Department of Energy
Office of Legacy Management

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

Subject: Annual Ground Water Report, Tuba City, Arizona, Disposal Site

Dear Ms. Roanhorse:

Enclosed is your copy of the *Annual Ground Water Report, April 2005 through March 2006, Tuba City, Arizona, Disposal Site*.

Please call me at 970-248-6073 if you have any questions.

Sincerely,

Richard B. Bush

Richard Bush
Site Manager

Enclosure

cc:
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DOE-LM/GJ1231-2006

Annual Ground Water Report April 2005 through March 2006 Tuba City, Arizona, Disposal Site

August 2006

U.S. Department of Energy

Office of Legacy Management

Work Performed Under DOE Contract No. DE-AC01-02GJ79491 for the U.S. Department of Energy Office of Legacy Management.

DOE-LM/GJ1231-2006

Annual Ground Water Report
April 2005 through March 2006
Tuba City, Arizona, Disposal Site

August 2006

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

Contents

Figures

Tables

Appendices

End of current text

1.0 Introduction

1.1 Background Information

This report evaluates the performance of the ground water remediation system at the U.S. Department of Energy (DOE) Legacy Management site near Tuba City, Arizona for the period of March 2005 through March 2006. The site is located in Coconino County, Arizona, within the Navajo Nation and near Hopi Reservation land (Figure 1). Locally, ground water in an underlying sandstone aquifer is contaminated by several inorganic constituents, including nitrate, uranium, and sulfate, the primary site contaminants, as a result of former uranium-ore milling at the site. Surface remedial actions, consisting of encapsulating all solid waste within an on site engineered disposal cell, occurred between 1988 and 1990. A remnant plume of ground water contamination extended off site to the south and southeast from the former mill area. DOE then constructed a pump-and-treat remediation system, operational by mid-2002, to remove the contaminants from the aquifer and thus restore ground water quality. Evaluation of system performance is reported annually.

1.2 Ground Water Remediation System

The ground water remediation system currently operates 37 extraction wells completed within the contaminated region of the aquifer. The extracted water is conveyed in underground piping to an on-site facility (treatment plant) where it is mechanically distilled following ion exchange pretreatment. Engineered solar evaporation ponds receive the waste liquid (brine) and an infiltration trench located upgradient of the contaminant plume returns the treated water (distillate) to the aquifer to enhance contaminant flushing. Six injection wells (wells 1003 through 1008) originally intended to create a hydraulic barrier at the downgradient limit of contamination remain unused for that purpose. Of the 37 extraction wells, eight wells (wells 1126 through 1133) were installed in summer 2004 to expand the capture zone of the original 25 wells (wells 1101 through 1125). In addition, wells 935, 942, 936, and 938, used formerly for monitoring purposes only, were converted to extraction use at that time. Numerous other monitoring wells used to track the progress of water quality restoration are situated within and surrounding the network of extraction wells. Primary features of the site are depicted in Figure 2.

1.3 Ground Water Compliance Strategy

The ground water compliance strategy for the Tuba City site, as defined in the *Phase I Ground Water Compliance Action Plan for the Tuba City, Arizona, UMTRA Site* (DOE 1999), is to achieve applicable cleanup levels through active remediation of those portions of the aquifer affected by previous site activities. Cleanup levels for the aquifer comprise restoration "standards" (requirements of 40 CFR 192 [Uranium Mill Tailings Radiation Control Act]), and restoration "goals" (cleanup levels requested by the Navajo Nation but not required by 40 CFR 192).

Ground water contaminants requiring active remediation at the site are molybdenum, nitrate, selenium, sulfate, and uranium [DOE 1999]). Restoration standards (see Table 1–1) for these constituents, except sulfate, correspond to a maximum concentration limit (MCL) in ground water as established in 40 CFR 192. Sulfate is not regulated by 40 CFR 192. However, a restoration standard was adopted for this constituent because it is present in ground water at the

site at concentrations that cause an excess potential risk (DOE 1999). The Navajo Nation also requested that the distillate not exceed 20 mg/L of sodium.

Table 1–1. Ground Water Remediation Goals
(source: DOE 1999)

Constituent/Property	Cleanup Level	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
Sulfate[a]	250 mg/L	1,700–3,500 mg/L
TDS[b]	500 mg/L	3,500–10,000 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]Restoration standard
[b]Restoration goal

1.4 Performance Monitoring and Reporting

The effectiveness of the remediation system in removing contaminants from the aquifer and progressing toward cleanup levels is evaluated yearly on the basis of ground water monitoring conducted in August and February of each year. During these events, samples are collected at monitoring wells and extraction wells for water quality analysis, and water levels are measured. The data are then compared to baseline conditions to evaluate the capture zone of the extraction system, possible movement of contaminant mass in the aquifer, and concentration trends at monitoring locations, individually and collectively.

Routine monitoring specific to treatment system operation includes 1) continuous flow metering of each extraction well, 2) continuous flow metering of the bulk influent, and all outflow streams, 3) weekly determination of bulk inflow and distillate composition through composite sampling, and 4) approximate monthly analysis of ground water composition at each extraction well. These data are used to not only evaluate the efficiency of the treatment system but also to compare the extracted mass and volume of contamination to pre-existing conditions.

The semi-annual monitoring events covered in this report occurred in August 2005 and February 2006. Monitoring data obtained between 1998 and March 2002 represent baseline conditions at the site (DOE 2003). The 12-month review period for this report includes April 2005 through March 2006.

1.5 Hydrogeologic Setting

The Tuba City site lies on the middle of three alluvial terraces resulting from ancestral flows in Moenkopi Wash, located about 1.25 miles southeast of the site. The thin ($\leq$ 20 ft) surficial deposits of coarse, semi-indurated, Quaternary alluvium or loose dune sand and silt are underlain by the regionally extensive Navajo Sandstone, a massively cross-bedded, friable, fine to very

fine sandstone and siltstone. Escarpments that separate the terraces are dominated by cliffs of exposed bedrock. The regional dip of the bedrock is about one degree to the northeast.

At about 200 feet below ground, the massive eolian dune deposits typifying "classic" Navajo Sandstone become interbedded with fine-grained alluvium more typical of the underlying Kayenta Formation. This "inter-tonguing interval" is 400 to 450 feet thick. Occasional thin (≤ 2 ft), resistant limestone beds, relicts of former playa lakes, are interspersed throughout both the classic and inter-tonguing intervals. The Kayenta Formation consists primarily of 100 or more feet of less resistant, fine-bedded red silt and fine sand, lacking the characteristic cross-beds of the Navajo formation.

Ground water beneath the Tuba City site occurs in the regionally extensive "N" multiple-aquifer (Cooley et al. 1969), which in the site area comprises the classic and inter-tonguing intervals of the Navajo Sandstone. Because of the fine-grained nature of the Kayenta Formation locally, it is not water bearing and so is excluded from the "N" aquifer. Ground water saturation occurs from the ambient water table, about 50 to 60 feet below the surface of the upper and middle terraces, to the upper contact of the Kayenta Formation, accounting for a saturated thickness on the order of 500 ft. Ground water flow beneath the site is southeast to Moenkopi Wash. There, regional aquifer discharge is expressed as a laterally extensive (miles) spring zone near the exposed base of the inter-tonguing interval. Local discharge of ground water from higher in the formation occurs in some areas, as evidenced by scattered bands of desert phreatophytes typically near the base of the escarpment between the middle and lower terraces. One such area is noted in Figure 2 as the "greasewood area", where the depth to water is only about 20 feet. Plant sustenance requires the water to reside in fractured, decomposed, or unconsolidated material rather than competent bedrock. Figure A-1 in Appendix A depicts a conceptual model of the site hydrogeology.

1.5.1 Vertical Discretization of the N-Aquifer

In the absence of laterally continuous bedding surfaces as physical hydrostratigraphic markers, for this project, the subsurface is arbitrarily discretized into 50-ft intervals, or "horizons," each with a letter designation. These designations provided a convenient frame of reference particularly in interpreting the complex vertical flow potentials apparent in the monitoring data. The top of the middle terrace, nominally 5,050 feet in elevation, marks the top of the uppermost horizon (Horizon A). Horizons A, B, C, and possibly D span the interval of "classic" Navajo Sandstone beneath the site, whereas the depths of Horizons E through J include the regions of the inter-tonguing interval. Horizons K, L, and M include the lower intertonguing interval and possibly the upper Kayenta Formation. Because of surface topography, the uppermost horizon on the lower terrace progresses from Horizon C to D, north to south. The steep topography at Moenkopi Wash intersects Horizons E through G. Ground water remediation at the site focuses primarily on the upper 250 ft of the bedrock aquifer (Horizons A through E).

These stratigraphic relationships to aquifer horizon are shown in Figure A-1. In Figure 2, color-coding identifies the corresponding horizon in which the mid-point of the screen of each well is located for project extraction wells (round symbols) and monitoring wells (square symbols). Well screen placement depth in relation to aquifer horizon and elevation for all project wells is shown schematically in Figure A-2 of Appendix A. Table A-1 includes additional well completion detail such as screen length and elevation information.

2.0 Treatment & Extraction Systems

2.1 Bulk Treatment Parameters

During the review period the treatment plant operated for 299 of 365 total days, for a net on-stream factor of 82 percent. About 44-million gallons of water were treated during this 52-week period resulting in an average operating rate of 103 gpm and an effective rate (downtime included) of 84 gpm. The operating capacity of the treatment plant is about 120 gallons per minute. This rate is not attained because of limited formation yield to the extraction system as currently configured. Total ground water treatment as of April 1, 2006 was approximately 180-million gallons, equivalent to about 15 percent of the total estimated pre-existing volume of uranium-contaminated ground water (see Section 5.3).

Figure 3 shows the feed rate to the treatment plant and the corresponding concentration of nitrate and sulfate determined from weekly composite samples since the start of remediation. This figure indicates relatively stable concentrations of these constituents entering the treatment system at typical inflows of about 100 gpm. As seen in Figure 4, uranium concentration in the bulk feed exhibits a slight downward trend over the same period. Although this may signify a degree of progress, it should not be used to estimate the aquifer clean up time because in general, the composition of the water in an extraction well may be unrepresentative of ambient water quality for several reasons (see Section 4.0 for cleanup time forecasts). The masses of nitrate, sulfate, and uranium extracted during the current review period, based on the weekly inflow volume and feed composition are respectively, 148,800 lbs, 367, 400 lbs, and 87 lbs (Table 2–1).

Table 2–1. Treatment System Performance Summary

Contaminant	Typical Feed Concentration (mg/L)	Typical Distillate Concentration (mg/L)	Mass Removed During Review Period (lb)
Nitrate	400	6-14	148,800
Sulfate	1000	14-45	367,400
Uranium	0.24	0.001-0.01	87

2.2 Distillate Quality

Concentrations of nitrate, sulfate, and uranium in the distillate averaged about 9, 30, and 0.008 mg/L, respectively, during the review period (Table 2–1 and Figure 5). Total dissolved solids (TDS) ranged between about 20 and 100 mg/L, and chloride concentrations were generally less than 2 mg/L with little variation. These results indicate highly effective contaminant removal and very high quality of water returned to the aquifer.

2.3 Treatment System Water Balance

About 93 percent of the total feed to the treatment system was returned to the aquifer at the infiltration trench. Wastewater production comprised about 4 percent of the total inflow as brine

and about 3 percent as loss for softener regeneration. The remaining fraction (<0.5 percent) accounts for direct routing of feed or distillate to the evaporation pond.

2.4 Extraction Wells

In Figure 2, the extraction wells labeled 1101 to 1125 are constructed of 6-inch diameter Schedule 40 PVC solid casing and 6-inch, continuous V-wrap stainless steel (0.017-inch slot). A filter pack of 20-40 mesh graded silica sand completes the 2-in annulus to 30 or 40 feet above the screen slots. Screen lengths are 150-ft, extending from the bottom half of Horizon B to the mid-depth of Horizon E, except for wells 1116, 1117, and 1118, having 100-ft screens to near the base of Horizon D. Extraction wells 1126 to 1133, installed in September 2004, are of similar specification but consist of 4-inch diameter casing and screen. In addition, they are much shallower such that their 30-ft screen is located across most of Horizon B. These wells became operational in August 2005, as did wells 935, 942, 936, and 938, used formerly for monitoring purposes only. The extraction well pumps (1/4 and 1/3 horsepower submersible) are generally positioned 10 to 15 ft above the bottom of the well, but nearer the bottom of wells 935, 942, 936, and 938 because of their shallow depth. Many well pumps are variable speed that self-regulate to a maximum sustainable pumping rate. Others are programmed to shut down at a low water level and resume pumping after a prescribed recovery period. In July 2004, adjustments of these controls greatly reduced on/off cycling at most of these locations. The operational history of each extraction well for the evaluation period is included in Appendix A, Table A–2.

At each of the original 25 extraction wells (wells 1101 – 1125), except locations 1123 and 1125, pumping is nearly continuous. Active pumping varied between 40 and 50 percent and less than 50 percent to nearly 100 percent during the period at wells 1123 and 1125, respectively. Continuous pumping cannot be sustained at wells 1126 to 1133 because of low aquifer yield. The on-stream time for these wells is about five percent or less. Only one of the four former monitoring wells converted for extraction use (well 942) produces water. The water table has dropped below the screen intakes at the remaining locations (wells 935, 936, and 938).

The instantaneous, total production rate of the well field generally matches that of the treatment plant feed rate shown in Figures 3 and 4. Flow rates at wells 1101 – 1125 vary from 1 to 6 gpm, for a combined average of about 3.7 gpm while the plant is operating. The contribution from wells 1101 to 1125 is about 98 percent of total production. Wells 1126 to 1133 contribute one percent of the total and well 942 contributes the remaining one percent.

3.0 Ground Water Capture Analysis

3.1 Extent of Ground Water Contamination

Figures 6a through 14a illustrate the concentrations of nitrate, sulfate, and uranium in ground water before the start of remediation. Most of the information is from sample collection in March 2002 but extends back to 1999 for some locations. These figures define contaminant distribution during the baseline period in the various aquifer horizons shown. Figures 6b through 14b show contaminant distribution in August 2005.

Although each well location sampled for the respective period is shown, a concentration value is posted only where the applicable remediation goal or standard was exceeded. In map view, the distribution of contamination in the various horizons do not appear significantly different from the baseline condition, indicating no lateral spreading of the contaminant plume (see also Section 4.1). Before installation of wells 272 through 276 in August and September 2004, discrete depth monitoring of Horizons C and D in the main area of the plume was not possible. Sample collection in August 2005 indicates contamination at the respective depths of well 273 and well 275 (Figures 7b, 10b, and 13b), but no contamination in the screened intervals at the remaining locations (wells 272, 274, and 276). The absence of contamination in Horizon E (see Figures 8b, 11b, and 14b) or below suggests no downward plume movement to these depths. On the lower terrace, nitrate and sulfate contamination remains minor and localized in extent (Figures 7b and 10b). Uranium contamination remained less than the remediation standard at all lower terrace for the second consecutive year.

Appendix B includes simplified maps showing computer-generated contours of the contaminant distributions for February 2006 (Figures B-1, B-2, and B-3). User intervention was required to generate meaningful contours, including the use of selected extraction wells. Only the wells used in the interpolations are shown with posted concentrations in Figures B-1, B-2, and B-3. The "natural neighbor" method was applied as the data interpolation model. This method is an exact interpolator and does not generate data in areas beyond the data range. For example, contours do not extend beneath the cell, where no data is available. Tabulated analytical results for August 2005, February 2006, and the baseline period for each contaminant requiring remediation are included in Appendix C.

3.2 Water Table Configuration

Figure 15 shows the estimated water table for the baseline period using water levels in Horizon A and B monitor wells for the middle terrace and Horizon C wells for the lower terrace. On the middle terrace, water levels from deeper wells are not representative of water table conditions because of pronounced vertical hydraulic gradients (see Section 3.1.4) and so are not used in constructing the water table map. On the lower terrace, the water table occurs within Horizon C among the monitoring wells located within the area of interest. The horizontal direction of ground water flow was predominantly south during the baseline period. A steeper hydraulic gradient corresponds to aquifer thinning at the escarpment (Figure 15).

Figure 16 shows a similarly constructed water table for August 2005. Comparison of Figures 15 and 16 indicates that operation of the extraction wells has significantly depressed the water table and consequently changed flow directions in the shallow ground water throughout much of the area of extraction. The water table underlying the escarpment and lower terrace appears unaffected by ground water extraction. Ground water flow directions are analyzed in detail in Sections 3.4 and 3.5. Also evident in Figure 16, and since the start of active remediation, is the elongate ground water mound and increased hydraulic gradients along the north edge of the disposal cell because of infiltrating distillate at the trench.

3.2.1 Infiltration Trench

The infiltration trench is constructed into bedrock along the north side of the site (see Figure 2 for trench location). Distillate enters the trench at its mid-point from where it can flow in either direction in perforated pipe embedded in a 3 ft thick gravel pack. Through mid-2003, non-

uniform infiltration caused greater than 20 ft of ground water mounding beneath the southwest section of the trench but only about 1 ft of mounding beneath the northeast section. The ground water mound progressively became more symmetrical after November 2003 when flow valves were installed and all inflowing water was diverted to the northeast segment of the trench. More recent trending through the previous review period suggested the need redirect some flow back to the southwest section of the trench, which was accomplished in April 2005. In response to that adjustment, water levels in the southwest section of the trench rose by 10 or more feet, such that the water level at well 946 in February 2006 was a historical maximum for that location (water level hydrographs for wells completed in the aquifer in the area of the trench are presented as Figure D-1 in Appendix D). Monitor wells 284 and 285 (see Figure 2 for location), screened across the contact of the terrace alluvium and bedrock immediately downgradient of the trench, remain dry indicating that mounding has not over-topped the trench to saturate the alluvium.

3.3 Water Level Drawdown

Figure 17 further illustrates the effect of ground water extraction and infiltration by showing the difference in water levels, or drawdown, in Horizons A and B between the baseline period and August 2005. Figures 18 and 19 plot the drawdowns for the deeper horizons for the same period. Positive values identify locations where the water level in August 2005 is less than the baseline value. Negative values, such as those at the wells surrounding the infiltration trench (Figure 17), indicate that water levels at the respective locations are presently higher than during the baseline period. Well hydrographs in Appendix D provide an additional view of water level drawdowns over time at selected monitoring wells.

The overall pattern of water level drawdown illustrated in Figures 17 – 19 reflects three-dimensional converging flow to the extraction wells. Because the water level in each extraction well is generally maintained near the base of the well (Horizon D or E), the greatest drawdown (up to 55 ft) is observed at the Horizon E wells (wells 251 and 268) located within the extraction field. Among all monitor wells, the intakes of wells 251 and 268 are nearest in radial distance to the interval of ground water extraction. Consistent with convergent flow, drawdown at the remaining monitor wells is observed to decrease with distance from the extraction zone. Although water level drawdown in response to ground water extraction affects the entire contaminated region of the aquifer, it does not imply capture of all contaminated ground water. The predominantly downward trend in ground water levels indicated in the water hydrographs suggests an expanding capture zone.

3.4 Horizontal Capture

Figure 20 depicts the estimated zone of ground water capture in lateral extent. All ground water within the dashed line presumably will flow to an extraction well. The estimate is based on the assumption of an accurate water table representation shown in Figure 16. Using a commercially available computerized grid-based contouring application (SURFER), an electronic version of the water table was analyzed to generate a vector map to reflect the direction and magnitude of the slope of that surface. The dashed line in Figure 20 is the flow divide that separates vectors that converge on the extraction wells from those that do not. Several conditions were imposed to obtain this result. First, the water table at each extraction well was assigned a uniform water table elevation of 4990 ft. This value is consistent with the water table elevation in the several

monitoring wells located within the extraction field. Additionally, to mimic the regional water table gradient, prescribed water table elevations were assigned at several locations in a line upgradient of the site near well 901 and along Moenkopi Wash east and west of well 902.

The results indicate that the estimated capture zone does not fully encompass the lateral extent of contamination. In particular, ground water in the area of extraction wells 1126 – 1128 appears to escape capture. The full width of the contaminant plume along the south edge of the disposal cell appears to be captured. Both the estimated extent of lateral capture and the observed water table drawdowns are very consistent with those predicted by the ground water model that was developed as a design tool for the remediation system (DOE 1998).

3.5 Vertical Capture

Hydrographs included in Appendix D for selected sets of co-located monitor wells illustrate that at a given location, the piezometric head is a function of well-intake depth. This relationship clearly identifies vertical flow components throughout the entire monitored thickness of the aquifer, both before and since the start of ground water remediation. With few exceptions, the vertical potentials were downward during the baseline period. Since that time, the magnitude of downward flow in the horizons above the extraction interval has increased, as seen as the greater water level differences in the hydrographs for the respective locations of well pairs 265/266, 263/264, 908/912, and 909/932, since about mid-2002 (see Appendix D, Figures D-4 through D-7). In the main region of contamination, these increased gradients imply capture of ground water from the upper horizons by the extraction wells.

In the deeper horizons, vertical gradients are now generally upward to the extraction intakes. For example, the vertical flow potentials reversed to upward between Horizons M, I, and E at co-located wells 268/256/257 in response to ground water extraction (Figure D-8; wells 256 and 257 were decommissioned August 2005). A similar result between Horizons E and I, and possibly M, is apparent at the location of wells 251/252/253 (see Figure D-9, the monitoring record is incomplete for well 253, a former Horizon M well that was abandoned in 2001). A downward flow potential remains between Horizon I and M at wells 254/255 (Figure D-10; well 255 decommissioned August 2005); however, there is an upward gradient at that location between Horizon I (well 254; decommissioned August 2005) and Horizon D (well 277). The apparent vertical flow divide at this location implies ground water capture possibly to Horizon I but not Horizon M.

Because the observed vertical influence of the extraction wells extends much deeper than the presumed depth of contamination, it is likely that the remediation system captures the full vertical extent of the contaminant plume. Although ground water extraction has no affect on downward flow between Horizons D and G at wells 915 and 916 (Figure D-11), this region of the aquifer is not contaminated. Downward flow potentials in lower terrace ground water also remain unaffected by ground water extraction (Figure D-12) but contamination there is only minor and limited to the shallowest horizon and there is no evidence of vertical or lateral spreading of contamination in the lower terrace ground water.

4.0 Remediation Progress

4.1 Contaminant Concentration Trends at Monitor Wells

Appendix E contains time-series graphs of nitrate, sulfate, and uranium concentrations in ground water at selected monitor wells located throughout the project area. Within Horizons A and B, wells 940, 941, and 942 are nearest the south side of the disposal cell and were likely to first detect return flow from the infiltration trench as a pronounced decrease in contaminant concentration. During the review period, the water table dropped below the screen interval of wells 940 and 941, and well 942 was converted to an extraction well. These wells are therefore no longer suited to detect breakthrough of clean water. During previous review periods, trending at these locations indicative of breakthrough was not apparent (see Figure E–1 through E–3). Assuming porous media flow under the observed water table gradient (Figure 16) and hydraulic conductivity of 1 ft/day, the calculated travel time from the infiltration trench to well 940 is 17 years, which is greater than the cumulative remediation period to date.

In the mid-section of the plume, near wells 262, 906, 908, 934, 935, and 936, concentrations generally remain relatively stable, with local exceptions of either increasing or decreasing trends. Toward the outer (south) margin of the plume (near wells 263, 265, 267, and 909), contaminant concentrations are relatively stable or decreasing. Horizon A and B sentinel wells, which are those located near but beyond the plume boundary (wells 271, 683, 684, 914, and 921), remain uncontaminated with the exception of minor nitrate contamination at well 929, which overall indicates no significant expansion of the contaminant plume (Figures E–4 through E–6).

Stable concentrations below remediation standards in Horizon C and D wells 264, 266, 915, and 932 (Figures E–7 through E–8) indicate no southward expansion of the plume at this depth in the aquifer. In these figures, elevated nitrate and sulfate concentrations at well 912 (Horizon C) are seen to decrease over time, which also indicates that contamination is not spreading in this direction.

In ground water beneath the lower terrace, uranium contamination did not exceed the restoration standard at any location during the past year. Previously, uranium contamination in lower terrace ground water was limited to low levels at co-located wells 691 and 1003. These are also the only wells with appreciable nitrate and sulfate contamination on the lower terrace. Stable concentration trends have not developed for these constituents at these wells. At three other nearby wells, stable nitrate values only marginally exceed the restoration standard. Migration of the localized and relatively low magnitude contamination on the lower terrace apparently is not significant, as indicated by persistent background levels at nearby wells located farther downgradient. Contaminant concentration plots for lower terrace monitor wells are included in Appendix E, Figures E–10 to E–12.

4.2 Contaminant Concentration Trends at Extraction Wells

Figures 21, 22, and 23 illustrate concentration trends at the extraction wells for nitrate, sulfate, and uranium, respectively. For each contaminant, the trend at most wells is of decreasing concentration as contaminant mass is removed from the aquifer. Appendix F contains concentration plots for each extraction well based on the monthly on-site sampling and analysis

(in Appendix F, concentration units are mg/L for nitrate as NO_3 and sulfate, and µg/L for uranium).

Figures 24, 25, and 26 are identical to the previous three figures but at a finer concentration scale to highlight occurrences of ground water extraction at concentrations less than the respective remediation standards. In a summary of that information, Table 4–1 identifies that at no location is the extract below the remediation standard for all three contaminants, although very nearly so at well 1125.

Table 4–1. Pumping Wells where a Contaminant Concentration is Below the Remediation Standard in the Extract

Nitrate [a]	Sulfate [b]	Uranium [a]
--	--	1107
--	1112	1112
--	1113	1113
--	1116	1116
--	--	1117
--	1123	1123
(1125, 44 mg/L)	1125	1125

[a] April 2006 data from on-site analysis.
[b] August 2005 data.

4.3 Contaminant Inventory and Removal Rates

Table 4–2 compares cumulative quantities of contamination removed from the aquifer as of April 1, 2006. Calculation methods to estimate the initial volume of contaminated ground water and initial contaminant mass listed in Table 4–2 are included in Appendix G as Calculation Set 1. The listed initial mass of solute in ground water above remediation standards assumes a geometric average of measured baseline concentrations at numerous monitoring wells, per respective contaminant, in the corresponding estimated volume of contaminated ground water.

By these estimates, at current mass recovery rates of about 2 to 4.5 percent per year (see Appendix G, Calculation Set 2), ground water restoration will require between about 21 and 59 years to complete since the inception of active remediation in mid-2002. The corresponding volume of ground water extracted at 21 years, assuming constant withdrawal of 85 gpm, is 940-million gallons or approximately equivalent to one estimated pore volume of the contaminant plume.

Table 4–2. Summary of Cumulative Mass and Volume Recovery as of April 1, 2006

Contaminant	Initial Mass (lb)[a]	Cumulative Mass Removed (lb)	Cumulative Percent Mass Reduction	Initial Volume (gal)[a]	Volume Treated (gal)	Percent Plume Volume Reduction
Nitrate	9,500,000	607,800	6.4	1.2E+09	179,900,000	15
Sulfate	20,150,000	1,490,000	7.4	1.2E+09	179,900,000	15
Uranium	2,300	412	17.9	1.2E+09	179,900,000	15

[a]Source: see Appendix G

4.3.1 Aquifer Restoration Index

Using a similar approach to that described in the preceding section, but independent of the estimated volume of contaminated ground water, the average concentration of a contaminant, when computed for each sampling event from a selected group of wells provides an additional measure of restoration progress when viewed over time. By this method, the composition of the ground water plume is represented as a single concentration value for a given contaminant at a given time. Figures 27 and 28 illustrate respectively how the geometric mean of the sulfate and uranium concentration for the individual sampling events varies since the baseline period. The selected monitor wells for this analysis are those located throughout the contaminant plume and sampled most regularly. Appendix G provides calculation information for this performance metric as Calculation Sets 3 and 4.

Despite the small increment of change and the relatively brief period of observation, the results presented in Figures 27 and 28 suggest a developing trend showing the effects of remediation in reducing the bulk concentration of the uranium and sulfate plume (nitrate results not analyzed). Linear projection of these data predicts a total restoration time of 20 to 30 years since the inception of active remediation in mid-2002. This compares to an estimated 25 years to remove one pore volume of the initial contaminant plume (Table 4–2) at the cumulative extraction rate of about 4 percent per year by volume, assuming 3.8 years of active treatment as of April 1, 2006.

