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Report for the Pilot Investigation of the Buckman Well Field Piezometers

Prepared by the Environmental Programs Directorate

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May 2012

Responsible project manager:

| | | | | |
|--------------|---|--------------------|---------------------------|----------------|
| Steve Paris |  | Project Manager | Environmental Programs | April 27, 2012 |
| Printed Name | Signature | Title | Organization | Date |

Responsible LANS representative:

| | | | | |
|-------------------|---|-----------------------|---------------------------|-------------|
| Michael J. Graham |  | Associate Director | Environmental Programs | 27 April 12 |
| Printed Name | Signature | Title | Organization | Date |

Responsible DOE representative:

| | | | | |
|----------------|---|----------------------|--------------|-----------|
| Peter Maggiore |  | Assistant Manager | DOE-LASO | 4-27-2012 |
| Printed Name | Signature | Title | Organization | Date |

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Acronyms and Abbreviations

| | |
|------|-----------------------------------|
| B | Buckman (well) |
| bgs | below ground surface |
| BWF | Buckman well field |
| CV | casing volume |
| DO | dissolved oxygen |
| DP | drop pipe |
| GPM | gallons per minute |
| LANL | Los Alamos National Laboratory |
| NMED | New Mexico Environment Department |
| MDA | minimum detectable activity |
| MDL | method detection limit |
| mV | millivolt |
| NTU | nephelometric turbidity unit |
| ORP | oxidation-reduction potential |
| PQL | practical quantitation limit |
| SW | surface water |
| TDS | total dissolved solids |
| UTL | upper tolerance limit |

1.0 BACKGROUND

1.1 Introduction

Los Alamos National Laboratory (LANL or the Laboratory) submitted a work plan for a pilot investigation of existing piezometers within the Buckman well field (BWF) in August 2011 (Figures 1.1-1 and 1.1-2) (LANL 2011, 205710). The work plan was approved by the New Mexico Environment Department (NMED 2011, 206475), and implemented to determine if existing piezometers next to the BWF might be useful for supplementing monitoring currently being conducted on a quarterly basis within three water-supply wells in the BWF. Using the piezometers as monitoring points allows monitoring from more discrete stratigraphic horizons near the top of the groundwater production zone in the BWF than what is currently being monitored using the water-supply wells (Figure 1.1-3). Information gathered from this pilot investigation and presented in this report are the basis for determining additional monitoring of the BWF. The overall approach follows from the conceptual model presented in section 2 of this report. Data collected from the piezometers are summarized in section 3 and evaluated in section 4. Recommendations regarding the continued use of these piezometers as monitoring points are presented in section 5.

Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to NMED in accordance with U.S. Department of Energy policy.

1.2 Objectives

The objectives for this pilot investigation are

1. to assess the general representativeness of groundwater samples obtained from the piezometers without redeveloping or removing downhole objects or obstacles,
2. if data are representative, to assess whether there is any indication of contamination from the Laboratory in groundwater samples obtained from the piezometers, and
3. to gather data to supplement existing information to assess whether the groundwater produced in the BWF (water-supply wells or deep piezometers) has a recognizable component of water that originates from beneath the Pajarito Plateau.

Presently, the Laboratory collects samples on a quarterly basis from supply wells Buckman 1 (B-1), B-6, and B-8. Although groundwater-quality data from these water-supply wells directly inform the quality of water delivered into the BWF treatment and distribution system, these samples represent groundwater quality integrated over long screen lengths. The piezometers, in contrast, allow for sampling of more discrete stratigraphic horizons.

1.3 Scope

Two rounds of data were collected during the pilot investigation: the first round was collected in September and October 2011, and the second round was collected during the last week of January 2012. For each piezometer, the A-series is the deepest screen, the C-series is the shallowest screen, and the B-series is intermediate in depth between the A-series and C-series. Samples were collected from piezometers SF-2B, SF-3A, and SF-4A, each screened near or within one of the same stratigraphic depth intervals as nearby water-supply wells B-1 and B-8 (Figure 1.1-3). Samples were also collected from

piezometer SF-4C, which is in a shallow groundwater zone that shows water-level responses consistent with changes in stage in the Rio Grande.

The first round of sampling was attempted using a Bennett pump for the deeper screens (SF-2B, SF-3A, and SF-4A) and a portable bladder pump for the shallow screen (SF-4C). Because of a buoyancy problem with the mobile Bennett pump system, the sampling crew was unable to lower the Bennett pump down to the screened intervals in the deeper piezometers. As a result, piezometer SF-3A was sampled 80 ft above the top of the screen and piezometer SF-4A was sampled 110 ft above the top of the screen during the first round. A Grundfos submersible pump was retrofitted as a mobile pump and successfully used to sample screen SF-2B during the first sampling round and again to sample all of the deeper screens during the second sampling round.

Field parameters, including dissolved oxygen (DO), specific conductance, temperature, pH, and turbidity, were monitored using flow-through cells. During the first round, the deeper screens were sampled after purging between ~0.5 casing volume (CV) and 2 CVs once DO, specific conductance, and pH had stabilized. During the second round, samples were collected after purging 1 CV and stability was achieved in all field parameters. The shallow piezometer SF-4C was sampled using low flow techniques after field parameters had stabilized for both sampling rounds.

Time-series samples were collected from SF-2B during the second round to determine if analyte concentrations had stabilized during purging; these samples were submitted to the Laboratory's on-site laboratory for analysis.

Both rounds of samples were analyzed for metals, general inorganics, and radionuclides. Samples SF-2B, SF-3A, and SF-4A were also analyzed for stable isotopes of oxygen and deuterium in water, stable isotopes of nitrogen and oxygen in nitrate, and stable carbon isotopes to assist in addressing the objective of assessing potential mixing of waters within the BWF.

The data from these two rounds of sampling are presented in section 3 and evaluated along with existing analytical data and other information in section 4 to address the objectives of this pilot investigation.

