Department of Energy
Office of Legacy Management

WM-73

September 8, 2004

Mr. Norman Honie
The Hopi Tribe
Office of Mining and Mineral Resources
P.O. Box 123
Kykotsmovi, AZ 86039

Ms. Madeline Roanhorse, Director
Division of Natural Resources
Navajo UMTRA Program
P.O. Box 1875
Window Rock, AZ 86515

Subject: *Tuba City, Arizona, UMTRA Project Site Semi-Annual Performance Evaluation September 2003 through February 2004*

Dear Ms. Roanhorse and Mr. Honie:

Enclosed is the *Tuba City, Arizona, Land Management Project Site Semi-Annual Performance Evaluation, September 2003 through February 2004*. The report shows that during the six month period, the water treatment system operated 92 percent of the time; treating over 24.6 million gallons of groundwater. The overall system has proven to be highly effective, removing 54 pounds of uranium, and over 270,000 pounds of Nitrates and Sulfates from the groundwater during the period. After treatment, the system returned approximately 87 percent of the water to the shallow groundwater aquifer via the infiltration trench.

If you have any questions or comments, or need additional copies of the report, please do not hesitate to give me a call at 970/248-6037.

Sincerely,

Art Kleinrath
Site Manager

Enclosure

cc w/enclosure:
G. Janosko, NRC
Tuba City Library
Project File TUB 700.05.15 (D. Roberts)
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NMSS08

DOE–LM/GJ708–2004

Office of Legacy Management

Tuba City, Arizona, Land Management Project Site Semi-Annual Performance Evaluation September 2003 Through February 2004

August 2004

U.S. Department of Energy

Work Performed Under DOE Contract No. DE–AC01–02GJ79491
for the U.S. Department of Energy Office of Legacy Management.
Approved for public release; distribution is unlimited.

DOE-EM/GJ708-2004

Tuba City, Arizona, Land Management Project Site Semi-Annual Performance Evaluation September 2003 through February 2004

August 2004

Work Performed by S.M. Stoller Corporation under DOE Contract No. DE-AC01-02GJ79491
for the U.S. Department of Energy, Grand Junction, Colorado

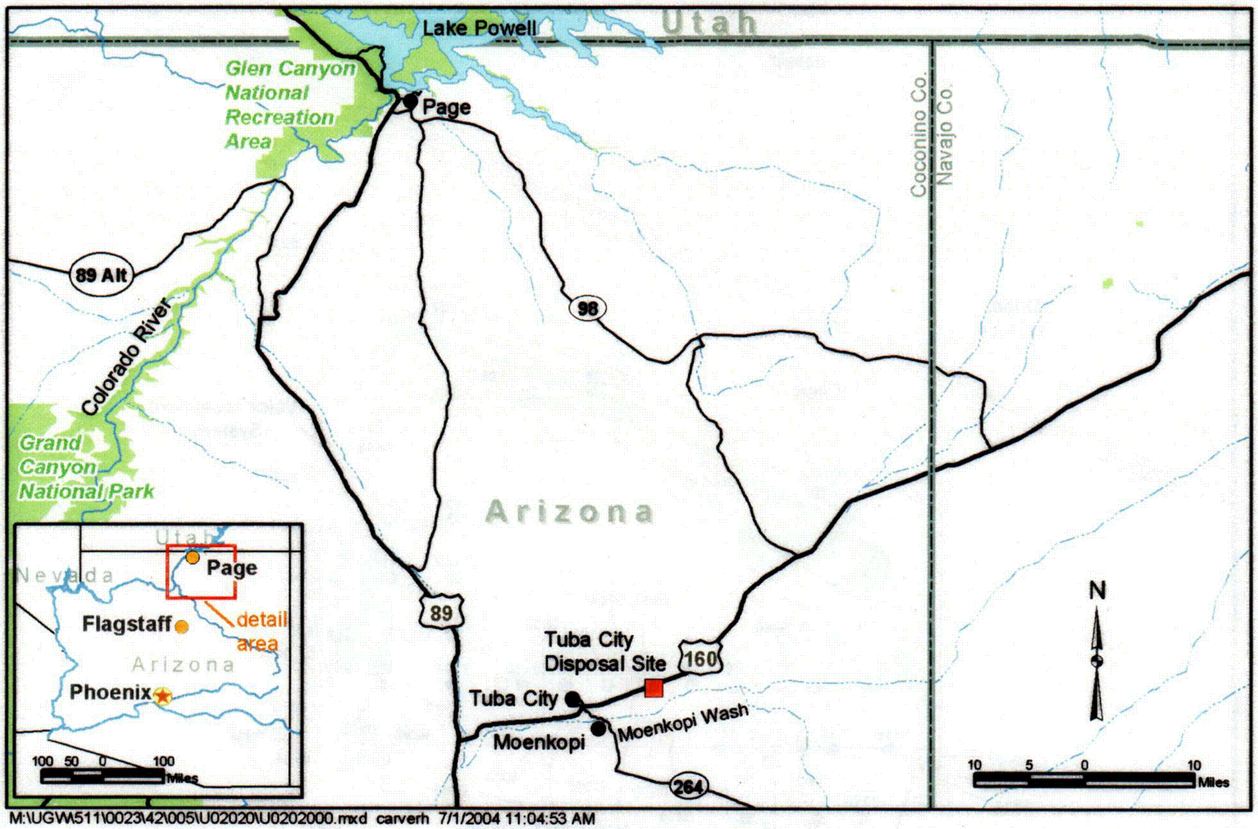

Figure 1. Tuba City Site Location

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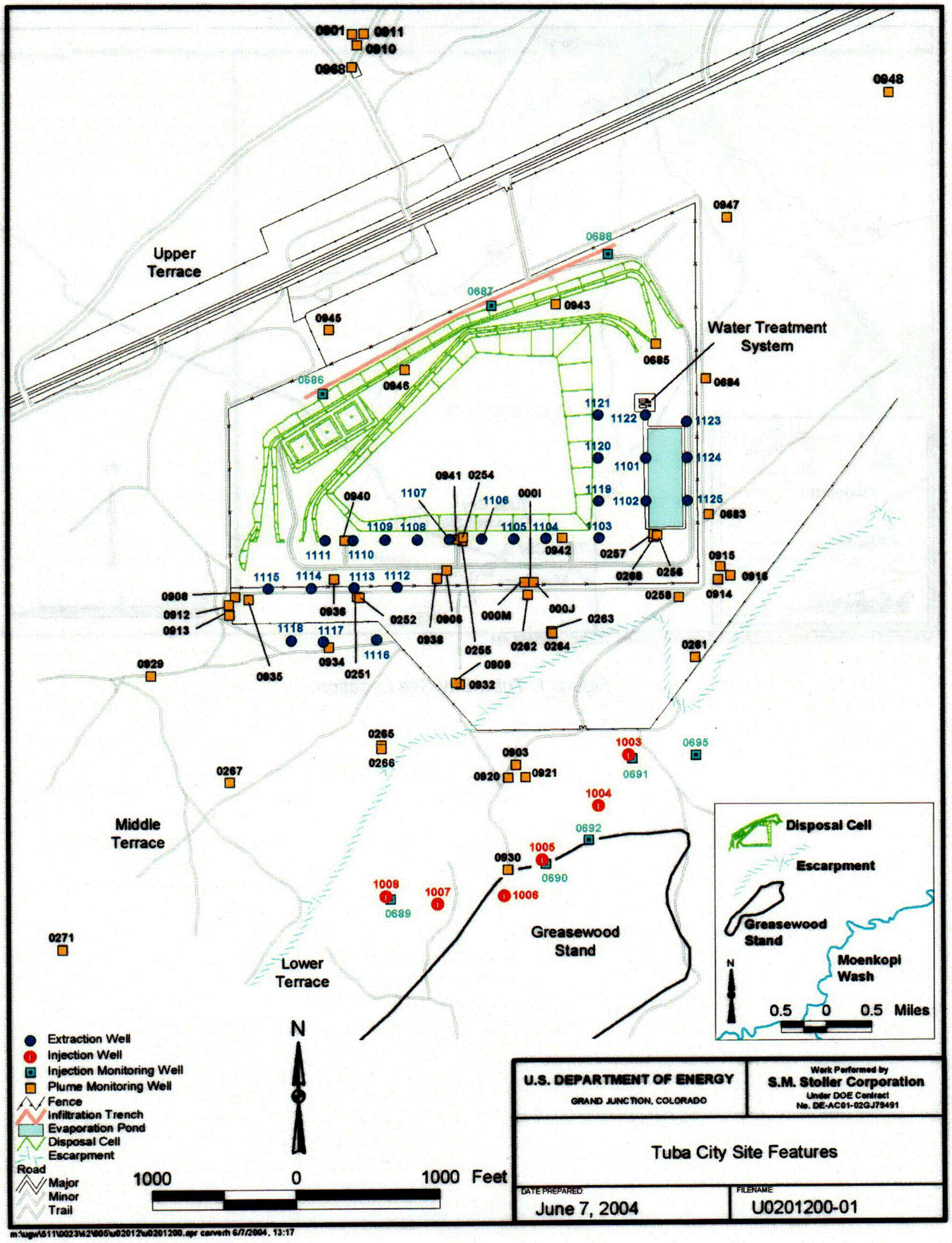

Figure 2. Tuba City Site Features

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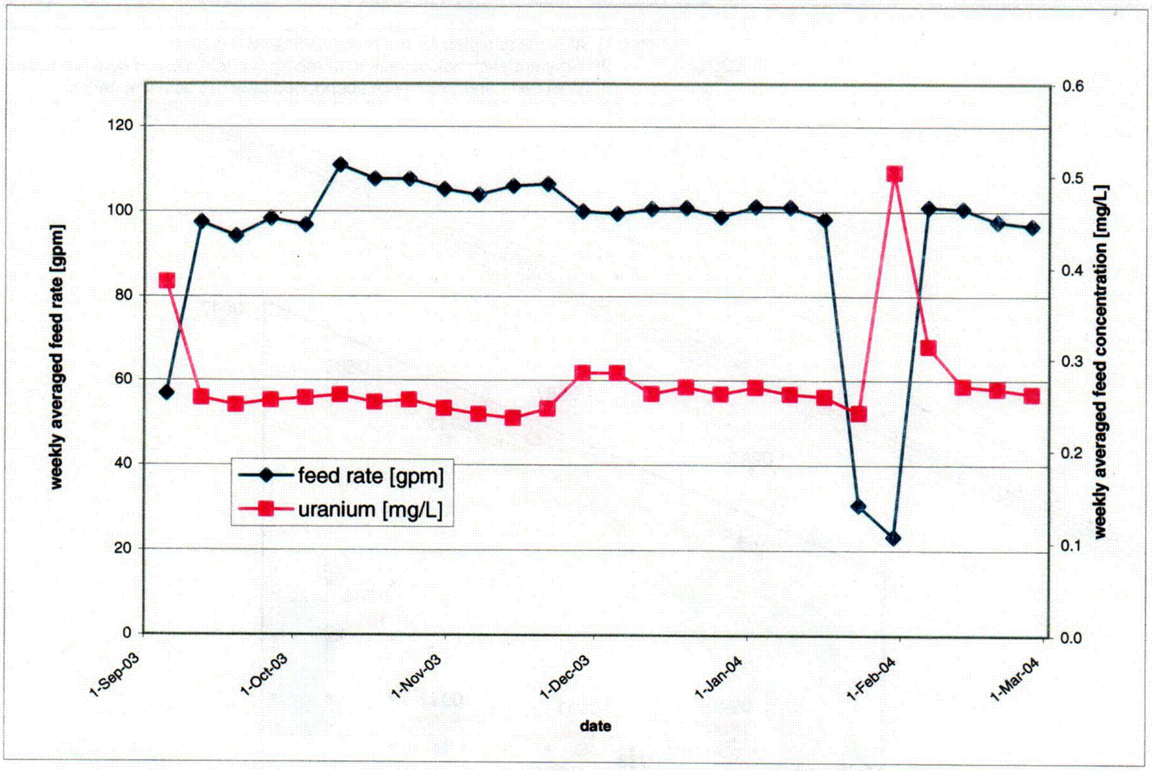

Figure 3. Treatment System Inflow Rate and Uranium Concentration

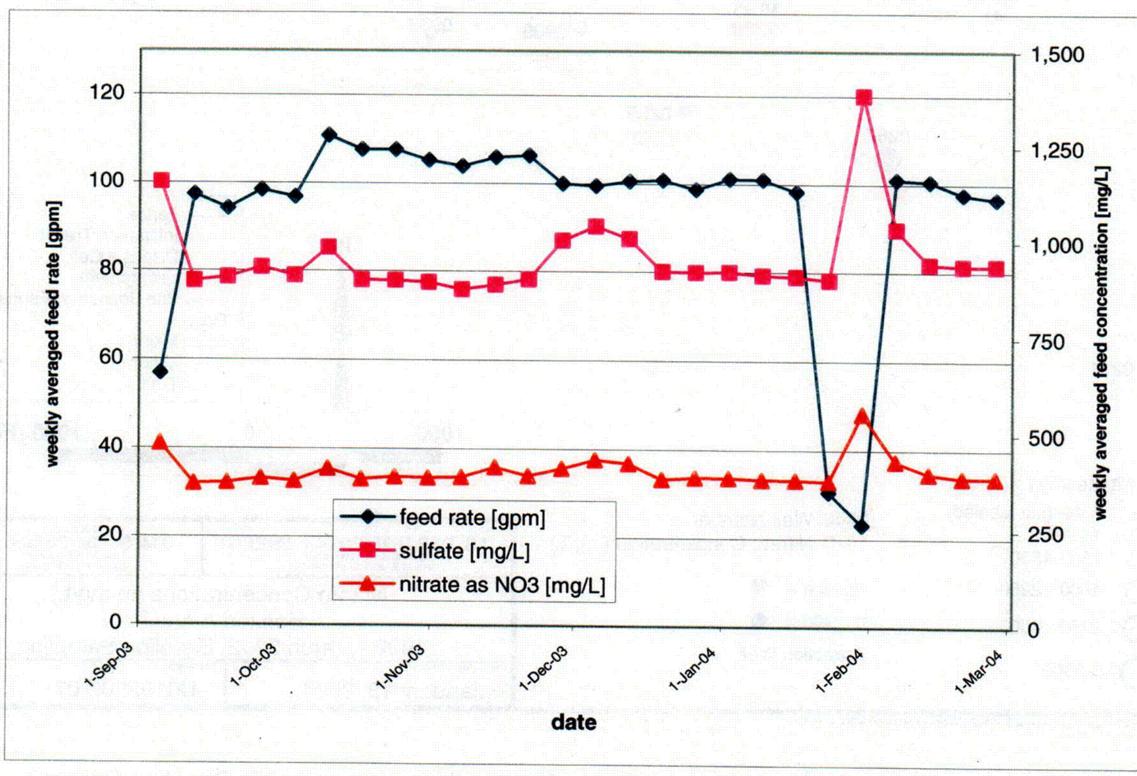

Figure 4. Treatment System Inflow Rate and Nitrate and Sulfate Concentrations

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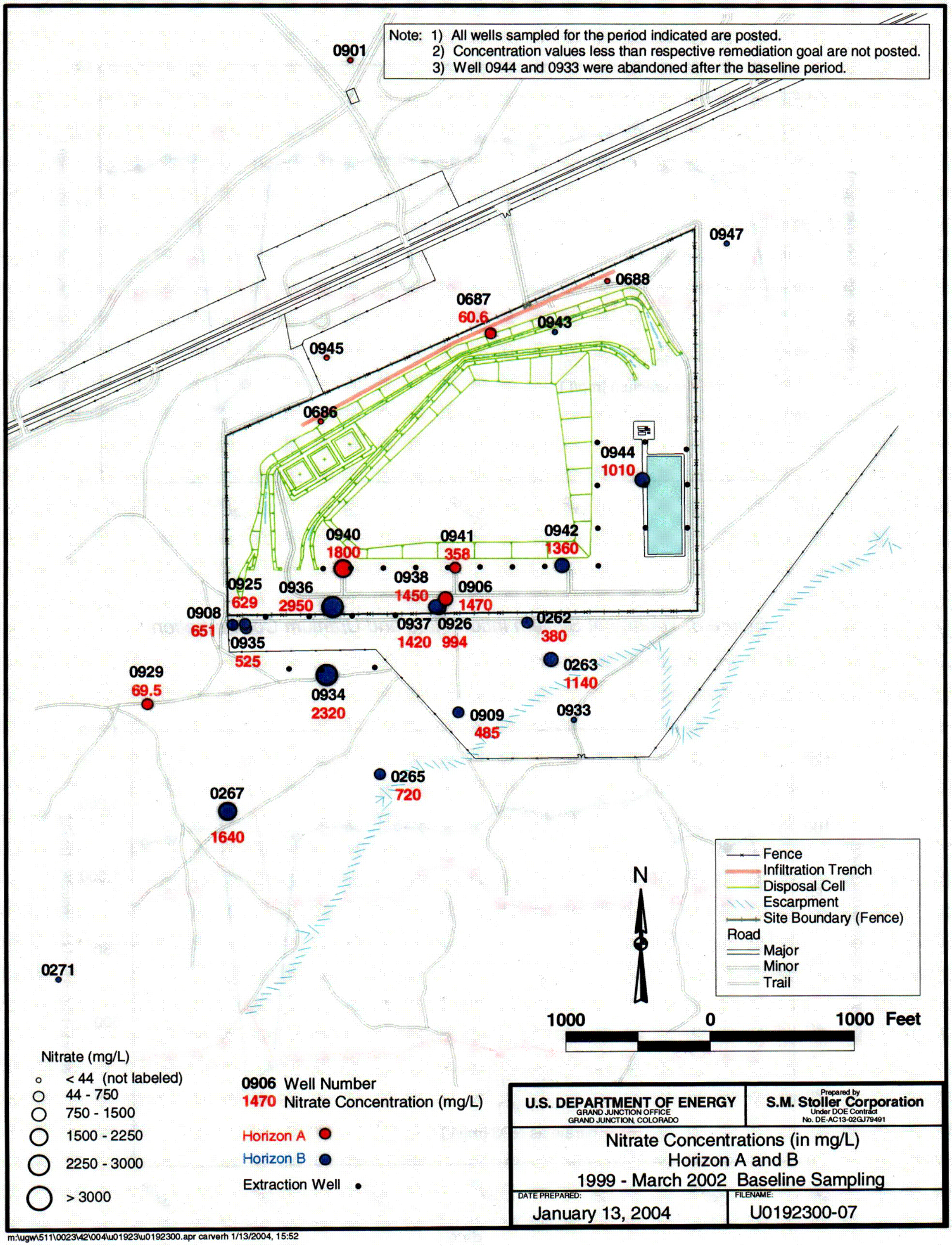

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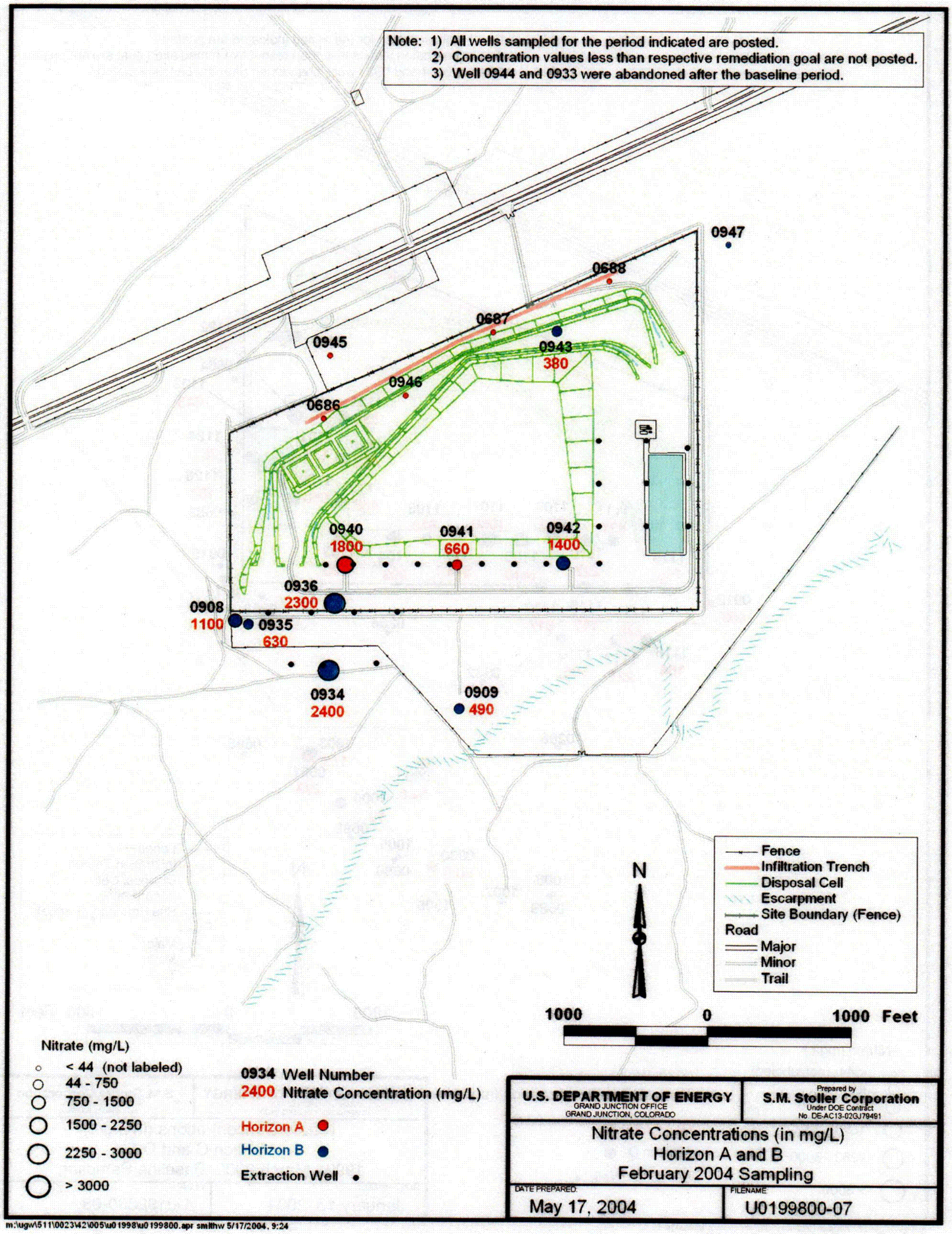

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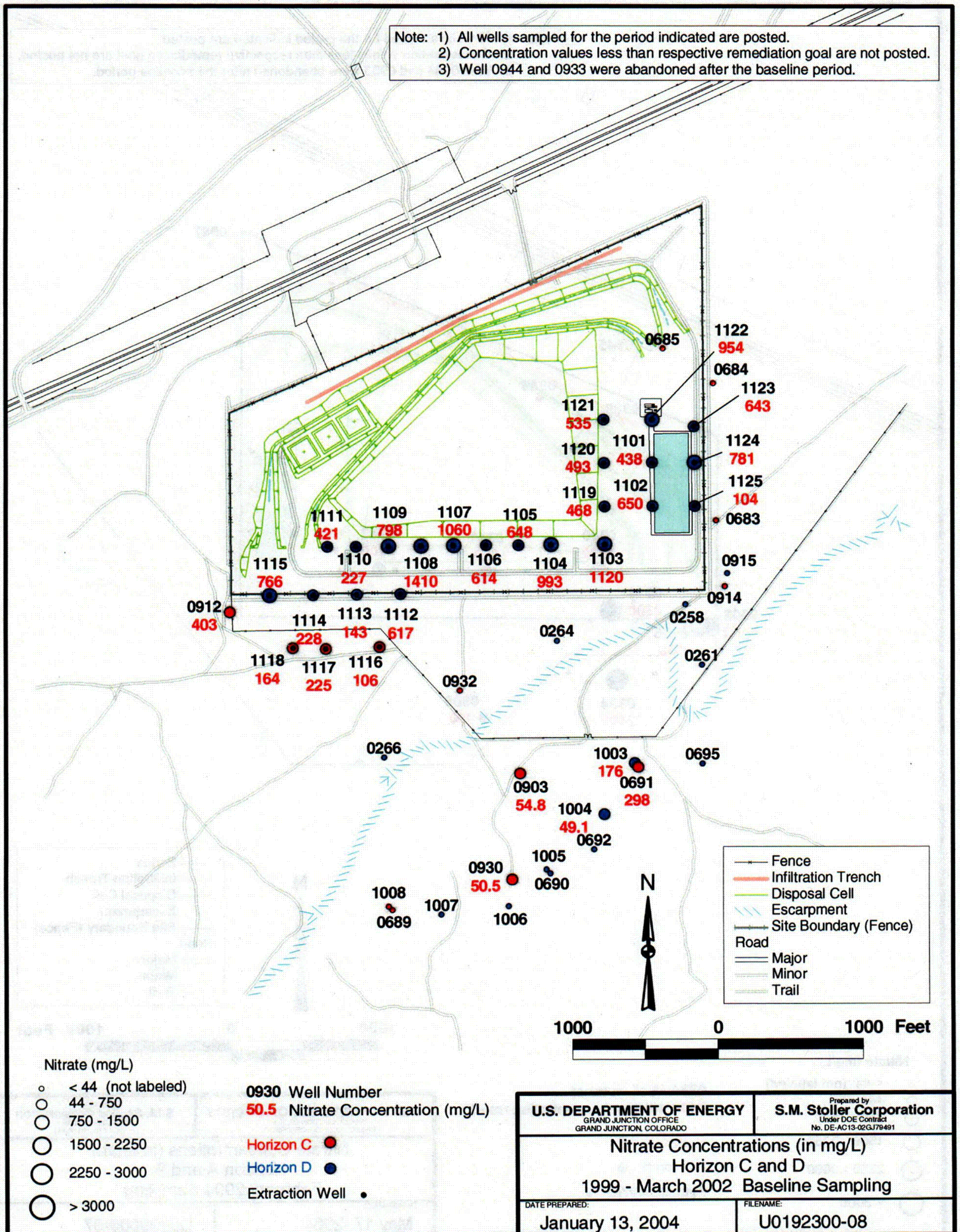

