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U.S. DEPARTMENT OF ENERGY

Salmon Site
ENVIRONMENTAL MANAGEMENT
END STATE VISION
Final

SAL 115.02

Executive Summary

The Environmental Management End State Vision is to be used as the primary tool for communicating the individual site end state to the involved parties (e.g., U.S. Department of Energy [DOE], regulators, public stakeholders, Tribal Nations). The end state document is not a decisional document. If the DOE decides to seek changes to the current compliance agreements, decisions, or statutory/regulatory requirements, those changes will be made in accordance with applicable requirements (DOE/EM, 2003).

Restoration activities have been conducted on the surface of the Salmon Site and investigation of subsurface contamination has been completed. Only long-term stewardship activities remain for the Salmon Site. Therefore, the surface and subsurface at the Salmon Site are in the end state.

The Salmon Site, formerly known as the Tatum Dome Test Site, is located in Lamar County, approximately 20 miles southwest of Hattiesburg, Mississippi. Two nuclear and two gas explosives tests were conducted at the Salmon Site between 1964 and 1970, as part of the U.S. Atomic Energy Commission's Vela Uniform Program. The Salmon Site is currently managed by the DOE Nevada Site Office (DOE/NSO) (NNSA/NSO, 2003).

Testing activities at the Salmon Site resulted in the release of radionuclides into the Tatum Salt Dome. During post-detonation re-entry drilling and other site activities, liquid and solid wastes containing radioactivity were generated, resulting in surface soil and shallow groundwater contamination. During site decommissioning in 1972, most of the waste and the contaminated soil and water were disposed of either in the test cavity or in a deep injection well on site. Other radioactive wastes were transported off the facility for disposal at the Nevada Test Site. Waste determined to be nonhazardous and nonradioactive was disposed of in pits at the site. These pits were subsequently backfilled with clean soil and graded.

The Salmon Site is partially fenced and is surrounded by privately owned parcels. Although the site is abandoned and posted, local hunters often use the site for access to hunting leases adjacent to the Salmon Site (NNSA/NSO, 2003). Nearby areas of urban development include Lumberton, Hattiesburg, and Purvis. In 1998, the DOE completed site characterization and issued the *Salmon Site Remedial Investigation Report, Lamar County, Mississippi*, Rev. 1 (DOE/NV, 1999). Characterization results indicated that the site does not pose a significant current or future risk to human health or the environment under planned use scenarios.

The DOE is currently proposing two future land use scenarios for the Salmon Site: (1) long-term response action responsibilities would be maintained by the DOE for all environmental media, but official responsibility would transfer from the DOE Environmental Management Program to the Office of Legacy Management (LM); and (2) ownership of the land surface (which may or may not include Surface Ground Zero [SGZ]) would be transferred to the State of Mississippi for future use consistent with current land use restrictions, and ownership of subsurface soils and groundwater would be retained by the DOE and managed by the LM (Johnston, 2003a).

Results of remedial action alternative analysis indicate that institutional controls are the most appropriate remedial action for the Salmon Site. These include maintaining institutional controls at the site, establishing a public awareness program, and maintaining the long-term hydrologic monitoring program. The sampling protocol will also be modified to focus on contaminants identified as significant in the risk assessment calculations. These contaminants include tritium and volatile organic compounds in the shallow aquifer in the vicinity of SGZ and Source Area 2, and tritium and gamma emitters in the deeper aquifers. It has been proposed that monitoring of the Alluvial and Local Aquifers be conducted annually until contaminants naturally attenuate to below regulatory limits, and every five years after that time. It has also been proposed that monitoring be conducted every five years in the deeper aquifers (NNSA/NSO, 2003).

The DOE has funded Lamar County to extend the existing regional water supply system to residents in the vicinity of the Salmon Site. As part of the installation of this system, Lamar County will require all existing and new residences with access to the water supply system to connect to the system. Groundwater modeling results indicate that contaminants will naturally attenuate to below regulatory limits before they reach the site boundary; however, since the regional water supply system was extended, the groundwater pathway is not considered applicable for the residential scenario risk assessment (NNSA/NSO, 2003). According to the Life-Cycle Baseline Revision 5, closure of the site is expected to be completed in fiscal year 2004.

The DOE/NSO developed a public participation plan for the Salmon Site End State Vision. The plan provided a draft copy of this document, an information sheet, and a letter soliciting feedback by July 1, 2004, to involved parties and stakeholders. All written comments that were submitted to the DOE/NSO received comment resolution.

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List of Acronyms and Abbreviations

μg/L	Micrograms per liter
AEC	U.S. Atomic Energy Commission
AOC	Area of concern
bgs	Below ground surface
COC	Contaminant(s) of concern
CSM	Conceptual site model
DOE	U.S. Department of Energy
DOE/NSO	U.S. Department of Energy, Nevada Site Office
EM	U.S. Department of Energy, Environmental Management Program
EPA	U.S. Environmental Protection Agency
ft	Foot (feet)
FY	Fiscal year
ILCR	Incremental Lifetime Cancer Risk
LM	U.S. Department of Energy, Office of Legacy Management
LTHMP	Long-Term Hydrologic Monitoring Program
MCL	Maximum contaminant level
mi	Mile(s)
mi^2	Square mile(s)
NTS	Nevada Test Site
OU	Operable Unit
pCi/L	Picocurie(s) per liter
PL	Public Law
RI	Remedial Investigation
SGZ	Surface ground zero
TCE	Trichloroethylene
VC	Vinyl chloride
VOC	Volatile organic compound

1.0 Introduction

The Environmental Management End State Vision is to be used as the primary tool for communicating the individual site end state to the involved parties (e.g., U.S. Department of Energy [DOE], regulators, public stakeholders, Tribal Nations). The end state document is not a decisional document. If the DOE decides to seek changes to the current compliance agreements, decisions, or statutory/regulatory requirements, those changes will be made in accordance with applicable requirements (DOE/EM, 2003).

The Environmental Management End State Vision juxtaposes land use with remediation requirements, establishing a conceptual completion goal (or end state) that is both realistic and protective of human health and the environment. The purpose of the vision is to identify where and how potentially harmful exposures to hazardous or radioactive contaminants might occur under projected future conditions, and to determine what actions will be necessary to minimize the potential for harm under those conditions. Consistent with the objectives of cleanup, the vision conceptualizes specific end state conditions that will minimize the potential for harm in the future.

The July 2003 DOE Policy 455.1, "Use of Risk-Based End States," requires DOE Environmental Management Program (EM) sites to define and document a risk-based end state vision that is acceptable to regulators and stakeholders, and then to revise clean-up program plans as necessary to achieve that end state in the most efficient manner (DOE, 2003). The policy is a formal mandate for EM sites to implement risk-based corrective action programs as described in numerous DOE and U.S. Environmental Protection Agency (EPA) publications, American Society of Testing and Materials Standard Guides, and National Research Council recommendations.

Environmental corrective action is an application of standard scientific, engineering, and mathematical principles, enabling steady progress in solving even very complex clean-up problems. The complexities of cleanup at a typical EM site are generally similar: multiple contaminants distributed in multiple environmental media, released over long periods of time and over large areas of land. Uncertainties in source(s), nature, extent, transport, and fate of contaminants are very large and can never be absolutely eliminated. Corrective action provides an objective means of managing uncertainties to the degree necessary and sufficient to make defensible decisions about effective clean-up actions.

The end state vision describes clean-up goals that would be protective under planned future uses. Proposed corrective actions based on risk and other factors associated with land use are presented, negotiated, and agreed to by the State of Mississippi and DOE.

The DOE's risk-based end state initiative is fully consistent with the EPA's recent endorsement of systematic planning, which uses risk-based decision methods to ensure objectivity, defensibility, and cost-effectiveness in corrective action programs (EPA, 2001). The DOE/NSO will collaborate with its stakeholders to revise the proposed Environmental Management End State Vision, as needed, to define clear goals for completion of its EM-sponsored clean-up work.

The DOE/NSO developed a public participation plan for the Salmon Site End State Vision. The plan provided a draft copy of this document, an information sheet, and a letter soliciting feedback by July 1, 2004, to involved parties and stakeholders. All written comments that were submitted to the DOE/NSO received comment resolution.

Restoration activities have been conducted on the surface of the Salmon Site and investigation of subsurface contamination has been completed. Only long-term stewardship activities remain for the Salmon Site. These activities include maintaining institutional controls, establishing a public awareness program, and maintaining a groundwater monitoring program. Therefore, the surface and subsurface of the Salmon Site are in the end state.

The DOE Nevada Operations Office (now the DOE/NSO) initiated a Remedial Investigation (RI) of the Salmon Site (formerly known as the Tatum Dome Test Site) in 1992 to collect sufficient information to determine if the site poses a current or future risk to human health and/or the environment. A detailed description of the site location, a chronological history of site restoration activities, a discussion of the waste generation processes, potential contamination source areas, and previous investigation results and conclusions are provided in the *Remedial Investigation and Feasibility Study (RI/FS) of the Tatum Dome Test Site, Lamar County, Mississippi, Volume 1, Final Work Plan* (DOE/NV, 1992a), *Work Plan Addendum for the Remedial Investigation and Feasibility Study of the Salmon Site* (DOE/NV, 1995b), and the *Salmon Site Remedial Investigation Report, Lamar County, Mississippi*, Rev. 1 (DOE/NV, 1999). Since the 1999 Salmon Site Remedial Investigation Report contains all the characterization and risk assessment results, it is referenced throughout this document and identified as the Salmon Site RI Report.

The Salmon Site is located in Lamar County, approximately 20 miles (mi) southwest of Hattiesburg, Mississippi. Two nuclear and two gas explosives tests were conducted at the Salmon Site between 1964 and 1970 as part of the U.S. Atomic Energy Commission's (AEC) Vela Uniform Program. Prior to 1992, the DOE leased the Salmon Site property; however, the DOE acquired the site from a private owner in 1992. The Salmon Site is currently managed by the DOE/NSO (NNSA/NSO, 2003).

Testing activities at the Salmon Site resulted in the release of radionuclides into the Tatum Salt Dome. During post-detonation re-entry drilling and other site activities, liquid and solid wastes containing radioactivity were generated, resulting in surface soil and groundwater contamination. Cleanup and waste removal operations were conducted at the Salmon Site during the 1972 site decommissioning activities. During the decommissioning activities, most of the contaminants from the surface ground zero (SGZ) mud pits, and the radiologically contaminated soil from other parts of the site were removed. The excavated material was mixed into slurry and injected into the test cavity. In addition, miscellaneous hardware and debris were removed (AEC, 1972). The decommissioning equipment was decontaminated and transported to the Nevada Test Site (NTS) for disposal. Nonradioactive and nonhazardous sanitary wastes were disposed of in pits at the site, which were then covered with clean soil and graded. The site was relatively inactive from 1972 to 1992, except for routine annual groundwater monitoring that was part of the EPA's Long-Term Hydrologic Monitoring Program (LTHMP) (NNSA/NSO, 2003).

Following decommissioning of the Salmon Site, additional issues were raised by concerned citizens, the State of Mississippi, and congressional leaders. The DOE initiated a series of studies in response to these concerns that culminated in the issuance of a work plan for conducting a *Comprehensive Environmental Response, Compensation, and Liability Act* type investigation at the Salmon Site. The work plan identified three operable units, as defined in the Salmon Site RI Report (DOE/NV, 1999).

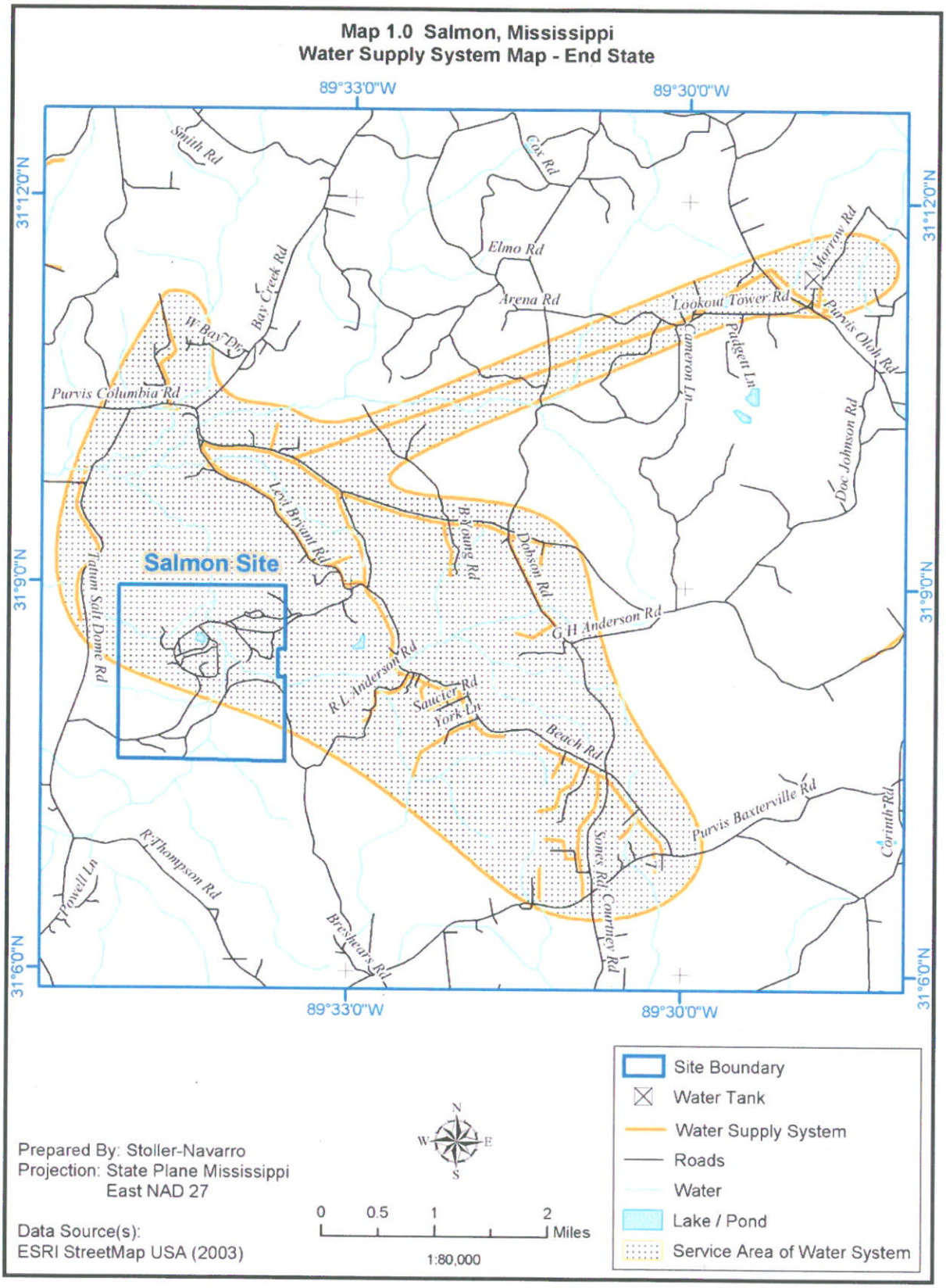
The characterization and risk assessment results identified two areas of potential concern at the Salmon Site. These included subsurface soils in the area of the SGZ mud pits, and groundwater in the Alluvial and Local Aquifers. The *Salmon Site Restoration Plan* (NNSA/NV, 2002) identified feasible remediation alternatives, evaluated them, and recommended the following remedial actions for the site:

- The expansion of an existing water supply system to provide potable water to residences in the proximity of the site

- Continued maintenance of surface institutional controls in the area of SGZ and site subsurface restrictions
- Continued implementation of the EPA LTHMP
- Implementation of a public awareness program
- Final stewardship of the site by the State of Mississippi as a wildlife refuge and working demonstration forest as required by Public Law (PL) 104-201, "National Defense Authorization Act for Fiscal Year 1997" (U.S. Public Laws, 1996)

The land use identified in the *Salmon Site Completion Report and Long-Term Stewardship Plan* (NNSA/NSO, 2003) is to release the surface of the site to the State of Mississippi for use as a wildlife refuge and working demonstration forest. The current site baseline calls for the site to be ready for transfer to the State of Mississippi by August 2004, with physical transfer occurring by September 30, 2004. Under this alternative, ownership of the land would be transferred to the State of Mississippi for future use consistent with land use restrictions defined above. However, ownership of subsurface soils and groundwater would be retained by the DOE and managed by the Office of Legacy Management (LM). The drivers for consideration of transfer to the State include: (1) their interest in using the surface for purposes as defined in the public law, and (b) the facilitation of such transfer by PL 104-201 (U.S. Public Laws, 1996).

The DOE has provided funding to Lamar County to extend an existing regional drinking water supply system to residents in the vicinity of the Salmon Site. The water supply system has been built, with the exception of an additional well and storage tank scheduled to be installed by Lamar County in fiscal year (FY) 2004. The system consists of approximately 16 mi of water line to the areas shown on Map 1.0. As part of the installation of this system, the DOE will also pay for existing residents in the affected area to be connected to the new drinking water supply system.