5.0 Year in Review Summary

- On-stream extraction and treatment flow rates meet design objectives.
- Distillate quality meets or exceeds design objectives.
- Return flow to the aquifer as a percentage of extracted water meets design objectives.
- The current configuration and operation of the extraction system effectively captures the region of maximum ground water contamination.
- The current configuration and operation of the extraction system likely captures the full vertical extent of ground water contamination.
- Plume expansion is not significant on either the middle or lower terrace.
- Uranium concentrations have decreased to less than the restoration standard at all lower terrace monitoring locations.
- Developing bulk concentration trends indicate measurable progress in water quality restoration.
- Production from the new extraction wells installed in 2004 is much less than expected. Contamination in the area surrounding these wells is apparently within a zone of relatively low hydraulic conductivity that results in low well yields.
- Wells 254, 255, 256, and 257 were decommissioned in August 2005 because of compromised annular seal integrity.

6.0 Recommendations

- Reduce ground water monitoring (except that conducted for treatment plant operations) to one annual event.
- Eliminate sampling and analysis for gross alpha and gross beta activity (not specified in the GCAP as a contaminant of concern), strontium (identified in the GCAP as not requiring remediation), and isotopic uranium (continued analysis of uranium mass concentration is adequate at present).
- Continue ground water extraction, treatment, and infiltration as currently conducted.
- Install three or more monitoring wells to replace those that have gone dry.
- Determine that low production from extraction wells installed in summer 2004 is not a mechanical problem. Consider installing a deeper adjacent well if a mechanical problem is not apparent.
- Slightly decrease flow to the southwest part of the infiltration trench.
- Use the current ground water flow model and particle tracking analysis to estimate the restoration time as the system is currently operating and under assumed conditions of ground water capture from beneath the cell or greater capture in the area of wells 1126 to 1129.

7.0 References

Cooley, M.E., J.W. Harshbarger, J.P. Akers, and W.F. Hardt, 1969. *Regional Hydrogeology of the Navajo and Hopi Indian Reservations, Arizona, New Mexico and Utah*, U.S. Geological Survey Professional Paper 521-A.

U. S. Department of Energy (DOE), 1999. *Phase I Ground Water Compliance Action Plan for the Tuba City, Arizona, UMTRA Site,* GJO–99–99–TAR. U. S. Department of Energy Grand Junction Office, Grand Junction, Colorado, June.

———, 2003. *Tuba City UMTRA Site Baseline Performance Evaluation,* GJO–2002–370–TAC, GJO-GWTUB 30.13.2-1. U. S. Department of Energy Grand Junction Office, Grand Junction, Colorado, May.

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Figure 1. Tuba City Site Location

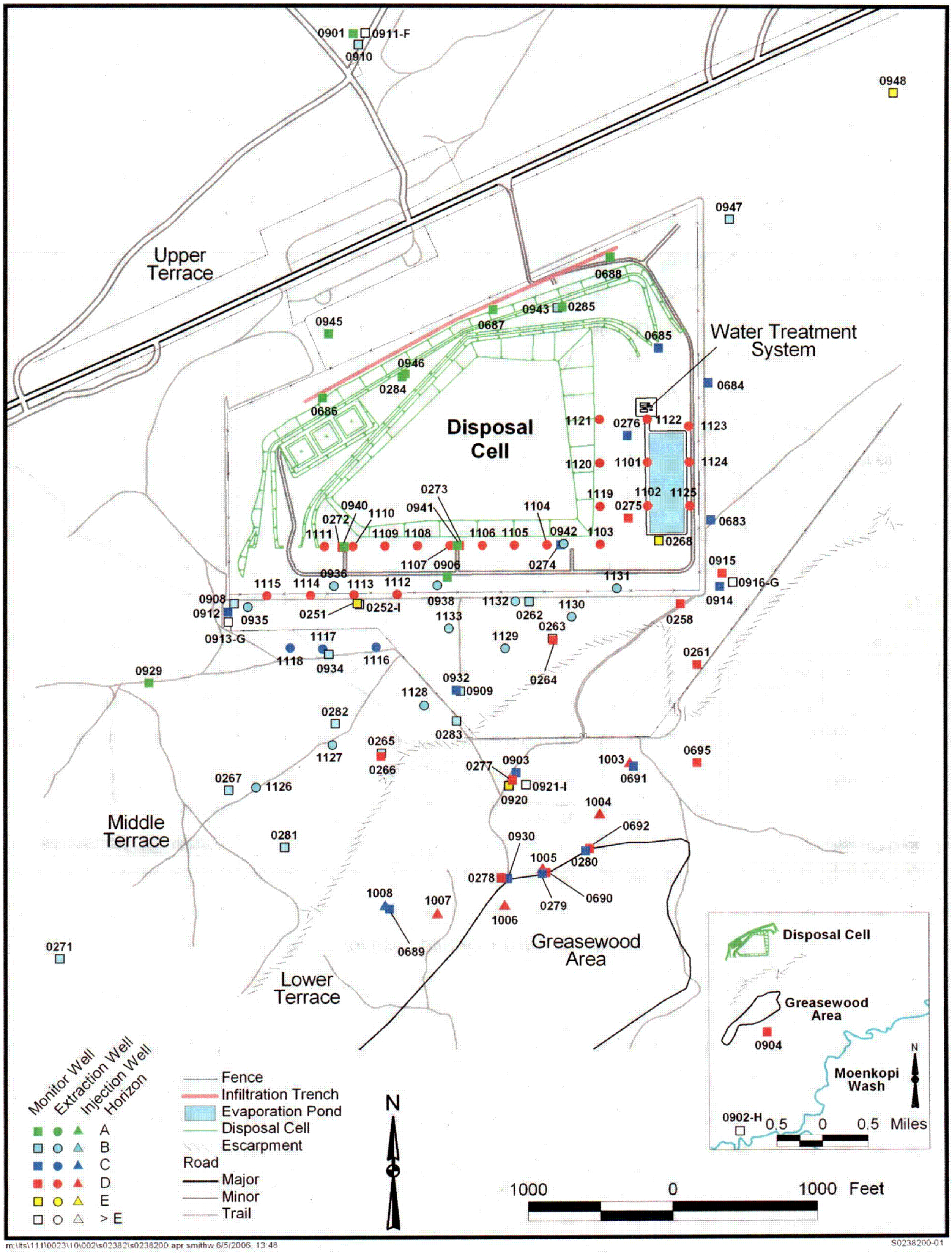

Figure 2. Tuba City Site Features and Well Locations

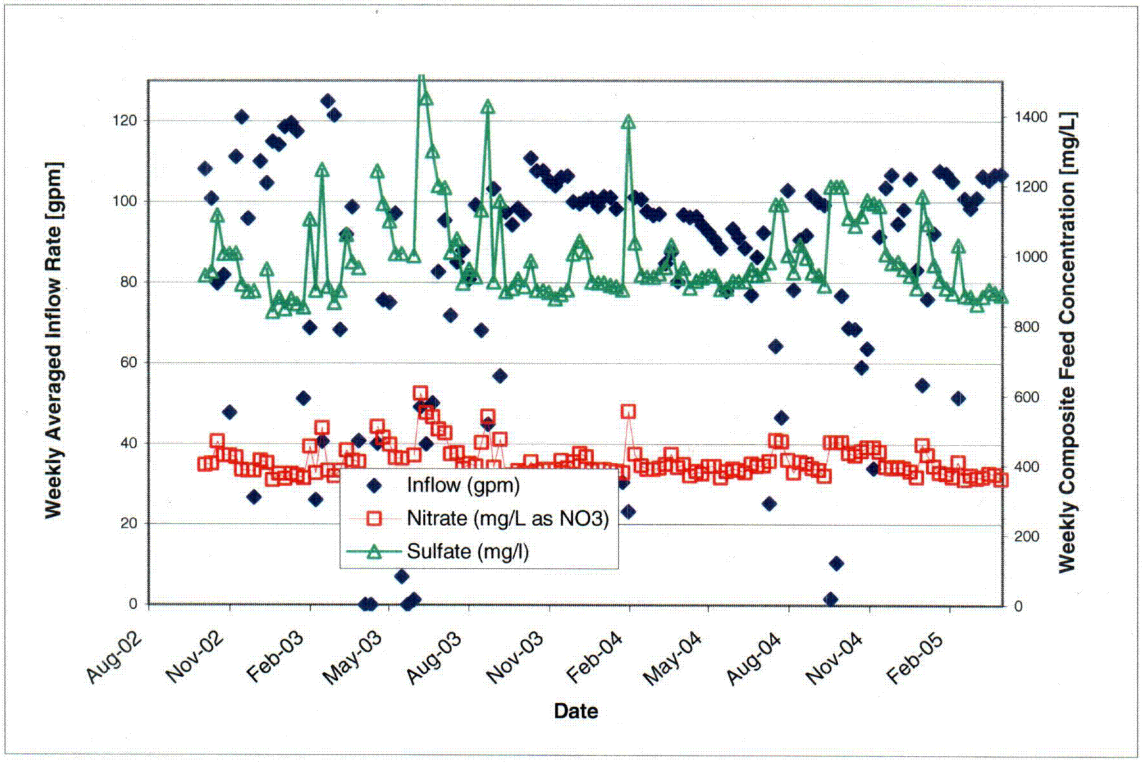

Figure 3. Treatment Plant Inflow Rate and Nitrate and Sulfate Concentration

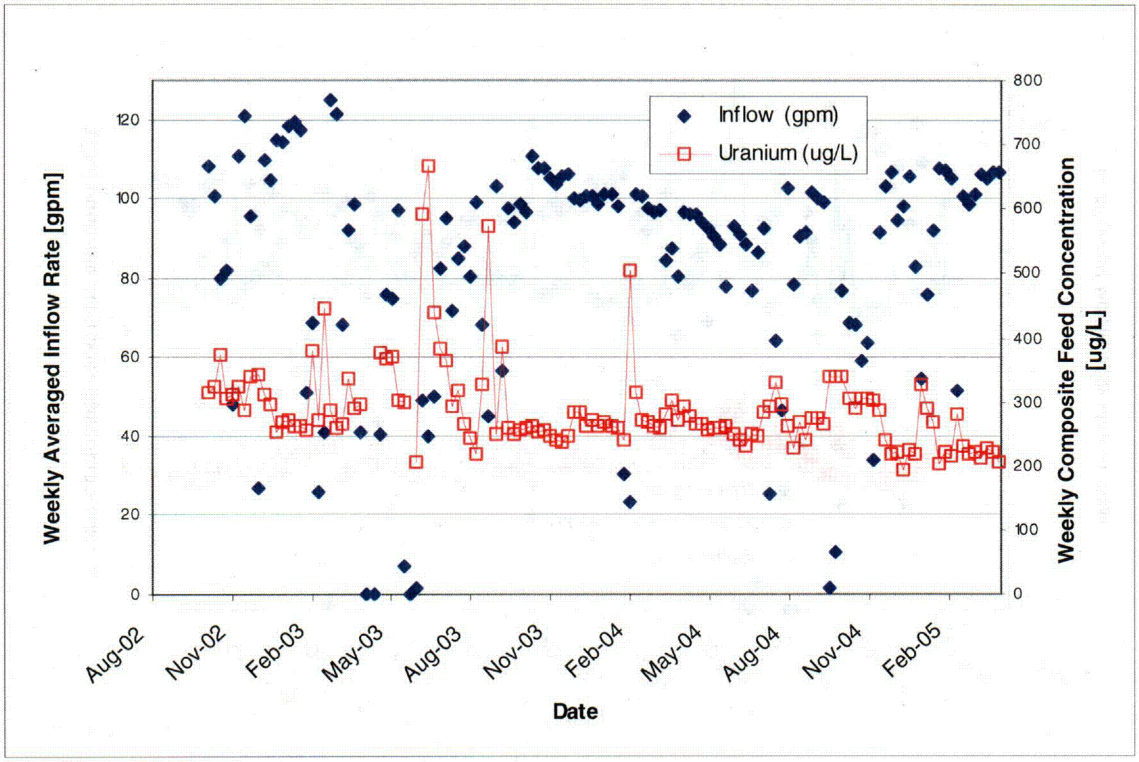

Figure 4. Treatment Plant Inflow Rate and Uranium Concentration

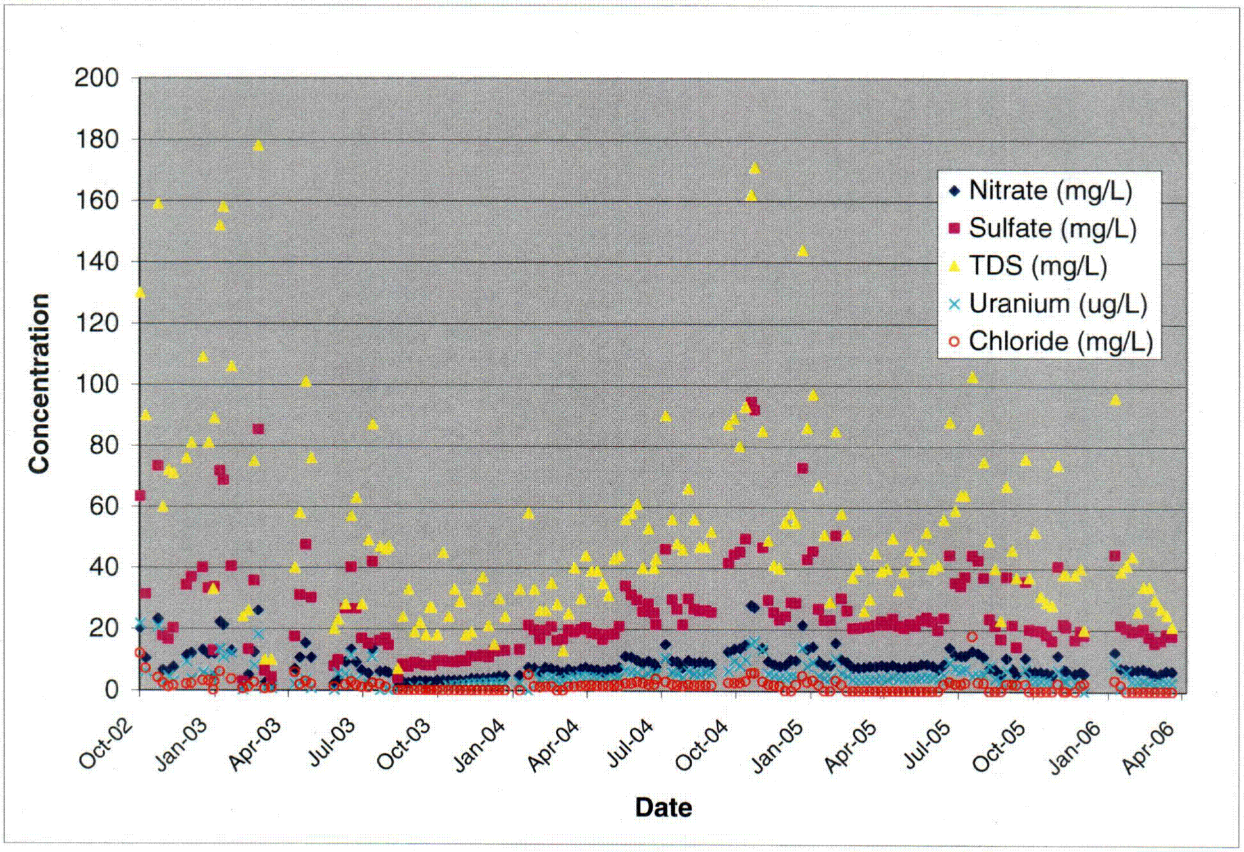

Figure 5. Treatment Plant Distillate Quality

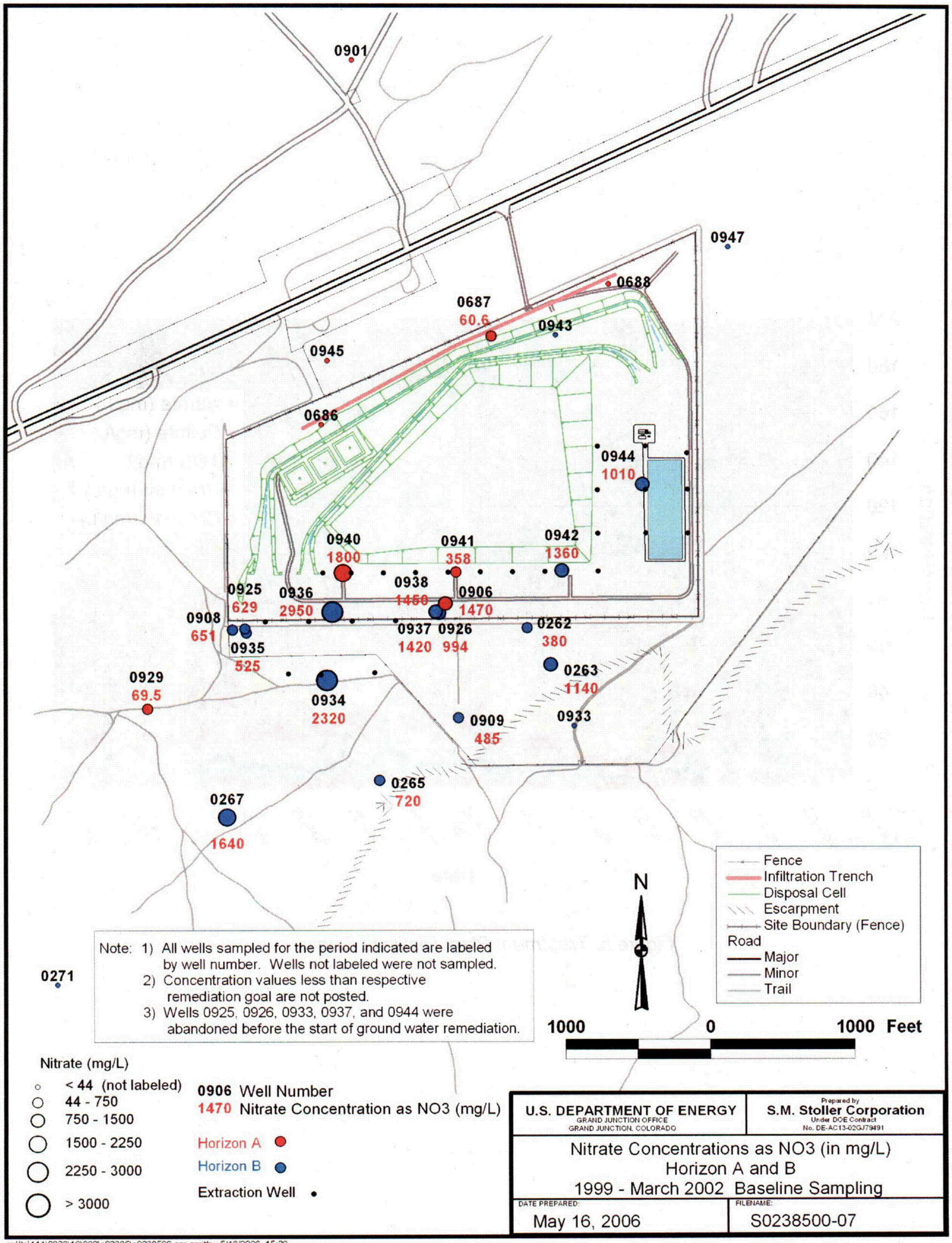

Figure 6a. Nitrate Concentrations in Ground Water, Horizons A and B, Baseline Period

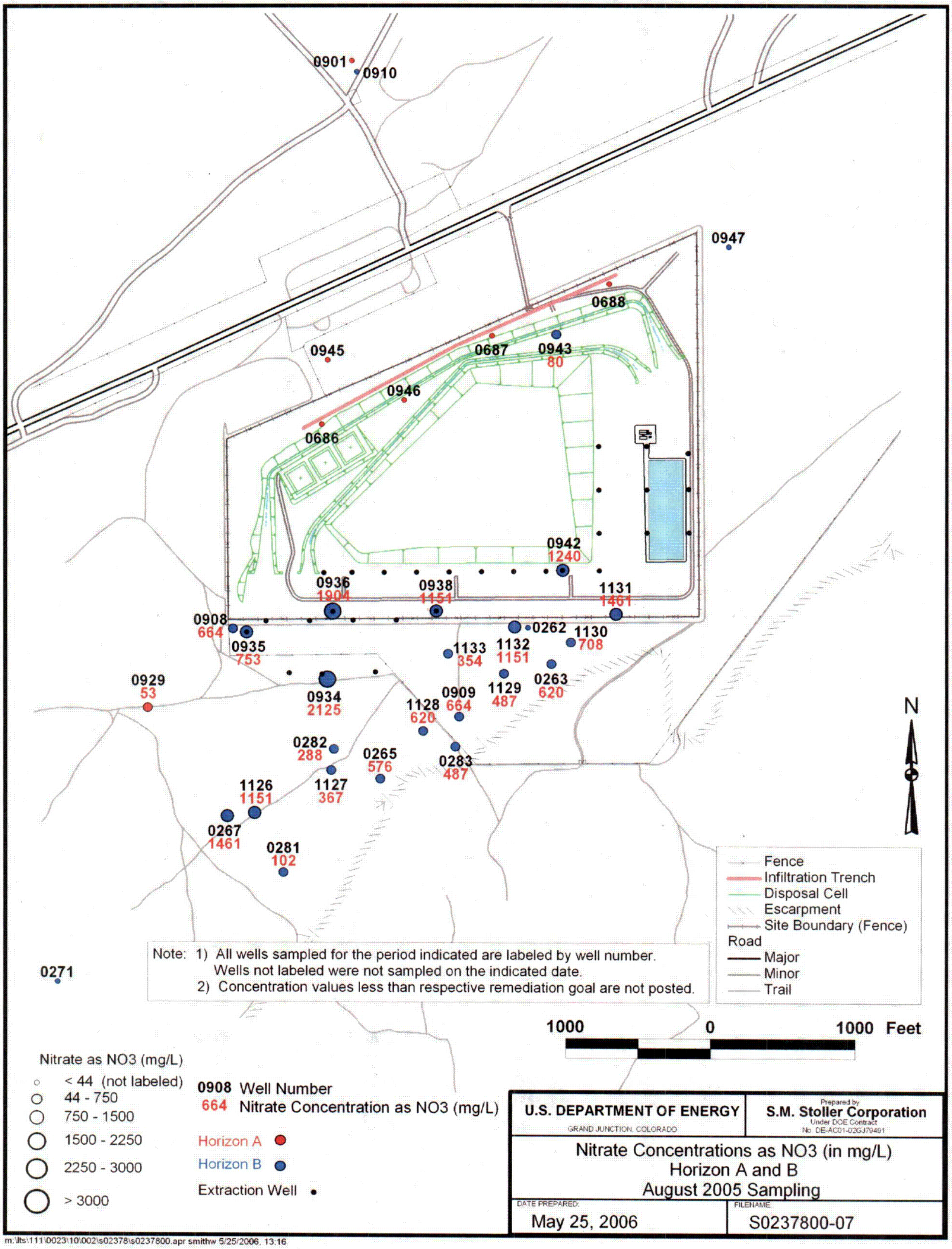

Figure 6b. Nitrate Concentrations in Ground Water, Horizons A and B, August 2005

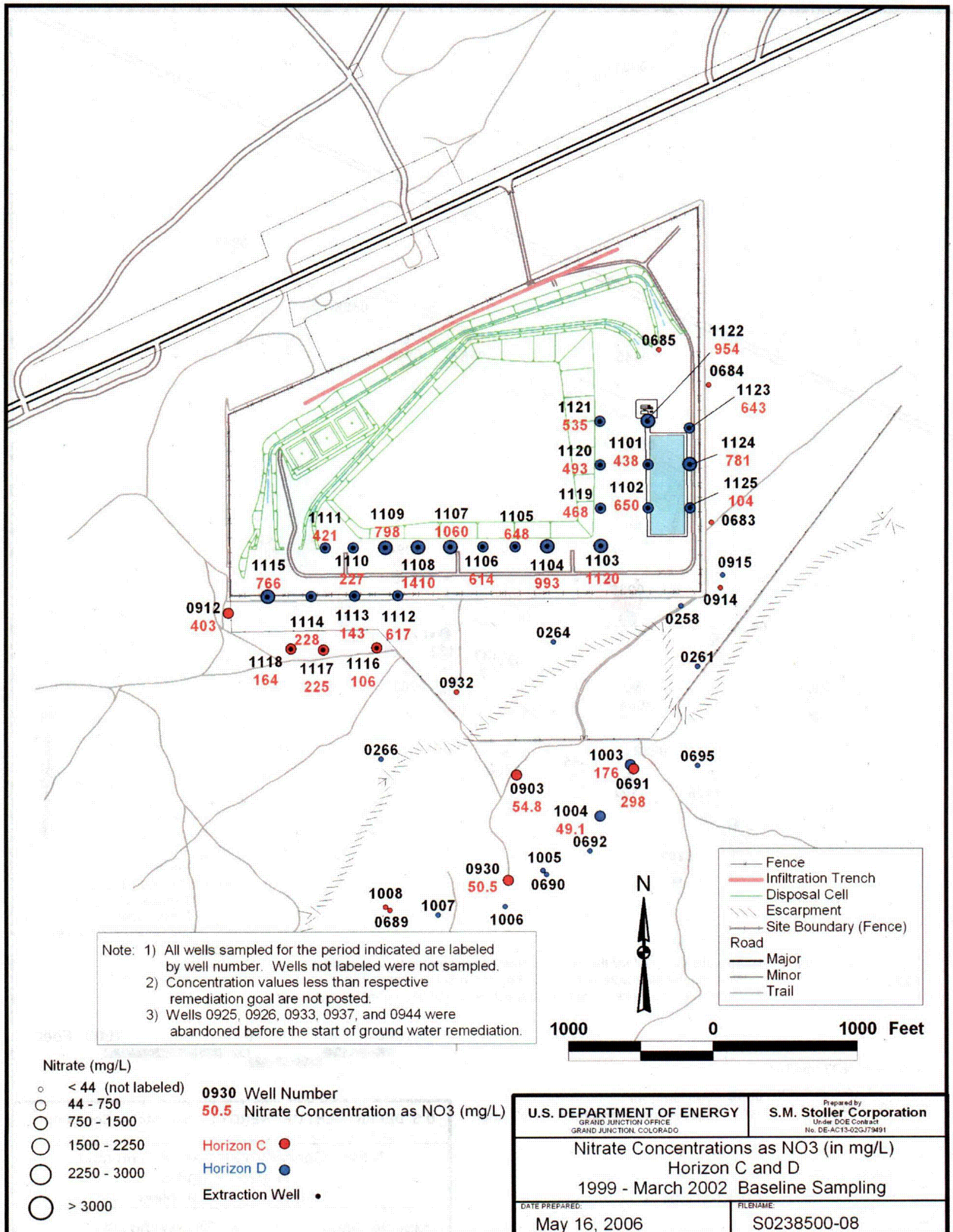

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Figure 7a. Nitrate Concentrations in Ground Water, Horizons C and D, Baseline Period

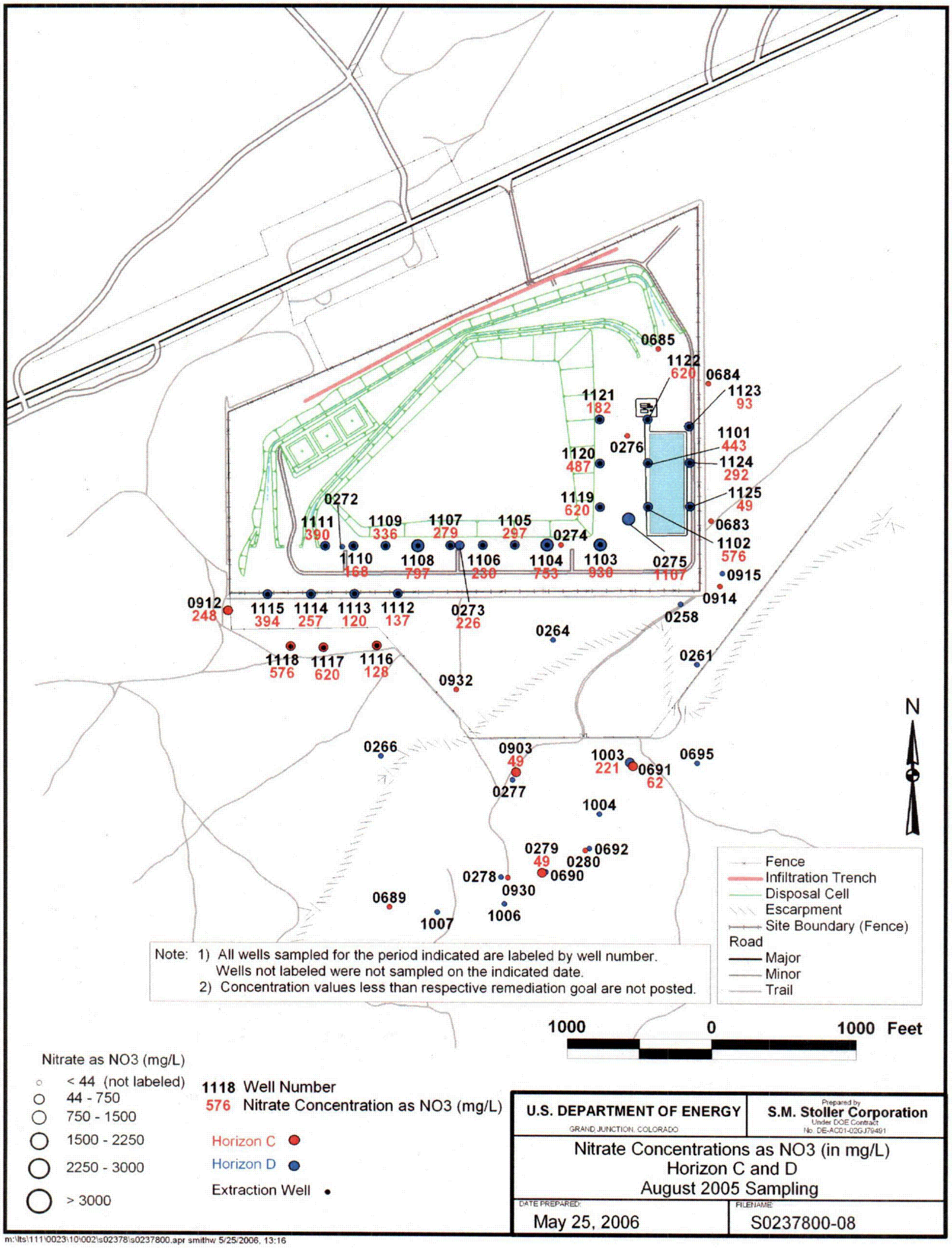

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Figure 7b. Nitrate Concentrations in Ground Water, Horizons C and D, August 2005