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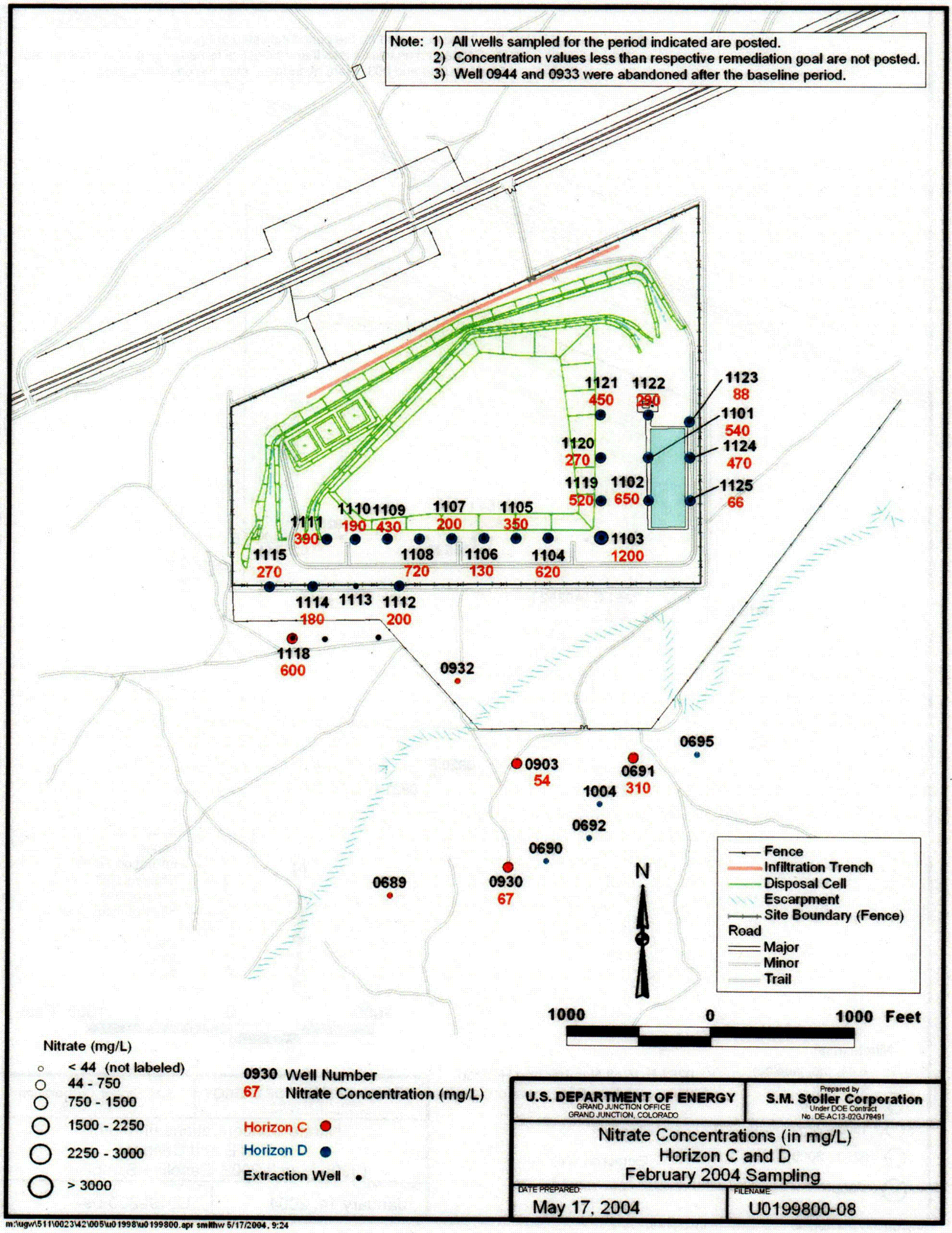

Figure 6b. Nitrate Concentrations in Ground Water, Horizons C and D, February 2004

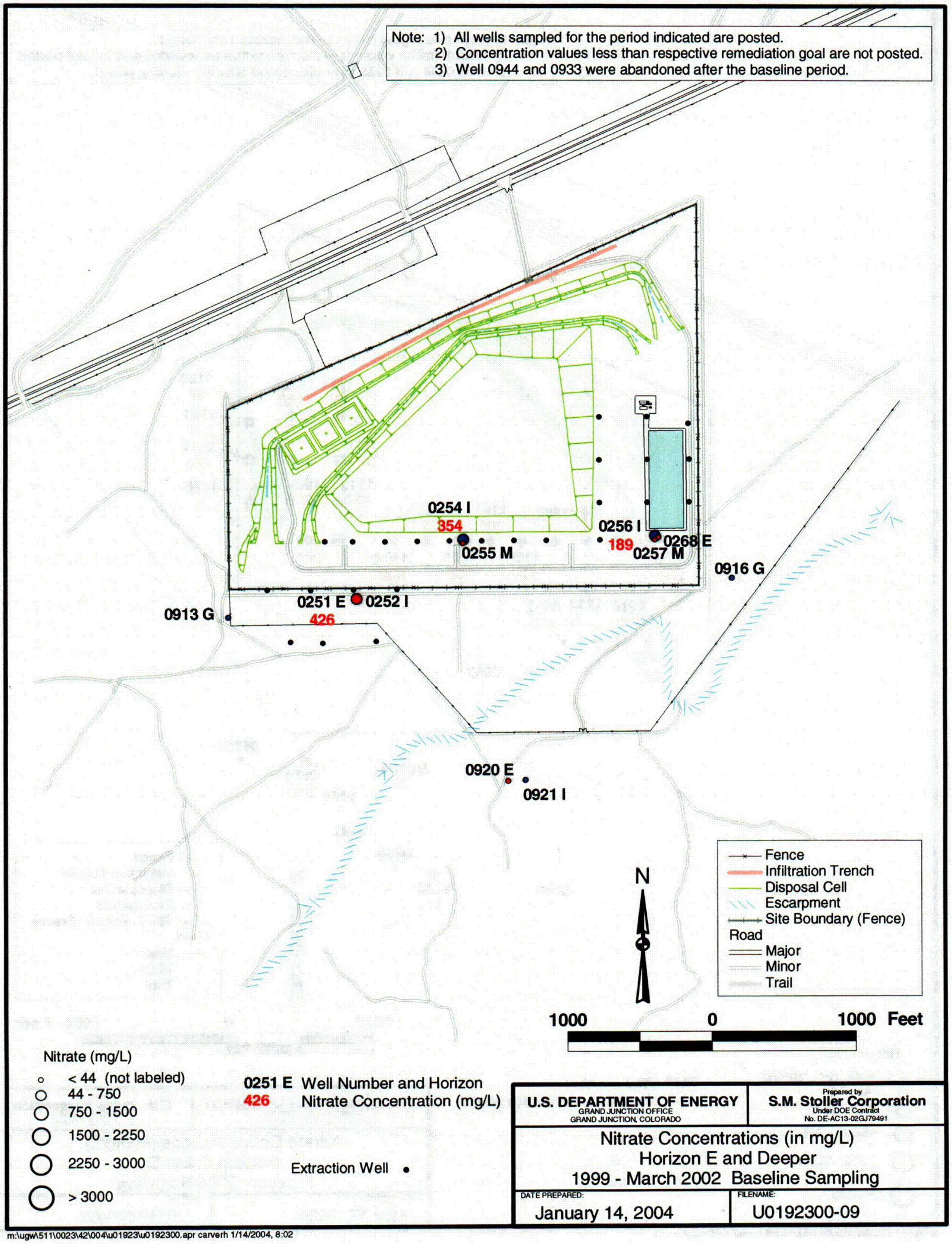

Figure 7a. Nitrate Concentrations in Ground Water, Horizons E and Deeper, Baseline Period

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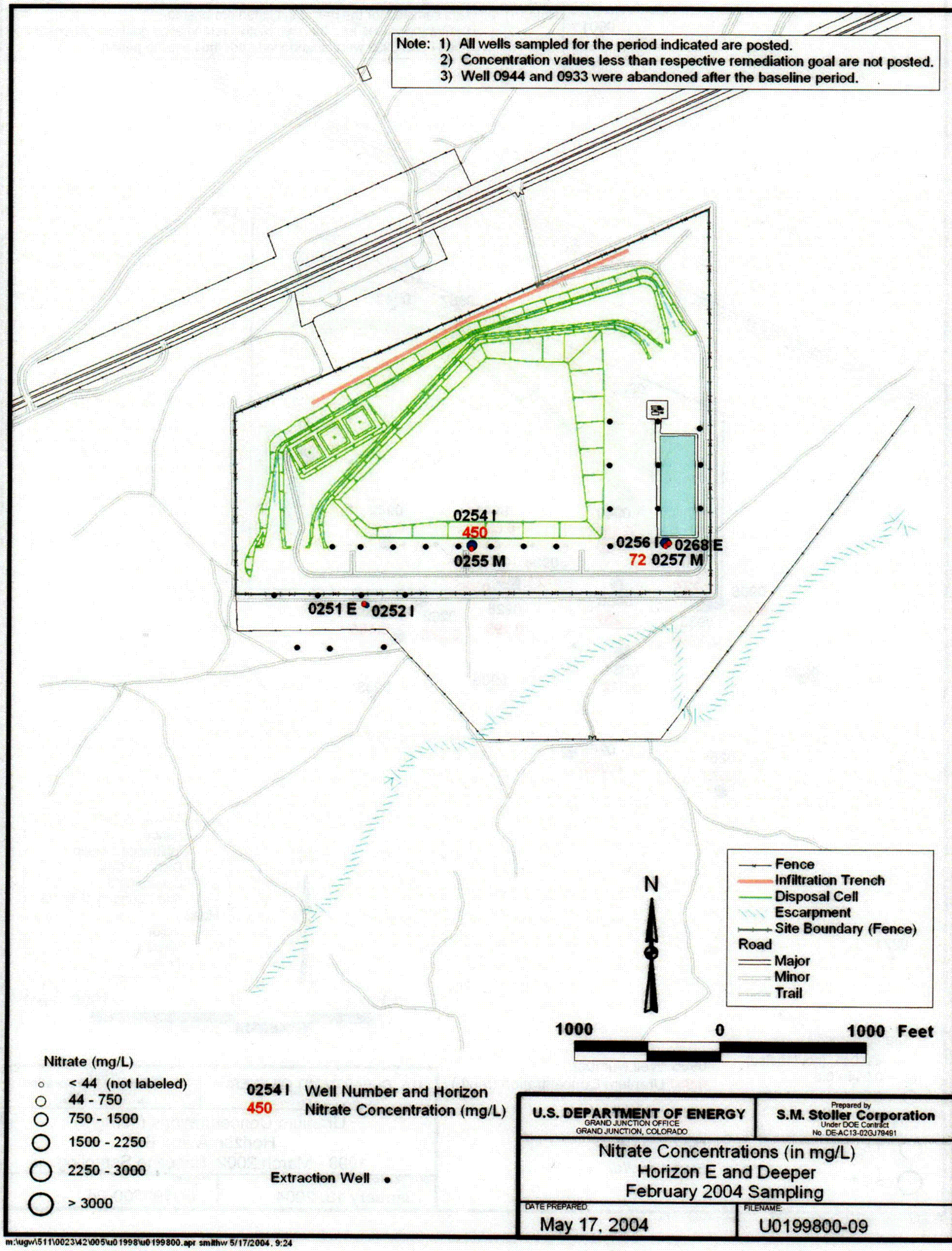

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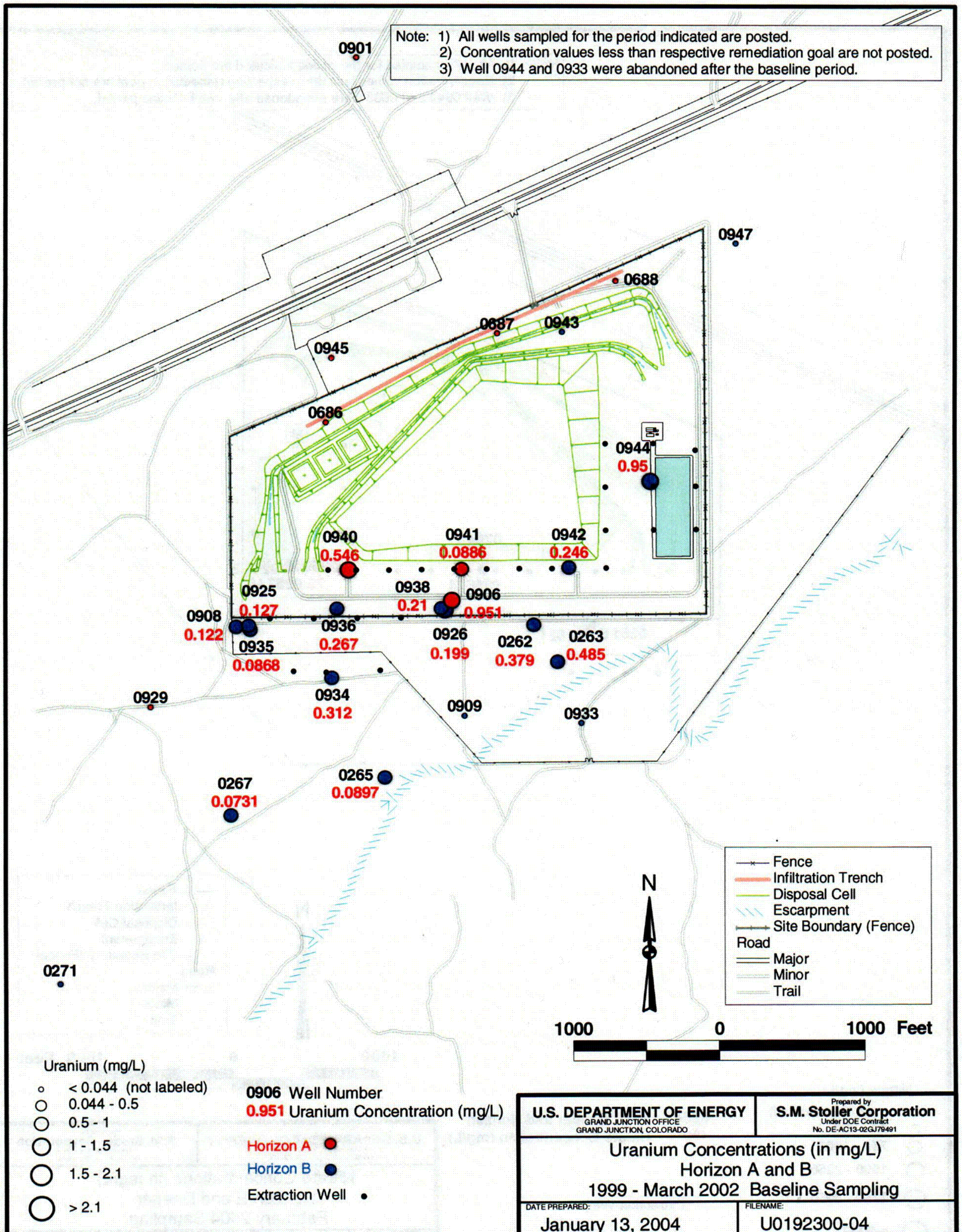

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Figure 8a. Uranium Concentrations in Ground Water, Horizons A and B, Baseline Period

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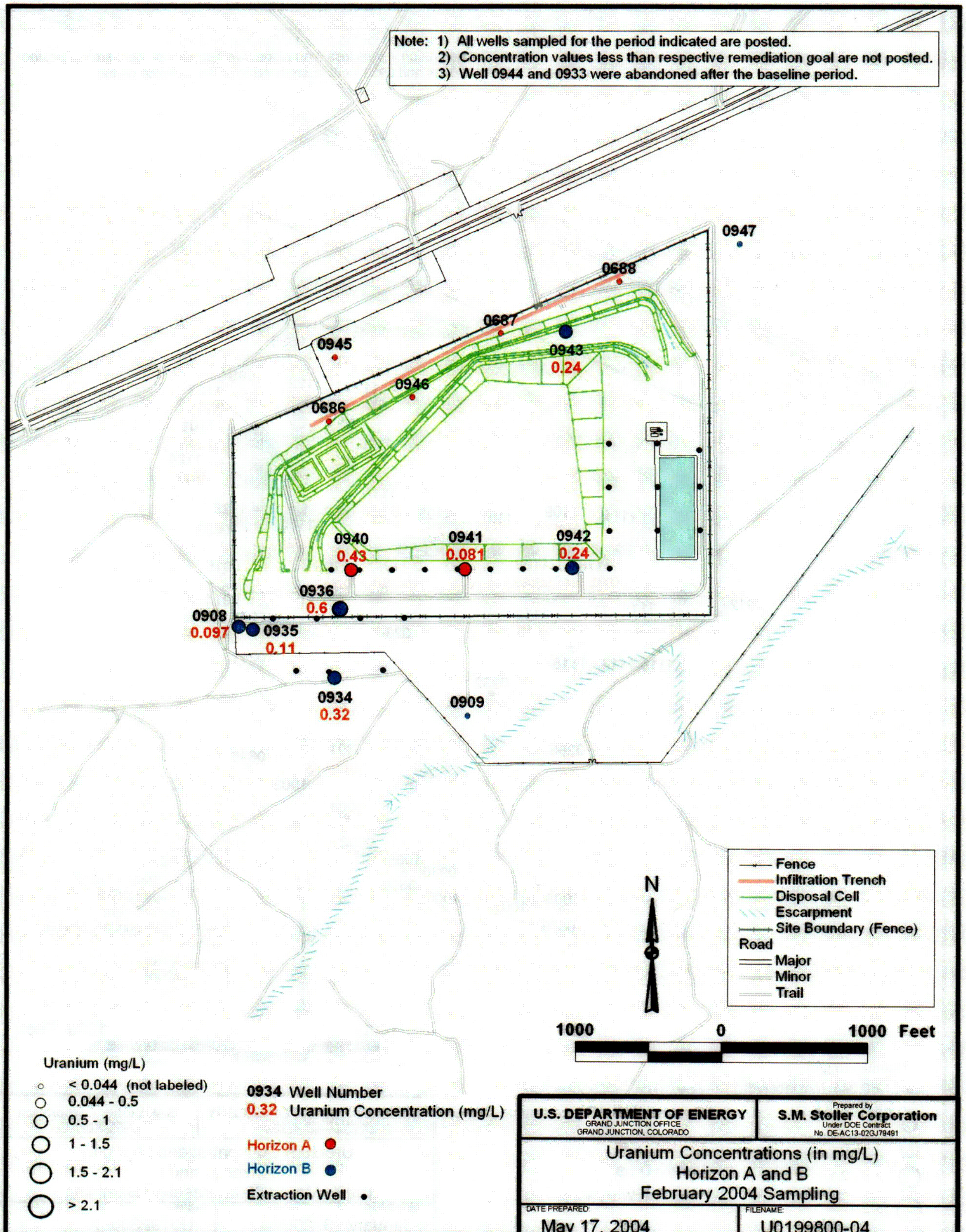

Figure 8b. Uranium Concentrations in Ground Water, Horizons A and B, February 2004

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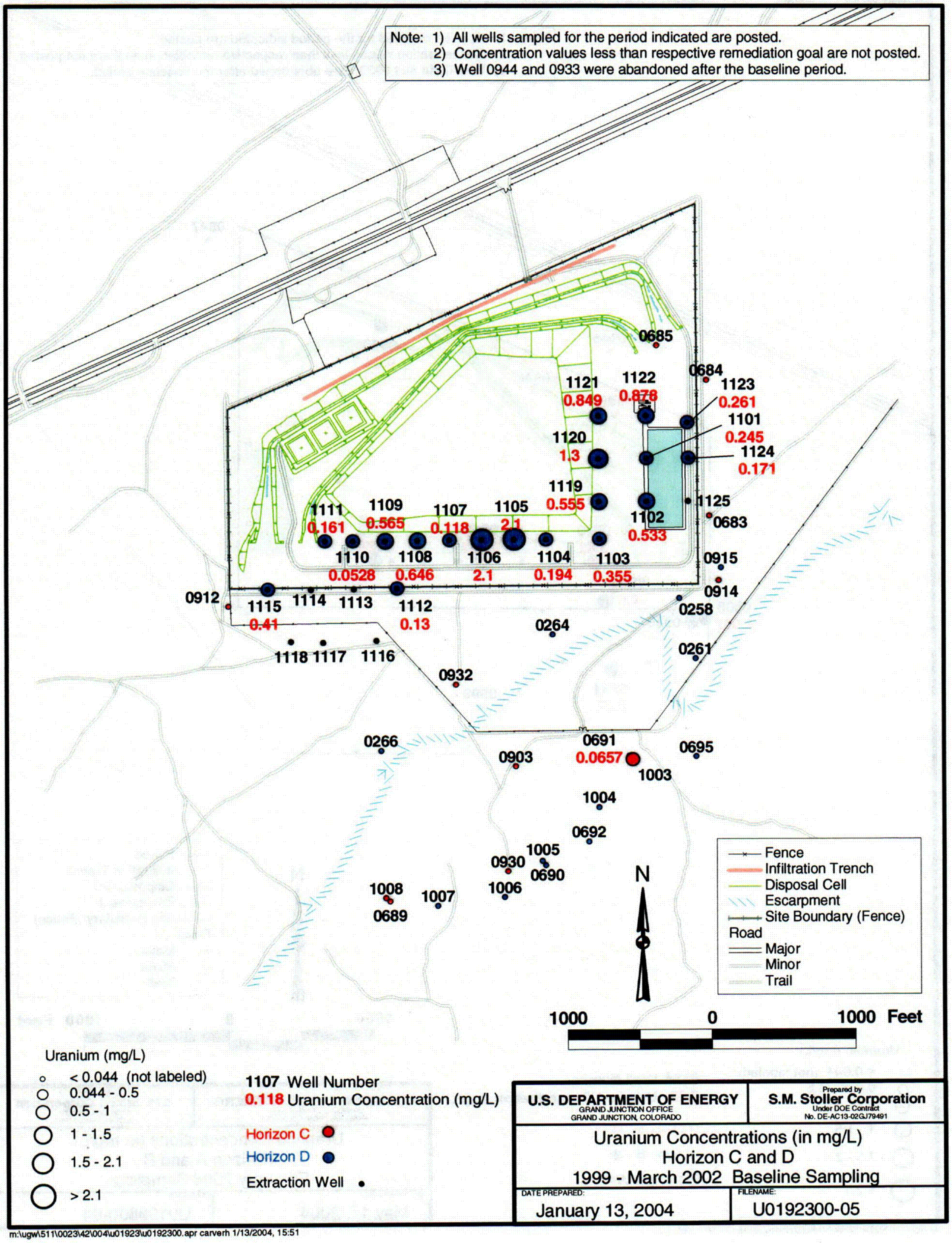

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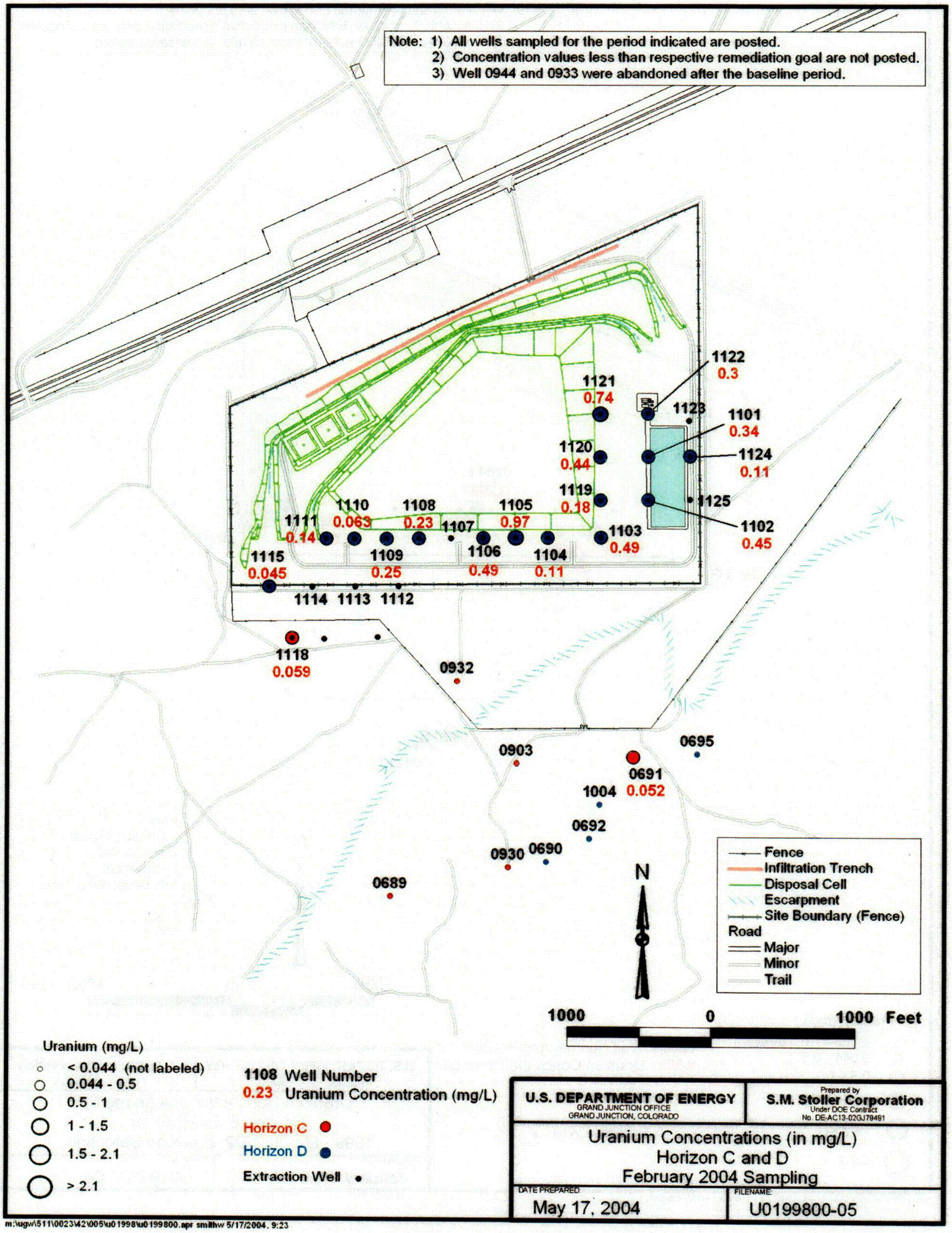