2.0 CONCEPTUAL MODEL

The artesian conditions in the shallow aquifer indicate that this aquifer is hydraulically disconnected from the aquifer pumped by the BWF (Vesselinov 2010, 215853). The shallow aquifer is present in the area between wells B-1 and B-8 at piezometer nests SF-3, SF-4, and SF-5. A piezometer nest consists of a group of piezometers located either within the same borehole or in boreholes located in close proximity to each other with screens positioned to sample distinct stratigraphic zones. The spatial extent of the shallow aquifer and the origin of groundwater are not known. The artesian conditions not only isolate the shallow aquifer but also create upward flow gradients that may inhibit groundwater flow and contaminant migration toward the deep aquifer pumped by the well field. Four piezometer nests are located near supply wells B-8 and B-1 (Figure 1.1-2). Each piezometer nest consists of three discrete screened horizons, shown in Figure 1.1-3.

Figures 2.0-1 and 2.0-2 show a group of hydrographs for each screened horizon in piezometer nests SF-2, SF-3, SF-4, and SF-5. Review of these hydrographs indicates the following.

- The deep piezometer screens (SF-3A, SF-4A, and SF-2C) show very similar hydrographs (Figure 2.0-1), indicating the screens in these piezometers monitor pressures in the same hydrostratigraphic zone. These screens are within or near the top of the screened intervals of nearby B-1 and B-8 (Figure 1.1-3). The pressure responses in these deep piezometer screens

show some response to pumping at B-1 and are nonresponsive to pumping at B-8. (Note the water-level response to reduced water-supply pumping at well B-1 after 2004 in Figure 2.0-1.)

- The intermediate zones (B-series screens in SF-3, SF-4, and SF-5) are under confined conditions and do not show response to pumping. The pressure heads in the B-series screens are higher than those in the deeper (A-series) and shallow (C-series) screens.
- The shallow piezometer screens (C-series screens in SF-3, SF-4, and SF-5) show consistent variations in water level that have an apparent seasonality with the highest water level generally occurring in late spring or early summer, indicating probable hydraulic connection to stage in the Rio Grande (dashed lines in Figure 2.0-2). The shallow piezometers appear to monitor within a shallow inset alluvial deposit likely associated with deposits of Ancha Arroyo.
- The hydrostratigraphic zones monitored by the A-, B-, and C-series screens in SF-3, SF-4, and SF-5 appear to be hydraulically isolated from each other.

In contrast, water levels in SF-2B are more strongly influenced by the pumping of B-1 as compared with the A-series screens of SF-3, SF-4, and SF-5 (Figure 2.0-1). Samples were collected from SF-2B to evaluate the vertical stratification of groundwater geochemistry within the aquifer.

3.0 DATA

Data collected during this investigation are summarized in the figures and tables listed below. For comparison, water-quality data for groundwater samples collected from water-supply wells B-1, B-6, and B-8 in 2011 are also included.

- Time-series of field parameters monitored at each piezometer during purging (Figures 3.0-1 to 3.0-4)
- Final field parameters (Table 3.0-1)
- Analytical data for general inorganics (Figures 3.0-5 to 3.0-9; Table 3.0-2)
- Analytical data for metals in filtered samples (Figures 3.0-5 to 3.0-8; Table 3.0-3)
- Analytical data for metals in unfiltered samples (Table 3.0-4)
- Analytical data for radionuclides (Table 3.0-5)

Figures 3.0-5 to 3.0-8 are concentration profiles (hereafter, “fingerprint” plots) for the groundwater that facilitate quick visual comparison of geochemical conditions. Upper tolerance limit (UTLs) for background regional groundwater beneath the Pajarito Plateau (LANL 2011, 207447) are indicated on these plots, although these UTLs are not directly comparable with regional groundwater in the BWF.

The trilinear (Piper) plot shown in Figure 3.0-9 is a common graphical tool used to identify waters with similar chemistries and to compare relative major-ion concentrations with those of other local groundwaters.

Attachment 1 (on CD included with this report) includes the full set of analytical data for the BWF piezometers.

4.0 DATA ASSESSMENT

4.1 Evaluation of Representativeness

Piezometer SF-2B produces water-quality samples for which some, but not all, constituents are likely representative of ambient groundwater at this location. Concentrations of some trace metals and major cations are compromised in unfiltered samples by the presence of iron corrosion products and silt. These influences are not as problematic in filtered samples and only minimally affect the reliability of data for most mobile contaminants of interest (e.g., tritium, chloride, and sulfate). These conclusions are based on the following lines of evidence from both rounds of samples.

- Key field parameters largely stabilized at the tail end of purging (Figure 3.0-1). However, water collected throughout the purge was described as having a dark grey color, a strong odor, and noticeable suspended flakes. The field team for the October 2011 sampling event also noted the dirty condition of the downhole pump tubing (which had been decontaminated before it was used) when it was retrieved at the end of sampling.
- Final field parameters showed high turbidity (≥ 100 nephelometric turbidity unit [NTU]), low DO (1 mg/L), negative oxidation-reduction potential (ORP), and high specific conductance (>900 $\mu\text{S}/\text{cm}$) (Table 3.0-1).
- Iron concentrations were moderately elevated in the filtered sample (548 $\mu\text{g}/\text{L}$ in the 1-CV sample collected in January 2012) and considerably elevated in unfiltered samples (10,700 $\mu\text{g}/\text{L}$) (Tables 3.0-3 and 3.0-4). The high ratio of unfiltered to filtered iron concentrations (ratio >10) indicates the presence of metal corrosion products, possibly from corrosion of the piezometer's steel casing. The presence of iron corrosion products affects the reliability of trace metals that may adsorb to these particulates.
- Unfiltered concentrations of lead (229 $\mu\text{g}/\text{L}$) and zinc (298 $\mu\text{g}/\text{L}$) were notably elevated above those in filtered samples in which concentrations of these metals were below the practical quantitation limit (PQL) (Tables 3.0-3 and 3.0-4). Lead and zinc concentrations in unfiltered samples covaried with those of manganese, indicating a common origin for these three trace metals.
- Elevated aluminum concentrations (2410 $\mu\text{g}/\text{L}$ and 3650 $\mu\text{g}/\text{L}$) in unfiltered samples reflect the presence of silt in the well. This trace metal was not detected in filtered samples.
- Nitrate and perchlorate were detected at low concentrations.
- High concentrations of alkaline-earth metals (calcium, magnesium, barium, and strontium) and carbonate alkalinity (Tables 3.0-2 and 3.0-3) are consistent with the presence of carbonate minerals in the Santa Fe Group sediments.
- Elevated concentrations of uranium (42 $\mu\text{g}/\text{L}$ in the filtered sample; Table 3.0-3) are typical of some of the groundwaters produced in the BWF (Johnson et al. 2008, 214892).

