Department of Energy
Office of Legacy Management

NOV 1 0 2008

Ms. Madeline Roanhorse
Director Navajo AML Reclamation
Division of Natural Resources
The Navajo Nation
P.O. Box 1875
Window Rock, AZ 86515

Subject: Annual Performance Report for Shiprock Remediation System Operations

Dear Ms. Roanhorse:

Enclosed are two copies of the *Annual Performance Report April 2007 Through March 2008 for the Shiprock, New Mexico, Site.* This report evaluates the performance of the ground water remediation system at the disposal and processing site in Shiprock, New Mexico, for the period of April 2007 through March 2008. This evaluation is based upon comparison of the site conditions in March 2007 to the baseline site conditions presented in the Baseline Performance Report (DOE 2003).

Please call me at (970) 248-6621 if you have any questions.

Sincerely,

Tracy A. Ribeiro
Site Manager

Enclosure

cc w/enclosure:
B. von Till, Nuclear Regulatory Commission
S. Austin, Navajo Nation Environmental Protection Agency
R. MacRae, U.S. Fish and Wildlife Service
D. Taylor, Navajo Nation Department of Justice
G. Tom, Navajo Nation Department of Fish and Wildlife
File: SHP 045.15 (Roberts)

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2597 B 3/4 Road, Grand Junction, CO 81503	☐	3600 Collins Ferry Road, Morgantown, WV 26505
1000 Independence Ave., S.W., Washington, DC 20585	☐	11025 Dover St., Suite 1000, Westminster, CO 80021
10995 Hamilton-Cleves Highway, Harrison, OH 45030	☐	955 Mound Road, Miamisburg, OH 45342
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REPLY TO: Grand Junction Office

LMS/SHP/S04378

Annual Performance Report April 2007 Through March 2008 for the Shiprock, New Mexico, Site

September 2008

U.S. Department of Energy

Office of Legacy Management

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Annual Performance Report
April 2007 Through March 2008
for the Shiprock, New Mexico, Site

September 2008

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1.0 Introduction

This report evaluates the performance of the groundwater remediation system at the disposal and processing site in Shiprock, New Mexico, for the period of April 2007 through March 2008. The Shiprock site, a former uranium mill tailings facility under the Uranium Mill Tailings Radiation Control Act (UMTRCA), is currently managed by the U.S. Department of Energy Office of Legacy Management (DOE-LM). This evaluation is based on a comparison of the site conditions in March 2008 to the baseline site conditions presented in the *Baseline Performance Report* (DOE 2003). The baseline conditions were established using data collected primarily from March 2003. A detailed description of the site conditions is presented in the *Site Observational Work Plan* (SOWP) (DOE 2000), and the compliance strategy is presented in the *Groundwater Compliance Action Plan* (GCAP) (DOE 2002).

The Shiprock site is divided into two distinct areas, the floodplain and the terrace. An escarpment forms the boundary between the two areas. The floodplain remediation system currently consists of two groundwater extraction wells, a seep collection drain, two collection trenches, and an open pit sump system. The terrace remediation system currently consists of nine groundwater extraction wells, two collection drains (Bob Lee Wash and Many Devils Wash), and a terrace drainage channel diversion structure. All extracted groundwater goes into a lined evaporation pond on the terrace. The entire groundwater remediation system is shown in Figure 1–1.

1.1 Remediation System Performance Standards

This performance assessment is based on the analysis of groundwater-quality and groundwater-level data obtained from site monitor wells in addition to groundwater flow rates associated with the extraction wells, drains, and seeps.

Specific performance standards as established for the Shiprock floodplain groundwater remediation system in the *Baseline Performance Report* (DOE 2003) are summarized as follows:

- Groundwater flow directions in the vicinity of the extraction wells should be toward the extraction wells.
- Pumping on the floodplain should intercept contaminants of concern (COC) that would otherwise discharge to the San Juan River.

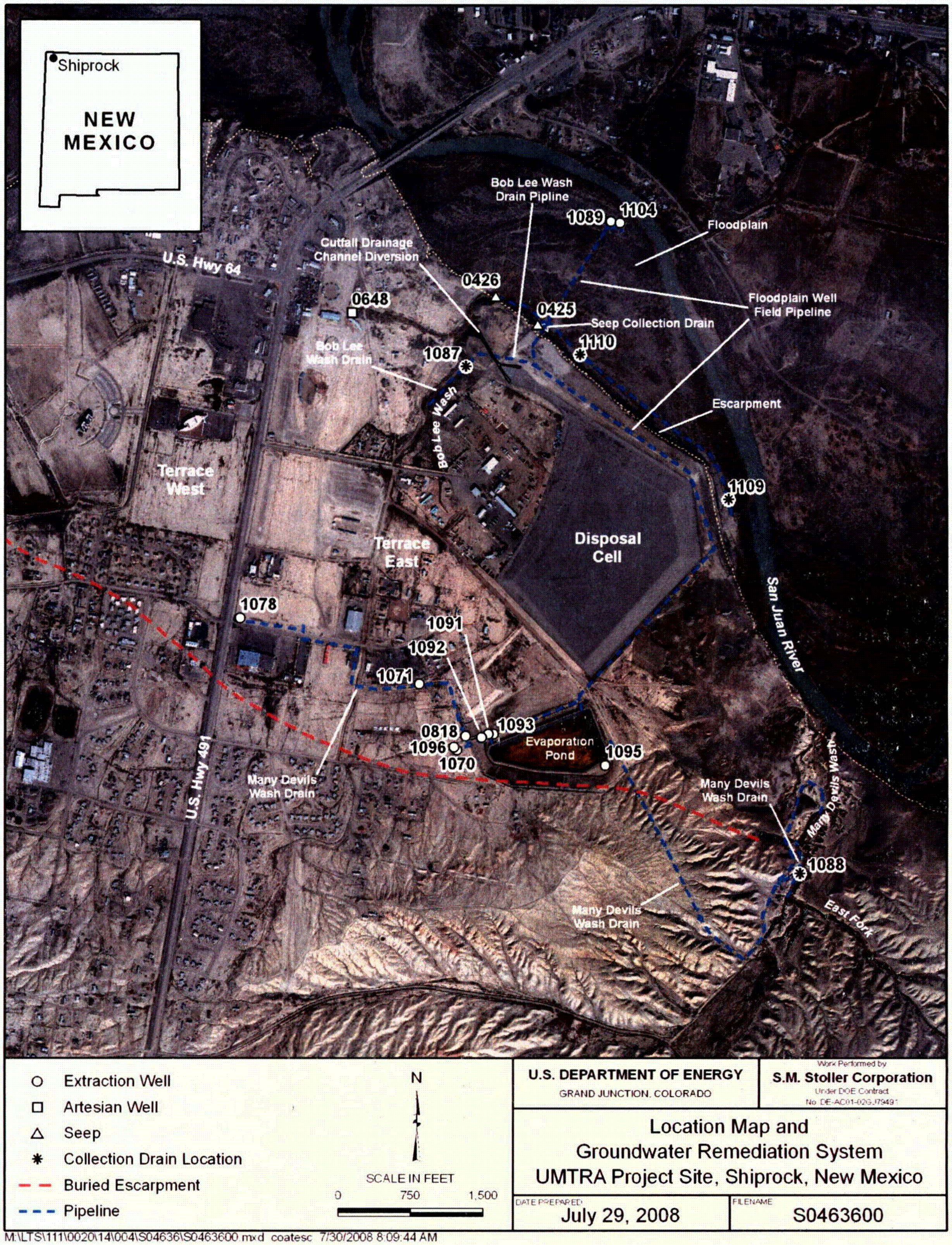

Figure 1–1. Location Map and Groundwater Remediation System

Specific performance standards as established for the Shiprock terrace groundwater remediation system in the *Baseline Performance Report* (DOE 2003) are summarized as follows:

- Terrace groundwater surface elevations should decrease as water is removed from the terrace system.
- Groundwater flow directions in the vicinity of the extraction wells should be toward the extraction wells. This was evaluated in the first 4 years of the project and is no longer required.
- The volume of water discharging to the interceptor drains located in Bob Lee Wash and Many Devils Wash should decrease over time as groundwater levels on the terrace decline.
- The flow rates of seeps located at the escarpment face (locations 0425 and 0426) should decrease over time as groundwater levels on the terrace decline.