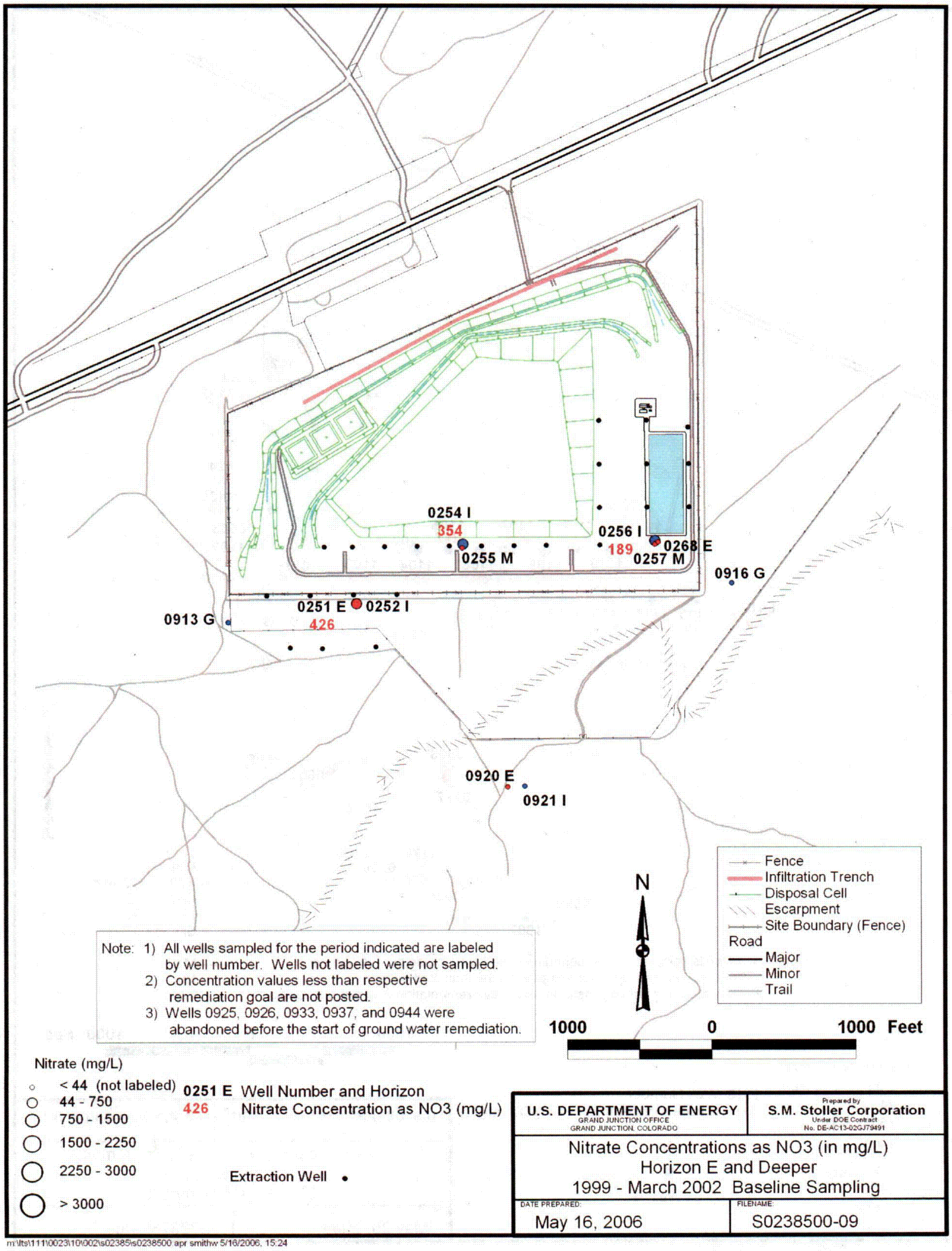

Figure 8a. Nitrate Concentrations in Ground Water, Horizons E and Deeper, Baseline Period

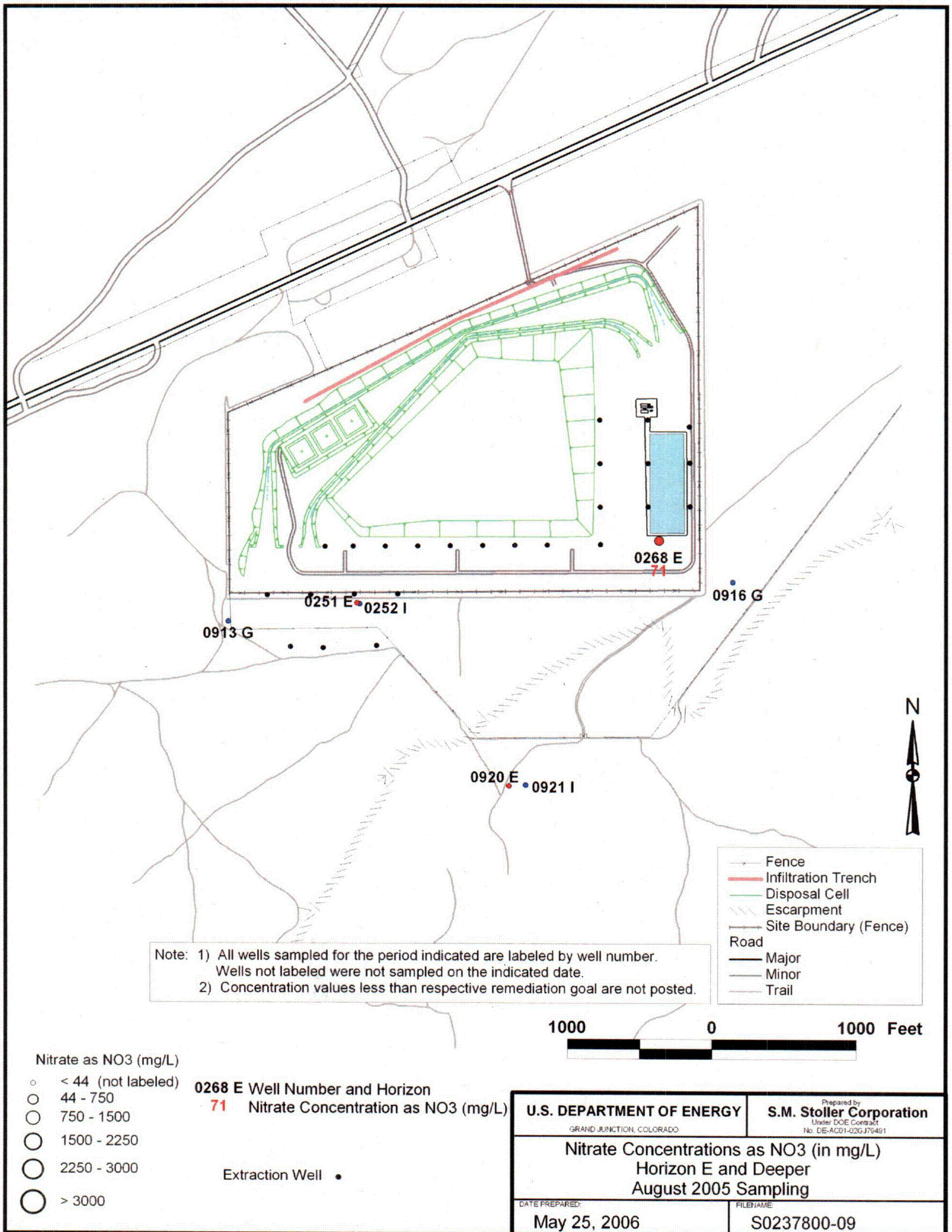

Figure 8b. Nitrate Concentrations in Ground Water, Horizons E and Deeper, August 2005

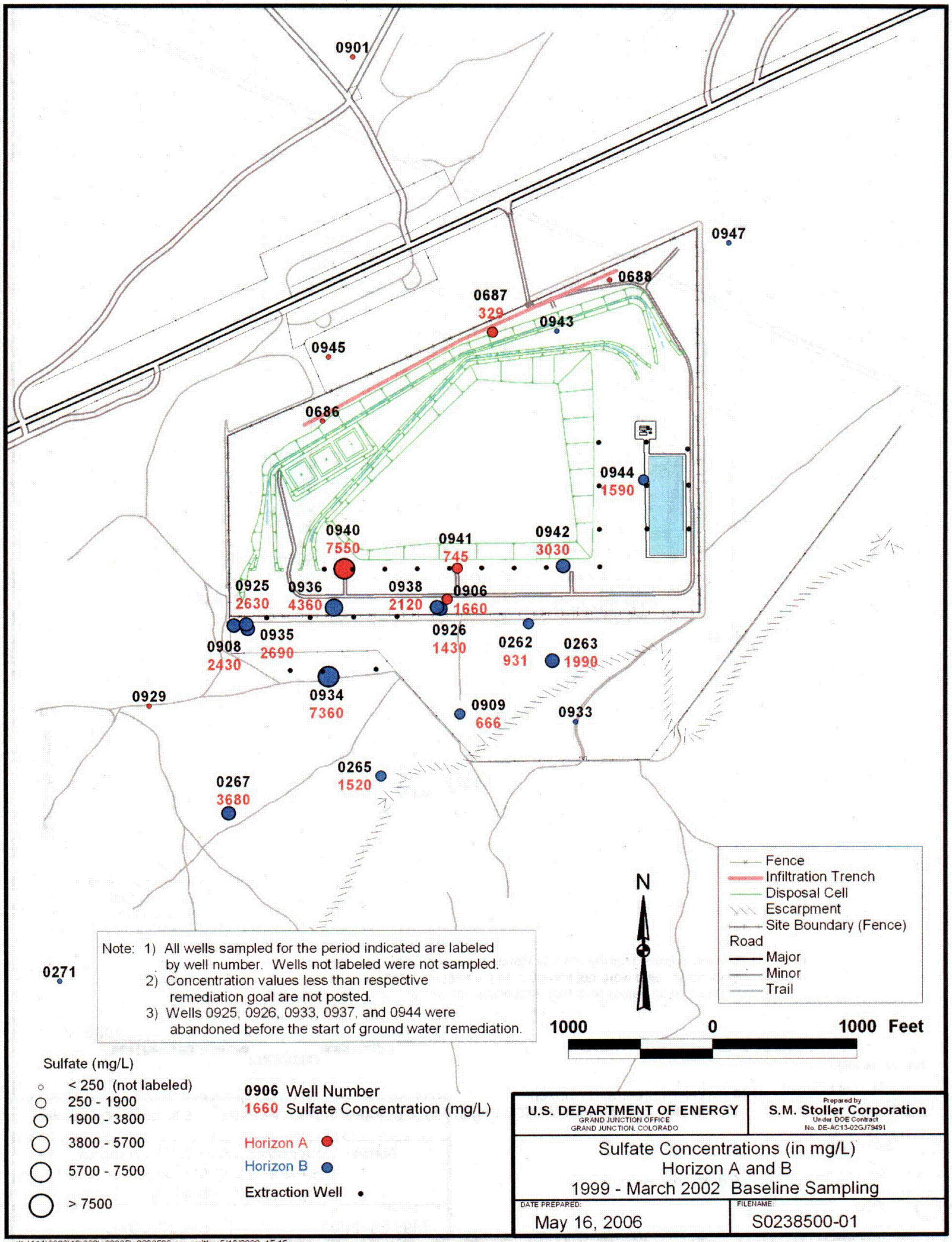

Figure 9a. Sulfate Concentrations in Ground Water, Horizons A and B, Baseline Period

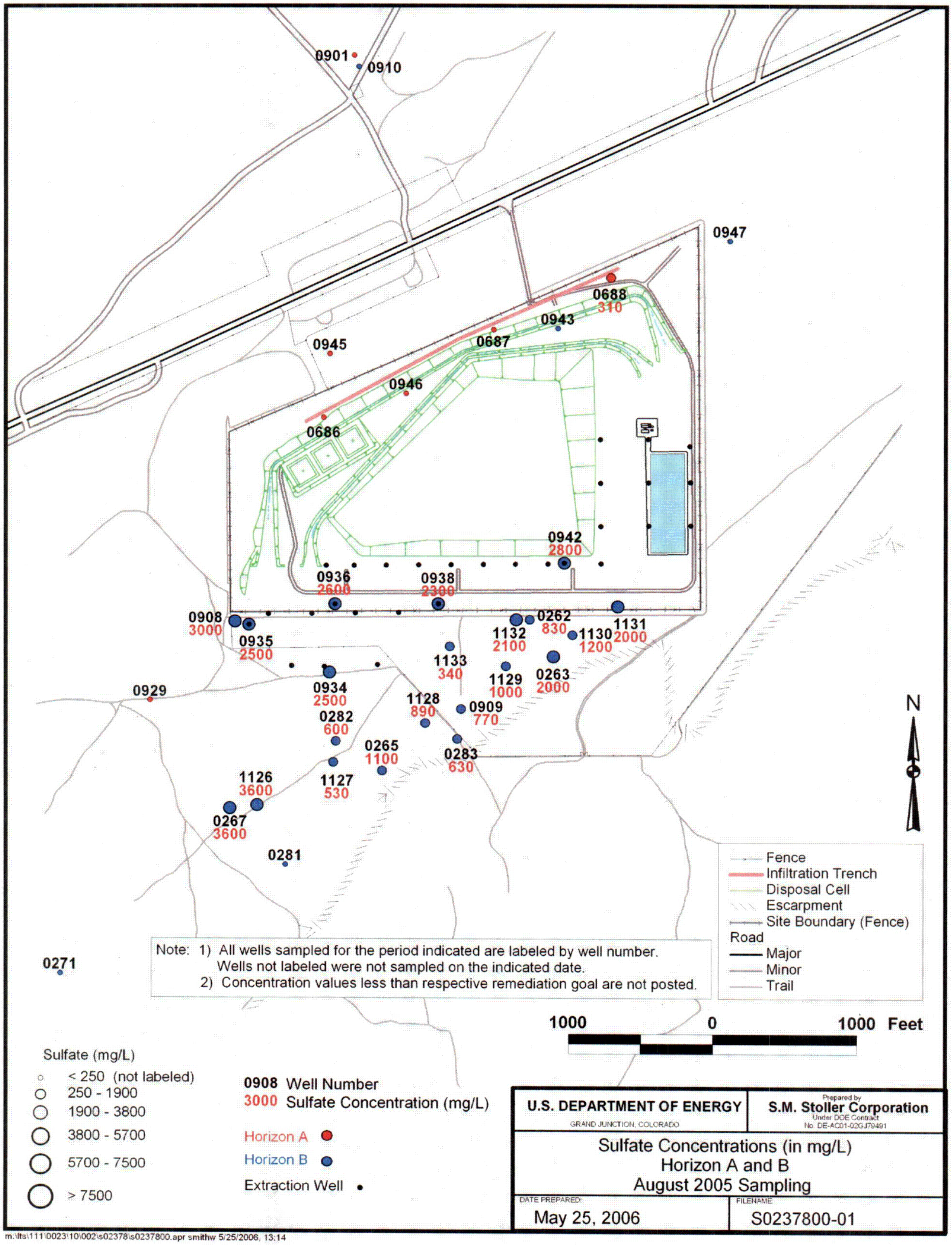

Figure 9b. Sulfate Concentrations in Ground Water, Horizons A and B, August 2005

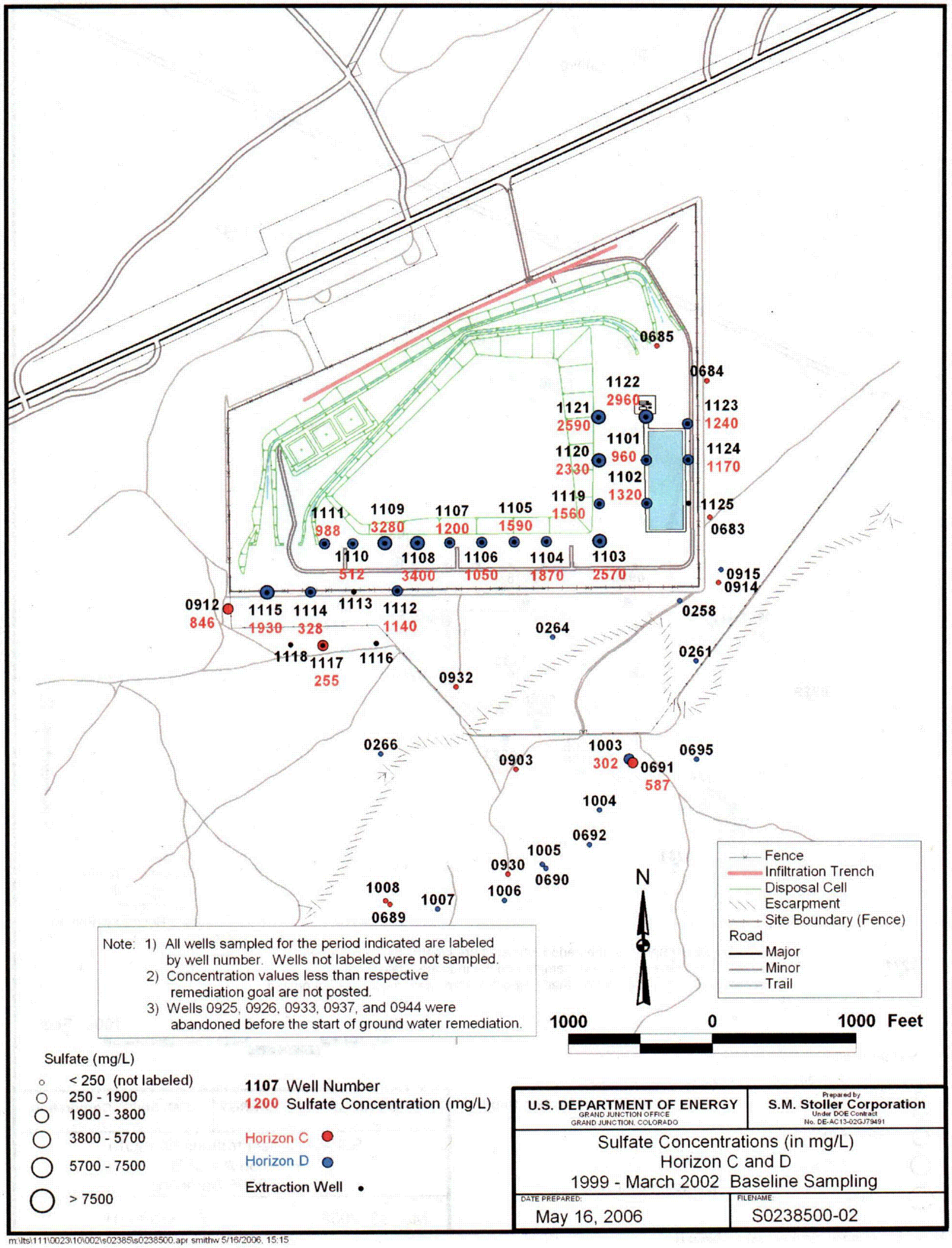

Figure 10a. Sulfate Concentrations in Ground Water, Horizons C and D, Baseline Period

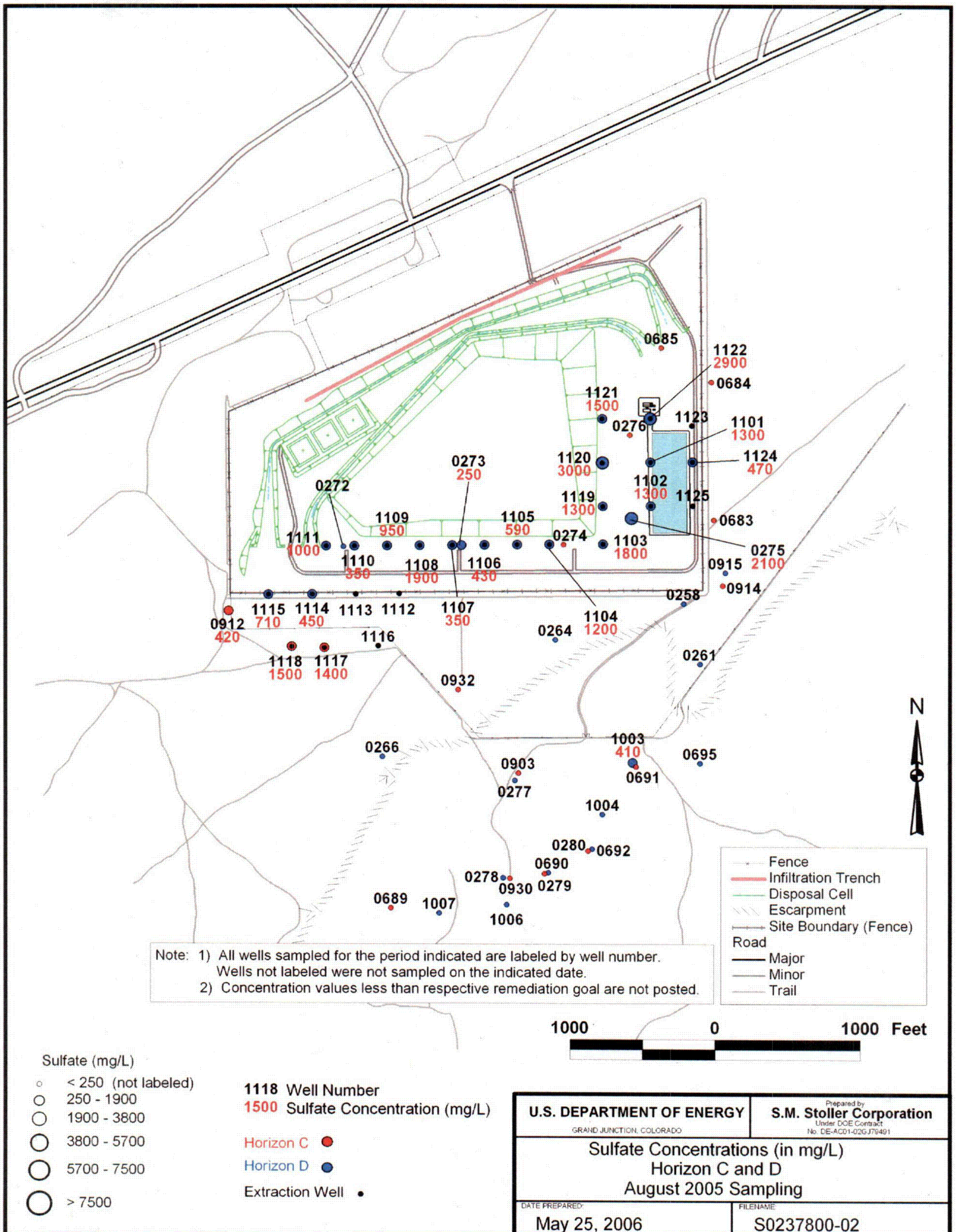

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Figure 10b. Sulfate Concentrations in Ground Water, Horizons C and D, August 2005

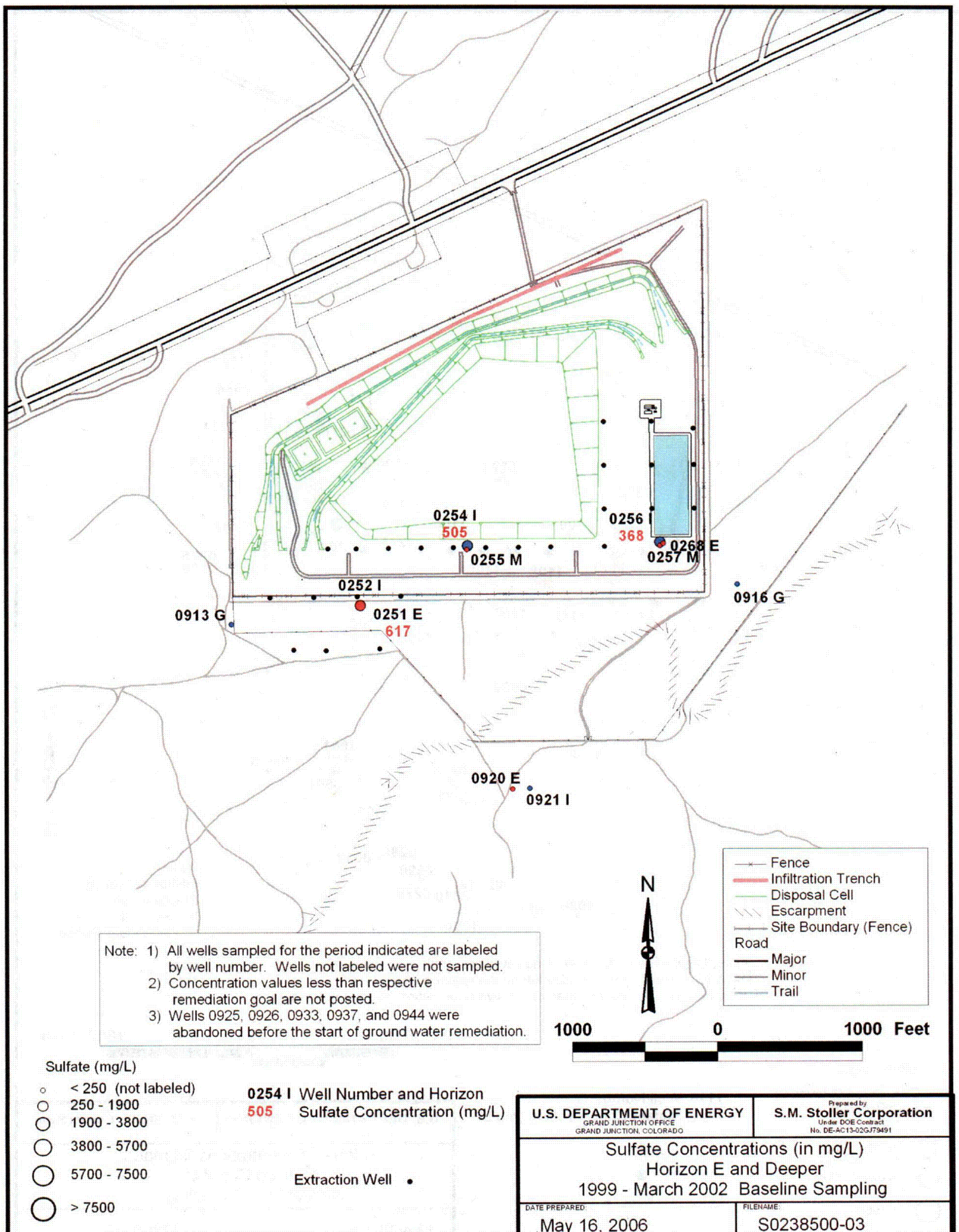

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Figure 11a. Sulfate Concentrations in Ground Water, Horizons E and Deeper, Baseline Period