Piezometer SF-3A produces water-quality samples representative of ambient groundwater at this location. This conclusion is based on the following lines of evidence from both rounds of samples.

- Key field parameters stabilized during purging (Figure 3.0-2). Water discharged throughout the purge was described as clear with no odor.
- Final field parameters indicated representative groundwater, with low turbidity (2 NTU and 3 NTU), low specific conductance (177 $\mu\text{S}/\text{cm}$ and 180 $\mu\text{S}/\text{cm}$), moderately high DO concentrations (6 mg/L), and positive ORP (16 millivolts [mV] and 131 mV) (Table 3.0-1).

- Concentrations of general inorganic anions were low and appear to be representative of ambient groundwater quality: chloride (1.7 mg/L and 1.8 mg/L), sulfate (3.1 mg/L and 3.3 mg/L), nitrate+nitrite (0.4 mg/L and 0.5 mg/L as N), and perchlorate (0.3 µg/L) (Table 3.0-2).
- Trace metal concentrations were generally low or else were not detected above the PQL. For example, iron was below detection in the filtered sample and detected below the PQL in the unfiltered sample (Tables 3.0-3 and 3.0-4). The similarity between results for filtered and unfiltered samples indicates the absence of a significant particulate fraction. Such low iron concentrations are typical of groundwater with detectable DO.

Piezometer SF-4A produces water-quality samples representative of ambient groundwater at this location. This conclusion is based on the following lines of evidence from both rounds of samples.

- Key field parameters stabilized during purging (Figure 3.0-3). Water discharged during purging was described as having a brown tint initially but was clear after purging 0.5 CV.
- Final field parameters indicated representative groundwater with moderate turbidity (6 NTU and 12 NTU), moderately high DO concentrations (6 mg/L), positive ORP (101 mV and 104 mV), and low specific conductance (181 µS/cm and 186 µS/cm) (Table 3.0-1).
- Concentrations of general inorganic anions were low and are representative of ambient groundwater quality: chloride (1.8 mg/L), sulfate (3.1 mg/L and 3.2 mg/L), nitrate+nitrite (0.3 mg/L and 0.4 mg/L as N), and perchlorate (0.3 µg/L) (Table 3.0-2).
- Trace metal concentrations in filtered samples were generally low.
- In unfiltered samples, iron was notably higher (699 µg/L and 885 µg/L), which is consistent with the moderate turbidity of the water. Suspended iron may derive from the tape-like object, tentatively identified as a corroded metal measuring tape found obstructing the well when the downhole video log was obtained.

Piezometer SF-4C produces water-quality samples representative of ambient groundwater at this location. This conclusion is based on the following lines of evidence from both rounds of samples.

- Key field parameters stabilized during purging (Figure 3.0-4). Water discharged during purging was described as clear and odorless.
- Final field parameters were representative of ambient groundwater, with low turbidity (<5 NTU), moderately high DO concentrations (6 mg/L and 7 mg/L), positive ORP (38 mV and 200 mV), and moderate specific conductance (422 µS/cm and 431 µS/cm) (Table 3.0-1).
- Concentrations of general inorganic anions were low and are representative of ambient groundwater quality: chloride (2.4 mg/L and 2.5 mg/L), sulfate (12 mg/L), and perchlorate (0.6 µg/L) (Table 3.0-2). Elevated values of nitrate+nitrite (5.2 mg/L and 6.8 mg/L as N) in this shallow piezometer are inferred to be from the grazing of cattle in this area.
- Trace metal concentrations in filtered samples were generally low.

4.2 Evaluation of Groundwater Samples for Laboratory-Derived Contaminants

Water-quality data for the samples obtained from the piezometers are examined for any indication of contamination from the Laboratory, particularly for mobile contaminants: tritium, chloride, perchlorate, nitrate, and chromium.

- There is no indication of tritium as a contaminant originally from Laboratory sources. Tritium was below the minimum detectable activity (MDA) in piezometers SF-2B, SF-3A, and SF-4A as well as in wells B-1, B-6, and B-8. Tritium was detected only in the shallowest piezometer, SF-4C, at 16 pCi/L (Table 3.0-5), which is within the range of modern precipitation and generally is consistent with concentrations measured in base-flow conditions in the Rio Grande.
- There is no indication of Laboratory-derived radionuclides such as americium-241, cesium-137, strontium-90, or plutonium isotopes (Table 3.0-5).
- There is no indication of the presence of chloride, perchlorate, nitrate, or chromium as Laboratory-derived contaminants in groundwater at piezometers SF-3A or SF-4A. The concentrations of these constituents were within the range of values for groundwater in the Española Basin (Johnson et al. 2008, 214892). These constituent concentrations were also within the range of background concentrations for the groundwater beneath the Pajarito Plateau (Figure 3.0-5).
- The poor groundwater conditions in SF-2B from corrosion preclude a reliable evaluation of potential contamination.
- There is no indication of Laboratory-derived contaminants in SF-4C. The slightly elevated nitrate is more likely associated with the presence of livestock that graze in the Ancha Arroyo/BWF area.

