LMS/SAL/S07531

# Post-Closure Inspection, Sampling, and Maintenance Report for the Salmon, Mississippi, Site

# Calendar Year 2010

March 2011



U.S. DEPARTMENT OF ENERGY | Legacy Management

LMS/SAL/S07531

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# Abbreviations

| | |
|---|---|
| AEC | U.S. Atomic Energy Commission |
| COC | contaminant of concern |
| DOE | U.S. Department of Energy |
| EPA | U.S. Environmental Protection Agency |
| ft | feet/foot |
| LM | Office of Legacy Management |
| MCL | maximum contaminant level |
| MDC | minimum detectable concentration |
| MSFC | Mississippi Forestry Commission |
| pCi/L | picocurie(s) per liter |
| SOARS | System Operation and Analysis at Remote Sites |
| TCE | trichloroethene |
| TRG | State of Mississippi target remediation goal |
| VOC | volatile organic compound |

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# 1.0 Introduction

This report summarizes the annual inspection, sampling, measurement, and maintenance activities performed at the Salmon, Mississippi, Site in calendar year 2010. The draft *Long-Term Surveillance and Maintenance Plan for the Salmon Site, Lamar County Mississippi* (DOE 2007) specifies the submittal of an annual report of site activities with the results of sample analyses.

The Salmon, MS, Site is a federally owned site located in Lamar County, MS, approximately 12 miles west of Purvis, MS, and about 21 miles southwest of Hattiesburg, MS (Figure 1). The U.S. Department of Energy (DOE), a successor agency to the U.S. Atomic Energy Commission (AEC), is responsible for the long-term surveillance and maintenance of the 1,470-acre site. DOE's Office of Legacy Management (LM) is the operating agent for the surface and subsurface real estate.

The surface real estate was transferred via quitclaim deed from federal ownership to the State of Mississippi on 15 December 2010. The transfer deed was signed by a representative from LM, the Secretary of State, and the Governor (Appendix A, Image A–1). The deed and its attachments were filed with the Lamar County Chancery Clerk. The subsurface real estate (including minerals) below the site boundary remains under federal ownership.

The AEC conducted Projects Dribble and Miracle Plan to study seismic signatures from the detonations in the Tatum Salt Dome beneath the site. Figure 2 shows an outline of the salt dome at about 2,500 feet (ft) below the surface. Two underground nuclear tests (Dribble) and two chemical explosive tests (Miracle Plan) were conducted in the Tatum Salt Dome between 1964 and 1970. The first nuclear test, called Salmon, created a cavity 2,710 ft below ground surface. The second test, called Sterling, and the two subsequent chemical detonations, Diode Tube and Humid Water, were conducted within the cavity created by the Salmon test. No radioactivity was released to the surface during the four tests. Residual radioactivity from Project Dribble is contained within the salt cavity. The properties of the salt—plasticity and impermeability—provide geologic isolation from the surroundings.

The site was cleaned up and decommissioned in 1972. During the cleanup, most of the soil and drilling mud contamination from drill-back operations were slurried and injected into the cavity. At two locations near ground zero, shallow contamination that could not be completely removed effectively and safely was left in place. The contamination in the drilling mud consisted of tritium, metals, and volatile organic compounds (VOCs); the latter two are drilling-mud additives. The two shallow-contamination locations are the rathole (used for vertical storage of drill pipe) and a drilling-mud pit. The rathole is located beneath concrete that supports the concrete base of the monument at ground zero. The mud pit is located nearby (centered at about 178 ft S16.5°E from ground zero) and covered with clean fill. Some of the contaminated liquids removed during drill-back were injected into Aquifer 5, an aquifer used for brine disposal by the oil and gas industry. The injection borehole, located in the southwest corner of the site, was sealed after the injection.

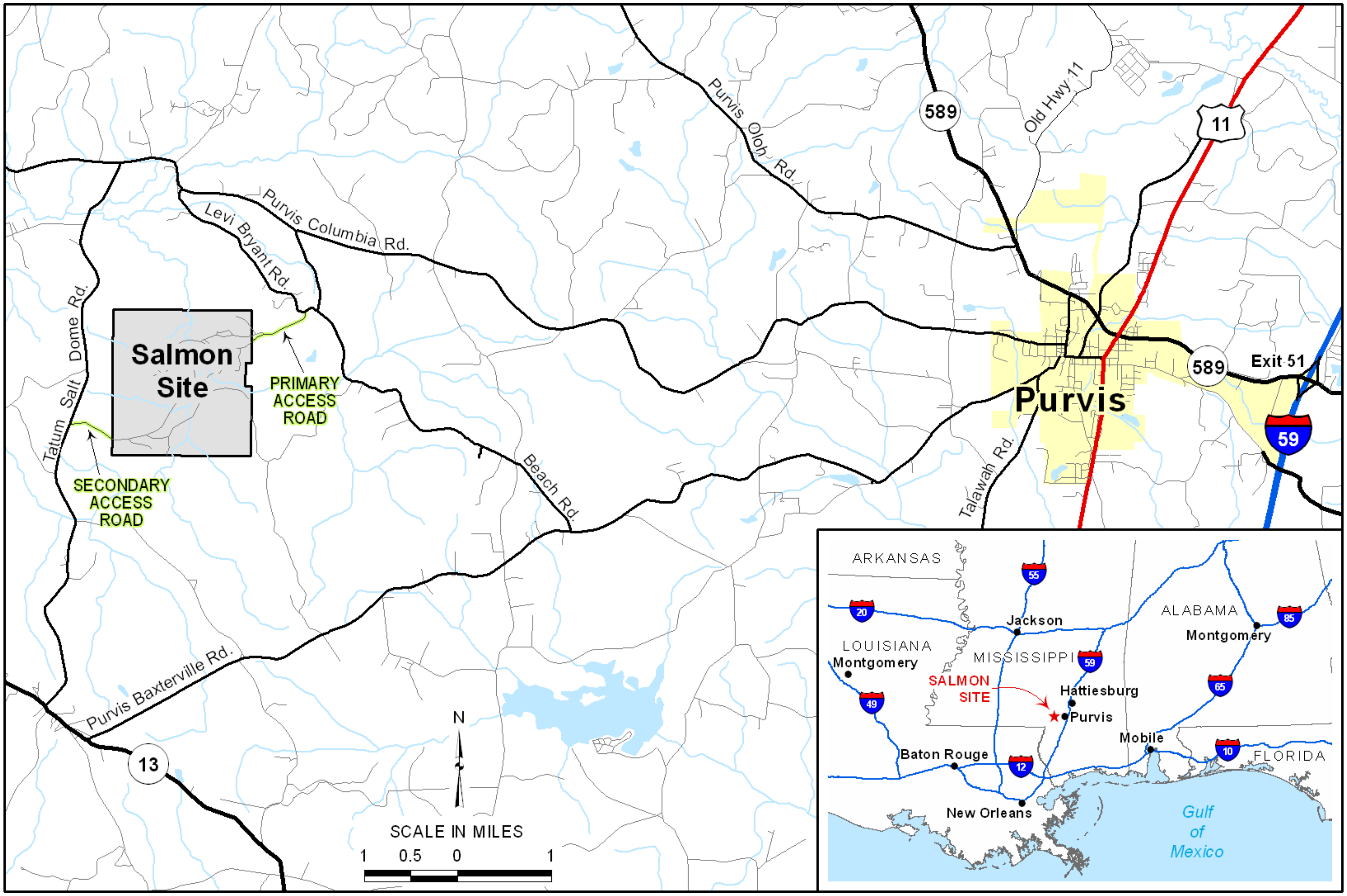

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*Figure 1. Regional Location Map for the Salmon, Mississippi, Site*

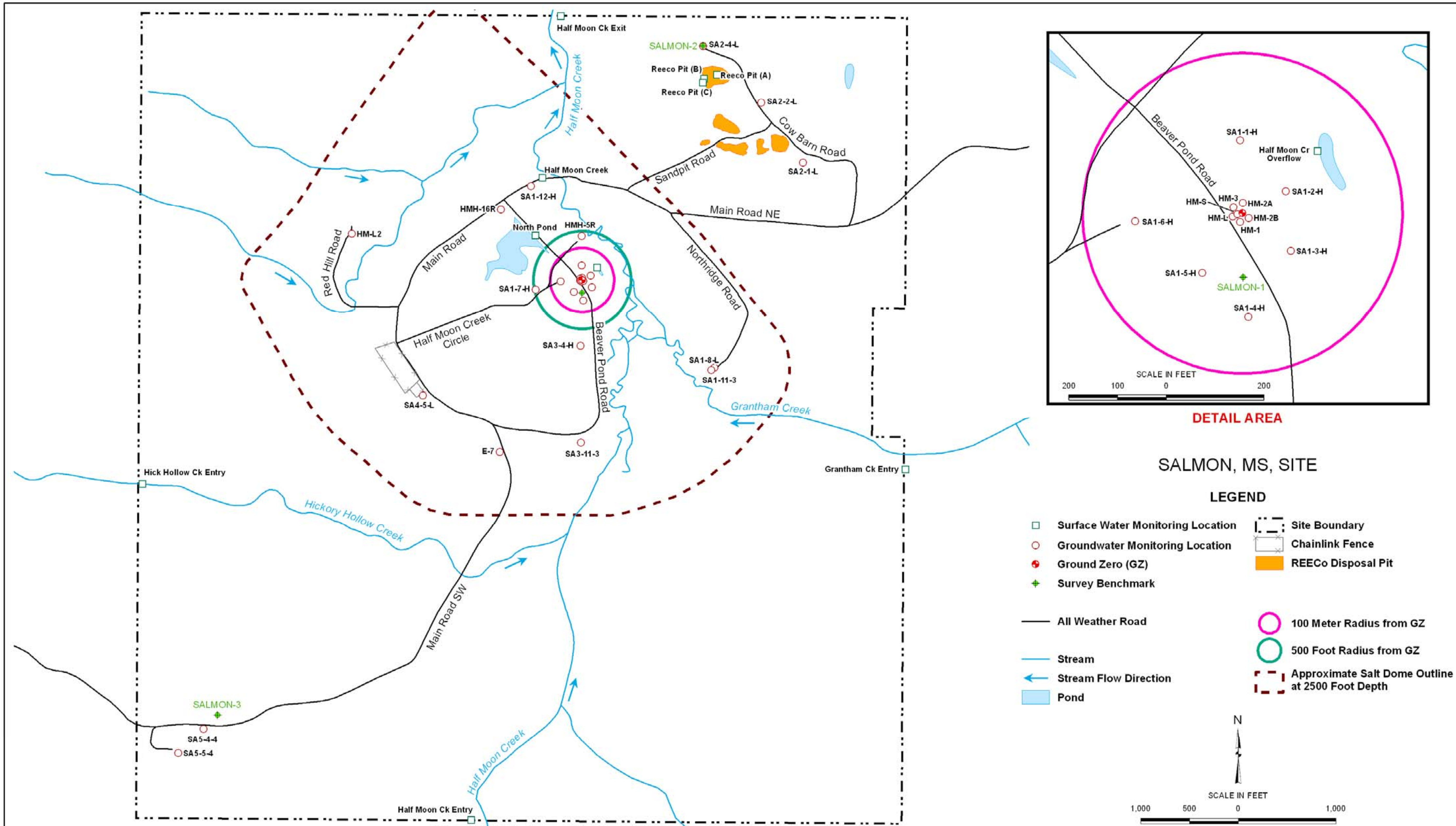


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*Figure 2. Sampling Locations at the Salmon, Mississippi, Site*

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Tritium was brought to the surface during the drill-back operations. It has been detected in shallow groundwater samples collected by the U.S. Environmental Protection Agency (EPA) between 1972 and 2007 and by LM through 2010. In the monitoring wells where tritium has been detected, the concentration is attenuating faster than the rate predicted by the law of radioactive decay. Radioactivity from the detonations has neither been detected in the deep wells that monitor the plugged emplacement wells at ground zero (Appendix A, Image A–2) nor in the two deep wells that monitor Aquifer 5 — the aquifer liquid radioactivity was injected. Current surface water sample points and monitoring well locations are shown in Figure 2.

Contamination remaining at the site is contained within the deep cavity in the salt dome and in Aquifer 5. The potential source locations of contamination of the surface water and groundwater at the site are:

- The rathole and drilling-mud pit, both less than 30 ft from the surface.
- The cavity and the now-plugged ground-zero boreholes.
- The wastes injected into Aquifer 5 and the borehole used to inject the wastes.

All test and injection boreholes were plugged and abandoned in accordance with the requirements of the State of Mississippi.

The contaminants of concern (COCs) for the site are given in Table 1. These COCs are determined from water sample concentrations detected since 2004 that exceeded either the drinking water maximum contaminant level (MCL) (EPA 2004) or the Mississippi target remediation goal (TRG) (MDEQ 2006).

*Table 1. Contaminants of Concern Detected Above the MCL or TRG since 2004*

| Radioactivity | Metals | VOC |
|---|---|---|
| Tritium | Arsenic* | Trichloroethene* |
| | Barium* | *cis*-1,2-Dichloroethene |
| | Chromium* | Vinyl chloride* |
| | Lead | |

* Detected in 2010 above the MCL.

Tritium is listed as a COC because it moves faster in groundwater than any of the other radioactive products resulting from a nuclear detonation. Tritium has not been detected above its MCL since 2002. The source of the arsenic is unknown and may be unrelated to DOE activities. Methylene chloride has been detected above the MCL, and naphthalene has been detected above the risk based screening level (EPA 2004); however, the detections are few and irregular. Since naphthalene is a common solvent, and methylene chloride is a common laboratory contaminant, these compounds are not believed to be due to historical test activities.

The surveillance and maintenance objectives shown in Table 2 are used as guidance for annual site inspections and sampling events.

**Summary of 2010 Site Activities**

At the request of DOE and prior to the transfer of the site, a due-diligence tour of the site was given to State personnel. The State plans to use the site for forestation, and selected tree-wood samples were collected for analysis (see Section 3.4). The flatcar bridge was inspected for the first time in January. Three site maintenance visits were conducted; these consisted of (1) routine maintenance (February), (2) extensive culvert work (March–April), and (3) repair of the flatcar bridge (April–May). Water samples and tree-wood samples were collect during the annual site inspection conducted 19–23 April. The flatcar bridge over Half Moon Creek passed re-inspection in May.

Selected digital images from the site visits are included in Appendix A. Analytical results obtained in 2010 are tabulated in Appendix B, and time-series plots of selected contaminants are in Appendix C.

*Table 2. Long-Term Surveillance and Maintenance Objectives for the Salmon, Mississippi, Site*

| Surveillance and Maintenance Objective | Strategies to Achieve Objective |
|---|---|
| Prevent exposure to radioactive materials contained in the salt dome | • Monitor groundwater and evaluate results<br>• Monitor and maintain institutional controls |
| Control exposure to contaminated groundwater | • Monitor groundwater and evaluate results<br>• Monitor institutional controls |
| Maintain the physical integrity of the site wells and bollards, the survey benchmarks, and the monument at ground zero. | • Conduct regular inspections<br>• Perform needed maintenance<br>• Maintain access controls |
| Prevent loss of knowledge | • Comply with DOE requirements of mandatory surveillance and maintenance program<br>• Communicate with regulators and stakeholders regularly (including public education, outreach information, and notices)<br>• Record site institutional controls in Lamar County with real property records and management agencies<br>• Comply with National Archives and Records Administration records management requirements<br>• Maintain local records collection and make annual reports available |

# 2.0 Inspection and Maintenance Activities

## 2.1 Institutional, Engineering, and Physical Controls

### 2.1.1 Deed Restrictions and Ground Zero Monument

The U.S. Bureau of Land Management (BLM) office in Jackson, MS, was provided an electronic copy of the deed restriction for their land management database. When BLM receives an application to drill into the Salmon subsurface, their land database search will find the deed restriction and thereby give notice to LM.