Map 1.0 Salmon, Mississippi
Water Supply System Map - End State
89°33'0"W
89°30'0"W
31°12'0"N
31°9'0"N
31°6'0"N
Smith Rd
Cox Rd
Elmo Rd
Arena Rd
Bay Creek Rd
W Bay Dr
Purvis Columbia Rd
Lookout Tower Rd
Morrow Rd
Purvis Oloh Rd
Cameron Ln
Pidgett Ln
Doc Johnson Rd
Leil Bryant Rd
B Young Rd
Dobson Rd
G H Anderson Rd
Salmon Site
Tatum Salt Dome Rd
R L Anderson Rd
Saucier Rd
York Ln
Beach Rd
Purvis Baxterville Rd
Corinth Rd
Soines Rd
Courtney Rd
R Thompson Rd
Powell Ln
Breshears Rd
Site Boundary
Water Tank
Water Supply System
Roads
Water
Lake / Pond
Service Area of Water System
N
S
E
W
0
0.5
1
2
Miles
1:80,000
Prepared By: Stoller-Navarro
Projection: State Plane Mississippi
East NAD 27
Data Source(s):
ESRI StreetMap USA (2003)

Residual contamination is present in the subsurface soils and groundwater, precluding future unrestricted use. As part of the risk assessment, the future land use agreed upon by the State of Mississippi and the DOE will be a demonstration forest and wildlife refuge, in order to ensure that there are no unacceptable exposures to human health and the environment. The clean-up criteria agreed to by the State of Mississippi for the planned use of the site have been met by the DOE. This end state is consistent with the future land use for both the surface and subsurface, as agreed to by all parties.

1.1 Organization of the Report

The Salmon Site End State Vision is organized into five sections. Since the current state and the end state are the same for the Salmon Site, only one map is presented for each subsection.

Section 1.0 introduces the site, including a brief discussion of past, present, and future site missions. This section also briefly discusses site hazards, the extent of environmental contamination, past remediation work, and any planned future clean-up work.

Section 2.0 describes the regional context end state. This section examines physical and surface interface and human and ecological land use in the regional context. A map showing the current state and the end state is also included for each subsection.

Section 3.0 describes the site-specific end state. This section examines physical and surface interface and human and ecological land use for the site and immediately adjacent lands. Legal ownership and demographics are also presented, and each subsection includes a map showing the current state and the end state.

Section 4.0 discusses specific site hazards including the nature of each hazard, potential impacts on human health and the environment, and any hazard mitigation identified. This section includes a current site-wide hazard map in addition to a current state/end state map for each specific hazard. A conceptual site model (CSM) is also included in this section. This model shows the current state/end state for each hazard. The CSM is used to show the known and potential contaminant pathways, potential receptors, and barriers that have been put in place to minimize exposure to contamination.

Section 5.0 provides references used to develop the Salmon Site Environmental Management End State Vision.

Attachment A provides a report table detailing that there are no variances between the end state vision and current remediation plans for this site.

1.2 Site Mission

The Salmon Site was operational from 1964 through 1970. The site overlies the Tatum Salt Dome and it was originally used to conduct two nuclear and two gas explosives tests. The Salmon test, conducted on October 22, 1964, consisted of a 5.3-kiloton yield nuclear detonation. The device was emplaced 2,710 feet (ft) below ground surface (bgs) in the Tatum Salt Dome. The Sterling detonation, conducted on December 3, 1966, consisted of a 380-ton yield nuclear device suspended in the cavity created by the Salmon test (DOE/EM, 2001).

Following the first two tests, the Salmon Site was used for two non-nuclear explosives tests, Diode Tube and Humid Water, which were part of the Miracle Play Program. These tests were detonated on February 2, 1969, and April 19, 1970, respectively. Each test had a yield of approximately 315 tons, created by a mixture of methane and oxygen (NNSA/NSO, 2003).

None of the tests at the Salmon Site resulted in releases of radionuclides from the salt cavity; however, during reentry drilling and other site activities, solid and liquid wastes containing radioactivity were generated, resulting in surface and shallow groundwater contamination at the site. Most of the waste and the contaminated soil and water were disposed of either in the test cavity or in a deep injection well in the southwest corner of the site. Other radioactive wastes were transported to the NTS for disposal. Nonradioactive wastes were disposed of in pits at the site. The pits were subsequently backfilled with clean soil and graded (NNSA/NSO, 2003).

The Salmon Site is currently owned by the DOE and has been relatively inactive since the end of the Miracle Play Program in 1970. Site cleanup and decommissioning activities began in 1972. The Tatum Lumber Company may have conducted some limited forest logging activity between 1972 and 1992, when the site was privately owned.

The DOE's current mission at the Salmon Site is to continue long-term stewardship activities of the residual subsurface contamination in the test cavity. It has been proposed that monitoring of the Alluvial and Local Aquifers be conducted annually until contaminants naturally attenuate to below regulatory limits, and every five years after that time. It has also been proposed that monitoring be conducted every five years in the deeper aquifers (NNSA/NSO, 2003). The DOE

anticipates transferring the site surface to the State of Mississippi to establish a demonstration forest and wildlife refuge (NNSA/NV, 2002). The LM will retain ownership and oversight of the EPA LTHMP for the site.

The contaminants of concern (COCs) for the subsurface are volatile organic compounds (VOCs) and tritium. Gamma emitters will be monitored to ensure that migration out of the salt cavity is not occurring. Table 1.1 shows the representative source term for the Salmon Site.

Table 1.1 Representative Source Term for the Salmon Site

Mean radionuclide inventory for 76 nuclear tests detonated below or within 328 ft of the water table in Areas 19 and 20 at the NTS, decay corrected to January 1, 1994 (Smith, 2001).

Radionuclide	Isotope Symbol	Half life ($t_{1/2}$; year)	Estimated Inventory (Ci) *
Tritium	H-3	1.23E+01	9.20E+05
Carbon-14	C-14	5.73E+03	7.3E+00
Aluminum-26	Al-26	7.30E+05	1.18E-04
Chlorine-36	Cl-36	3.01E+05	2.82E+00
Argon-39	Ar-39	2.69E+02	2.43E+01
Potassium-40	K-40	1.28E+09	6.17E+00
Calcium-41	Ca-41	1.03E+05	2.16E+01
Nickel-59	Ni-59	7.60E+04	5.25E-01
Nickel-63	Ni-63	1.00E+02	5.54E+01
Krypton-85	Kr-85	1.07E+01	1.26E+03
Strontium-90	Sr-90	2.91E+01	1.57E+04
Zirconium-93	Zr-93	1.50E+06	5.49E-01
Niobium-93m	Nb-93m	1.61E+01	9.99E+01
Niobium-94	Nb-94	2.00E+04	2.28E+00
Technetium-99	Tc-99	2.13E+05	4.04E+00
Paladium-107	Pd-107	6.50E+06	2.07E-02
Cadmium-113m	Cd-113m	1.41E+01	1.53E+01
Tin-121m	Sn-121m	5.50E+01	5.67E+01
Tin-126	Sn-126	1.00E+05	6.47E-01
Iodine-129	I-129	1.57E+07	1.24E-02
Cesium-135	Cs-135	2.30E+06	4.17E-01
Cesium-137	Cs-137	3.02E+01	1.99E+04
Samarium-151	Sm-151	9.00E+01	7.51E+02
Europium-150	Eu-150	3.60E+01	1.46E+01
Europium-152	Eu-152	1.35E+01	4.33E+02
Europium-154	Eu-154	8.59E+00	2.04E+02
Holmium-166m	Hm-166m	1.20E+03	5.89E-01
Thorium-232	Th-232	1.40E+10	7.68E-04
Uranium-232	U-232	7.00E+01	3.36E+00
Uranium-233	U-233	1.59E+05	2.25E+00
Uranium-234	U-234	2.46E+05	1.62E+00
Uranium-235	U-235	7.04E+08	2.18E-02
Uranium-236	U-236	2.34E+07	6.22E-02
Uranium-238	U-238	4.47E+09	2.88E-02
Neptunium-237	Np-237	2.14E+06	4.80E-01
Plutonium-238	Pu-238	8.77E+01	9.42E+01
Plutonium-239	Pu-239	2.41E+04	2.54E+02
Plutonium-240	Pu-240	6.56E+03	8.16E+01
Plutonium-241	Pu-241	1.44E+01	1.18E+03
Plutonium-242	Pu-242	3.75E+05	4.42E-02
Americium-241	Am-241	4.33E+02	6.14E+01
Americium-243	Am-243	7.37E+03	2.36E-03
Curium-244	Cm-244	1.81E+01	3.91E+01

*Value is from the mean unclassified radionuclide inventory for 76 nuclear tests detonated below or within 328 ft of the water table in Areas 19 and 20 of the NTS.

1.3 Status of Clean-up Program

Potential surface contamination at the Salmon Site resulted from drilling operations after the first test was conducted. The COCs in the abandoned mud pits, shallow disposal areas, and burn pits included tritium and diesel fuel. In 1972, the AEC initiated cleanup of the surface contamination by excavating soils, decommissioning facilities, and disposing of wastes. In 1977, the DOE conducted an additional sampling program, which included exploratory borings and extensive soil and groundwater sampling. The results of this study showed that tritium contamination remained in shallow mud pits (NNSA/NV, 2002).

The DOE completed site characterization, modeling, and risk assessments for both the surface and subsurface areas of the Salmon Site, and has completed remediation activities at the site (NNSA/NSO, 2003). In October 1999, the DOE initiated final closure negotiations with the State of Mississippi. In addition, the DOE has signed a Memorandum of Understanding with Lamar County that provides approximately $2 million to extend a drinking water system to residences in the vicinity of the site. This work has been completed, with the exception of an additional well and storage tank scheduled to be installed by Lamar County in FY 2004. This water system will eliminate the potential for receptors from groundwater contamination (DOE/NV, 2002). All surface remediation activities at the site were completed in 2003.

The end state for environmental restoration field activities at the Salmon Site surface has been reached. The surface end state began with the completion of all necessary engineered barriers and institutional controls. Actions taken to reach the surface end state included placing a native soil cover over the mud pits and posting warning signs to prohibit digging or removal of subsurface soil on the site. Final elements for the end state of surface environmental restoration activities will include establishment of institutional controls and maintenance criteria, and assignment of applicable surface control responsibilities (NNSA/NSO, 2003).

Subsurface and groundwater contamination is addressed by implementing an end state approach using the EPA LTHMP. Drilling and water use within the entire 1,470-acre Salmon Site, will be prohibited, and groundwater production for residential use is limited outside the boundary. This is protective because, though it is not technologically feasible to remediate the contamination associated with an underground nuclear test, the use (withdrawal) of and exposure to contaminated groundwater will be precluded by implementation of institutional controls, restricting the drilling of wells within the boundary, and extension of the public water supply system. In the potential future event that contaminants are detected beyond the drilling

restriction area, the monitoring system and groundwater model will be re-evaluated to determine if the drilling restriction area and associated institutional controls need to be changed. The subsurface of the Salmon Site is in the end state.

The planned future use for the surface of the Salmon Site is as a wildlife refuge and demonstration forest. The law enables the State of Mississippi to accept the land from the federal government for the authorized uses. The DOE is currently negotiating to transfer the surface of the site to the State. Necessary restrictions will be placed on the property transfer. The four elements of the institutional controls remedial action alternative include the following:

- Deed restrictions, water-right restrictions, and intrusion restrictions
- Postings to prevent incidental intrusion
- Long-term monitoring
- Public awareness

After the site is transferred, general site maintenance will be the responsibility of the State of Mississippi. The long-term monitoring will remain the responsibility of the DOE.

The DOE has funded the expansion of an existing water distribution system in the vicinity of the site. The operation and maintenance of this system will be the responsibility of Lamar County and/or local water supply franchises.

As of 2003, DOE activities at the site are limited to long-term stewardship. The DOE will not maintain an active presence at this site, but will be responsible for monitoring and maintaining institutional controls over subsurface contamination. Final long-term stewardship requirements for the subsurface will be negotiated with the State of Mississippi during 2004. Periodic monitoring will be conducted to ensure that there is no contaminant migration from the test cavity to the groundwater outside the site boundary (NNSA/NV, 2002).

A groundwater monitoring program will be continued at the Salmon Site, with the EPA collecting periodic groundwater samples. Sampling will be conducted annually for the Alluvial and Local Aquifer wells until all parameters are below the current regulatory limits. After that time, the wells will be sampled on a 5-year interval for 20 years. The deep aquifer wells will be sampled every five years. The EPA LTHMP will be re-evaluated by the DOE every 25 years (NNSA/NSO, 2003).

A monument has been placed at the Salmon Site SGZ to mark the location of the test cavity (Johnston, 2003a). The DOE will maintain institutional controls over the subsurface in perpetuity to prevent access to the test cavity, groundwater, and associated subsurface contamination. Institutional controls will include restricting surface intrusions at the site. The DOE will continue to conduct groundwater monitoring at the site, as described above, after the closure of the site in 2004 (NNSA/NSO, 2003).

2.0 Regional Context End State Description

This section examines physical and surface interface and human and ecological land use in the regional context. This section also provides a discussion of current and planned future land use for the area surrounding the Salmon Site.

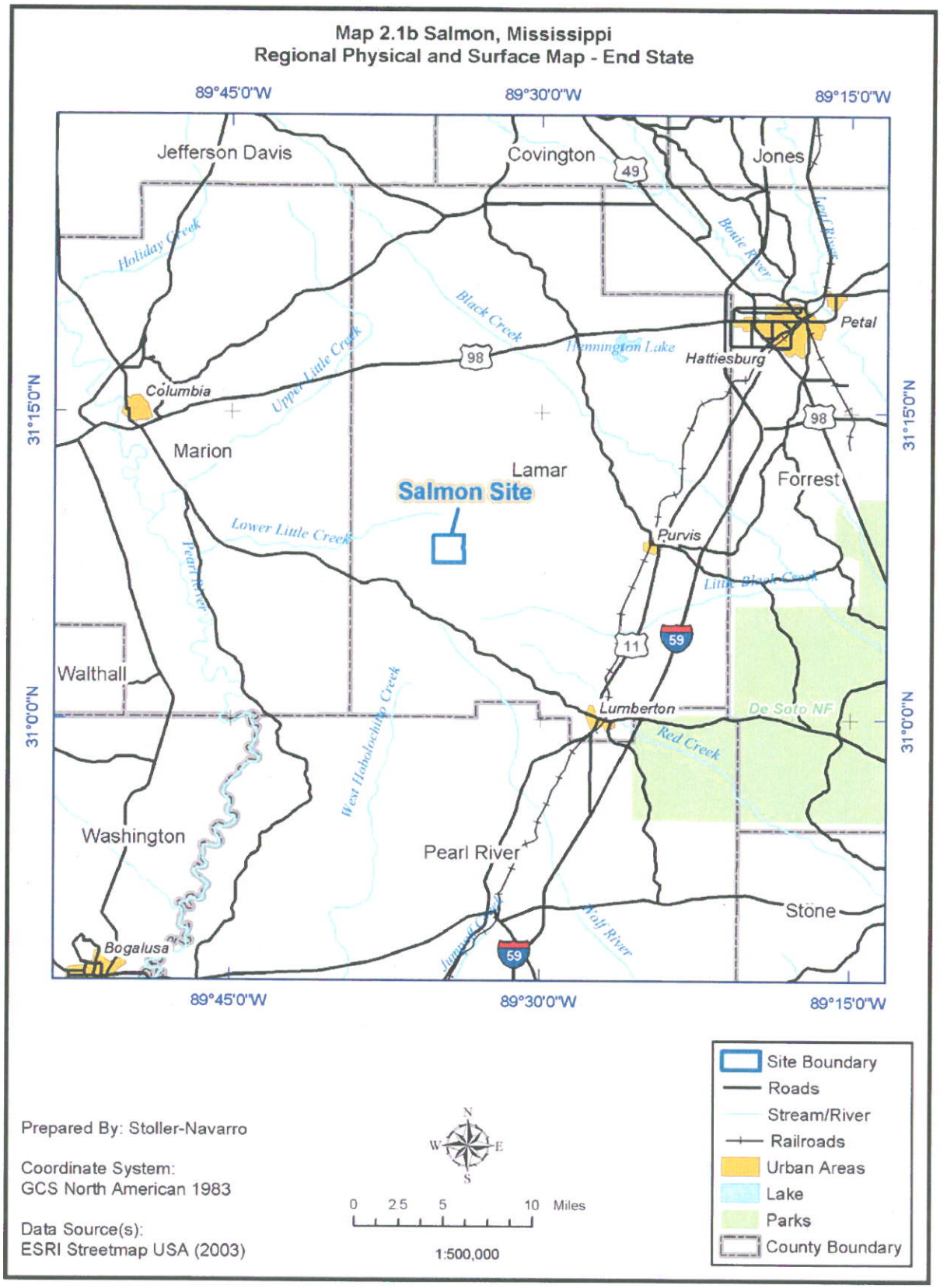
2.1 Regional Physical and Surface Interface

The Salmon Site encompasses approximately 1,470 acres in Sections 11, 12, 13, and 14 of Township 2 North, Range 16 West, St. Stephens Meridian, and is located in a major regional geologic province referred to as the Mississippi Embayment, a major part of the Atlantic and Gulf Coastal Plain Groundwater Region. This region is characterized by a series of unconsolidated deposits of gravel, sand, silt, and clay that are underlain by thick sequences of consolidated rock (DOE/NV, 1999). The Mississippi Embayment is a 100,000-square mile (mi^2), wedge-shaped region that extends from southern Illinois and southwestern Missouri to about 32 degrees north latitude in Texas, Louisiana, Mississippi, and Alabama. The Mississippi Embayment encompasses parts of nine states and adjoins the Gulf Coast Geosyncline south of 32 degrees north latitude (DOE/NV, 1999). The Pearl River Basin is located within the Mississippi Embayment.