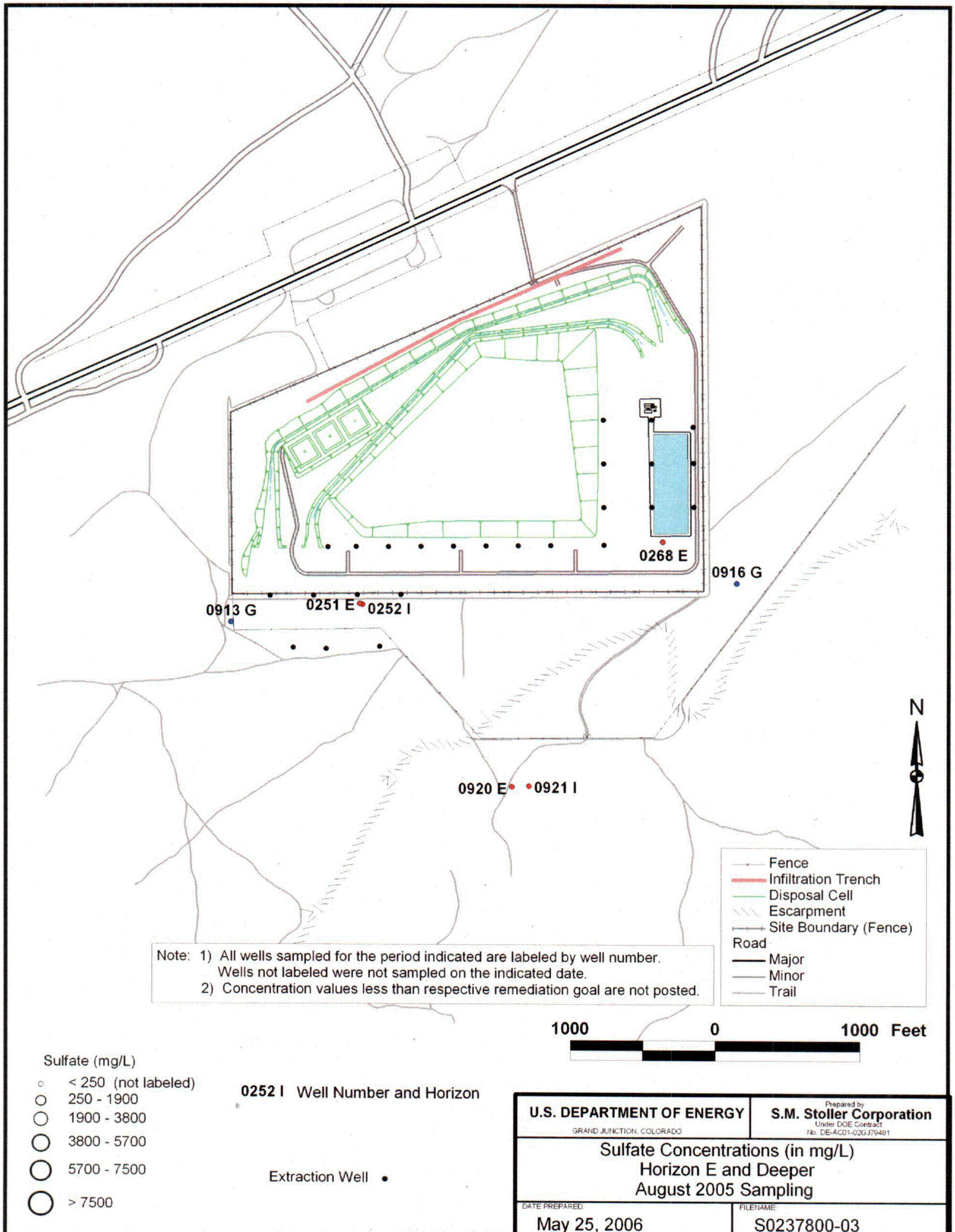

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Figure 11b. Sulfate Concentrations in Ground Water, Horizons E and Deeper, August 2005

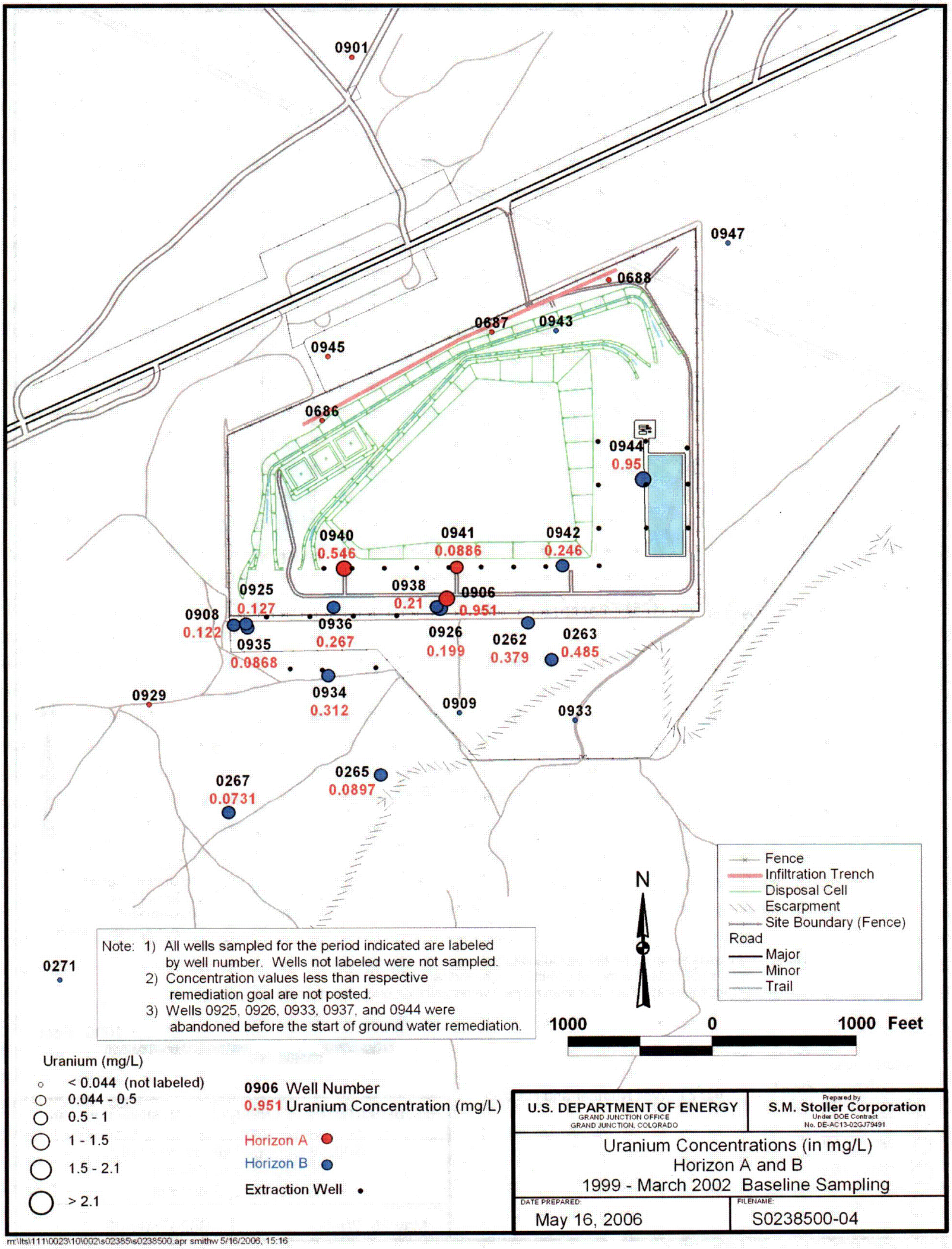

Figure 12a. Uranium Concentrations in Ground Water, Horizons A and B, Baseline Period

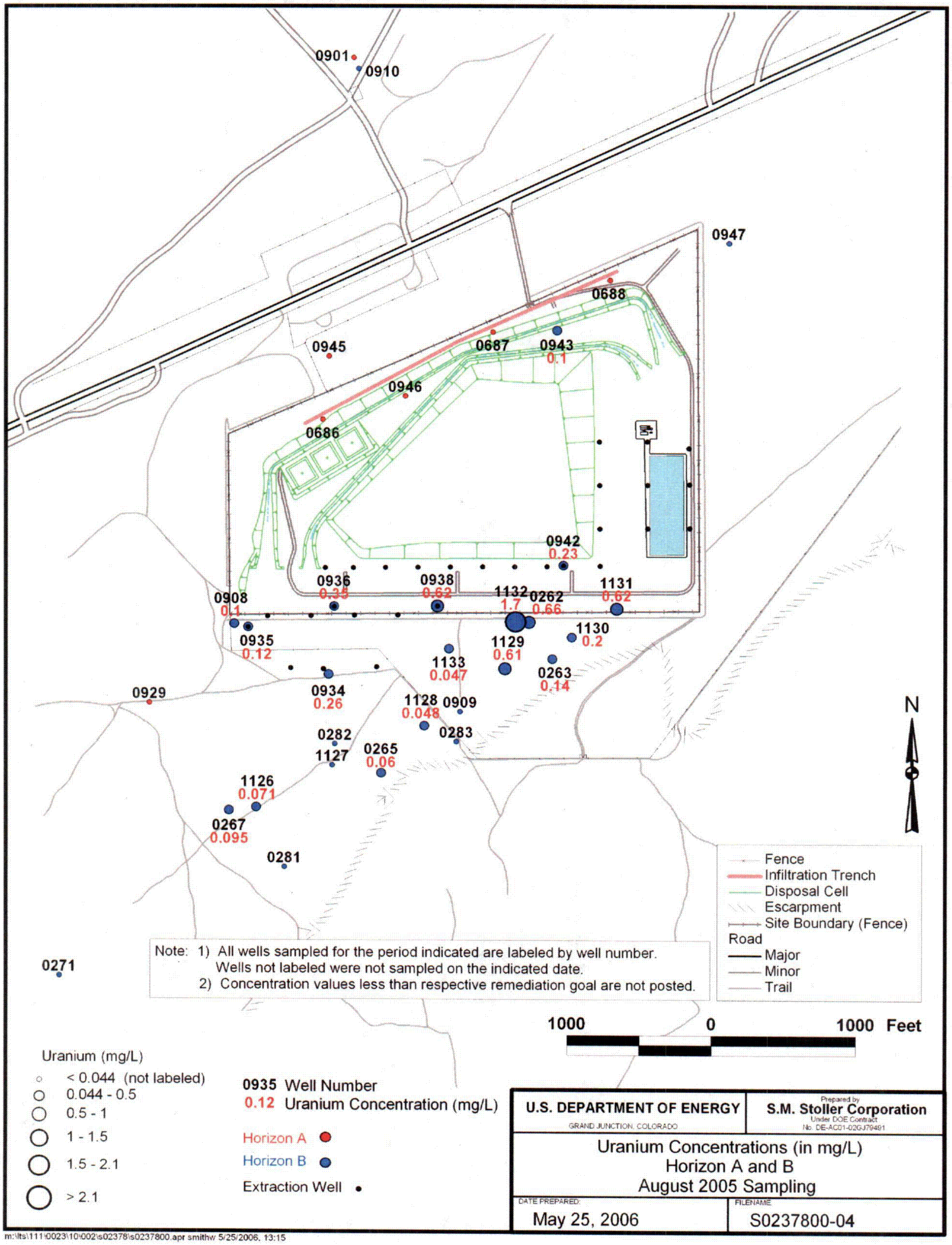

Figure 12b. Uranium Concentrations in Ground Water, Horizons A and B, August 2005

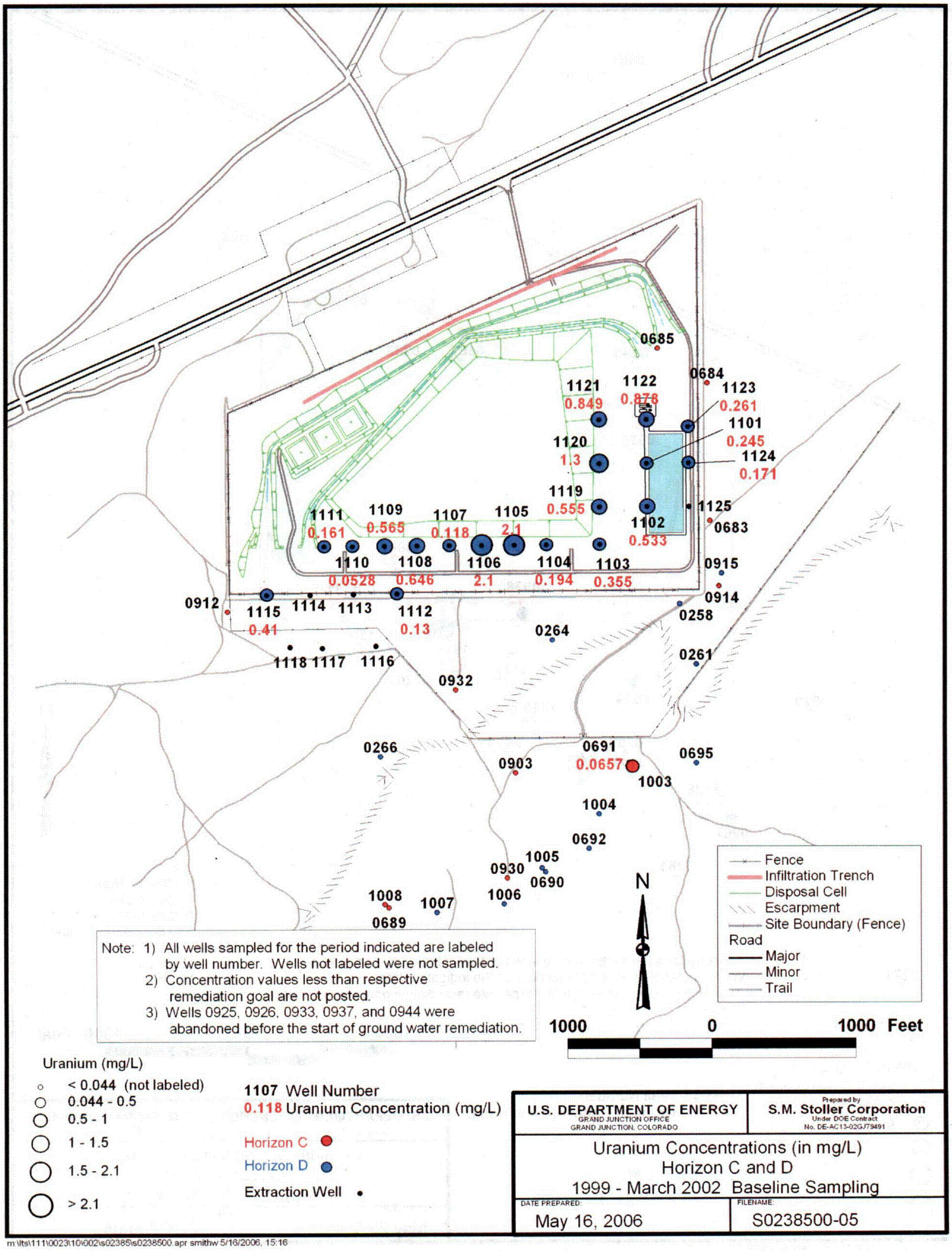

Figure 13a. Uranium Concentrations in Ground Water, Horizons C and D, Baseline

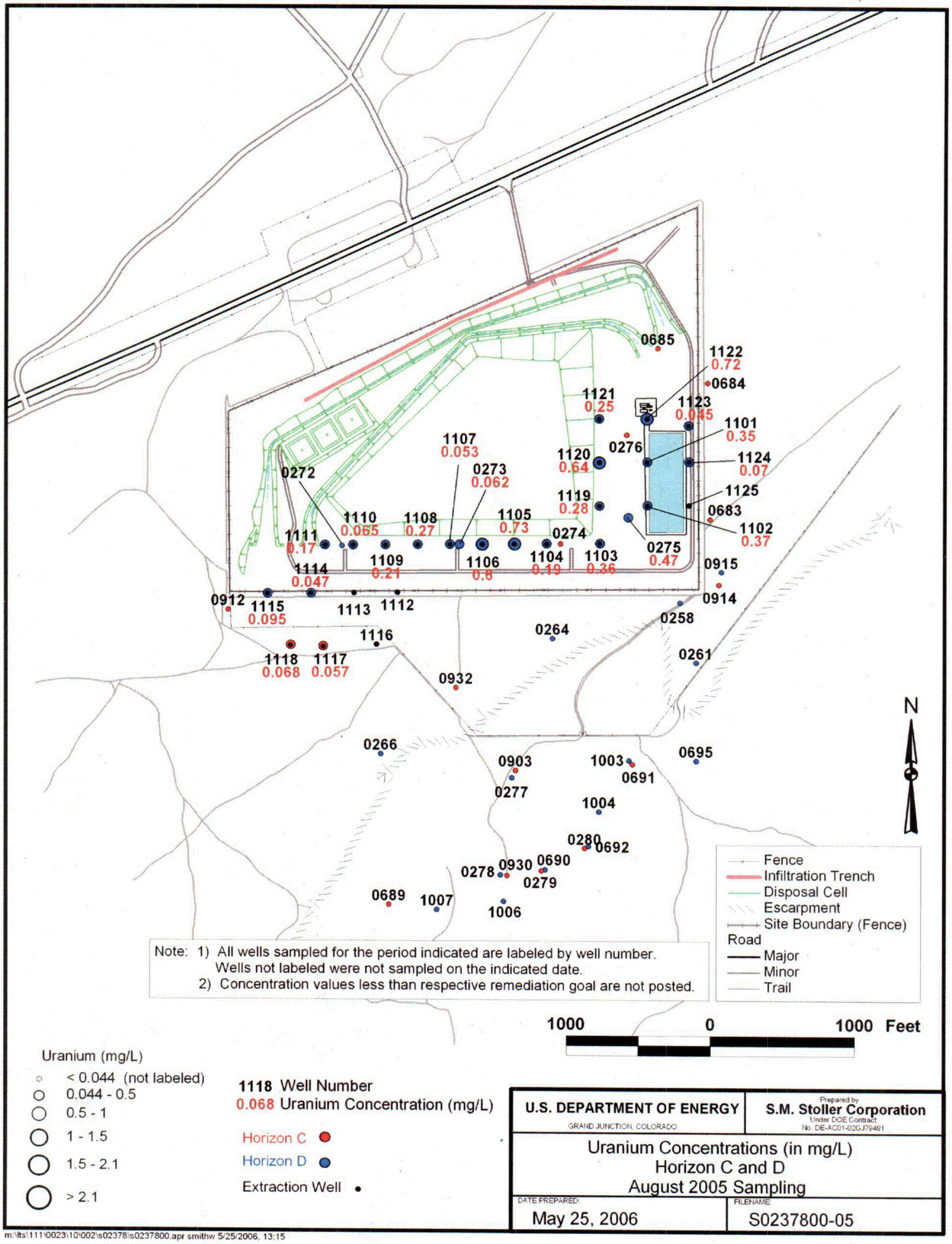

Figure 13b. Uranium Concentrations in Ground Water, Horizons C and D, August 2005

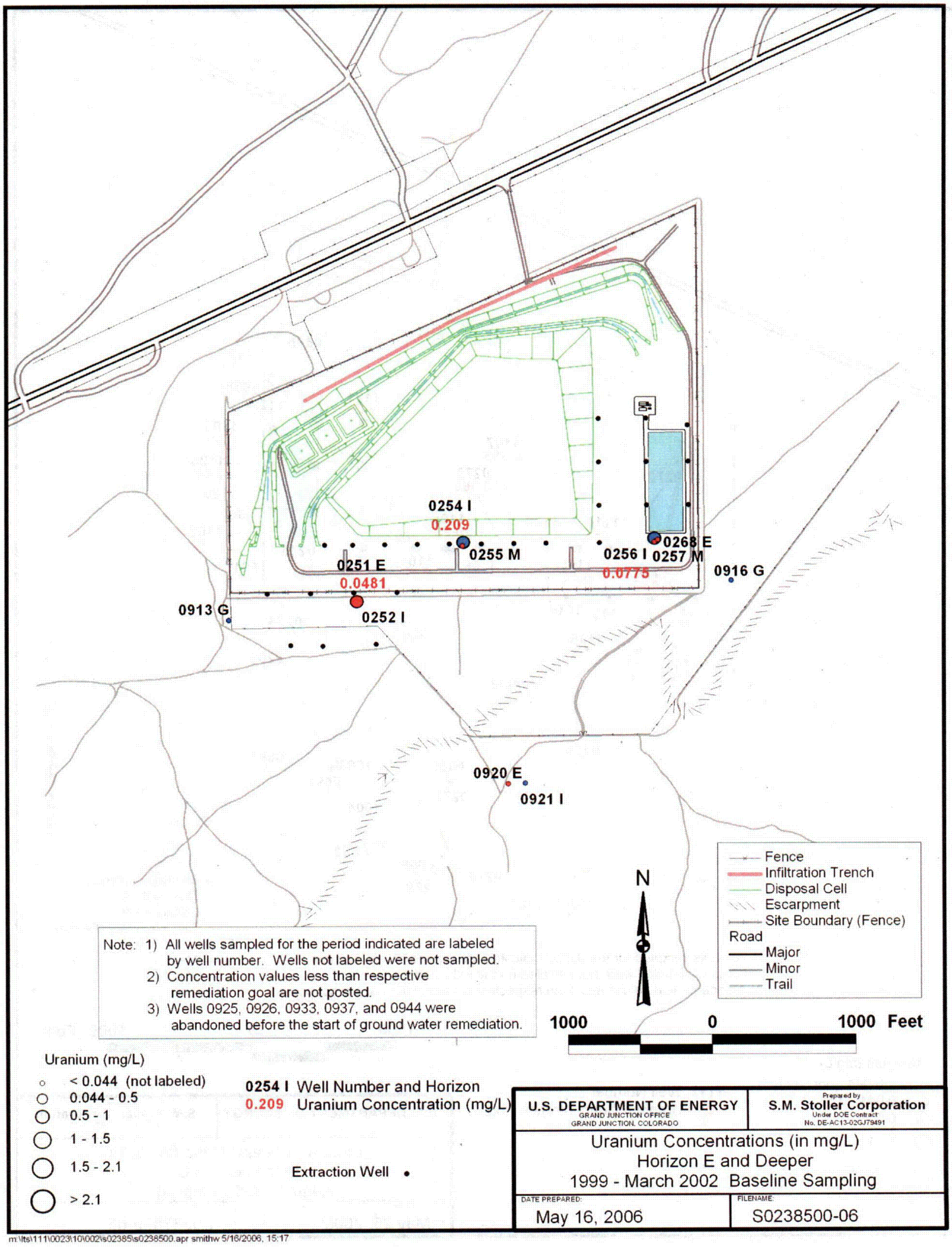

Figure 14a. Uranium Concentrations in Ground Water, Horizons E and Deeper, Baseline Period

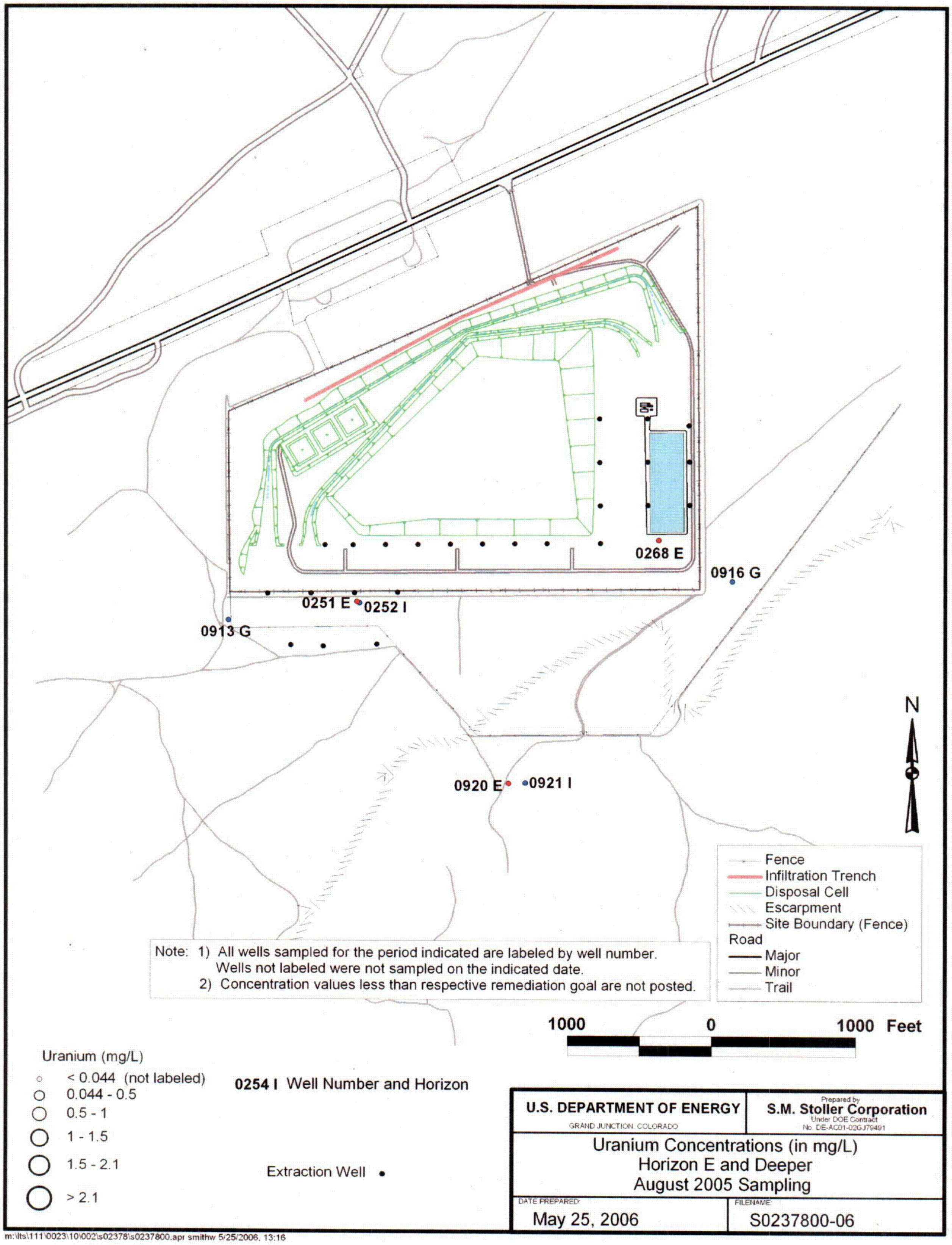

Figure 14b. Uranium Concentrations in Ground Water, Horizons E and Deeper, August 2005

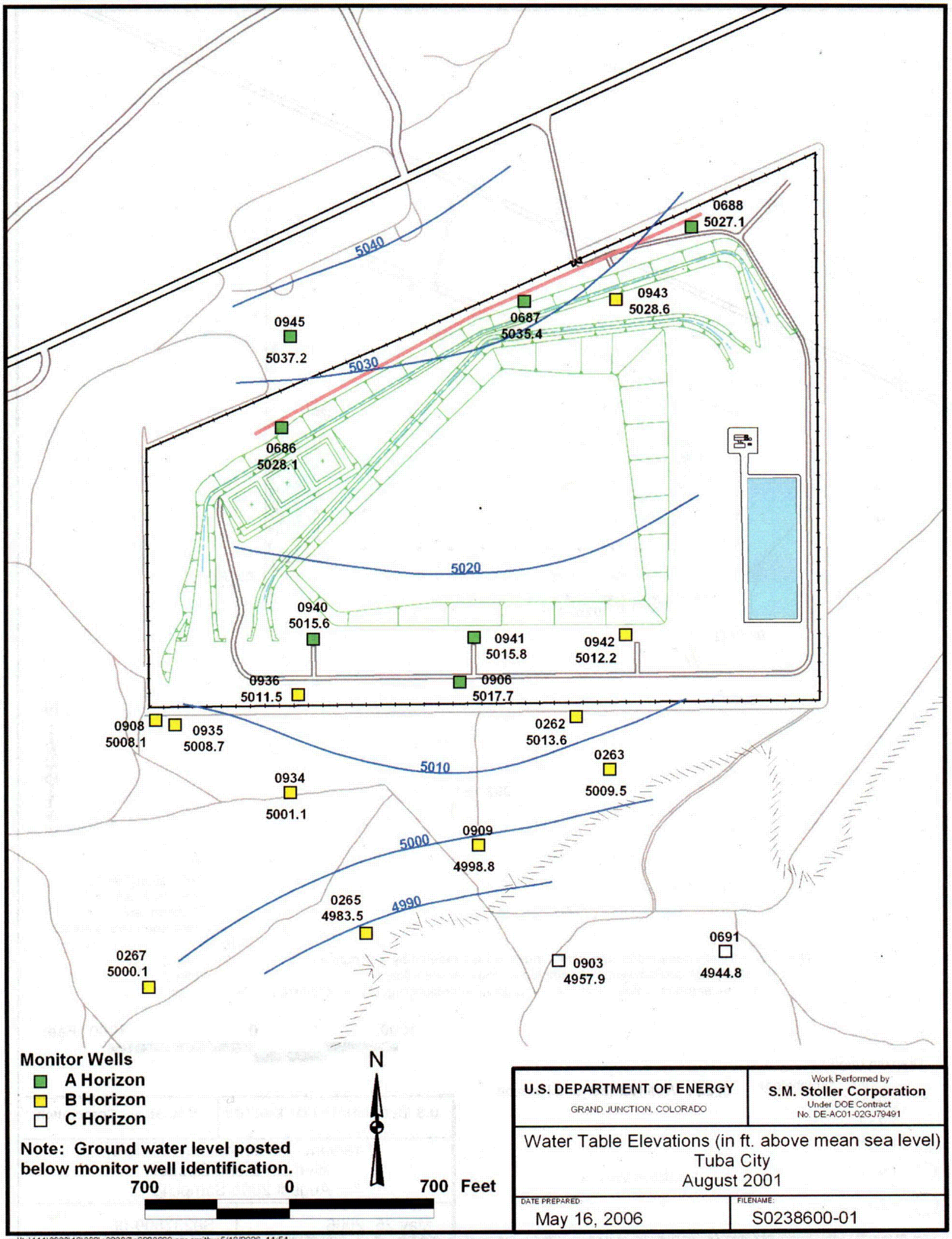

Figure 15. Water Table Elevations (in ft. above mean sea level), Tuba City Site, August 2001