After the formal transfer of the surface real estate to the State, the quitclaim deed and its attachments were recorded by the Lamar County Chancery Clerk on 20 December 2010 in Book 21M at Page 239 of the Land Deed Records. The deed restriction is also one of the documents attached to the quitclaim deed. LM has provided BLM a copy of the true quitclaim transfer deed. A copy of the quitclaim deed is accessible from the LM webpage, http://www.lm.doe.gov/salmon/Documents.aspx.

The Mississippi Forestry Commission (MSFC) is the State's agent for the site. The MSFC plans to operate the site as a "wildlife refuge and a working demonstration forest," which are the terms of the 1997 congressional authorization (PL 104-201, 1996). The new state property name is the Jamie Whitten Forest Management Area. The MSFC does not plan to conduct logging operations within 500 ft of ground zero (see Figure 3).

The condition of the monument at ground zero is good. The plaque describing the deed restriction should be replaced to correct an error

### 2.1.2 Fences

The Salmon site fence is not functional except for a private fence on the eastern perimeter between the Main Road NE gate and Grantham Creek. Dense vegetation limits site access along most of the perimeter.

The chainlink fence surrounding the lay-down area remains in good condition.

### 2.1.3 Gates and Locks

The two site gates and locks are in good condition. The main gate is shown in Appendix A, Image A–3.

### 2.1.4 Signs

All posted signs at the gates are in good condition. Prior to the transfer of the surface real-estate to the State of Mississippi, DOE did not permit trespassing on the site

## 2.2 Physical Site Conditions

### 2.2.1 Roads and Roadwork

Five road segments were repaired (see Appendix A, Image A–4). The total length of road repairs was slightly less than one-quarter mile. The road damage was erosion caused by runoff from unusually heavy spring rains during the spring of 2009. This site road system is approximately 1.7 miles and is used to access the groundwater monitoring well network. The roads are shown in Figure 3.

On-site roads were mowed. During road maintenance, a 65.5 ft long culvert was discovered under Sand Pit Road where it intersects the Main Road NE. The inlet and outlet were uncovered and cleared of debris to allow surface runoff water to find its way to Half Moon Creek

Twenty-six buried culverts were repaired or replaced. Seventeen culverts were replaced and six culverts were repaired. The replaced culvert lengths were the same as the old culvert lengths. Three of the culverts were replaced by two swales. The MSFC suggested the use of a swale (or broad-based dip) instead of a culvert at certain locations. Except for the plastic culverts under Beaver Pond Road, all culverts were galvanized steel. Most culverts were fitted with flared ends at inlet and outlet and after staged compaction. The culverts were completed with riprap on the road shoulders and on the road edge at the inlet and outlet. Known culvert locations are shown in Figure 3. Images taken during the repair are in Appendix A, Images A–5 through A–8.

During the pre-bid subcontractor site-maintenance tour, a surveyor's stake was found about 15 ft inside the main gate in the middle of the Main Road NE (Appendix A, Image A–3). If the surveyor's stake is true, the posted main gate is 15 feet beyond the site boundary on private property.

Dead trees that threatened to fall onto Beaver Pond Road were knocked down, away from the road.

### 2.2.2 Bridge

The bridge that spans north-flowing Half Moon Creek is made from two railroad flatcars laid side by side. The bridge is 18 ft wide with a span of 50 ft. Each flatcar is 90 ft long and 9 ft wide; the wheel assemblies (trucks) have been removed.

The bridge was inspected by a qualified[1] bridge inspector on 12 January 2010 to comply with a DOE requirement[2]. The inspector observed deterioration of the wood head caps[3] due to localized bulging and some wood rot. The head caps are sandwiched between the top of each 24-inch-wide bridge bent—an inverted T-shaped pier—and the underside of the flatcars, at the approximate location where the trucks were formerly attached.

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[1] Meets the minimum qualification requirements to be an inspector as specified by the National Bridge Inspection Standard, (23 CFR650 Subpart C).
[2] DOE Office of Engineering and Construction Management: Inspection of DOE Real Property Assets, 14 September 2009
[3] Also called bent caps

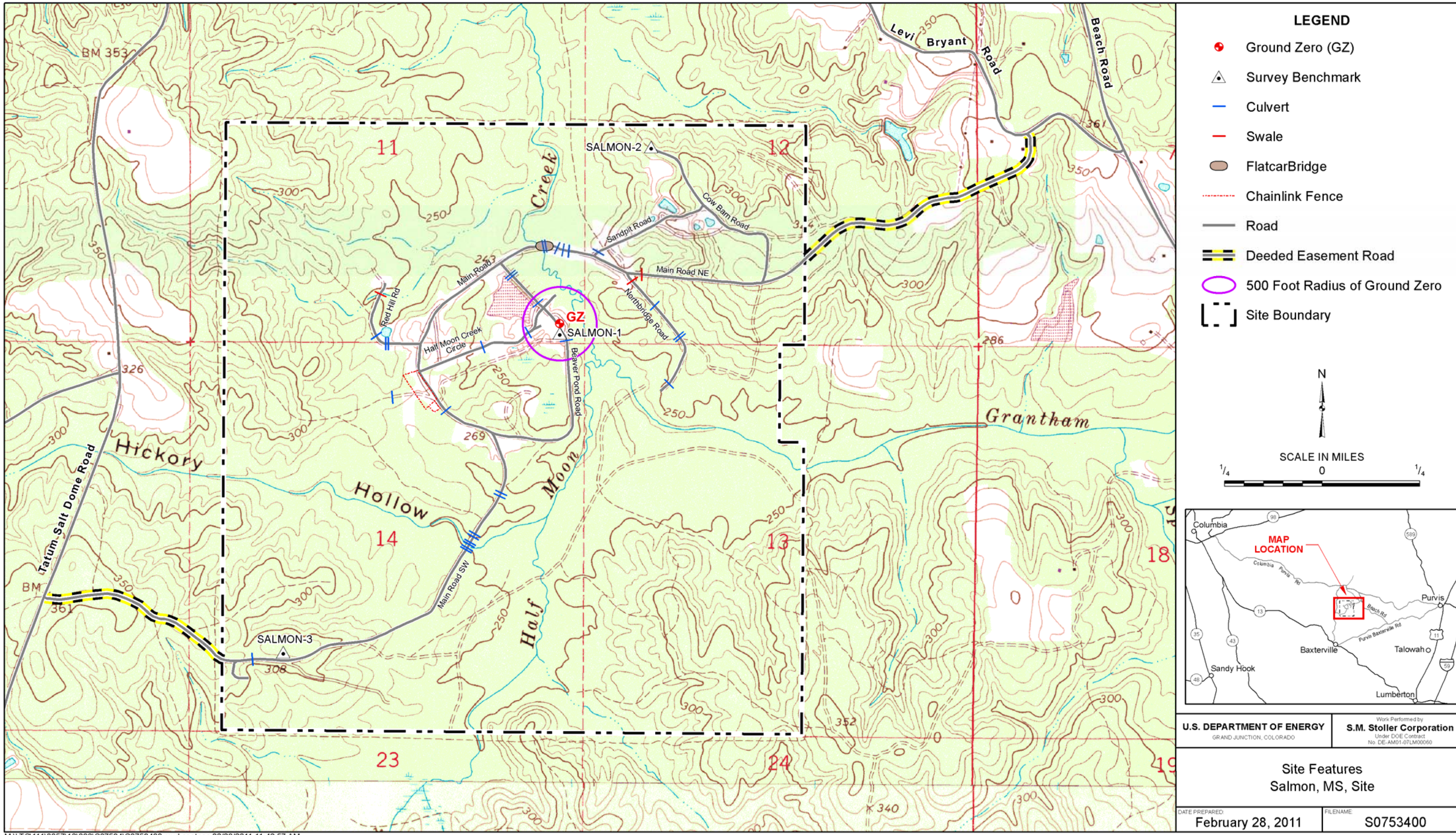


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*Figure 3. Topographic Map Showing Flatcar Bridge, Roads, Culverts, and Swales*

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The inspector's report specified a reduced load-limit of 5 tons until the wood head caps are replaced. Prior to the inspection, no load-limit posting was required. The inspector also recommended:

- Installation of hazard markers at both ends and sides of the bridge.
- Adding riprap to the end bents for creek-erosion protection.
- Straightening the roadway on the west side of the bridge to safely accommodate long vehicles such as logging trucks.

The 5-ton load limit signs and hazard signs were installed during site maintenance.

In May, the head caps were replaced with concrete head caps. The subcontractor raised each end of the bridge, removed the wood head caps, installed concrete head caps on the bents, and topped each head cap by an isomeric (neoprene) pad or pads onto which the bridge was lowered. The concrete head caps were cast according to the structural engineer's design specifications: concrete compressive strength of 3,000 pounds-force per square inch and compressive yield strength of 750 pounds-force per square inch. When each end of the bridge was elevated on blocking for head cap replacement, the structural engineer inspected the bridge substructure and found both ends to be in good condition. Images of the bridge repair are in Appendix A, Images A–9 through A–11.

The bridge passed the subsequent re-inspection (Appendix A, Image A–12). A copy of the inspector's report and a completed Mississippi Department of Transportation Bridge Inspection form was sent to the MSFC.

The load-limit signs were removed.

### 2.2.3 Other Site Conditions

Electrical components and desiccant were replaced in the electrical System Operation and Analysis at Remote Sites (SOARS) electrical cabinets. SOARS is a measurement and telemetry system. In this application, SOARS monitors water levels by dedicated transducers located below the water level in wells SA1-7-H and HMH-5R. The telemetry system is powered by solar panels. The water level data are sent to the LM office in Grand Junction by mobile telephone.

The SOARS system was disassembled for the maintenance work on the wells. After a needs reevaluation, the system was decommissioned and returned to Grand Junction for deployment elsewhere.

## 2.3 Monitoring Wells

There are 28 active groundwater monitoring wells on the Salmon site. The wells are used for monitoring groundwater in aquifers below the site, especially the Alluvial Aquifer, the Local Aquifer, and Aquifer 5.

Six wells monitor the cavity and plugged emplacement wells in the vicinity of ground zero. One of the six is in the Local Aquifer: it and six other wells monitor the Local Aquifer, a source of drinking water off site. Ground zero is the center point around which 12 wells are located to monitor the near-surface Alluvial Aquifer. Two deep wells in the southwest corner of the site monitor Aquifer 4 for leakage from Aquifer 5.

Dedicated bladder pumps are installed in 26 of the wells. Dedicated submersible Grundfos electric pumps are installed in the two deep wells.

Purge water from well HMH-5R (about 1 gallon) was containerized for shipment to the Environmental Sciences Laboratory in Grand Junction for treatment—30 minutes of air sparging—and disposal according to guidance from the Environmental Compliance group[4]. This purge water is not regulated under any existing waste regulations except that it cannot be placed back into the aquifer, discharged to State surface waters, or discharged to ground if it exceeds State TRGs. Based on the 2009 sample analysis, trichloroethene (TCE) is presumed to exceed the drinking water MCL (EPA 2004) for TCE.

The cover cap of well SA1-2-H was repaired. The broken hinges were replaced, primed, and painted white during site maintenance. The hinges on the main access gate were repositioned.

A typical monitoring well installation has a white, locked, metal protective cover surrounded at the base by a rectangular concrete pad with a 4 ft high bollard at each corner. A bollard is a concrete-filled pipe set into a concrete-filled hole. The well cover is painted white and the bollards bright “safety orange.” A three-bollard set surrounds each of the three surveyor benchmarks.

Existing bollard sets were repaired or new bollard sets installed. Twenty-two new sets of bollards were installed, three sets were replaced, and two sets were repaired. Three concrete well pads were replaced. Bollards and new well pads are shown in Appendix A, Image A–2.

## 2.4 Site Ecology Conditions

### 2.4.1 Timber

As part of due diligence, the MSFC collected tree-wood samples to analyze for tritium, since trees logged from the site would be sold commercially. LM independently sampled one-tenth of the same trees sampled by MSFC. Details and summary results are in Section 3.4. Images of LM’s tree-wood collection activity are in Appendix A, Images A–13 and A–14.

The Mississippi Department of Health Division of Radiological Health sent a letter informing the MSFC that results of their tritium analysis of 400 tree-wood samples “found no evidence restricting the sale of timber from the site.”

### 2.4.2 Other Flora

The third and last application of herbicide was sprayed on four patches of the noxious weed cogongrass. The cogongrass was sprayed with the herbicide recommended by the State of

[4]Management of Purge Water for the Annual Sampling at the Salmon Site: Note to File renewal, D. DePinho, Environmental Compliance Specialist, 6 April 2010.

Mississippi[5]. One patch is at ground zero, two patches are west of the lay-down area, and one patch is in the southwest corner. The previous applications have been successful.

### 2.4.3 Fauna

No active gopher tortoise burrows were found in 2010. Ideal gopher tortoise habitat is well-drained, open areas, preferably in longleaf pine forests. Because of the dense tree canopy, the site has no open areas.

The gopher tortoise is a federally listed threatened species and is listed by the State of Mississippi as endangered.

Beaver control activities were conducted during 2010. The U.S. Department of Agriculture Animal and Plant Health Inspection Service Wildlife Services is responsible for on-site beaver management. USDA APHIS routinely conducts on-site inspections.

## 2.5 Cultural Resource Conditions

To comply with Section 106 of the National Historic Preservation Act, LM contacted the Mississippi Department of Archives and History (MDAH) regarding the transfer of the surface real estate to the State. LM determined there would be “no effect” to cultural resources by the site transfer. After review, the MDAH Review and Compliance Officer concurred.

## 2.6 Public Information Access

The *Post-Closure Inspection, Sampling, and Maintenance Report for the Salmon, Mississippi, Site Calendar Year 2009* was posted on the DOE LM webpage (http://www.lm.doe.gov/salmon/Sites.aspx). Other documents were also added to the webpage during 2010.

The Mississippi Secretary of State’s office issued a press release when the surface real estate was transferred to the State.

[5]The herbicide mix is 2 percent glyphosate with 1.5 percent imazapyr.

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# 3.0 Analytical Results

Groundwater samples were collected from each of the 28 active wells (see Appendix A, Image A–15). Surface water samples were collected from 10 on-site locations (see Appendix A, Image A–16) and one off-site location[6]. Samples collected at the 39 locations were analyzed for tritium. Selected surface water and groundwater samples were analyzed for VOCs, metals, gamma-emitting radionuclides, or some combination.

Temperature, pH, turbidity, and conductivity were measured before each well was sampled.

Samples were analyzed by ALS Paragon (Fort Collins, CO) for metals (RCRA metals—arsenic, barium, cadmium, chromium, lead, selenium, silver, and mercury—plus antimony, beryllium, nickel, and zinc). The EPA Laboratory in Las Vegas, Nevada, performed the tritium, enriched tritium, and high-resolution gamma analyses.

Tritium was analyzed by the standard tritium analysis method in groundwater samples collected from nine wells: eight of the wells are in the Alluvial Aquifer and one well, at ground zero, is in the Local Aquifer. Twenty-five percent of the samples collected for tritium were analyzed by the more sensitive enriched tritium method. In three wells, tritium results were above the detection limit for the enriched method.

The highest tritium result by the standard analysis was 4,130 picocuries per liter (pCi/L) in the shallow well SA1-1-H, up 49 percent from 2009. This is a familiar oscillation pattern for tritium concentration in this well (see Appendix C, Figure C–1).