1.2 COCs and Remediation Goals

Groundwater at the site is contaminated as a result of uranium-milling activities between 1954 and 1968. The COC for both the floodplain and terrace are ammonia (total as nitrogen), manganese, nitrate (nitrate + nitrite as nitrogen), selenium, strontium, sulfate, and uranium. The concentrations of COC in terrace and floodplain groundwater, based on the March 2008 sampling event, are shown in Figure 1–2 through Figure 1–8. Figure 1–9 through Figure 1–15 present changes in the extent of the floodplain and terrace contaminates plumes based on data from 2000/2001 and September 2007. A more complete sampling event is planned for the March 2009 sampling that will allow these plume maps to be further updated in the next performance report.

Floodplain compliance standards for uranium and nitrate are their respective UMTRCA standards of 0.044 and 10 milligrams per liter (mg/L). A secondary standard of 250 mg/L for sulfate exists under the U.S. Environmental Protection Agency (EPA) Safe Drinking Water Act. However, studies conducted by the Centers for Disease Control in conjunction with EPA have shown that no adverse effects from sulfate ingestion occur at concentrations of up to 1,200 mg/L (EPA 1999). The report notes that other studies have shown that concentrations of sulfate exceeding 2,000 mg/L may have little to no adverse effect on humans and animals. Because of high background sulfate concentrations at the site in floodplain groundwater (4,300 mg/L in background well 0797) and the high sulfate concentration of water entering the floodplain from flowing artesian well 0648 (up to 2,340 mg/L), the proposed cleanup goal for floodplain sulfate is 2,000 mg/L. Relatively high selenium concentrations in the floodplain make it unlikely that the UMTRCA standard of 0.01 mg/L for this constituent can be met while contaminated terrace water is still providing a source. DOE proposed an alternate concentration limit for selenium of 0.05 mg/L (DOE 2003), which is the EPA maximum contaminant level for drinking water. The cleanup objective for manganese is the maximum background concentration for the floodplain, which is currently 2.74 mg/L. There are no cleanup standards or background concentrations established for ammonia and strontium.

Groundwater compliance for the terrace is based on hydrologic control, and concentration standards do not apply.

1.3 Hydrogeological Setting

This section summarizes the floodplain and terrace groundwater systems. A more detailed description is available in the SOWP (DOE 2000).

1.3.1 Floodplain Alluvial Aquifer

The thick Mancos Shale of Cretaceous age forms the bedrock underlying the entire site. A floodplain alluvial aquifer occurs in unconsolidated medium- to coarse-grained sand, gravel, and cobbles that were deposited in former channels of the San Juan River above the Mancos Shale. The floodplain aquifer is hydraulically connected to the San Juan River; the river is a source of groundwater recharge to the floodplain aquifer in some areas, and it receives groundwater discharge in other areas. In addition, the floodplain aquifer almost certainly receives some inflow from a groundwater system in the terrace area. The floodplain alluvium is up to 20 feet (ft) thick and overlies Mancos Shale, which is typically soft and weathered for the first several feet below the alluvium.

Most groundwater contamination in the floodplain lies close to the escarpment east and north of the disposal cell. A plume extends northward from this contaminated area in an arc-shape as it crosses the floodplain and reaches the San Juan River near the floodplain extraction wells (Figure 1–2 through Figure 1–8). This plume configuration is best characterized by elevated concentrations of sulfate and uranium. Contamination does not occur along the escarpment base in the northwest part of the floodplain because relatively uncontaminated surface water from Bob Lee Wash discharges into the floodplain, recharging local groundwater and then flowing to the north and west. Surface water in Bob Lee Wash originates primarily as deep groundwater from the Morrison Formation that flows to the land surface via artesian well 0648. Well 0648 flows at approximately 65 gallons per minute (gpm) and drains eastward into lower Bob Lee Wash. Background groundwater quality in the floodplain aquifer has been defined by monitor wells installed in the floodplain approximately 1 mile upriver from the site.

1.3.2 Terrace Groundwater System

The terrace groundwater system occurs partly in unconsolidated alluvium in the form of medium- to coarse-grained sand, gravel, and cobbles deposited in the floodplain of the ancestral San Juan River. Terrace alluvial material is Quaternary in age; it varies from 0 to 20 ft thick and caps the Mancos Shale. Though less well mapped, some terrace groundwater also occurs in weathered Mancos Shale underlying the alluvium. The Mancos Shale is exposed in the escarpment overlooking the present floodplain.

The terrace groundwater system extends southwestward from the escarpment separating the terrace from the floodplain for up to 1 mile, where it is abruptly bounded by a buried escarpment. Terrace alluvial material is exposed at the terrace–floodplain escarpment, but to the southwest, it is covered by an increasing thickness of eolian silt, or loess. At the southwest edge of the terrace aquifer, along the base of the buried escarpment, up to 40 ft of loess overlies the alluvium; the alluvium in this area consists of coarse, ancestral San Juan River deposits.

Mancos Shale in the terrace area is weathered (fractured and soft) several feet below its contact with the alluvium. Groundwater is known to occur in the weathered shale, and it may flow through deeper portions of the shale that might be fractured, and along bedding surfaces.

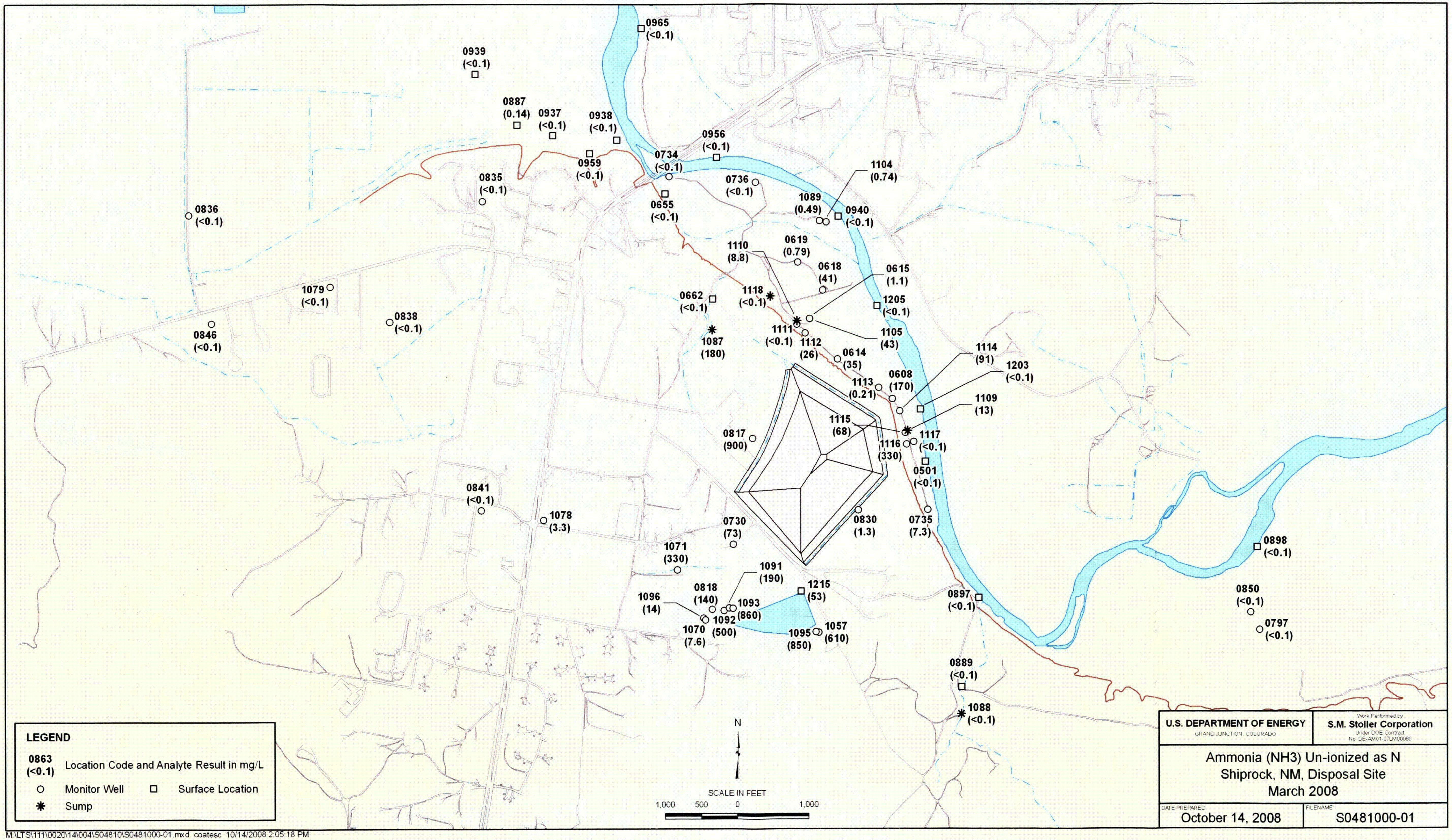

Figure 1–2. Concentrations of Ammonia (NH3) Un-ionized as N in Terrace and Floodplain Groundwater, March 2008