4.3 Comparison of Groundwater Chemistry within the BWF with Groundwater Chemistry beneath the Pajarito Plateau

Water-quality data for the samples obtained from the piezometers supplement existing information to assess whether the groundwater produced in the BWF has a recognizable component of water that originates from beneath the Pajarito Plateau.

Wells in the BWF draw groundwater from Santa Fe Group sediments, which consist of sandstones, siltstones, and some interbedded basalts (Collins et al. 2005, 092028, Table 3-A-10). Groundwater in these wells is quite old, having passed through the deeper portion of the Española Basin–fill sediments where it acquired a higher load of dissolved solutes (Vesselinov and Keating 2002, 089752). Some Buckman wells have elevated uranium (up to 230 µg/L in B-2). Such naturally occurring uranium is common in waters sourced from deep zones of the Tesuque Formation in this part of the Española Basin (Johnson et al. 2008, 214892). The Buckman wells also have high concentrations of sodium, alkalinity, and total dissolved solids (TDS) as has been documented by earlier studies (e.g., Johnson et al. 2008, 214892) (Figures 3.0-6 to 3.0-8 and Table 3.0-2). These data are similar to earlier data collected from wells within the Espanola Basin and reinforce the conceptual model that water in the BWF originates from the east (Johnson et al. 2008, 214892).

Evidence of the presence of groundwater originating from the eastern portion of the Española Basin rather than from beneath the Pajarito Plateau is further evaluated in this report using graphical approaches. On a trilinear plot (Figure 3.0-9), relative major-ion concentrations for groundwater collected from the three wells plot in distinctly different (nonoverlapping) fields, indicating different degrees of mixing of waters of different origins or ages. Each of the four piezometers corresponds closely with one well on this plot. Relative major-ion concentrations in groundwater from piezometers SF-3A and SF-4A

form a tight cluster with well B-1 despite having generally lower major-ion concentrations (e.g., the fingerprint plot for major ion concentrations in groundwater from SF-3A and SF-4A in Figure 3.0-5 can be compared with the plot for groundwater from well B-1 in Figure 3.0-6). Higher absolute concentrations of major ions in groundwater from well B-1 may reflect contributions of groundwater from slightly different lithologies or with longer residence times. The clustering of data from SF-3A and SF-4A with B-1 is consistent with the hydrologic connection observed from water-level data.

For comparison, two Laboratory monitoring wells, R-10 and R-16 located west of the Rio Grande, are also included in Figure 3.0-9. The distinct chemistry of the groundwater in these two wells, especially relative to water-supply wells B-1 and B-8 is further evidence that groundwater beneath the Pajarito Plateau is not mixed with groundwater from within the BWF.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The deep piezometers (SF-2B, SF-3A, and SF-4A) are of particular interest as potential future monitoring locations because their screened intervals are near or within the screened portions of nearby water-supply wells B-1 and B-8. Piezometer SF-2B responds to pumping of nearby B-1; however, not all constituents are likely representative of ambient groundwater at this location. Piezometers SF-3A and SF-4A respond to pumping in nearby B-1 but do not appear to respond to pumping at B-8 even with their relatively close proximity to B-8. Evaluation of groundwater chemistry obtained from this study, in conjunction with previously collected data, indicates groundwater from the deep piezometers is similar to that of B-1 and has a geochemical signature distinctly different from groundwater beneath the Pajarito Plateau. The absence of detectable tritium in the deep piezometers and in the water-supply wells in the BWF is one line of evidence indicating no contamination is present within the deeper confined portions of the BWF. An additional line of evidence is that no other potential Laboratory-derived contaminants with generally high mobility in groundwater (e.g., chromium, nitrate, or perchlorate) are present within the water-supply wells or within the more discrete stratigraphic horizons monitored by the deep piezometers. Groundwater data from this study also correlate well with data compiled by Johnson et al. (2008, 214892) and reflect waters found in this portion of the Española Basin.

SF-4C shows a clear connection to changes in stage in the Rio Grande (Figure 2.0-2). As expected, based on its stratigraphic position and the hydrologic response relative to changes in stage in the Rio Grande, SF-4C is distinctly different from B-1 and B-8. Somewhat unexpectedly, the chemistry of SF-4C aligns most closely with B-6 and not with that of the Rio Grande. Nitrate detected in SF-4C is thought to be related to the presence of livestock grazing in the area.

The results of this study also indicate that samples collected from piezometers SF-3A and SF-4A provide representative data. Because these deep piezometers monitor a discrete stratigraphic horizon near the top of the screened interval of nearby B-1 and B-8, they could potentially supplement the Laboratory's program of monitoring directly within water-supply wells. The recommendation is to include monitoring within SF-3A and SF-4A on a triennial basis to supplement monitoring within water-supply wells. The piezometers would be used in lieu of installation of regional aquifer well R-58 (the "Buckman Sentinel") as required most recently by NMED's approval letter dated November 2, 2009 (NMED 2009, 107353). If approved, monitoring in the piezometers would be conducted for mobile constituents of possible Laboratory origin including tritium, perchlorate, nitrate, and chromium. The monitoring requirements will be incorporated into the Laboratory Sitewide Monitoring Program, City of Santa Fe Buckman Supply Wells, 2013–2014 Sampling and Analysis Plan.