The EPA MCLs (EPA 2004) are the groundwater and surface water standards. The tritium drinking water standard is 20,000 pCi/L for the Salmon site.

Tritium was detected in 2 of the 11 surface water samples. The two results were analyzed by the enriched tritium method.

No gamma-emitting elements were detected in samples collected at the 39 sample locations. Tritium results in groundwater above the laboratory minimum detectable concentration are shown in Appendix B, Table B−1a for groundwater and for surface water in Table B−1b.

Analyses for VOCs and metals in groundwater samples that reported results above the appropriate laboratory detection limit are tabulated in Appendix B, Table B−2. Metals in surface water samples are tabulated in Table B−3.

Metal concentrations above the detection limit in creek water samples are listed in Table 3 by sample location. The field measured pH is also listed.

[6] The Mississippi Department of Health also collected a sample at most locations.

*Table 3. Metals Detected with Concentrations above the Detection Limit in Creeks Flowing into and out of the Site*

| Location | Metals (mg/L) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Antimony | Arsenic | Barium | Beryllium | Chromium | Lead | Selenium | Zinc | pH |
| Grantham Cr. Entry | 0.000018 | 0.00038 | 0.027 | 0.0002 | NA | 0.00019 | 0.000047 | 0.001 | 6.14 |
| Half Moon Cr. Entry | 0.000014 | 0.00021 | 0.031 | 0.00022 | 0.00071 | 0.00031 | 0.000066 | NA | 7.02 |
| Hick Hollow Cr. Entry | 0.000019 | 0.00017 | 0.02 | NA | NA | 0.0001 | NA | 0.0011 | 5.96 |
| Half Moon Cr. Exit | 0.000014 | 0.00029 | 0.028 | 0.00026 | 0.00075 | 0.00023 | 0.000062 | NA | 6.25 |

mg/L = milligrams per liter
Cadmium and nickel were not detected (NA)

## 3.1 2010 Sample Results Greater Than Standards

Sample analyses reported a total of 177 results greater than the appropriate detection limit (for VOCs and metals) or minimum detectable concentration (for radioactive elements). By category, 76 results were VOC concentrations, 86 results were metal concentrations, and 15 results were tritium concentrations. Of the 177 results, six met or exceeded MCL or State of Mississippi TRG for either VOCs or metals. These results are listed by well name in Table 4.

*Table 4. 2010 Analytical Results Exceeding the MCL or TRG*

| Location | Date | Analyte | Result | MCL or TRG | Units |
|---|---|---|---|---|---|
| SA1-3-H | 21-Apr-10 | Arsenic | 0.023 | 0.01 | mg/L |
| SA1-7-H | 21-Apr-10 | Arsenic | 0.011 | 0.01 | mg/L |
| SA4-5-L | 20-Apr-10 | Barium | 2.0 | 2.0 | mg/L |
| HM-3 | 20-Apr-10 | Chromium | 0.120 | 0.1 | mg/L |
| HMH-5R | 22-Apr-10 | Trichloroethene | 91 | 5.0 | µg/L |
| SA1-2-H | 20-Apr-10 | Vinyl Chloride | 2.2 | 2.0 | µg/L |

mg/L = milligrams per liter ($1 \times 10^{-3}$ gram per liter)
µg/L = micrograms per liter ($1 \times 10^{-6}$ gram per liter)

## 3.2 Contaminant Concentration Trends

Historical results through 2010 are plotted in Appendix C, Figures C−1 through C−6, for tritium in groundwater and grouped by location or aquifer for trend comparison. Tritium in precipitation (at Ottawa, Canada) is also plotted (Brown 1995, Lehr and Lehr 2000) along with a tritium decay trend line. The law of radioactive decay is described by an exponential decay function. When exponential decay is plotted on a vertical logarithmic scale versus a linear horizontal scale (time), the trend is a straight line. The half-life of tritium is 12.32 years.

Concentration trend data for metals detected in groundwater are plotted in Appendix C, Figures C−7 through C−10, for arsenic, barium, chromium, and lead. Lead was not detected above its MCL in 2010.

VOC concentration trends detected in the Alluvial Aquifer are plotted in Appendix C, Figures C−11 and C−13. In 2010, the *cis*-1,2-dichloroethene concentration was below its MCL (DOE 2010a).

All trends, except for tritium in well HM-L and barium in well SA4-5-L, appear to be decreasing with time, as expected. Tritium in well HM-L and barium in well SA4-5-L have increased over the last 3 years. The increase of barium, a component of drilling mud, only in well SA4-5-L is mysterious.

## 3.3 2010 Water Level Measurements

Water levels are measured quarterly. The Mississippi Department of Health Division of Radiologic Health made three of the four quarterly water level measurements. LM took the spring quarter measurements.

Water elevations for each well in 2010 are tabulated in Appendix B, Table B–4. Water elevations measured between September 2007 and December 2010 for 12 wells in the Alluvial Aquifer are plotted in Appendix C, Figure C–14. Water levels for the seven wells in the Local Aquifer are plotted in Appendix C, Figure C–15.

## 3.4 Tree-Wood Sample Results

The MSFC collected nearly 300 on-site tree-wood samples at breast height. (Breast height is defined as 1.4 meters above ground level. Such samples are referred to as basal stem samples.) Sixty tree-wood samples from 30 trees were collected at mid-stem and at the upper-stem. Seventy-five tree-wood control samples were collected from trees off site. All samples were analyzed by Mississippi State University.

LM independently sampled 10 percent of the same on-site trees that MSFC sampled. A contract laboratory performed the analyses for LM. Reported tritium results for free water and bound water were appropriately combined for comparison of LM’s results with the State’s results (Table 5).

*Table 5. Statistics for Tritium Concentrations Detected in Samples from On-Site Trees Collected at Breast Height by the State and by LM*

| Sampler | No. of Samples | Total Tritium Concentration (pCi/L) in Trees at Breast Height | | | | | |
|---|---|---|---|---|---|---|---|
| | | Minimum | First Quartile | Median | Mean | Third Quartile | Maximum |
| MS | 273 | –1.87 | –0.30 | 0.400 | 0.598 | 1.190 | 7.49 |
| LM | 36 | –19.23 | –5.37 | –0.575 | –1.698 | 3.597 | 11.07 |

A negative result is not uncommon for tritium at low concentrations. In an analytic counting method, the analyte has a composite computed and measured “background” that is subtracted from the analyte count-rate. Due to statistical fluctuations at low concentrations, it is not surprising when negative results are reported.

Appendix C, Figure C–17, is a visual comparison of the data in Table 5 using box plots.

LM, in its report on tree-sample analysis results, concluded that “Tritium concentrations in the sampled trees at the Salmon Site were too low to be quantified” (DOE 2010b).

# 4.0 Recommendations

The following actions are recommended for the Salmon site:

- Remove the federal property signs posted at the gates and property boundary.
- Install cautionary signs at the gates and property boundary locations regarding subsurface penetration without DOE permission wherever the State installs its property signs.
- Install “No subsurface penetration” signs spaced appropriately on the perimeter of a circle of 500-foot radius about the ground zero monument.
- Correct and replace the plaque on the monument at ground zero.
- Use businesses from nearby communities for future maintenance.
- Continue the Long-Term Hydrologic Monitoring Program on-site water sampling plan, namely, analyze water samples for:

  — Resource Conservation and Recovery Act metals plus antimony, barium, beryllium, chromium, mercury, nickel, and zinc

  — VOCs

  — Tritium and appropriate gamma-emitting radionuclides.

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# 5.0 References

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# Appendix A

# 2010 Site Photographs

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*Image A−1. Transfer of the Salmon site in the Mississippi Secretary of State's Office. From left to right, Secretary of State C. Delbert Hosemann, Jr., Steven R. Schiesswohl, DOE Reality Officer, and Jack Craig, DOE Site Task Manager.*

*Image A−2. Four ground zero wells, orange bollards, and new concrete well pads are shown. The wells reside inside the white protective casing. The monument (ground zero) is in the background, to the right.*

*Image A−3. Main gate. The blue flags in the center of the repaired road, mark the location of a surveyor's stake, about 15 feet inside the gate.*

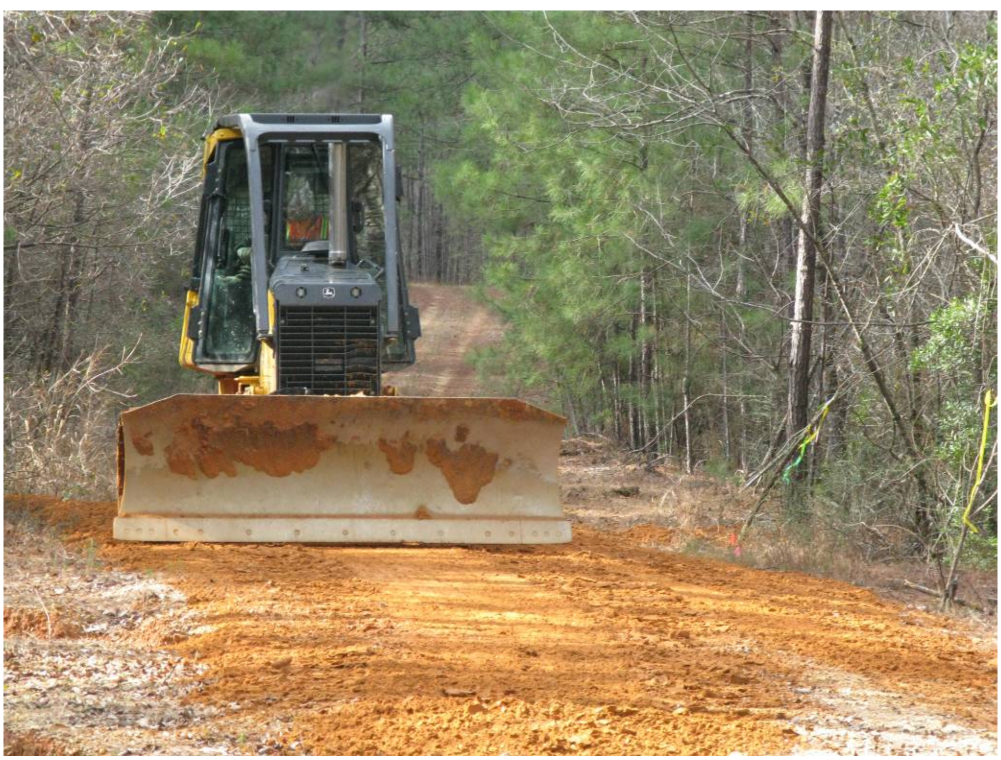

*Image A−4. Road repair.*

*Image A−5. Removal of an old culvert.*

*Image A−6. Installation of a new plastic culvert on Beaver Pond Road. Most new culverts that were installed are galvanized steel.*


*Image A−7. Compacting backfill.*

*Image A–8. Finished end of a new culvert.*

*Image A–9. West end of flatcar bridge raised on hydraulic jacks that sit on cribbing.*

*Image A–10. Removing wood head cap from west end of the flatcar bridge.*

*Image A–11. Installation of a new concrete head cap under the west end of the flatcar bridge.*

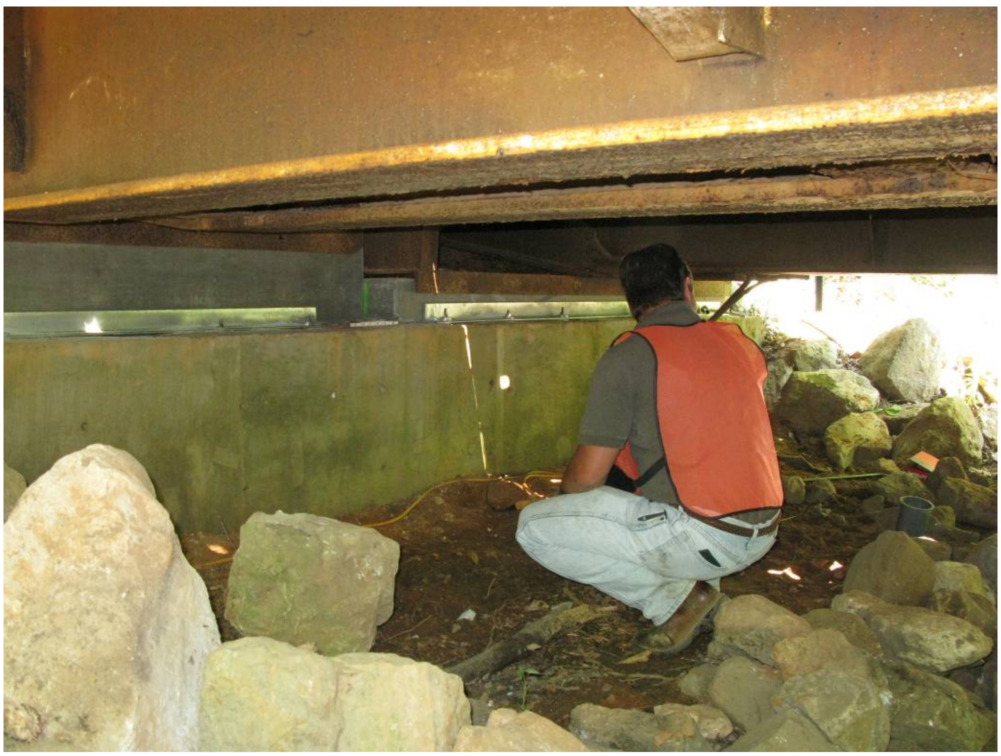

*Image A–12. Re-inspection of flatcar bridge after the new concrete head caps are in place and secured by stainless steel angles.*

*Image A–13. Collection of a tree core sample. The orange tape indicates the tree had previously been sampled by the State.*

*Image A–14. The core sample withdrawn from the incremental borer. The tree rings are visible.*


*Image A–15. Collection of a groundwater sample at well E-7 by LM.*

*Image A–16. Collection of a surface water sample by the State.*

# Appendix B

# Tables of 2010 Analytical Results

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*Table B−1a. Tritium Detected above the Minimum Detectable Concentration (MDC) in Groundwater Samples Collected in April 2010.*

| Location | Date | Analyte | Result | Units | Data Validation Qualifiers |
|---|---|---|---|---|---|
| HM-1 | 21-Apr-10 | Enriched Tritium | 4.06 | pCi/L | J |
| HM-L | 20-Apr-10 | Tritium | 849 | pCi/L | |
| HM-S | 20-Apr-10 | Tritium | 322 | pCi/L | J |
| HM-S (dup) | 20-Apr-10 | Tritium | 348 | pCi/L | J |
| HMH-16R | 20-Apr-10 | Tritium | 61.1 | pCi/L | |
| HMH-5R | 22-Apr-10 | Tritium | 1,200 | pCi/L | |
| SA1-1-H | 20-Apr-10 | Tritium | 4,130 | pCi/L | |
| SA1-2-H | 20-Apr-10 | Tritium | 560 | pCi/L | |
| SA1-3-H | 21-Apr-10 | Tritium | 260 | pCi/L | J |
| SA1-4-H | 21-Apr-10 | Enriched Tritium | 20.5 | pCi/L | |
| SA1-5-H | 21-Apr-10 | Tritium | 159 | pCi/L | J |
| SA1-6-H | 22-Apr-10 | Enriched Tritium | 8.07 | pCi/L | J |
| SA3-4-H | 22-Apr-10 | Tritium | 97.9 | pCi/L | J |

**Data Validation Qualifier:**
J Estimated —the result is less than the sum of the detection limit plus 2 times the total propagated uncertainty.