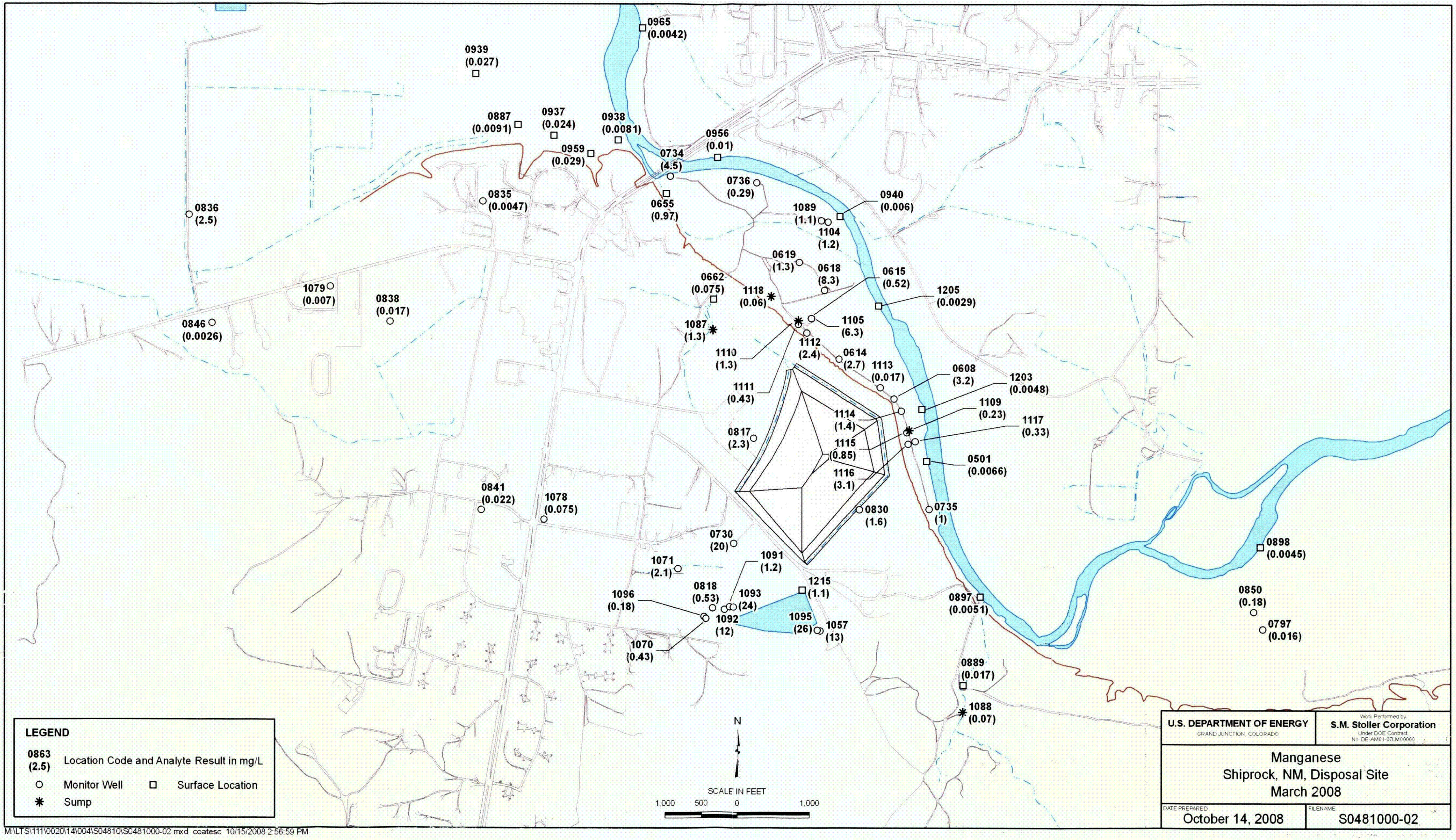

Figure 1–3. Concentrations of Manganese in Terrace and Floodplain Groundwater, March 2008

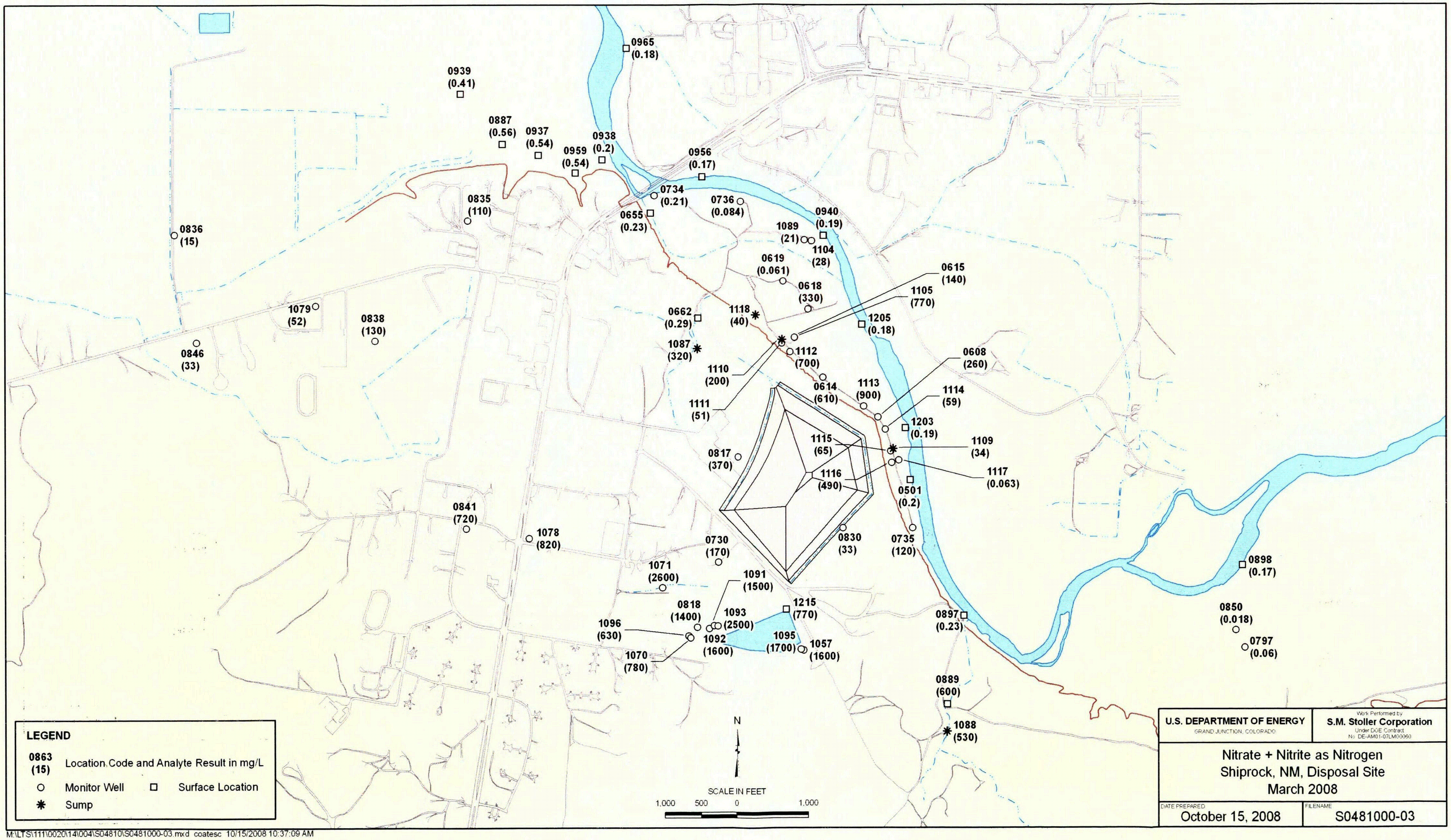

Figure 1–4. Concentrations of Nitrate + Nitrite as Nitrogen in Terrace and Floodplain Groundwater, March 2008