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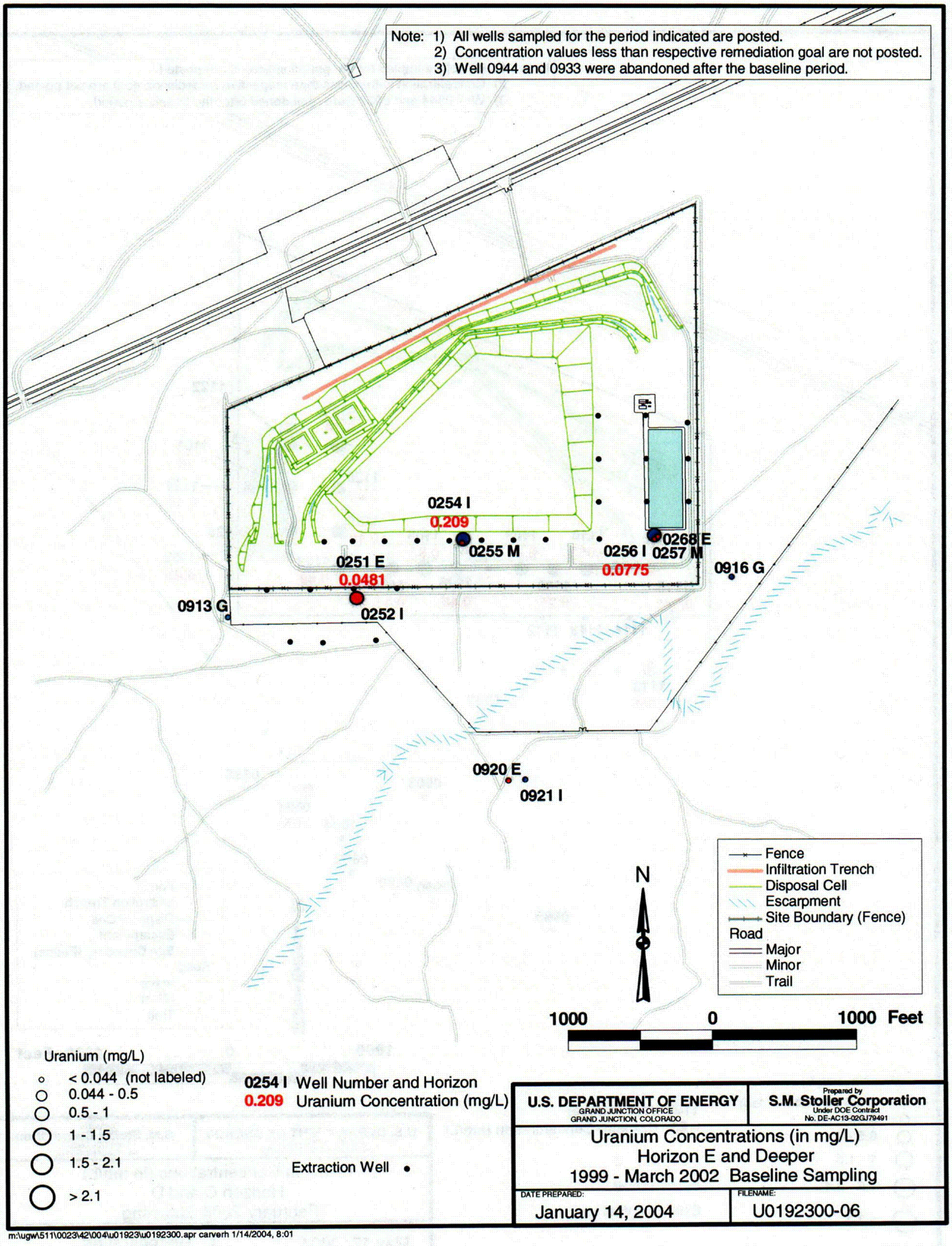

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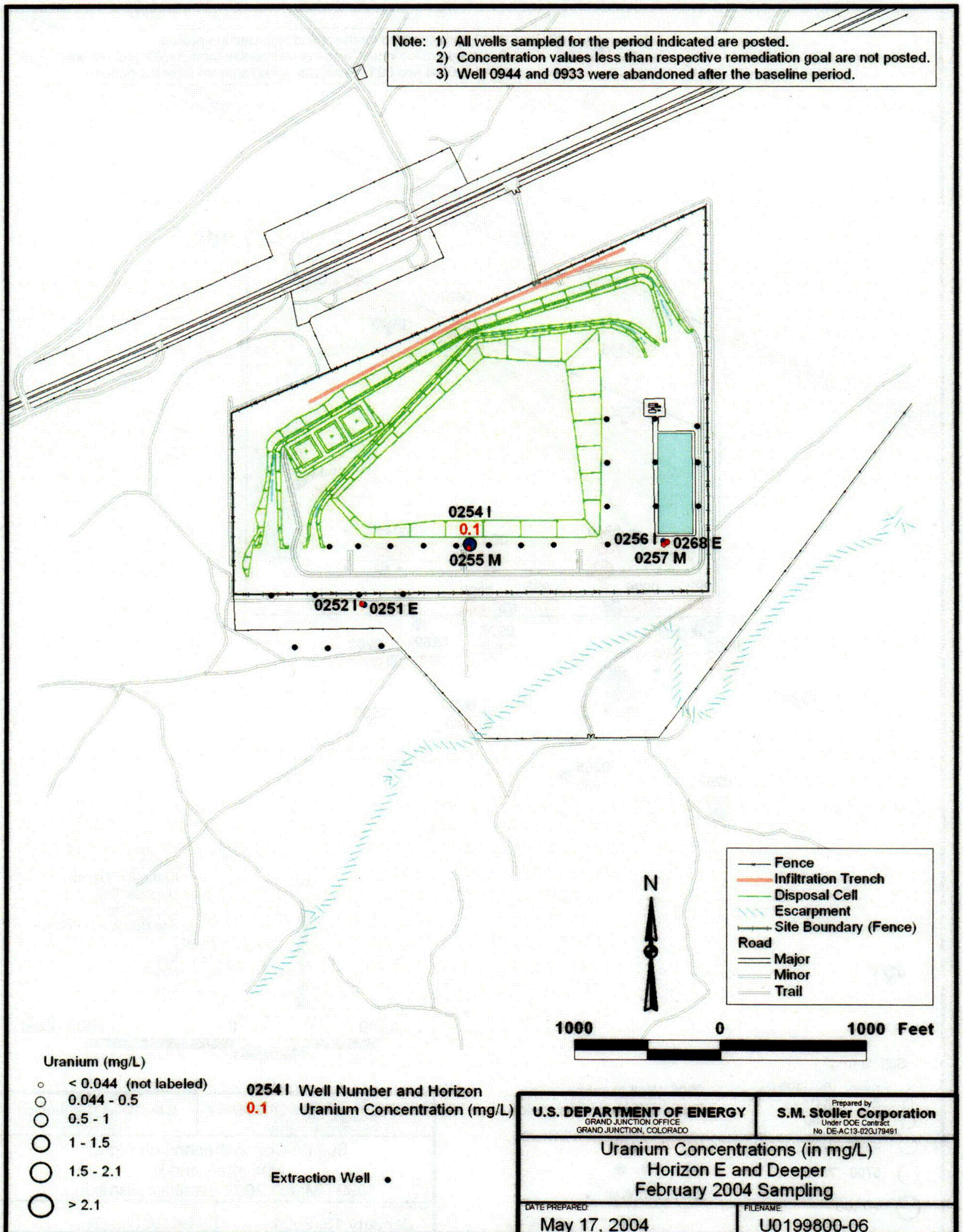

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Figure 10b. Uranium Concentrations in Ground Water, Horizons E and Deeper, February 2004

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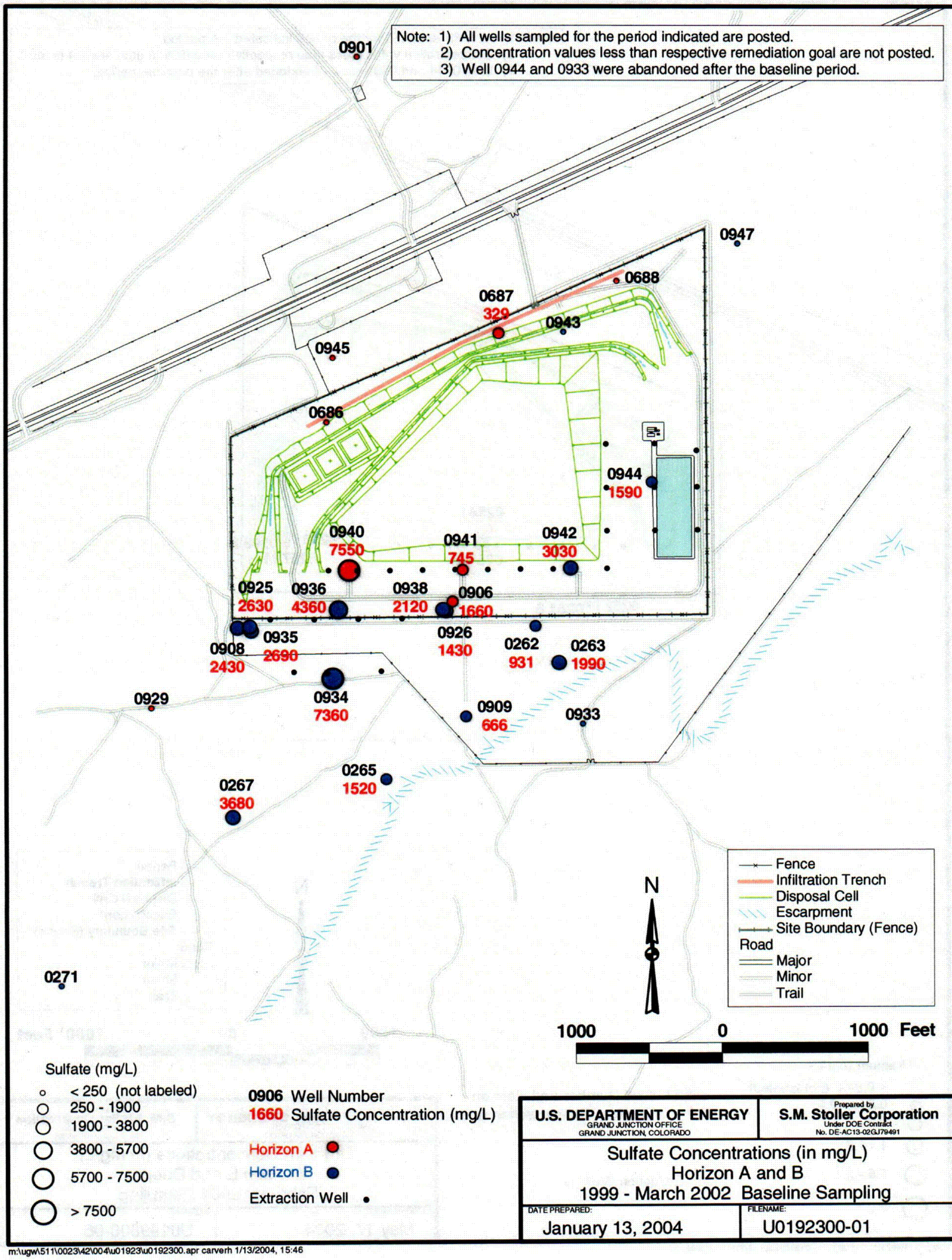

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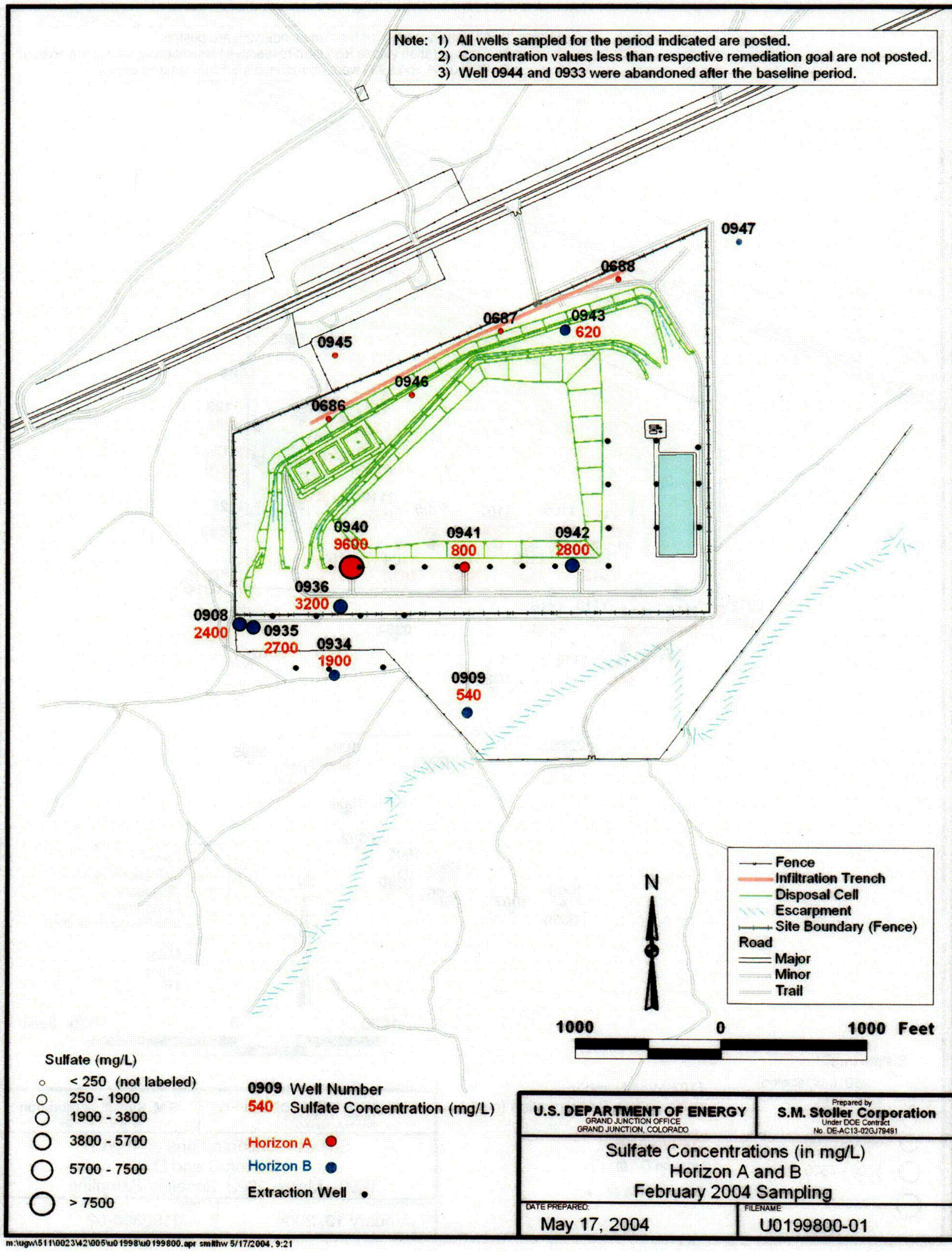

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Figure 11b. Sulfate Concentrations in Ground Water, Horizons A and B, February 2004

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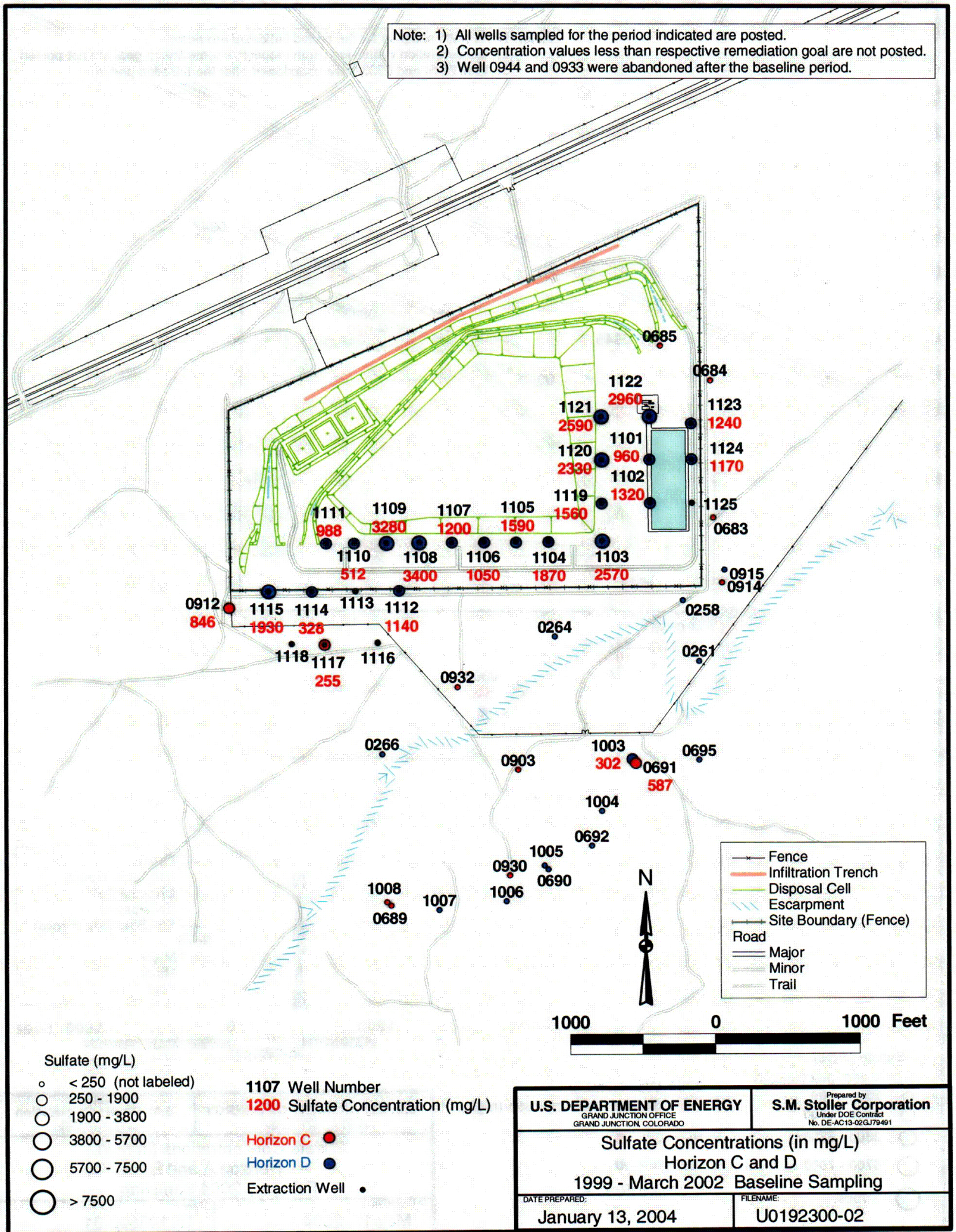

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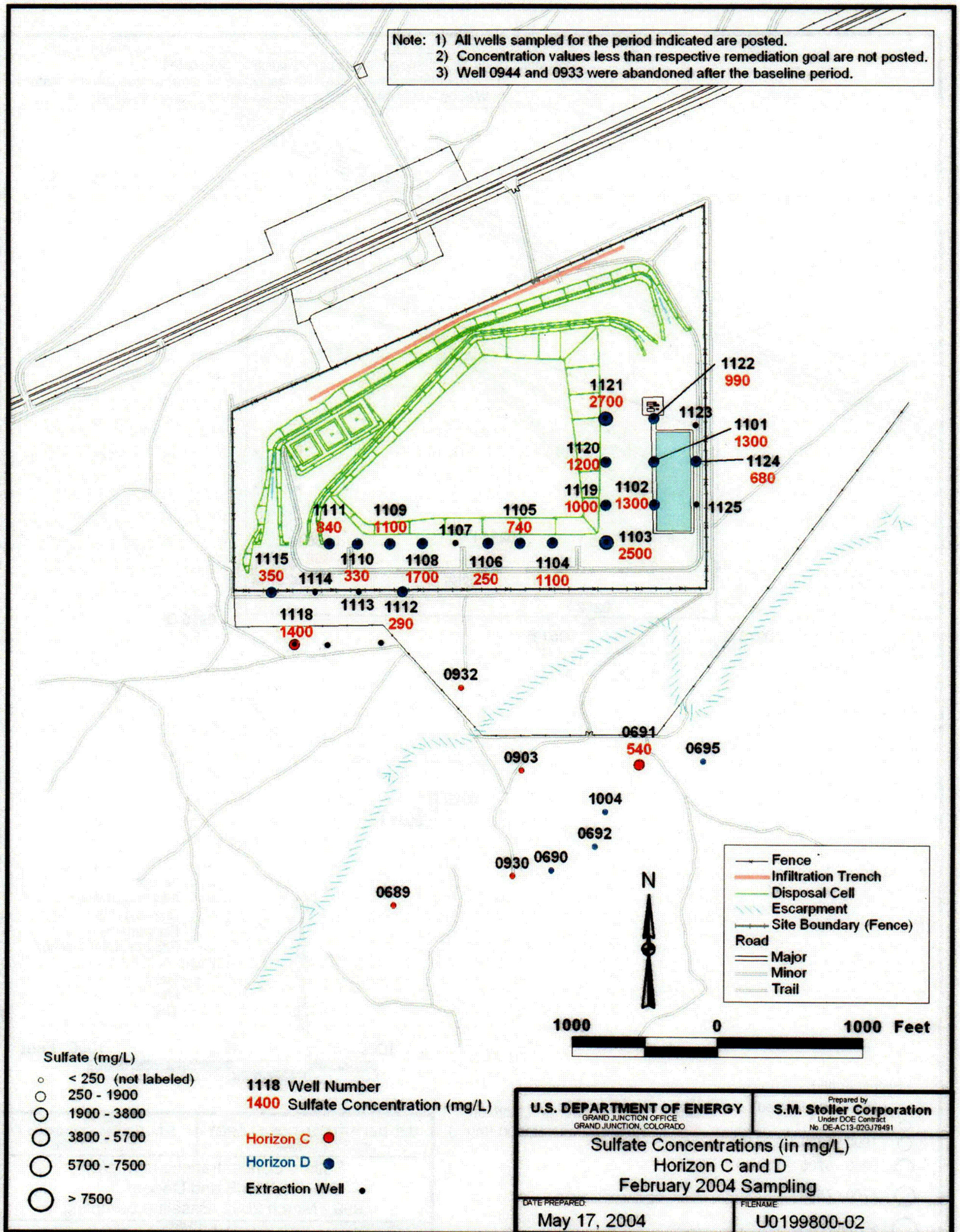

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Figure 12b. Sulfate Concentrations in Ground Water, Horizons C and D, February 2004