**Groundwater Statistics:**
13 Tritium results above MDC
1 Duplicate result
7 Estimated tritium results greater than MDC but not considered quantitative (J)
5 Unique quantitative results

*Table B−1b. Tritium Detected above the Minimum Detectable Concentration (MDC) in Surface Water Samples Collected in April 2010.*

| Location | Date | Analyte | Result | Units | Data Validation Qualifiers |
|---|---|---|---|---|---|
| Pond West of GZ | 20-Apr-10 | Enriched Tritium | 13.2 | pCi/L | |
| REECo Pit (B) | 21-Apr-10 | Enriched Tritium | 40.4 | pCi/L | |

**Surface Water Statistics:**
2 Tritium results above MDC
0 Duplicate result
2 Unique quantitative results

*Table B−2. Volatile Organic Compounds and Metals Detected above the Detection Limit in Groundwater Samples Collected in April 2010. Results above the MCL or TRG Are Shown in Bold.*

| Location | Date | Analyte | Result | Units | Lab Qualifiers | MCL or TRG |
|---|---|---|---|---|---|---|
| E-7 | 22-Apr-10 | Benzene | 0.31 | µg/L | J | |
| E-7 | 22-Apr-10 | Ethylbenzene | 0.2 | µg/L | J | |
| E-7 | 22-Apr-10 | Naphthalene | 0.24 | µg/L | J | |
| E-7 | 22-Apr-10 | Toluene | 0.53 | µg/L | J | |
| HM-3 | 20-Apr-10 | Antimony | 0.00008 | mg/L | | |
| HM-3 | 20-Apr-10 | Arsenic | 0.00059 | mg/L | | |
| HM-3 | 20-Apr-10 | Barium | 0.17 | mg/L | | |
| **HM-3** | **20-Apr-10** | **Chromium** | **0.12** | **mg/L** | | **0.10** |
| HM-3 | 20-Apr-10 | Lead | 0.00064 | mg/L | | |
| HM-3 | 20-Apr-10 | Selenium | 0.000049 | mg/L | B | |
| HM-3 | 20-Apr-10 | Zinc | 0.0031 | mg/L | B | |
| HM-L | 20-Apr-10 | Antimony | 0.000033 | mg/L | | |
| HM-L | 20-Apr-10 | Arsenic | 0.0011 | mg/L | | |
| HM-L | 20-Apr-10 | Barium | 0.47 | mg/L | | |
| HM-L | 20-Apr-10 | Beryllium | 0.00028 | mg/L | B | |
| HM-L | 20-Apr-10 | Chromium | 0.0025 | mg/L | | |
| HM-L2 | 20-Apr-10 | Antimony | 0.00006 | mg/L | | |
| HM-L2 | 20-Apr-10 | Arsenic | 0.000082 | mg/L | B | |
| HM-L2 | 20-Apr-10 | Barium | 0.066 | mg/L | | |
| HM-L2 | 20-Apr-10 | Beryllium | 0.00031 | mg/L | B | |
| HM-L2 | 20-Apr-10 | Lead | 0.0002 | mg/L | | |
| HM-S | 20-Apr-10 | Antimony | 0.000024 | mg/L | B | |
| HM-S | 20-Apr-10 | Arsenic | 0.00011 | mg/L | | |
| HM-S | 20-Apr-10 | Arsenic | 0.00012 | mg/L | | |
| HM-S | 20-Apr-10 | Barium | 0.032 | mg/L | | |
| HM-S | 20-Apr-10 | Benzene | 0.17 | µg/L | J | |
| HM-S | 20-Apr-10 | Beryllium | 0.0002 | mg/L | B | |
| HM-S | 20-Apr-10 | Cadmium | 0.000022 | mg/L | B | |
| HM-S | 20-Apr-10 | Cadmium | 0.000033 | mg/L | | |
| HM-S | 20-Apr-10 | Lead | 0.000072 | mg/L | | |
| HM-S | 20-Apr-10 | Lead | 0.00012 | mg/L | | |
| HM-S | 20-Apr-10 | Mercury | 0.00001 | mg/L | B | |
| HM-S | 20-Apr-10 | Selenium | 0.000075 | mg/L | B | |
| HM-S | 20-Apr-10 | Selenium | 0.000087 | mg/L | B | |
| HM-S | 20-Apr-10 | Trichloroethene | 1.5 | µg/L | | |
| HM-S | 20-Apr-10 | Trichloroethene | 1.6 | µg/L | | |
| HM-S | 20-Apr-10 | Zinc | 0.0011 | mg/L | B | |
| HM-S | 20-Apr-10 | Zinc | 0.0088 | mg/L | B | |
| HM-S | 20-Apr-10 | *cis*-1,2-Dichloroethene | 3.3 | µg/L | | |
| HM-S | 20-Apr-10 | *cis*-1,2-Dichloroethene | 3.4 | µg/L | | |
| HM-S | 20-Apr-10 | *trans*-1,2-Dichloroethene | 0.29 | µg/L | J | |
| HM-S | 20-Apr-10 | *trans*-1,2-Dichloroethene | 0.31 | µg/L | J | |
| HMH-16R | 20-Apr-10 | Antimony | 0.000019 | mg/L | B | |
| HMH-16R | 20-Apr-10 | Arsenic | 0.00022 | mg/L | | |
| HMH-16R | 20-Apr-10 | Barium | 0.47 | mg/L | | |
| HMH-16R | 20-Apr-10 | Beryllium | 0.00028 | mg/L | B | |
| HMH-16R | 20-Apr-10 | Cadmium | 0.000022 | mg/L | B | |
| HMH-16R | 20-Apr-10 | Selenium | 0.000037 | mg/L | B | |
| HMH-16R | 20-Apr-10 | Zinc | 0.00093 | mg/L | B | |
| HMH-5R | 22-Apr-10 | Antimony | 0.000046 | mg/L | | |
| HMH-5R | 22-Apr-10 | Arsenic | 0.0046 | mg/L | | |
| HMH-5R | 22-Apr-10 | Barium | 0.22 | mg/L | | |

*Table B−2 (continued). Volatile Organic Compounds and Metals Detected above the Detection Limit in Groundwater Samples Collected in April 2010. Results above the MCL or TRG Are Shown in Bold.*

| Location | Date | Analyte | Result | Units | Lab Qualifiers | MCL or TRG |
|---|---|---|---|---|---|---|
| HMH-5R | 22-Apr-10 | Beryllium | 0.00028 | mg/L | B | |
| HMH-5R | 22-Apr-10 | Chromium | 0.00068 | mg/L | B | |
| HMH-5R | 22-Apr-10 | Lead | 0.00039 | mg/L | | |
| HMH-5R | 22-Apr-10 | Selenium | 0.000068 | mg/L | B | |
| **HMH-5R** | **22-Apr-10** | **Trichloroethene** | **91** | **µg/L** | | **5.00** |
| HMH-5R | 22-Apr-10 | *cis*-1,2-Dichloroethene | 46 | µg/L | | |
| HMH-5R | 22-Apr-10 | *trans*-1,2-Dichloroethene | 3.2 | µg/L | | |
| SA1-1-H | 20-Apr-10 | 1,2,4-Trimethylbenzene | 0.22 | µg/L | J | |
| SA1-1-H | 20-Apr-10 | Antimony | 0.000016 | mg/L | B | |
| SA1-1-H | 20-Apr-10 | Arsenic | 0.0043 | mg/L | | |
| SA1-1-H | 20-Apr-10 | Barium | 0.26 | mg/L | | |
| SA1-1-H | 20-Apr-10 | Benzene | 0.34 | µg/L | J | |
| SA1-1-H | 20-Apr-10 | Ethylbenzene | 0.2 | µg/L | J | |
| SA1-1-H | 20-Apr-10 | Lead | 0.000075 | mg/L | | |
| SA1-1-H | 20-Apr-10 | Selenium | 0.000077 | mg/L | B | |
| SA1-1-H | 20-Apr-10 | Toluene | 1.2 | µg/L | | |
| SA1-1-H | 20-Apr-10 | Trichloroethene | 2.4 | µg/L | | |
| SA1-1-H | 20-Apr-10 | Zinc | 0.0016 | mg/L | B | |
| SA1-1-H | 20-Apr-10 | *cis*-1,2-Dichloroethene | 6.4 | µg/L | | |
| SA1-1-H | 20-Apr-10 | m,p-Xylene | 0.66 | µg/L | J | |
| SA1-1-H | 20-Apr-10 | o-Xylene | 0.26 | µg/L | J | |
| SA1-1-H | 20-Apr-10 | *trans*-1,2-Dichloroethene | 1.9 | µg/L | | |
| SA1-12-H | 22-Apr-10 | Antimony | 0.00002 | mg/L | B | |
| SA1-12-H | 22-Apr-10 | Arsenic | 0.000078 | mg/L | B | |
| SA1-12-H | 22-Apr-10 | Barium | 0.32 | mg/L | | |
| SA1-12-H | 22-Apr-10 | Nickel | 0.01 | mg/L | B | |
| SA1-2-H | 20-Apr-10 | Antimony | 0.000019 | mg/L | B | |
| SA1-2-H | 20-Apr-10 | Arsenic | 0.0046 | mg/L | | |
| SA1-2-H | 20-Apr-10 | Barium | 0.047 | mg/L | | |
| SA1-2-H | 20-Apr-10 | Benzene | 0.24 | µg/L | J | |
| SA1-2-H | 20-Apr-10 | Cadmium | 0.000013 | mg/L | B | |
| SA1-2-H | 20-Apr-10 | Lead | 0.000099 | mg/L | | |
| SA1-2-H | 20-Apr-10 | Selenium | 0.00015 | mg/L | | |
| SA1-2-H | 20-Apr-10 | Trichloroethene | 1.4 | µg/L | | |
| **SA1-2-H** | **20-Apr-10** | **Vinyl chloride** | **2.2** | **µg/L** | | **2.00** |
| SA1-2-H | 20-Apr-10 | *cis*-1,2-Dichloroethene | 17 | µg/L | | |
| SA1-2-H | 20-Apr-10 | *trans*-1,2-Dichloroethene | 1.5 | µg/L | | |
| SA1-3-H | 21-Apr-10 | Antimony | 0.000052 | mg/L | | |
| **SA1-3-H** | **21-Apr-10** | **Arsenic** | **0.023** | **mg/L** | | **0.01** |
| SA1-3-H | 21-Apr-10 | Barium | 0.064 | mg/L | | |
| SA1-3-H | 21-Apr-10 | Benzene | 0.76 | µg/L | J | |
| SA1-3-H | 21-Apr-10 | Lead | 0.000066 | mg/L | | |
| SA1-3-H | 21-Apr-10 | Selenium | 0.00021 | mg/L | | |
| SA1-3-H | 21-Apr-10 | Trichloroethene | 1.7 | µg/L | | |
| SA1-3-H | 21-Apr-10 | Vinyl chloride | 1.1 | µg/L | | |
| SA1-3-H | 21-Apr-10 | *cis*-1,2-Dichloroethene | 38 | µg/L | | |
| SA1-3-H | 21-Apr-10 | *trans*-1,2-Dichloroethene | 16 | µg/L | | |
| SA1-4-H | 21-Apr-10 | Arsenic | 0.00037 | mg/L | | |
| SA1-4-H | 21-Apr-10 | Barium | 0.27 | mg/L | | |
| SA1-5-H | 21-Apr-10 | Antimony | 0.000026 | mg/L | B | |
| SA1-5-H | 21-Apr-10 | Arsenic | 0.00047 | mg/L | | |
| SA1-5-H | 21-Apr-10 | Barium | 0.023 | mg/L | | |
| SA1-5-H | 21-Apr-10 | Nickel | 0.001 | mg/L | B | |

*Table B−2 (continued). Volatile Organic Compounds and Metals Detected above the Detection Limit in Groundwater Samples Collected in April 2010. Results above the MCL or TRG Are Shown in Bold.*

| Location | Date | Analyte | Result | Units | Lab Qualifiers | MCL or TRG |
|---|---|---|---|---|---|---|
| SA1-5-H | 21-Apr-10 | Selenium | 0.00022 | mg/L | | |
| SA1-5-H | 21-Apr-10 | Trichloroethene | 0.17 | µg/L | J | |
| SA1-5-H | 21-Apr-10 | Zinc | 0.0022 | mg/L | B | |
| SA1-5-H | 21-Apr-10 | *cis*-1,2-Dichloroethene | 7.9 | µg/L | | |
| SA1-5-H | 21-Apr-10 | *trans*-1,2-Dichloroethene | 1.1 | µg/L | | |
| SA1-6-H | 22-Apr-10 | Antimony | 0.000028 | mg/L | B | |
| SA1-6-H | 22-Apr-10 | Arsenic | 0.0025 | mg/L | | |
| SA1-6-H | 22-Apr-10 | Barium | 0.019 | mg/L | B | |
| SA1-6-H | 22-Apr-10 | Cadmium | 0.000016 | mg/L | B | |
| SA1-6-H | 22-Apr-10 | Lead | 0.00061 | mg/L | | |
| SA1-6-H | 22-Apr-10 | Selenium | 0.00012 | mg/L | | |
| SA1-6-H | 22-Apr-10 | Zinc | 0.0018 | mg/L | B | |
| SA1-7-H | 21-Apr-10 | Antimony | 0.000039 | mg/L | | |
| **SA1-7-H** | **21-Apr-10** | **Arsenic** | **0.011** | **mg/L** | | **0.01** |
| SA1-7-H | 21-Apr-10 | Barium | 0.26 | mg/L | | |
| SA1-7-H | 21-Apr-10 | Cadmium | 0.000039 | mg/L | | |
| SA1-7-H | 21-Apr-10 | Nickel | 0.0019 | mg/L | B | |
| SA1-7-H | 21-Apr-10 | Selenium | 0.0012 | mg/L | | |
| SA1-7-H | 21-Apr-10 | Zinc | 0.0033 | mg/L | B | |
| SA1-7-H | 21-Apr-10 | *cis*-1,2-Dichloroethene | 0.88 | µg/L | J | |
| SA1-8-L | 20-Apr-10 | Antimony | 0.000016 | mg/L | B | |
| SA1-8-L | 20-Apr-10 | Arsenic | 0.0053 | mg/L | | |
| SA1-8-L | 20-Apr-10 | Barium | 0.22 | mg/L | | |
| SA1-8-L | 20-Apr-10 | Zinc | 0.025 | mg/L | | |
| SA2-1-L | 20-Apr-10 | Antimony | 0.00017 | mg/L | | |
| SA2-1-L | 20-Apr-10 | Arsenic | 0.01 | mg/L | | |
| SA2-1-L | 20-Apr-10 | Barium | 0.057 | mg/L | | |
| SA2-1-L | 20-Apr-10 | Lead | 0.00013 | mg/L | | |
| SA2-1-L | 20-Apr-10 | Selenium | 0.00022 | mg/L | | |
| SA2-1-L | 20-Apr-10 | Zinc | 0.0015 | mg/L | B | |
| SA2-2-L | 20-Apr-10 | Antimony | 0.00056 | mg/L | | |
| SA2-2-L | 20-Apr-10 | Arsenic | 0.00049 | mg/L | | |
| SA2-2-L | 20-Apr-10 | Barium | 0.86 | mg/L | | |
| SA2-2-L | 20-Apr-10 | Chromium | 0.014 | mg/L | | |
| SA2-2-L | 20-Apr-10 | Lead | 0.0091 | mg/L | | |
| SA2-2-L | 20-Apr-10 | Selenium | 0.00019 | mg/L | | |
| SA2-2-L | 20-Apr-10 | Zinc | 0.012 | mg/L | B | |
| SA2-4-L | 20-Apr-10 | Antimony | 0.000075 | mg/L | | |
| SA2-4-L | 20-Apr-10 | Arsenic | 0.01 | mg/L | | |
| SA2-4-L | 20-Apr-10 | Barium | 0.1 | mg/L | | |
| SA2-4-L | 20-Apr-10 | Lead | 0.00012 | mg/L | | |
| SA2-4-L | 20-Apr-10 | Zinc | 0.0015 | mg/L | B | |
| SA3-4-H | 22-Apr-10 | Antimony | 0.000022 | mg/L | B | |
| SA3-4-H | 22-Apr-10 | Arsenic | 0.00012 | mg/L | | |
| SA3-4-H | 22-Apr-10 | Barium | 0.31 | mg/L | | |
| SA3-4-H | 22-Apr-10 | Cadmium | 0.000061 | mg/L | | |
| SA3-4-H | 22-Apr-10 | Selenium | 0.000046 | mg/L | B | |
| SA3-4-H | 22-Apr-10 | Zinc | 0.007 | mg/L | B | |
| SA4-5-L | 20-Apr-10 | Antimony | 0.00028 | mg/L | | |
| SA4-5-L | 20-Apr-10 | Arsenic | 0.00024 | mg/L | | |
| **SA4-5-L** | **20-Apr-10** | **Barium** | **2.6** | **mg/L** | | **2.00** |
| SA4-5-L | 20-Apr-10 | Cadmium | 0.000039 | mg/L | | |
| SA4-5-L | 20-Apr-10 | Chromium | 0.048 | mg/L | | |

*Table B−2 (continued). Volatile Organic Compounds and Metals Detected above the Detection Limit in Groundwater Samples Collected in April 2010. Results above the MCL or TRG Are Shown in Bold.*

| Location | Date | Analyte | Result | Units | Lab Qualifiers | MCL or TRG |
|---|---|---|---|---|---|---|
| SA4-5-L | 20-Apr-10 | Lead | 0.006 | mg/L | | |
| SA4-5-L | 20-Apr-10 | Nickel | 0.0011 | mg/L | B | |
| SA4-5-L | 20-Apr-10 | Selenium | 0.00024 | mg/L | | |
| SA4-5-L | 20-Apr-10 | Zinc | 0.19 | mg/L | | |

Results shown are greater than the detection limit or 5 times the reported concentration in the method blank.

