Risk-Based Concentration in Drinking Water

The attached table presents that risk-based concentration (RBC) for tritium in drinking water. The calculation adopts Mass DEP default exposure assumptions for child and adult drinking water consumption over a total exposure duration of 30 years. The calculations adjust for inherent radioactive decay of tritium (half-life = 12 years). As shown in the table, a 10-5 RBC for drinking water is 23,060 pCi/L, which is consistent with the EPA and Mass DEP drinking water criteria of 20,000 pCi/L.

The average concentration over the child (0 - 6 years) and adult (6 - 24 years) was calculated following the methods in Section 4.2.2 of the January 2005 YAEC Human Health Risk Assessment Work Plan (Draft), excerpted below without modification for ease of reference.

January 2005 YAEC Human Health Risk Assessment Work Plan (Draft) - Excerpt

4.2.2 Exposure Quantification for Radionuclides

Potential exposure to radionuclides is calculated in terms of radioactivity (in pico-curies, or "pCi") rather than in chemical mass units. Exposures *via* ingestion and inhalation pathways are calculated using similar approaches to those just described for chemical exposure, simply expressing exposure as the total amount of radioactivity (pCi) received over a particular duration. In the equations below, the radiation exposure is expressed in terms of an "intake factor." The intake factor accounts for either ingestion (*e.g.*, soil, water, food) or inhalation. Radiation intake for these pathways is given by (USEPA, 2000):[1]

$$IF = EPC \times IR \times EF \times ED \qquad (4\text{-}4)$$

where:

IF	=	Intake factor (pCi)
EPC	=	Exposure point concentration (*e.g.*, pCi/g, pCi/m^3, pCi/L)
IR	=	Media intake rate (*e.g.*, g/day, m^3/day, L/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)

As can be seen by comparing Equation (4-1) and (4-4), the intake factor for radionuclides is a function of exposure duration and exposure frequency. The media intake rates, exposure frequency and duration for radionuclide intake are identical to those for the chemical exposure estimates, and are provided in Table 2.

The concentration of radionuclides in the environment declines according to radionuclide-specific decay rates. Thus, the EPC is not a constant, but rather declines as a function of time according to the following exponential equation:

$$EPC(t) = EPC_o\, e^{-\lambda t} \qquad (4\text{-}5)$$

where

EPC(t) = concentration as a function of time (pCi/g)

[1] The equations presented by USEPA (2000) are for a "risk-based" concentration in soil, air, water, *etc.* The intake is given by simply rearranging those equations such that they are expressed as a "risk equation" without substituting a "target risk" value.

EPC_o = initial concentration at time t=0 (pCi/g)

λ = $\dfrac{\ln(2)}{t_{1/2}}$ is the decay constant (per year)

$t_{1/2}$ = half-life (years)

The average concentration ($\overline{\mathrm{EPC}}$) over a particular time period (T) is given by integrating the declining concentration over the time period:

$$\overline{\mathrm{EPC}} = \frac{1}{\mathrm{T}}\int_0^{\mathrm{T}} \mathrm{EPC_o} e^{-\lambda t} dt = \mathrm{EPC_0}\frac{(1-e^{-\lambda \mathrm{T}})}{\mathrm{T}\lambda} \tag{4-6}$$

In the above equation, the time period "T" is equivalent to the exposure duration (ED) in Equation (4-4). Thus, combining the expression for the average concentration for EPC in Equation (4-6) with the intake factor expression in Equation 4-4), gives the following decay-adjusted intake factor

$$IF = EPC_0 \frac{(1-e^{-\lambda T})}{\lambda} \times IR \times EF \tag{4-7}$$

where EPC_o is the exposure point concentration at the beginning (time t=0) of the exposure period.

Tritium Drinking Water Risk-Based Concentration Determination

Chemicals Evaluated	Concentration (C) (pCi/L)	Half-Life $t_{1/2}$ (yrs)	Cadj child (pCi/L)	Cadj adult (pCi/L)	Slope Factor (SF) (Risk/pCi)	DCF Ing (mrem/pCi)	Cancer Risk (Cadj×IF×SF)	Dose (mrem/yr)	RBC 1.00E-05	RBC (dose) 4
Tritium	**23,000**	12.0	19,437.6	8,798.7	5.07E-14	6.40E-08	9.97E-06	0.87	**23,060**	106,342
						Total	**1.0E-05**	**0.9**		

Intake Factor (IF) -- adult	IR x FS x EF x ED	=	**1.75E+04**	IF (dose) = IR x FS x EF =	**7.30E+02**
Intake Factor (IF) -- child	IR x FS x EF x ED	=	**2.19E+03**	IF (dose) = IR x FS x EF =	**3.65E+02**

IR	Ingestion Rate--adult (L/day)	2
ED	Exposure Duration--adult (yr)	24
IR	Ingestion Rate -- child (L/day)	1
ED	Exposure Duration - child (yr)	6
EF	Exposure Frequency (d/yr)	365
FS	Fraction from Contaminated Source	1

Notes:

Cadj is the decay-adjusted concentration over the exposure period based on the radionuclide decay half-life.

Slope Factor source: HEAST