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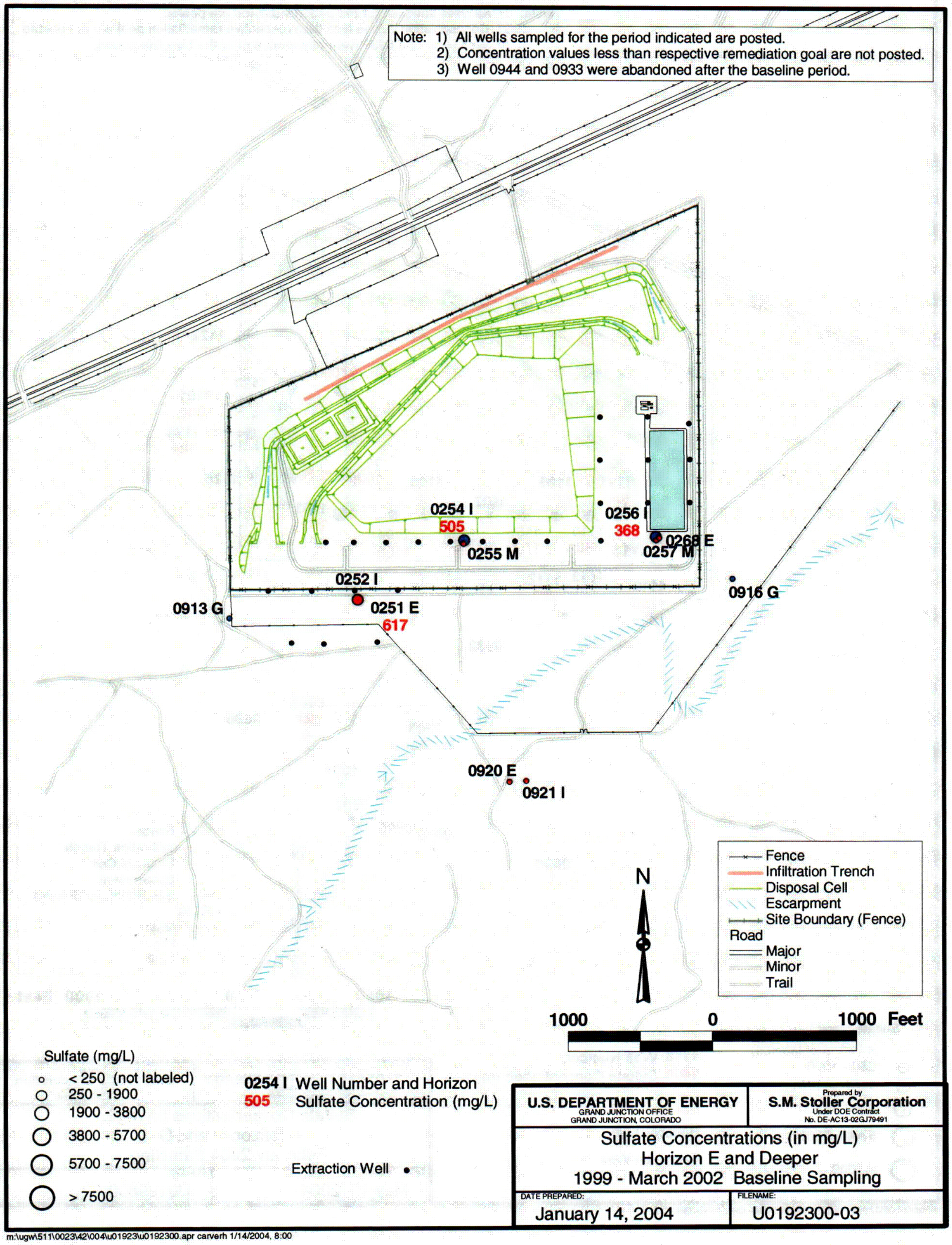

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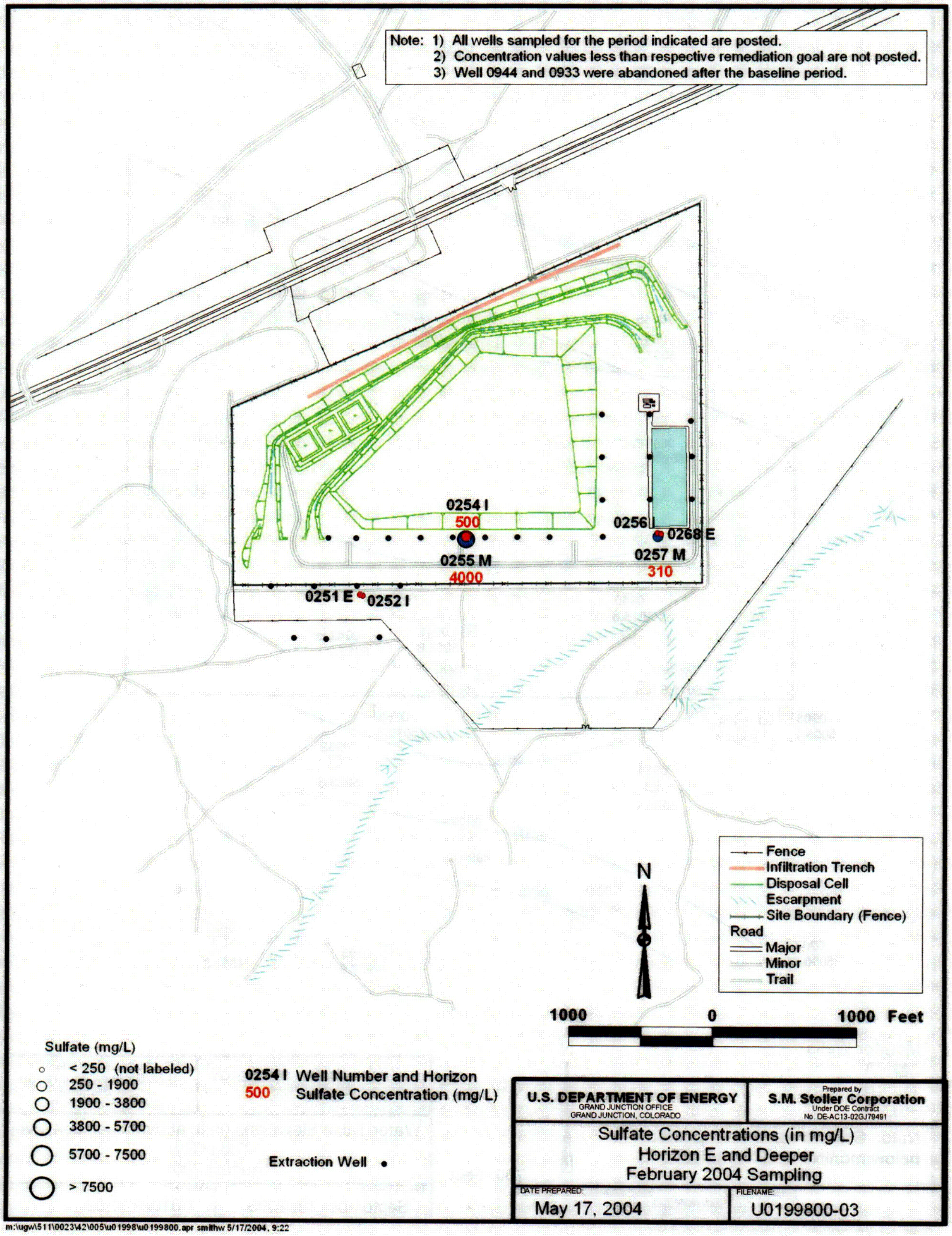

Figure 13b. Sulfate Concentrations in Ground Water, Horizons E and Deeper, February 2004

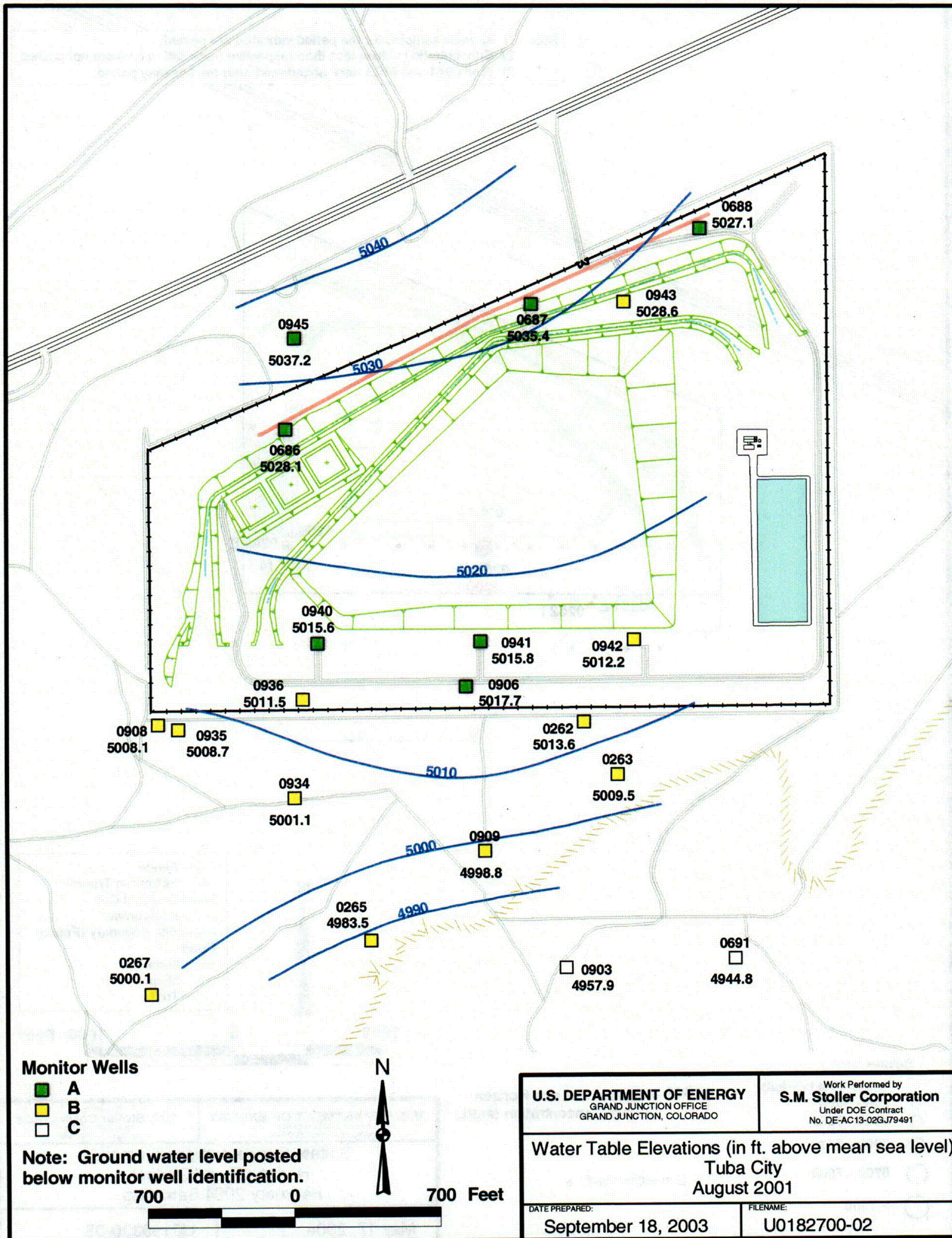

Figure 14a. Water Table Contour Map, Baseline Period

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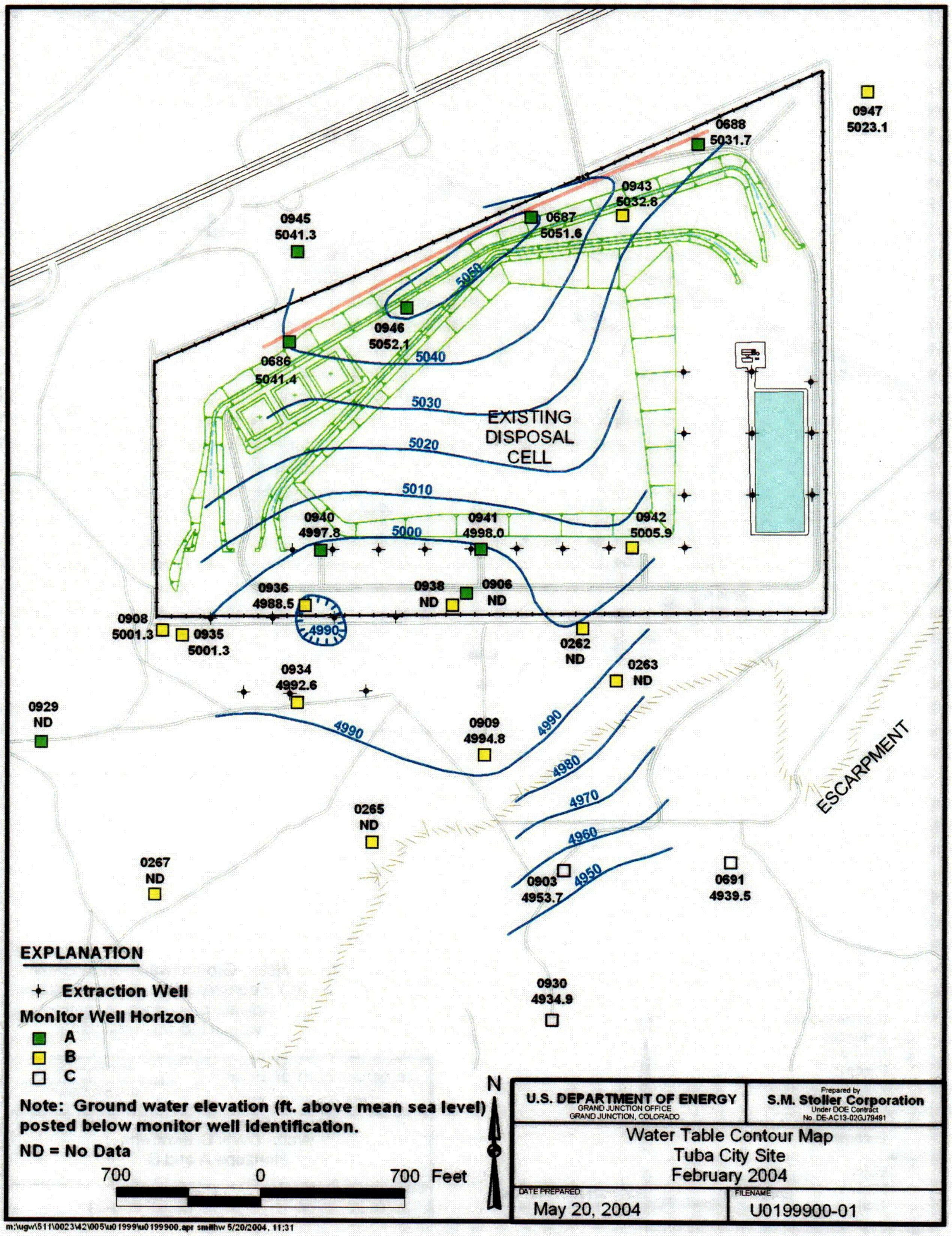

Figure 14b. Water Table Contour Map, February 2004

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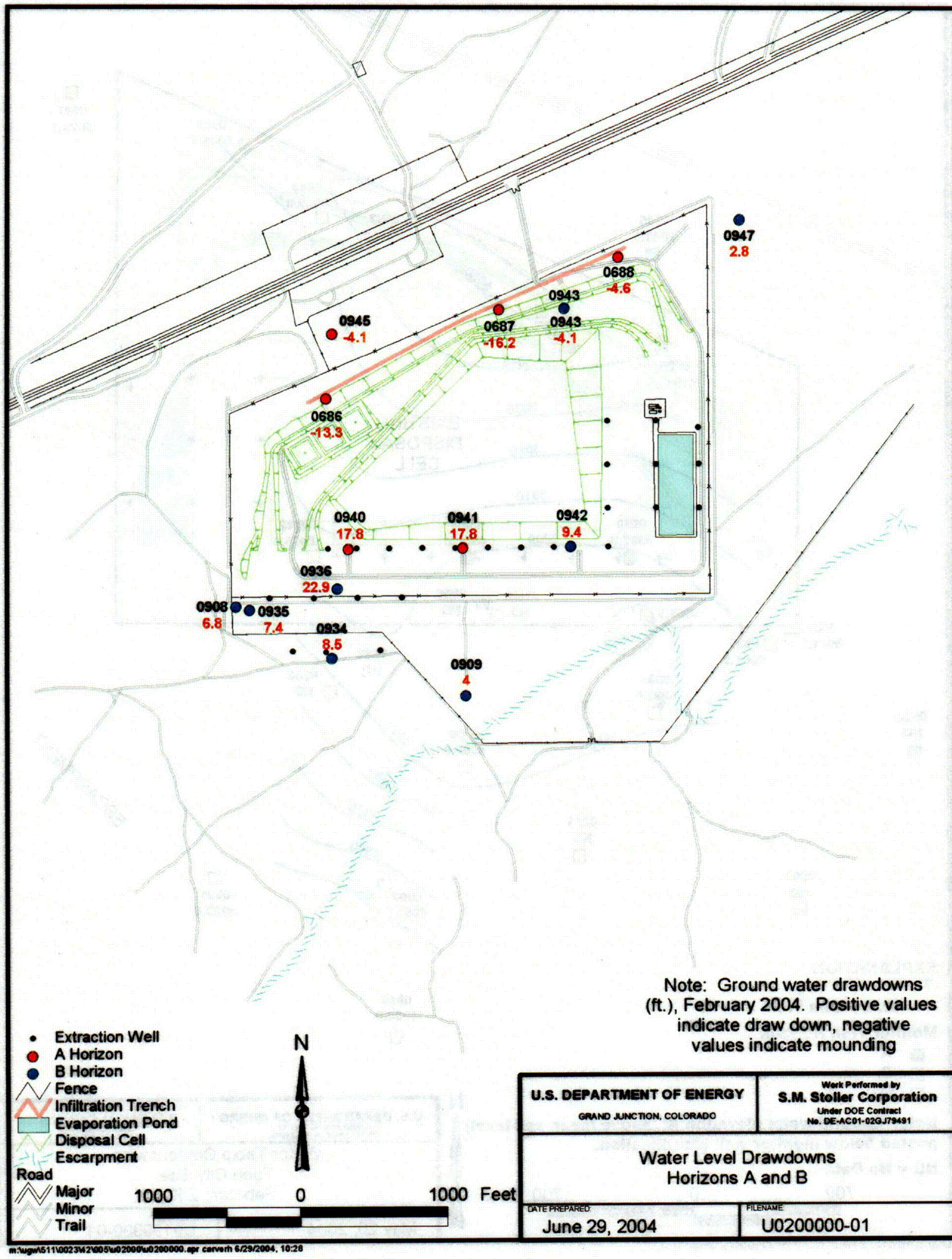

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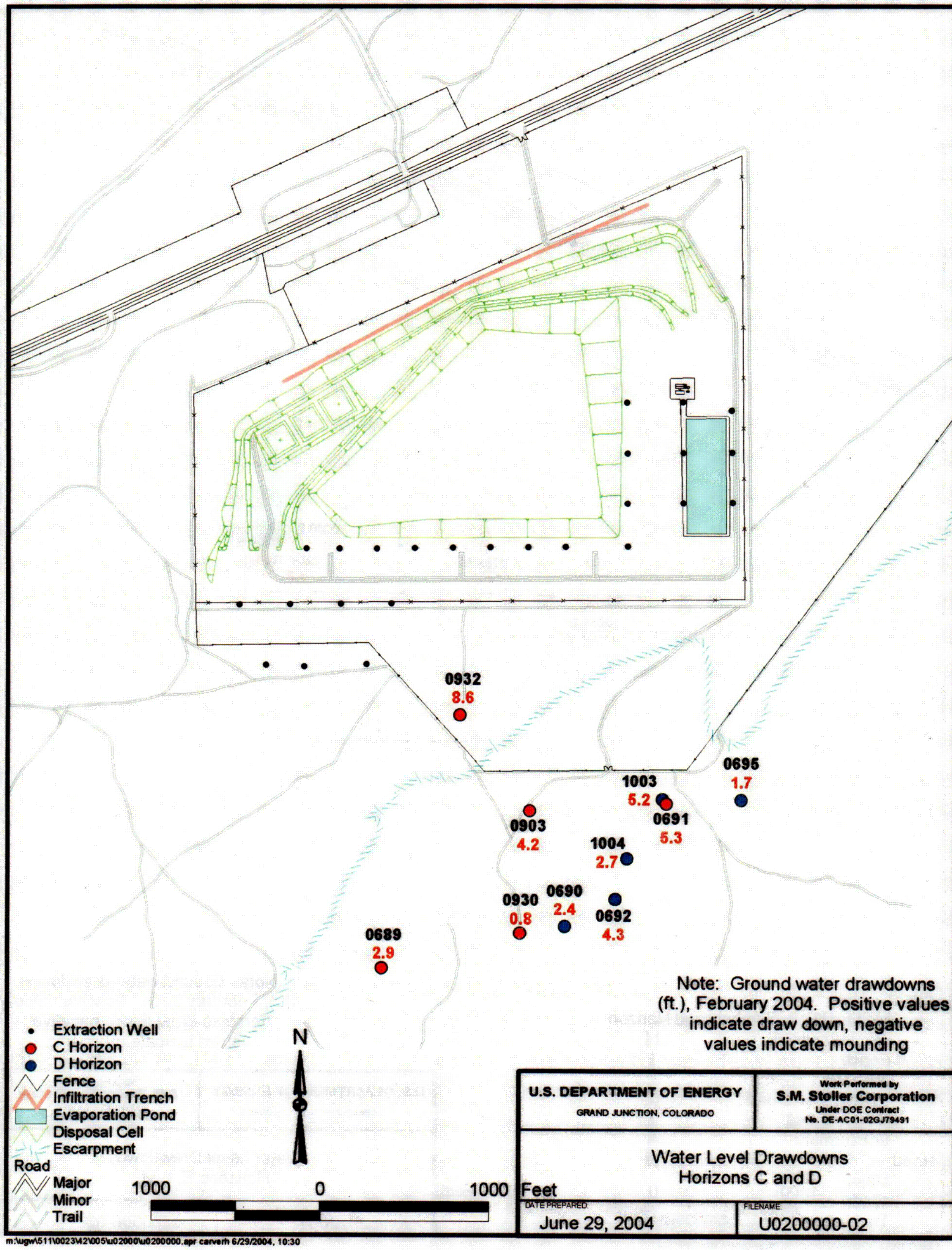

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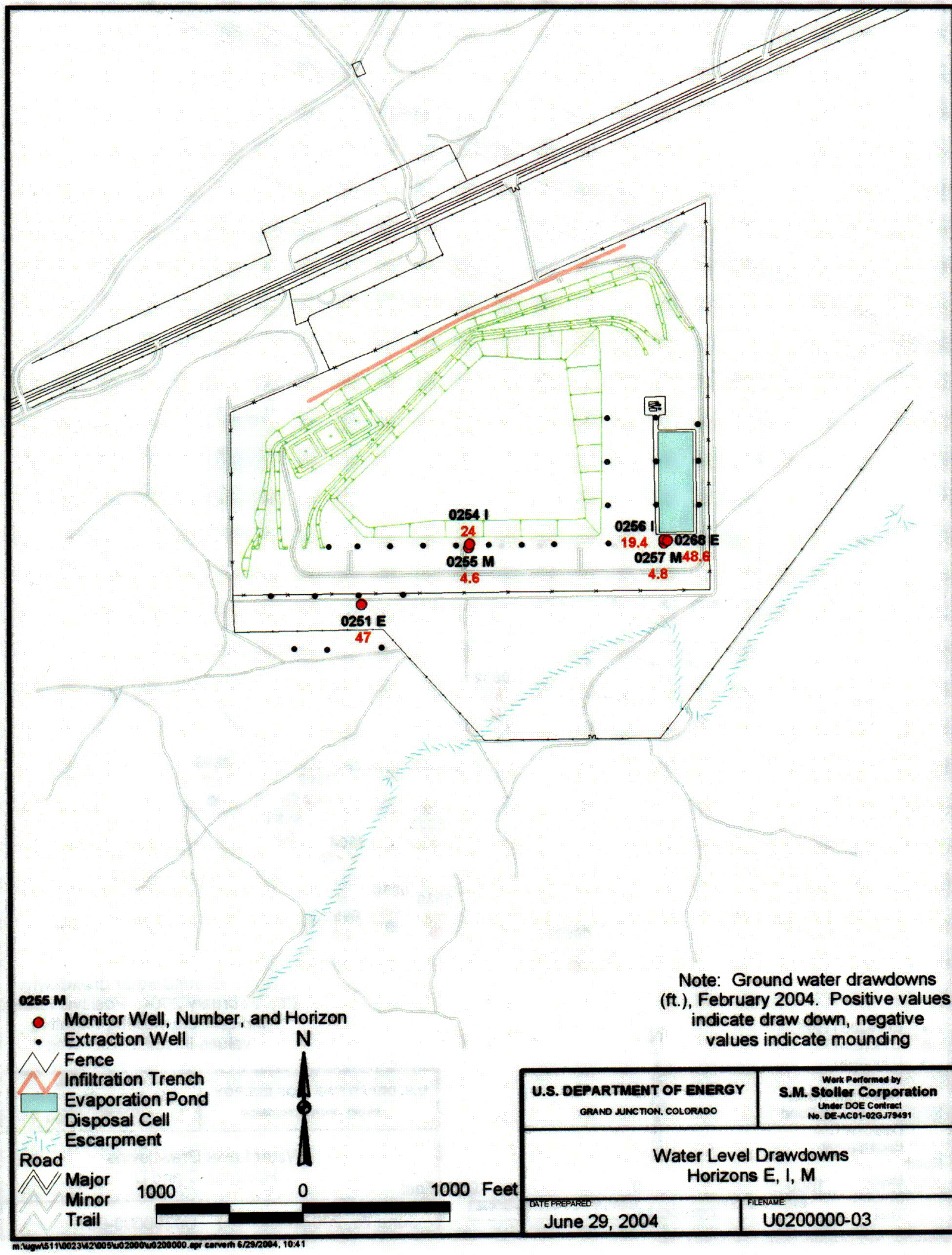

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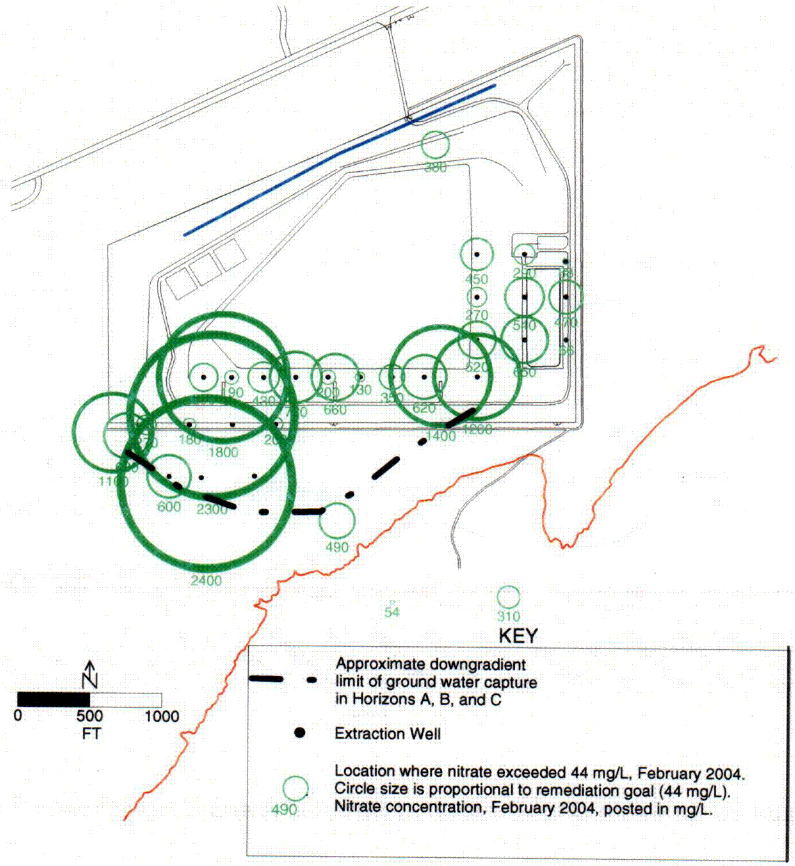