Lab qualifiers
B: If the analyte is inorganic, the result is less than the contract required detection limit.
If the analyte is organic, the analyte is found in the method blank.
J: Estimated —the result is less than the sum of the detection limit plus 2 times the total propagated uncertainty.

**Groundwater Statistics:**

162 Results greater than detection limit
8 Duplicate results
154 Unique results

6 Results greater than MCL or TRG
5 Locations with results greater than MCL or TRG

*Table B–3. Metals Detected above the Detection Limit in Surface Water Samples Collected in April 2010.*

| Location | Date | Analyte | Result | Units | Lab Qualifiers | MCL or TRG |
|---|---|---|---|---|---|---|
| Grantham Cr Entry | 21-Apr-10 | Antimony | 0.000018 | mg/L | B | |
| Grantham Cr Entry | 21-Apr-10 | Arsenic | 0.00038 | mg/L | | |
| Grantham Cr Entry | 21-Apr-10 | Barium | 0.027 | mg/L | | |
| Grantham Cr Entry | 21-Apr-10 | Beryllium | 0.0002 | mg/L | B | |
| Grantham Cr Entry | 21-Apr-10 | Lead | 0.00019 | mg/L | | |
| Grantham Cr Entry | 21-Apr-10 | Selenium | 0.000047 | mg/L | B | |
| Grantham Cr Entry | 21-Apr-10 | Zinc | 0.001 | mg/L | B | |
| HALFMOON CREEK | 21-Apr-10 | Antimony | 0.000018 | mg/L | B | |
| HALFMOON CREEK | 21-Apr-10 | Arsenic | 0.00031 | mg/L | | |
| HALFMOON CREEK | 21-Apr-10 | Barium | 0.028 | mg/L | | |
| HALFMOON CREEK | 21-Apr-10 | Beryllium | 0.00022 | mg/L | B | |
| HALFMOON CREEK | 21-Apr-10 | Chromium | 0.001 | mg/L | B | |
| HALFMOON CREEK | 21-Apr-10 | Lead | 0.00024 | mg/L | | |
| HALFMOON CREEK | 21-Apr-10 | Mercury | 0.000011 | mg/L | B | |
| HALFMOON CREEK | 21-Apr-10 | Nickel | 0.0016 | mg/L | B | |
| HALFMOON CREEK | 21-Apr-10 | Selenium | 0.000068 | mg/L | B | |
| HALFMOON CREEK | 21-Apr-10 | Zinc | 0.0015 | mg/L | B | |
| HALFMOONCRKOVERFLOW | 21-Apr-10 | Antimony | 0.000036 | mg/L | B | |
| HALFMOONCRKOVERFLOW | 21-Apr-10 | Arsenic | 0.0016 | mg/L | | |
| HALFMOONCRKOVERFLOW | 21-Apr-10 | Barium | 0.098 | mg/L | | |
| HALFMOONCRKOVERFLOW | 21-Apr-10 | Chromium | 0.0044 | mg/L | | |
| HALFMOONCRKOVERFLOW | 21-Apr-10 | Lead | 0.0004 | mg/L | | |
| HALFMOONCRKOVERFLOW | 21-Apr-10 | Mercury | 0.00002 | mg/L | B | |
| HALFMOONCRKOVERFLOW | 21-Apr-10 | Selenium | 0.00026 | mg/L | | |

*Table B–3 (continued). Metals Detected above the Detection Limit in Surface Water Samples Collected in April 2010.*

| Location | Date | Analyte | Result | Units | Lab Qualifiers | MCL or TRG |
|---|---|---|---|---|---|---|
| Half Moon Cr Entry | 21-Apr-10 | Antimony | 0.000014 | mg/L | B | |
| Half Moon Cr Entry | 21-Apr-10 | Arsenic | 0.00021 | mg/L | | |
| Half Moon Cr Entry | 21-Apr-10 | Barium | 0.031 | mg/L | | |
| Half Moon Cr Entry | 21-Apr-10 | Beryllium | 0.00022 | mg/L | B | |
| Half Moon Cr Entry | 21-Apr-10 | Chromium | 0.00071 | mg/L | B | |
| Half Moon Cr Entry | 21-Apr-10 | Lead | 0.00031 | mg/L | | |
| Half Moon Cr Entry | 21-Apr-10 | Selenium | 0.000066 | mg/L | B | |
| Half Moon Cr Exit | 21-Apr-10 | Antimony | 0.000014 | mg/L | B | |
| Half Moon Cr Exit | 21-Apr-10 | Arsenic | 0.00029 | mg/L | | |
| Half Moon Cr Exit | 21-Apr-10 | Barium | 0.028 | mg/L | | |
| Half Moon Cr Exit | 21-Apr-10 | Beryllium | 0.00026 | mg/L | B | |
| Half Moon Cr Exit | 21-Apr-10 | Chromium | 0.00075 | mg/L | B | |
| Half Moon Cr Exit | 21-Apr-10 | Lead | 0.00023 | mg/L | | |
| Half Moon Cr Exit | 21-Apr-10 | Selenium | 0.000062 | mg/L | B | |
| Hick Hollow Cr Entry | 21-Apr-10 | Antimony | 0.000019 | mg/L | B | |
| Hick Hollow Cr Entry | 21-Apr-10 | Arsenic | 0.00017 | mg/L | | |
| Hick Hollow Cr Entry | 21-Apr-10 | Barium | 0.02 | mg/L | B | |
| Hick Hollow Cr Entry | 21-Apr-10 | Lead | 0.0001 | mg/L | | |
| Hick Hollow Cr Entry | 21-Apr-10 | Zinc | 0.0011 | mg/L | B | |
| HickHCrTSD-East | 21-Apr-10 | Antimony | 0.000016 | mg/L | B | |
| HickHCrTSD-East | 21-Apr-10 | Arsenic | 0.00014 | mg/L | | |
| HickHCrTSD-East | 21-Apr-10 | Arsenic | 0.00016 | mg/L | | |
| HickHCrTSD-East | 21-Apr-10 | Barium | 0.022 | mg/L | | |
| HickHCrTSD-East | 21-Apr-10 | Barium | 0.023 | mg/L | | |
| HickHCrTSD-East | 21-Apr-10 | Lead | 0.000087 | mg/L | | |
| HickHCrTSD-East | 21-Apr-10 | Lead | 0.00009 | mg/L | | |
| HickHCrTSD-East | 21-Apr-10 | Selenium | 0.000038 | mg/L | B | |
| HickHCrTSD-East | 21-Apr-10 | Selenium | 0.000055 | mg/L | B | |
| HickHCrTSD-East | 21-Apr-10 | Zinc | 0.0013 | mg/L | B | |
| HickHCrTSD-East | 21-Apr-10 | Zinc | 0.0021 | mg/L | B | |
| Pond West of GZ | 20-Apr-10 | Antimony | 0.000056 | mg/L | | |
| Pond West of GZ | 20-Apr-10 | Arsenic | 0.0017 | mg/L | | |
| Pond West of GZ | 20-Apr-10 | Barium | 0.068 | mg/L | | |
| Pond West of GZ | 20-Apr-10 | Cadmium | 0.000012 | mg/L | B | |
| Pond West of GZ | 20-Apr-10 | Lead | 0.00045 | mg/L | | |
| Pond West of GZ | 20-Apr-10 | Mercury | 0.000012 | mg/L | B | |
| Pond West of GZ | 20-Apr-10 | Nickel | 0.0011 | mg/L | B | |
| Pond West of GZ | 20-Apr-10 | Selenium | 0.00024 | mg/L | | |
| Pond West of GZ | 20-Apr-10 | Zinc | 0.0053 | mg/L | B | |
| Reeco Pit (A) | 21-Apr-10 | Antimony | 0.000036 | mg/L | | |
| Reeco Pit (A) | 21-Apr-10 | Arsenic | 0.00039 | mg/L | | |
| Reeco Pit (A) | 21-Apr-10 | Barium | 0.027 | mg/L | | |
| Reeco Pit (A) | 21-Apr-10 | Lead | 0.00026 | mg/L | | |
| Reeco Pit (A) | 21-Apr-10 | Mercury | 0.000012 | mg/L | B | |

*Table B–3 (continued). Metals Detected above the Detection Limit in Surface Water Samples Collected in April 2010.*

| Location | Date | Analyte | Result | Units | Lab Qualifiers | MCL or TRG |
|---|---|---|---|---|---|---|
| Reeco Pit (A) | 21-Apr-10 | Selenium | 0.00007 | mg/L | B | |
| Reeco Pit (A) | 21-Apr-10 | Zinc | 0.0027 | mg/L | B | |
| Reeco Pit (B) | 21-Apr-10 | Antimony | 0.00004 | mg/L | | |
| Reeco Pit (B) | 21-Apr-10 | Arsenic | 0.00062 | mg/L | | |
| Reeco Pit (B) | 21-Apr-10 | Barium | 0.035 | mg/L | | |
| Reeco Pit (B) | 21-Apr-10 | Cadmium | 0.000023 | mg/L | B | |
| Reeco Pit (B) | 21-Apr-10 | Lead | 0.00056 | mg/L | | |
| Reeco Pit (B) | 21-Apr-10 | Mercury | 0.000014 | mg/L | B | |
| Reeco Pit (B) | 21-Apr-10 | Selenium | 0.00015 | mg/L | | |
| Reeco Pit (B) | 21-Apr-10 | Zinc | 0.011 | mg/L | B | |
| Reeco Pit (C) | 21-Apr-10 | Antimony | 0.000032 | mg/L | | |
| Reeco Pit (C) | 21-Apr-10 | Arsenic | 0.00051 | mg/L | | |
| Reeco Pit (C) | 21-Apr-10 | Barium | 0.036 | mg/L | | |
| Reeco Pit (C) | 21-Apr-10 | Cadmium | 0.000016 | mg/L | B | |
| Reeco Pit (C) | 21-Apr-10 | Lead | 0.00031 | mg/L | | |
| Reeco Pit (C) | 21-Apr-10 | Mercury | 0.000011 | mg/L | B | |
| Reeco Pit (C) | 21-Apr-10 | Selenium | 0.000063 | mg/L | B | |
| Reeco Pit (C) | 21-Apr-10 | Zinc | 0.0033 | mg/L | B | |

If the result is greater than five times the concentration in the method blank, it is also included in the table.

Lab qualifiers:
B: If the analyte is inorganic, the result is less than the contract required detection limit.
If the analyte is organic, the analyte is found in the method blank.
J: Estimated—the result is less than the sum of the MDC plus 2 times the total propagated uncertainty.

**Surface water statistics:**

86 Surface water results greater than detection limit
5 Duplicate surface water results
81 Unique surface water results

0 Results greater than MCL or TRG.

*Table B−4. 2010 Water Level Elevations (Feet Above Mean Sea Level)*

| Aquifer | Well | Measurement Date | | | |
|---|---|---|---|---|---|
| | | **1/13/2010[a]** | **4/19/2010[b]** | **7/9/2010[a]** | **10/1/2010[a]** |
| Alluvial | HMH-16R | 239.05 | 237.34 | 234.31 | 232.51 |
| Alluvial | HMH-5R | NA | 234.24 | 233.7 | 231.9 |
| Alluvial | HM-S | 236.59 | 235.46 | 235.23 | 233.2 |
| Alluvial | SA1-1-H | 236.33 | 235.1 | 234.7 | 232.68 |
| Alluvial | SA1-2-H | 236.35 | 235.23 | 234.83 | 232.9 |
| Alluvial | SA1-3-H | 236.34 | 235.25 | 235.13 | 233.07 |
| Alluvial | SA1-4-H | 236.54 | 236.07 | 235.87 | 233.76 |
| Alluvial | SA1-5-H | 237.28 | 236.11 | 235.96 | 233.62 |
| Alluvial | SA1-6-H | 237.35 | 236.27 | 236.28 | 233.86 |
| Alluvial | SA1-7-H | NA | 236.48 | 236.49 | 233.84 |
| Alluvial | SA1-12-H | 234.78 | 233.64 | 232.05 | 231.7 |
| Alluvial | SA3-4-H | 238.18 | 236.84 | 236.33 | 234.35 |
| Local | HM-L | NA | 152.87 | 152.87 | NA |
| Local | HM-L2 | NA | 156.02 | NA | NA |
| Local | SA1-8-L | NA | 157.23 | NA | NA |
| Local | SA2-1-L | 157.38 | 157.41 | 157.36 | 157.22 |
| Local | SA2-2-L | NA | 157.44 | NA | NA |
| Local | SA2-4-L | NA | 157.79 | NA | NA |
| Local | SA4-5-L | NA | 155.62 | NA | NA |
| 1 | HM-1 | 146.98 | 146.84 | 146.57 | 146.17 |
| 2 | HM-2A | 128.57 | 127.98 | 127.39 | 127.06 |
| 2 | HM-2B | 119.67 | 119.28 | 118.79 | 118.45 |
| 3 | HM-3 | 121.57 | 121.44 | 121.06 | 120.55 |
| 3 | SA1-11-3 | 119.14 | 118.84 | 118.41 | 117.93 |
| 3 | SA3-11-3 | 118.15 | 118.23 | 117.43 | 116.99 |
| 4 | SA5-4-4 | NA | 191.57 | NA | NA |
| 4 | SA5-5-4 | 138.65 | 179.55* | 138.04 | 137.71 |
| Cap | E-7 | NA | 121.08 | NA | NA |

[a] Water level measurements made by the Mississippi Department of Health Division of Radiologic Health
[b] Water level measurements made by LM
NA = no value
* Probable measurement error

# Appendix C

# Time-Trend Plots of Selected Analytical Results

Plots C–1 through C–6: Measured tritium in precipitation is shown for 1980 through 1995 (Brown1995, Lehr and Lehr 2000). Tritium concentration decay is a straight line when plotted on a vertical logarithmic scale versus a horizontal linear time scale.