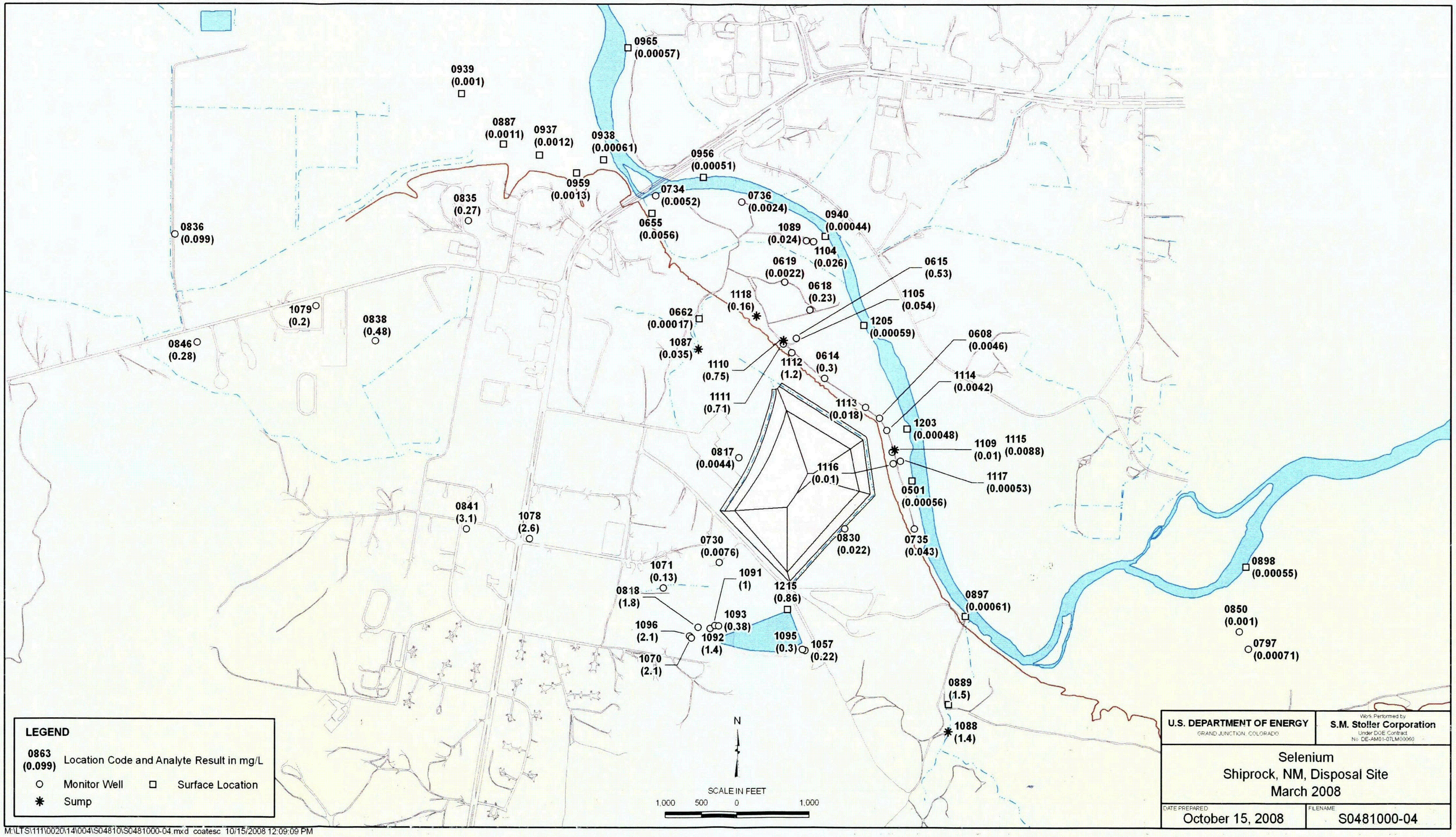

Figure 1–5. Concentrations of Selenium in Terrace and Floodplain Groundwater, March 2008

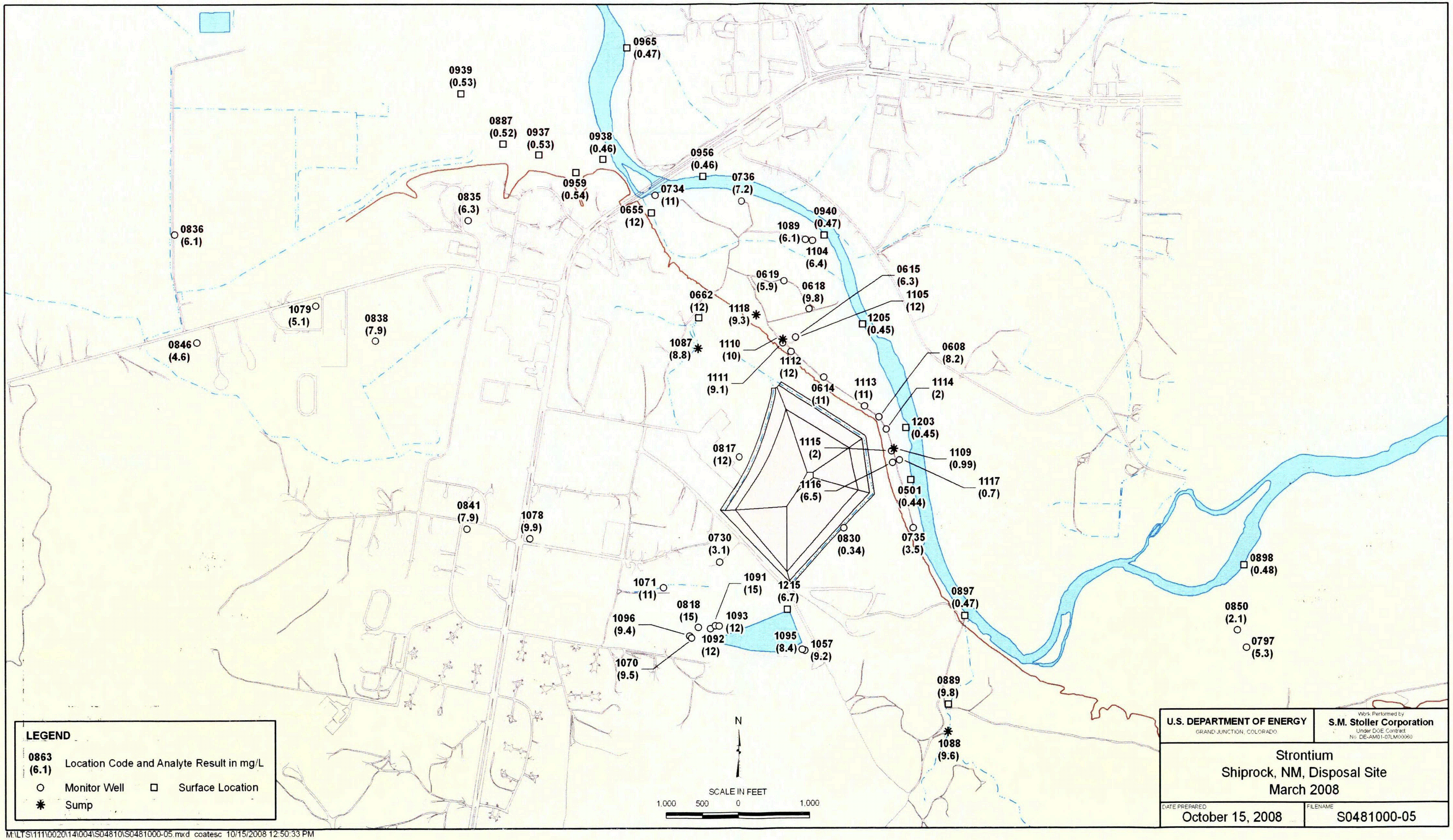

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Figure 1–6. Concentrations of Strontium in Terrace and Floodplain Groundwater, March 2008