Figure 18. Nitrate Plume Capture Summary

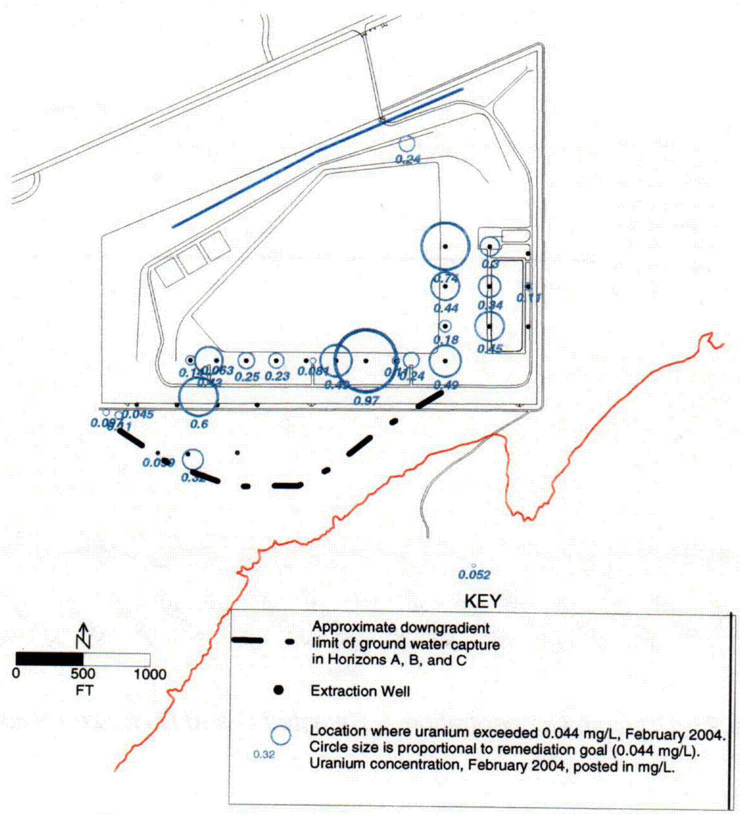

Figure 19. Uranium Plume Capture Summary

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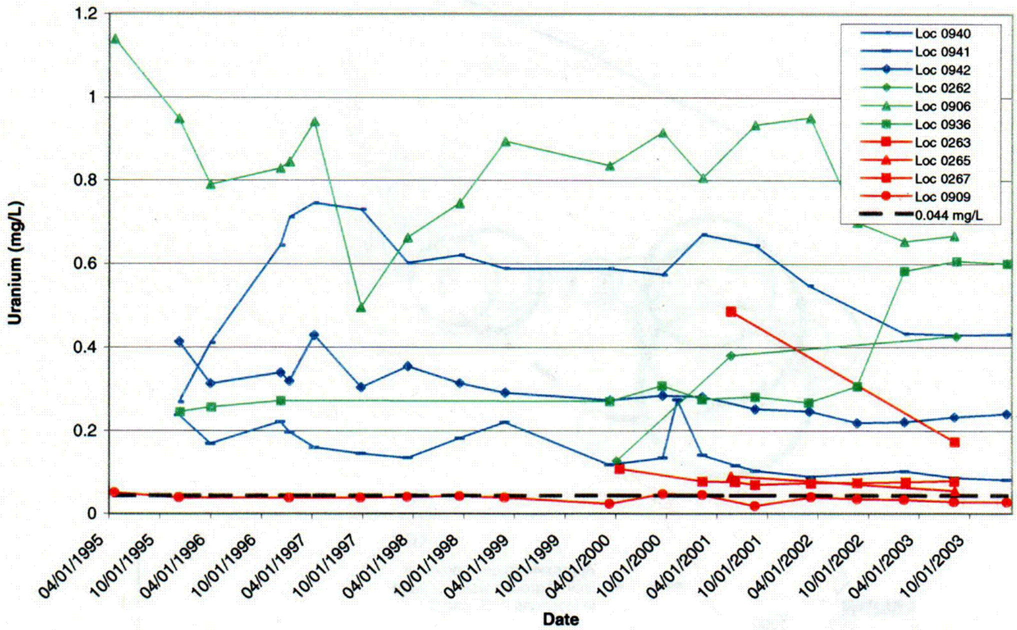

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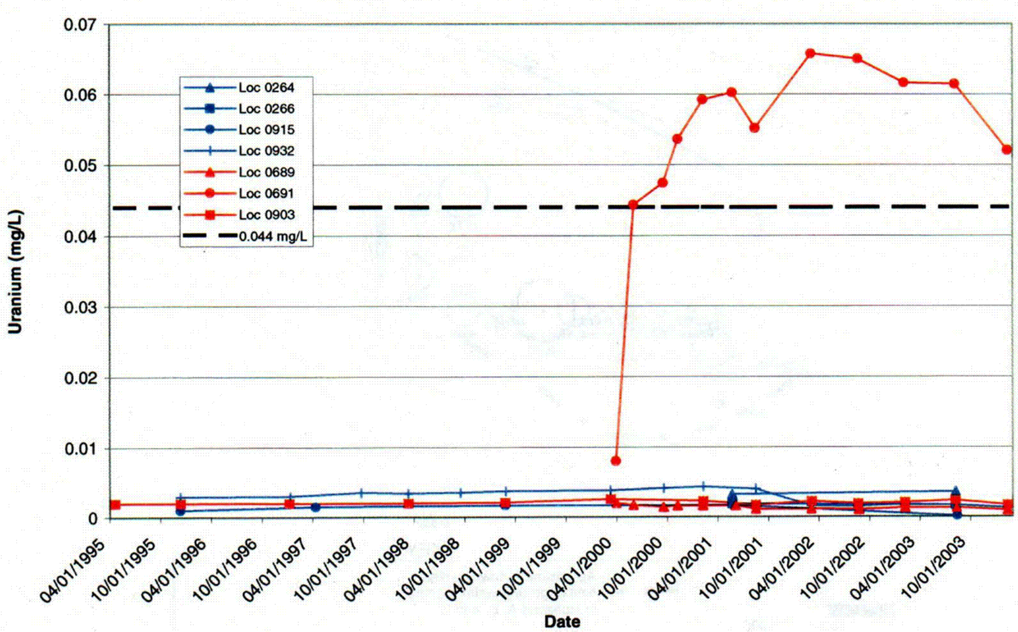

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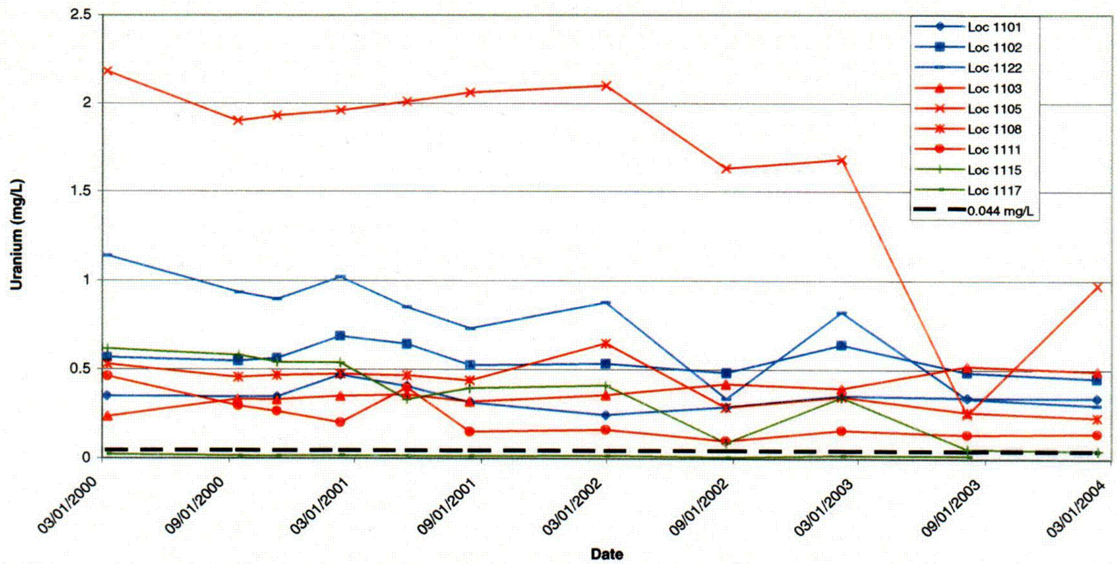

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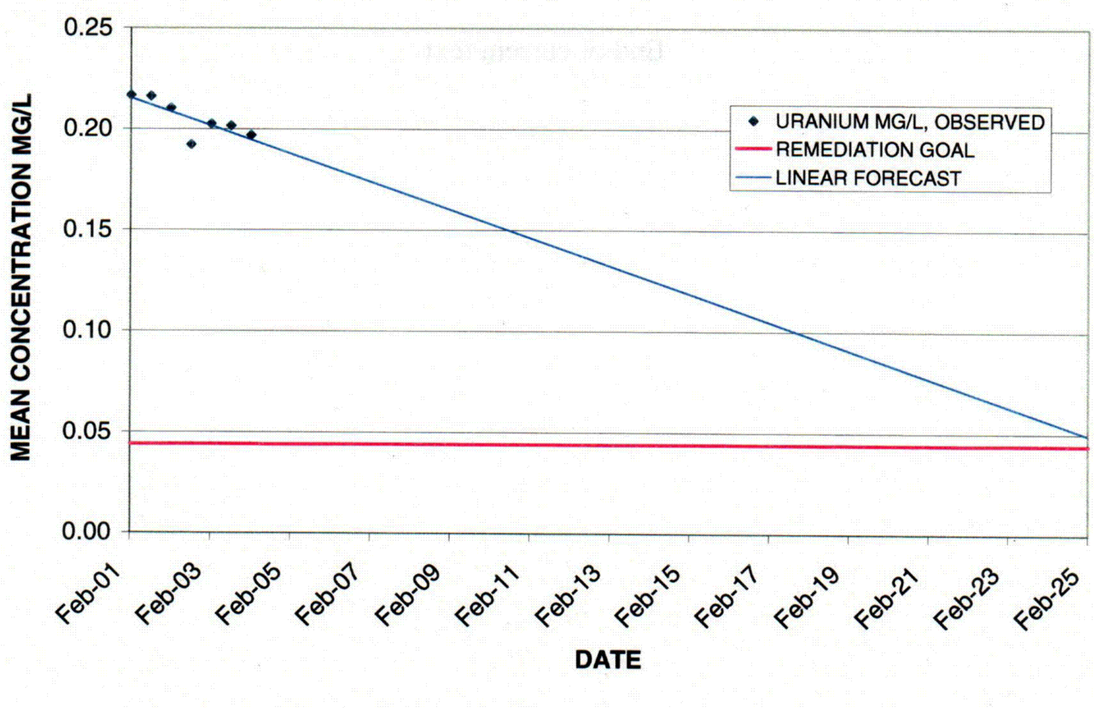

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1.0 Introduction

Ground water in an underlying sandstone aquifer at the U.S. Department of Energy (DOE) Land Management site near Tuba City, Arizona (Tuba City site), is contaminated by various inorganic constituents, including nitrate, uranium, and sulfate, as a result of former uranium-ore-milling. To restore ground water quality, a series of recovery wells, an infiltration trench, and a water treatment system were constructed to create a circulation process whereby contaminated ground water is extracted, purified, and then returned to the aquifer in a way that enhances contaminant recovery. Active ground water remediation at the Tuba City site has been in full-scale operation since mid-2002.

The current remediation system comprises 25 ground water extraction wells completed within the most contaminated regions of the aquifer, ion-exchange pretreatment, distillation treatment, solar evaporation of waste liquids in engineered ponds, and an infiltration trench to return treated water to the aquifer. Six injection wells, intended to return treated water to the aquifer and prevent plume expansion, are present along the downgradient margin of the contaminant plume. These wells have not yet been used for this purpose; instead, all treated water is discharged to the infiltration trench. The location of the site and its primary features are shown in Figures 1 and 2, respectively.

Performance of the ground water remediation system in achieving project objectives is evaluated two-times yearly upon receipt of water quality and water level monitoring data obtained during August and February of each year. This report presents an evaluation of the remediation system for the period of September 2003 through February 2004.

1.1 Ground Water Remedial Action Strategy

The ground water compliance strategy for the Tuba City site, as defined in *Phase I Ground Water Compliance Action Plan for the Tuba City, Arizona, UMTRA Site* (GCAP) (DOE 1999), is to achieve applicable water quality standards through active ground water remediation in those portions of the aquifer affected by previous site activities. Contaminants requiring active ground water remediation at the Tuba City site are molybdenum, nitrate, selenium, uranium, and sulfate (DOE 1999).

Restoration goals (see Table 1) for each analyte but sulfate correspond to the maximum concentration limit (MCL) in ground water as established in 40 CFR 192 (Uranium Mill Tailings Radiation Control Act [UMTRCA]) for these constituents. The site remediation goal for sulfate, for which an MCL has not been established, is 250 milligrams per liter (mg/L), as requested by the Navajo Nation.

Table 1. Ground Water Remediation Goals

Constituent/Property	Remediation Goal	Baseline Concentrations in Plume
Nitrate[a]	10 mg/L as N (44 mg/L as NO_3^-)	840–1,500 mg/L
Molybdenum[a]	0.10 mg/L	0.01–0.58 mg/L
Selenium[a]	0.01 mg/L	0.01–0.10 mg/L
Uranium[a]	30 pCi/L (0.044 mg/L) U-234 + U-238	0.3–0.6 mg/L
TDS[b]	500 mg/L	3,500–10,000 mg/L
Sulfate[b]	250 mg/L	1,700–3,500 mg/L
Chloride[b]	250 mg/L	20–440 mg/L
pH[b]	6.5–8.5	6.3–7.6
Corrosivity[b]	not corrosive	not applicable

[a]MCL and required remediation goal.
[b]Secondary remediation goal requested by the Navajo Nation.

1.2 Remediation System Performance Metrics

The following subsections outline the primary categories considered in the performance evaluation (treatment plant, plume capture, and concentration trends in ground water) in addition to the types of information used as the basis of evaluation.

1.2.1 Treatment Plant Operation

Water treatment system performance objectives are:

- Treatment rate of 100 gallons per minute or greater.
- On-stream treatment percentage of 85 percent or greater.
- Quality of the distillate (total dissolved solids (TDS) and contaminant concentrations below remediation goals).
- Rate of waste liquid production is not greater than 15 percent of inflow.

1.2.2 Plume Capture Analysis

Several hydraulic metrics are examined during each evaluation period and compared to pre-pumping baseline conditions (DOE 2003a) primarily to determine the lateral and vertical extent of contaminated ground water that is captured by the extraction system. These hydraulic metrics are:

- Computed horizontal hydraulic gradients in discrete vertical depth intervals in the aquifer.
- Computed vertical hydraulic gradients between discrete depth intervals in the aquifer.
- Water table configuration.
- Ground water level drawdowns.

1.2.3 Remediation Progress

Metrics whereby the progress of remediation in meeting aquifer cleanup goals is evaluated include:

- Contaminant distribution maps to compare current and pre-pumping extents of contamination.
- Concentration trend analysis at monitor wells and extraction wells.
- Tracking the volume of ground water and contaminant mass extracted with respect to pre-pumping quantities.

1.2.4 Performance Monitoring Data

The primary sources of monitoring data used in this performance evaluation are:

- Weekly volumes of the treatment system inflow, distillate, and brine.
- Weekly composition of the treatment system inflow and distillate from weekly composite samples.
- Composition of ground water at the extraction wells (monthly to quarterly sampling frequency) and monitor wells (semiannual sampling frequency, August and February).
- Ground water elevations in the aquifer measured twice yearly (August and February).

1.2.5 Reporting

Previous evaluations of the performance of the Tuba City site ground water remediation system, and the corresponding review periods are:

DOE 2003b	2/02 through 8/02
DOE 2003c	9/02 through 2/03
DOE 2004a	3/03 through 8/03

Additional documentation (see also Section 7.0) of ground water investigations at the site during recent months include the revised conceptual model and remediation strategy report (DOE 2004b); a report on the origin of apparent contamination in deep zones of the aquifer (DOE 2004c); and, separate reports addressing various aspects of contaminant distribution and geochemistry at the site (DOE 2004d, 2004e, 2004f).

1.3 Ground Water Setting

Ground water beneath the Tuba City site occurs in the regionally extensive "N" multiple-aquifer (Cooley et al. 1969), which in the site area mainly comprises relatively flat-lying sedimentary rocks of the Navajo Sandstone. The Navajo Sandstone is primarily a massively cross-bedded, fine- to medium-grained, eolian sand. It is weakly cemented and friable. Occasional remnants of former playa lakes occur as resistant, thin (≤ 2 feet [ft]) limestone beds. An underlying transitional zone ("intertonguing" interval) that is approximately 250 to 350 ft thick and shares both eolian and fluvial depositional features, separates the Navajo Sandstone and the deeper Kayenta Formation. Combined thickness the Navajo Sandstone and intertonguing interval is about 500 ft at the site.

Where exposed near the Tuba City site, the Kayenta Formation consists primarily of flat-bedded, weakly consolidated siltstone. Ground water seeps are common along the base of the intertonguing interval and are traceable for several miles or more where the contact of the intertonguing interval and Kayenta Formation is exposed at or near ground surface. Ground water seeps associated with this boundary are visible in cliff faces near Moenkopi Wash, located approximately 2 miles south of the site (Figure 2).

Due to the fine-grained composition of the Kayenta and the conspicuous spring zone within sandstone deposits above its upper surface, it is likely that this formation locally acts as an aquitard. Recent field reconnaissance indicates that the fine-grained deposits of the Kayenta Formation are probably at least 100 ft thick and overlie similar siltstones of the Moenave Formation, which are also at least 100 ft thick and are not water-bearing (Cooley et al. 1969). The base of the bedrock aquifer beneath the site is thus interpreted to coincide with the base of the intertonguing interval and upper surface of the Kayenta Formation. Predominantly north-to-south ground water flow in the Navajo Sandstone and intertonguing interval at the site is controlled by regional discharge to Moenkopi Wash.

The site lies on the middle of three alluvial terraces associated with ancestral surface flows in Moenkopi Wash. Locally, ground water in the aquifer is discharged as evapotranspiration from a dense stand of greasewood plants located near the base of the escarpment that separates the middle and lower terraces (Figure 2). Under nonpumping conditions, depth to ground water in the Navajo Sandstone in the area of the disposal cell is generally about 50 ft; ground water is about 18 to 20 ft below ground surface in the greasewood area under pumping and nonpumping conditions. The terraces are generally mantled with up to 20 to 30 ft of unconsolidated, unsaturated dune sand and alluvium, but bedrock is exposed at land surface at some locations. In the greasewood area, the base of the alluvium may locally be saturated. Relatively shallow ground water also occurs just south of the greasewood area at well 904 (not shown in Figure 2).

1.3.1 Vertical Discretization of the N-Aquifer

To aid in evaluating subsurface conditions, the subsurface environment of the site is divided vertically into thirteen 50-ft intervals; each interval, or "horizon," is assigned a letter designation. The uppermost three horizons (A through C) tend to represent conditions in the classic Navajo Sandstone, Horizons D through J correspond generally to the intertonguing interval, and Horizons K, L, and M include the lower intertonguing interval and possibly the upper Kayenta Formation. The uppermost aquifer horizon below the middle terrace is Horizon A. Corresponding to south-sloping surface topography, the uppermost horizons below the lower terrace progress from Horizons C to D, north to south. The steep topography associated with Moenkopi Wash intersects Horizons E through G. The Tuba City ground water investigation focuses primarily on the upper 250 ft of the bedrock aquifer (Horizons A through E).

Each site monitor and extraction well is identified with a horizon on the basis of the midpoint of its intake. All but three extraction wells have a 150-ft screened interval that extends from the bottom half of Horizon B into the top half of Horizon E. Extraction wells 1116, 1117, and 1118 have 100-ft screens that extend from the lower half of Horizon B to just above the base of Horizon D. Additional well completion information is provided in Appendix A, Tables A–1 through A–4. Figures A–1 and A-2 illustrates the well completion intervals in map view and vertical profile, respectively. Figure A–3 presents a cross-sectional view of the site to illustrate the relationship between geologic strata, topography, and aquifer horizon.

2.0 Six-Month Extraction and Treatment Summary

Between September 1, 2003, and March 1, 2004, the treatment unit was in operation for 4,025 hours out of a possible 4,386 hours, resulting in an on-stream factor of 92 percent. The only down time occurred during January 19–28, when scheduled maintenance was performed, and on January 29–30 due to an electrical failure immediately following plant re-start. A total of 24,605,724 gallons of water were treated during the 6-month period, resulting in an average on-stream feed rate of 102 gallons per minute (gpm) and an overall effective rate (i.e., including downtime) of about 94 gpm. As of March 1, 2004, approximately 88 million gallons of ground water in total had been treated, which amounts to about 3 percent of the total estimated volume of the pre-pumping uranium plume.

The weekly inflow rate to the treatment system and the variation of uranium mass in the bulk feed for the 6-month period are shown in Figure 3. Minimum and maximum uranium concentrations over this duration were 0.236 and 0.504 mg/L, respectively. The mean uranium concentration, determined from the weekly average concentration, was 0.275 mg/L, and the mass of uranium removed from the aquifer for the period was 54 pounds. Table 2 presents additional data regarding uranium recovery and analogous information for nitrate and sulfate. Variations in nitrate and sulfate concentrations in the bulk extract are shown in Figure 4. Remediation times as estimated from current and cumulative removal rates are provided in Section 5.2.

Table 2. Contaminant Mass Removal Summary

	Average Bulk Feed Composition (mg/L)	Six-Month Mass Removal (lb)	Cumulative Mass Removed (lb)	Initial Mass above Remedial Goal (lb)[a]	Initial Volume of Ground Water above Goal (gal)[a]	Cumulative Mass Reduction (%)
Nitrate	404	81,422	299,592	12,400,000	3.4E+09	2.4
Sulfate	960	192,892	732,822	17,900,000	2.7E+09	4.1
Uranium	0.275	54	223	2,800	3.0E+09	8.0

[a]Source: DOE 2003a
lb = pound
gal = gallon

2.1 Treated Water Quality and Aquifer Injection

The average TDS concentration of the treatment system distillate for the review period was 28 mg/L. Average concentrations of nitrate, uranium, and sulfate in the distillate were 4.3, 0.0025, and 12.1 mg/L, respectively. These results indicate highly effective contaminant removal and very low TDS concentrations of the distillate. The treatment system produced 3 percent brine by volume of the system feed. In addition, about 7.5 percent of system influent for the 6-month period was sent to the evaporation pond as waste from the pre-treatment softener (ion exchange). A total of 21,500,372 gallons of treated water (distillate), equal to approximately 87 percent of the extracted volume, was returned to the aquifer via the infiltration trench.

3.0 Extent of Ground Water Contamination

Nitrate, uranium, and sulfate are the most widespread contaminants at the site. Concentrations of these constituents, measured twice yearly in samples collected at site monitor wells and extraction wells, are used to track the progress of remediation and movement of the contaminant plume.

Figures 5a through 13a illustrate the baseline concentrations of these contaminants in ground water, as determined from water-quality samples collected in spring 2002, or 1999–2001 in the absence of spring 2002 data, prior to pump-and-treat operations. To simplify the analysis, the results for Horizons A and B are combined in these figures, as are the results from Horizons C and D, and Horizons E, I, and M. Analogous concentration data for February 2004 are shown in Figures 5b through 13b. Each location where a sample was collected for the respective period is identified in the figures by a well number, however, a concentration value is posted only at locales where the applicable remediation goal was exceeded. Many previously sampled wells were not sampled in February 2004. This is manifested by a lack of data near the southern periphery of the contaminant plume for the current period. The corresponding figures, therefore, may not show the full extent of the contaminant plumes. Tabulated analytical results for February 2004 and the baseline period for each contaminant requiring remediation are included in Appendix B.

Comparison of the present extent of ground water contamination with the extents observed under baseline and previous evaluations indicates the following:

- Given the abbreviated sampling scope for February 2004, the area of ground water contamination in Horizons A, B, C, and D in which remediation goals are exceeded is similar to that identified in the baseline period.
- Major differences between February 2004 concentrations and baseline values are not evident at the monitor wells.
- Nitrate, sulfate, and uranium concentrations in the extraction wells in February 2004 are generally less than corresponding values from the baseline period.
- Increased concentrations at well 943 (Figures 5b, 8b, and 11b) may be related to altered flow directions caused by infiltration at the trench. Ground water in the area of well 943 is likely captured at the extraction wells.
- Ground water contamination on the lower terrace continues to be minor. Plume expansion on the lower terrace is not evident.
- Contaminant concentrations in Horizon E have decreased to less than applicable remediation goals since the start of ground water remediation.
- Minor levels of contamination remain at Horizon I wells 254 and 256, and Horizon M wells 255 and 257 (see Section 5.4).