The Pearl River Basin encompasses the Salmon Site. To the south, east, and west, the basin is bounded by low hills. The Pearl River, with a total drainage area of approximately 8,760 mi^2, flows into the Gulf of Mexico. Three streams are part of the Pearl River Drainage and drain the Salmon Site. These streams receive groundwater discharge from the surficial aquifer. There is one pond at the Salmon Site. This pond also receives surface runoff and groundwater discharge (DOE/NV, 1999).

The Tatum Salt Dome is located in south-central Mississippi, approximately 20 mi southwest of the city of Hattiesburg (Map 2.1b). The region is characterized by narrow, flat-topped ridges and intervening valleys that trend predominantly in a south-southeast direction toward the Gulf of Mexico (DOE/NV, 1992a). The Tatum Salt Dome is a typical Gulf Coast salt dome consisting of a salt core overlain by an anhydrite and limestone caprock.

In Lamar County, the near-surface aquifers are a minor source of water for domestic and stock wells and account for about two percent of the groundwater pumped. Recharge to this aquifer is derived directly from precipitation over the aquifer (DOE/NV, 1999).


Map 2.1b Salmon, Mississippi
Regional Physical and Surface Map - End State
89°45'0"W
89°30'0"W
89°15'0"W
31°15'0"N
31°0'0"N
Jefferson Davis
Covington
Jones
Marion
Lamar
Forrest
Walthall
Washington
Pearl River
Stone
Salmon Site
Columbia
Hattiesburg
Petal
Purvis
Lumberton
Bogalusa
Holiday Creek
Black Creek
Upper Little Creek
Lower Little Creek
Pennington Lake
Beaver River
Leaf River
Pearl River
West Hobolochitto Creek
Red Creek
Little Black Creek
Wolf River
De Soto NF
49
98
11
59
Site Boundary
Roads
Stream/River
Railroads
Urban Areas
Lake
Parks
County Boundary
Prepared By: Stoller-Navarro
Coordinate System:
GCS North American 1983
Data Source(s):
ESRI Streetmap USA (2003)
N
W
E
S
0 2.5 5 10 Miles
1:500,000

2.2 Human and Ecological Land Use

Human Land Use

Currently, the Salmon Site is inactive. During FY 2004, the Salmon Site will be turned over to the LM for long-term monitoring. Public Law 104-201 allows for the establishment of a demonstration forest and wildlife refuge (U.S. Public Laws, 1996). The Salmon Site is partially fenced and is surrounded by privately owned parcels of land (Map 2.2b). Although the site is inactive and posted, local hunters often use the site for access to hunting leases adjacent to the Salmon Site (NNSA/NSO, 2003). Nearby areas of urban development include Lumberton, Hattiesburg, and Purvis. All of these communities use land for residential, commercial, and industrial purposes (DOE/NV, 1992a).

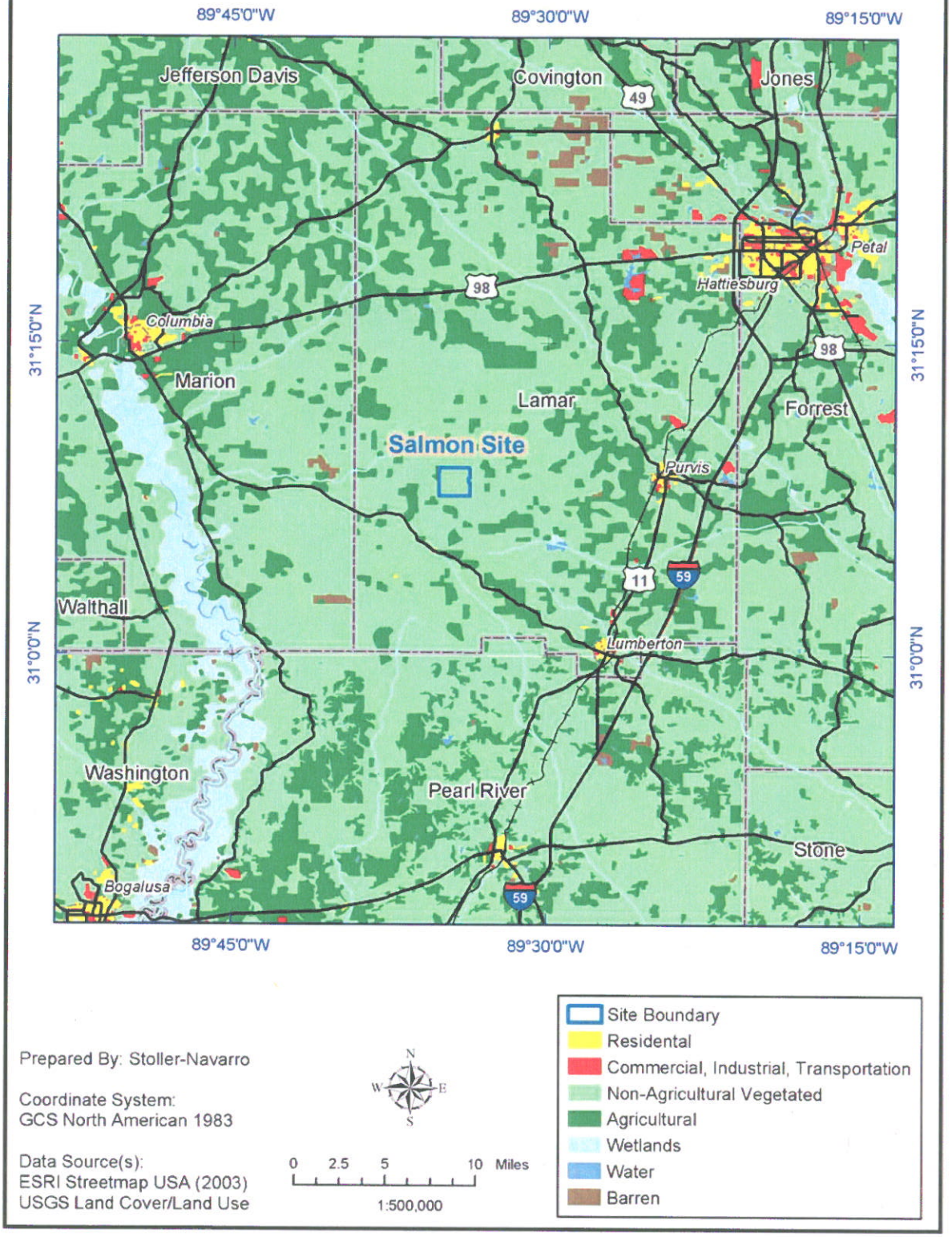
There are extensive oil and gas leases in the area surrounding the Salmon Site, but none on the site. Remington Oil and Gas Company collected seismic data from the Salmon Site in 2001. This data was used to enhance oil and gas exploration activities of the area surrounding the Salmon Site. Subsurface drilling restrictions have been imposed at the Salmon Site, thereby preventing oil and gas development in or near the test cavity (NNSA/NSO, 2003).

The future land use for the Salmon Site is dictated by PL 104-201, "National Defense Authorization Act for Fiscal Year 1997" (U.S. Public Laws, 1996). This law requires that the State of Mississippi use the conveyed property as a wildlife refuge and working demonstration forest, to be designated as the Jamie Whitten Forest Management Area.

The subsurface will be retained by the LM and will require the implementation of the EPA LTHMP. The future roles and responsibilities of the DOE, the State, and other agencies are documented in Table 2.2 (Johnston, 2003b). The current status of the Salmon Site is consistent with the land use outlined in PL 104-201 (U.S. Public Laws, 1996).

There is no human population located within the Salmon Site boundaries; however, there is a residence outside the site boundaries, in the vicinity of Source Area 6 (Section 4.0, Map 4.0b), the helicopter pad and storage area. No COCs were detected in Source Area 6 and it has been returned to private ownership.

Map 2.2b Salmon, Mississippi
Regional Human and Ecological Land Use Map - End State



Prepared By: Stoller-Navarro

Coordinate System:
GCS North American 1983

Data Source(s):
ESRI Streetmap USA (2003)
USGS Land Cover/Land Use

Table 2.2
DOE/NSO Land Status

Landlord	Surface Steward	Subsurface Steward	Withdrawal Order/Public Law	Specific Restriction Record	Oil/Gas Owner and Leases	Water Well Permits	Mineral Rights	Grazing Rights
U.S. Army Corps of Engineers	DOE (Wells), State of Mississippi (Demon-stration Forest and Wildlife Refuge)	**Current:** DOE/NSO **Future:** LM	**Surface:** Public Law 104-201	On-site plaque	Third party ownership restricted within Salmon Site boundaries	DOE/NSO	DOE	None

The EPA regularly monitors groundwater quality in the vicinity of the Salmon Site as part of the LTHMP. No radioactive materials attributable to the Salmon Site or tritium concentrations above background were detected in any off-site samples taken during the April 2003 sampling. Well SA1-1H (shallow well near SGZ) had the highest tritium level at 18,100 picocuries per liter (pCi/L), which continues the decreasing trend previously observed. The maximum contaminant level for tritium is 20,000 pCi/L. In general, natural attenuation for tritium continues for on-site locations that have shown detectable tritium concentrations in the past. All samples were analyzed for the presence of gamma-ray emitting radionuclides and none were detected. Sampling for VOCs was not conducted in 2003 (EPA, 2003).

Ecological Land Use

Currently, the Salmon Site is inactive. During FY 2004, the Salmon Site will be turned over to the LM for long-term monitoring and to the State of Mississippi for establishment of the demonstration forest and wildlife refuge. Lamar County is located in the Gulf Coast region and contains a large amount of forested land that is classified into two major types: loblolly/short leaf pine and longleaf/slash pine. The region is host to several species of plants, nine of which are labeled as special to the region. There are numerous species of animals in Lamar County, including birds, amphibians, fish, mammals, and invertebrates (DOE/NV, 1992b).

Rodents (squirrels, rats, mice), other smaller mammals (rabbits, raccoons, possums), and larger mammals (bears, panthers, deer) currently reside in the forested areas. The Gopher Tortoise (*Gopherus polyphemus*) is the only species identified in the 1992 threatened and endangered species study known to be on the Federal List of Threatened and Endangered Wildlife (DOE/NV, 1992b).

3.0 Site-Specific End State Description

This section examines physical and surface interface and human and ecological land use in the site-specific context. This section also provides a discussion of current and planned future land use for the site, legal ownership of the site and immediately adjacent lands, and demographics for the area.

3.1 Site Physical and Surface Interface

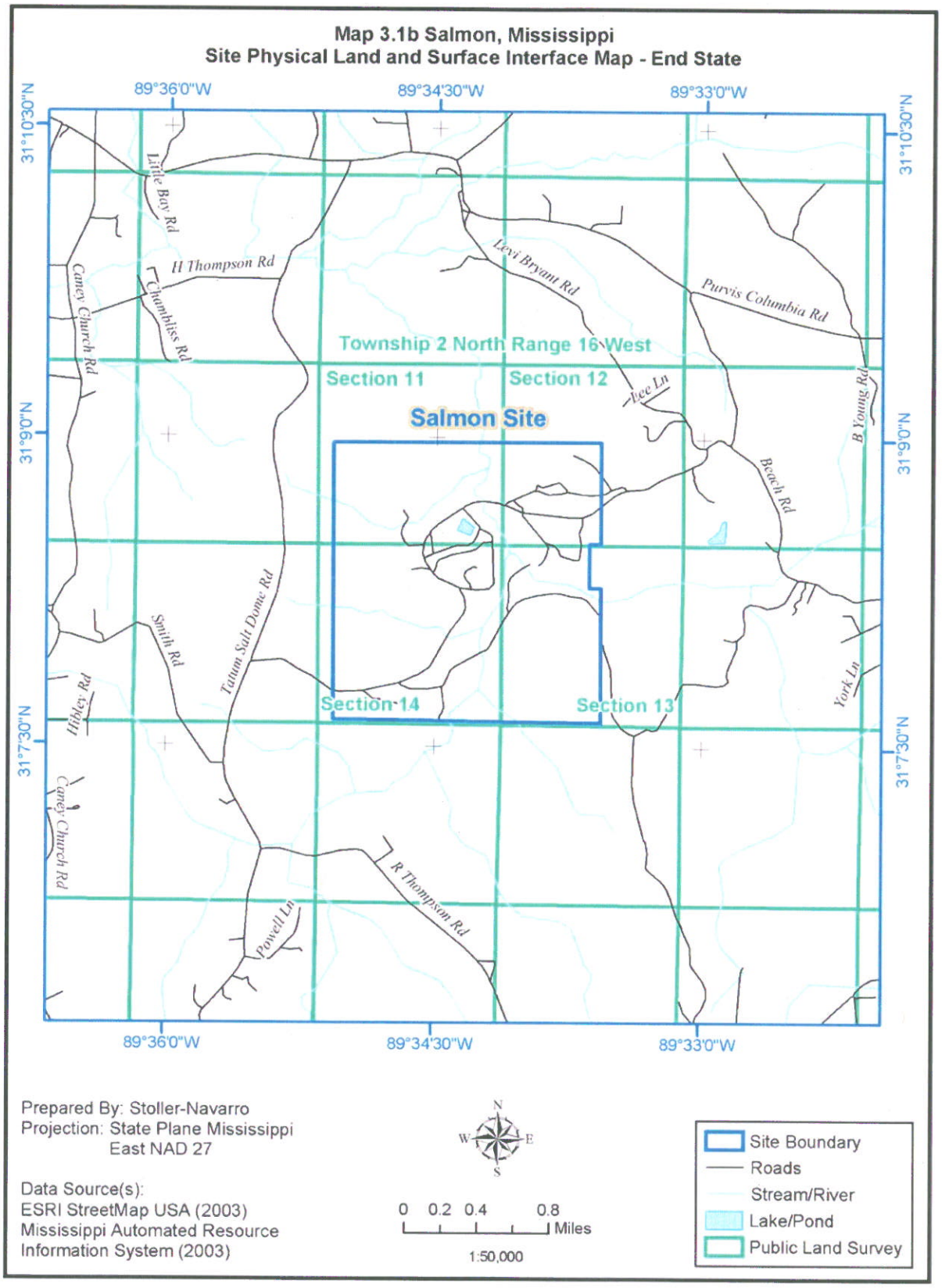
The Tatum Salt Dome is located in south-central Mississippi, approximately 20 miles southwest of the city of Hattiesburg. The Salmon Site directly overlies the Tatum Salt Dome and encompasses approximately 1,470 acres in Sections 11, 12, 13, and 14 of Township 2 North, Range 16 West, St. Stephens Meridian (Map 3.1b). The Salmon Site is partially fenced and is surrounded by privately owned parcels.

The initial 1995 evaluation at the site identified six source areas, designated as follows:

- Source Area 1 –Surface Ground Zero
- Source Area 2 – Northern Disposal Area
- Source Area 3 – Southern Disposal Area
- Source Area 4 - Western Disposal Area
- Source Area 5 – Injection Well Area
- Source Area 6 – Helicopter Pad and Storage area[1]

Each of these areas, depicted on Map 4.0b, has been declared clean closed, and the State of Mississippi requires no further action (Weathersby, 2003). The State has accepted the closure report, pending issuance of the final report.

[1] Source Area 6 is outside the Salmon Site boundary and is on private land. It will not be part of the surface area turned over to the State of Mississippi for the demonstration forest and wildlife refuge.