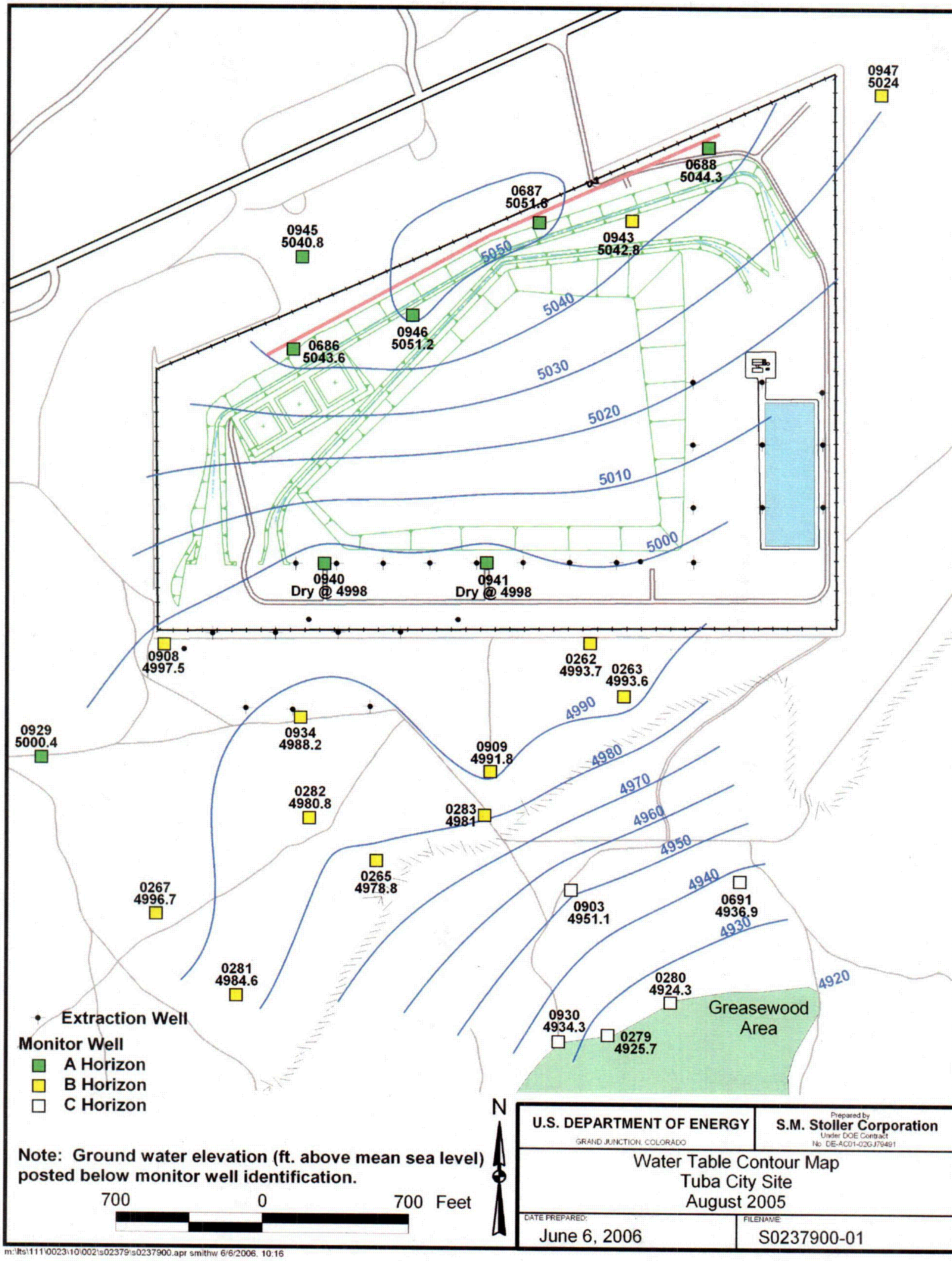

Figure 16. Water Table Contour Map, Tuba City Site, August 2005

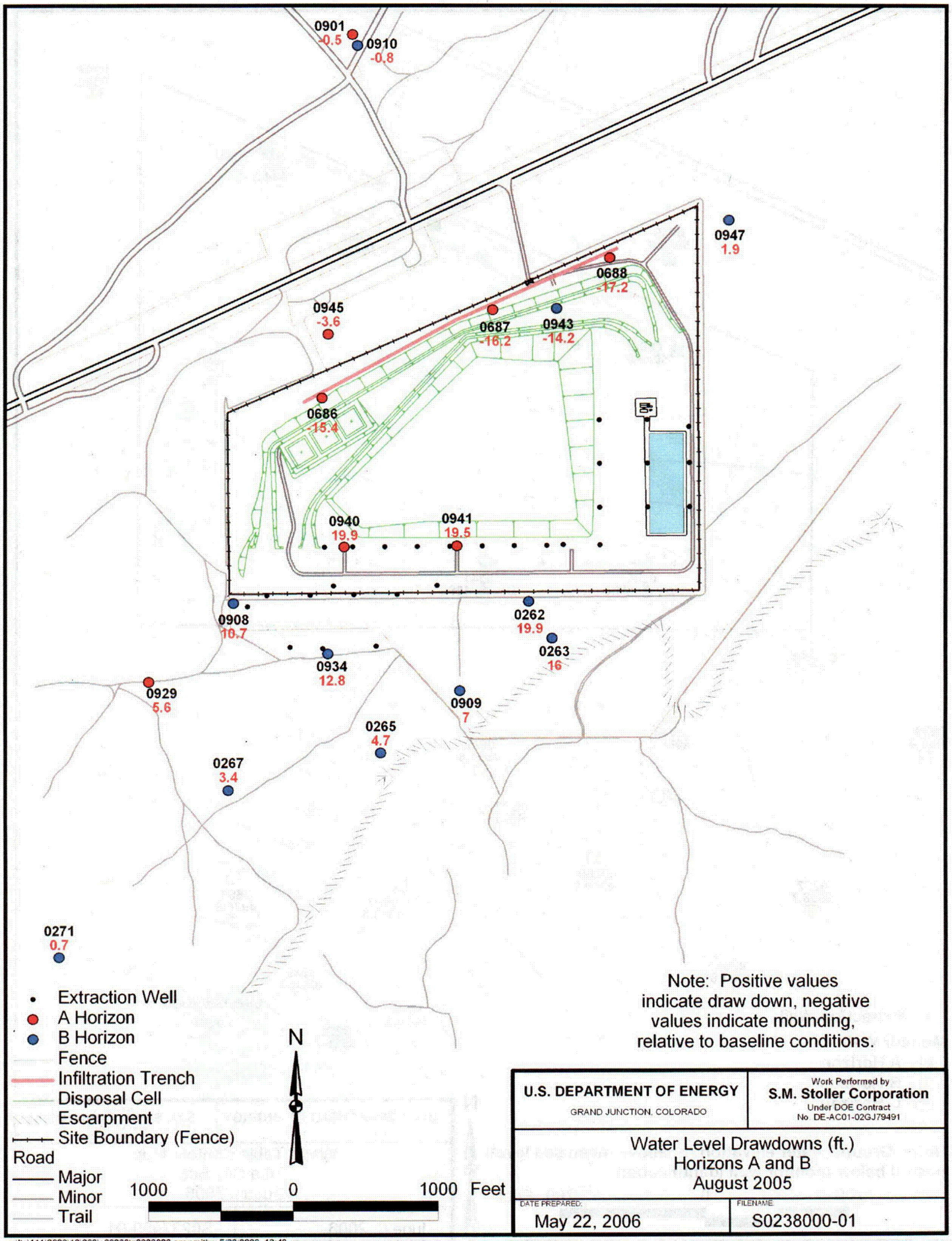

Figure 17. Water Level Drawdowns (ft), Horizons A and B, August 2005

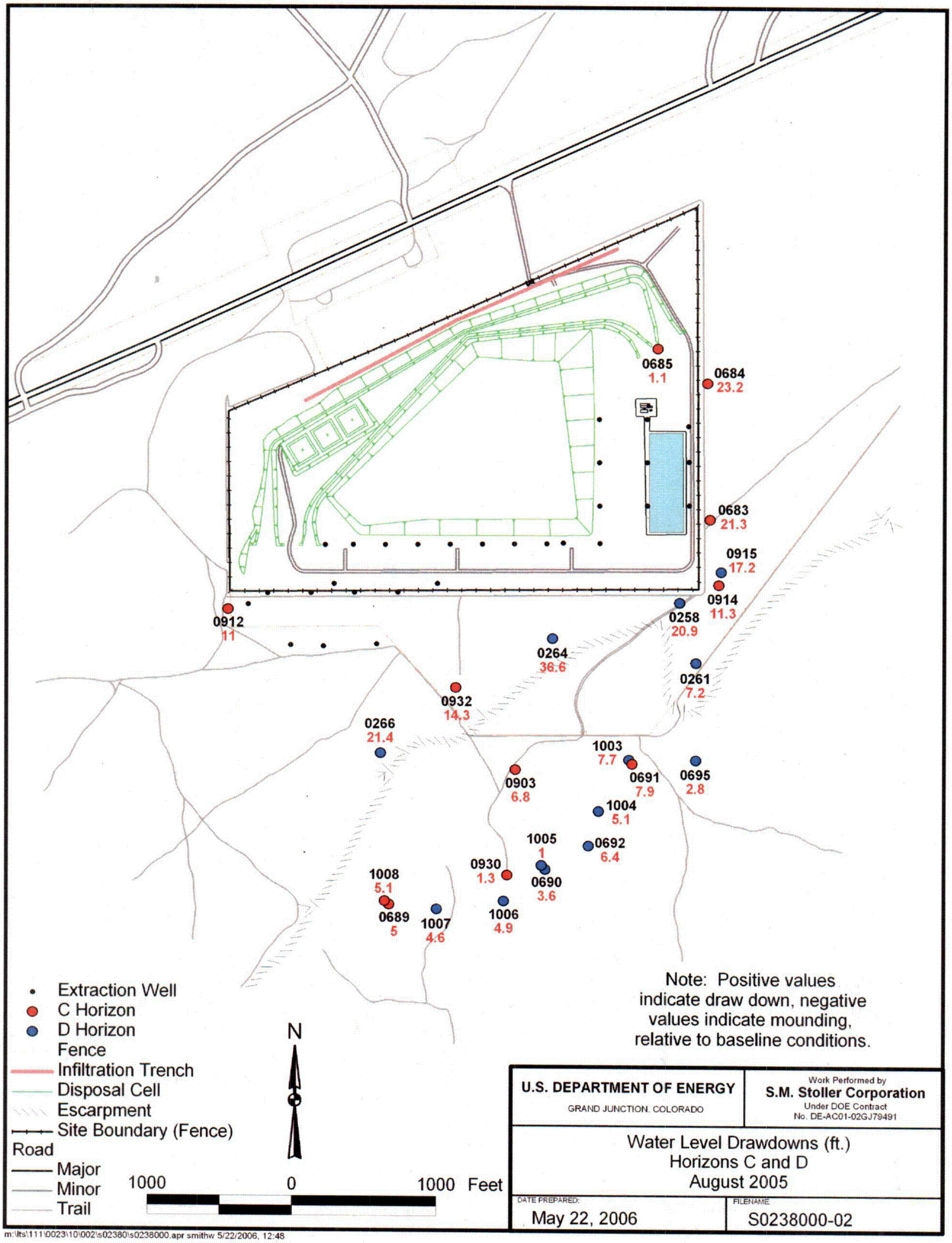

Figure 18. Water Level Drawdowns (ft), Horizons C and D, August 2005

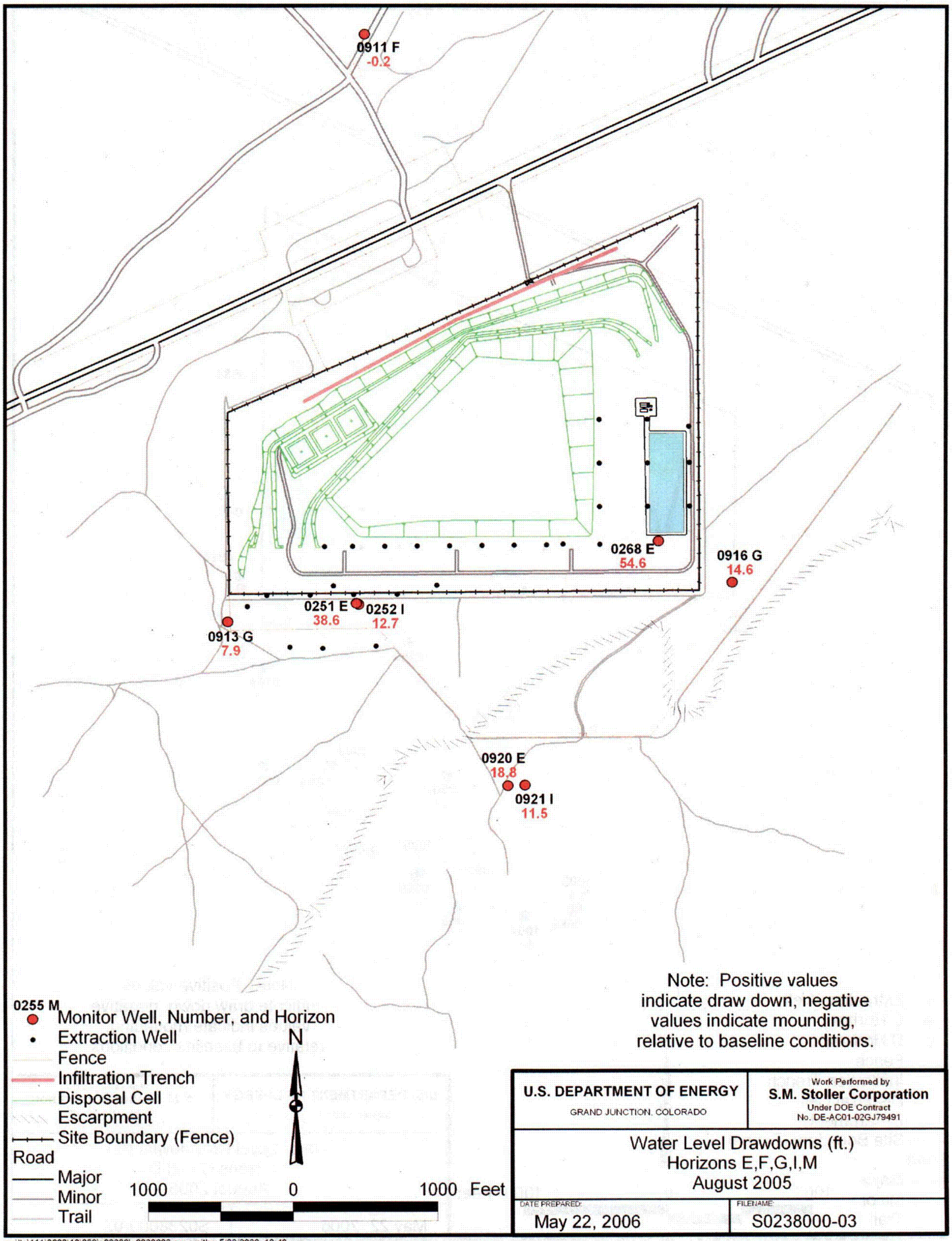

Figure 19. Water Level Drawdowns (ft), Horizons E, F, G, I, and M, August 2005

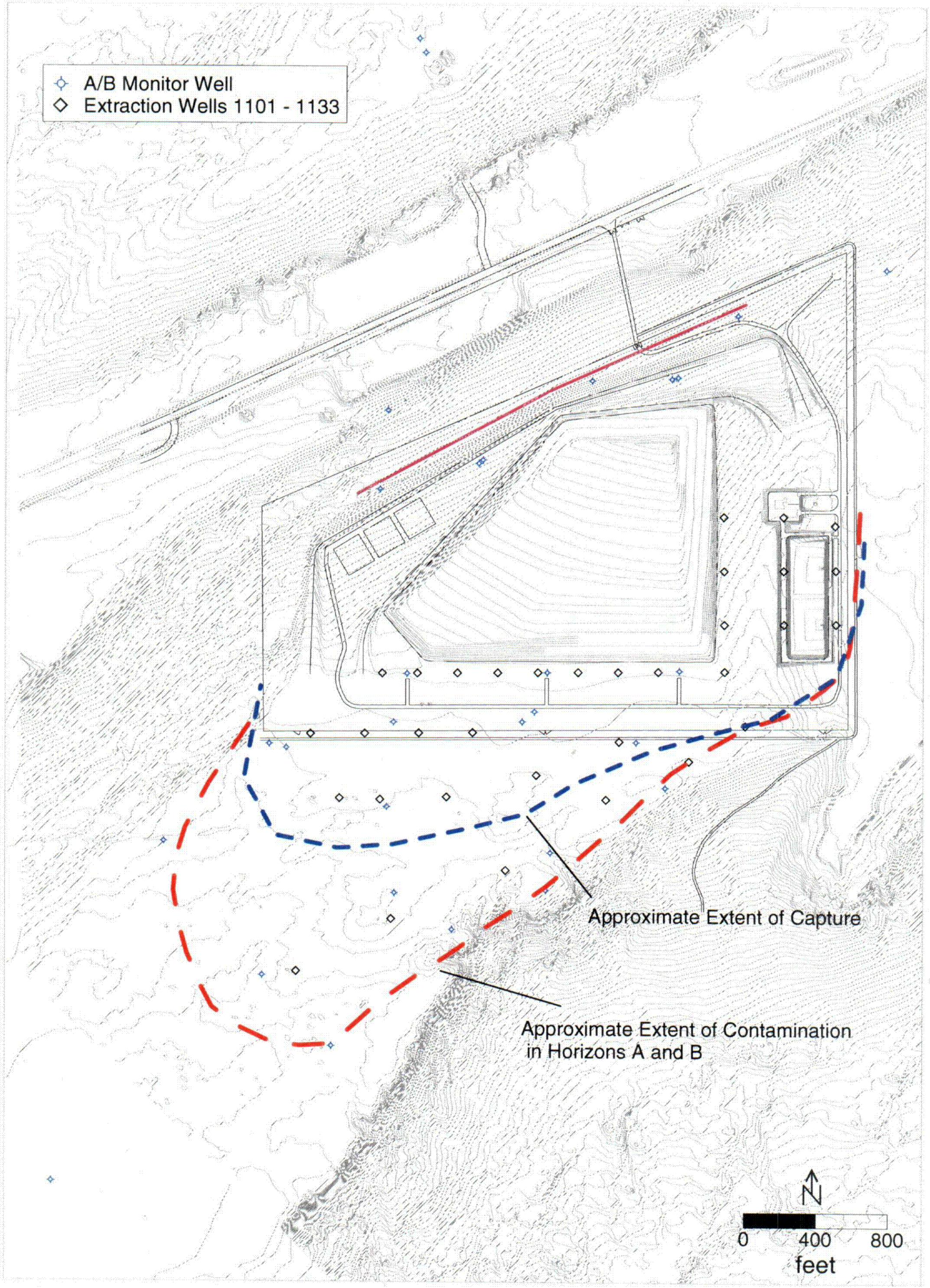

Figure 20. Extent of Ground Water Contamination and Extraction System Capture Zone: Horizons A and B