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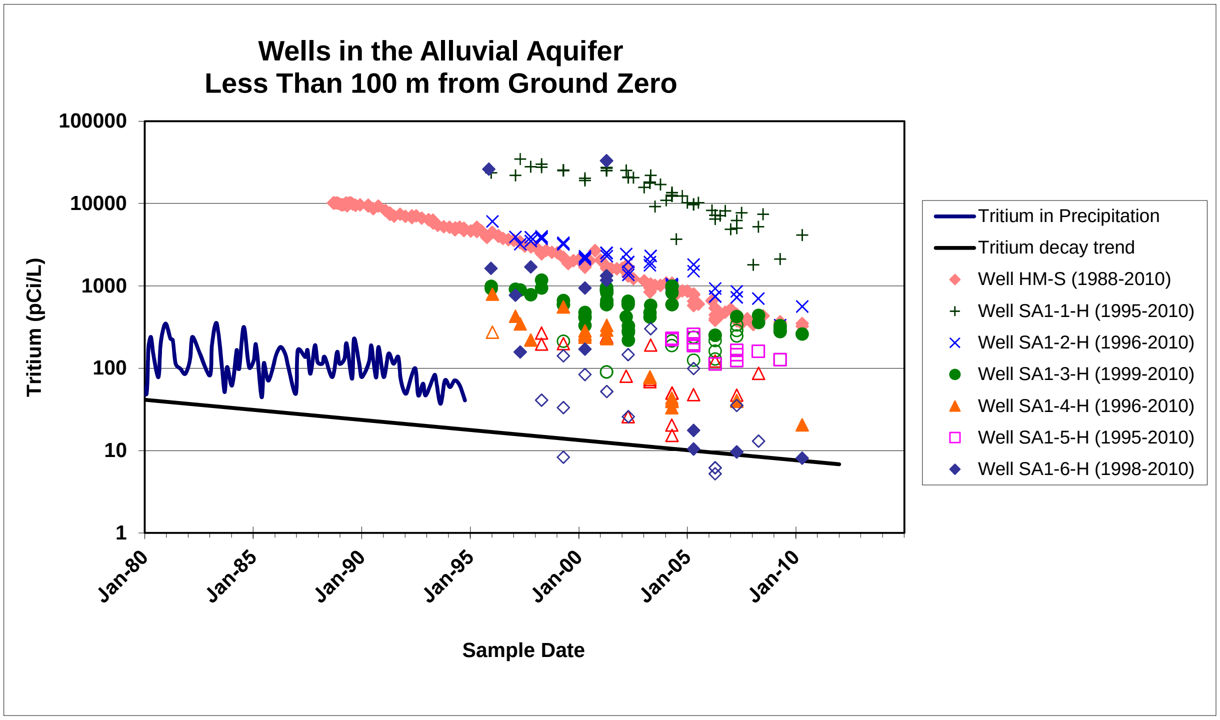


*Figure C–1. Tritium concentration trends plotted for the Alluvial Aquifer groundwater within 100 m of ground zero. A hollow geometric symbol represents a value less than its MDC and is not quantitative; the same symbol shown solid represents a value greater than its MDC. A point symbol represents a value greater than its MDC.*

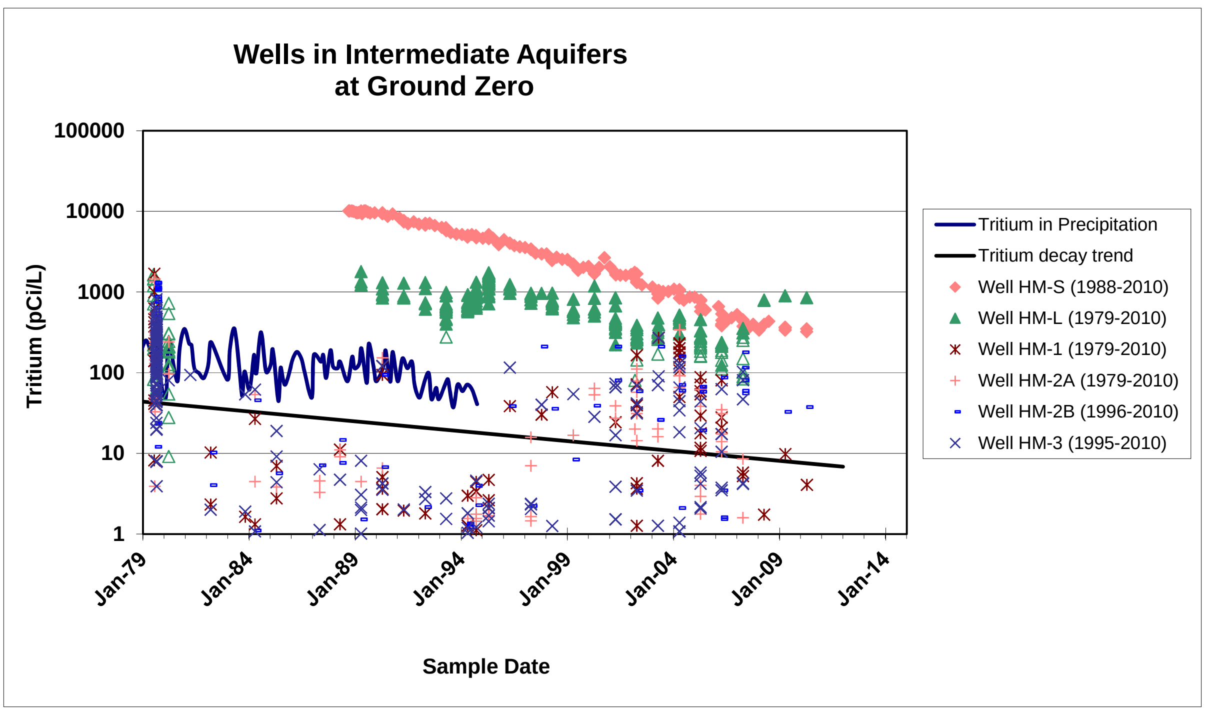


*Figure C–2. Tritium concentration trends plotted for wells in the Alluvial (S), Local (L) and Intermediate (1, 2A, 2B, and 3) Aquifers at ground zero. A hollow geometric symbol represents a value less than its MDC and is not quantitative; the same symbol shown solid represents a value greater than its MDC. A point symbol represents a value less than its MDC.*

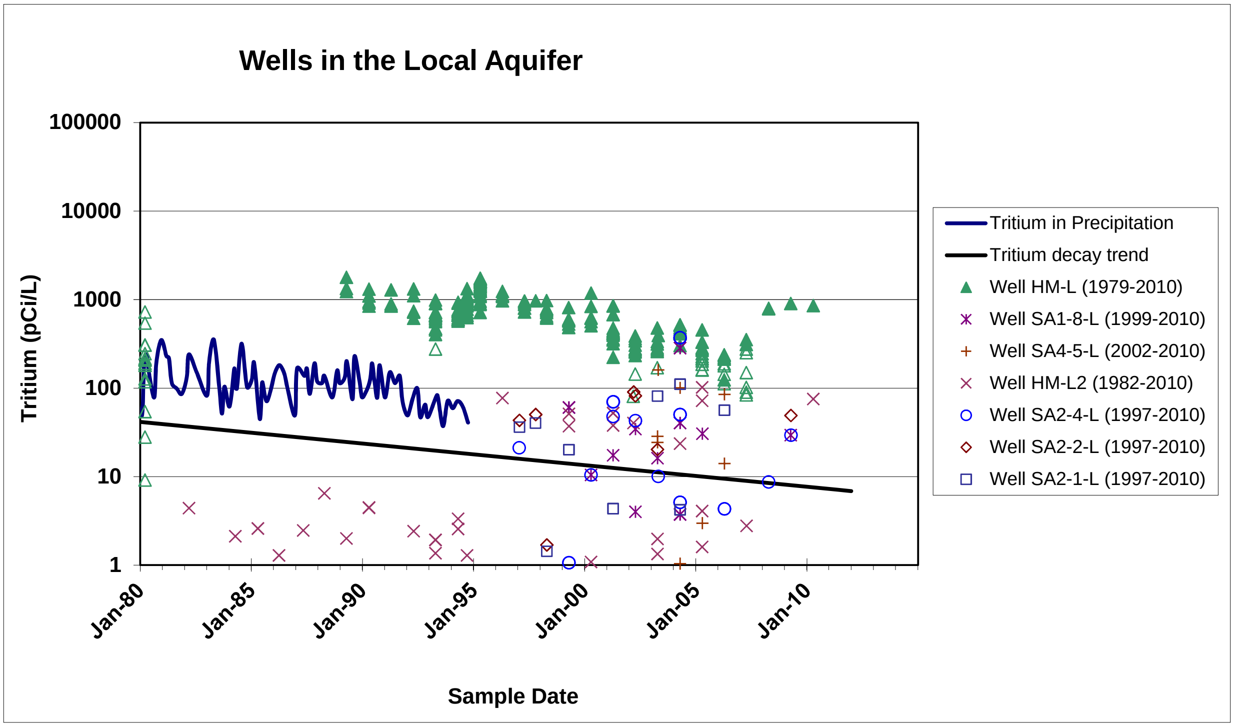


*Figure C–3. Tritium concentration trends plotted for wells in the Local Aquifer. A hollow geometric symbol represents a value less than its MDC and is not quantitative; the same symbol shown solid represents a value greater than its MDC. A point symbol represents a value less than its MDC.*

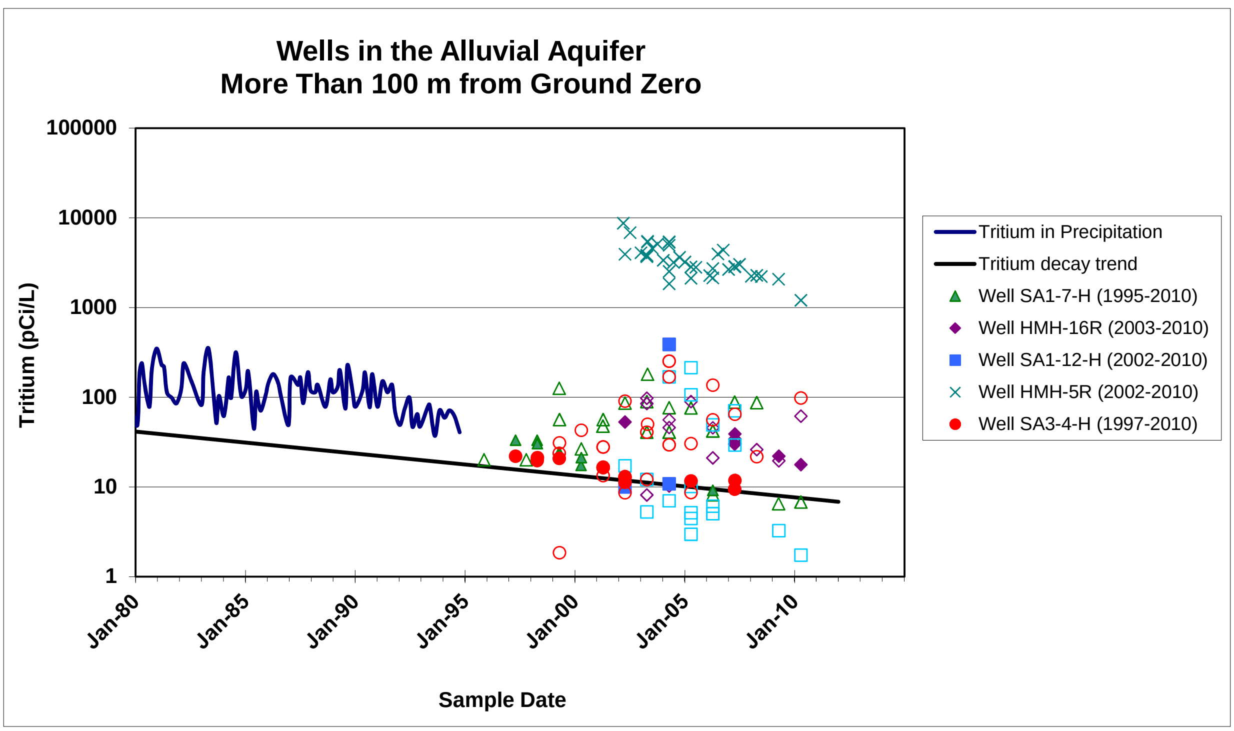


*Figure C–4. Tritium concentration trends plotted for wells in the Alluvial Aquifer and more than 100 m from ground zero. A hollow geometric symbol represents a value less than its MDC and is not quantitative; the same symbol shown solid represents a value greater than its MDC. A point symbol represents a value greater than its MDC.*

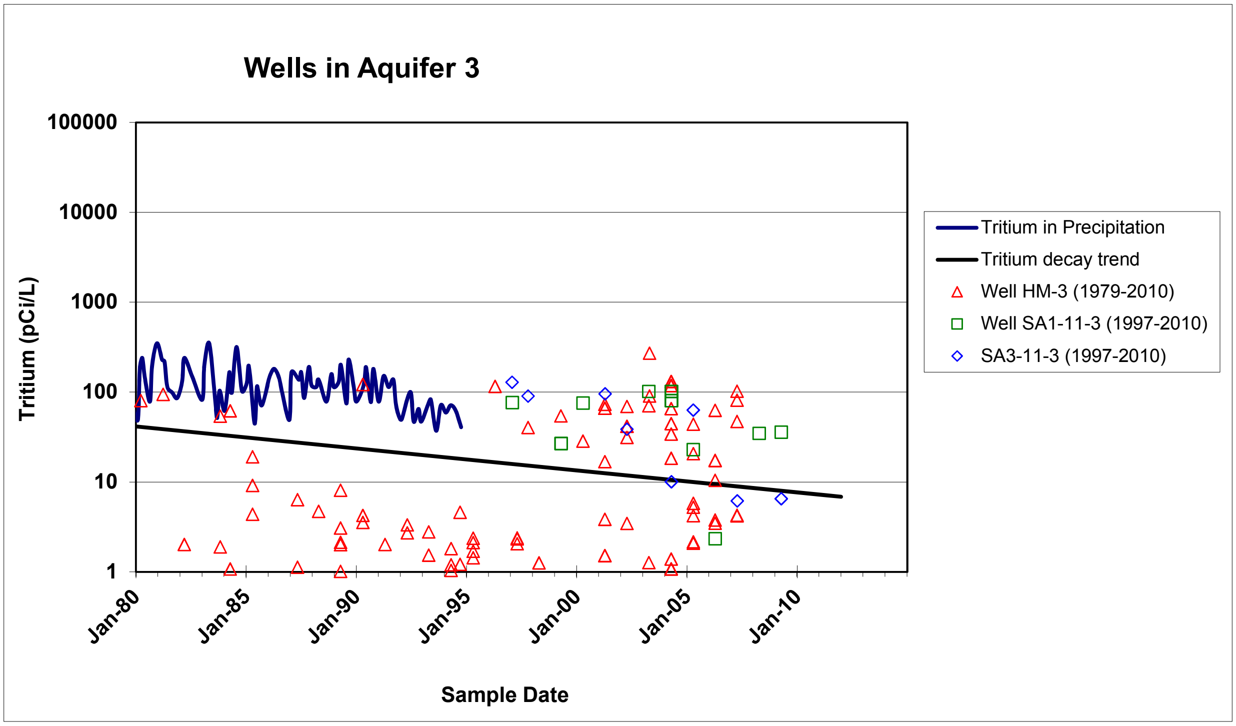


*Figure C–5. Tritium concentration trends plotted for wells in Aquifer 3. A hollow geometric symbol represents a value less than its MDC and is not quantitative.*