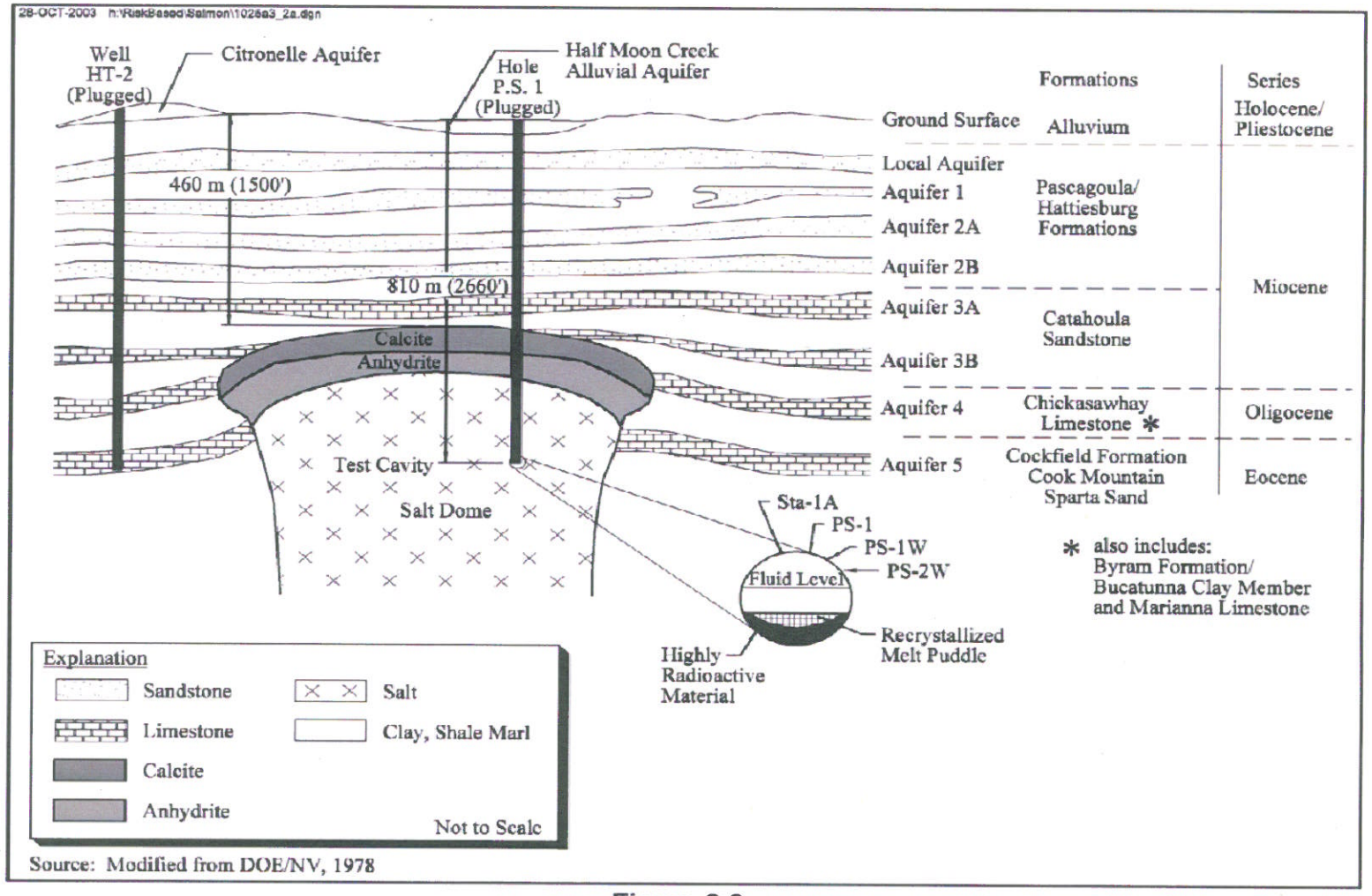

Map 3.1b Salmon, Mississippi
Site Physical Land and Surface Interface Map - End State
89°36'0"W
89°34'30"W
89°33'0"W
31°10'30"N
31°9'0"N
31°7'30"N
Little Bay Rd
H Thompson Rd
Chomhliss Rd
Caney Church Rd
Levi Bryant Rd
Purvis Columbia Rd
Township 2 North Range 16 West
Section 11
Section 12
Lee Ln
Salmon Site
B Young Rd
Beach Rd
Tatum Salt Dome Rd
Smith Rd
Hibler Rd
Section 14
Section 13
York Ln
R Thompson Rd
Powell Ln
Prepared By: Stoller-Navarro
Projection: State Plane Mississippi East NAD 27
Data Source(s):
ESRI StreetMap USA (2003)
Mississippi Automated Resource Information System (2003)
N
W
E
S
0 0.2 0.4 0.8 Miles
1:50,000
Site Boundary
Roads
Stream/River
Lake/Pond
Public Land Survey

Three near-surface aquifers identified at the Salmon Site include the Upper Aquifer, the Citronelle Aquifer, and the Half Moon Creek Alluvial Aquifer (Figure 3.0). These shallow aquifers, along with the surface and shallow subsurface soil and surface water, comprise Operable Unit 1 (OU-1) at the Salmon Site. In the vicinity of the Salmon Site, the Citronelle Aquifer is primarily in a red-orange silty sand formation. The Citronelle Formation is approximately 80 ft in maximum thickness and crops out on the slopes and tops of hills at the Salmon Site, above the 250 ft contour. The Half Moon Creek Alluvial Aquifer predominantly consists of alluvial deposits with more coarse-grained gravels and sands, and is limited to the reaches of the major drainages. For the purposes of this report, the Upper Aquifer, Citronelle Formation, and Half Moon Creek Alluvial Aquifer are combined and referred to as the Alluvial Aquifer.

The near-surface aquifers are a minor source of water for domestic and stock wells and account for about two percent of the groundwater pumped in Lamar County. Recharge to this aquifer is derived directly from precipitation over the aquifer. Flow is from the highland areas toward local discharge areas represented by springs, creeks, and ponds. This accounts for the large base flow common to streams in the area. Downward leakage of water from the near-surface aquifers into the underlying Miocene aquifers also occurs (DOE/NV, 1999).

The Local Aquifer and Aquifers 1, 2a, 2b, 3a, and 3b comprise Operable Unit 2 (OU-2) at the Salmon Site. The Local Aquifer occurs at depths of 150 ft bgs in the vicinity of SGZ and is about 100 ft thick (Figure 3.0). On a regional basis, flow in this aquifer is generally to the southwest. In the vicinity of the Salmon Site, the groundwater flow direction in the Local Aquifer is approximately south-southwest and may be influenced by local geologic conditions. Recharge to this aquifer is derived from precipitation, with discharge to major streams that drain southern Mississippi. The Local Aquifer is an important potable and non-potable water supply source in Lamar County (DOE/NV, 1999).

Aquifers 1, 2a, and 2b comprise individual water bearing zones of the undifferentiated deposits of the Pascagoula and Hattiesburg Formations. These units are believed to be continuous across the Salmon Site and are separated by discontinuous clay beds that serve as aquitards. Many existing water supply wells in Lamar County use groundwater from one or more of these aquifers.



Source: Modified from DOE/NV, 1978

Figure 3.0
Salmon Site Geologic Cross-Section Showing Tatum Salt Dome, the Test Cavity, Aquifers, and Representative Stratigraphic Column

In the vicinity of SGZ, the depth to the top of Aquifer 1 is 340 ft bgs and the aquifer is approximately 60 ft thick. Aquifer 2a is approximately 80 ft thick and begins at a depth of approximately 445 ft. The top of Aquifer 2b is approximately 600 ft bgs and is approximately 90 ft thick.

The direction of groundwater flow through these aquifers is variable, reflecting both the regional flow system and local perturbations. Regional flow through this aquifer is to the southeast, south, and southwest (DOE/NV, 1999).

Aquifer 3a, in the upper part of the Catahoula Sandstone Formation, is approximately 100 ft thick and lies approximately 775 ft beneath SGZ. Off the flanks of the dome, the aquifer thickens to 200 ft or more. Aquifer 3a is the deepest freshwater aquifer in southern Lamar County and is the deepest water supply aquifer used in the area. Regional groundwater flow in this aquifer is generally to the southeast, south, or southwest. At the Salmon Site, the direction of groundwater flow in this aquifer is to the east/northeast (DOE/NV, 1999).

Aquifer 3b is the Tatum Limestone Member of the Catahoula Sandstone Formation. This unit is not present over the Tatum Salt Dome, but does occur in the subsurface on the flanks of the dome, at depths in excess of 875 ft. Its thickness ranges from about 100 ft near the salt dome to about 200 ft in thickness approximately 1,500 ft on the lateral sides of the salt dome. No site-specific data is available on the direction of flow in Aquifer 3b; however, on a regional scale, the flow direction is to the southwest (DOE/NV, 1999).

Aquifers 4 and 5 comprise Operable Unit 3 (OU-3) at the Salmon Site. Unlike the overlying aquifers, Aquifer 4 receives its recharge primarily over its outcrop area, a relatively narrow band extending from near Vicksburg on the west to central Wayne County on the east. Groundwater in Aquifer 4 is derived from precipitation in Clarke and Jasper Counties and the flow is to the south-southwest. Aquifer 4 is not typically a source of drinking water in Lamar County; consequently, only a limited number of potential receptors may be currently withdrawing water from the aquifer. Aquifer 4 qualifies as a drinking water source because the total dissolved solids concentration is less than 3,000 parts per million (DOE/NV, 1999).

The Cook Mountain Formation aquifer (designated aquifer 5 at the site) is not considered a freshwater aquifer. Typically, the Cook Mountain Formation is approximately 280 ft thick in the Mississippi Salt Basin. Within the vicinity of the Salmon Site, this unit is approximately 200 ft thick. Two wells constructed in Source Area 5 (HT-1 and HT-2) penetrate the full thickness of

Aquifer 5. In Well HT-2 (approximately 1 mi southwest of the monument), the aquifer portion of the Cook Mountain Formation is 174 ft thick and consists of interbedded gray, fine to coarse-grained limestone and gray to greenish-gray clays. Because of the saline groundwater present in Aquifer 5, this aquifer has been used for the injection of wastewater streams, predominately by the oil and gas industry. Due to the injection of wastewater into Aquifer 5, the direction of flow has been altered. Under natural conditions, the flow through the Cook Mountain Aquifer is to the southeast. However, at the Salmon Site, the pressure gradient induced by the injection of wastewaters into Aquifer 5 has reversed the flow and it is currently to the northeast (DOE/NV, 1999).

3.2 Human and Ecological Land Use

Human Land Use

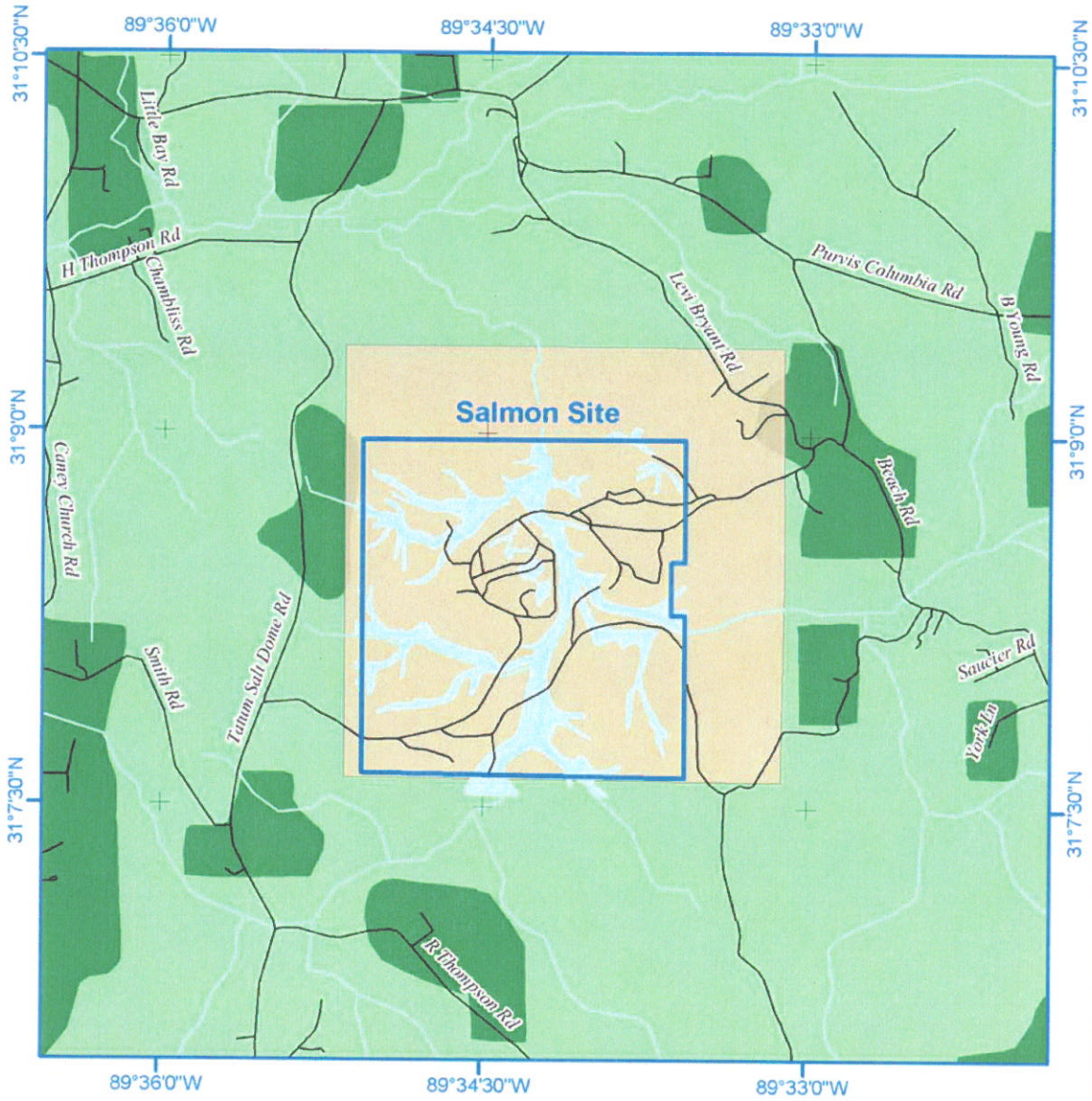
The DOE/NSO owns the Salmon Site and will not allow a permanent residence to be established on the site. There is currently a 1,470-acre drilling restriction for the entire Salmon Site. Based on an Act of Congress (Section 2851[b] of Part IV of PL 104-201, "National Defense Authorization Act of Fiscal Year 1997" [U.S. Public Laws, 1996]), the DOE may transfer the Salmon Site to the State of Mississippi to be used as a wildlife refuge and demonstration forest. Part of the site transfer will include deed restrictions stating that the site cannot be transferred to private owners, and no permanent residences will be allowed on the site (NNSA/NV, 2002).

Subsurface use restrictions in the vicinity of the Salmon Site test cavity will remain in place in perpetuity. These restrictions, shown on Map 3.2b, are described on the permanent monument located at SGZ on the site. The restrictions are as follows:

> "No excavation, drilling, and/or removal of materials is permitted without U.S. Government permission to penetrate below mean sea level on the 1,470 acre tract situated within sections 11, 12, 13 and 14, T2N, R16W, ST. Stephens Meridian, Mississippi" (Johnston, 2003a).

Permanent deed restrictions for surface and subsurface use restrictions in the Master Title Plat for the land encompassing the Salmon Site have not been finalized. Final use restrictions will be determined and recorded by the LM, with concurrence from the State of Mississippi.

Map 3.2b Salmon, Mississippi
Site Human and Ecological Land Use Map - End State



Prepared By: Stoller-Navarro
Projection: State Plane Mississippi East NAD 27

Data Source(s):
ESRI StreetMap USA (2003)
Mississippi Automated Resource Information System (2003)
USGS Land Cover/Land Use

N
W E
S

0 0.2 0.4 0.8 Miles
1:50,000

- Site Boundary
- Road
- Water
- Wetlands
- Non-Agricultural Vegetated
- Agricultural
- Area of Subsurface Drilling Restriction

Additional restrictions will include a ban on the installation of domestic drinking water wells on the site. The emplacement of these restrictions will limit the site to recreational use and periodic inspections by a park ranger or site custodian (NNSA/NSO, 2003).

A cultural resources investigation was conducted on the Salmon Site in 1992, and four locales of cultural significance or potential cultural significance were identified. The report recommended avoidance as the preferred means of protecting any identified archeological resources or possible resources at the Salmon Site. If disturbance is necessary, additional testing should be conducted to determine the degree of impact the proposed work would have. Disturbance of culturally significant areas within the Salmon Site is unlikely given its planned future land use as a wildlife preserve and demonstration forest.

The U.S. Government currently owns the mineral rights for the Salmon Site. No current oil or gas leases were noted and no record of water wells other than those used for monitoring were indicated in the historical files (NNSA/NSO, 2003).

The DOE/NSO developed a public participation plan for the Salmon Site End State Vision. The plan provided a draft copy of this document, an information sheet, and a letter soliciting feedback by July 1, 2004, to involved parties and stakeholders. All written comments that were submitted to the DOE/NSO received comment resolution.

Ecological Land Use

The Salmon Site has largely reverted to its original state and there is little visible indication of past DOE activities. The areas where soils were excavated have been backfilled and seeded, and there is a well-established cover of vegetation (DOE/NV, 1999). Wildlife is also abundant at the test site. Considering the similarity of the Salmon Site to the surrounding areas in the longleaf pine belt, it is unlikely that the site is a crucial habitat for the survival of any species (DOE/NV, 1992b). The planned future use of the Salmon Site as a wildlife preserve and demonstration forest is consistent with the end state and will protect both wildlife and plant species at the site.

Numerous environmental resources are present in Lamar County. Forests provide recreation, aesthetic enjoyment, and a habitat for wildlife. Timber harvesting is also an important component in both environmental and economic resources for Lamar County. The many creeks and streams provide habitats for riparian vegetation and animals. There are 16 flora species and 20 fauna species existing in Lamar County that are state or federal candidates for either proposed endangered, threatened, rare, or otherwise significant species. A threatened and endangered

protected species study was completed in 1992. The gopher tortoise (Gopherus polyphemus) was the only species inhabiting this area that was identified as being threatened or endangered (NNSA/NV, 2002).