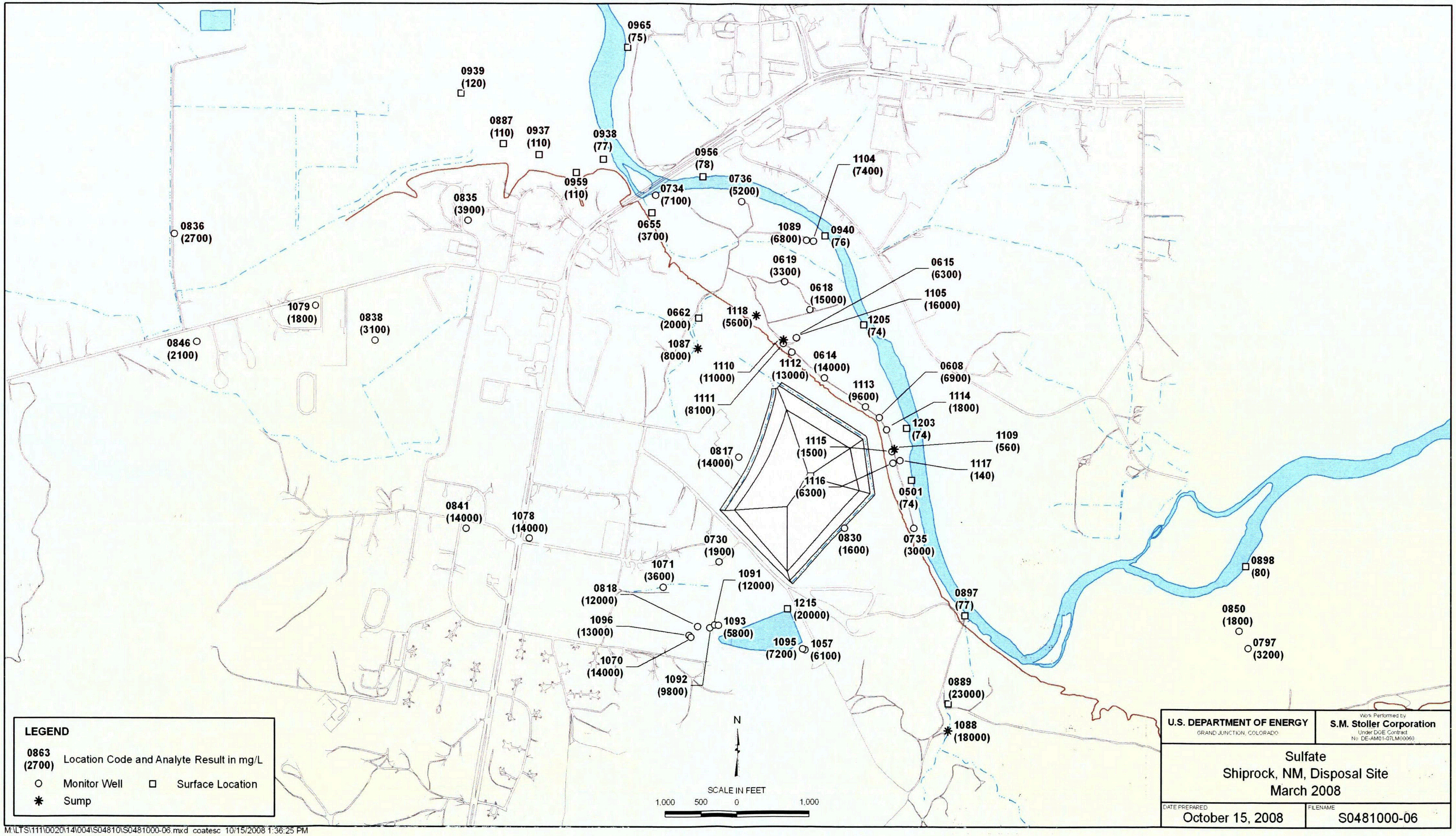

Figure 1–7. Concentrations of Sulfate in Terrace and Floodplain Groundwater, March 2008

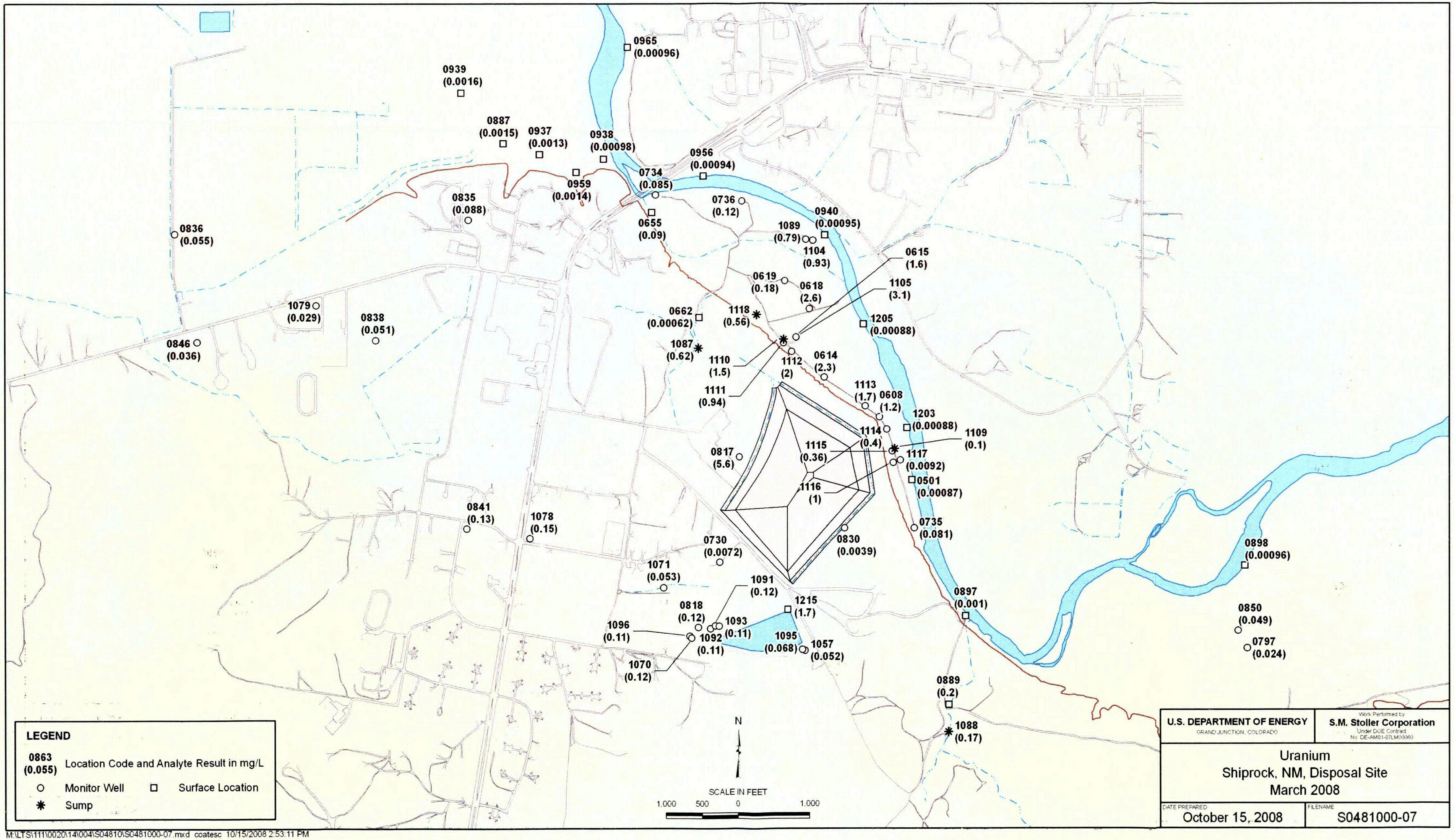

Figure 1–8. Concentrations of Uranium in Terrace and Floodplain Groundwater, March 2008