6.0 REFERENCES

The following list includes all documents cited in this report. Parenthetical information following each reference provides the author(s), publication date, and ER ID. This information is also included in text citations. ER IDs are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

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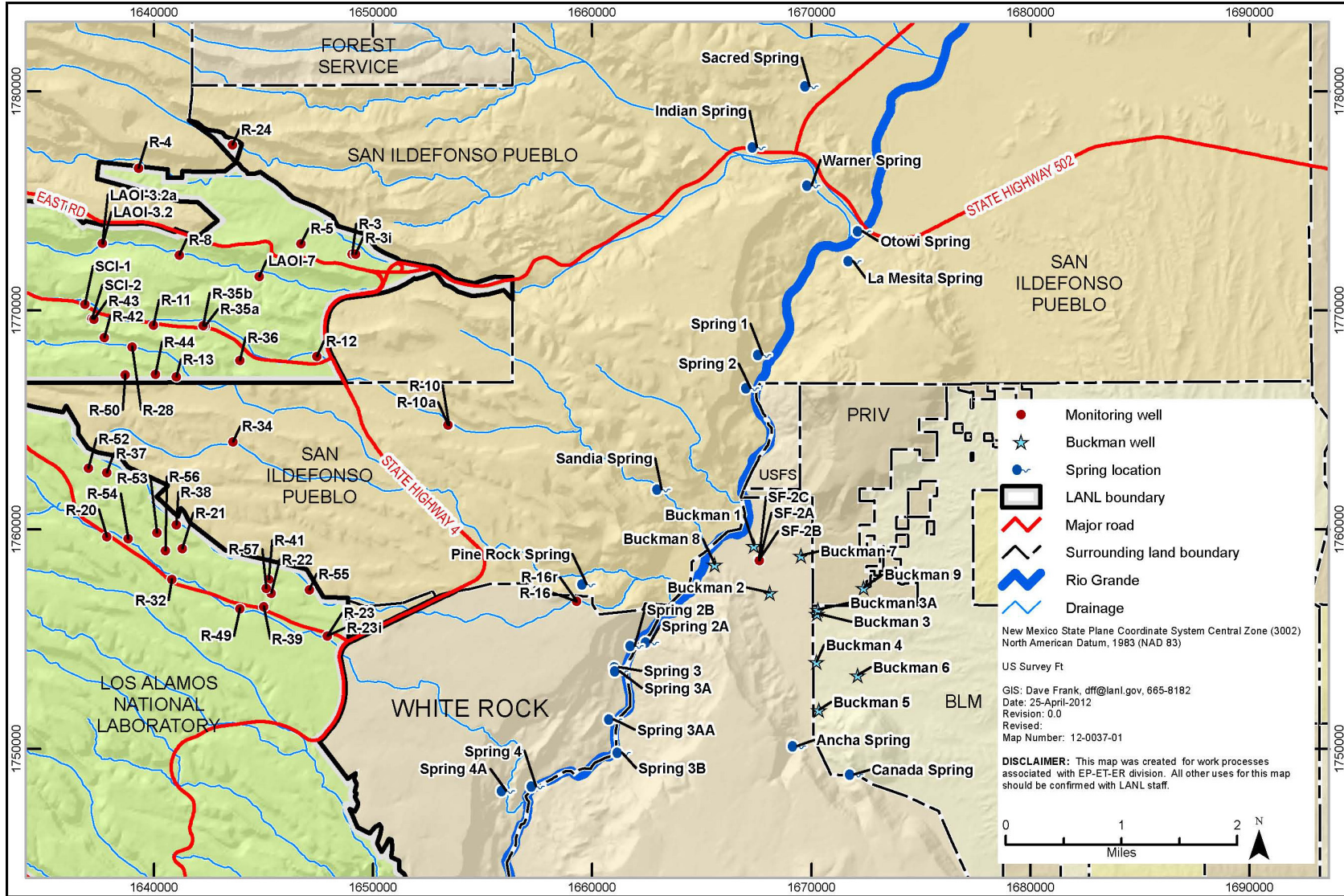
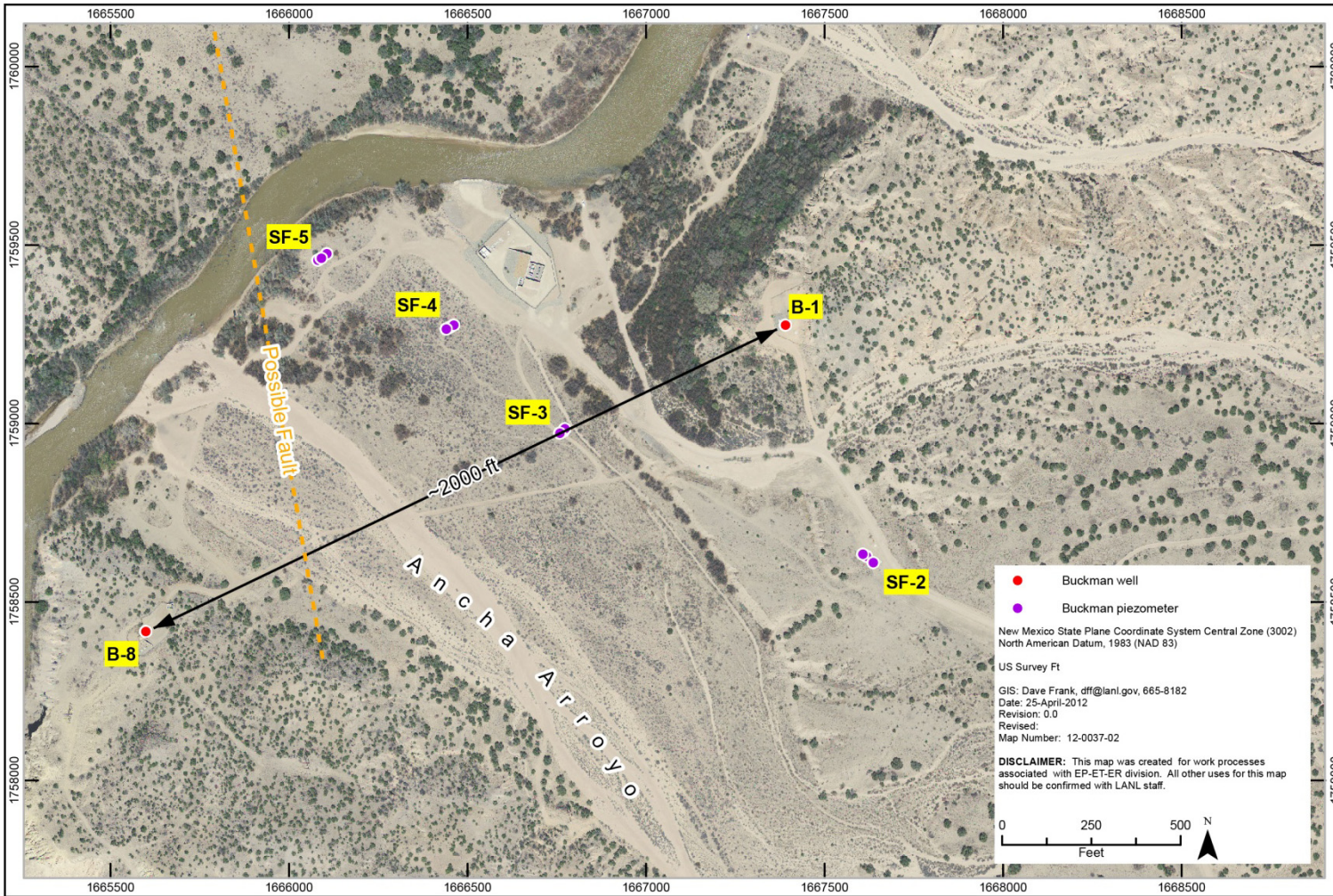
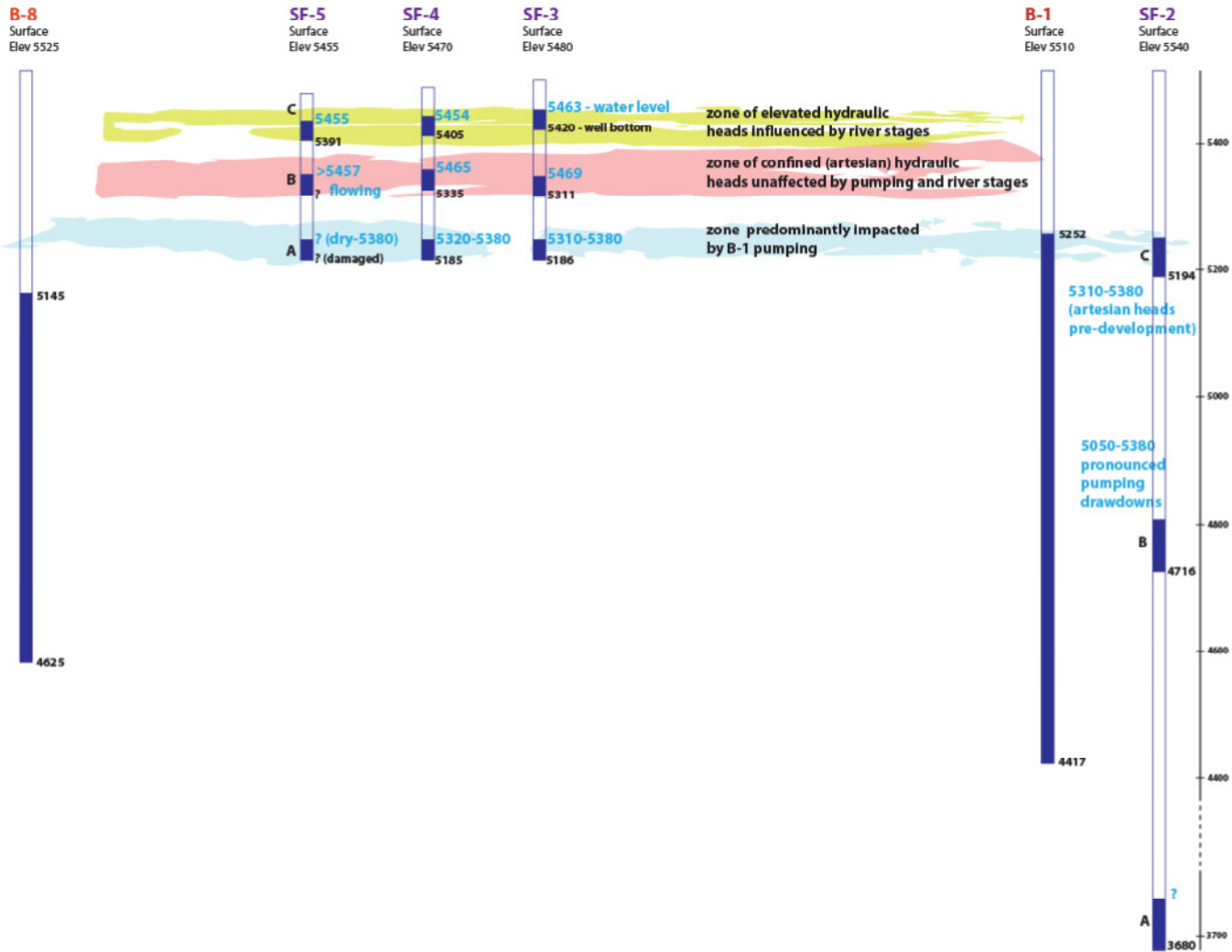