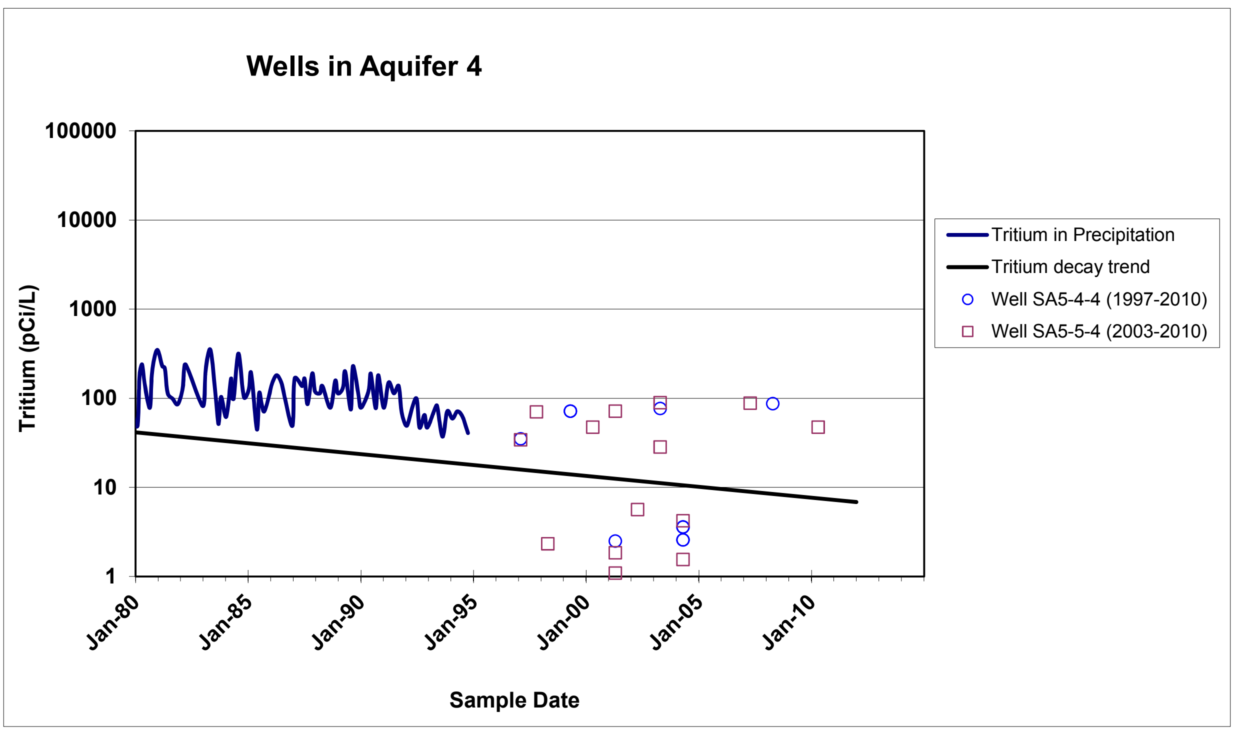


*Figure C–6. Tritium concentration trends plotted for wells in the Aquifer 3. A hollow geometric symbol represents a value less than its MDC and is not quantitative.*

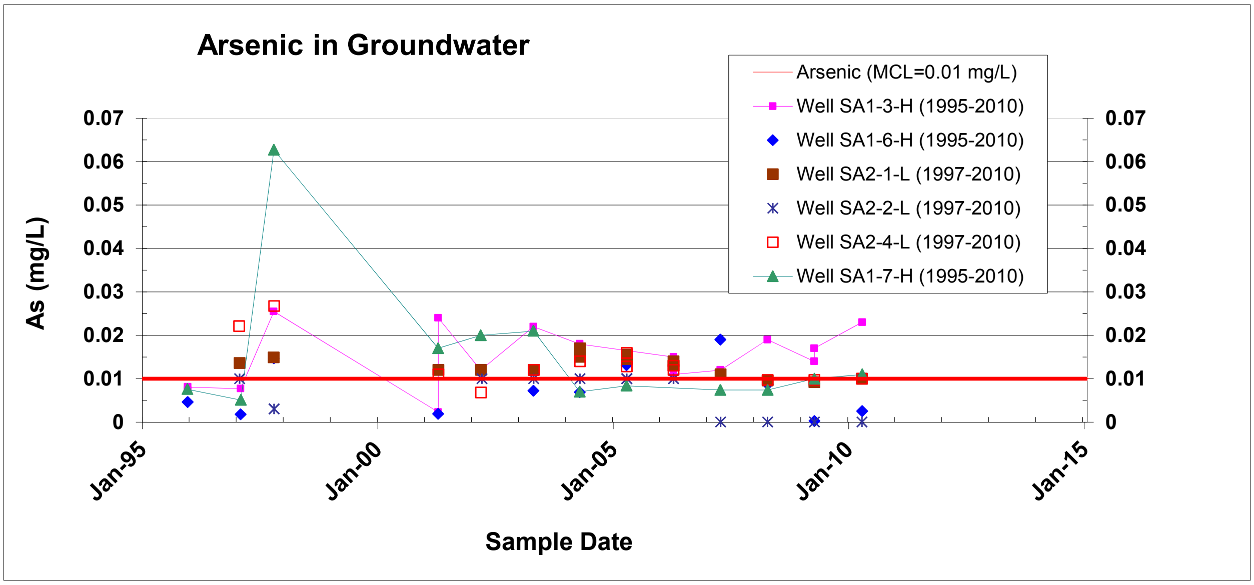


*Figure C–7. Arsenic detected in groundwater collected from on-site wells that historically have exceeded the MCL. A line is drawn through the data per well if the arsenic concentration exceeded the MCL in 2010.*

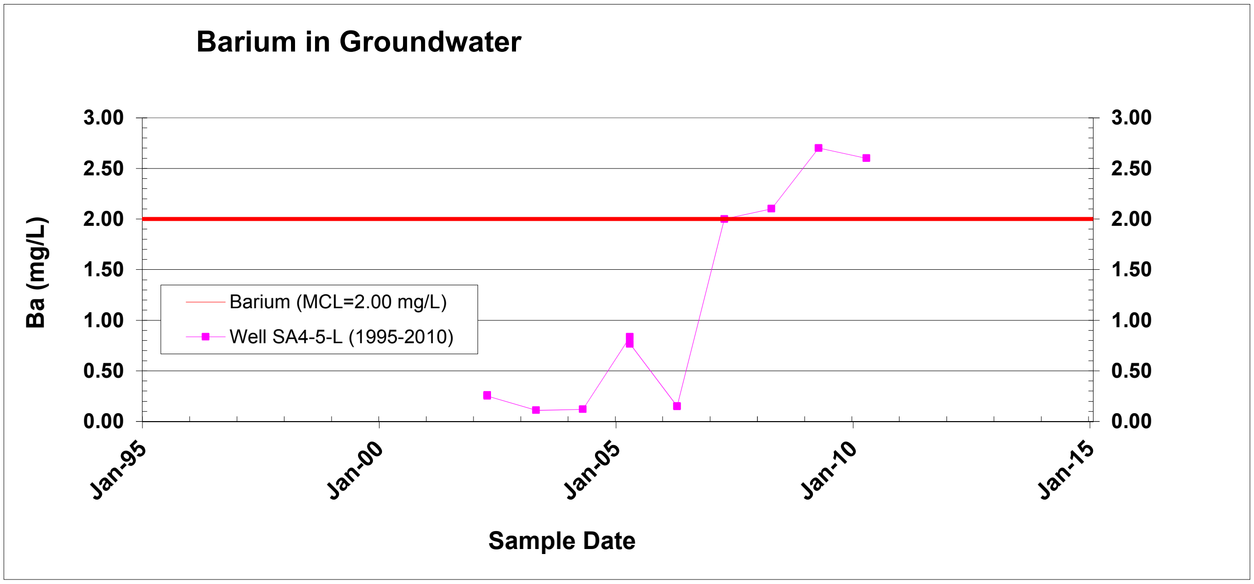


*Figure C–8. Barium detected in groundwater collected from well SA4-5-L. The barium concentration for the last three years has exceeded the MCL.*

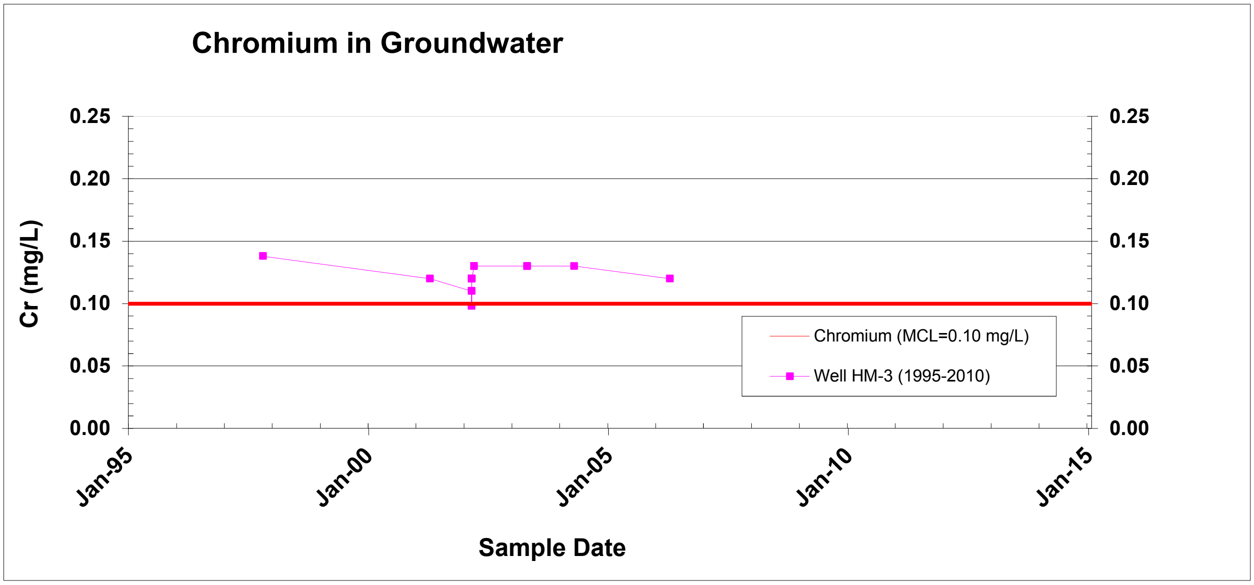


*Figure C–9. Chromium concentration detected in groundwater collected from well HM-3. A line is drawn through the data because the chromium concentration exceeded the MCL in 2010.*

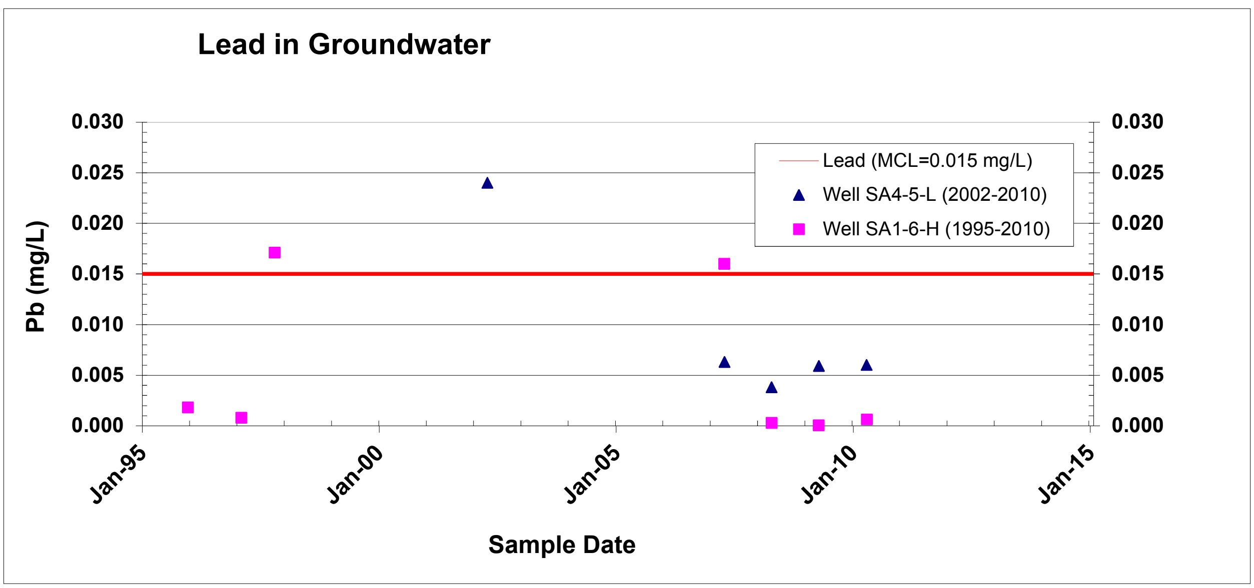


*Figure C–10. Lead concentration detected in groundwater collected from on-site wells that historically have exceeded the MCL. Lead was not detected above the MCL in 2010.*

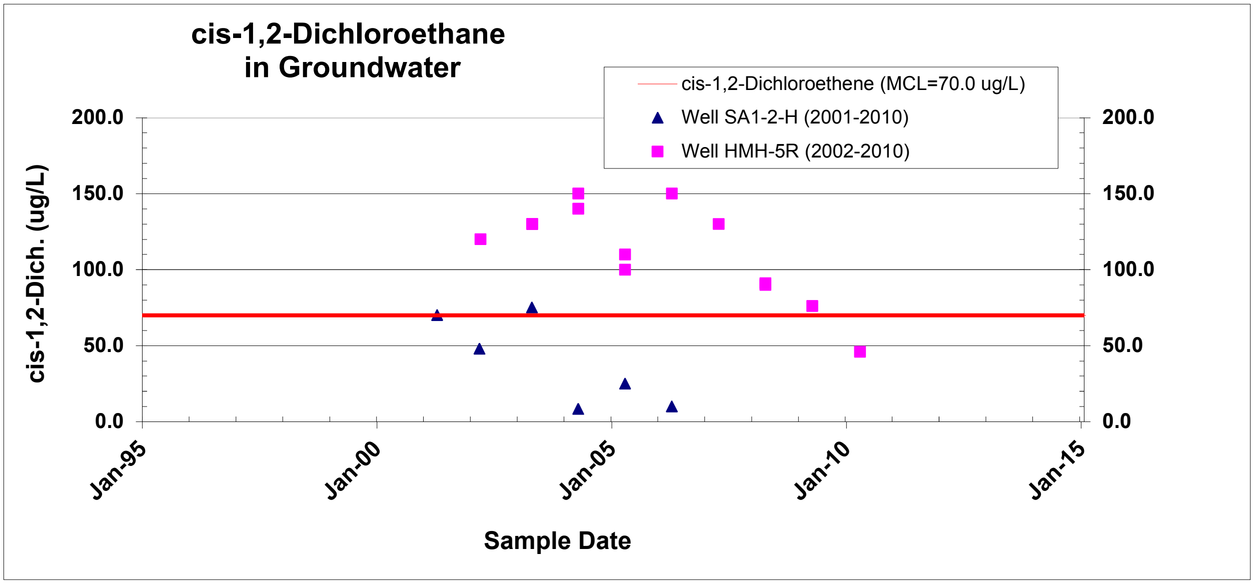


*Figure C–11. cis-1,2-Dichloroethene detected in groundwater collected from on-site wells that historically have exceeded the MCL. cis-1,2-Dichloroethene was not detected above the MCL in 2010.*