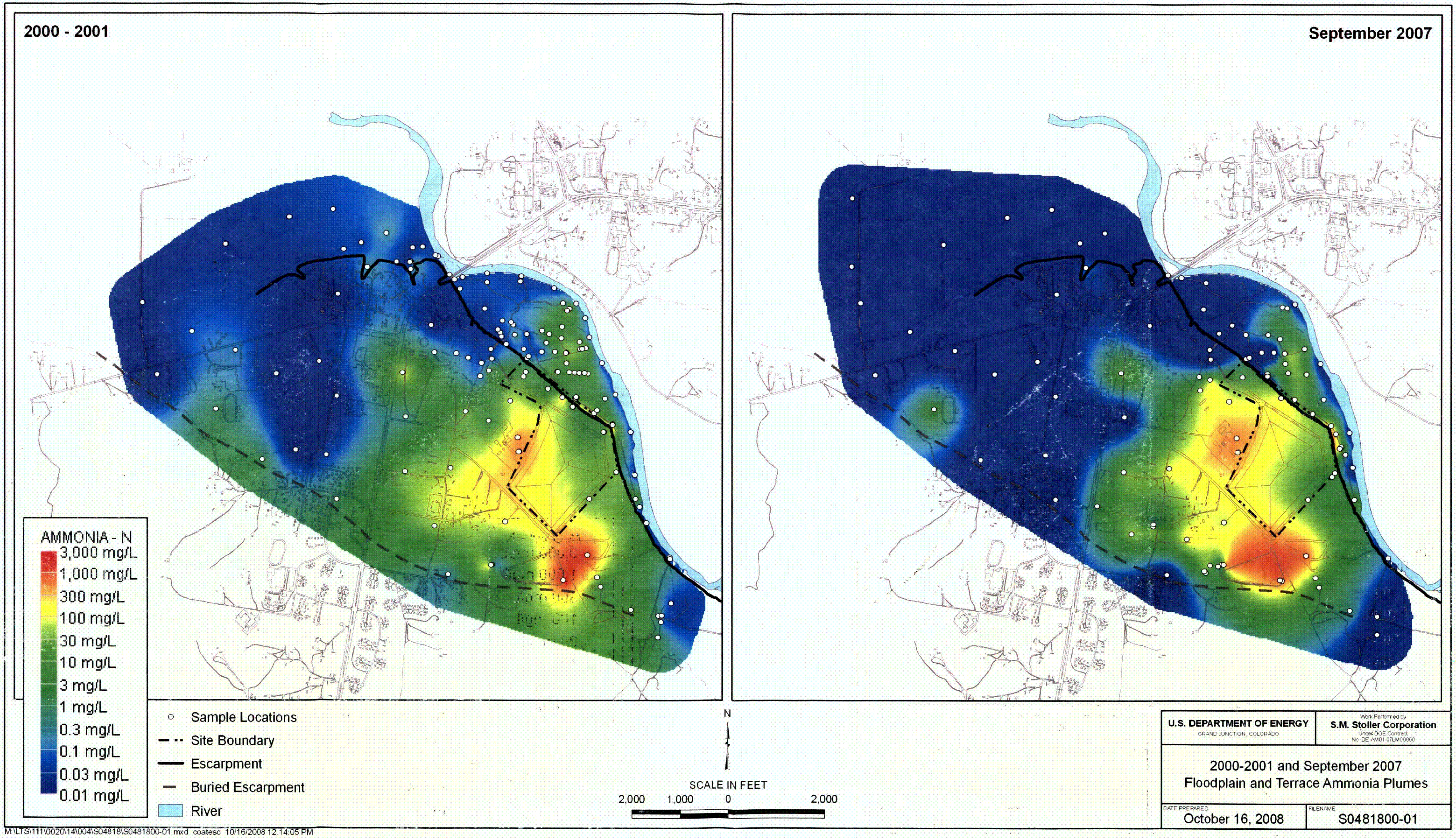

Figure 1–9. 2000/2001 and September 2007 Floodplain and Terrace Ammonia Plumes

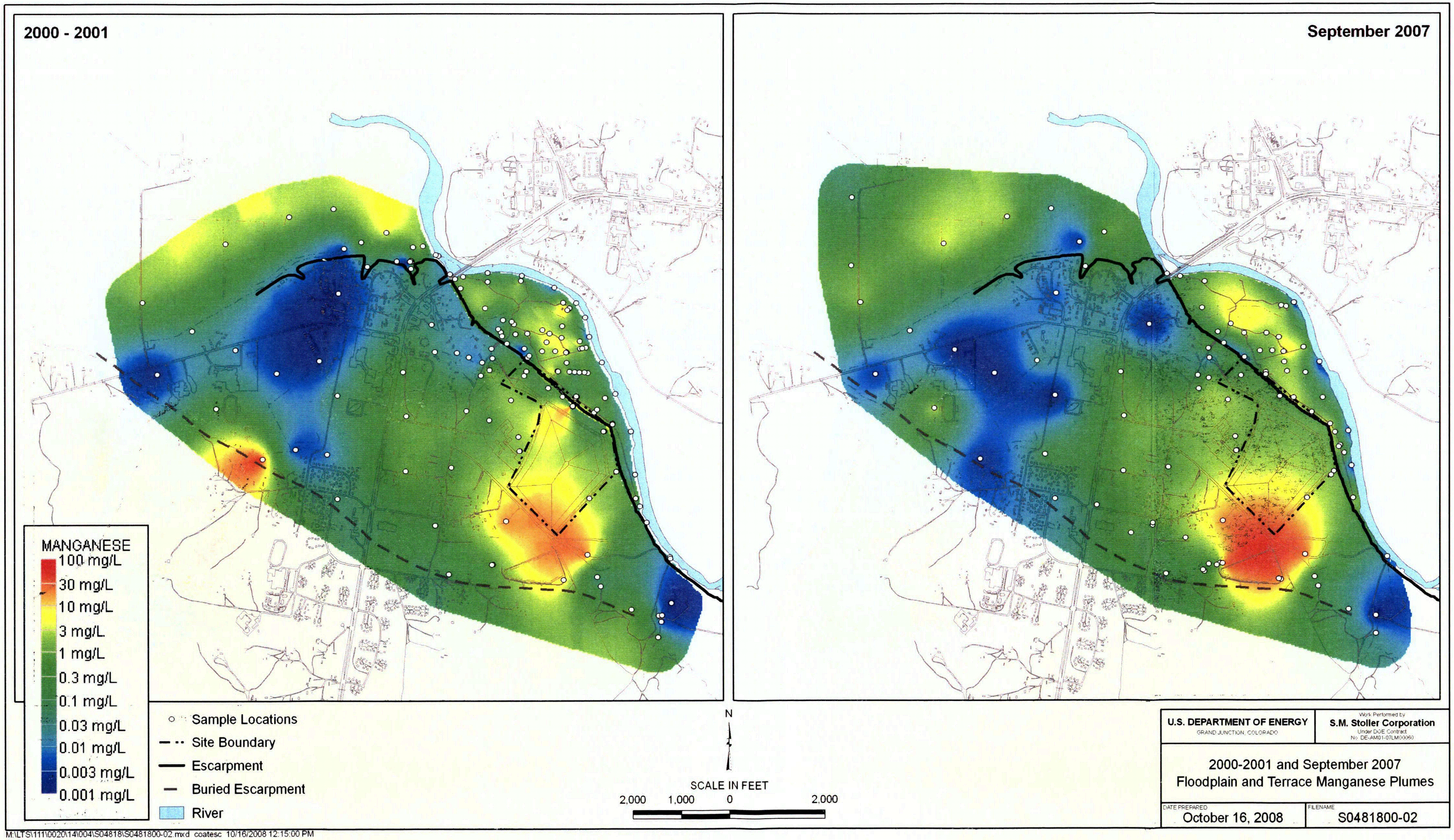

Figure 1–10. 2000/2001 and September 2007 Floodplain and Terrace Manganese Plumes