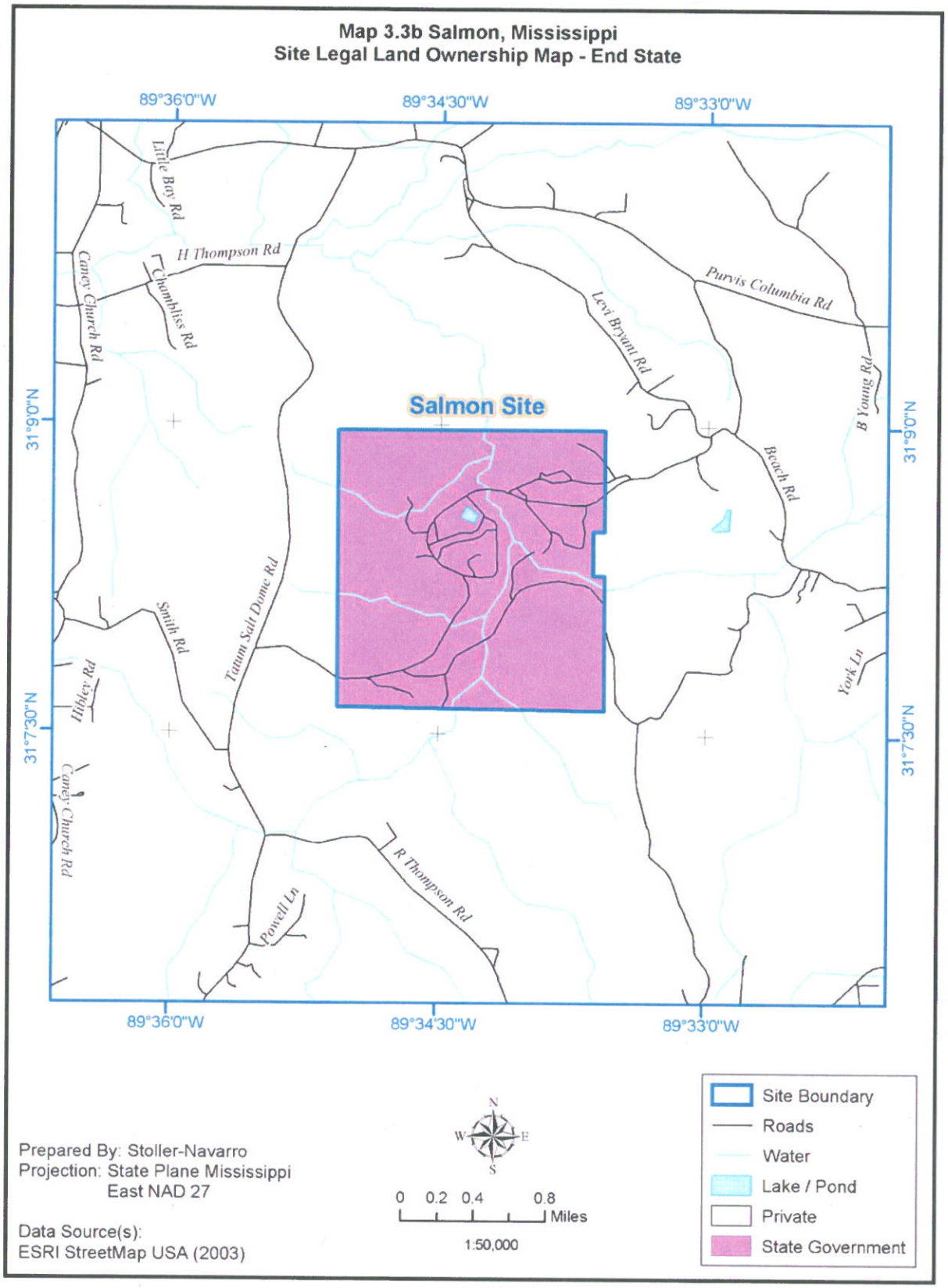
The presence and type of wetlands delineated were based on information obtained from a U.S. Geological Survey topographic map (USGS, 1990), aerial photographs of the site dated March 13, 1991, and actual field investigation/verification. National Wetlands Inventory maps do no exist for the area (DOE/NV, 1992a).

3.3 Site Context Legal Ownership

The land for the Salmon Site was purchased from the Tatum Lumber Company as noted in the Warranty Deed Conveying Fee and Easement, filed on December 2, 1994, and is now owned by the U.S. Government (Map 3.3b). The agency listed on the deed is the U.S. Department of the Army, Mobile District, Corps of Engineers. The deed states that the property is subject to all oil, gas, and mineral rights outstanding in third parties. However, the mineral rights were purchased by the AEC in 1962 and 1963. The deed includes a 40-ft right of way within Sections 14 and 15 for surface removal of all trees, underbrush, and other vegetation, structures, or obstacles within the right of way. With this deed, the owner has all rights to surface and subsurface resources subject to outstanding third party rights, if any (Johnston, 2003a). The Salmon Site is partially fenced and the area surrounding the property consists of privately owned parcels of land.

The DOE has funded Lamar County to extend the existing regional water supply system to residents in the vicinity of the Salmon Site. As part of the installation of this system, Lamar County will require all existing and new residences with access to the water supply system to connect to the system. The operation and maintenance of this system will be the responsibility of Lamar County and/or local water supply franchises (NNSA/NV, 2002).

After the site is transferred, general site maintenance and development will be the responsibility of the State of Mississippi. The long-term groundwater monitoring will remain the responsibility of the DOE.

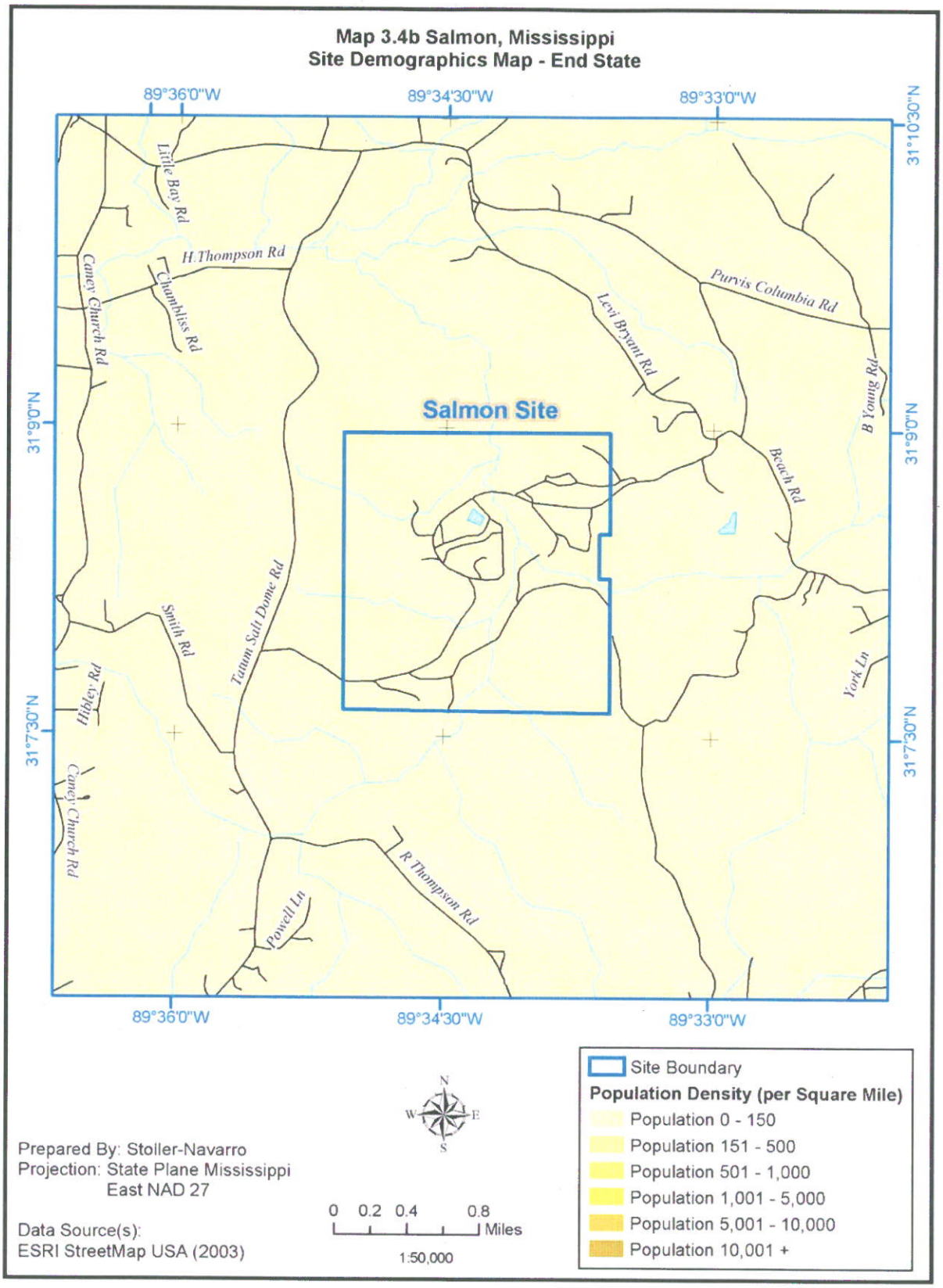

Map 3.3b Salmon, Mississippi
Site Legal Land Ownership Map - End State
89°36'0"W
89°34'30"W
89°33'0"W
31°9'0"N
31°7'30"N
Little Bay Rd
H Thompson Rd
Caney Church Rd
Chambliss Rd
Levi Bryant Rd
Purvis Columbia Rd
B Young Rd
Salmon Site
Beach Rd
Tatum Salt Dome Rd
Smith Rd
Hibley Rd
York Ln
Caney Church Rd
R Thompson Rd
Powell Ln
Prepared By: Stoller-Navarro
Projection: State Plane Mississippi East NAD 27
Data Source(s):
ESRI StreetMap USA (2003)
N
W
E
S
0 0.2 0.4 0.8 Miles
1:50,000
Site Boundary
Roads
Water
Lake / Pond
Private
State Government

3.4 Site Context Demographics

The Salmon Site is partially fenced and is surrounded by privately owned parcels. Although the site is abandoned and posted, local hunters often use the site for access to hunting leases adjacent to the Salmon Site (NNSA/NSO, 2003). Nearby areas of urban development include Lumberton, Hattiesburg, and Purvis (Map 3.4b). All three communities use land for residential, commercial, and industrial purposes (DOE/NV, 1992a). Lamar County is a rural community with a growing population of diverse social and cultural characteristics. However, economic limitations hinder the region's overall development. As of 2000, the population of the county and communities surrounding the Salmon Site were as follows (U.S. Census Bureau, 2000):

Lamar County	39,070
Purvis	2,164
Lumberton	2,228
Hattiesburg	6,305

The timber, cattle, and oil industries dominate the local economy. Major employers for Lamar County include Tatum Lumber Company, the Southland Oil Company, and Chevron, USA, Inc. (DOE/NV, 1992a).


Map 3.4b Salmon, Mississippi
Site Demographics Map - End State
89°36'0"W
89°34'30"W
89°33'0"W
31°10'30"N
31°9'0"N
31°7'30"N
Little Bay Rd
H.Thompson Rd
Caney Church Rd
Chambliss Rd
Levi Bryant Rd
Purvis Columbia Rd
B Young Rd
Salmon Site
Beach Rd
Tatum Salt Dome Rd
Smith Rd
Hibley Rd
York Ln
R Thompson Rd
Powell Ln
Site Boundary
Population Density (per Square Mile)
Population 0 - 150
Population 151 - 500
Population 501 - 1,000
Population 1,001 - 5,000
Population 5,001 - 10,000
Population 10,001 +
N
W
E
S
0 0.2 0.4 0.8 Miles
1:50,000
Prepared By: Stoller-Navarro
Projection: State Plane Mississippi East NAD 27
Data Source(s):
ESRI StreetMap USA (2003)

4.0 Hazard-Specific Discussion

In 1998, the DOE completed site characterization and issued the *Salmon Site Remedial Investigation Report, Lamar County, Mississippi*, Rev. 1 (DOE/NV, 1999). Characterization results and risk calculations indicated that the site does not pose a significant current or future risk to human health and/or the environment under planned use scenarios.

Based on the physical layout of the Salmon Site and the types of activities conducted there, the site was divided into six source areas in the RI, as shown on Map 4.0b:

- Source Area 1 - Surface Ground Zero
- Source Area 2 - Northern Disposal Area
- Source Area 3 - Southern Disposal Area
- Source Area 4 - Western Disposal Area
- Source Area 5 - Injection Well Area
- Source Area 6 - Helicopter Landing Pad and Storage Area

Table 4.0 summarizes the Areas of Concern (AOC) that were characterized as part of the RI, and lists the COCs in each area. The RI eliminated many sites as source areas, while others were remediated, removed, or determined through human health risk assessment not to be a significant risk to future land users if existing surface institutional controls and subsurface restrictions are maintained. No surface soil source areas remain at the Salmon Site. The only remaining hazards at the Salmon Site are subsurface soil and groundwater. Restrictions have been placed on subsurface digging and drilling to manage subsurface groundwater exposure concerns.

Based on the characterization and risk assessment results for the Salmon Site, two areas listed in Table 4.0 have been identified as locations of continued potential concern. These areas include subsurface soils in the area of the SGZ mud pits in Source Area 1 and groundwater in the Alluvial and Local Aquifers. The *Salmon Site Restoration Plan* (NNSA/NV, 2002) identified and evaluated feasible remediation alternatives and recommended remedial actions for the site.

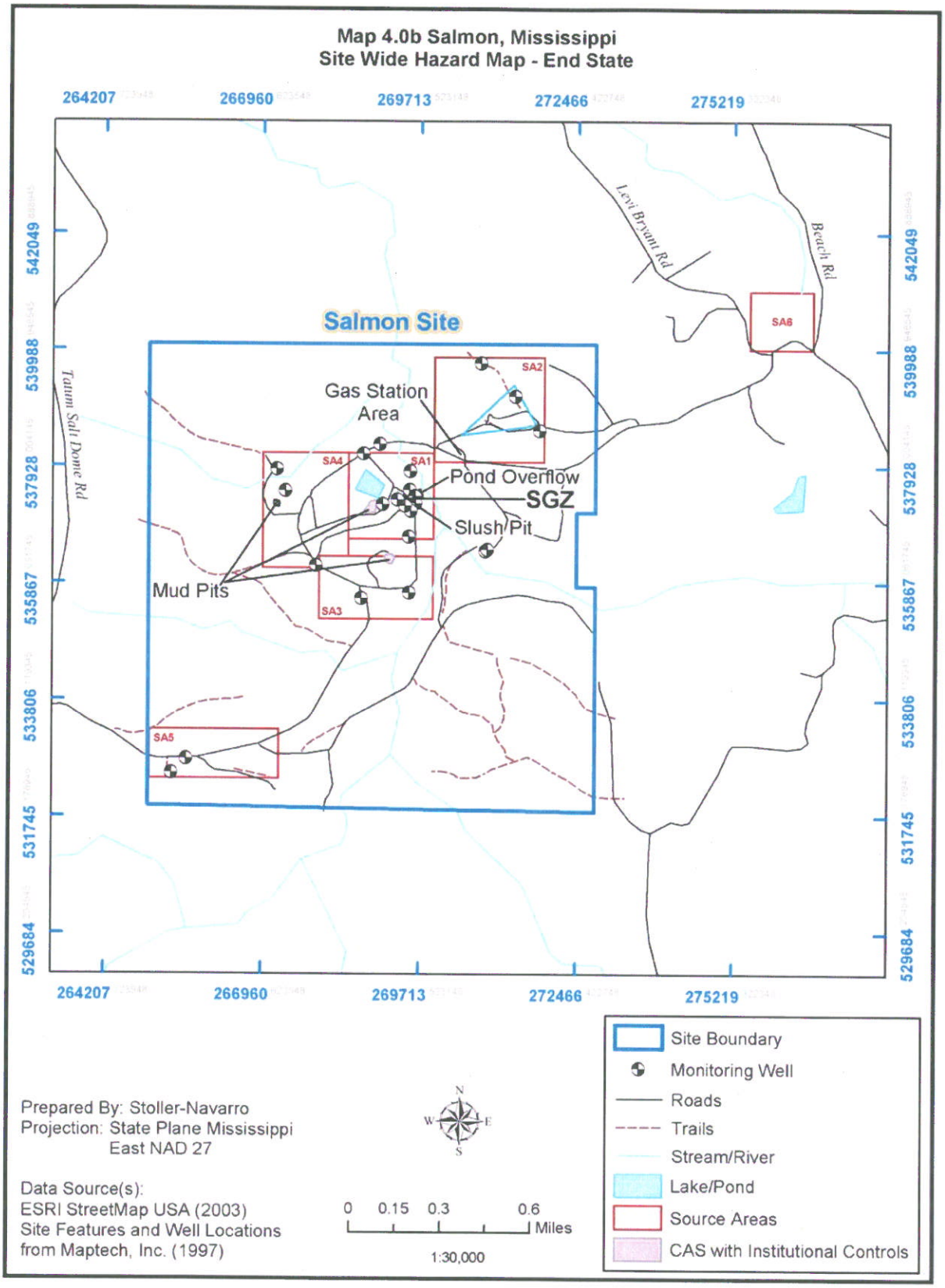

Map 4.0b Salmon, Mississippi
Site Wide Hazard Map - End State
264207
266960
269713
272466
275219
542049
539988
537928
535867
533806
531745
529684
Salmon Site
Gas Station Area
Pond Overflow
SGZ
Slush Pit
Mud Pits
SA1
SA2
SA3
SA4
SA5
SA6
Tatum Salt Dome Rd
Levi Bryant Rd
Beach Rd
Site Boundary
Monitoring Well
Roads
Trails
Stream/River
Lake/Pond
Source Areas
CAS with Institutional Controls
Prepared By: Stoller-Navarro
Projection: State Plane Mississippi East NAD 27
Data Source(s):
ESRI StreetMap USA (2003)
Site Features and Well Locations from Maptech, Inc. (1997)
0 0.15 0.3 0.6 Miles
1:30,000

Table 4.0
List of Source Areas, Individual Sites, and
Contaminants of Concern for the Salmon Site, Lamar County, Mississippi

Source Area Description	Area of Concern (AOC)	Site Name	Contaminants of Concern (COC)	RI/Risk Assessment Findings, Institutional Controls, and/or Subsurface Restrictions	Closure Status	Total Risk Excluding Background Radionuclides for Each Source Area
1. Surface Ground Zero	1-A	Station 1-A Mud Pit	Organics and metals	Did not present a risk to human health or environment based on planned use scenarios	No Further Action	**Soils:** Recreational – 4.8×10^{-7} Wildlife Refuge – 3.5×10^{-7}
	1-B	Beaver Pond	1993 sampling indicated no COCs present Tritium below 400 pCi/L; lead^{212}, radium, and uranium at reference sample levels		No Further Action	
	1-C	Half Moon Creek Overflow Pond	Tritium below EPA drinking water levels, 1993 sampling gross alpha below maximum detectable activity; no other COCs in water samples Chromium and lead were detected in sediment samples	Did not present a risk to human health or environment based on planned use scenarios	No Further Action	
	1-D	Post Shot No. 1 Slush Pit and "Mouse Hole" – recess excavated	Tritium, radionuclides, and drilling fluids	Pit was excavated to a depth of 8 ft, backfilled with clean dirt, and	No Further Action	