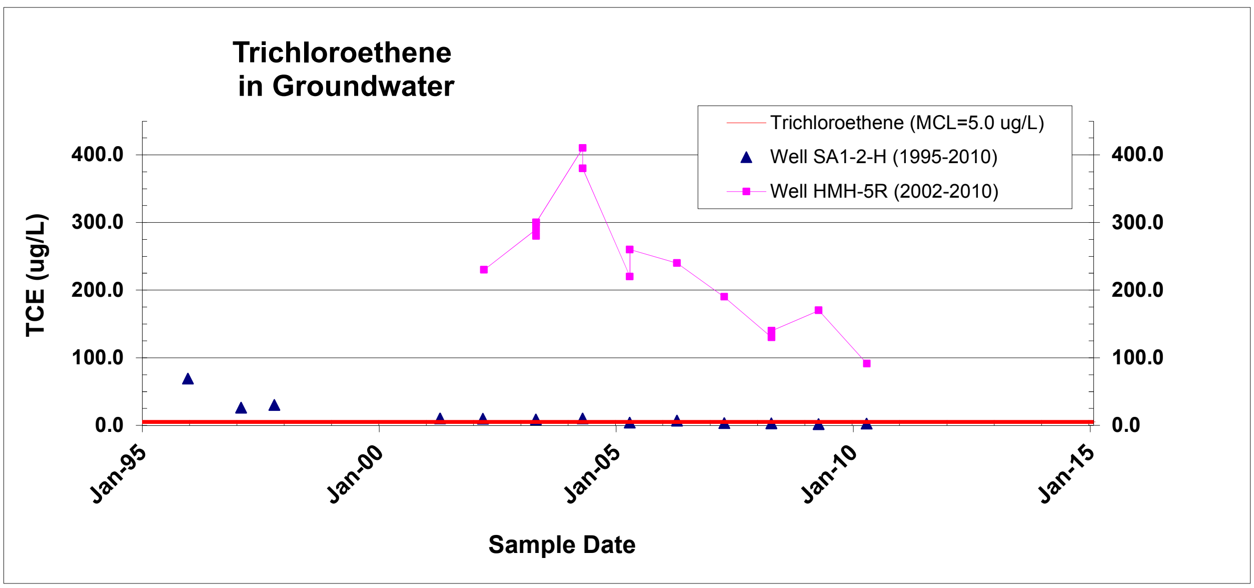


*Figure C–12. Trichloroethene (TCE) detected in groundwater collected from wells that historically have exceeded the MCL. A line is drawn through the data because the TCE concentration exceeded the MCL in 2010.*

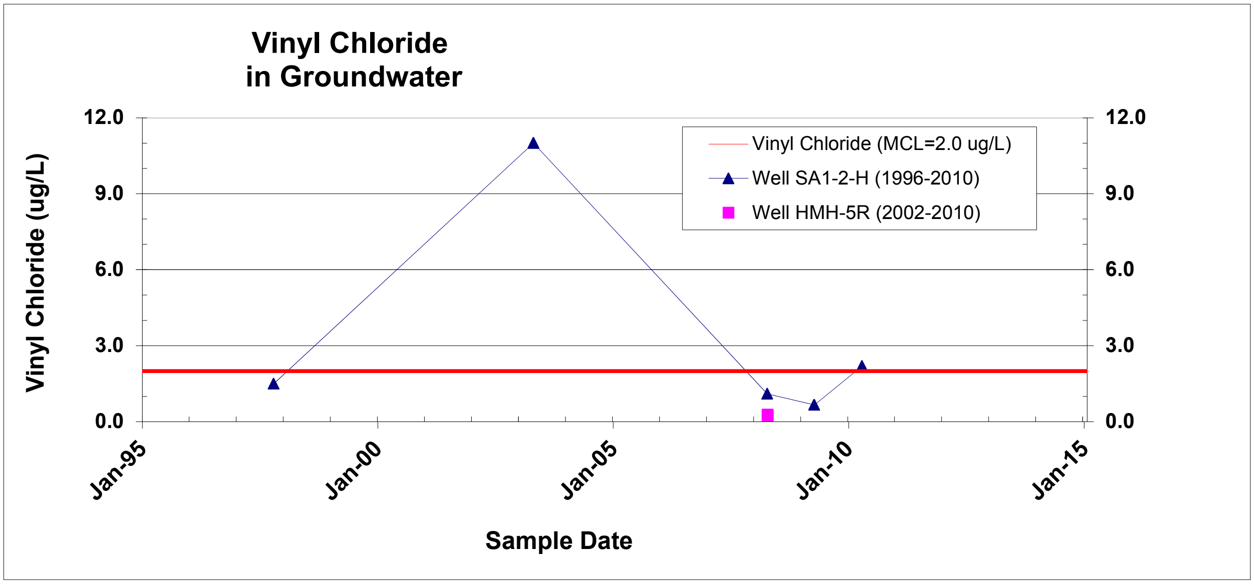


*Figure C–13. Vinyl chloride detected in groundwater collected from wells that historically have exceeded the MCL. The line is drawn through the data because the vinyl chloride concentration exceeded the MCL in 2010.*

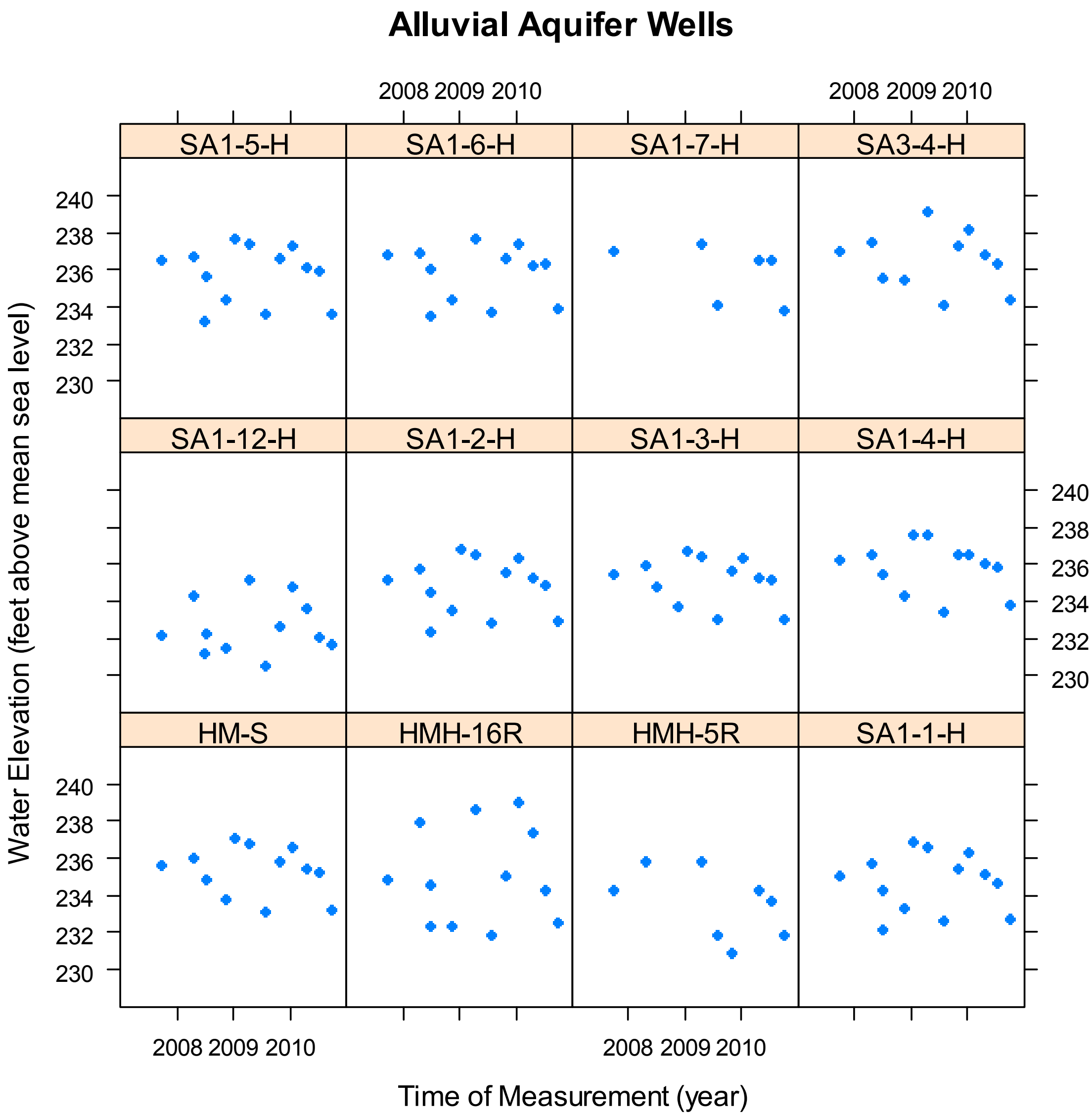


*Figure C–14. Measured water levels in the 12 Alluvial Aquifer wells are plotted by measurement date between September 2007 and October 2010.*

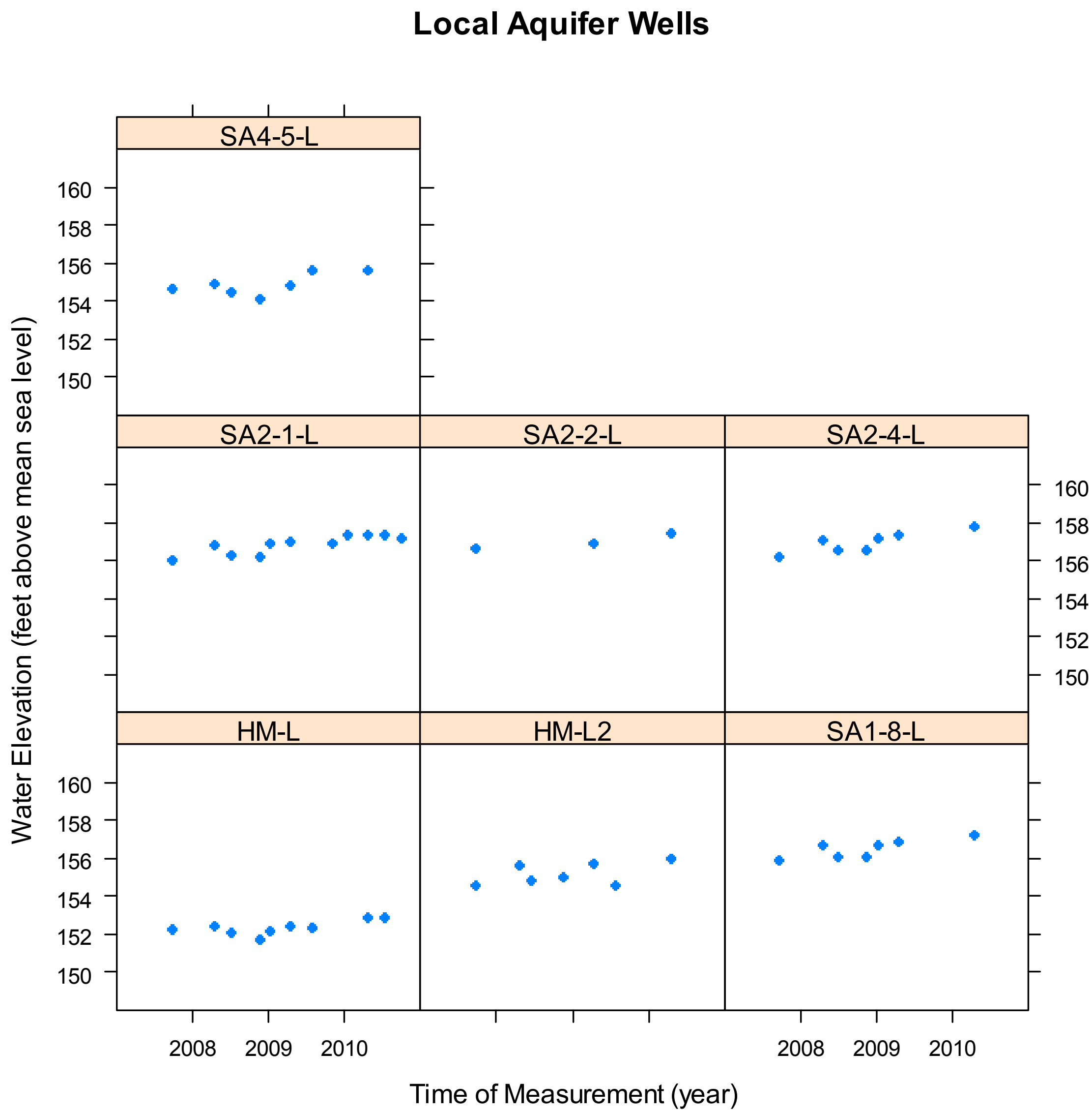


*Figure C–15. Measured water levels in the 7 Local Aquifer wells are plotted by measurement date between September 2007 and October 2010.*

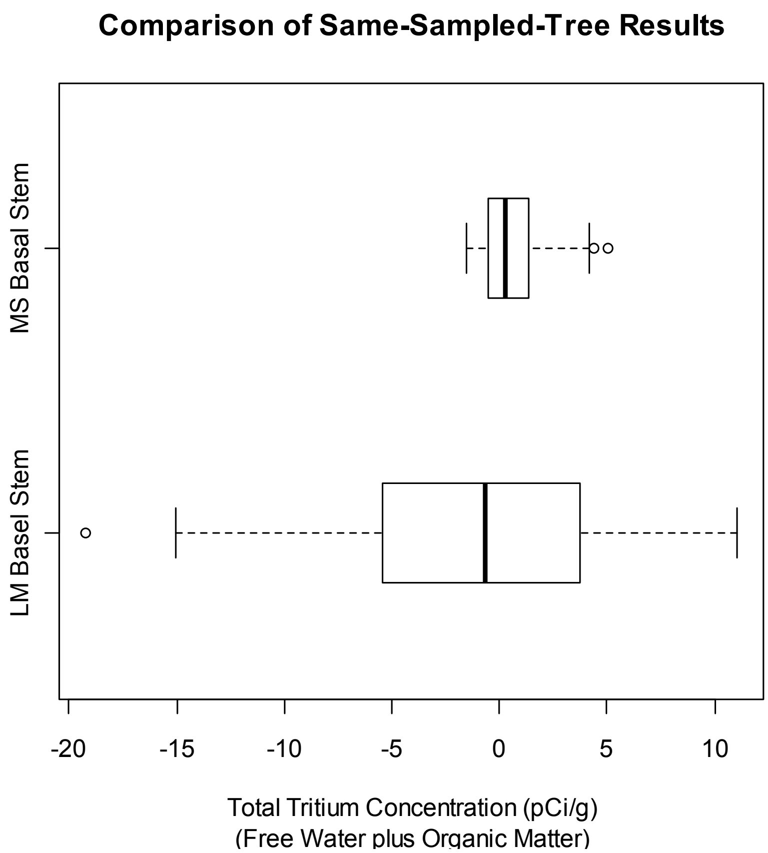


*Figure C–16. State and LM tritium-concentration statistics for basal stem samples are compared by box plots. The key values plotted are tabulated in Table 3–3. The left edge of the box plot is the first quartile; the right edge is the third quartile. The mean and median, roughly in the middle of each box, are indistinguishable. There are 35 LM sample results and 32 comparable State sample results. Points judged outliers are shown as open circles.*

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