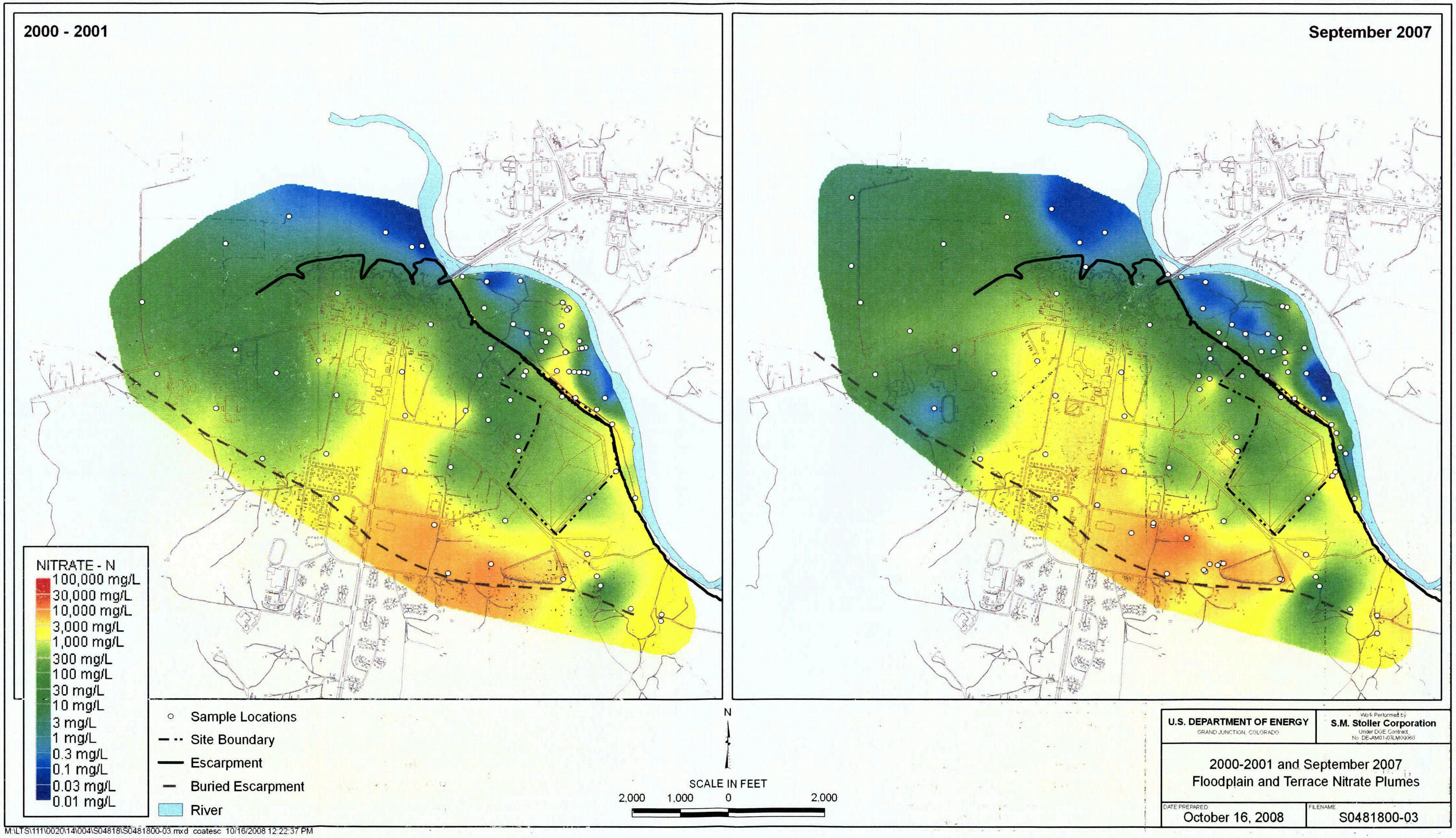

Figure 1–11. 2000/2001 and September 2007 Floodplain and Terrace Nitrate Plumes

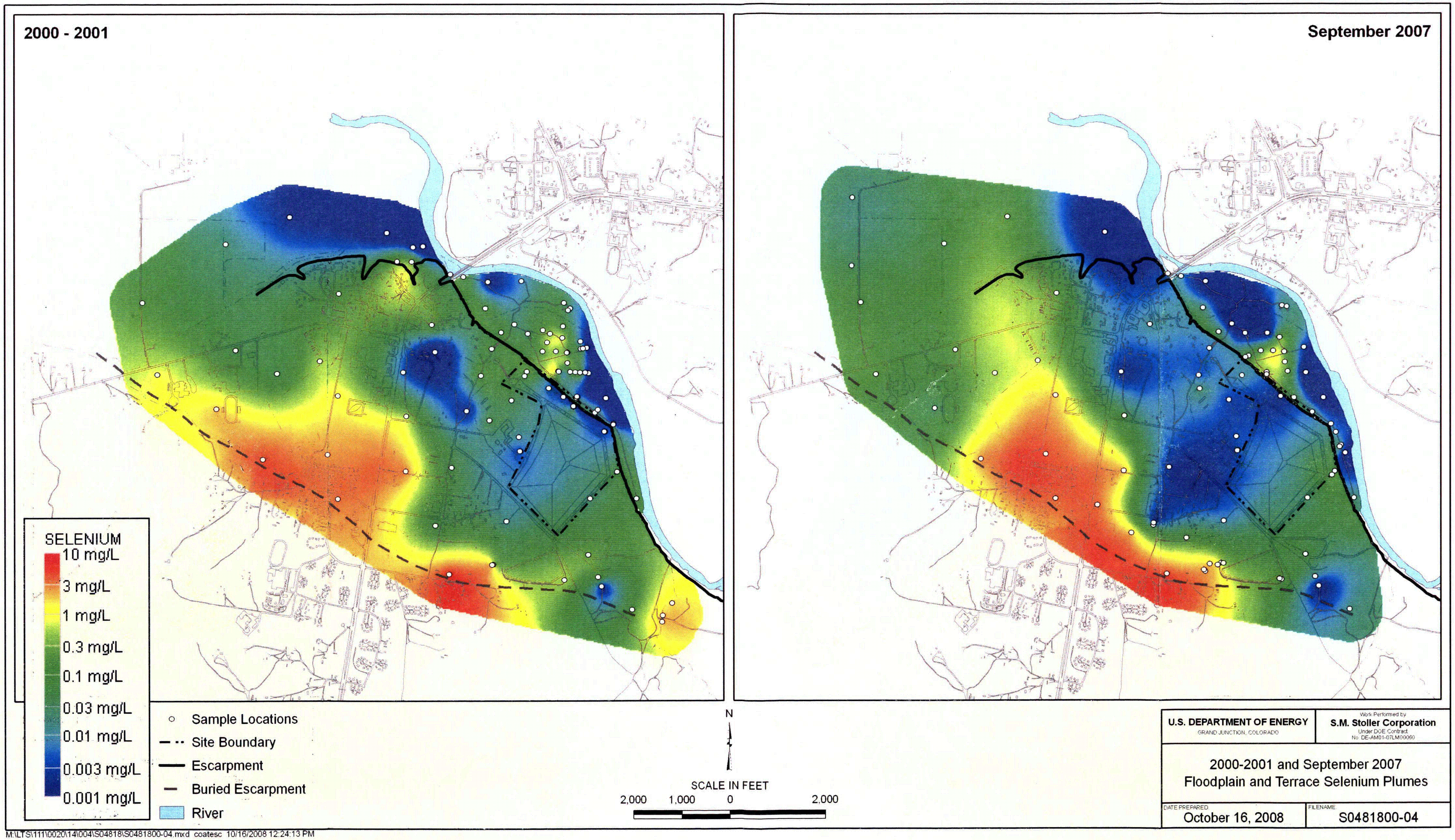

Figure 1–12. 2000/2001 and September 2007 Floodplain and Terrace Selenium Plumes

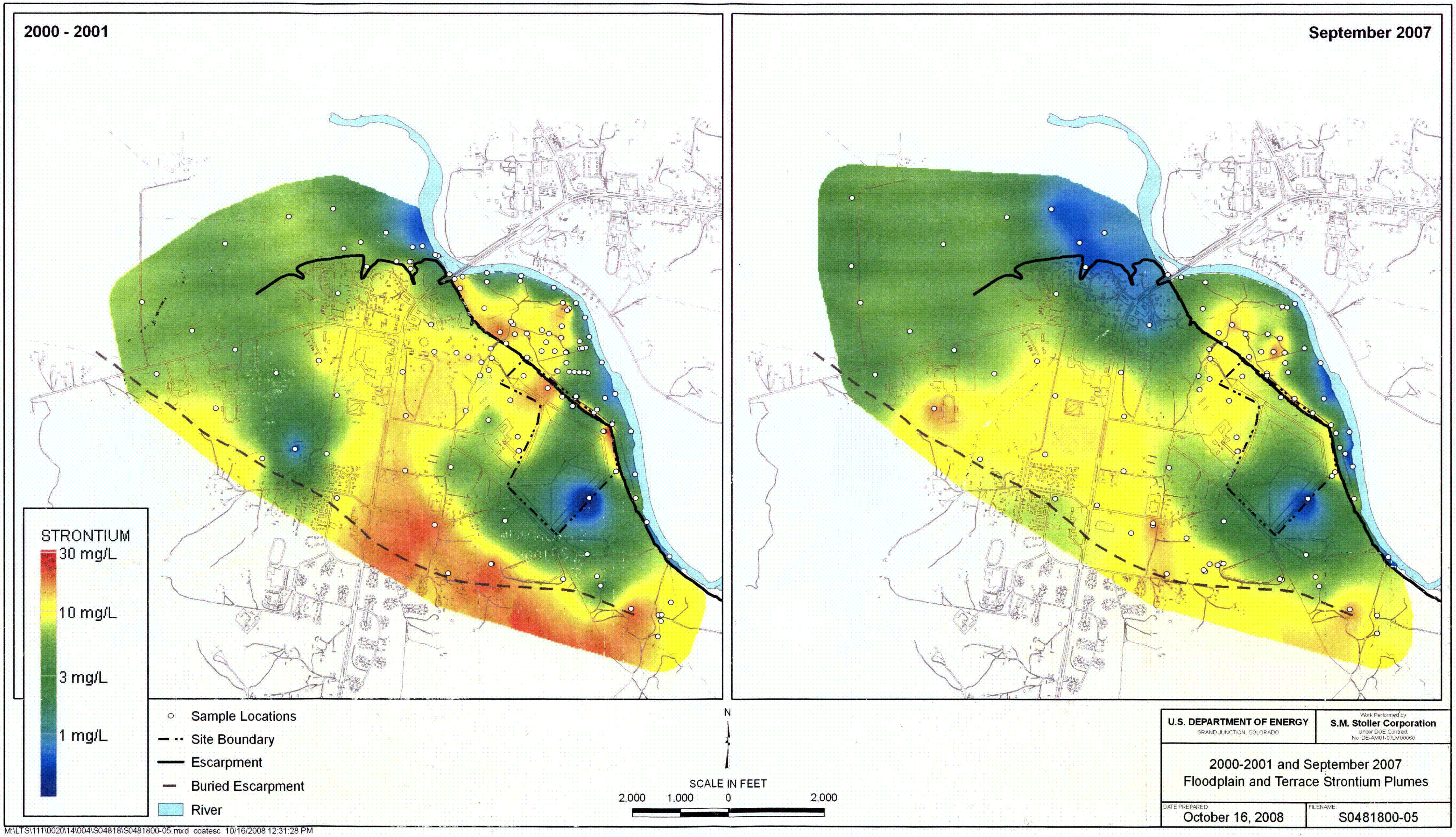

Figure 1–13. 2000/2001 and September 2007 Floodplain and Terrace Strontium Plumes