Temporal trends in contaminant concentration are presented in Section 5.3

4.0 Aquifer Response to Extraction and Injection

The hydraulic responses of the aquifer to ground water extraction and injection are evaluated by comparing baseline water levels and hydraulic gradients to those observed during

September 2003 through February 2004. These analyses provide the basis for evaluating the extent to which the extraction system captures contaminated ground water.

4.1 Water Table Configuration

The estimated water table associated with baseline conditions is shown in Figure 14a. In that figure, the water level data from monitor wells with screens centered in Horizons A and B were used in developing the water table contours for the middle terrace area because the water table drops several tens of feet between the north end of the disposal cell and the escarpment, and in doing so, intersects both of these horizons. Water levels from middle terrace wells that are deeper than Horizon C are not considered representative of the water table due to the relatively large vertical hydraulic gradients observed at the site (see Section 4.3). The water table underlying the lower terrace was estimated using water levels in monitor wells completed only in Horizon C because, due to the vertical relief of the escarpment, Horizons A and B are absent there. As indicated in Figure 14a, the horizontal direction of ground water flow was predominantly southward during the baseline period. A steeper water table at the escarpment signified increased downward flow beneath this feature (Figure 14a).

Figure 14b shows a similarly constructed water table for February 2004. At that time, ground water mounding and increased hydraulic gradients in Horizons A and B were evident along the north edge of the disposal cell due to infiltration of treatment system effluent at the trench (further discussed in Section 4.2.1). Comparison of Figures 14a and 14b indicates that operation of the extraction wells has significantly depressed the water table throughout the southwest area of the extraction field. Insufficient well control in the area of ground water extraction on the east side of the site prevents analysis of water table conditions there. It is difficult to discern whether the water table underlying the escarpment and lower terrace has been affected by ground water extraction.

4.2 Zone of Influence

The zone of influence of the remediation system describes the volume of the aquifer in which ground water levels, and hence, the directions of horizontal and vertical flow, are affected by extraction and injection. The size and shape of this zone is a function of the properties of the aquifer and the rates, durations, and locations of the hydraulic stresses. Water level drawdown, computed as the difference between current and baseline water levels at a given well can be used to identify the zone of influence. Because the temporal trend in regional water levels was minor, computed drawdowns indicate that the zone of influence encompassed all wells in which a water level was measured in February 2004. However, not all of the ground water within the zone of influence is ultimately captured by an extraction well (see Section 5.1).

Figures 15, 16, and 17 display the drawdown values for various aquifer horizons in February 2004. Appendix C provides tabulated drawdown calculation information. Positive values indicate drawdown, such that the current (February 2004) water level is less than the baseline value, and negative values indicate that the current level is higher.

The distribution of water level drawdowns reflects an overall pattern of convergent ground water flow to the system of partially penetrating extraction wells. Water levels within the extraction wells are generally maintained close to the bottom of the wells; as a consequence, the effective interval of extraction and hence, the interval of lowest hydraulic head, occurs in Horizon D or E. The nearer a monitor well intake is to this interval of extraction, the greater is the observed drawdown. Confirmed by measured hydraulic heads (Appendix C), this flow pattern explains the maximum observed drawdowns of about 47 and 49 ft at Horizon E monitor wells 251 and 268, respectively (Figure 17), which are located close to extraction wells. Drawdown decreases below Horizon E due to the fact that most extraction wells terminate in Horizon E. Nonetheless, observed drawdowns in deeper horizons signify possible effects on vertical flow beneath the zone of extraction.

Significant drawdown also extends over large horizontal distances. For example, 4 to 5 ft of drawdown was observed among lower terrace monitor wells located about 2,000 ft south of the extraction wells (Figure 16). This far-reaching effect is partially attributed to a low storage function of the aquifer.

4.2.1 Infiltration Trench

Treatment plant distillate is returned to the aquifer at an infiltration trench located north of the disposal cell (Figure 2). The water enters the trench at its midpoint from where it can flow northeast and southwest in perforated pipe to seep through 3 ft of gravel bedding and subsequently to the bedrock. Through July 2003, non-uniform infiltration in the distillate resulted in about 18 ft of ground water mounding in Horizon A beneath the southwest section of the trench whereas only about 1 ft of mounding occurred beneath the northeastern section. Since installation of flow control valves in November 2003, all distillate has been diverted to the northeast segment of the infiltration trench.

Despite this effort to control flow distribution in the trench, mounding continues to be greater beneath its southwest section (Figure 15). However, the excessive mounding levels observed previously have dissipated appreciably (5 to 10 ft). Correspondingly, water levels beneath the northeast segment have risen, resulting in a more symmetric mound surrounding the trench. The shape of the ground water mound at the trench in February 2004 may be temporary. It is recommended that the current practice of diverting all distillate to the northeast end of the trench be continued to further evaluate the hydraulic response before any additional adjustments are made.

4.3 Vertical Flow Gradients

Vertical hydraulic gradients, computed from water levels at closely spaced monitor wells screened at different depths of the aquifer, provide a more definitive determination of vertical flow directions and ground water/contaminant capture at depth than can be identified using drawdown data alone. Table 3 summarizes vertical gradient data for the baseline and current review periods at well pairs screened in adjacent or nearly adjacent aquifer horizons.

Pertinent observations regarding vertical flow directions and gradients within the region of the contaminant plume are:

- Vertical ground water flow in Horizons A, B, and C, in and near the extraction field is downward. The magnitude of the downward hydraulic gradient is currently larger than baseline equivalents. The upward flow implied at wells 906 and 938 (Table 3) is anomalous relative to all previous measurements (baseline and post-baseline) at this well pair and may be a transient effect of an unknown cause.
- Vertical flow in the upper portion of the aquifer at wells 914/915 (Horizons C and D, respectively) upward possibly due to partial aquifer discharge at the base of the escarpment

where ground water is relatively close to land surface. Deeper flow at this location, as indicated at wells 915 and 916 (Table 3), is downward, conforming to the topography of the escarpment and ultimate aquifer discharge at Moenkopi Wash.

- Below the middle terrace, vertical flow potentials in the deeper aquifer zones (below Horizon E) were downward before the start of remediation but have since reversed to upward (well pairs 254/255 and 256/257, Horizons I and M).
- Downward flow gradients observed beneath the lower terrace since the baseline period are of little concern because contamination there is minor and does not extend below Horizon C.

In summary, vertical flow in the area of extraction converges from above and below to Horizons D and E. Vertically upward flow in response to pumping may occur as deep as 200 ft below the extraction wells to Horizon I, and possibly an additional 150 ft deeper to Horizon M.

Table 3. Summary of Vertical Hydraulic Gradients at Well Pairs

Well pair	Horizon	Baseline water elev (ft)	Baseline date	Baseline vertical gradient	Flow direction	February 2004 water elev (ft)	Vertical gradient	Flow direction
Middle Terrace								
901 910	A B	5,054.13 5,052.26	Sep-98	0.02	Down	5,055.60[a] 5,053.15[a]	0.03	Down
906 938	A B	5,019.48 5,018.89	Feb-99	0.04	Down	5,002.83[a] 5,004.26[a]	-0.10	Up
908 912	B C	5,009.83 5,008.26	Sep-00	0.02	Down	5,002.42[a] 4,993.61[a]	0.11	Down
909 932	B C	4,999.24 4,964.89	Sep-00	0.67	Down	4,994.84 4,955.36	0.77	Down
914 915	C D	4,970.10 4,976.95	Feb-99	-0.24	Up	4,961.47[a] 4,962.93[a]	-0.05	Up
915 916	D G	4,976.95 4,952.64	Feb-99	0.14	Down	4,962.93[a] 4,944.56[a]	0.10	Down
251 252	E I	5,000.38 4,992.33	May-00	0.04	Down	4,942.20[a] 4,981.06*	-0.19	Up
268 256	E I	4,985.12 4,964.31	May-00	0.10	Down	4,938.32 4,955.30	-0.08	Up
254 255	I M	4,988.85 4,974.17	May-00	0.07	Down	4,984.56 4,985.92	-0.01	Up
256 257	I M	4,964.31 4,962.07	May-00	0.01	Down	4,955.30 4,957.31	-0.01	Up
Lower Terrace								
903 920	C E	4,957.82 4,954.53	Sep-00	0.03	Down	4,953.95* 4,936.25*	0.18	Down
920 921	E I	4,954.53 4,941.85	Sep-00	0.06	Down	4,936.25* 4,933.85*	0.01	Down

[a]October 30, 2004 water level data

4.4 Extraction Well Performance

Twenty-four extraction wells were pumped during the evaluation period. Well 1116 has not operated since March 2003 when pump failure occurred. Concentrations of nitrate, sulfate, and uranium had decreased to less than the remediation goals at that location in the previous month. Pumping from well 1117 was discontinued in December 2003 when pump failure occurred. At that time, uranium concentrations had decreased to less than the remediation goal for this contaminant, but nitrate and sulfate levels remained above their respective goals. A replacement pump will be installed at well 1117 in summer 2004. A replacement pump will not be installed in well 1116 unless contaminant concentrations rebound significantly.

The extraction pumps shut off automatically when the water level in the well reaches the pump intake, which is about 10 to 15 ft above the well bottom. Pumping then resumes after a period of water level recovery that can be manually adjusted. Sixteen of the extraction wells were pumped without low-water interruption for greater than 95 percent of the 6-month period. While functional, the pump in well 1117 also operated continuously. Pumping rates from these extraction wells ranged between 2 and 7 gpm and averaged about 5 gpm.

Due to low-water cycling, pumping duration in wells 1106, 1112, 1120, and 1123 ranged from about 25 to 50 percent of the 6-month period. Including inactive periods, effective pumping rates at these wells ranged from < 0.5 to 3 gpm. Pumping occurred about 50 percent of the time at well 1105 and about 60 and 80 percent at wells 1113 and 1110, respectively. The effective pumping rates at these wells were 6, 2.5, and 3.5 gpm, respectively. The operational history of each extraction well for the evaluation period is included in Appendix A, Table A–4.

Well-cycling due to low-water levels indicates that the extraction rate at a given well is limited by aquifer yield rather than by the pump capacity. In general, pump capacity is optimal at the extraction wells that operate continuously as became evident after July 2003 when higher capacity replacement pumps installed in wells 1105, 1106, and 1120 failed to significantly increase long-term yield at those locations, yet caused low-water cycling when none had occurred previously. Because water levels were not measured in the extraction wells during the evaluation period, analysis of pumping rates and available drawdown at the extraction wells is not provided.

5.0 Remediation Progress

5.1 Plume Capture Zone

The estimated capture zone of the extraction system, as it affects recovery of nitrate and uranium from Horizons A, B, and C for this evaluation period is shown in Figures 18 and 19. Sufficient water level data were not available to construct a plume capture map for Horizons C and D as was done in previous performance reports. Capture zone analysis was accomplished using grid-based contouring to compute a potentiometric surface representative of Horizons A, B, and C in February 2004. Computer-generated vectors identified the direction of maximum slope of the surface and, by inference, the direction of ground water flow at each grid node.

The dashed line in Figures 18 and 19 defines the ground water divide, as interpreted from the vector analysis, that separates the region where computed flow paths converged on the extraction wells from the region of non-convergent flow. Only the ground water north of the divide is captured and treated. The capture zone likely extends farther to the east than shown, but confirmatory well control is absent in that area. Proportionally scaled circles in the figures indicate the relative magnitude of contaminant concentration in excess of the remediation goal in February 2004. The diameter of the largest circle in Figure 18 (for nitrate) is about 50 times greater than that of the smallest circle. This scaling corresponds to concentrations ranging from

50 to 2,400 mg/L among February 2004 results exceeding the nitrate remediation goal. The diameter of the largest circle in Figure 19 (for uranium) is about 20 times greater than that of the smallest circle, corresponding to a uranium concentration range of 0.045 to 0.97 mg/L.

The main features of the plume capture zone for the evaluation period are summarized as follows:

- The current configuration and operation of the extraction system effectively captures the region of maximum ground water contamination.
- Hydraulic containment of all current contaminated flow from the site is indicated in the analysis of hydraulic gradients and water quality data.
- Sample results from previous evaluations identified moderately high concentrations of nitrate, sulfate, and uranium in ground water extending south of the estimated capture zone to the escarpment separating the middle and lower terraces.
- Ground water capture does not extend to any portion of the lower terrace.
- The horizontal extent of capture in Horizon E and deeper cannot be determined with the available data. This limitation is of no practical consequence because significant contamination does not extend to these depths.

5.1.1 Contaminant Recovery from Specific Aquifer Horizons

Monitoring data indicate that contamination is generally restricted to Horizons A through D, but the distribution of contamination among these horizons is unknown. Numerous A and B horizon wells exhibit high levels of contamination that define the main portion of the plume. None of these shallow wells is paired with a C or D horizon well, which would aid in defining the base of the plume (the extraction wells are not suited for such monitoring purposes). At the lateral margins of the plume, and below the lower terrace, contamination occurs only in the upper one or two horizons. Generalizing this apparent concentration trend with depth, it is possible that Horizons A, B, and C are the primary contributors of contamination to the extraction system. Continued extraction from marginally contaminated intervals may reduce the total efficiency of the remediation system.

5.2 Contaminant Concentration Trends

Variation in uranium concentration over time at selected Horizon A and B monitor wells located throughout the uranium plume is shown in Figure 20. Wells 940, 941, and 942 are located closest to the south side of the disposal cell and thus represent the likely sites for identifying the breakthrough of clean water from the infiltration trench. The gradually decreasing uranium concentrations observed at those locations (Figure 20) are probably not indicative of such breakthrough at this time. Farther south, in the mid-section of the plume at wells 262, 906, and 936, uranium concentration do not exhibit a stable or consistent trend. Uranium concentrations toward the outer (south) margin of the plume at wells 263, 265, 267, and 909 are generally stable.

Analogous uranium concentration versus time data for selected monitor wells completed in Horizons C and D near the plume margin below the middle terrace (wells 264, 266, 915, and 932) and beneath the lower terrace (wells 689, 691, and 903) are shown in Figure 21. With the exception of well 691, which is the only location of uranium contamination at the lower terrace, these plots indicate that uranium concentrations in these areas remain stable and below the uranium remediation goal.

A subtle yet general trend of decreasing uranium concentrations is observed in the extraction wells (Figure 22). Wells 1101, 1102, and 1122 are located in the center of the area of extraction wells east of the disposal cell. Wells 1115 and 1117 are among the southern most extraction wells. The remaining wells are located along the south border of the disposal cell.

5.2.1 Aquifer Restoration Metric

To provide a general measure of aquifer restoration as a whole, the arithmetic mean of measured uranium concentrations from a selected set of monitor wells is plotted versus time in Figure 23. The wells used for this analysis (Table 4) are distributed throughout and bordering the contaminant plume. If a well was not sampled, the result for that well from the previous sampling event was used in calculating the mean, as indicated by italics in Table 4.

Table 4. Uranium Concentration Metric

Monitor Well	Uranium [mg/L]						
	Feb-01	Aug-01	Feb-02	Aug-02	Feb-03	Aug-03	Feb-04
0254	*0.188*	*0.209*	0.209	0.138	0.146	0.128	0.100
0267	0.078	0.070	0.073	0.074	0.077	0.078	*0.078*
0906	0.806	0.934	0.951	0.698	0.653	0.667	*0.667*
0908	*0.120*	0.111	0.122	0.122	0.124	0.106	0.097
0909	0.045	0.018	0.039	0.035	0.033	0.028	0.027
0929	0.002	0.001	0.001	0.001	0.002	0.002	*0.002*
0930	0.003	0.002	0.002	0.003	0.003	0.003	0.003
0932	0.004	0.004	0.002	0.001	0.002	0.002	0.001
0934	0.313	0.298	0.312	0.336	0.355	0.350	0.320
0935	0.113	0.102	0.087	0.123	0.105	*0.105*	0.110
0936	0.275	0.281	0.267	0.306	0.579	0.606	0.600
0940	0.669	0.643	0.546	*0.546*	0.432	0.428	0.430
0941	0.138	0.103	0.089	*0.089*	0.102	0.086	0.081
0942	0.281	0.251	0.246	0.218	0.221	0.232	0.240
Arithmetic Mean [mg/L]	**0.217**	**0.216**	**0.210**	**0.192**	**0.202**	**0.201**	**0.197**

This concentration metric, which is independent of volume or mass estimates of the uranium plume, has decreased slightly in value as ground water remediation has progressed. Given the small increment of change and the relatively brief period of observation, this result may indicate the start of a developing trend that shows the effects of remediation on the size and bulk concentration of the uranium plume. Linear projection of this apparent trend, despite its limited history, indicates that the uranium remediation goal will be attained in year 2025, or 21 years from present. This analysis excludes capture and treatment of the contaminated ground water beneath the lower terrace. At a constant total pumping rate of 85 gpm, about one-billion gallons of ground water will be extracted during that period. If the volume of uranium-contaminated ground water beneath the middle terrace is 3.8E+08 gallons, remediation will be complete upon the extraction of about 2.5 pore volumes. This estimate assumes plume dimensions of 1,000 ft (length) by 2,000 ft (width) by 100 ft (depth), and effective porosity of 25 percent.

5.3 Rebound Study

A field study conducted during the latter portion of this evaluation period evaluated the extent to which contaminant concentrations increased or "rebounded" after extraction wells remained idle for a period of 9 days. The objective of the study was to determine if mass removal efficiency could be improved by employing pulsed pumping. By this approach, selected extraction wells would periodically be idled to allow contaminant rebound. The study identified several wells that would respond favorably to this strategy and others that would not (DOE 2004f). Pulsed pumping will be considered after expansion of the extraction system is completed in fall 2004.

5.4 Deep Wells

DOE issued a draft report in April 2004 (DOE 2004c) addressing the origin of contamination in the deep (≥ 300 ft) wells at the site. Of particular interest were wells 254, 255, 256, and 257, which have shown contaminant levels in excess of remediation goals for key site contaminants since their installation in 2001. Citing numerous lines of evidence, the report concluded that the deep contamination is the result of failed annular seals and consequent downward flow of contaminated ground water through the well bore from shallower in the aquifer. Until the start of full-time ground water remediation, the vertical gradients at these locations indicated downward flow which provided the necessary hydraulic driving force. Since pumping began, the flow direction has changed to upward. The report recommended that monitoring continue at these deep wells for one additional year before considering their abandonment.

6.0 Summary

- The most contaminated portion of the ground water plume is captured by the extraction system.
- Containment of the contaminant plume at depth is indicated in the analysis of hydraulic gradients, drawdown, and water quality data.
- Remediation goals have been achieved in aquifer Horizon E as a result of ground water extraction.
- On-stream extraction and treatment flow rates achieve design objectives.
- Distillate quality meets or exceeds remediation objectives.
- The percentage of extracted water (87 percent) that is returned to the aquifer meets design objectives.
- A developing though uncertain uranium concentration trend suggests measurable progress in attaining water-quality remediation goals possibly within several tens of years.

7.0 References

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Appendix A

Tuba City Project Well Data

Table A-1. Aquifer Horizon Elevations

Horizon	Depth Interval, ft above msl[a]	Number of Wells	Geologic Unit
A	5,000–5,050	10	Navajo Sandstone
B	4,950–5,000	21	Navajo Sandstone
C	4,900–4,950	15	Navajo Sandstone
D	4,850–4,900	36	Intertonguing Interval
E	4,800–4,850	4	Intertonguing Interval
F	4,750–4,800	1	Intertonguing Interval
G	4,700–4,750	3	Intertonguing Interval
H	4,650–4,700	1	Intertonguing Interval
I	4,600–4,650	4	Intertonguing Interval
J	4,550–4,600	0	Intertonguing Interval
K	4,500–4,550	0	Kayenta Formation
L	4,450–4,500	0	Kayenta Formation
M	4,400–4,450	3	Kayenta Formation

[a]msl = mean sea level

Table A-2. Well Screen Intervals

Well ID	Mid-Screen Horizon	Screen Depth (ft)		Screen Length [ft]	Screen Elevation (ft)			Well Type
		Top	Bottom		Top	Mid	Bottom	
0686	A	60	100	40	5,045.5	5,025.5	5,005.5	monitor
0687	A	60	100	40	5,047.6	5,027.6	5,007.6	monitor
0688	A	60	100	40	5,044.1	5,024.1	5,004.1	monitor
0901	A	58	78	20	5,045.8	5,035.8	5,025.8	monitor
0906	A	44	64	20	5,016.9	5,006.9	4,996.9	monitor
0928	A	30	55	25	5,022.1	5,009.6	4,997.1	monitor
0929	A	No data	90	No data	No data	No data	No data	monitor
0940	A	45	60	15	5,017.9	5,010.4	5,002.9	monitor
0941	A	45	65	20	5,018.0	5,008.0	4,998.0	monitor
0945	A	110	130	20	5,028.1	5,018.1	5,008.1	monitor
0946	A	40	60	20	5,057.6	5,047.6	5,037.6	monitor
0262	B	60	100	40	4,999.2	4,979.2	4,959.2	monitor
0263	B	60	100	40	5,000.2	4,980.2	4,960.2	monitor
0265	B	60	100	40	4,991.1	4,971.1	4,951.1	monitor
0267	B	60	100	40	4,990.8	4,970.8	4,950.8	monitor
0271	B	60	100	40	4,984.0	4,964.0	4,944.0	monitor
0905	B	63	78	15	5,006.0	4,998.5	4,991.0	monitor
0908	B	52	67	15	5,005.3	4,997.8	4,990.3	monitor
0909	B	65	80	15	4,990.8	4,983.3	4,975.8	monitor
0910	B	97	197	100	5,007.6	4,957.6	4,907.6	monitor
0918	B	61	66	5	4,986.2	4,983.7	4,981.2	monitor
0925	B	53	93	40	5,005.8	4,985.8	4,965.8	monitor
0926	B	42	92	50	5,018.3	4,993.3	4,968.3	monitor
0934	B	45	90	45	5,013.0	4,990.5	4,968.0	monitor
0935	B	50	90	40	5,008.8	4,988.8	4,968.8	monitor
0936	B	42	82	40	5,017.9	4,997.9	4,977.9	monitor
0937	B	40	95	55	5,020.2	4,992.7	4,965.2	monitor
0938	B	40	95	55	5,020.4	4,992.9	4,965.4	monitor
0939	B	40	95	55	5,021.1	4,993.6	4,966.1	monitor
0942	B	54	74	20	5,009.5	4,999.5	4,989.5	monitor
0943	B	101	121	20	4,994.1	4,984.1	4,974.1	monitor
0947	B	105	125	20	4,990.0	4,980.0	4,970.0	monitor
0683	C	95	145	50	4,973.2	4,948.2	4,923.2	monitor
0684	C	124	176	51	4,943.1	4,917.4	4,891.8	monitor
0685	C	94	146	52	4,975.6	4,949.7	4,923.8	monitor
0689	C	55	95	40	4,923.9	4,903.9	4,883.9	monitor
0691	C	55	95	40	4,921.9	4,901.9	4,881.9	monitor
0903	C	28	48	20	4,953.5	4,943.5	4,933.5	monitor
0912	C	123	163	40	4,934.7	4,914.7	4,894.7	monitor
0914	C	137	154	17	4,930.3	4,921.8	4,913.3	monitor
0917	C	128	148	20	4,917.8	4,907.8	4,897.8	monitor
0930	C	20	50	30	4,933.0	4,918.0	4,903.0	monitor
0932	C	113	133	20	4,942.3	4,932.3	4,922.3	monitor
1008	C	56	106	50	4,926.8	4,901.6	4,876.4	injection
1116	C	92	196	104	4,964.1	4,912.5	4,861.0	extraction

Table A-2 (continued). Well Screen Intervals

Well ID	Mid-Screen Horizon	Screen Depth (ft)		Screen Length [ft]	Screen Elevation (ft)			Well Type
		Top	Bottom		Top	Mid	Bottom	
1117	C	92	196	104	4,965.3	4,913.7	4,862.1	extraction
1118	C	90	196	106	4,967.9	4,915.1	4,862.3	extraction
0258	D	159	199	40	4,894.0	4,874.0	4,854.0	monitor
0261	D	160	200	40	4,907.0	4,887.0	4,867.0	monitor
0264	D	160	200	40	4,899.6	4,879.6	4,859.6	monitor
0266	D	160	200	40	4,890.6	4,870.6	4,850.6	monitor
0690	D	55	95	40	4,893.3	4,873.3	4,853.3	monitor
0692	D	55	95	40	4,895.6	4,875.6	4,855.6	monitor
0695	D	55	95	40	4,919.3	4,899.3	4,879.3	monitor
0904	D	28	38	10	4,873.8	4,868.8	4,863.8	monitor
0915	D	170	180	10	4,897.8	4,892.8	4,887.8	monitor
1003	D	56	106	50	4,923.4	4,898.4	4,873.4	injection
1004	D	46	96	50	4,918.1	4,893.1	4,868.1	injection
1005	D	46	96	50	4,904.7	4,879.7	4,854.7	injection
1006	D	46	96	50	4,903.7	4,878.7	4,853.7	injection
1007	D	46	96	50	4,915.6	4,890.5	4,865.4	injection
1101	D	96	252	156	4,974.2	4,896.6	4,818.9	extraction
1102	D	102	252	150	4,968.8	4,893.8	4,818.8	extraction
1103	D	100	250	150	4,962.3	4,887.3	4,812.3	extraction
1104	D	90	245	155	4,972.3	4,894.8	4,817.3	extraction
1105	D	90	245	155	4,972.1	4,894.6	4,817.1	extraction
1106	D	97	251	154	4,966.0	4,888.7	4,811.4	extraction
1107	D	91	246	155	4,971.2	4,894.0	4,816.8	extraction
1108	D	96	246	150	4,966.1	4,891.1	4,816.1	extraction
1109	D	90	245	155	4,972.1	4,894.7	4,817.3	extraction
1110	D	96	246	150	4,966.8	4,891.8	4,816.8	extraction
1111	D	91	245	154	4,971.9	4,894.7	4,817.5	extraction
1112	D	91	246	155	4,969.1	4,891.6	4,814.1	extraction
1113	D	91	246	155	4,968.7	4,891.2	4,813.7	extraction
1114	D	91	246	155	4,968.5	4,891.0	4,813.6	extraction
1115	D	91	246	155	4,968.6	4,891.2	4,813.7	extraction
1119	D	95	245	150	4,968.7	4,893.7	4,818.7	extraction
1120	D	96	246	150	4,971.0	4,896.0	4,821.0	extraction
1121	D	98	248	150	4,972.0	4,897.0	4,822.0	extraction
1122	D	97	251	154	4,973.4	4,896.3	4,819.2	extraction
1123	D	91	245	154	4,976.2	4,899.2	4,822.2	extraction
1124	D	88	246	158	4,978.7	4,899.9	4,821.1	extraction
1125	D	96	246	150	4,972.8	4,897.8	4,822.8	extraction
0251	E	200	300	100	4,858.9	4,808.9	4,758.9	monitor
0268	E	200	300	100	4,864.5	4,814.5	4,764.5	monitor
0920	E	114	154	40	4,866.0	4,846.0	4,826.0	monitor
0948	E	222	402	180	4,893.9	4,803.9	4,713.9	monitor
0911	F	309	349	40	4,795.2	4,775.2	4,755.2	monitor
0913	G	329	369	40	4,729.2	4,709.2	4,689.2	monitor
0916	G	346	356	10	4,721.7	4,716.7	4,711.7	monitor