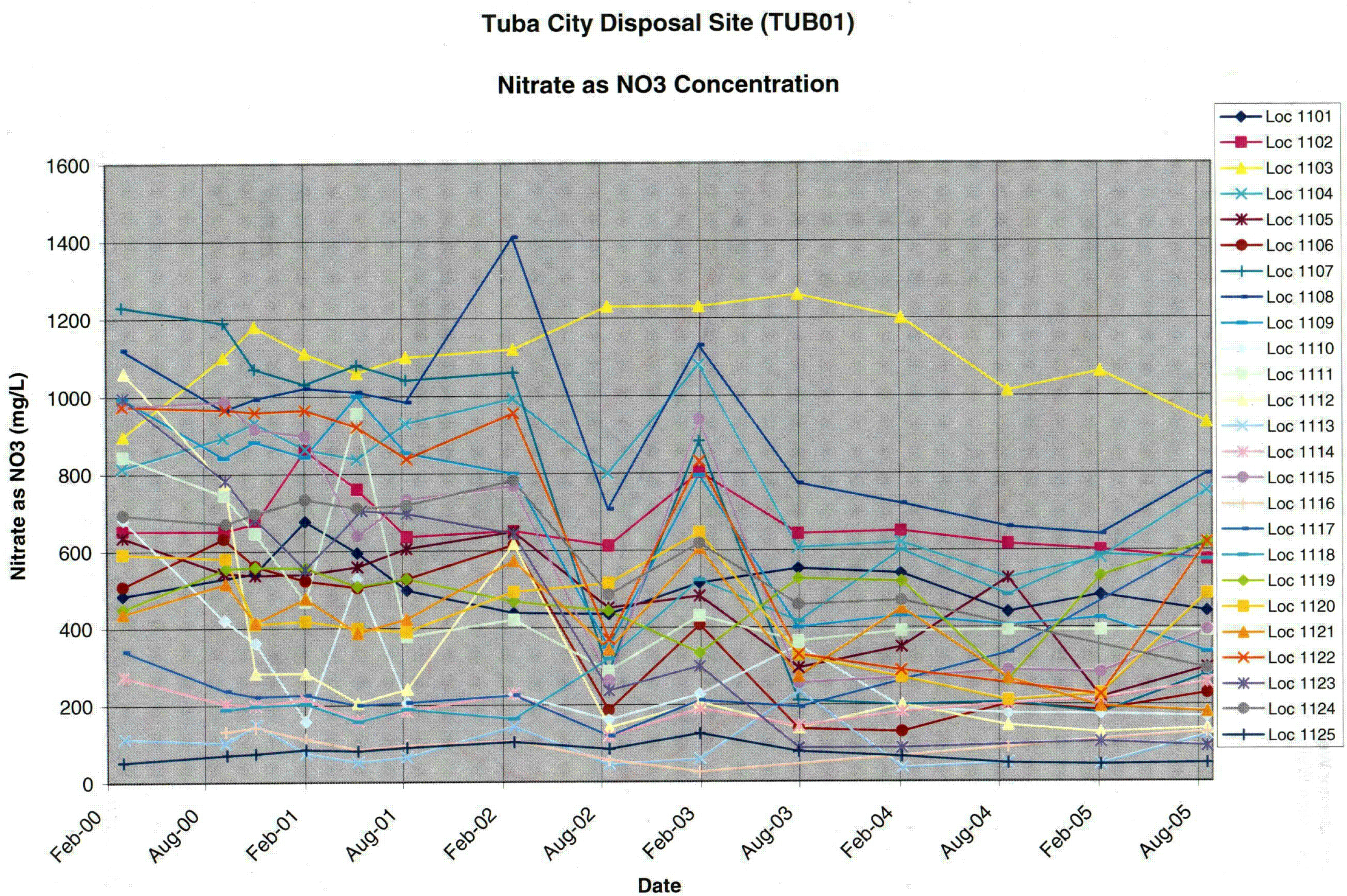

Figure 21. Nitrate Concentration Trends at Extraction Wells

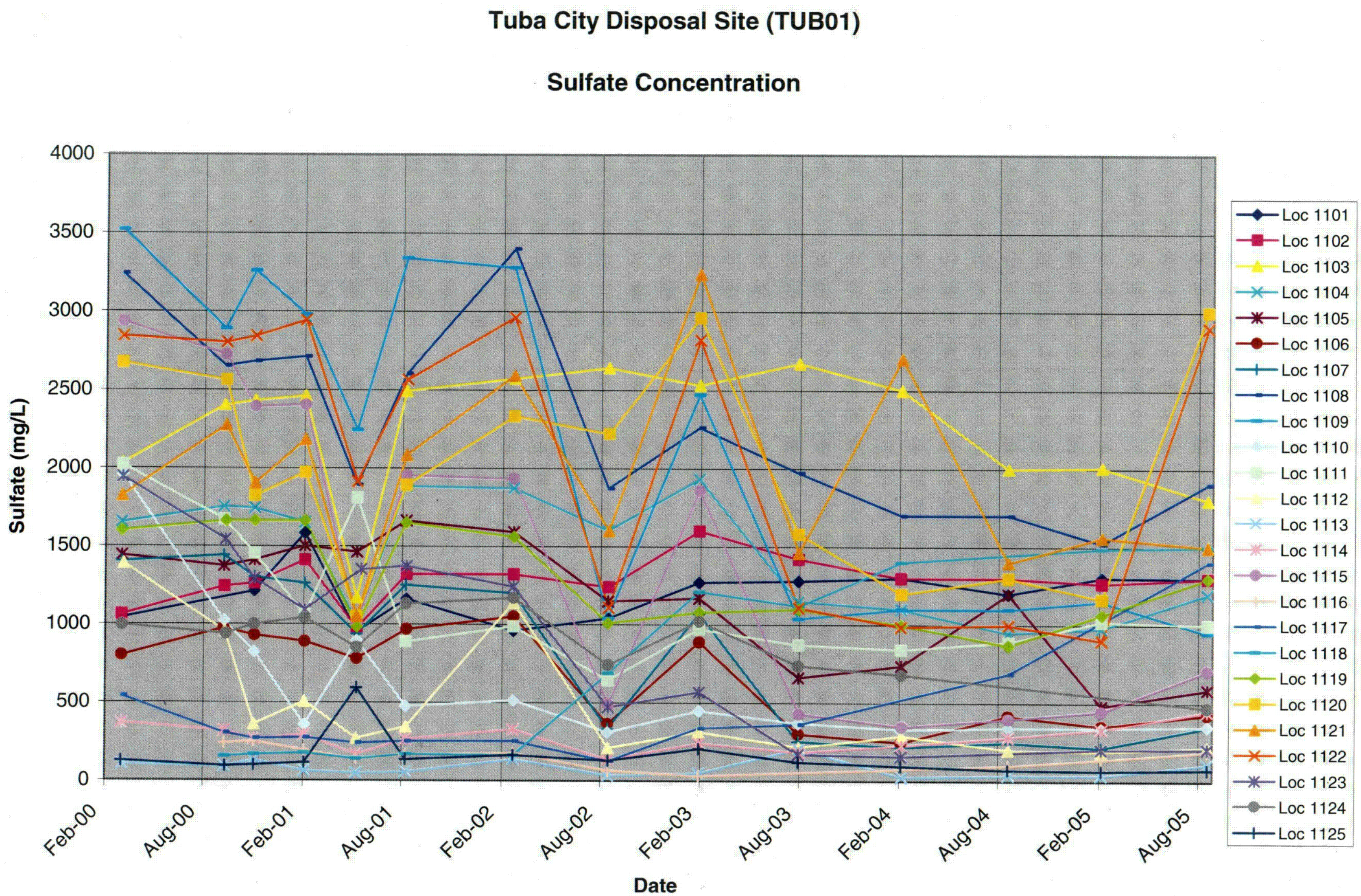

Figure 22. Sulfate Concentration Trends at Extraction Wells

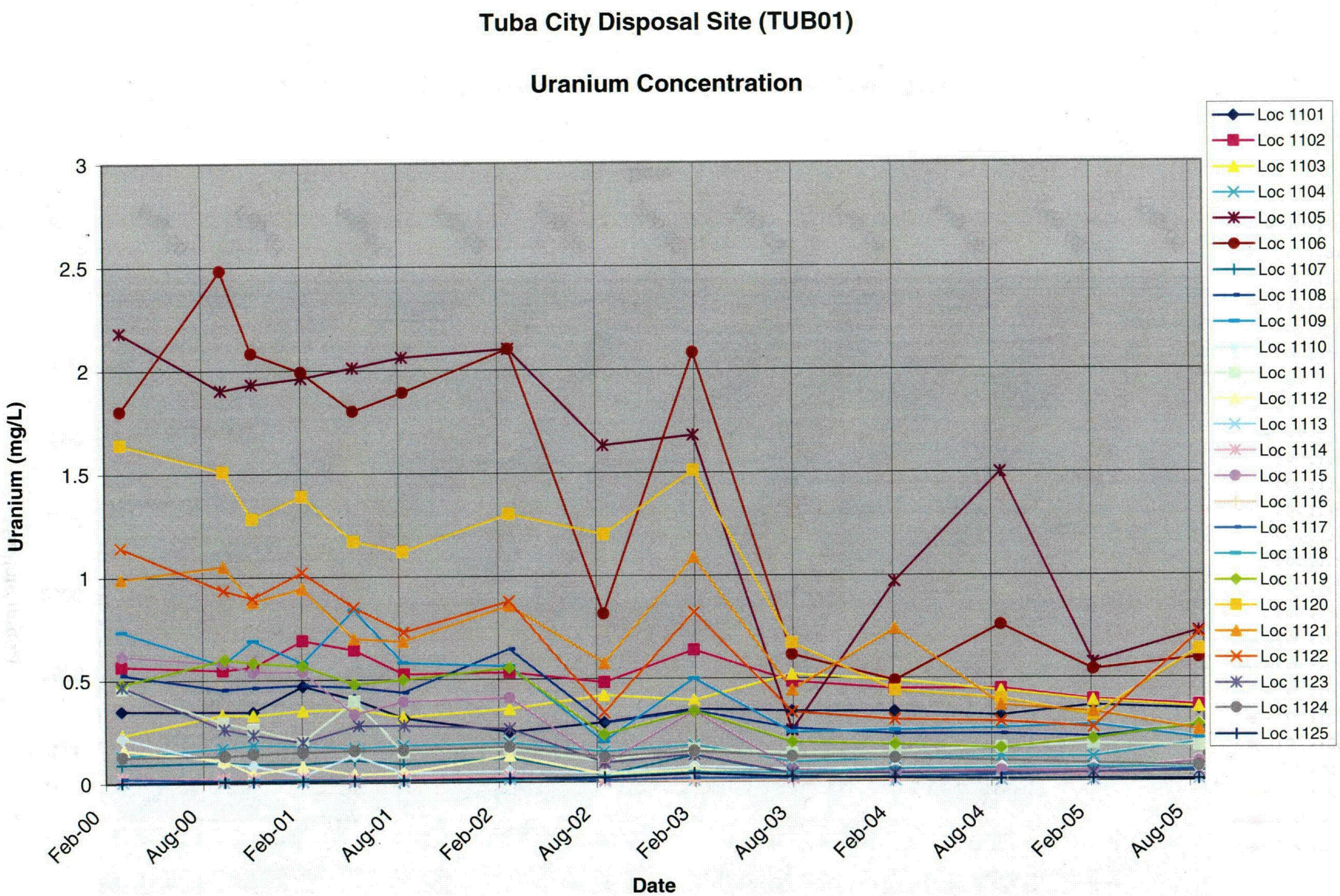

Figure 23. Uranium Concentration Trends at Extraction Wells

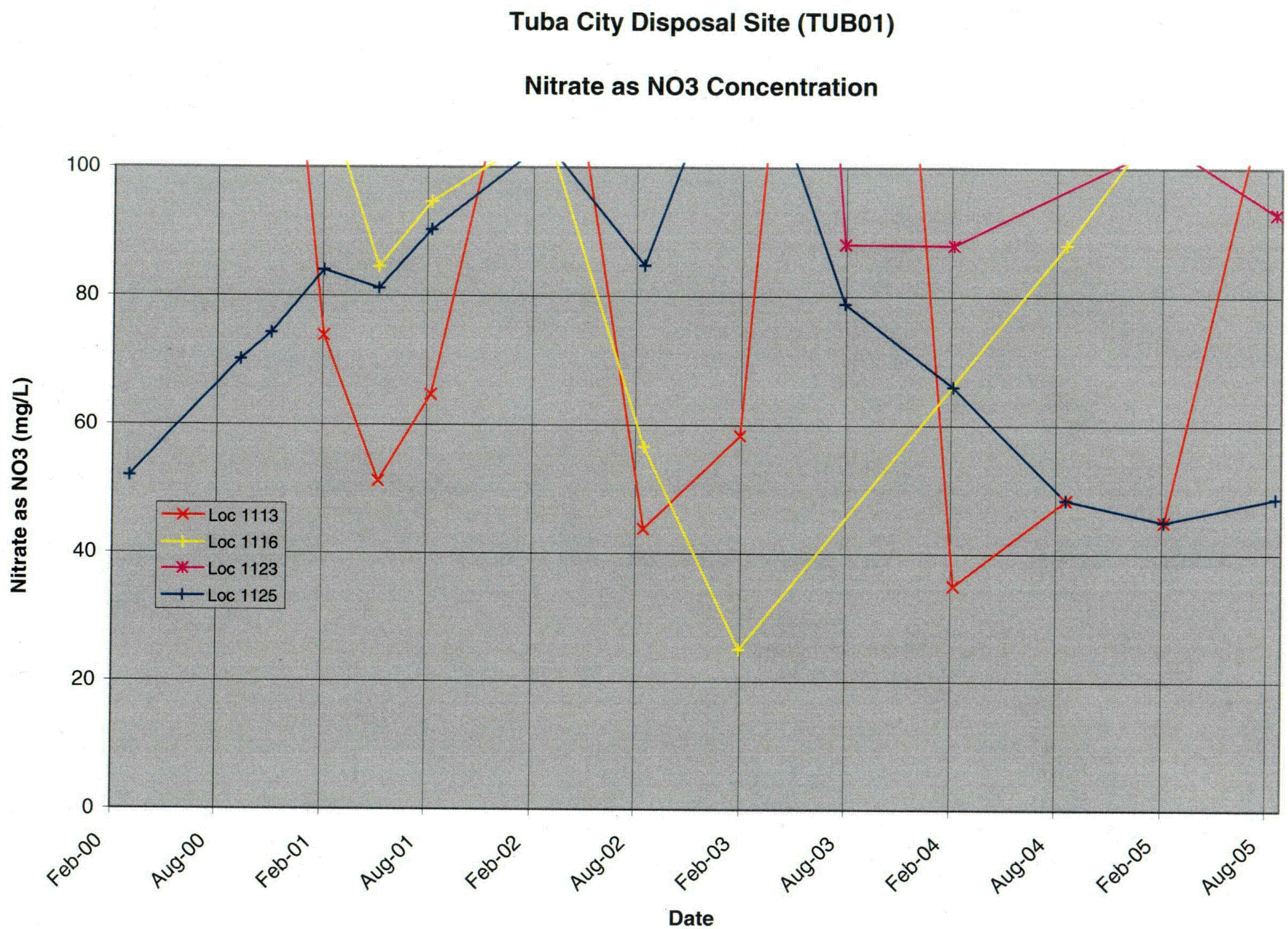

Figure 24. Nitrate Concentrations Trends Near Remediation Standard (44 mg/L as NO_3) at Extraction Wells

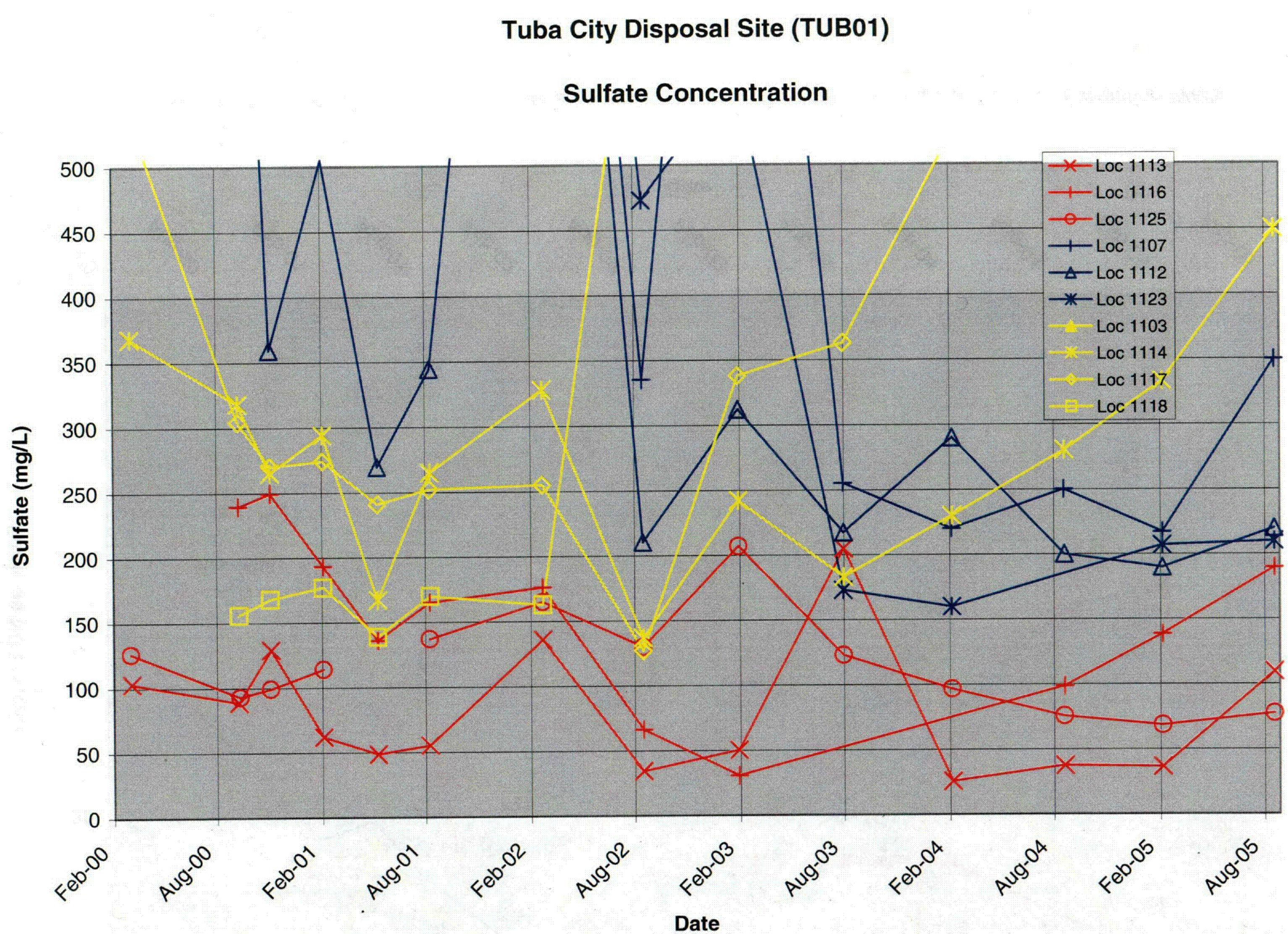

Figure 25. Sulfate Concentrations Trends Near Remediation Standard (250 mg/L) at Extraction Wells

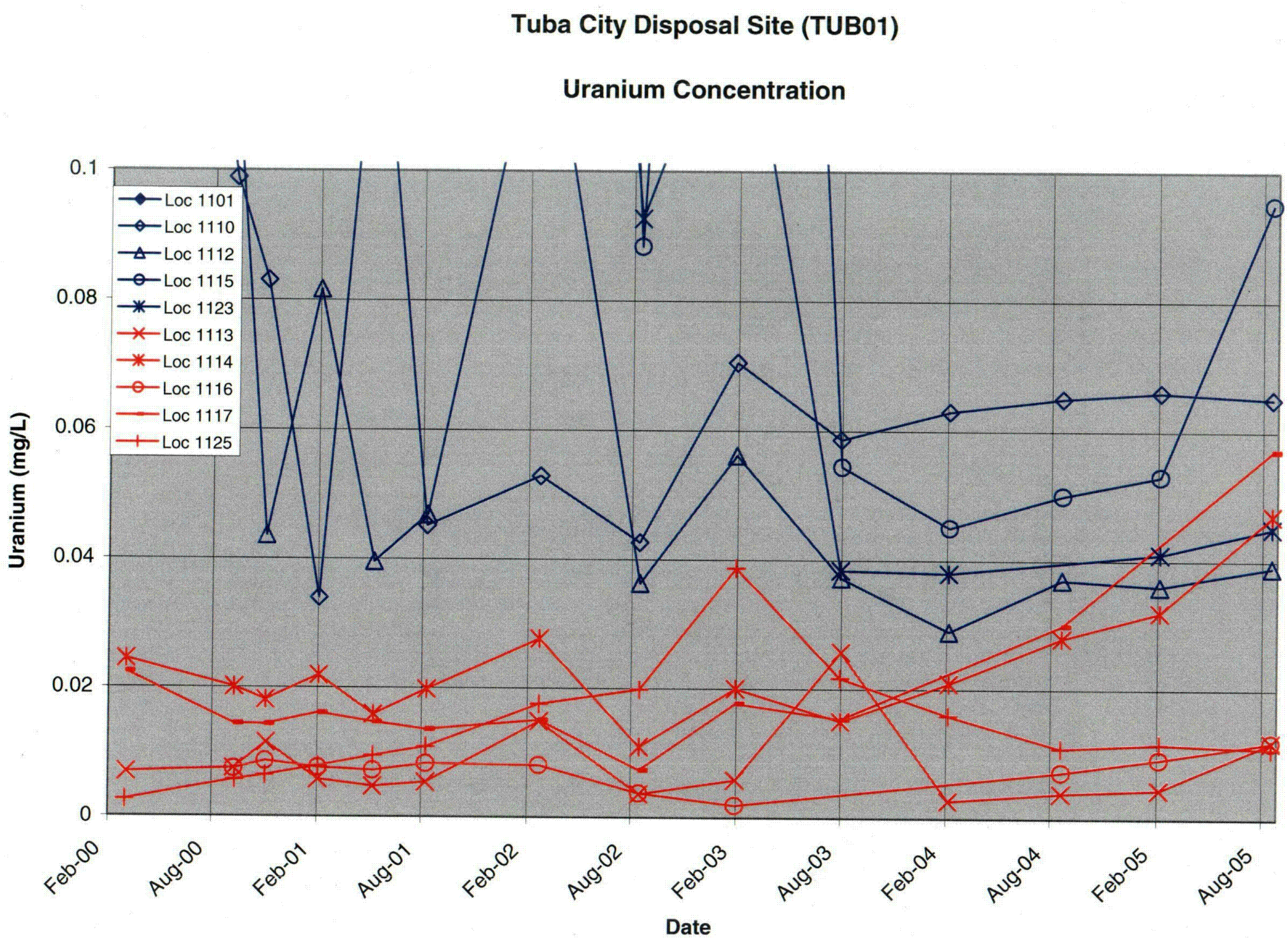

Figure 26. Uranium Concentrations Trends Near Remediation Standard (0.044 mg/L) at Extraction Wells

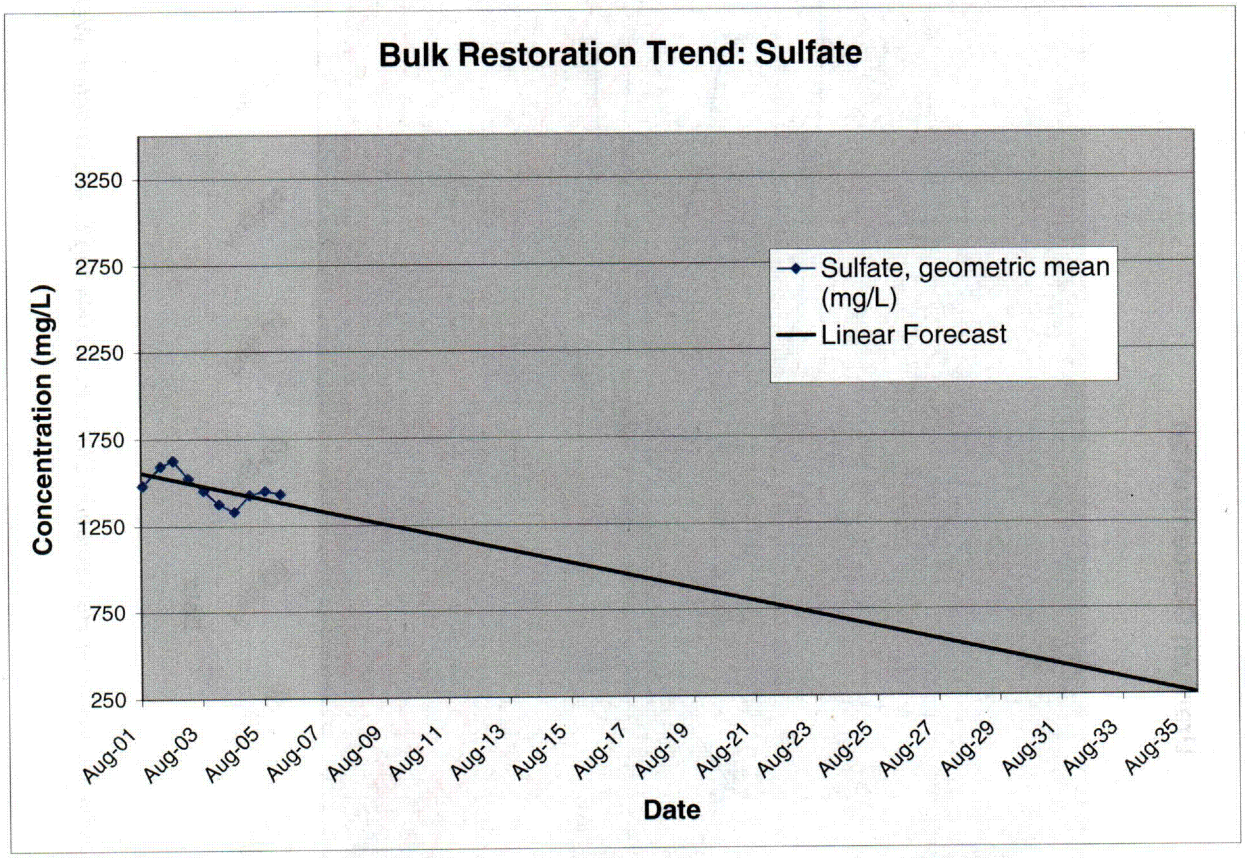

Figure 27. Bulk Restoration Trend for Sulfate

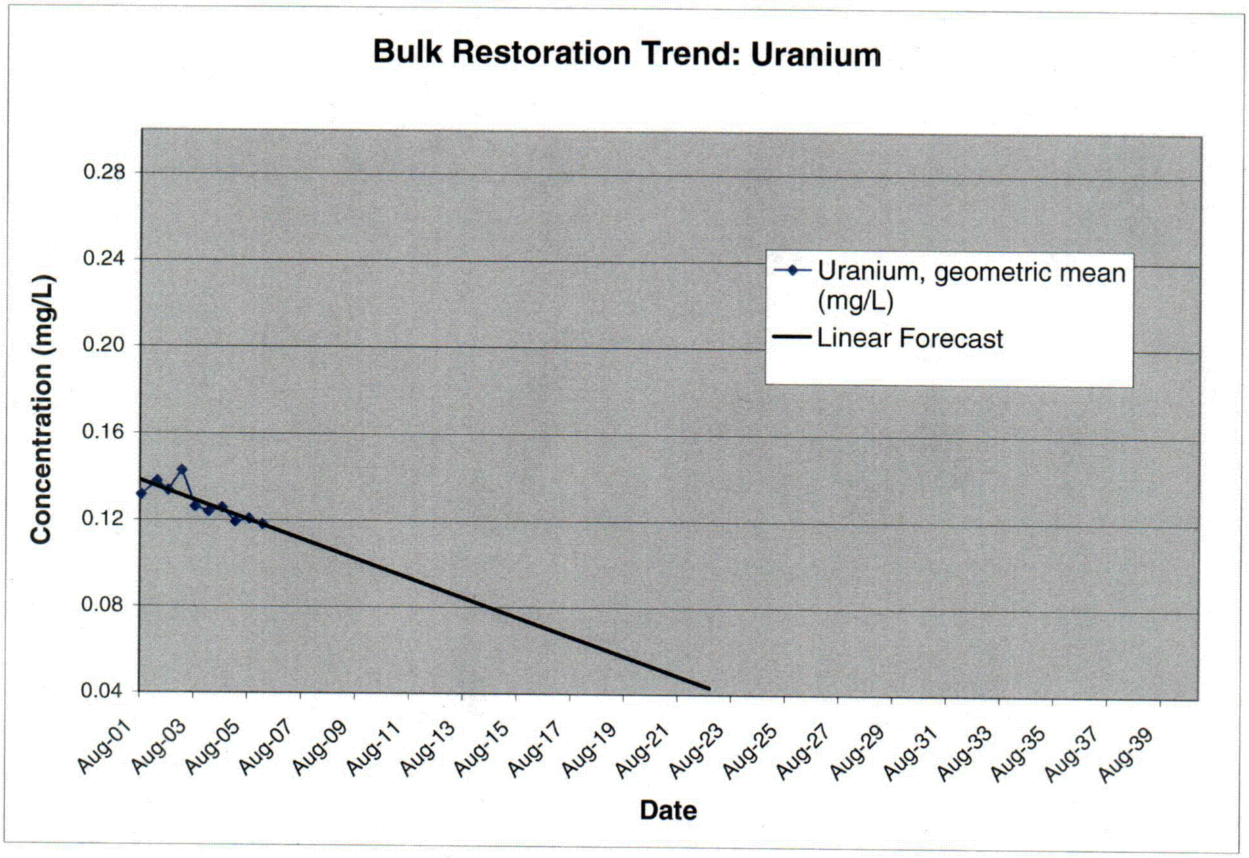

Figure 28. Bulk Restoration Trend for Uranium

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Appendix A

Well Completion Information, Conceptual Site Model, and Extraction Well Operation Summary

Table A-1. Well Completion Information

WELL	TYPE	Horizon	TOP OF SCREEN ELEV	MID SCREEN ELEV	BOTTOM OF SCREEN ELEV	TOP OF SCREEN DEPTH	MID SCREEN DEPTH	BOTTOM OF SCREEN DEPTH	SCREEN LENGTH	SUMP LENGTH	WELL DEPTH
0284	MW	A	5079.8	5074.8	5069.8	16.5	21.5	26.5	10.0	1.5	28.0
0285	MW	A	5090.8	5088.3	5085.8	3.0	5.5	8.0	5.0	0.1	8.1
0686	MW	A	5045.5	5025.5	5005.5	60.0	80.0	100.0	40.0	0.3	100.3
0687	MW	A	5047.6	5027.6	5007.6	60.0	80.0	100.0	40.0	0.3	100.3
0688	MW	A	5044.1	5024.1	5004.1	60.0	80.0	100.0	40.0	0.3	100.3
0901	MW	A	5045.8	5035.8	5025.8	58.0	68.0	78.0	20.0	2.0	80.0
0906	MW	A	5016.9	5006.9	4996.9	44.0	54.0	64.0	20.0	2.0	66.0
0907	MW	A	5010.7	5000.7	4990.7	66.5	76.5	86.5	20.0		
0928	MW	A	5022.1	5009.6	4997.1	30.0	42.5	55.0	25.0	3.0	58.0
0929	MW	A	5010.4	4990.4	4970.4	48.2	68.2	88.2	40.0		
0940	MW	A	5017.9	5010.4	5002.9	45.0	52.5	60.0	15.0	3.0	68.0
0941	MW	A	5018.0	5008.0	4998.0	45.0	55.0	65.0	20.0	3.0	68.0
0945	MW	A	5028.1	5018.1	5008.1	110.0	120.0	130.0	20.0	3.0	133.0
0946	MW	A	5057.6	5047.6	5037.6	40.0	50.0	60.0	20.0	3.3	63.3
0262	MW	B	4999.2	4979.2	4959.2	60.0	80.0	100.0	40.0	0.3	100.3
0263	MW	B	5000.2	4980.2	4960.2	60.0	80.0	100.0	40.0	0.3	100.3
0265	MW	B	4991.1	4971.1	4951.1	60.0	80.0	100.0	40.0	0.3	100.3
0267	MW	B	4990.8	4970.8	4950.8	60.0	80.0	100.0	40.0	0.3	100.3
0271	MW	B	4984.0	4964.0	4944.0	60.0	80.0	100.0	40.0	0.3	100.3
0281	MW	B	4977.8	4972.8	4967.8	70.5	75.5	80.5	10.0	1.5	82.0
0282	MW	B	4983.3	4978.3	4973.3	74.1	79.1	84.1	10.0	1.5	85.6
0283	MW	B	4984.8	4979.8	4974.8	70.5	75.5	80.5	10.0	1.5	82.0
0905	MW	B	5006.0	4998.5	4991.0	63.0	70.5	78.0	15.0	2.0	80.0
0908	MW	B	5005.3	4997.8	4990.3	52.0	59.5	67.0	15.0	2.0	69.0
0909	MW	B	4990.8	4983.3	4975.8	65.0	72.5	80.0	15.0	2.0	82.0
0910	MW	B	5007.6	4957.6	4907.6	97.0	147.0	197.0	100.0	1.0	198.0
0918	MW	B	4986.2	4983.7	4981.2	61.0	63.5	66.0	5.0	2.0	68.0
0925	EXT	B	5005.8	4985.8	4965.8	53.0	73.0	93.0	40.0	0.5	93.5
0926	EXT	B	5018.3	4993.3	4968.3	42.2	67.2	92.2	50.0	3.0	95.2
0933	MW	B	4993.3	4992.3	4991.3	23.0	24.0	25.0	2.0		
0934	MW	B	5013.0	4990.5	4968.0	45.0	67.5	90.0	45.0	3.0	93.0
0935	MW	B	5008.8	4988.8	4968.8	50.0	70.0	90.0	40.0	3.0	93.0
0936	MW	B	5017.9	4997.9	4977.9	42.0	62.0	82.0	40.0	3.0	85.0
0937	MW	B	5020.2	4992.7	4965.2	40.0	67.5	95.0	55.0	3.0	98.0
0938	MW	B	5020.4	4992.9	4965.4	40.0	67.5	95.0	55.0	3.0	98.0
0939	EXT	B	5021.1	4993.6	4966.1	40.0	67.5	95.0	55.0	3.0	98.0
0942	MW	B	5009.5	4999.5	4989.5	54.0	64.0	74.0	20.0	3.0	77.0
0943	MW	B	4994.1	4984.1	4974.1	101.0	111.0	121.0	20.0	3.0	124.0
0944	MW	B	4979.9	4969.9	4959.9	85.0	95.0	105.0	20.0	2.0	107.0
0947	MW	B	4990.0	4980.0	4970.0	105.0	115.0	125.0	20.0	3.3	128.3
1126	EXT	B	4991.9	4971.9	4951.9	60.0	80.0	100.0	40.0	3.3	103.3
1127	EXT	B	4984.2	4964.2	4944.2	72.7	92.7	112.7	40.0	3.3	116.0
1128	EXT	B	4982.3	4962.3	4942.3	72.7	92.7	112.7	40.0	3.3	116.0
1129	EXT	B	4990.9	4975.9	4960.9	68.2	83.2	98.2	30.0	3.3	101.5
1130	EXT	B	4987.3	4962.3	4937.3	71.7	96.7	121.7	50.0	3.3	125.0
1131	EXT	B	4998.1	4978.1	4958.1	59.7	79.7	99.7	40.0	3.3	103.0
1132	EXT	B	5009.1	4984.1	4959.1	49.7	74.7	99.7	50.0	3.3	103.0
1133	EXT,	B	4999.4	4979.4	4959.4	59.7	79.7	99.7	40.0	3.3	103.0
0274	MW	C	4913.6	4903.6	4893.6	149.0	159.0	169.0	20.0	1.5	170.5
0276	MW	C	4910.0	4900.0	4890.0	154.5	164.5	174.5	20.0	1.5	176.0
0279	MW	C	4922.1	4917.1	4912.1	26.5	31.5	36.5	10.0	1.5	38.0
0280	MW	C	4922.6	4917.6	4912.6	26.5	31.5	36.5	10.0	1.5	38.0
0683	MW	C	4973.2	4948.2	4923.2	95.0	120.0	145.0	50.0	3.0	148.0
0684	MW	C	4943.1	4917.4	4891.8	124.2	149.9	175.5	51.3	2.5	178.0
0685	MW	C	4975.6	4949.7	4923.8	93.7	119.6	145.5	51.8	2.5	148.0
0689	MW	C	4923.9	4903.9	4883.9	55.0	75.0	95.0	40.0	0.3	95.3
0691	MW	C	4921.9	4901.9	4881.9	55.0	75.0	95.0	40.0	0.3	95.3
0903	MW	C	4953.5	4943.5	4933.5	28.0	38.0	48.0	20.0	2.0	50.0
0912	MW	C	4934.7	4914.7	4894.7	123.0	143.0	163.0	40.0	2.0	165.0
0914	MW	C	4930.3	4921.8	4913.3	137.2	145.7	154.2	17.0	2.0	156.2
0917	MW	C	4917.8	4907.8	4897.8	128.0	138.0	148.0	20.0	2.0	150.0
0930	MW	C	4933.0	4918.0	4903.0	20.0	35.0	50.0	30.0	3.0	53.0
0932	MW	C	4942.3	4932.3	4922.3	112.5	122.5	132.5	20.0	2.7	135.2
1008	INJ	C	4926.8	4901.6	4876.4	55.6	80.8	106.0	50.4	2.5	108.5
1116	EXT	C	4964.1	4912.5	4861.0	92.4	143.9	195.5	103.1	2.5	198.0
1117	EXT	C	4965.3	4913.7	4862.1	92.3	143.9	195.5	103.2	2.5	198.0
1118	EXT	C	4967.9	4915.1	4862.3	89.9	142.7	195.5	105.6	2.5	198.0
0258	MW	D	4894.0	4874.0	4854.0	159.0	179.0	199.0	40.0	0.3	199.3