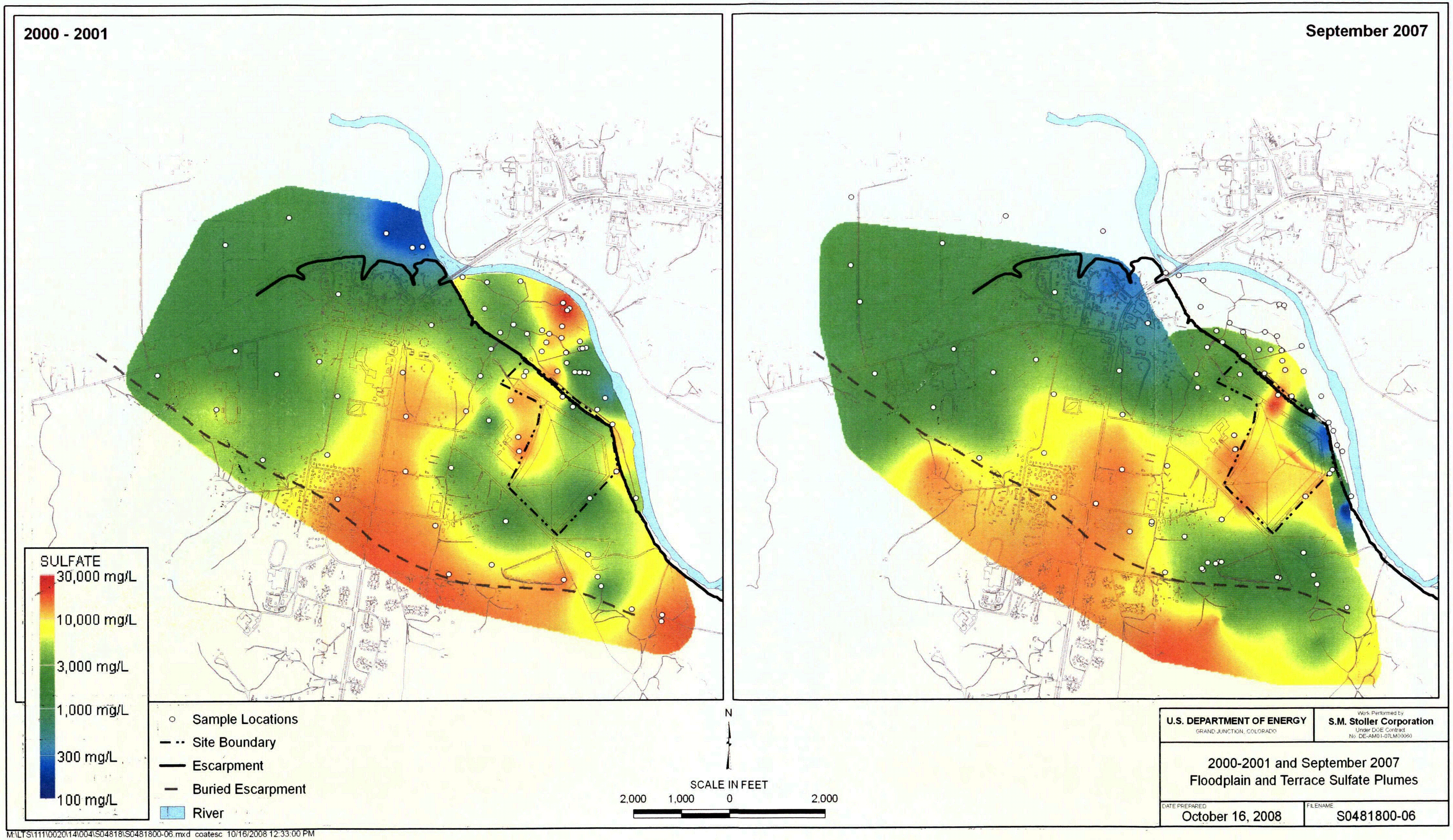

Figure 1–14. 2000/2001 and September 2007 Floodplain and Terrace Sulfate Plumes

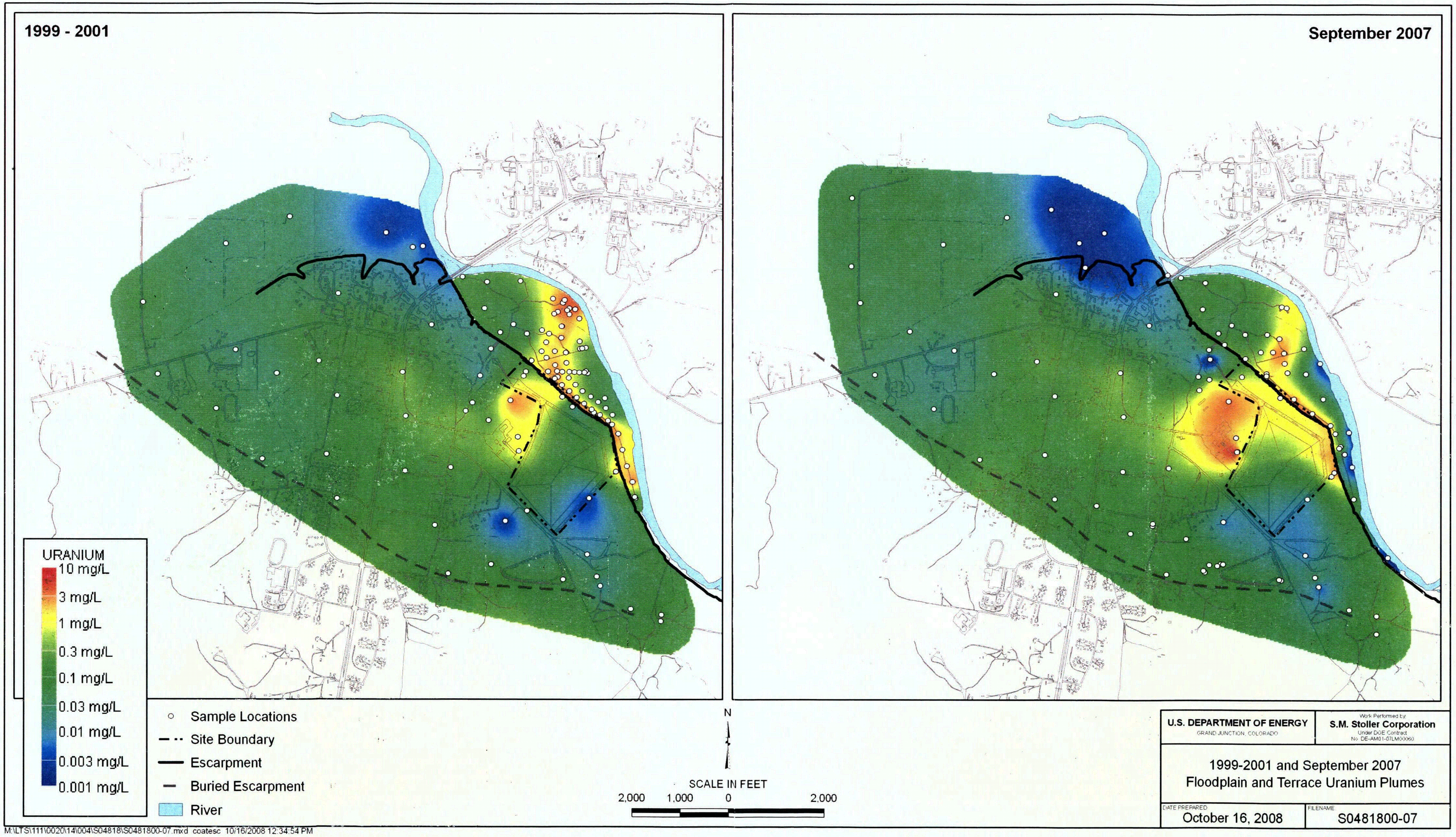

Figure 1–15. 2000/2001 and September 2007 Floodplain and Terrace Uranium Plumes