Table A–2 (continued). Well Screen Intervals

Well ID	Mid-Screen Horizon	Screen Depth (ft)		Screen Length [ft]	Screen Elevation (ft)			Well Type
		Top	Bottom		Top	Mid	Bottom	
0919	G	338	348	10	4,707.9	4,702.9	4,697.9	monitor
0902	H	63	73	10	4,673.7	4,668.7	4,663.7	monitor
0252	I	400	500	100	4,658.9	4,608.9	4,558.9	monitor
0254	I	400	500	100	4,662.7	4,612.7	4,562.7	monitor
0256	I	400	500	100	4,664.0	4,614.0	4,564.0	monitor
0921	I	313	353	40	4,663.7	4,643.7	4,623.7	monitor
0253	M	600	700	100	4,458.8	4,408.8	4,358.8	monitor
0255	M	600	700	100	4,462.3	4,412.3	4,362.3	monitor
0257	M	600	700	100	4,463.4	4,413.4	4,363.4	monitor

Table A-3. Extraction and Injection Well Design Rates and Screened Horizons

Well Number	Well Type	Design Pumping Rate (gpm)	Screen Length (ft)	Horizon Top of Well Screen	Horizon Bottom Of Well Screen
1003	Injection	1.0	50	C	D
1004	Injection	1.0	50	C	D
1005	Injection	1.0	50	C	D
1006	Injection	1.0	50	C	D
1007	Injection	1.0	50	C	D
1008	Injection	1.0	50	C	D
Infiltration Trench	Infiltration Trench	57.0	NA	NA	NA
1101	Extraction	4.0	155	B	D
1102	Extraction	3.0	150	B	E
1103	Extraction	4.0	150	B	E
1104	Extraction	4.0	155	B	E
1105	Extraction	5.0	155	B	E
1106	Extraction	5.1	155	B	E
1107	Extraction	5.1	154	B	E
1108	Extraction	5.1	150	B	E
1109	Extraction	5.1	155	B	E
1110	Extraction	5.0	150	B	E
1111	Extraction	8.6	154	B	E
1112	Extraction	3.1	155	B	E
1113	Extraction	2.0	155	B	E
1114	Extraction	3.5	155	B	E
1115	Extraction	3.5	155	B	E
1116	Extraction	2.0	103	B	D
1117	Extraction	2.0	103	B	D
1118	Extraction	3.2	106	B	D
1119	Extraction	2.6	155	B	E
1120	Extraction	2.6	150	B	E
1121	Extraction	3.1	150	B	E
1122	Extraction	2.6	154	B	E
1123	Extraction	3.1	154	B	E
1124	Extraction	2.6	158	B	E
1125	Extraction	2.6	150	B	E

Table A–4. Extraction Well Operation Summary

Sep-03						
Total Time On		27 47	days			
Well	Total Time	OST	Gallons		OST gpm	effective gpm
1101	14 23	51 8%	79,614	--	3.9	2 0
1102	0 01	0 0%	130	--	14 4	0 0
1103	27 41	99 8%	259,196	>95%	6 6	6.6
1104	27 41	99 8%	175,310	>95%	4 4	4 4
1105	16 44	59 9%	222,093	--	9 4	5 6
1106	13 75	50 0%	107,589	--	5 4	2 7
1107	27 41	99 8%	178,309	>95%	4 5	4 5
1108	27 41	99 8%	197,675	>95%	5 0	5 0
1109	27 41	99 8%	111,434	>95%	2 8	2 8
1110	23 07	84 0%	132,655	--	4 0	3 4
1111	27 41	99 8%	177,186	>95%	4 5	4 5
1112	17 92	65 2%	78,683	--	3 0	1 9
1113	15 20	55 3%	92,206	--	4 2	2 3
1114	27 41	99 8%	207,461	>95%	5.3	5 2
1115	3 45	12 6%	23,353	--	4 7	0 6
1116	0.00	0 0%	0	--	0 0	0 0
1117	27 41	99 8%	243,242	>95%	6 2	6 1
1118	27 41	99 8%	126,581	>95%	3 2	3 2
1119	27 41	99 8%	157,868	>95%	4 0	4 0
1120	20 73	75 5%	171,677	--	5 6	4 3
1121	27 46	100 0%	164,158	>95%	4 2	4 2
1122	27 41	99 8%	151,654	>95%	3 8	3.8
1123	1 50	5 5%	3,745	--	1 7	0 1
1124	27 41	99 8%	199,911	>95%	5 1	5 1
1125	27 41	99 8%	172,801	>95%	4 4	4 4
			3,432,530	total gal		
			86 8	OST gpm		

Oct-03						
Total Time On		30 66	days			
Well	Total Time	OST	Gallons		OST gpm	effective gpm
1101	30 53	99.6%	170,031	>95%	4.3	4 3
1102	30 13	98 2%	271,364	>95%	7 0	6 9
1103	30 60	99.8%	288,017	>95%	7 3	7 3
1104	30 57	99 7%	186,524	>95%	4 7	4 7
1105	20 14	65 7%	234,799	--	9 0	5 9
1106	12 85	41 9%	111,777	--	6 7	2 8
1107	30.63	99 9%	191,279	>95%	4 8	4 8
1108	30.61	99 8%	213,656	>95%	5 4	5 4
1109	30.66	100 0%	117,066	>95%	3 0	3 0
1110	25 38	82 8%	141,413	--	4 3	3 6
1111	30 65	100 0%	189 446	>95%	4 8	4 8
1112	16 21	52 9%	80,674	--	3 9	2 0
1113	19 10	62 3%	97,244	--	3 9	2 5
1114	30 50	99.5%	212,630	>95%	5 4	5 4
1115	29 92	97 6%	250,206	>95%	6 5	6 3
1116	0 00	0 0%	0	--	0 0	0 0
1117	30 57	99 7%	259,691	>95%	6 6	6.6
1118	30 58	99 7%	111,787	>95%	2 8	2 8
1119	29 66	96 7%	170,582	>95%	4 5	4 3
1120	10 98	35 8%	107,569	--	7 6	2 7
1121	30 66	100 0%	216,899	>95%	5.5	5 5
1122	30 66	100 0%	157,255	>95%	4 0	4.0
1123	4 61	15 0%	5,400	--	0 9	0 1
1124	30 66	100 0%	205,523	>95%	5 2	5 2
1125	30 65	99 9%	180,026	>95%	4 6	4.6
			4,170,660	total gal		
			94 5	OST gpm		

Nov-03						
Total Time On		30 00	days			
Well	Total Time	OST	Gallons		OST gpm	effective gpm
1101	29 22	97 4%	229,475	>95%	6 0	5 8
1102	29 21	97 4%	255,516	>95%	6 6	6 5
1103	29 90	99 7%	280,329	>95%	7 1	7 1
1104	29 87	99 6%	177,735	>95%	4 5	4 5
1105	19 67	65 6%	232,632	--	9 0	5 9
1106	12 38	41 3%	106,421	--	6 5	2 7
1107	29 90	99 7%	183,654	>95%	4 7	4 6
1108	29 90	99 7%	204,072	>95%	5 2	5.2
1109	29 90	99 7%	106,100	>95%	2 7	2 7
1110	24 40	81 3%	134,722	--	4 2	3 4
1111	29 90	99 7%	179,484	>95%	4 6	4 5
1112	15 29	51 0%	77,540	--	3 8	2 0
1113	19 41	64 7%	94,706	--	3 7	2 4
1114	29 80	99 3%	208,324	>95%	5 3	5 3
1115	29 90	99 7%	258,248	>95%	6 5	6 5
1116	0.00	0 0%	0	--	0 0	0 0
1117	16 47	54 9%	139,709	--	6 4	3.5
1118	29 90	99 7%	87,606	>95%	2 2	2.2
1119	29 90	99 7%	154,129	>95%	3 9	3 9
1120	6 67	22 2%	15,362	--	1 7	0 4
1121	29 90	99 7%	209,017	>95%	5 3	5 3
1122	29 89	99 6%	148,093	>95%	3 8	3 7
1123	18 85	62 8%	17,903	--	0 7	0 5
1124	29 90	99 7%	160,517	>95%	4 0	4 0
1125	29 90	99 7%	167,043	>95%	4 2	4.2
			3,854,346	total gal		
			89 2	OST gpm		

Dec-03						
Total Time On		31 00	days			
Well	Total Time	OST	Gallons		OST gpm	effective gpm
1101	31 00	100 0%	230,544	>95%	5 8	5.8
1102	31 00	100 0%	264,182	>95%	6 7	6 7
1103	31 00	100 0%	287,366	>95%	7 3	7 3
1104	30 78	99 3%	179,021	>95%	4 6	4 5
1105	18 29	59 0%	232,236	--	10 0	5 9
1106	12 75	41 1%	109 437	--	6 7	2 8
1107	31 00	100 0%	189 302	>95%	4 8	4 8
1108	31 00	100 0%	208,483	>95%	5 3	5 3
1109	31 00	100 0%	103,118	>95%	2 6	2 6
1110	24 88	80 2%	138,159	--	4 4	3 5
1111	31 00	100 0%	181,757	>95%	4 6	4 6
1112	14 95	48 2%	80,996	--	4 2	2 0
1113	19 32	62 3%	104,316	--	4 2	2 6
1114	30 96	99 9%	222,695	>95%	5 6	5 6
1115	31 00	100 0%	269,654	>95%	6 8	6 8
1116	0 00	0 0%	0	--	0 0	0 0
1117	0 00	0 0%	0	--	0 0	0 0
1118	31 00	100 0%	69,998	>95%	1 8	1 8
1119	31 00	100 0%	147,341	>95%	3 7	3 7
1120	11 12	35 9%	23,382	--	1 6	0 6
1121	30 32	97 8%	192,241	>95%	5 0	4 9
1122	30 92	99 8%	144,231	>95%	3 7	3 6
1123	13 96	45 0%	16,553	--	0 9	0 4
1124	31 00	100 0%	188,496	>95%	4 8	4 8
1125	31 00	100 0%	167,141	>95%	4 2	4 2
			3,750,649	total gal		
			84 0	OST gpm		

Jan-04						
Total Time On		19 86	days			
Well	Total Time	OST	Gallons		OST gpm	effective gpm
1101	19 84	99 9%	146,844	>95%	3 7	3 7
1102	19 86	100 0%	169,824	>95%	4 3	4 3
1103	19 76	99 5%	184,061	>95%	4 7	4 7
1104	19 65	98 9%	117,660	>95%	3 0	3 0
1105	11 73	59 1%	154,951	--	6 6	3 9
1106	9 28	46 7%	76,678	--	4 1	1 9
1107	19 76	99 5%	123,771	>95%	3 1	3 1
1108	19 76	99 5%	134,008	>95%	3 4	3 4
1109	19 76	99 5%	67,954	>95%	1 7	1 7
1110	15 79	79 5%	91,817	--	2 9	2 3
1111	19 76	99.5%	116,649	>95%	3 0	2 9
1112	9 47	47 7%	56,727	--	3 0	1 4
1113	12 18	61 3%	71,133	--	2 9	1 8
1114	19 58	98 6%	145,597	>95%	3 7	3 7
1115	19 76	99.5%	174,613	>95%	4 4	4 4
1116	0 00	0 0%	0	--	0 0	0 0
1117	0 00	0 0%	0	--	0 0	0 0
1118	19 76	99 5%	33,050	>95%	0 8	0 8
1119	19 76	99 5%	96,111	>95%	2 4	2 4
1120	6 49	32 7%	5,877	--	0 5	0 1
1121	19 59	98 6%	125,877	>95%	3 2	3 2
1122	19 69	99 1%	93,782	>95%	2 4	2 4
1123	8 31	41 8%	10,977	--	0 7	0 3
1124	19 76	99 5%	122,181	>95%	3 1	3 1
1125	19 76	99 5%	109,377	>95%	2 8	2 8
			2,429,320	total gal		
			84 9	OST gpm		

Feb-04						
Total Time On		28 71	days			
Well	Total Time	OST	Gallons		OST gpm	effective gpm
1101	28 71	100 0%	170,164	>95%	4 3	4 3
1102	28 70	100 0%	237,844	>95%	6 0	6 0
1103	28.70	100 0%	266,906	>95%	6 7	6 7
1104	28 70	100 0%	174,484	>95%	4 4	4 4
1105	15 58	54 3%	222,106	--	10 3	5 6
1106	15 11	52 6%	111,831	--	5 4	2 8
1107	28 70	100 0%	182,797	>95%	4 6	4 6
1108	28 70	100 0%	197,281	>95%	5 0	5 0
1109	28 70	100 0%	101,676	>95%	2 6	2 6
1110	24 22	84 4%	135,860	--	4 1	3 4
1111	28 70	100 0%	168,548	>95%	4 3	4 3
1112	14 29	49 8%	82,669	--	4 2	2 1
1113	17 88	62 3%	101,578	--	4 1	2 6
1114	28 68	99 9%	210,987	>95%	5 3	5 3
1115	28 70	100 0%	253,176	>95%	6 4	6 4
1116	0 00	0 0%	0	--	0 0	0 0
1117	0 00	0 0%	0	--	0 0	0 0
1118	28 70	100 0%	44,792	>95%	1 1	1 1
1119	28 70	100 0%	142,591	>95%	3 6	3 6
1120	7 74	27 0%	17,624	--	1 7	0 4
1121	24 12	84 0%	184,432	--	4 9	4 2
1122	28 70	100 0%	139,009	>95%	3 5	3 5
1123	12 55	43 7%	16,242	--	0 9	0 4
1124	28 70	100 0%	179,481	>95%	4 5	4 5
1125	28 70	100 0%	159,860	>95%	4 0	4 0
			3,481,533	total gal		
			84 2	OST gpm		

6-mth total gal (9/2/03 - 2/29/04) 21,119,038
effective 6-mth rate gpm 81

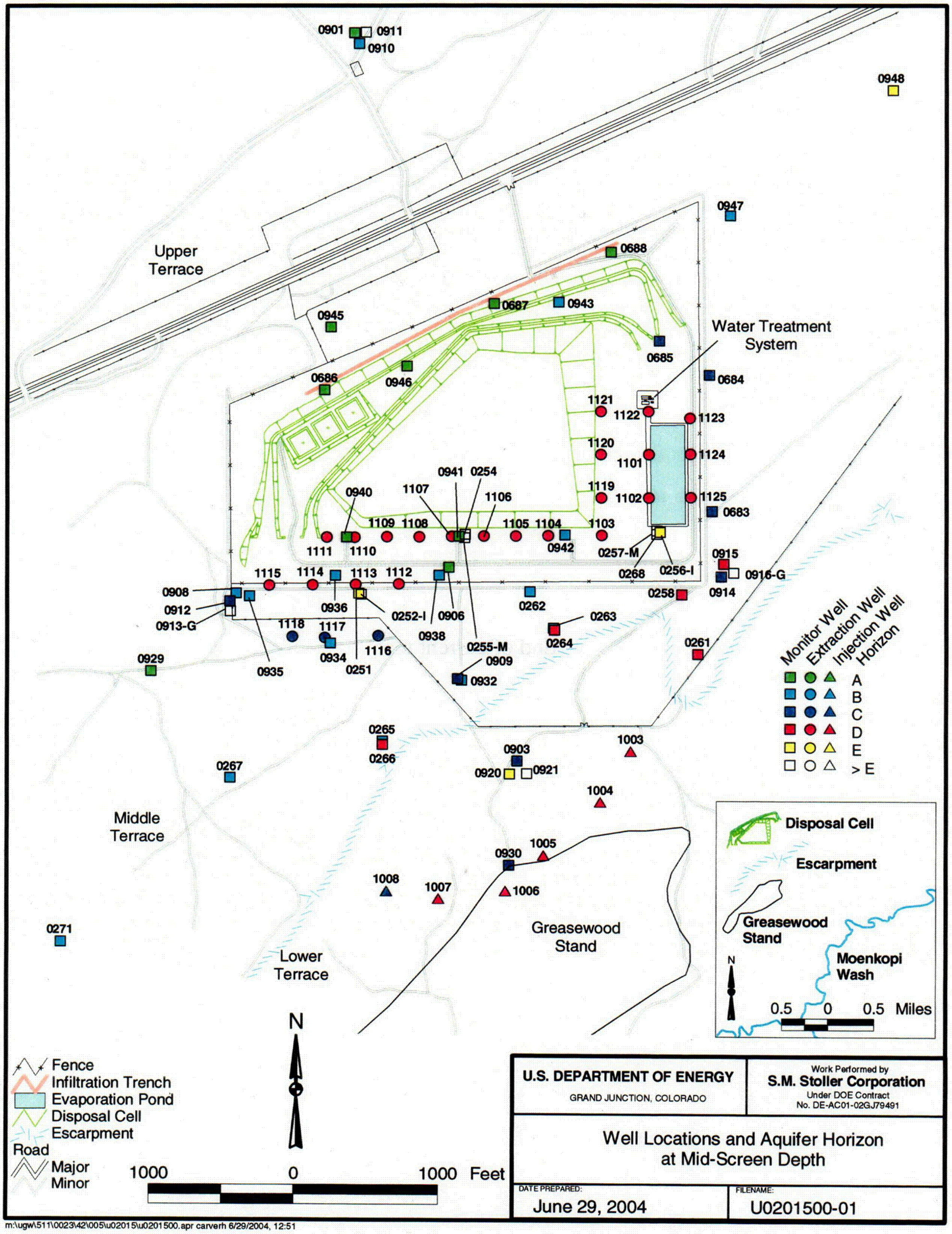

Figure A–1. Well Locations and Mid-Screen Aquifer Horizon

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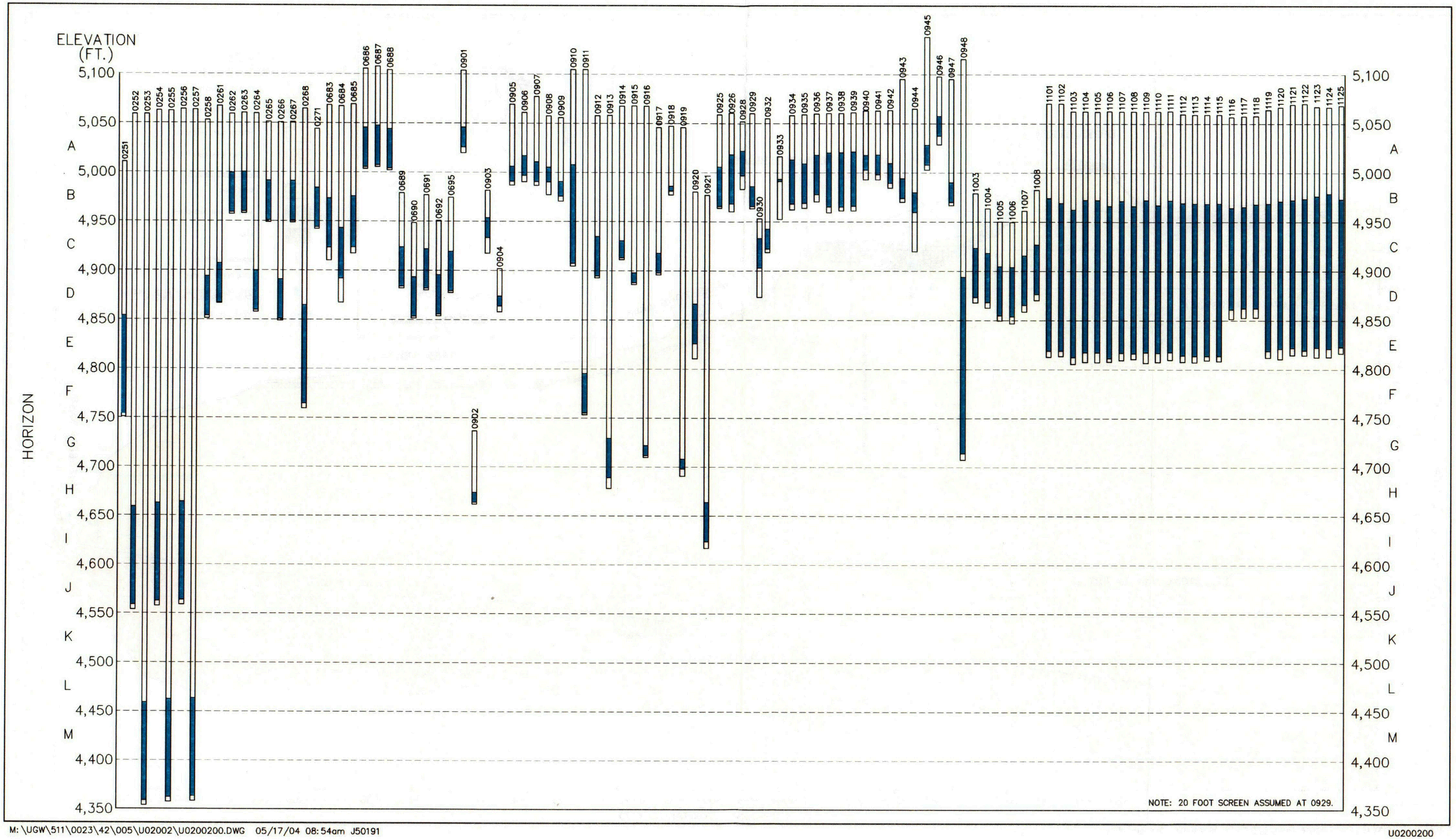

Figure A–2. Well Screen Intervals and Horizons

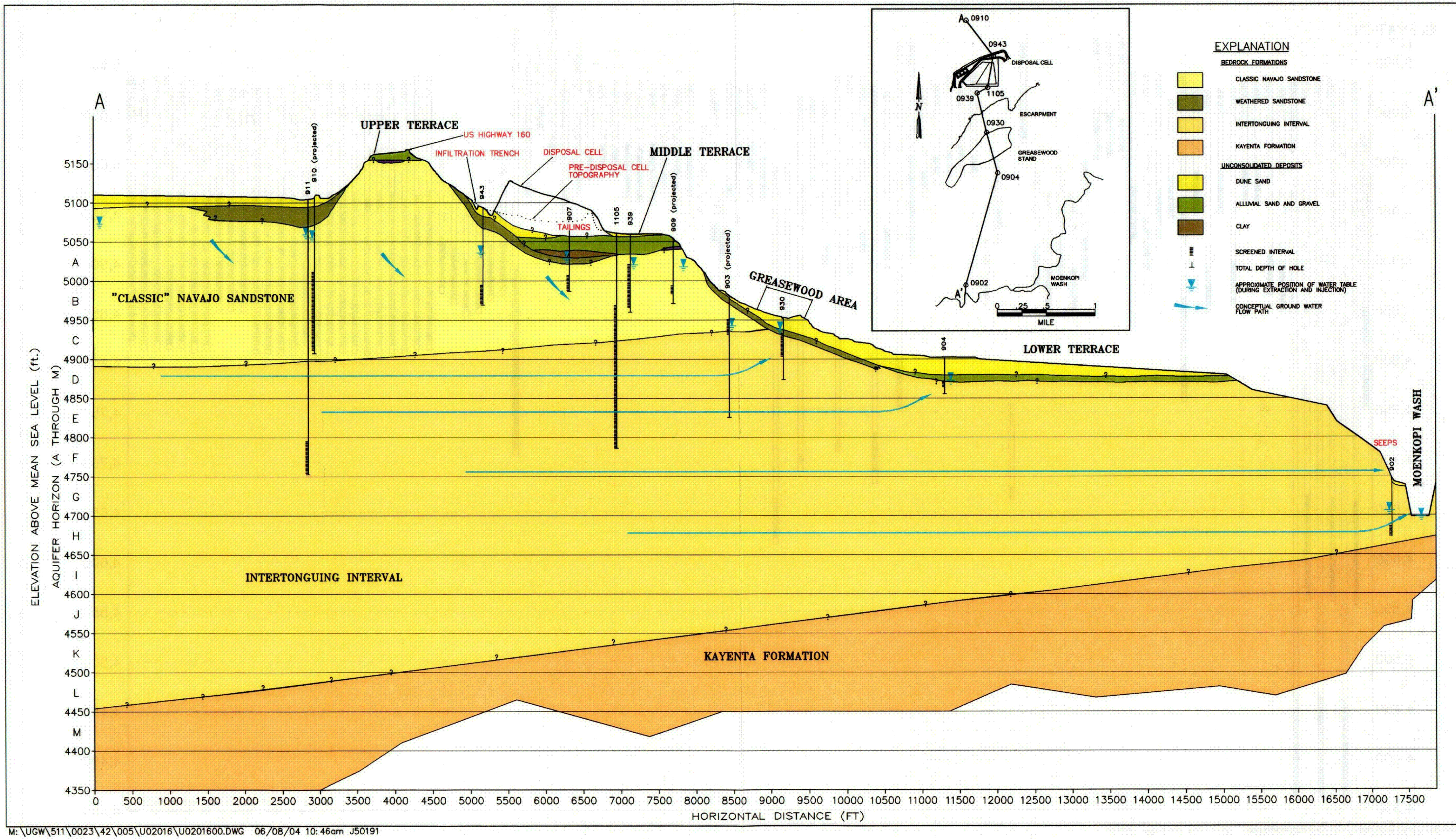

Figure A–3. Geologic Cross Section

Appendix B

Ground Water Sample Results for February 2004 and the Baseline Period for Contaminants Requiring Remediation