Table 4.0
List of Source Areas, Individual Sites, and
Contaminants of Concern for the Salmon Site, Lamar County, Mississippi

Source Area Description	Area of Concern (AOC)	Site Name	Contaminants of Concern (COC)	RI/Risk Assessment Findings, Institutional Controls, and/or Subsurface Restrictions	Closure Status	Total Risk Excluding Background Radionuclides for Each Source Area
		below the floor of the rig deck used as a holding place for the next drill pipe		decommissioning activities ceased		
	1-E	Bleed-Down Plant Area	Possible residual radioactive contamination from radioactive gas treatment plant	Not identified; removed from list of AOCs	No Further Action	
	1-F	East Electrical Substation	Polychlorinated biphenyls	Excavation of soils at SGZ removed any Polychlorinated biphenyl contamination present at the site	No Further Action	
	1-G	E-14 Pad and Mud Pits	Barium, cadmium, chromium, lead exceeded maximum contaminant levels (MCLs) in water samples Gross alpha and beta exceeded MCLs in soil samples	Eliminated as a COC – Table 5-1, 1995 *Baseline Ecological Risk Assessment, Salmon Site, Lamar County, Mississippi* (DOE/NV, 1995a) Eliminated as a COC – Table 5-5, 1995 *Baseline Ecological Risk Assessment, Salmon Site, Lamar County, Mississippi* (DOE/NV, 1995a)	No Further Action	

Table 4.0
List of Source Areas, Individual Sites, and
Contaminants of Concern for the Salmon Site, Lamar County, Mississippi

Source Area Description	Area of Concern (AOC)	Site Name	Contaminants of Concern (COC)	RI/Risk Assessment Findings, Institutional Controls, and/or Subsurface Restrictions	Closure Status	Total Risk Excluding Background Radionuclides for Each Source Area
	1-H	E-6 Decontamination Pad (included a sump)	No COCs identified in 1993 sampling			
	1-I	Post Test No. 2 Mud Pit	1993 sampling indicated chromium and lead exceeded MCLs in water samples	Eliminated as a COC – Table 5-1, 1995 *Baseline Ecological Risk Assessment, Salmon Site, Lamar County, Mississippi* (DOE/NV, 1995a)	No Further Action	
			Gross alpha and beta exceeded MCLs	Eliminated as a COC – Table 5-5, 1995 *Baseline Ecological Risk Assessment, Salmon Site, Lamar County, Mississippi* (DOE/NV, 1995a)	Included in LTHMP	
			Tritium in water exceeded 50,000 pCi/L	Natural attenuation		
	1-J	E-3/E-9 Drill Site	No COCs			
2. Northern Disposal Area	2-A	Reynolds Electrical and Engineering Company Disposal Pits	1993 sampling indicated tritium below 2,000 pCi/L in water samples	Eliminated as COC – Table 5-1, 1995 *Baseline Ecological Risk Assessment, Salmon Site, Lamar County, Mississippi*	Included in LTHMP	**Soils:** Recreational – 4.8×10^{-10} Wildlife Refuge – 4.8×10^{-10}
			Barium, chromium,			

Table 4.0
List of Source Areas, Individual Sites, and
Contaminants of Concern for the Salmon Site, Lamar County, Mississippi

Source Area Description	Area of Concern (AOC)	Site Name	Contaminants of Concern (COC)	RI/Risk Assessment Findings, Institutional Controls, and/or Subsurface Restrictions	Closure Status	Total Risk Excluding Background Radionuclides for Each Source Area
			lead, nickel exceeded MCLs in water samples	(DOE/NV, 1995a)		
	2-B	Debris Disposal Pits	Metals	Did not present a risk to human health or the environment based on planned use scenarios	No Further Action	
	2-C	Clean Burn Pit	Gross alpha and beta exceeded MCLs in water samples	Eliminated as a COC – Table 5-1, 1995 *Baseline Ecological Risk Assessment, Salmon Site, Lamar County, Mississippi* (DOE/NV, 1995a)	No Further Action	
			Gross alpha and beta exceeded reference soil sample	Eliminated as a COC – Table 5-5, 1995 *Baseline Ecological Risk Assessment, Salmon Site, Lamar County, Mississippi* (DOE/NV, 1995a)		
	2-D	Gas Station	Arsenic, chromium, and lead exceeded contract required detection limits in soil samples	Eliminated as a COC – Table 5-5, 1995 *Baseline Ecological Risk Assessment, Salmon Site, Lamar County, Mississippi* (DOE/NV, 1995a)	No Further Action	

Table 4.0
List of Source Areas, Individual Sites, and
Contaminants of Concern for the Salmon Site, Lamar County, Mississippi

Source Area Description	Area of Concern (AOC)	Site Name	Contaminants of Concern (COC)	RI/Risk Assessment Findings, Institutional Controls, and/or Subsurface Restrictions	Closure Status	Total Risk Excluding Background Radionuclides for Each Source Area
3. Southern Storage Area	3-A	Mud Storage Pits/South Borrow Pit	Barium, chromium, and lead exceeded MCLs in water samples	Eliminated as a COC – Table 5-1, 1995 *Baseline Ecological Risk Assessment, Salmon Site, Lamar County, Mississippi* (DOE/NV, 1995a)	No Further Action	**Soils:** Recreational – 4.6×10^{-7} Wildlife Refuge – 4.6×10^{-7}
	3-B	Big Chief Drilling Storage Area	No COCs identified in 1993 sampling		No Further Action	
	3-C	E-2 and E-7 Areas	Alpha activities exceeded reference values by approximately 2.5 times		No Further Action	
	3-D	Government Storage Area 1 (drilling storage yard)	No COCs identified in samples		No Further Action	
	3-E	Government Storage Area 2	1993 sampling indicated arsenic, barium, chromium, and lead exceeded contract required detection limits in soil samples	Eliminated as a COC – Table 5-5, 1995 *Baseline Ecological Risk Assessment, Salmon Site, Lamar County, Mississippi* (DOE/NV, 1995a)	No Further Action	
	3-F	Sewage Disposal Tank	Tank not found		No Further Action	
	3-G	Station 4 and W.P. 4 Drilling Sites	No COCs identified in samples		No Further Action	
4. Western Disposal	4-A	Reserve Mud Pits	No COCs identified		No Further Action	**Soils:**

Table 4.0
List of Source Areas, Individual Sites, and
Contaminants of Concern for the Salmon Site, Lamar County, Mississippi

Source Area Description	Area of Concern (AOC)	Site Name	Contaminants of Concern (COC)	RI/Risk Assessment Findings, Institutional Controls, and/or Subsurface Restrictions	Closure Status	Total Risk Excluding Background Radionuclides for Each Source Area
Area			in samples			Recreational – 3.8×10^{-10} Wildlife Refuge – 3.7×10^{-10}
	4-B	Debris Burial Pit	Chromium and lead exceeded MCLs in water samples	Eliminated as a COC – Table 5-1, 1995 *Baseline Ecological Risk Assessment, Salmon Site, Lamar County, Mississippi* (DOE/NV, 1995a)	No Further Action	
			Gross alpha and beta exceeded maximum detectable activity in soil samples	Eliminated as a COC – Table 5-5, 1995 *Baseline Ecological Risk Assessment, Salmon Site, Lamar County, Mississippi* (DOE/NV, 1995a)	No Further Action	
	4-C	West Electrical Substation	Chromium and lead exceeded MCLs in soil samples	Eliminated as a COC – Table 5-5, 1995 *Baseline Ecological Risk Assessment, Salmon Site, Lamar County, Mississippi* (DOE/NV, 1995a)	No Further Action	
	4-D	CH Fuel Storage Area	No COCs identified in 1993 sampling		No Further Action	
	4-E	Cable Storage Area	No COCs identified in 1993 sampling		No Further Action	

Table 4.0
List of Source Areas, Individual Sites, and
Contaminants of Concern for the Salmon Site, Lamar County, Mississippi

Source Area Description	Area of Concern (AOC)	Site Name	Contaminants of Concern (COC)	RI/Risk Assessment Findings, Institutional Controls, and/or Subsurface Restrictions	Closure Status	Total Risk Excluding Background Radionuclides for Each Source Area
	4-F	South Electrical Substation	No COCs identified in 1993 sampling		No Further Action	
	4-G	North Electrical Substation	No COCs identified in 1993 sampling		No Further Action	
	4-H	E-5 Drill Site	No COCs identified in 1993 sampling		No Further Action	
5. Injection Well Area	5-A	Well HT-2	Well was plugged in 1971	Completed new monitoring wells for OU-3	Included in LTHMP	**Soils:** Recreational – 8.3×10^{-9} Wildlife Refuge – 6.9×10^{-9}
	5-B	Well HT-2m	Well was plugged in 1972	Completed new monitoring wells for OU-3	Included in LTHMP	
6. Helicopter Pad and Storage Area	6-A	Helicopter Pad and Storage Area	No COCs detected in surface soil		No Further Action	**Soils:** Recreational – 8.6×10^{-12} Wildlife Refuge – 4.3×10^{-8}

According to the Salmon Site RI Report, contaminants were detected at the site in concentrations that do not present a significant risk to existing and/or future land users, if surface institutional controls and subsurface restrictions are maintained. Soil and water samples taken from below the water table at the SGZ mud pits contained contamination, primarily trichloroethylene (TCE) and tritium. Surface contamination was not encountered at the SGZ mud pits, and no other significant surface or shallow subsurface contamination was detected at other source areas. The test cavity resulting from the detonation is contaminated and cannot be economically remediated with existing technologies. No biological uptake of contaminants was detected in the plants or animals sampled (DOE/NV, 1999).

Arsenic was not detected above the maximum contaminant level (MCL) of 50 micrograms per liter [μg/L] for drinking water in groundwater samples collected in 1999 and 2002. Arsenic was not sampled during the 2003 season because DOE and the State concluded that it was naturally occurring and not a result of DOE activities. Therefore, arsenic is not retained as a COC in groundwater at the site.

Laboratory results from soil samples indicate that tritium and TCE are at a higher concentration inside the SGZ mud pits than outside. The laboratory results also confirm that the contaminants are naturally decaying (decreasing in concentrations) over time. Tritium has already decayed to below the MCL. Groundwater flow and transport modeling validated this observation and calculated that the TCE will naturally decay to below the MCL in significantly less time than is required for the contaminant to reach the site boundary. Section 5 of the Salmon Site RI Report gives a detailed analysis of the modeling conducted to confirm that natural attenuation and decay will prevent migration off site (DOE/NV, 1999).

As indicated by Table 4.0, risk levels for recreational use and use as a wildlife refuge are well below the regulatory target level of 10^{-6}. In September 2003, the State of Mississippi accepted clean closure of the Salmon Site and agreed that no further action is required (Weathersby, 2003). It is intended that, as a minimum, the surface institutional controls and subsurface restrictions currently in place will be maintained in perpetuity at the Salmon Site. The future plan for the site is to release the surface to the State of Mississippi for use as a wildlife refuge and working demonstration forest.

A CSM for the site is provided in Figure 4.0. The CSM illustrates the relationship between the identified potential sources of contamination, the mechanisms for release and migration away from the potential source, the pathways the contamination would follow once released, the

exposure routes by which potential contamination would affect receptors, and the receptors that would be impacted by potential contamination (NNSA/NV, 2002). Only areas that continue to have potential as a contamination source are included in the CSM.

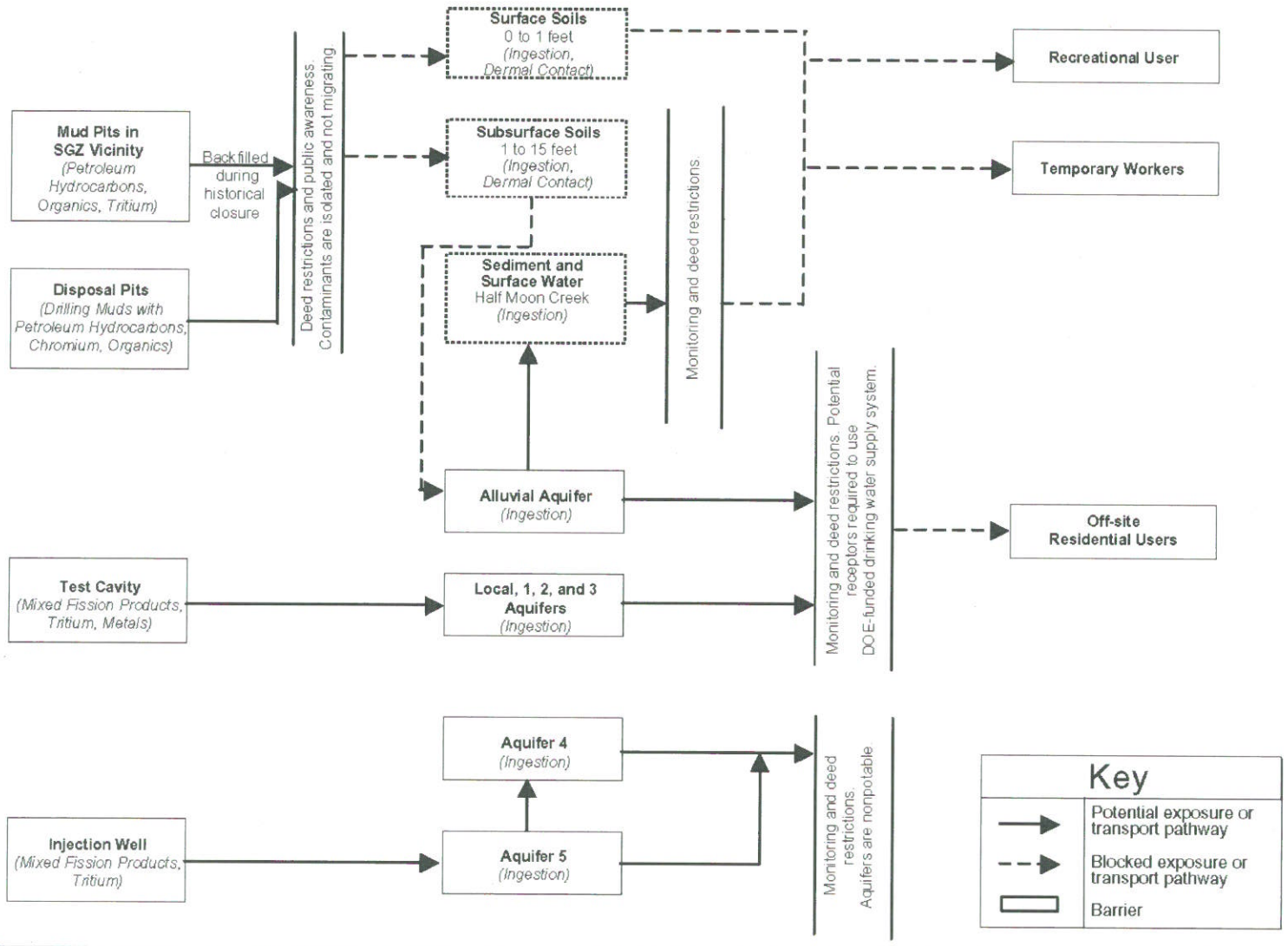
The surface and subsurface of the Salmon Site are in the end state; therefore, only the end state CSM and hazard-specific maps are presented in the hazard-specific sections.

In the hazard-specific discussion, source areas are presented as Operable Units, as designated in the Salmon Site RI Report (DOE/NV, 1999). For this report, Operable Units are defined as geographical units with the same potential source of contamination. Three operable units have been established, based on three primary sources of potential contamination through exposure to surface and subsurface soil and water.

As described in Section 3.1 of this document, OU-1 includes surface and near-surface soil, water, and shallow groundwater, while OU-2 and OU-3 include deep groundwater only. A complete discussion of the nature and extent of contamination at the Salmon Site is provided in Section 4.0 of the Salmon Site RI Report (DOE/NV, 1999). The RI results summary is presented below for each Operable Unit. A complete discussion of the nature and extent of contamination at the Salmon Site is also provided in Section 2.0 of the *Salmon Site Restoration Plan*, Rev. 1 (NNSA/NV, 2002).

Based on results of the baseline ecological risk assessment, the RI groundwater flow and transport model, and human health risk assessment, the risk for existing and future land-use scenarios at the Salmon Site is minimal (NNSA/NV, 2002). In the following sections, a hazard-specific map is presented for each Operable Unit. The CSM shows known and potential migration pathways at the site, and identifies potential receptors and barriers that have been put in place to limit or eliminate potential exposure to land users.

Figure 4.0 - Salmon Site Conceptual Site Model – Current State and End State



4.1 Operable Unit 1 – Surface and Near-Surface Soil and Shallow Groundwater

This operable unit consists of surface Source Areas 1 through 6, as defined in the Salmon Site RI Work Plan (DOE/NV, 1992a). Soil and groundwater samples were collected from each source area and the results are discussed in the Salmon Site RI Report (DOE/NV, 1999). This operable unit also includes a discussion of surface water and sediment samples collected from on-site surface water bodies and the alluvial aquifer.