Figure 1.1-1 General location of BWF



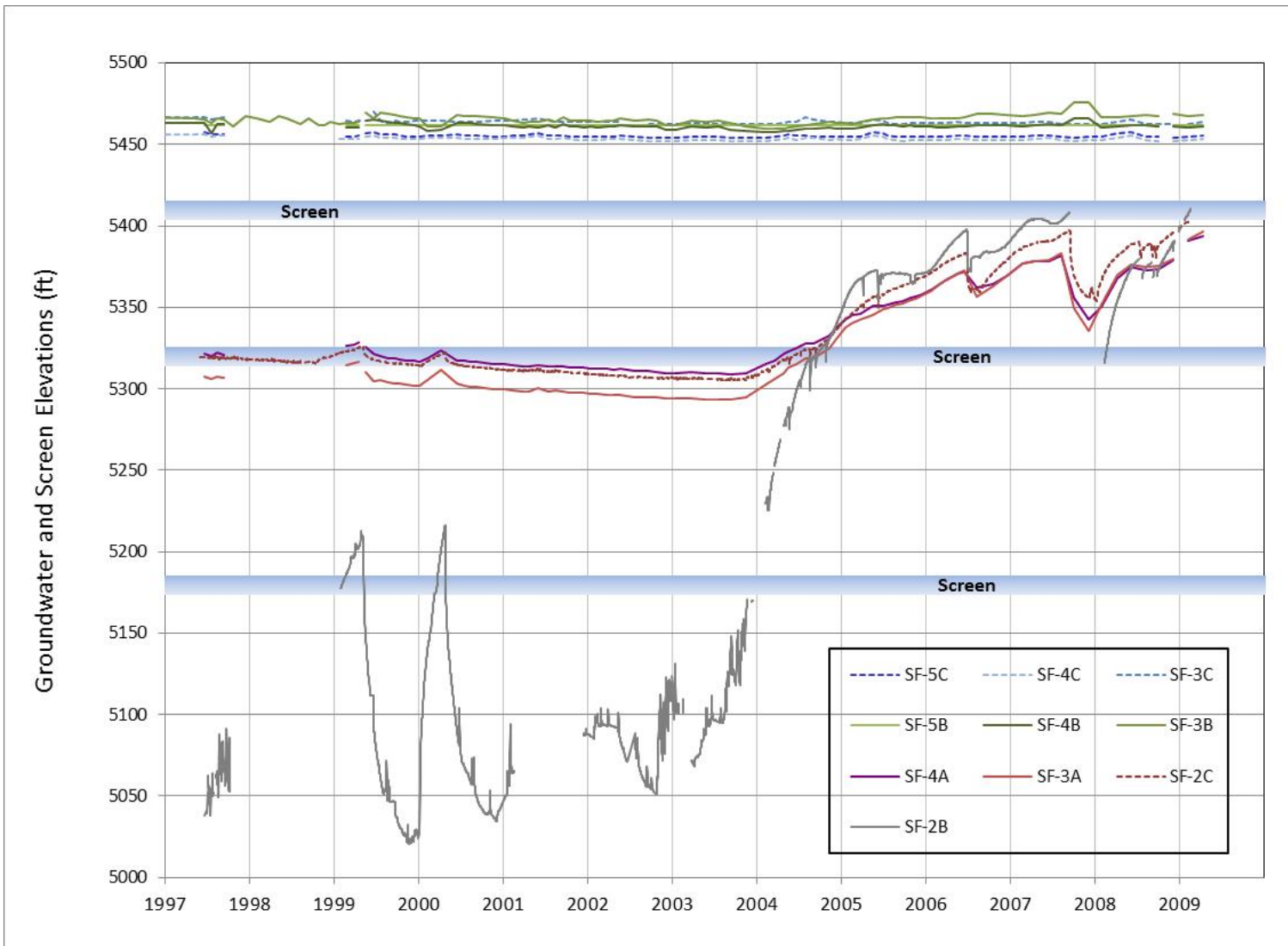
Note: The dashed line shows the location of a potential fault zone.

Figure 1.1-2 Location of Buckman piezometers SF-2, SF-3, SF-4, and SF-5 and water-supply wells B-1 and B-8



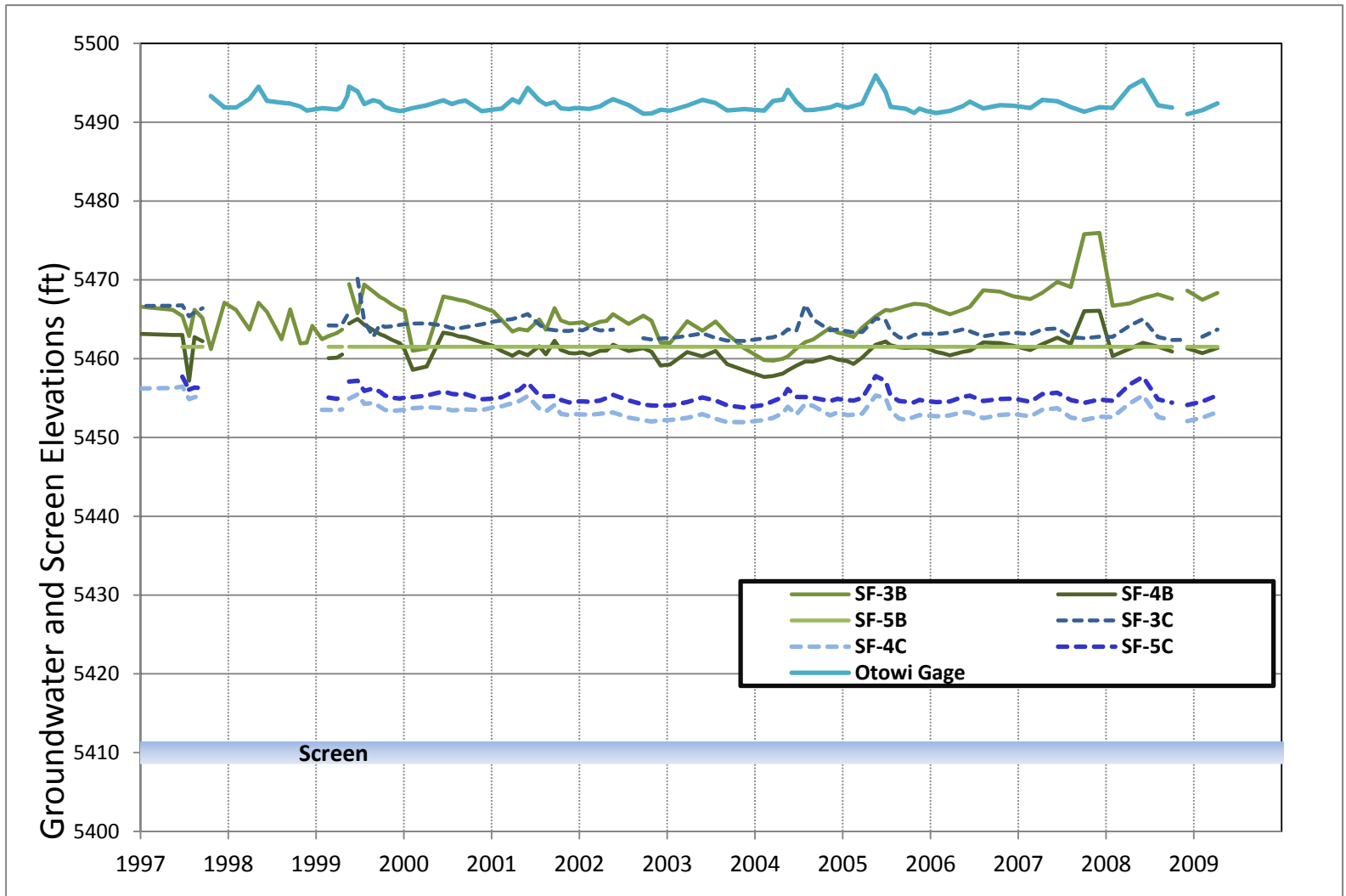
Note: The observed water levels (approximate) are provided in blue. Elevations are in feet above mean sea level.