Table B-1. Baseline and February 2004 Nitrate Concentrations

Well Number	Horizon	Baseline Nitrate Concentration (mg/L)	Year Sampled, Baseline	February 2004 Nitrate Concentration (mg/L)
		MCL=44.0 mg/L		NS
0686	A	32.2	2002	15
0687	A	60.6	2002	9
0688	A	35.1	2002	33
0901	A	13	2001	NS
0906	A	1470	2002	NS
0929	A	69.5	2002	NS
0940	A	1800	2002	1,800
0941	A	358	2002	660
0945	A	12.7	2002	12
0946	A	NS		29
0262	B	380	2001	NS
0263	B	1140	2001	NS
0265	B	720	2001	NS
0267	B	1640	2002	NS
0271	B	15.6	2002	NS
0908	B	651	2002	1,100
0909	B	485	2002	490
0910	B	NS		NS
0918	B	NS		NS
0934	B	2320	2002	2,400
0935	B	525	2002	630
0936	B	2950	2002	2,300
0938	B	1450	1999	NS
0942	B	1360	2002	1,400
0943	B	22.1	2002	380
0947	B	12.5	2002	13
0683	C	14.1	2002	NS
0684	C	13.9	2002	NS
0685	C	14.3	2002	NS
0689	C	14.3	2002	14
0691	C	298	2002	310
0903	C	54.8	2002	54
0912	C	403	2001	NS
0914	C	13	2001	NS
0917	C	15.7	2001	NS
0930	C	50.9	2002	67
0932	C	25.3	2002	26
1008	C	15.7	2000	NS
1116	C	106	2002	NS
1117	C	225	2002	NS
1118	C	164	2002	600

Table B-1 (continued). Baseline and February 2004 Nitrate Concentrations

Well Number	Horizon	Baseline Nitrate Concentration (mg/L)	Year Sampled, Baseline	February 2004 Nitrate Concentration (mg/L)
		MCL=44.0 mg/L		NS
0258	D	15	2000	NS
0261	D	14	2001	NS
0264	D	24.3	2001	NS
0266	D	14	2001	NS
0690	D	12.5	2002	13
0692	D	12.5	2002	13
0695	D	25.4	2002	28
0904	D	5.13	2001	NS
0915	D	14.1	2001	NS
1003	D	176	2000	NS
1004	D	49.1	2000	20
1005	D	14.5	2000	NS
1006	D	14.1	2000	NS
1007	D	15.3	2000	NS
1101	D	438	2002	540
1102	D	650	2002	650
1103	D	1120	2002	1,200
1104	D	993	2002	620
1105	D	648	2002	350
1106	D	614	2002	130
1107	D	1060	2002	200
1108	D	1410	2002	720
1109	D	798	2002	430
1110	D	227	2002	190
1111	D	421	2002	390
1112	D	617	2002	200
1113	D	143	2002	35
1114	D	228	2002	180
1115	D	766	2002	270
1119	D	468	2002	520
1120	D	493	2002	270
1121	D	573	2002	450
1122	D	954	2002	290
1123	D	643	2002	88
1124	D	781	2002	470
1125	D	104	2002	66
0251	E	426	2002	14
0268	E	15.4	2002	18
0920	E	14.8	2001	NS
0911	F	NS		NS
0913	G	12.4	2001	NS
0916	G	11.6	2001	NS
0919	G	NS		NS

Table B-1 (continued). Baseline and February 2004 Nitrate Concentrations

Well Number	Horizon	Baseline Nitrate Concentration (mg/L)	Year Sampled, Baseline	February 2004 Nitrate Concentration (mg/L)
		MCL=44.0 mg/L		NS
0902	H	NS		NS
0252	I	15.3	2002	12
0254	I	354	2002	450
0256	I	189	2002	72
0921	I	11	2001	NS
0255	M	9.6	2000	0.044U
0257	M	6.9	2000	0.044U

NS = Not sampled.
U=Analytical result below detection limit.

Table B–2. Baseline and February 2004 Molybdenum Concentrations

Well Number	Horizon	Baseline Molybdenum Concentration (mg/L)	Year Sampled, Baseline	February 2004 Molybdenum Concentration (mg/L)
		MCL=0.1 mg/L		
0686	A	0.0015U	2002	0.0016
0687	A	0.0113	2002	0.0033
0688	A	0.0015U	2002	0.00042B
0901	A	0.00078	2001	NS
0906	A	0.0137	2002	NS
0929	A	0.0015U	2002	NS
0940	A	0.0015U	2002	0.0029
0941	A	0.0284	2002	0.079
0945	A	0.0015U	2002	0.00097B
0946	A	NS		0.0019
0262	B	0.432	2001	NS
0263	B	0.192	2001	NS
0265	B	0.00046	2001	NS
0267	B	0.0015U	2002	NS
0271	B	0.0015U	2002	NS
0908	B	0.0015U	2002	0.00028B
0909	B	0.0015U	2002	0.00054B
0910	B	NS		NS
0918	B	NS		NS
0934	B	0.0015U	2002	0.00018B
0935	B	0.0015U	2002	0.00024B
0936	B	0.0015U	2002	0.00066B
0938	B	0.001U	1999	NS
0942	B	0.021	2002	0.02
0943	B	0.0015U	2002	0.00024B
0947	B	0.0015U	2002	0.00094B
0683	C	0.0015U	2002	NS
0684	C	0.0015U	2002	NS
0685	C	0.0015U	2002	NS
0689	C	0.0015U	2002	0.00061B
0691	C	0.0015U	2002	0.00033B
0903	C	0.0015U	2002	0.00045B
0912	C	0.0003U	2001	NS
0914	C	0.00081	2001	NS
0917	C	0.0013	2001	NS
0930	C	0.0015U	2002	0.00051B
0932	C	0.0018U	2002	0.00089B
1008	C	0.0004U	2000	NS
1116	C	0.0015U	2002	NS
1117	C	0.0015U	2002	NS
1118	C	0.0015U	2002	0.00029B

Table B-2 (continued). Baseline and February 2004 Molybdenum Concentrations

Well Number	Horizon	Baseline Molybdenum Concentration (mg/L)	Year Sampled, Baseline	February 2004 Molybdenum Concentration (mg/L)
		MCL=0.1 mg/L		
0258	D	0.00063	2000	NS
0261	D	0.0026	2001	NS
0264	D	0.0031	2001	NS
0266	D	0.00058	2001	NS
0690	D	0.0015U	2002	0.00088B
0692	D	0.0015U	2002	0.0007B
0695	D	0.0015U	2002	0.00068B
0904	D	0.00077	2001	NS
0915	D	0.00054	2001	NS
1003	D	0.0004U	2000	NS
1004	D	0.0004U	2000	0.00054B
1005	D	0.0004U	2000	NS
1006	D	0.0004U	2000	NS
1007	D	0.0004U	2000	NS
1101	D	0.0015U	2002	0.00031B
1102	D	0.0015U	2002	0.00028B
1103	D	0.0015U	2002	0.00087B
1104	D	0.0916	2002	0.043
1105	D	2.96	2002	1.1
1106	D	1.26	2002	0.29
1107	D	0.16	2002	0.015
1108	D	0.0015U	2002	0.00035B
1109	D	0.0015U	2002	0.00039B
1110	D	0.0015U	2002	0.00023B
1111	D	0.0015U	2002	0.00018B
1112	D	0.0015U	2002	0.00045B
1113	D	0.0015U	2002	0.00023B
1114	D	0.0027	2002	0.0012
1115	D	0.0015U	2002	0.0002B
1119	D	0.0053	2002	0.001
1120	D	0.0815	2002	0.022
1121	D	0.105	2002	0.073
1122	D	0.0015U	2002	0.00036B
1123	D	0.0015U	2002	0.00031B
1124	D	0.0015U	2002	0.00029B
1125	D	0.0015U	2002	0.00031B
0251	E	0.0015U	2002	0.00029B
0268	E	0.0015U	2002	0.00048B
0920	E	0.0003U	2001	NS
0911	F	NS		NS
0913	G	0.0003U	2001	NS
0916	G	0.00096	2001	NS
0919	G	NS		NS
0902	H	NS		NS

Table B-2 (continued). Baseline and February 2004 Molybdenum Concentrations

Well Number	Horizon	Baseline Molybdenum Concentration (mg/L)	Year Sampled, Baseline	February 2004 Molybdenum Concentration (mg/L)
		MCL=0.1 mg/L		
0252	I	0.0015U	2002	0.00019B
0254	I	0:164	2002	0.053
0256	I	0.0015U	2002	0.00059B
0921	I	0.0003U	2001	NS
0255	M	0.0043	2000	0.068
0257	M	0.00041	2000	0.037

B=Result is between the IDL and CRDL.
NS = Not sampled.
U=Analytical result below detection limit.

Table B-3. Baseline and February 2004 Selenium Concentrations

Well Number	Horizon	Baseline Selenium Concentration (mg/L)	Year Sampled, Baseline	February 2004 Selenium Concentration (mg/L)
		MCL=0.01 mg/L		
0686	A	0.0088	2002	0.0077
0687	A	0.0145	2002	0.00046
0688	A	0.0033	2002	0.003
0901	A	0.0024	2001	NS
0906	A	0.0335	2002	NS
0929	A	0.0028	2002	NS
0940	A	0.105	2002	0.072
0941	A	0.0348	2002	0.061
0945	A	0.0035	2002	0.0014
0946	A	NS		0.0076
0262	B	0.0621	2001	NS
0263	B	0.0632	2001	NS
0265	B	0.0071	2001	NS
0267	B	0.0532	2002	NS
0271	B	0.0016	2002	NS
0908	B	0.0163	2002	0.014
0909	B	0.0224	2002	0.022
0910	B	NS		NS
0918	B	NS		NS
0934	B	0.0116	2002	0.0081
0935	B	0.0195	2002	0.02
0936	B	0.0869	2002	0.063
0938	B	0.0432	1999	NS
0942	B	0.0348	2002	0.033
0943	B	0.0021	2002	0.01
0947	B	0.0019	2002	0.0018E
0683	C	0.0022	2002	NS
0684	C	0.0019	2002	NS
0685	C	0.0017	2002	NS
0689	C	0.0014	2002	0.0015
0691	C	0.0046	2002	0.0049
0903	C	0.0023	2002	0.0021
0912	C	0.0137	2001	NS
0914	C	0.0016	2001	NS
0917	C	0.0017	2001	NS
0930	C	0.002	2002	0.0024EN
0932	C	0.0019	2002	0.0017
1008	C	0.0015	2000	NS
1116	C	0.0018	2002	NS
1117	C	0.0028	2002	NS
1118	C	0.0028	2002	0.017
0258	D	0.0018	2000	NS
0261	D	0.0021	2001	NS

Table B-3 (continued). Baseline and February 2004 Selenium Concentrations

Well Number	Horizon	Baseline Selenium Concentration (mg/L)	Year Sampled, Baseline	February 2004 Selenium Concentration (mg/L)
		MCL=0.01 mg/L		
0264	D	0.0018	2001	NS
0266	D	0.0013	2001	NS
0690	D	0.0014	2002	0.0015
0692	D	0.0022	2002	0.0022
0695	D	0.0019	2002	0.0019
0904	D	0.0131	2001	NS
0915	D	0.0019	2001	NS
1003	D	0.003	2000	NS
1004	D	0.0021	2000	0.0023
1005	D	0.0014	2000	NS
1006	D	0.0013	2000	NS
1007	D	0.0013	2000	NS
1101	D	0.0188	2002	0.024
1102	D	0.0121	2002	0.021
1103	D	0.0613	2002	0.043
1104	D	0.0344	2002	0.02
1105	D	0.0871	2002	0.03
1106	D	0.0925	2002	0.018
1107	D	0.0903	2002	0.0095
1108	D	0.0704	2002	0.029
1109	D	0.0372	2002	0.014
1110	D	0.0081	2002	0.0076
1111	D	0.0172	2002	0.017
1112	D	0.0154	2002	0.0061
1113	D	0.0025	2002	0.0015
1114	D	0.0035	2002	0.0045
1115	D	0.0362	2002	0.0083
1119	D	0.029	2002	0.018
1120	D	0.0563	2002	0.025
1121	D	0.0455	2002	0.033
1122	D	0.0558	2002	0.019
1123	D	0.0449	2002	0.0057
1124	D	0.0186	2002	0.015
1125	D	0.0025	2002	0.0025EN
0251	E	0.0035	2002	0.00088
0268	E	0.0018	2002	0.0017
0920	E	0.0014	2001	NS
0911	F	NS		NS
0913	G	0.00063	2001	NS
0916	G	0.001	2001	NS
0919	G	NS		NS
0902	H	NS		NS

Table B-3 (continued). Baseline and February 2004 Selenium Concentrations

Well Number	Horizon	Baseline Selenium Concentration (mg/L)	Year Sampled, Baseline	February 2004 Selenium Concentration (mg/L)
		MCL=0.01 mg/L		
0252	I	0.00092	2002	0.0007
0254	I	0.0531	2002	0.044
0256	I	0.0031	2002	0.0017
0921	I	0.00091	2001	NS
0255	M	0.0011	2000	0.0002B
0257	M	0.0013	2000	0.00047

B=Result is between the IDL and CRDL.
E=Estimated value because of interference, see case narrative.
N=Spike sample recovery not within control limits.
NS = Not sampled.
U=Analytical result below detection limit.

Table B-4. Baseline and February 2004 Sulfate Concentrations

Well Number	Horizon	Baseline Sulfate Concentration (mg/L)	Year Sampled, Baseline	February 2004 Sulfate Concentration (mg/L)
		No MCL for sulfate		
0686	A	98.6	2002	120
0687	A	329	2002	26
0688	A	40	2002	37
0901	A	26.2	2001	NS
0906	A	1660	2002	NS
0929	A	28.1	2002	NS
0940	A	7550	2002	9,600
0941	A	745	2002	800
0945	A	32.1	2002	13
0946	A	NS		130
0262	B	931	2001	NS
0263	B	1990	2001	NS
0265	B	1520	2001	NS
0267	B	3680	2002	NS
0271	B	16.4	2002	NS
0908	B	2430	2002	2,400
0909	B	666	2002	540
0910	B	NS		NS
0918	B	NS		NS
0934	B	7360	2002	1,900
0935	B	2690	2002	2,700
0936	B	4360	2002	3,200
0938	B	2120	1999	NS
0942	B	3030	2002	2,800
0943	B	29	2002	620
0947	B	18.7	2002	16
0683	C	21.6	2002	NS
0684	C	18	2002	NS
0685	C	26.2	2002	NS
0689	C	13.7	2002	13
0691	C	587	2002	540
0903	C	76.5	2002	66
0912	C	846	2001	NS
0914	C	15.6	2001	NS
0917	C	13.9	2001	NS
0930	C	59.8	2002	76
0932	C	30.2	2002	24
1008	C	13	2000	NS
1116	C	176	2002	NS
1117	C	255	2002	NS
1118	C	163	2002	1,400

Table B-4 (continued). Baseline and February 2004 Sulfate Concentrations

Well Number	Horizon	Baseline Sulfate Concentration (mg/L)	Year Sampled, Baseline	February 2004 Sulfate Concentration (mg/L)
		No MCL for sulfate		
0258	D	17.4	2000	NS
0261	D	18.2	2001	NS
0264	D	37.7	2001	NS
0266	D	10.9	2001	NS
0690	D	13.8	2002	12
0692	D	20.8	2002	19
0695	D	50.4	2002	51
0904	D	96.5	2001	NS
0915	D	17.8	2001	NS
1003	D	302	2000	NS
1004	D	66.2	2000	28
1005	D	12.7	2000	NS
1006	D	12.2	2000	NS
1007	D	11.7	2000	NS
1101	D	960	2002	1,300
1102	D	1320	2002	1,300
1103	D	2570	2002	2,500
1104	D	1870	2002	1,100
1105	D	1590	2002	740
1106	D	1050	2002	250
1107	D	1200	2002	220
1108	D	3400	2002	1,700
1109	D	3280	2002	1,100
1110	D	512	2002	330
1111	D	988	2002	840
1112	D	1140	2002	290
1113	D	136	2002	26
1114	D	328	2002	230
1115	D	1930	2002	350
1119	D	1560	2002	1,000
1120	D	2330	2002	1,200
1121	D	2590	2002	2,700
1122	D	2960	2002	990
1123	D	1240	2002	160
1124	D	1170	2002	680
1125	D	165	2002	97
0251	E	617	2002	11
0268	E	17.4	2002	19
0920	E	12.7	2001	NS
0911	F	NS		NS
0913	G	8.43	2001	NS
0916	G	13.5	2001	NS
0919	G	NS		NS

Table B-4 (continued). Baseline and February 2004 Sulfate Concentrations

Well Number	Horizon	Baseline Sulfate Concentration (mg/L)	Year Sampled, Baseline	February 2004 Sulfate Concentration (mg/L)
		No MCL for sulfate		
0902	H	NS		NS
0252	I	19.2	2002	8.3
0254	I	505	2002	500
0256	I	368	2002	130
0921	I	8.52	2001	NS
0255	M	102	2000	4,000
0257	M	13.4	2000	310

NS = Not sampled.
U=Analytical result below detection limit.

Table B-5. Baseline and February 2004 Uranium Concentrations

Well Number	Horizon	Baseline Uranium Concentration (mg/L)	Year Sampled, Baseline	February 2004 Uranium Concentration (mg/L)
		MCL=0.044 mg/L		
0686	A	0.0021	2002	0.00083
0687	A	0.0208	2002	0.000066B
0688	A	0.002	2002	0.0015
0901	A	0.0026	2001	NS
0906	A	0.951	2002	NS
0929	A	0.0012	2002	NS
0940	A	0.546	2002	0.43
0941	A	0.0886	2002	0.081
0945	A	0.0031	2002	0.00073
0946	A	NS		0.00039
0262	B	0.379	2001	NS
0263	B	0.485	2001	NS
0265	B	0.0897	2001	NS
0267	B	0.0731	2002	NS
0271	B	0.0014	2002	NS
0908	B	0.122	2002	0.097
0909	B	0.0389	2002	0.027
0910	B	NS		NS
0918	B	NS		NS
0934	B	0.312	2002	0.32
0935	B	0.0868	2002	0.11
0936	B	0.267	2002	0.6
0938	B	0.21	1999	NS
0942	B	0.246	2002	0.24
0943	B	0.0049	2002	0.24
0947	B	0.0024	2002	0.00078
0683	C	0.0012	2002	NS
0684	C	0.0019	2002	NS
0685	C	0.0012	2002	NS
0689	C	0.0011	2002	0.00088
0691	C	0.0657	2002	0.052
0903	C	0.0022	2002	0.0017
0912	C	0.0342	2001	NS
0914	C	0.0013	2001	NS
0917	C	0.0013	2001	NS
0930	C	0.0023	2002	0.0025E
0932	C	0.0016	2002	0.0013
1008	C	0.001	2000	NS
1116	C	0.0081	2002	NS
1117	C	0.0151	2002	NS
1118	C	0.0098	2002	0.059
0258	D	0.0018	2000	NS
0261	D	0.0018	2001	NS
0264	D	0.0033	2001	NS

Table B–5 (continued). Baseline and February 2004 Uranium Concentrations

Well Number	Horizon	Baseline Uranium Concentration (mg/L)	Year Sampled, Baseline	February 2004 Uranium Concentration (mg/L)
		MCL=0.044 mg/L		
0266	D	0.0019	2001	NS
0690	D	0.0018	2002	0.0016
0692	D	0.0015	2002	0.0012
0695	D	0.002	2002	0.002
0904	D	0.0044	2001	NS
0915	D	0.0017	2001	NS
1003	D	0.0205	2000	NS
1004	D	0.0053	2000	0.0016
1005	D	0.0013	2000	NS
1006	D	0.0014	2000	NS
1007	D	0.0012	2000	NS
1101	D	0.245	2002	0.34
1102	D	0.533	2002	0.45
1103	D	0.355	2002	0.49
1104	D	0.194	2002	0.11
1105	D	2.1	2002	0.97
1106	D	2.1	2002	0.49
1107	D	0.118	2002	0.034
1108	D	0.646	2002	0.23
1109	D	0.565	2002	0.25
1110	D	0.0528	2002	0.063
1111	D	0.161	2002	0.14
1112	D	0.13	2002	0.029
1113	D	0.0149	2002	0.0028
1114	D	0.0277	2002	0.021
1115	D	0.41	2002	0.045
1119	D	0.555	2002	0.18
1120	D	1.3	2002	0.44
1121	D	0.857	2002	0.74
1122	D	0.878	2002	0.3
1123	D	0.261	2002	0.038
1124	D	0.171	2002	0.11
1125	D	0.0176	2002	0.016E
0251	E	0.0481	2002	0.0012
0268	E	0.0014	2002	0.0021
0920	E	0.0017	2001	NS
0911	F	NS		NS
0913	G	0.0016	2001	NS
0916	G	0.0014	2001	NS
0919	G	NS		NS
0902	H	NS		NS

Table B-5 (continued). Baseline and February 2004 Uranium Concentrations

Well Number	Horizon	Baseline Uranium Concentration (mg/L)	Year Sampled, Baseline	February 2004 Uranium Concentration (mg/L)
		MCL=0.044 mg/L		
0252	I	0.0024	2002	0.0017
0254	I	0.209	2002	0.1
0256	I	0.0775	2002	0.018
0921	I	0.0047	2001	NS
0255	M	0.0029	2000	0.0019
0257	M	0.0037	2000	0.016

B=Result is between the IDL and CRDL.
E=Estimated value because of interference, see case narrative.
NS = Not sampled.
U=Analytical result below detection limit.

End of current text

Appendix C

Water Levels and Drawdown Information

Table C-1. Water Level Drawdown Calculation

Horizon	Well	Baseline_date	Water level ft	February_2004_date	Water level ft	Drawdown ft
A	686	15-Aug-01	5,028.11	10-Feb-04	5,041.38	-13.27
A	687	15-Aug-01	5,035.35	10-Feb-04	5,051.56	-16.21
A	688	15-Aug-01	5,027.11	10-Feb-04	5,031.69	-4.58
A	940	15-Aug-01	5,015.61	12-Feb-04	4,997.82	17.79
A	941	16-Aug-01	5,015.83	11-Feb-04	4,997.99	17.84
A	945	14-Aug-01	5,037.15	12-Feb-04	5,041.25	-4.1
B	908	15-Aug-01	5,008.12	10-Feb-04	5,001.29	6.83
B	909	16-Aug-01	4,998.81	12-Feb-04	4,994.84	3.97
B	934	16-Aug-01	5,001.08	10-Feb-04	4,992.56	8.52
B	935	15-Aug-01	5,008.66	10-Feb-04	5,001.31	7.35
B	936	16-Aug-01	5,011.45	12-Feb-04	4,988.52	22.93
B	942	16-Aug-01	5,015.24	11-Feb-04	5,005.86	9.38
B	943	14-Aug-01	5,028.63	10-Feb-04	5,032.76	-4.13
B	947	10-Mar-00	5,025.86	12-Feb-04	5,023.05	2.81
C	689	16-Aug-01	4,945.76	12-Feb-04	4,942.82	2.94
C	691	15-Aug-01	4,944.80	12-Feb-04	4,939.48	5.32
C	903	16-Aug-01	4,957.90	12-Feb-04	4,953.67	4.23
C	930	16-Aug-01	4,935.67	12-Feb-04	4,934.90	0.77
C	932	16-Aug-01	4,964.01	12-Feb-04	4,955.36	8.65
D	690	16-Aug-01	4,928.38	12-Feb-04	4,926.01	2.37
D	692	15-Aug-01	4,931.90	12-Feb-04	4,927.57	4.33
D	695	15-Aug-01	4,931.53	12-Feb-04	4,929.80	1.73
D	1003	24-May-01	4,944.75	13-Feb-04	4,939.58	5.17
D	1004	23-May-01	4,943.02	12-Feb-04	4,940.35	2.67
E	251	14-Aug-01	4,997.95	10-Feb-04	4,950.95	47
E	268	13-Aug-01	4,986.96	11-Feb-04	4,938.32	48.64
I	254	16-May-01	5,009.88	11-Feb-04	4,985.92	23.96
I	256	16-May-01	4,974.68	11-Feb-04	4,955.30	19.38
M	255	13-Sep-00	4,974.49	11-Feb-04	4,969.87	4.62
M	257	31-May-00	4,962.07	11-Feb-04	4,957.31	4.76

End of current text