Table A-1 (continued). Well Completion Information

WELL	TYPE	Horizon	TOP OF CASING ELEV	GROUND ELEV	WELL DIAMETER	BORING STARTED	DECOMMISSION DATE	STATE PLANE EAST	STATE PLANE NORTH
0284	MW	A	5098.72	5096.3	2	16-Aug-04		730525	1873562
0285	MW	A	5096.47	5093.8	2	16-Aug-04		731629	1874042
0686	MW	A	5107.97	5105.5	2	28-Mar-00		729978	1873416
0687	MW	A	5109.82	5107.6	2	29-Mar-00		731152	1874024
0688	MW	A	5106.98	5104.1	2	29-Mar-00		731961	1874385
0901	MW	A	5105.46	5103.8	2	16-Oct-84		730185	1875918
0906	MW	A	5062.10	5060.9	2	19-Nov-84		730838	1872181
0907	MW	A	5079.17	5077.2	2	30-Nov-84	19-Apr-88	731252	1872920
0928	MW	A	5053.99	5052.1	4	20-Oct-95	24-May-00	729401	1870814
0929	MW	A	5060.82	5058.6	4			728780	1871453
0940	MW	A	5064.77	5062.9	4	01-Nov-95		730130	1872391
0941	MW	A	5065.97	5063.0	4	10-Nov-95		730908	1872398
0945	MW	A	5140.49	5138.1	4	11-Oct-95		730019	1873857
0946	MW	A	5100.50	5097.6	4	02-Nov-95		730547	1873582
0262	MW	B	5061.99	5059.2	2	03-Apr-00		731402	1872012
0263	MW	B	5063.10	5060.2	2	04-Apr-00		731565	1871757
0265	MW	B	5053.88	5051.1	2	16-Apr-00		730382	1870964
0267	MW	B	5053.40	5050.8	2	14-Apr-00		729329	1870707
0271	MW	B	5046.72	5044.0	2	29-Apr-00		728160	1869555
0281	MW	B	5051.00	5048.3	2	11-Aug-04		729714	1870315
0282	MW	B	5060.04	5057.4	2	10-Aug-04		730062	1871168
0283	MW	B	5057.97	5055.3	2	03-Aug-04		730901	1871185
0905	MW	B	5072.80	5069.0	2	14-Nov-84	24-May-00	732933	1873200
0908	MW	B	5058.14	5057.3	2	17-Nov-84		729366	1871999
0909	MW	B	5057.17	5055.8	2	18-Nov-84		730927	1871393
0910	MW	B	5106.70	5104.6	4	26-Jul-85		730219	1875840
0918	MW	B	5049.63	5047.2	4	15-Aug-85		727294	1868724
0925	EXT	B	5060.87	5058.8	6	21-Oct-95	24-May-00	729452	1872006
0926	EXT	B	5062.85	5060.5	6	25-Oct-95	17-May-00	730790	1872126
0933	MW	B	5018.03	5016.3	4	18-Oct-95	24-May-00	731727	1871341
0934	MW	B	5059.73	5058.0	4	02-Nov-95		730018	1871649
0935	MW	B	5061.50	5058.8	4	28-Oct-95 *		729461	1871978
0936	MW	B	5062.30	5059.9	6	26-Oct-95 *		730055	1872121
0937	MW	B	5062.80	5060.2	4	09-Nov-95	24-May-00	730790	1872116
0938	MW	B	5063.64	5060.4	4	26-Oct-95 *		730769	1872124
0939	EXT	B	5063.23	5061.1	6	23-Oct-95	16-May-00	731403	1872132
0942	MW	B	5066.45	5063.5	4	03-Nov-95 *		731642	1872409
0943	MW	B	5098.05	5095.1	4	13-Oct-95		731596	1874034
0944	MW	B	5067.00	5064.9	4	04-Nov-95	28-Jul-99	732199	1873007
0947	MW	B	5097.01	5095.0	4	03-Nov-95		732786	1874642
1126	EXT	B	*5051.9* **	*5051.9* **	4	09-Sep-04		729517	1870728
1127	EXT	B	*5056.9* **	*5056.9* **	4	11-Sep-04		730044	1871022
1128	EXT	B	*5055.0* **	*5055.0* **	4	12-Sep-04		730679	1871294
1129	EXT	B	*5059.1* **	*5059.1* **	4	30-Aug-04		731237	1871690
1130	EXT	B	*5059.0* **	*5059.0* **	4	29-Jul-04		731699	1871907
1131	EXT	B	*5057.8* **	*5057.8* **	4	08-Sep-04		732011	1872106
1132	EXT	B	*5058.8* **	*5058.8* **	4	31-Aug-04		731310	1872015
1133	EXT	B	*5059.1* **	*5059.1* **	4	02-Sep-04		730850	1871827
0274	MW	C	5064.42	5062.6	2	30-Aug-04		731623	1872403
0276	MW	C	5067.55	5064.5	2	01-Sep-04		732081	1873158
0279	MW	C	4951.04	4948.6	2	15-Aug-04		731494	1870132
0280	MW	C	4951.52	4949.1	2	15-Aug-04		731794	1870289
0683	MW	C	5070.64	5068.2	6	31-Aug-99		732661	1872574
0684	MW	C	5070.05	5067.3	6	20-Aug-99		732642	1873521
0685	MW	C	5072.44	5069.3	6	19-Aug-99		732295	1873760
0689	MW	C	4981.63	4978.9	2	31-Mar-00		730439	1869893
0691	MW	C	4979.41	4976.9	2	30-Mar-00		732124	1870872
0903	MW	C	4983.33	4981.5	2	30-Oct-84		731314	1870829
0912	MW	C	5059.97	5057.7	4	12-Aug-85		729324	1871942
0914	MW	C	5070.10	5067.5	4	16-Aug-85		732723	1872119
0917	MW	C	5048.02	5045.8	4	14-Aug-85		727255	1868642
0930	MW	C	4954.96	4953.0	4	23-Oct-95		731257	1870099
0932	MW	C	5057.32	5054.8	4	29-Oct-95		730900	1871401
1008	INJ	C	4980.52	4982.3	6	23-Jul-99		730410	1869916
1116	EXT	C	5053.74	5056.5	6	08-Aug-99		730350	1871702
1117	EXT	C	5054.95	5057.6	6	11-Aug-99		729981	1871688
1118	EXT	C	5055.11	5057.8	6	12-Aug-99		729756	1871695
0258	MW	D	5055.56	5053.0	2	13-Apr-00		732452	1871996

Table A-1 (continued). Well Completion Information

WELL	TYPE	Horizon	TOP OF SCREEN ELEV	MID SCREEN ELEV	BOTTOM OF SCREEN ELEV	TOP OF SCREEN DEPTH	MID SCREEN DEPTH	BOTTOM OF SCREEN DEPTH	SCREEN LENGTH	SUMP LENGTH	WELL DEPTH
0261	MW	D	4907.0	4887.0	4867.0	160.0	180.0	200.0	40.0	0.3	200.3
0264	MW	D	4899.6	4879.6	4859.6	160.0	180.0	200.0	40.0	0.3	200.3
0266	MW	D	4890.6	4870.6	4850.6	160.0	180.0	200.0	40.0	0.3	200.3
0272	MW	D	4902.8	4892.8	4882.8	159.1	169.1	179.1	20.0	1.5	180.6
0273	MW	D	4909.4	4899.4	4889.4	153.0	163.0	173.0	20.0	1.5	174.5
0275	MW	D	4903.0	4893.0	4883.0	158.2	168.2	178.2	20.0	1.5	179.7
0277	MW	D	4884.0	4879.0	4874.0	95.7	100.7	105.7	10.0	1.5	107.2
0278	MW	D	4862.9	4857.9	4852.9	90.5	95.5	100.5	10.0	1.5	102.0
0690	MW	D	4893.3	4873.3	4853.3	55.0	75.0	95.0	40.0	0.3	95.3
0692	MW	D	4895.6	4875.6	4855.6	55.0	75.0	95.0	40.0	0.3	95.3
0695	MW	D	4919.3	4899.3	4879.3	55.0	75.0	95.0	40.0	0.3	95.3
0904	MW	D	4873.8	4868.8	4863.8	28.0	33.0	38.0	10.0	2.0	40.0
0915	MW	D	4897.8	4892.8	4887.8	170.0	175.0	180.0	10.0	2.0	182.0
1003	INJ	D	4923.4	4898.4	4873.4	55.5	80.5	105.5	50.0	2.5	108.0
1004	INJ	D	4918.1	4893.1	4868.1	45.5	70.5	95.5	50.0	2.5	98.0
1005	INJ	D	4904.7	4879.7	4854.7	45.5	70.5	95.5	50.0	2.5	98.0
1006	INJ	D	4903.7	4878.7	4853.7	45.7	70.7	95.7	50.0	2.5	98.2
1007	INJ	D	4915.6	4890.5	4865.4	45.8	70.9	96.0	50.2	2.5	98.5
1101	EXT	D	4974.2	4896.5	4818.9	96.1	173.8	251.5	155.4	2.5	254.0
1102	EXT	D	4968.8	4893.8	4818.8	101.5	176.5	251.5	150.0	2.5	254.0
1103	EXT	D	4962.3	4887.3	4812.3	100.0	175.0	250.0	150.0	2.5	252.5
1104	EXT	D	4972.3	4894.8	4817.3	90.0	167.5	245.0	155.0	3.0	248.0
1105	EXT	D	4972.1	4894.6	4817.1	90.0	167.5	245.0	155.0	3.0	248.0
1106	EXT	D	4966.0	4888.7	4811.4	96.5	173.8	251.1	154.6	2.9	254.0
1107	EXT	D	4971.2	4894.0	4816.8	91.1	168.3	245.5	154.4	2.5	248.0
1108	EXT	D	4966.1	4891.1	4816.1	96.3	171.3	246.3	150.0	2.5	248.8
1109	EXT	D	4972.1	4894.7	4817.3	90.3	167.7	245.1	154.8	2.9	248.0
1110	EXT	D	4966.8	4891.8	4816.8	95.5	170.5	245.5	150.0	2.5	248.0
1111	EXT	D	4971.9	4894.7	4817.5	90.7	167.9	245.1	154.4	2.5	247.6
1112	EXT	D	4969.1	4891.6	4814.1	90.5	168.0	245.5	155.0	2.5	248.0
1113	EXT	D	4968.7	4891.2	4813.7	90.5	168.0	245.5	155.0	2.5	248.0
1114	EXT	D	4968.5	4891.0	4813.6	90.6	168.0	245.5	154.9	2.5	248.0
1115	EXT	D	4968.6	4891.2	4813.7	90.5	168.0	245.5	155.0	2.5	248.0
1119	EXT	D	4968.7	4893.7	4818.7	95.3	170.3	245.3	150.0	2.5	247.8
1120	EXT	D	4971.0	4896.0	4821.0	95.5	170.5	245.5	150.0	2.5	248.0
1121	EXT	D	4972.0	4897.0	4822.0	97.5	172.5	247.5	150.0	2.5	250.0
1122	EXT	D	4973.4	4896.3	4819.2	96.9	174.0	251.1	154.2	2.9	254.0
1123	EXT	D	4976.2	4899.2	4822.2	91.0	168.0	245.0	154.0	3.0	248.0
1124	EXT	D	4978.7	4899.9	4821.1	87.9	166.7	245.5	157.6	2.5	248.0
1125	EXT	D	4972.8	4897.8	4822.8	95.5	170.5	245.5	150.0	2.5	248.0
0251	MW	E	4858.9	4808.9	4758.9	200.0	250.0	300.0	100.0	0.3	300.3
0268	MW	E	4864.5	4814.5	4764.5	200.0	250.0	300.0	100.0	0.3	300.3
0920	MW	E	4866.0	4846.0	4826.0	114.4	134.4	154.4	40.0	2.0	156.4
0948	EXDS	E	4893.9	4803.9	4713.9	221.5	311.5	401.5	180.0	5.0	406.5
0911	MW	F	4795.2	4775.2	4755.2	309.4	329.4	349.4	40.0	2.0	351.4
0913	MW	G	4729.2	4709.2	4689.2	328.7	348.7	368.7	40.0	2.0	370.7
0916	MW	G	4721.7	4716.7	4711.7	345.7	350.7	355.7	10.0	2.0	357.7
0919	MW	G	4707.9	4702.9	4697.9	337.7	342.7	347.7	10.0	2.0	349.7
0902	MW	H	4673.7	4668.7	4663.7	63.0	68.0	73.0	10.0	2.0	75.0
0252	MW	I	4658.9	4608.9	4558.9	400.0	450.0	500.0	100.0	0.4	500.4
0254	MW	I	4662.7	4612.7	4562.7	400.0	450.0	500.0	100.0	0.4	500.4
0256	MW	I	4664.0	4614.0	4564.0	400.0	450.0	500.0	100.0	0.4	500.4
0921	MW	I	4663.7	4643.7	4623.7	313.2	333.2	353.2	40.0	2.0	355.2
0253	MW	M	4458.8	4408.8	4358.8	600.0	650.0	700.0	100.0	0.4	700.4
0255	MW	M	4462.3	4412.3	4362.3	600.0	650.0	700.0	100.0	0.4	700.4
0257	MW	M	4463.4	4413.4	4363.4	600.0	650.0	700.0	100.0	0.4	700.4
0968	EXDS		5000.4	4699.9	4399.4	106.0	406.5	707.0	601.0	0.0	707.0
0970	EXDS		5007.7	4705.2	4402.7	100.0	402.5	705.0	605.0	0.0	705.0
0971	EXDS		4985.3	4693.8	4402.3	117.0	408.5	700.0	583.0	0.0	700.0
0972	EXDS		5039.7	4724.7	4409.7	100.0	415.0	730.0	630.0	0.0	730.0

WELL	TYPE	Horizon	TOP OF CASING ELEV	GROUND ELEV	WELL DIAMETER	BORING STARTED	DECOMMISSION DATE	STATE PLANE EAST	STATE PLANE NORTH
0261	MW	D	5069.69	5067.0	2	01-Apr-00		732565	1871578
0264	MW	D	5062.19	5059.6	2	03-Apr-00		731569	1871746
0266	MW	D	5053.32	5050.6	2	15-Apr-00		730380	1870941
0272	MW	D	5064.24	5061.9	2	28-Aug-04		730112	1872389
0273	MW	D	5064.74	5062.4	2	29-Aug-04		730922	1872397
0275	MW	D	5062.64	5061.2	2	01-Sep-04		732092	1872586
0277	MW	D	4982.35	4979.7	2	12-Aug-04		731290	1870777
0278	MW	D	4956.09	4953.4	2	14-Aug-04		731210	1870104
0690	MW	D	4950.87	4948.3	2	30-Mar-00		731521	1870140
0692	MW	D	4953.31	4950.6	2	05-Apr-00		731821	1870303
0695	MW	D	4976.83	4974.3	2	06-Apr-00		732566	1870896
0904	MW	D	4904.11	4901.8	2	07-Nov-84		731808	1868036
0915	MW	D	5070.84	5067.8	4	24-Aug-85		732740	1872209
1003	INJ	D	4976.58	4978.9	6	26-Jul-99		732101	1870898
1004	INJ	D	4961.55	4963.6	6	27-Jul-99		731892	1870544
1005	INJ	D	4947.83	4950.2	6	25-Jul-99		731496	1870168
1006	INJ	D	4947.08	4949.5	6	24-Jul-99		731233	1869918
1007	INJ	D	4958.56	4961.4	6	23-Jul-99		730770	1869861
1101	EXT	D	5067.29	5070.4	6	24-Aug-99		732223	1872970
1102	EXT	D	5066.76	5070.3	6	24-Aug-99		732225	1872670
1103	EXT	D	5059.56	5062.3	6	30-Jul-99		731896	1872407
1104	EXT	D	5059.57	5062.3	6	01-Aug-99		731527	1872404
1105	EXT	D	5059.33	5062.1	6	02-Aug-99		731304	1872401
1106	EXT	D	5059.73	5062.5	6	03-Aug-99		731081	1872400
1107	EXT	D	5059.51	5062.3	6	03-Aug-99		730858	1872398
1108	EXT	D	5059.62	5062.4	6	03-Aug-99		730634	1872396
1109	EXT	D	5059.64	5062.4	6	04-Aug-99		730410	1872394
1110	EXT	D	5059.47	5062.3	6	07-Aug-99		730187	1872392
1111	EXT	D	5059.87	5062.6	6	06-Aug-99		729993	1872392
1112	EXT	D	5057.08	5059.6	6	17-Aug-99		730494	1872064
1113	EXT	D	5058.54	5059.2	6	17-Aug-99		730196	1872061
1114	EXT	D	5056.25	5059.1	6	11-Aug-99		729896	1872057
1115	EXT	D	5056.36	5059.2	6	07-Aug-99		729596	1872055
1119	EXT	D	5061.19	5064.0	6	31-Jul-99		731894	1872667
1120	EXT	D	5063.60	5066.5	6	28-Jul-99		731891	1872967
1121	EXT	D	5066.61	5069.5	6	28-Jul-99		731889	1873267
1122	EXT	D	5067.31	5070.3	6	26-Aug-99		732221	1873269
1123	EXT	D	5064.54	5067.2	6	02-Sep-99		732508	1873222
1124	EXT	D	5063.86	5066.6	6	23-Aug-99		732512	1872972
1125	EXT	D	5065.47	5068.3	6	25-Aug-99		732515	1872671
0251	MW	E	5061.25	5058.9	2	28-Apr-00		730215	1871999
0268	MW	E	5067.24	5064.5	2	15-May-00		732301	1872430
0920	MW	E	4982.97	4980.4	4	30-Jul-85		731262	1870737
0948	EXDS	E	5117.80	5115.4	4	17-Oct-95		733915	1875516
0911	MW	F	5106.96	5104.6	4	18-Jul-85		730265	1875920
0913	MW	G	5060.16	5057.9	4	02-Aug-85		729327	1871871
0916	MW	G	5070.00	5067.4	4	22-Aug-85		732811	1872146
0919	MW	G	5048.56	5045.6	4	26-Aug-85		727353	1868654
0902	MW	H	4737.42	4736.7	2	02-Dec-84		730179	1862292
0252	MW	I	5061.30	5058.9	4	26-Apr-00	*	730232	1871993
0254	MW	I	5065.38	5062.7	4	03-May-00	13-Aug-05	730951	1872411
0256	MW	I	5066.58	5064.0	4	13-May-00	12-Aug-05	732277	1872437
0921	MW	I	4979.08	4976.9	4	22-Jul-85		731379	1870742
0253	MW	M	5061.11	5058.8	4	18-Apr-00	11-Apr-01	730213	1871974
0255	MW	M	5064.89	5062.3	4	01-May-00	14-Aug-05	730947	1872387
0257	MW	M	5066.40	5063.4	4	11-May-00	10-Aug-05	732278	1872414
0968	EXDS		5107.00	5106.4	10			730180	1875689
0970	EXDS		5109.53	5107.7	10			730653	1876567
0971	EXDS		5104.00	5102.3	10			731590	1878306
0972	EXDS		5141.07	5139.7	10			728031	1877986

ALL DIMENSIONS IN FEET EXCEPT WELL DIAMETER IN INCHES
ALL DEPTHS ARE RELATIVE TO GROUND SURFACE

*	CONVERTED TO EXT 8/05
MW	MONITOR WELL
EXT	GROUNDWATER REMEDIATION EXTRACTION WELL
INJ	GROUNDWATER REMEDIATION INJECTION WELL
EXDS	OTHER SUPPLY WELL
**	APPROXIMATE

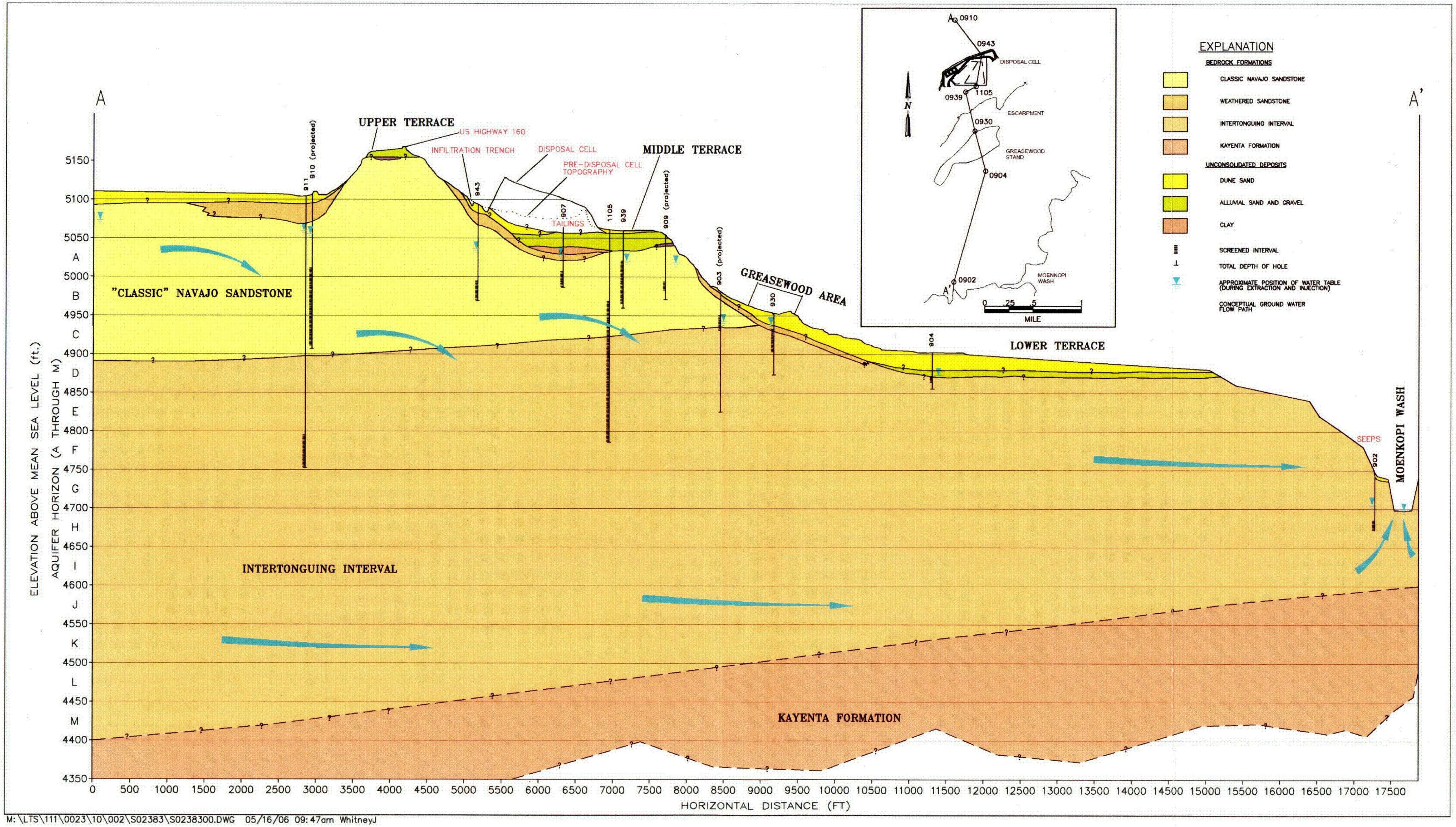

Figure A–1. Conceptual Model of the Site Hydrogeology

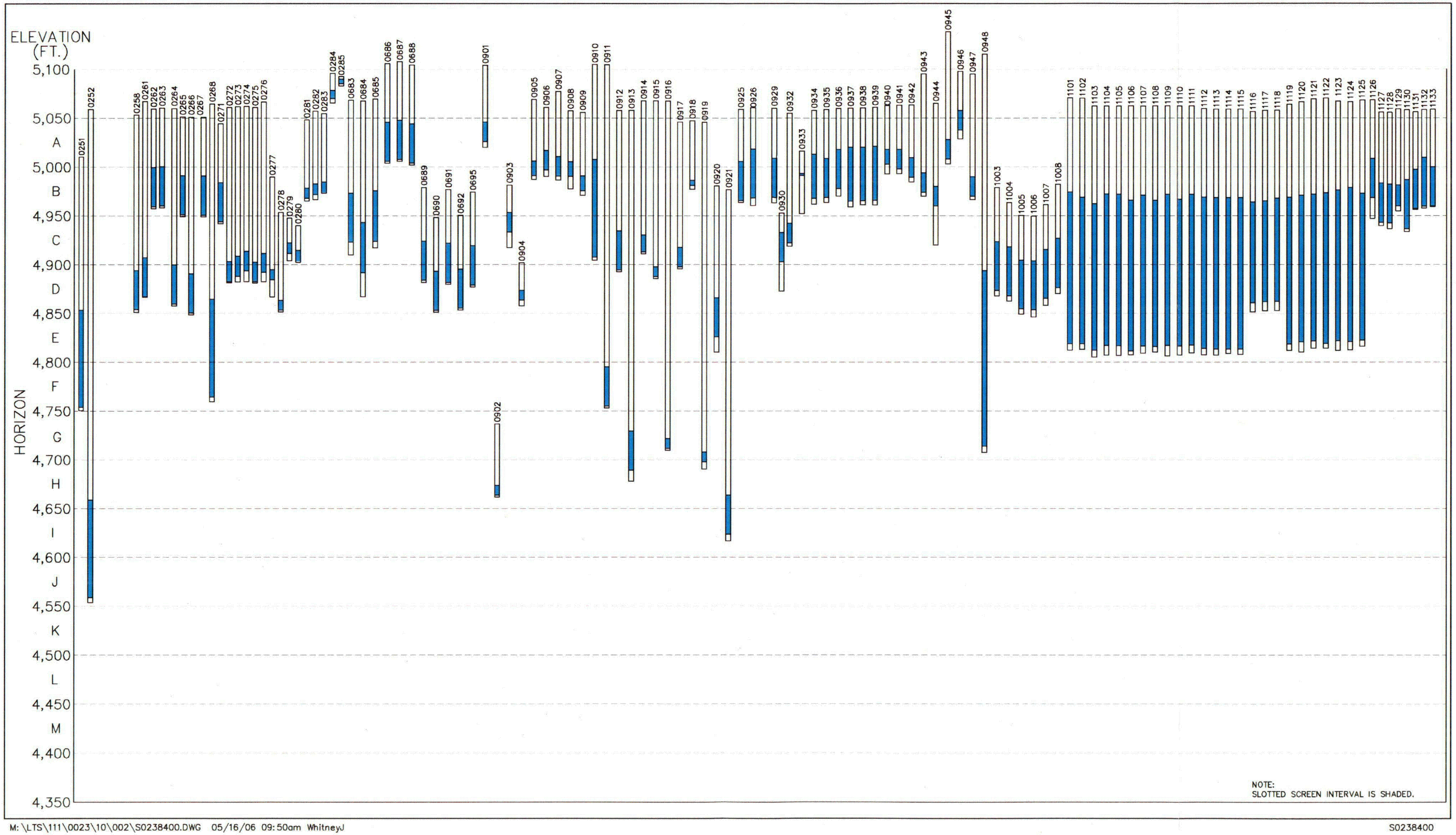

Figure A–2. Well Completions Schematic

Table A-2. Extraction Well Operation Summary—April 2005 through March 2006

	Apr-05							May-05					
Total Time On		29.84	days	q1 gpm	q2 gpm	q3 gpm			30.94	days	q1 gpm	q2 gpm	q3 gpm
Well	Total Time	OST	Gallons	pumping q	operating q	q/month		Total Time	OST	Gallons	pumping q	operating q	q/month
935	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
936	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
938	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
942	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1101	29.83	100%	283,933	6.6	6.6	6.6		30.93	100%	291,423	6.5	6.5	6.5
1102	29.84	100%	180,208	4.2	4.2	4.2		30.90	100%	186,173	4.2	4.2	4.2
1103	29.83	100%	267,992	6.2	6.2	6.2		30.94	100%	276,573	6.2	6.2	6.2
1104	29.68	99%	158,294	3.7	3.7	3.7		30.93	100%	163,765	3.7	3.7	3.7
1105	29.68	99%	265,496	6.2	6.2	6.1		30.84	100%	274,218	6.2	6.2	6.1
1106	29.68	99%	76,109	1.8	1.8	1.8		30.93	100%	79,328	1.8	1.8	1.8
1107	29.64	99%	153,025	3.6	3.6	3.5		30.94	100%	159,612	3.6	3.6	3.6
1108	29.65	99%	201,018	4.7	4.7	4.7		30.94	100%	209,143	4.7	4.7	4.7
1109	29.67	99%	91,493	2.1	2.1	2.1		30.94	100%	98,318	2.2	2.2	2.2
1110	29.41	99%	137,770	3.3	3.2	3.2		30.74	99%	143,139	3.2	3.2	3.2
1111	29.68	99%	137,186	3.2	3.2	3.2		30.93	100%	141,452	3.2	3.2	3.2
1112	29.31	98%	65,590	1.6	1.5	1.5		29.82	96%	76,088	1.8	1.7	1.7
1113	28.90	97%	84,675	2.0	2.0	2.0		21.62	70%	63,163	2.0	1.4	1.4
1114	29.49	99%	179,904	4.2	4.2	4.2		30.93	100%	186,995	4.2	4.2	4.2
1115	29.49	99%	238,675	5.6	5.6	5.5		30.93	100%	250,946	5.6	5.6	5.6
1116	29.49	99%	163,665	0.0	3.8	3.8		30.93	100%	173,029	0.0	3.9	3.9
1117	29.49	99%	126,632	0.0	2.9	2.9		30.93	100%	135,827	0.0	3.0	3.0
1118	29.49	99%	167,416	3.9	3.9	3.9		30.94	100%	174,263	3.9	3.9	3.9
1119	29.84	100%	126,537	2.9	2.9	2.9		30.93	100%	133,466	3.0	3.0	3.0
1120	15.76	53%	158,436	7.0	3.7	3.7		16.24	52%	161,700	6.9	3.6	3.6
1121	29.83	100%	184,187	4.3	4.3	4.3		30.93	100%	192,008	4.3	4.3	4.3
1122	29.83	100%	112,283	2.6	2.6	2.6		18.86	61%	68,947	2.5	1.5	1.5
1123	13.92	47%	8,880	0.4	0.2	0.2		9.60	31%	6,828	0.5	0.2	0.2
1124	29.83	100%	203,285	4.7	4.7	4.7		30.93	100%	211,461	4.7	4.7	4.7
1125	29.53	99%	133,955	3.1	3.1	3.1		29.17	94%	133,433	3.2	3.0	3.0
1126	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1127	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1128	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1129	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1130	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1131	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1132	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1133	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
	total gallons		3,906,643							3,991,299			
	operating q gpm		90.9							89.6			
	days/month		30							31			
	os factor		99%							100%			
	avg monthly q gpm		90							89			
	avg well q gpm			3.5	3.6	3.6					3.5	3.6	3.6