Surface and subsurface soil samples were collected from the six identified source areas. The types of contaminants identified included metals, radionuclides, and organic compounds. Contaminants detected at the Salmon Site are primarily associated with the SGZ mud pits. This area is approximately 300 ft from SGZ. Remedial actions completed in 1972 included removal and disposal of contamination sources from the source areas at the Salmon Site. During the 1972 remedial action, sources of soil contamination were removed from the SGZ mud pits down to the top of the water table (approximately 6 ft). The only significant residual contamination remaining in the SGZ mud pits is below the water table and is being monitored by the EPA LTHMP. During the 1972 remedial action, the SGZ mud pit excavations were backfilled with clean soil to provide an effective barrier between the remaining material and surface areas. This soil barrier supports a vegetative cover and minimizes the potential for accidental contact with the contaminated residual material below the surface (DOE/NV, 1999). Based on sample results and other evidence from the RI, surface soil acting as a potential source has been mitigated and transport of residual contamination from the SGZ mud pits to the shallow aquifer is minimal.

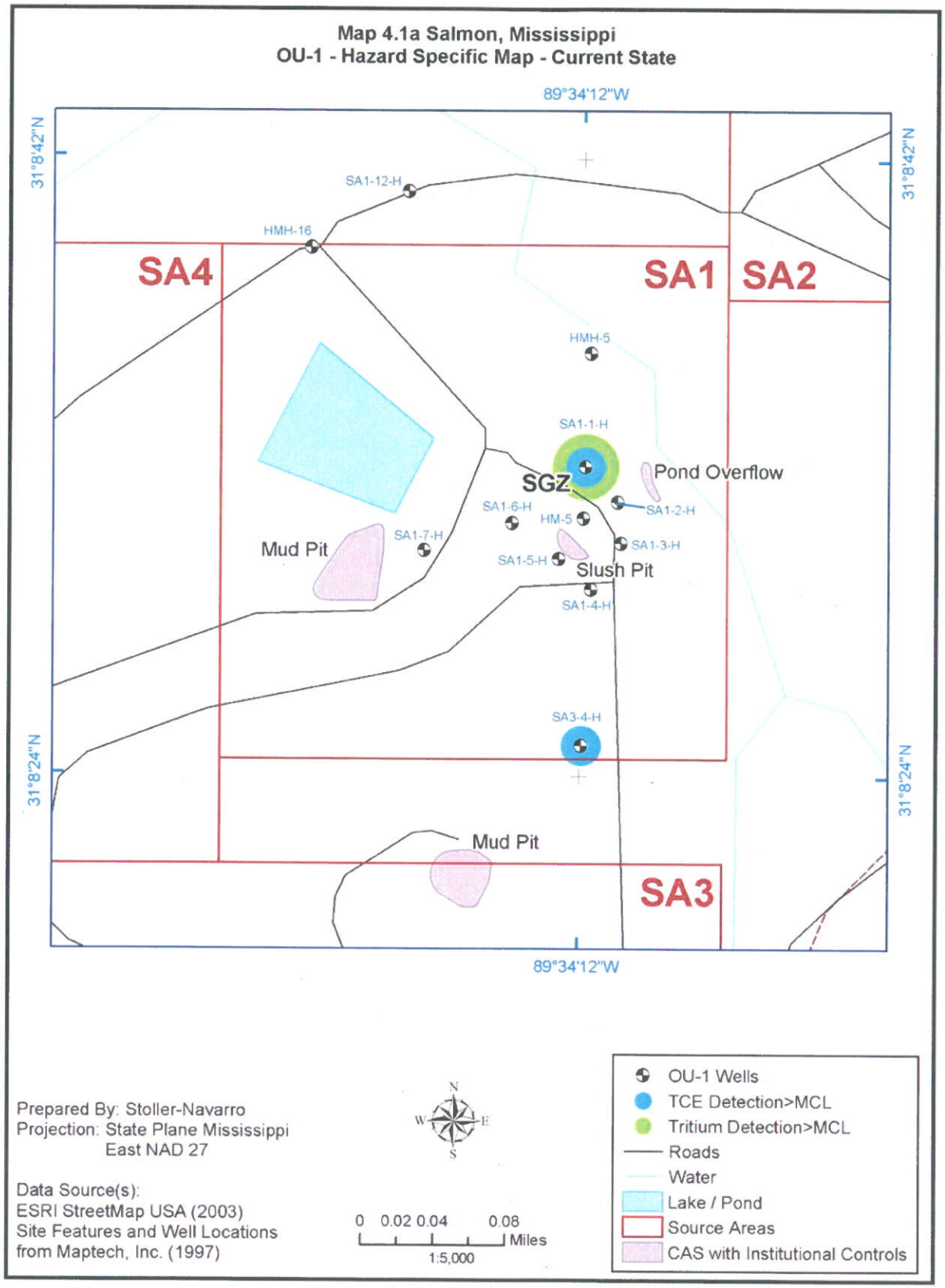
Three organic compounds (TCE, cis-1,2-Dichloroethane, and vinyl chloride [VC]) were detected above their respective MCLs in groundwater samples collected in 2002. Historical results of the primary constituent (TCE) show that concentrations in groundwater in Source Area 1 have decreased from 69 µg/L in 1995 to 9.8 µg/L in 2002, as result of natural attenuation. TCE was detected at 230 µg/L in one replacement monitoring well completed in Source Area 1 in 2002. The MCL for TCE is 5 µg/L. VOCs were not sampled in 2003; however, the State requested that they be retained as an analyte for the EPA LTHMP. In 2002, mercury was detected above the MCL (2 µg/L) in one groundwater monitoring well in Source Area 1, at a concentration of 11 µg/L. Metals were not sampled for in 2003, and they were not retained as COCs for the EPA LTHMP. In 2002, tritium was detected above the MCL (20,000 pCi/L) in one groundwater monitoring well in Source Area 1, at a concentration of 25,100 pCi/L (Map 4.1a) (NNSA/NSO, 2003). The highest tritium concentration (18,100 pCi/L) for the 2003 sampling was in Well

SA1-1H, adjacent to the SGZ mud pits. All values demonstrate a decreasing trend and verify that natural attenuation and decay is occurring.

According to the risk assessment, most radionuclides of concern are either naturally occurring isotopes (e.g., Thorium-232 and Uranium-238) or decay products (e.g., Thorium-232, Radium-228, Radium-226, Radon-222, and Lead-214) of naturally occurring isotopes. Because these radionuclides were above background, the DOE presented the risk assessment results including and excluding naturally occurring radionuclides. The DOE has assumed that these naturally occurring radionuclides and their respective daughter products are not related to historic DOE site activities. Site characterization analytical results also support this position.

No organic constituents were detected in the surface and subsurface soil samples, with the exception of those associated with the subsurface soil samples collected near the SGZ mud pits in Source Area 1. Detections were sporadic and only slightly elevated. Only benzene in the subsurface soils in Source Area 1 had a significant impact in the risk calculations. The organic results for Source Area 1 are presented in the Salmon Site RI Report (DOE/NV, 1999). To delineate and more accurately define the extent of petroleum hydrocarbon contamination associated with the single detection, additional subsurface soil samples were collected during the RI. The additional subsurface soil samples confirmed that the petroleum hydrocarbon contamination is isolated to a single small pocket in the vicinity of the SGZ mud pit, and is not migrating.

As discussed in the human health risk assessment presented in the *Salmon Site Restoration Plan*, Rev. 1 (NNSA/NV, 2002), the total Incremental Lifetime Cancer Risk (ILCR) for surface soil at the Salmon Site ranges from 8.6×10^{-12} to 4.8×10^{-7} when background radionuclides are excluded. On a site-wide scale including all source areas, the surface soil ILCR ranges from 4.3×10^{-8} to 9.5×10^{-7} when background radionuclides are excluded (NNSA/NV, 2002). These ILCR values are below the regulatory target value of 10^{-6} for the recreational and wildlife refuge and demonstration forest scenarios (DOE/NV, 1999).


Map 4.1a Salmon, Mississippi
OU-1 - Hazard Specific Map - Current State
89°34'12"W
31°8'42"N
31°8'24"N
SA1-12-H
HMH-16
SA4
SA1
SA2
HMH-5
SA1-1-H
SGZ
Pond Overflow
SA1-6-H
HM-5
SA1-2-H
SA1-7-H
Mud Pit
SA1-3-H
SA1-5-H
Slush Pit
SA1-4-H
SA3-4-H
Mud Pit
SA3
Prepared By: Stoller-Navarro
Projection: State Plane Mississippi
East NAD 27
Data Source(s):
ESRI StreetMap USA (2003)
Site Features and Well Locations
from Maptech, Inc. (1997)
N
W
E
S
0 0.02 0.04 0.08
Miles
1:5,000
OU-1 Wells
TCE Detection>MCL
Tritium Detection>MCL
Roads
Water
Lake / Pond
Source Areas
CAS with Institutional Controls

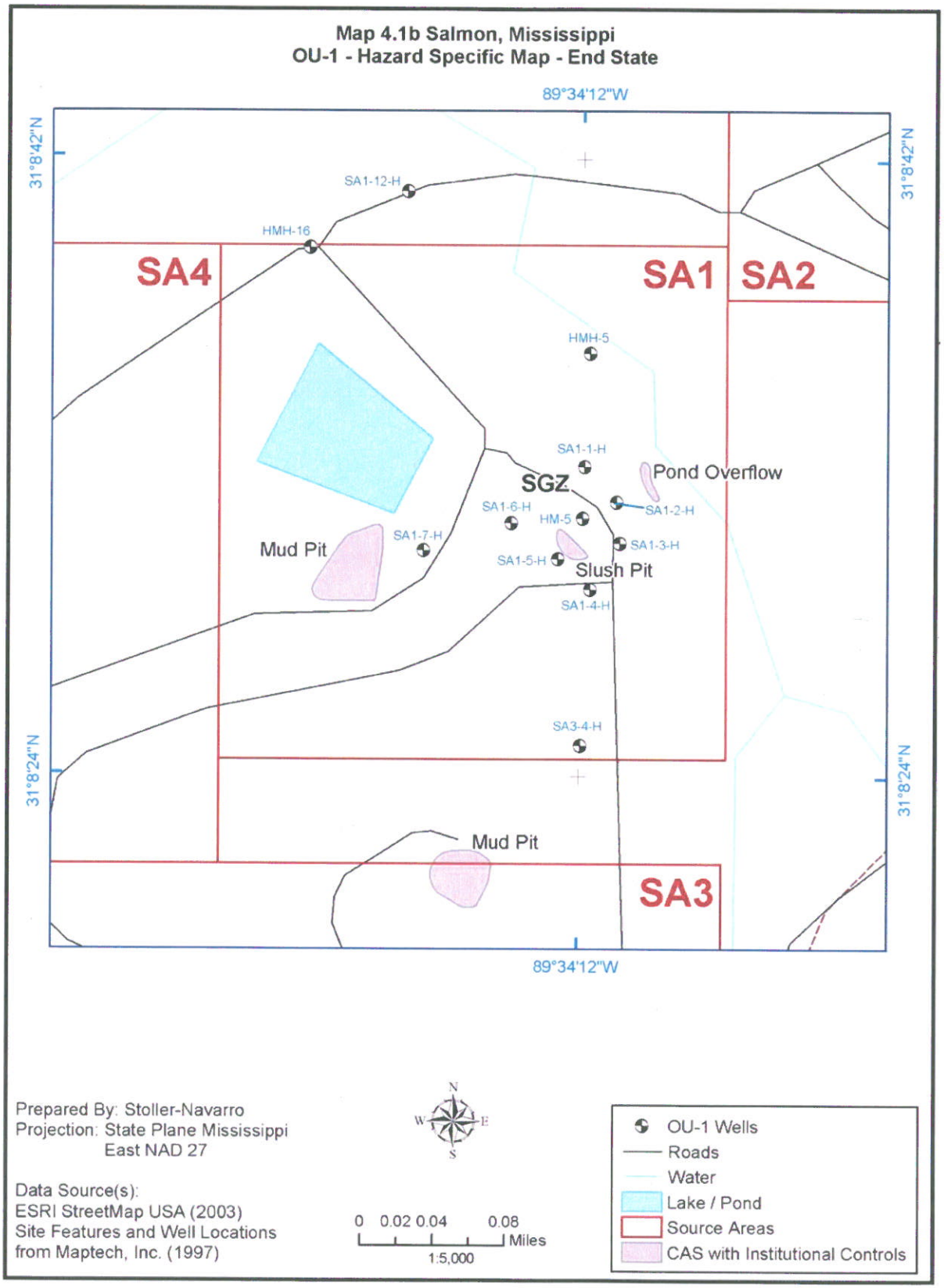
Surface water and sediment samples were collected from several locations at the Salmon Site. Other than naturally occurring elements such as aluminum, calcium, manganese, and sodium, only tritium and tin-113 were detected in the surface water samples. Tin-113 was only detected in one sample from Grantham Creek, at a location upgradient of all source areas, and therefore, was not considered a COC at the Salmon Site. Tritium was detected at several locations (DOE/NV, 1999).

In addition to surface soil, subsurface soil, sediment, and surface water, Operable Unit 1 also includes the shallow aquifer systems. Operable Unit 1 groundwater samples from the Alluvial Aquifer were collected from Source Area 1 through Source Area 5. No wells were installed in Source Area 6 because no COCs have ever been detected in the area. With the exception of Source Area 1, no sample results were reported that indicated any consistent pattern of contamination. The analytical results showed that the principal COC was tritium, with some detection of arsenic, TCE, and VC. Arsenic was determined to be naturally occurring and was therefore, excluded from further discussion. The TCE and VC detections were in the immediate vicinity of the SGZ mud pits and have naturally attenuated over time to below regulatory limits.

For the Alluvial Aquifer, the ILCR is less than the 10^{-6} for all COCs in all potential pathways except for the TCE (4.6×10^{-6}), VC (6.7×10^{-5}), and the tritium (1.3×10^{-4}). None of the COCs had a hazard quotient of greater than 1.0. Based on the Salmon Site RI Report groundwater modeling results, the contaminated Alluvial Aquifer groundwater does not travel beyond the site boundary (DOE/NV, 1999).

A groundwater fate and transport modeling effort was conducted for the operable units at the Salmon Site on a site-wide basis. The following describes the results of this activity. A more complete description is presented in Section 5.0 of the Salmon Site RI Report (DOE/NV, 1999). Contaminants found in the shallow aquifers were modeled for OU-1.

Modeling was conducted to predict the migration of COCs over time. The COCs included tritium, TCE, and VC. Modeling results for the Alluvial Aquifer indicate that within five years, all COCs will naturally attenuate to concentrations below their respective MCLs (Map 4.1b). The 2003 sampling for tritium confirmed this continuing decreasing trend.


Map 4.1b Salmon, Mississippi
OU-1 - Hazard Specific Map - End State
89°34'12"W
31°8'42"N
31°8'24"N
SA1-12-H
HMH-16
SA4
SA1
SA2
HMH-5
SA1-1-H
SGZ
Pond Overflow
SA1-6-H
HM-5
SA1-2-H
SA1-7-H
Mud Pit
SA1-3-H
SA1-5-H
Slush Pit
SA1-4-H
SA3-4-H
Mud Pit
SA3
Prepared By: Stoller-Navarro
Projection: State Plane Mississippi
East NAD 27
Data Source(s):
ESRI StreetMap USA (2003)
Site Features and Well Locations
from Maptech, Inc. (1997)
N
W
E
S
0 0.02 0.04 0.08
Miles
1:5,000
OU-1 Wells
Roads
Water
Lake / Pond
Source Areas
CAS with Institutional Controls

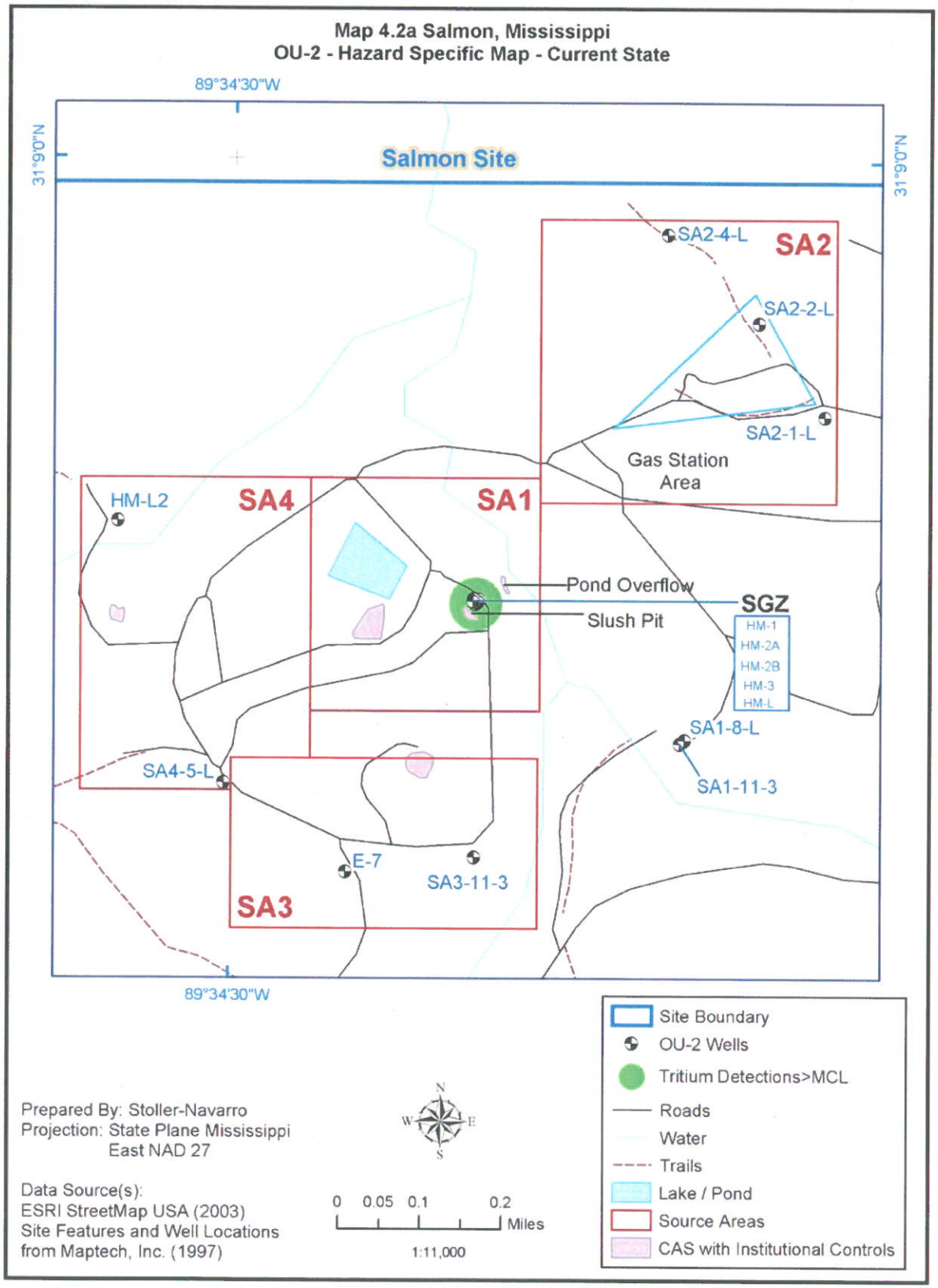
The Local Aquifer was modeled for tritium, with the results summarized in Section 5.0 of the Salmon Site RI Report (DOE/NV, 1999). The modeling of the Local Aquifer uses existing analytical data from groundwater samples to determine constituent concentrations. The modeling results for the Local Aquifer show that after 100 years, the tritium will naturally decay by 99.6 percent of its initial (1998) concentration and will not reach the site boundary (DOE/NV, 1999).