		KEY
total days on for 12-month period	297	total time on = number of days in month that pumps are operating
total days in period	365	total time = number of days in month of pump on-cycle; excludes off-cycle time
net onstream factor calc	81%	ost (on stream time) = total time on / total time
total gals out	38,950,519	q1 = instantaneous pumping rate
avg operating q gpm	91	q2 = effective pumping rate on-cycle plus off-cycle time
net q gpm	74	q3 = effective pumping rate during month

	Jun-05							Jul-05					
		25.56	days	q1 gpm	q2 gpm	q3 gpm			23.35	days	q1 gpm	q2 gpm	q3 gpm
Well	Total Time	OST	Gallons	pumping q	operating q	q/month		Total Time	OST	Gallons	pumping q	operating q	q/month
935	0.00	0%	0	0.0	0.0	0.0		0.11	0%	132	0.8	0.0	0.0
936	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
938	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
942	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1101	25.53	100%	242,125	6.6	6.6	5.6		23.07	99%	220,272	6.6	6.6	4.9
1102	25.53	100%	156,582	4.3	4.3	3.6		23.09	99%	140,996	4.2	4.2	3.2
1103	25.53	100%	227,885	6.2	6.2	5.3		23.23	99%	207,237	6.2	6.2	4.6
1104	25.51	100%	143,482	3.9	3.9	3.3		23.18	99%	132,345	4.0	3.9	3.0
1105	25.48	100%	243,479	6.6	6.6	5.6		23.19	99%	224,920	6.7	6.7	5.0
1106	25.53	100%	72,348	0.0	2.0	1.7		23.20	99%	70,294	2.1	2.1	1.6
1107	25.46	100%	136,189	3.7	3.7	3.2		23.09	99%	118,244	3.6	3.5	2.6
1108	9.93	39%	66,786	4.7	1.8	1.5		2.70	12%	18,463	4.7	0.5	0.4
1109	25.53	100%	91,401	2.5	2.5	2.1		23.21	99%	87,635	2.6	2.6	2.0
1110	25.53	100%	131,729	3.6	3.6	3.0		23.20	99%	120,156	3.6	3.6	2.7
1111	25.52	100%	119,111	3.2	3.2	2.8		23.19	99%	109,518	3.3	3.3	2.5
1112	24.10	94%	78,373	2.3	2.1	1.8		18.78	80%	70,978	2.6	2.1	1.6
1113	0.00	0%	0	0.0	0.0	0.0		0.56	2%	1,625	2.0	0.0	0.0
1114	25.52	100%	163,350	4.4	4.4	3.8		22.45	96%	145,880	4.5	4.3	3.3
1115	25.53	100%	211,693	5.8	5.8	4.9		22.45	96%	186,442	5.8	5.5	4.2
1116	25.53	100%	144,071	0.0	3.9	3.3		22.45	96%	129,173	0.0	3.8	2.9
1117	14.09	55%	61,081	0.0	1.7	1.4		4.99	21%	6,961	0.0	0.2	0.2
1118	25.52	100%	140,708	0.0	3.8	3.3		22.45	96%	128,741	0.0	3.8	2.9
1119	25.53	100%	115,230	3.1	3.1	2.7		23.09	99%	104,732	3.1	3.1	2.3
1120	14.93	58%	168,797	7.9	4.6	3.9		13.84	59%	161,598	8.1	4.8	3.6
1121	25.53	100%	164,317	4.5	4.5	3.8		23.09	99%	148,516	4.5	4.4	3.3
1122	0.00	0%	0	0.0	0.0	0.0		3.82	16%	11,831	2.1	0.4	0.3
1123	8.19	32%	6,049	0.5	0.2	0.1		5.70	24%	4,311	0.5	0.1	0.1
1124	25.53	100%	184,156	5.0	5.0	4.3		23.09	99%	167,298	5.0	5.0	3.7
1125	19.90	78%	96,721	3.4	2.6	2.2		10.35	44%	49,598	3.3	1.5	1.1
1126	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1127	0.00	0%	0	0.0	0.0	0.0		0.01	0%	0	0.0	0.0	0.0
1128	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1129	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1130	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1131	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1132	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1133	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
	total gallons		3,165,661							2,767,897			
	operating q gpm		86.0							82.3			
	days/month		30							31			
	os factor		85%							75%			
	avg monthly q gpm		73							62			
	avg well q gpm			3.3	3.4	2.9					3.5	3.2	2.4

total days on for 12-month period	297
total days in period	365
net onstream factor calc	81%
total gals out	38,950,519
avg operating q gpm	91
net q gpm	74

KEY
total time on = number of days in month that pumps are operating
total time = number of days in month of pump on-cycle; excludes off-cycle time
ost (on stream time) = total time on / total time
q1 = instantaneous pumping rate
q2 = effective pumping rate on-cycle plus off-cycle time
q3 = effective pumping rate during month

Table A–2 (continued). Extraction Well Operation Summary—April 2005 through March 2006

	Aug-05							Sep-05					
		25.27	days	q1 gpm	q2 gpm	q3 gpm			22.06	days	q1 gpm	q2 gpm	q3 gpm
Well	Total Time	OST	Gallons	pumping q	operating q	q/month		Total Time	OST	Gallons	pumping q	operating q	q/month
935	1.65	7%	14,541	6.1	0.4	0.3		1.15	5%	9,779	5.9	0.3	0.2
936	0.14	1%	398	2.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
938	0.13	0%	894	4.9	0.0	0.0		0.08	0%	145	1.3	0.0	0.0
942	1.07	4%	25,294	16.4	0.7	0.6		1.45	7%	27,482	13.2	0.9	0.6
1101	25.20	100%	230,901	6.4	6.3	5.2		21.65	98%	199,015	6.4	6.3	4.6
1102	25.22	100%	158,091	4.4	4.3	3.5		21.62	98%	131,675	4.2	4.1	3.0
1103	24.90	99%	222,476	6.2	6.1	5.0		21.50	97%	191,323	6.2	6.0	4.4
1104	25.22	100%	158,486	4.4	4.4	3.6		21.63	98%	134,787	4.3	4.2	3.1
1105	25.21	100%	263,922	7.3	7.3	5.9		21.65	98%	223,623	7.2	7.0	5.2
1106	25.22	100%	79,062	2.2	2.2	1.8		21.65	98%	65,279	2.1	2.1	1.5
1107	25.21	100%	139,645	3.8	3.8	3.1		21.65	98%	120,668	3.9	3.8	2.8
1108	25.22	100%	165,541	4.6	4.5	3.7		21.65	98%	142,320	4.6	4.5	3.3
1109	25.22	100%	114,856	3.2	3.2	2.6		21.65	98%	103,084	3.3	3.2	2.4
1110	25.22	100%	138,197	3.8	3.8	3.1		21.65	98%	115,037	3.7	3.6	2.7
1111	24.93	99%	131,574	3.7	3.6	2.9		21.65	98%	117,458	3.8	3.7	2.7
1112	22.77	90%	88,435	2.7	2.4	2.0		21.16	96%	72,714	2.4	2.3	1.7
1113	1.68	7%	3,742	1.5	0.1	0.1		2.46	11%	5,087	1.4	0.2	0.1
1114	24.91	99%	172,359	4.8	4.7	3.9		21.13	96%	139,421	4.6	4.4	3.2
1115	24.93	99%	210,833	5.9	5.8	4.7		21.15	96%	177,313	5.8	5.6	4.1
1116	24.93	99%	143,176	4.0	3.9	3.2		21.15	96%	121,500	4.0	3.8	2.8
1117	2.49	10%	7,645	2.1	0.2	0.2		1.37	6%	3,604	1.8	0.1	0.1
1118	24.93	99%	138,938	3.9	3.8	3.1		21.15	96%	116,455	3.8	3.7	2.7
1119	24.93	99%	117,502	3.3	3.2	2.6		21.65	98%	97,645	3.1	3.1	2.3
1120	14.88	59%	148,257	6.9	4.1	3.3		21.62	98%	150,510	4.8	4.7	3.5
1121	25.21	100%	174,666	4.8	4.8	3.9		21.65	98%	146,628	4.7	4.6	3.4
1122	25.22	100%	73,784	2.0	2.0	1.7		21.65	98%	59,717	1.9	1.9	1.4
1123	7.73	31%	6,023	0.5	0.2	0.1		8.86	40%	6,028	0.5	0.2	0.1
1124	25.22	100%	195,818	5.4	5.4	4.4		21.65	98%	165,283	5.3	5.2	3.8
1125	13.29	53%	67,638	3.5	1.9	1.5		10.83	49%	53,409	3.4	1.7	1.2
1126	0.60	2%	55	0.1	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1127	0.16	1%	115	0.5	0.0	0.0		0.26	1%	182	0.5	0.0	0.0
1128	0.76	3%	6,360	5.8	0.2	0.1		0.95	4%	7,628	5.6	0.2	0.2
1129	0.28	1%	2,273	5.7	0.1	0.1		0.48	2%	3,728	5.4	0.1	0.1
1130	1.30	5%	9,257	4.9	0.3	0.2		1.90	9%	14,042	5.1	0.4	0.3
1131	0.06	0%	8	0.1	0.0	0.0		0.00	0%	5	0.0	0.0	0.0
1132	0.42	2%	3,424	5.7	0.1	0.1		0.70	3%	5,627	5.6	0.2	0.1
1133	0.48	2%	4,007	5.8	0.1	0.1		0.75	3%	6,304	5.8	0.2	0.1
	total gallons		3,418,191							2,934,502			
	operating q gpm		93.9							92.4			
	days/month		31							30			
	os factor		82%							74%			
	avg monthly q gpm		77							68			
	avg well q gpm			4.3	2.5	2.1					4.2	2.6	1.9

		KEY
total days on for 12-month period	297	total time on = number of days in month that pumps are operating
total days in period	365	total time = number of days in month of pump on-cycle; excludes off-cycle time
net onstream factor calc	81%	ost (on stream time) = total time on / total time
total gals out	38,950,519	q1 = instantaneous pumping rate
avg operating q gpm	91	q2 = effective pumping rate on-cycle plus off-cycle time
net q gpm	74	q3 = effective pumping rate during month

	Oct-05							Nov-05					
Total Time On		30.98	days	q1 gpm	q2 gpm	q3 gpm			25.28	days	q1 gpm	q2 gpm	q3 gpm
Well	Total Time	OST	Gallons	pumping q	operating q	q/month		Total Time	OST	Gallons	pumping q	operating q	q/month
935	0.00	0%	0	0.0	0.0	0.0		0.01	0%	73	6.1	0.0	0.0
936	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
938	0.10	0%	85	0.6	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
942	1.20	4%	35,092	20.2	0.8	0.8		1.04	4%	30,293	20.2	0.8	0.7
1101	30.97	100%	281,399	6.3	6.3	6.3		25.25	100%	218,880	6.0	6.0	5.1
1102	30.74	99%	176,511	4.0	4.0	4.0		25.10	99%	138,607	3.8	3.8	3.2
1103	30.95	100%	274,035	6.1	6.1	6.1		25.25	100%	220,585	6.1	6.1	5.1
1104	30.96	100%	171,861	3.9	3.9	3.8		25.25	100%	144,475	4.0	4.0	3.3
1105	30.97	100%	279,643	6.3	6.3	6.3		24.40	97%	235,333	6.7	6.5	5.4
1106	30.98	100%	82,084	1.8	1.8	1.8		25.25	100%	68,623	1.9	1.9	1.6
1107	30.94	100%	162,107	3.6	3.6	3.6		25.25	100%	133,979	3.7	3.7	3.1
1108	30.97	100%	195,713	4.4	4.4	4.4		25.25	100%	161,799	4.4	4.4	3.7
1109	30.98	100%	120,072	2.7	2.7	2.7		25.25	100%	103,004	2.8	2.8	2.4
1110	30.98	100%	140,996	3.2	3.2	3.2		25.25	100%	117,475	3.2	3.2	2.7
1111	30.97	100%	163,539	3.7	3.7	3.7		25.25	100%	134,534	3.7	3.7	3.1
1112	30.98	100%	79,896	1.8	1.8	1.8		25.25	100%	71,515	2.0	2.0	1.7
1113	30.98	100%	55,677	1.2	1.2	1.2		25.23	100%	34,689	1.0	1.0	0.8
1114	30.98	100%	184,087	4.1	4.1	4.1		25.24	100%	142,768	3.9	3.9	3.3
1115	30.98	100%	253,193	5.7	5.7	5.7		25.25	100%	200,168	5.5	5.5	4.6
1116	30.98	100%	181,820	4.1	4.1	4.1		25.25	100%	141,155	3.9	3.9	3.3
1117	0.00	0%	0	0.0	0.0	0.0		22.83	90%	176,559	5.4	4.9	4.1
1118	30.98	100%	171,960	3.9	3.9	3.9		25.25	100%	128,171	3.5	3.5	3.0
1119	30.96	100%	133,151	3.0	3.0	3.0		25.25	100%	109,975	3.0	3.0	2.5
1120	30.98	100%	202,430	4.5	4.5	4.5		25.25	100%	165,660	4.6	4.6	3.8
1121	30.95	100%	197,728	4.4	4.4	4.4		25.25	100%	160,828	4.4	4.4	3.7
1122	30.98	100%	76,744	1.7	1.7	1.7		25.25	100%	62,821	1.7	1.7	1.5
1123	12.97	42%	8,202	0.4	0.2	0.2		12.86	51%	8,019	0.4	0.2	0.2
1124	30.98	100%	210,864	4.7	4.7	4.7		25.25	100%	175,518	4.8	4.8	4.1
1125	19.78	64%	89,315	3.1	2.0	2.0		18.93	75%	86,893	3.2	2.4	2.0
1126	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0
1127	0.35	1%	184	0.4	0.0	0.0		0.02	0%	8	0.3	0.0	0.0
1128	0.95	3%	7,342	5.4	0.2	0.2		0.73	3%	5,587	5.3	0.2	0.1
1129	0.60	2%	4,496	5.2	0.1	0.1		0.48	2%	3,668	5.3	0.1	0.1
1130	1.65	5%	13,750	5.8	0.3	0.3		1.18	5%	9,945	5.8	0.3	0.2
1131	9.43	30%	8	0.0	0.0	0.0		0.00	0%	0	0.1	0.0	0.0
1132	0.85	3%	6,766	5.6	0.2	0.2		0.72	3%	5,756	5.5	0.2	0.1
1133	0.90	3%	7,490	5.8	0.2	0.2		0.72	3%	5,908	5.7	0.2	0.1
	total gallons		3,968,237							3,403,270			
	operating q gpm		89.0							93.5			
	days/month		31							30			
	os factor		100%							84%			
	avg monthly q gpm		89							79			
	avg well q gpm			4.2	2.7	2.7					4.4	2.7	2.3

		KEY
total days on for 12-month period	297	total time on = number of days in month that pumps are operating
total days in period	365	total time = number of days in month of pump on-cycle; excludes off-cycle time
net onstream factor calc	81%	ost (on stream time) = total time on / total time
total gals out	38,950,519	q1 = instantaneous pumping rate
avg operating q gpm	91	q2 = effective pumping rate on-cycle plus off-cycle time
net q gpm	74	q3 = effective pumping rate during month

Table A-2 (continued). Extraction Well Operation Summary—April 2005 through March 2006

	Dec-05							Jan-06						
		10.61	days	q1 gpm	q2 gpm	q3 gpm			16.66	days	q1 gpm	q2 gpm	q3 gpm	
Well	Total Time	OST	Gallons	pumping q	operating q	q/month		Total Time	OST	Gallons	pumping q	operating q	q/month	Well
935	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0	935
936	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0	936
938	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0	938
942	0.43	4%	12,654	20.3	0.8	0.3		0.81	5%	23,644	20.2	1.0	0.5	942
1101	10.59	100%	91,780	6.0	6.0	2.1		16.55	99%	152,791	6.4	6.4	3.4	1101
1102	10.54	99%	57,777	3.8	3.8	1.3		16.56	99%	97,268	4.1	4.1	2.2	1102
1103	10.55	99%	91,591	6.0	6.0	2.1		16.49	99%	147,447	6.2	6.1	3.3	1103
1104	10.58	100%	60,753	4.0	4.0	1.4		16.55	99%	110,577	4.6	4.6	2.5	1104
1105	4.22	40%	85,205	14.0	5.6	1.9		8.31	50%	172,949	14.4	7.2	3.9	1105
1106	10.60	100%	28,686	1.9	1.9	0.6		16.56	99%	57,104	2.4	2.4	1.3	1106
1107	10.56	100%	55,988	3.7	3.7	1.3		16.56	99%	96,260	4.0	4.0	2.2	1107
1108	10.60	100%	67,759	4.4	4.4	1.5		16.56	99%	114,466	4.8	4.8	2.6	1108
1109	10.60	100%	42,386	2.8	2.8	0.9		16.56	99%	79,865	3.3	3.3	1.8	1109
1110	10.60	100%	46,840	3.1	3.1	1.0		16.56	99%	81,631	3.4	3.4	1.8	1110
1111	10.59	100%	56,508	3.7	3.7	1.3		16.56	99%	92,463	3.9	3.9	2.1	1111
1112	10.60	100%	29,137	1.9	1.9	0.7		16.57	99%	62,898	2.6	2.6	1.4	1112
1113	10.60	100%	15,202	1.0	1.0	0.3		16.56	99%	30,728	1.3	1.3	0.7	1113
1114	10.60	100%	58,322	3.8	3.8	1.3		16.55	99%	100,879	4.2	4.2	2.3	1114
1115	10.60	100%	83,396	5.5	5.5	1.9		16.56	99%	134,516	5.6	5.6	3.0	1115
1116	10.60	100%	58,770	3.9	3.8	1.3		16.56	99%	96,094	4.0	4.0	2.2	1116
1117	10.59	100%	81,215	5.3	5.3	1.8		16.63	100%	129,582	5.4	5.4	2.9	1117
1118	10.60	100%	51,726	3.4	3.4	1.2		16.57	99%	83,604	3.5	3.5	1.9	1118
1119	10.59	100%	45,737	3.0	3.0	1.0		16.56	99%	90,211	3.8	3.8	2.0	1119
1120	10.60	100%	69,922	4.6	4.6	1.6		16.57	99%	116,453	4.9	4.9	2.6	1120
1121	10.58	100%	67,629	4.4	4.4	1.5		16.56	99%	113,953	4.8	4.7	2.6	1121
1122	10.60	100%	26,153	1.7	1.7	0.6		16.56	99%	53,274	2.2	2.2	1.2	1122
1123	4.20	40%	2,760	0.5	0.2	0.1		9.05	54%	6,198	0.5	0.3	0.1	1123
1124	10.60	100%	72,773	4.8	4.8	1.6		16.56	99%	130,105	5.5	5.4	2.9	1124
1125	9.00	85%	41,977	3.2	2.7	0.9		14.55	87%	77,463	3.7	3.2	1.7	1125
1126	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0	1126
1127	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0	1127
1128	0.28	3%	2,124	5.4	0.1	0.0		0.59	4%	4,505	5.3	0.2	0.1	1128
1129	0.20	2%	1,479	5.2	0.1	0.0		0.36	2%	2,761	5.3	0.1	0.1	1129
1130	0.46	4%	3,855	5.8	0.3	0.1		2.61	16%	17,089	4.5	0.7	0.4	1130
1131	0.00	0%	0	0.0	0.0	0.0		0.00	0%	0	0.0	0.0	0.0	1131
1132	0.30	3%	2,360	5.5	0.2	0.1		0.58	4%	4,639	5.5	0.2	0.1	1132
1133	0.30	3%	2,410	5.7	0.2	0.1		0.55	3%	4,497	5.7	0.2	0.1	1133
	total gallons		1,414,874							2,485,911				
	operating q gpm		92.6							103.6				
	days/month		31							31				
	os factor		34%							54%				
	avg monthly q gpm		32							56				
	avg well q gpm			4.8	3.0	1.0					5.0	3.3	1.8	

total days on for 12-month period	297
total days in period	365
net onstream factor calc	81%
total gals out	38,950,519
avg operating q gpm	91
net q gpm	74

KEY
total time on = number of days in month that pumps are operating
total time = number of days in month of pump on-cycle; excludes off-cycle time
ost (on stream time) = total time on / total time
q1 = instantaneous pumping rate
q2 = effective pumping rate on-cycle plus off-cycle time
q3 = effective pumping rate during month

	Feb-06						Mar-06					
		25.60	days	q1 gpm	q2 gpm	q3 gpm		30.97	days	q1 gpm	q2 gpm	q3 gpm
Well	Total Time	OST	Gallons	pumping q	operating q	q/month	Total Time	OST	Gallons	pumping q	operating q	q/month
935	0.00	0%	11	0.0	0.0	0.0	0.00	0%	0	0.0	0.0	0.0
936	0.00	0%	0	0.0	0.0	0.0	0.00	0%	0	0.0	0.0	0.0
938	0.00	0%	0	0.0	0.0	0.0	0.00	0%	0	0.0	0.0	0.0
942	1.14	4%	33,221	20.2	0.9	0.8	1.40	5%	40,845	20.2	0.9	0.9
1101	25.57	100%	228,427	6.2	6.2	5.7	30.97	100%	271,789	6.1	6.1	6.1
1102	25.56	100%	140,947	3.8	3.8	3.5	30.97	100%	164,250	3.7	3.7	3.7
1103	25.55	100%	224,884	6.1	6.1	5.6	30.97	100%	270,188	6.1	6.1	6.1
1104	25.53	100%	147,883	4.0	4.0	3.7	30.97	100%	168,602	3.8	3.8	3.8
1105	10.16	40%	210,863	14.4	5.7	5.2	11.57	37%	241,979	14.5	5.4	5.4
1106	25.58	100%	72,648	2.0	2.0	1.8	30.97	100%	82,861	1.9	1.9	1.9
1107	25.50	100%	138,213	3.8	3.7	3.4	30.97	100%	163,880	3.7	3.7	3.7
1108	25.57	100%	167,449	4.5	4.5	4.2	30.97	100%	201,080	4.5	4.5	4.5
1109	25.58	100%	104,235	2.8	2.8	2.6	30.97	100%	121,537	2.7	2.7	2.7
1110	25.58	100%	93,250	2.5	2.5	2.3	30.97	100%	73,656	1.7	1.7	1.7
1111	25.56	100%	139,644	3.8	3.8	3.5	30.97	100%	169,699	3.8	3.8	3.8
1112	25.57	100%	71,402	1.9	1.9	1.8	30.97	100%	80,601	1.8	1.8	1.8
1113	25.57	100%	40,346	1.1	1.1	1.0	30.97	100%	46,664	1.0	1.0	1.0
1114	25.57	100%	146,502	4.0	4.0	3.6	30.97	100%	172,114	3.9	3.9	3.9
1115	25.58	100%	199,684	5.4	5.4	5.0	30.97	100%	239,367	5.4	5.4	5.4
1116	25.57	100%	143,254	3.9	3.9	3.6	30.97	100%	172,628	3.9	3.9	3.9
1117	25.55	100%	197,681	5.4	5.4	4.9	30.97	100%	239,213	5.4	5.4	5.4
1118	25.57	100%	124,779	3.4	3.4	3.1	30.97	100%	145,116	3.3	3.3	3.3
1119	25.56	100%	121,454	3.3	3.3	3.0	30.97	100%	136,710	3.1	3.1	3.1
1120	25.57	100%	171,476	4.7	4.7	4.3	30.97	100%	205,808	4.6	4.6	4.6
1121	25.55	100%	164,070	4.5	4.5	4.1	30.97	100%	193,743	4.3	4.3	4.3
1122	25.58	100%	67,555	1.8	1.8	1.7	30.97	100%	76,950	1.7	1.7	1.7
1123	11.06	43%	7,023	0.4	0.2	0.2	19.78	64%	10,212	0.4	0.2	0.2
1124	25.57	100%	182,962	5.0	5.0	4.5	30.97	100%	206,006	4.6	4.6	4.6
1125	18.36	72%	87,398	3.3	2.4	2.2	22.90	74%	104,417	3.2	2.3	2.3
1126	0.00	0%	0	0.0	0.0	0.0	0.00	0%	0	0.0	0.0	0.0
1127	0.08	0%	55	0.5	0.0	0.0	0.32	1%	116	0.3	0.0	0.0
1128	0.63	2%	4,789	5.3	0.1	0.1	0.70	2%	5,001	4.9	0.1	0.1
1129	0.45	2%	3,413	5.3	0.1	0.1	0.53	2%	3,910	5.2	0.1	0.1
1130	1.83	7%	13,974	5.3	0.4	0.3	1.40	5%	11,689	5.8	0.3	0.3
1131	0.00	0%	0	0.0	0.0	0.0	0.00	0%	0	0.0	0.0	0.0
1132	0.71	3%	5,655	5.5	0.2	0.1	0.79	3%	6,449	5.7	0.1	0.1
1133	0.68	3%	5,554	5.7	0.2	0.1	0.77	2%	6,256	5.6	0.1	0.1
		total gallons	3,460,702						4,033,332			
		operating q gpm	93.9						90.4			
		days/month	28						31			
		os factor	91%						100%			
		avg monthly q gpm	86						90			
		avg well q gpm		4.5	2.8	2.6				3.7	214.6	2.8

total days on for 12-month period	297	KEY
total days in period	365	total time on = number of days in month that pumps are operating
net onstream factor calc	81%	total time = number of days in month of pump on-cycle; excludes off-cycle time
total gals out	38,950,519	ost (on stream time) = total time on / total time
avg operating q gpm	91	q1 = instantaneous pumping rate
net q gpm	74	q2 = effective pumping rate on-cycle plus off-cycle time
		q3 = effective pumping rate during month