4.2 Operable Unit 2

Operable Unit 2 includes the test cavity and the intermediate depth aquifers. The investigation of this operable unit consisted of the installation of monitoring wells into the Local Aquifer and Aquifers 1, 2, and 3. The monitoring wells installed in the Local Aquifer in Source Area 2 were intended to monitor contaminants associated with disposal pits. The Source Area 2 Local Aquifer monitoring wells did detect arsenic in the groundwater at concentrations above those detected in the wells surrounding the Salmon Site that were used to determine background. The arsenic detected in the Source Area 2 Local Aquifer monitoring wells was determined to be naturally occurring because there is not a definable groundwater contaminant plume. In addition, there are no historical records of arsenic at the site. No arsenic was detected above the MCL in groundwater samples collected from OU-2 in 2002. Based on the discussion presented above, arsenic is not retained as a contaminant of concern in OU-2. Therefore, arsenic was not analyzed in the 2003 samples.

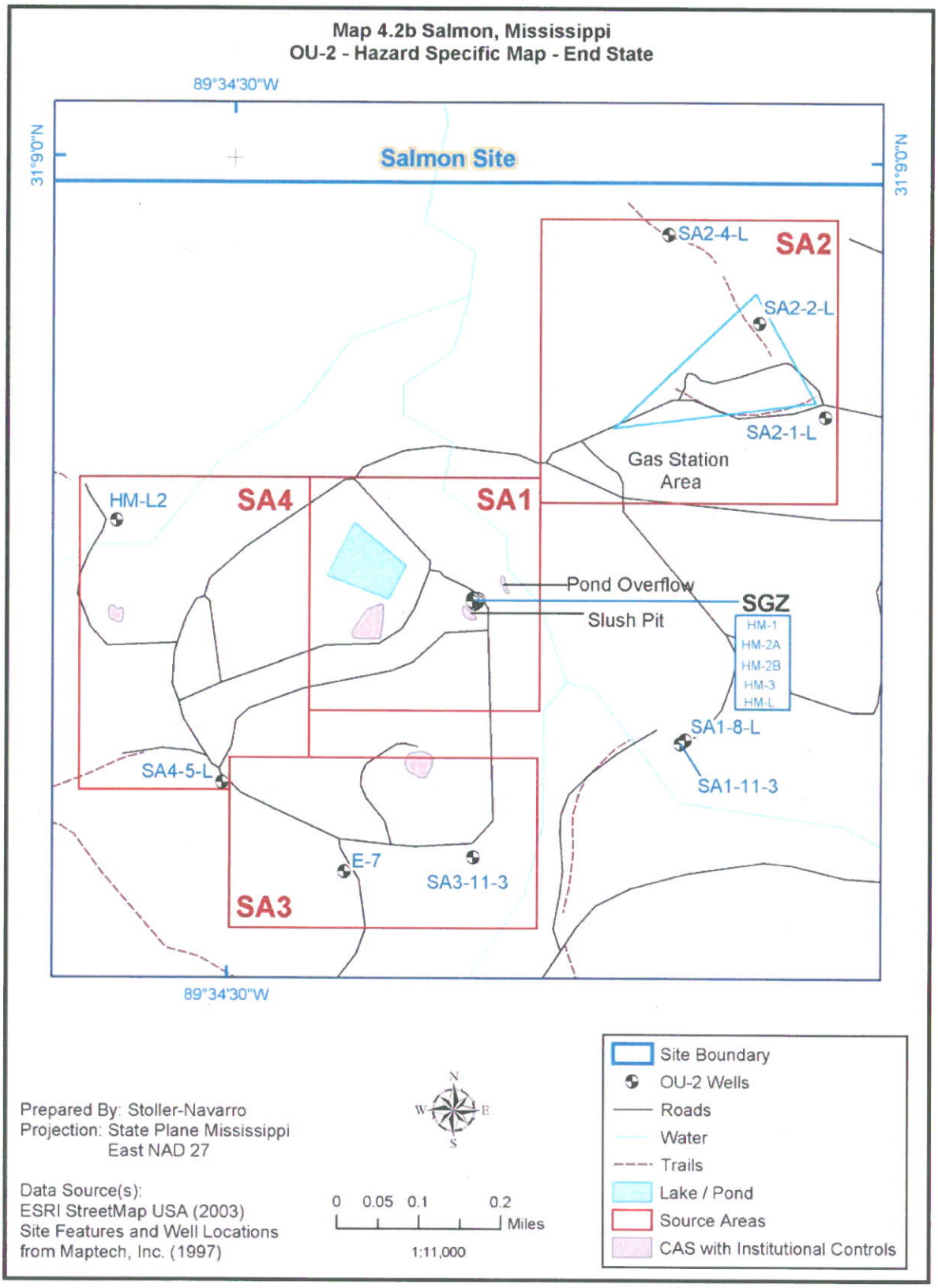
Two metals, chromium and lead, were detected above their respective MCLs of 100µg/L and 15 µg/L in groundwater samples collected from OU-2 in 2002. Chromium and lead were each detected as isolated occurrences in separate groundwater monitoring wells, at concentrations of 130 µg/L and 24 µg/L, respectively (Map 4.2a) (NNSA/NSO, 2003). Due to the spurious nature of the detections, the State has agreed that these are not COCs; therefore, the 2003 samples were not analyzed for chromium and lead.

Gross beta activity was detected at one location, with a maximum concentration of 38.8 pCi/L. Contaminants in the other aquifers consisted of estimated concentrations of carbon disulfide ranging from 2 to 4 µg/L, gross alpha activity at one location at 22.4 pCi/L, and gross beta activity at two locations at 12.7 and 23.9 pCi/L (NNSA/NV, 2002). The regulatory limit for gross alpha is 15 pCi/L (CFR, 1998). No Gamma emitters were detected in the 2003 samples.


Map 4.2a Salmon, Mississippi
OU-2 - Hazard Specific Map - Current State
89°34'30"W
31°9'0"N
Salmon Site
SA2-4-L
SA2
SA2-2-L
SA2-1-L
Gas Station Area
HM-L2
SA4
SA1
Pond Overflow
SGZ
Slush Pit
HM-1
HM-2A
HM-2B
HM-3
HM-L
SA1-8-L
SA1-11-3
SA4-5-L
E-7
SA3-11-3
SA3
Site Boundary
OU-2 Wells
Tritium Detections>MCL
Roads
Water
Trails
Lake / Pond
Source Areas
CAS with Institutional Controls
Prepared By: Stoller-Navarro
Projection: State Plane Mississippi East NAD 27
Data Source(s):
ESRI StreetMap USA (2003)
Site Features and Well Locations from Maptech, Inc. (1997)
0 0.05 0.1 0.2 Miles
1:11,000

For this operable unit, Aquifers 1, 2a, 2b, and 3 were modeled, with the results summarized in Section 5.0 of the Salmon Site RI Report (DOE/NV, 1999). The COCs modeled were tritium and arsenic for the local aquifer and only tritium for the remaining deeper aquifers. Existing analytical data from groundwater samples were used in the Local Aquifer modeling to determine constituent concentrations. The contaminant concentrations for the remaining aquifers are a hypothetical simulation of leakage from the test cavity upward into the uncontaminated overlying aquifers (DOE/NV, 1999).

According to the modeling results, the hypothetical plume in Aquifer 1 would never reach the boundary, and the contaminant concentration would be reduced by approximately 99.6 percent of its initial (1998) concentration over a period of 100 years. For Aquifers 2a, 2b, and 3, the hypothetical plumes would migrate off site; however, the maximum concentration of tritium in all cases would be far less than one half of the current MCL of 20,000 pCi/L (Map 4.2b).


Map 4.2b Salmon, Mississippi
OU-2 - Hazard Specific Map - End State
89°34'30"W
31°9'0"N
Salmon Site
SA2-4-L
SA2
SA2-2-L
SA2-1-L
Gas Station Area
HM-L2
SA4
SA1
Pond Overflow
SGZ
Slush Pit
HM-1
HM-2A
HM-2B
HM-3
HM-L
SA1-8-L
SA1-11-3
SA4-5-L
E-7
SA3-11-3
SA3
Site Boundary
OU-2 Wells
Roads
Water
Trails
Lake / Pond
Source Areas
CAS with Institutional Controls
Prepared By: Stoller-Navarro
Projection: State Plane Mississippi East NAD 27
Data Source(s):
ESRI StreetMap USA (2003)
Site Features and Well Locations from Maptech, Inc. (1997)
0 0.05 0.1 0.2 Miles
1:11,000

4.3 - Operable Unit 3

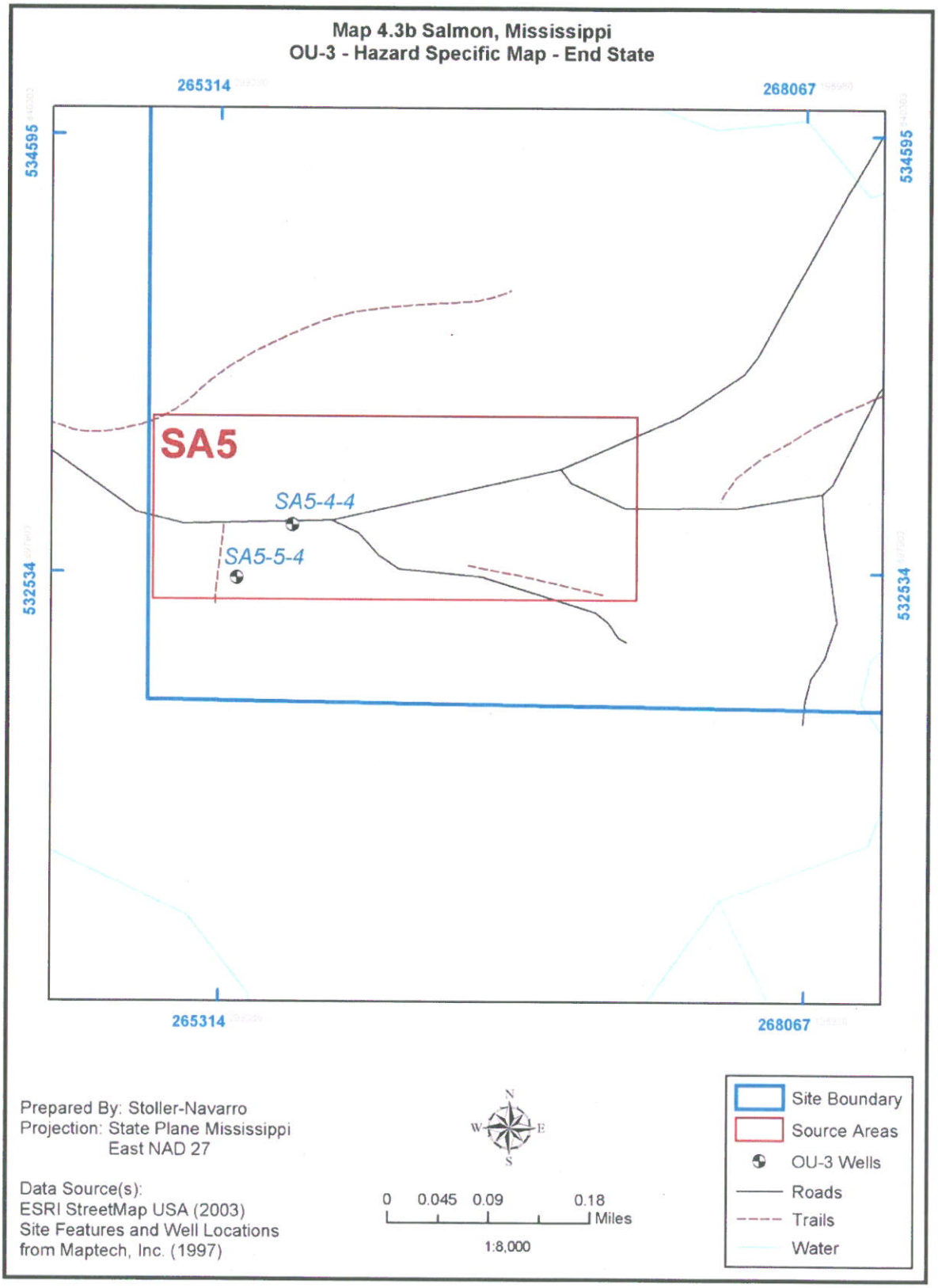
Operable Unit 3 includes the injection well and deep aquifers (Aquifers 4 and 5). Two wells were completed in Aquifer 4, and the injection well was completed in Aquifer 5, where the radioactive material was injected.

The fate and transport modeling effort for this operable unit consisted of hypothetical scenarios of the movement of a water particle through Aquifers 4 and 5 from Well HT-2, which was historically used as an injection well for water contaminated with tritium. The difference in the scenarios was the conductivity of an imaginary borehole where the cement grout seals are presumed to have failed. The results show that the clay layer above Aquifer 5 impedes over the course of the simulation (100 years). For the worst case, some water from this simulation does reach the bottom of Aquifer 4. In all cases, the water travels a maximum distance of approximately 3,000 ft from the injection well location. The OU-3 modeling results are discussed in greater detail in Section 5.0 of the Salmon Site RI Report (DOE/NV, 1999).

No COCs were detected above their respective MCLs in groundwater samples collected in 2002 (Map 4.3b).

4.4 Long-Term Hydrologic Monitoring Program

The EPA LTHMP has been agreed to by the State of Mississippi. It has been proposed that monitoring of the Alluvial and Local Aquifers be conducted annually until contaminants naturally attenuate to below regulatory limits, and every five years after that time. It is also proposed that monitoring be conducted every five years in the deeper aquifers (NNSA/NSO, 2003). The State of Mississippi accepted this proposed program in a letter dated October 2, 2001 (Merrill, 2001).


Map 4.3b Salmon, Mississippi
OU-3 - Hazard Specific Map - End State
265314
268067
534595
532534
SA5
SA5-4-4
SA5-5-4
Prepared By: Stoller-Navarro
Projection: State Plane Mississippi
East NAD 27
Data Source(s):
ESRI StreetMap USA (2003)
Site Features and Well Locations
from Maptech, Inc. (1997)
N
W
E
S
0 0.045 0.09 0.18
Miles
1:8,000
Site Boundary
Source Areas
OU-3 Wells
Roads
Trails
Water

5.0 References

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Attachment A – Discussion of Variances

The following variance report table is provided in accordance with Appendix D of the Environmental Management End State Vision Development Guidance dated September 11, 2003. The table below does not identify any variances, but does provide information clarifying why there are no perceived differences between the various plans and agreements governing activities at the site. There are no negative impacts in terms of scope, cost, schedule, and risk, and no known barriers to achieving the end state. Based on the above noted belief, the next steps are identified for future activities associated with the Salmon Site. There are no maps provided, as there are no differences between the end state based on the current requirements and the end state based on the end state. The maps within the main body of the end state document sufficiently identify pertinent information related to the Salmon Site.

Salmon Site Variance Report				
ID No.	**Description of Variances**	**Impacts (in Terms of Scope, Cost, Schedule, and Risk)**	**Barriers in Achieving the End State**	**Recommendations**
N/A	There are no known variances between the end state, the current Offsites baseline, the Nevada Site Office Performance Management Plan, and/or regulatory agreements.	The State of Mississippi has allowed for clean-up decisions consistent with planned future use as a wildlife refuge or demonstration forest. The State understands issues associated with the residual contamination at the site and has not expressed opposition nor alternative future environmental restoration plans.	None at this time.	Concur on current plans and documents and prepare the necessary long-term stewardship information for transfer of the site to the Office of Legacy Management.