Figure 1.1-3 Conceptual hydrogeologic cross-section showing the depths of piezometers and water-supply well screens



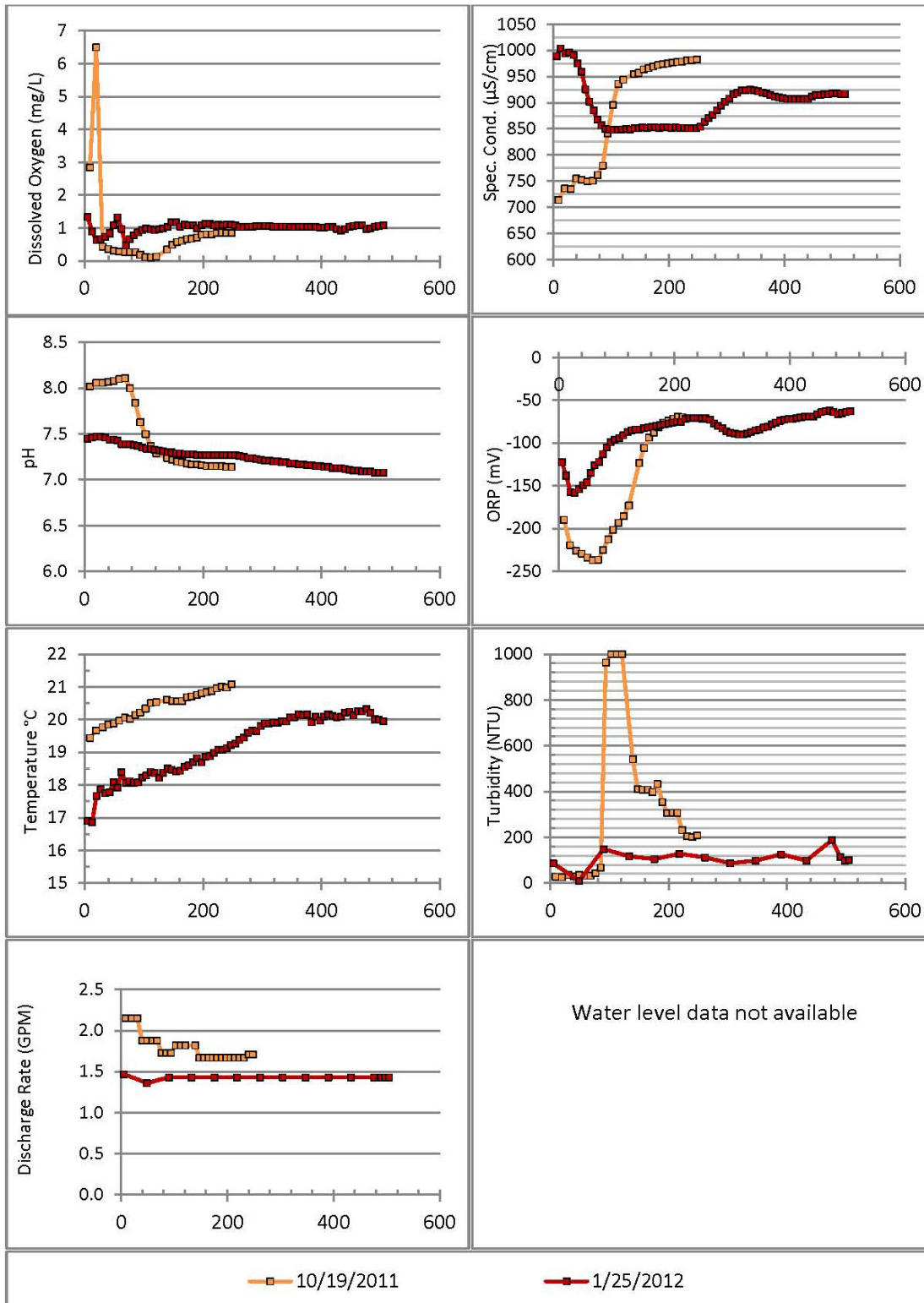
Notes: Water-level elevations observed at SF-2 are also included. The general trend of water-level recovery observed at SF-2 and the A-series screens of SF-3 and SF-4 since 2004 correlates with reduced water-supply pumping at well B-1. Elevations are in feet above mean sea level.

Figure 2.0-1 Water levels (hydraulic heads) and screen elevations (blue bands) of BWF piezometers SF-2, SF-3, SF-4, and SF-5



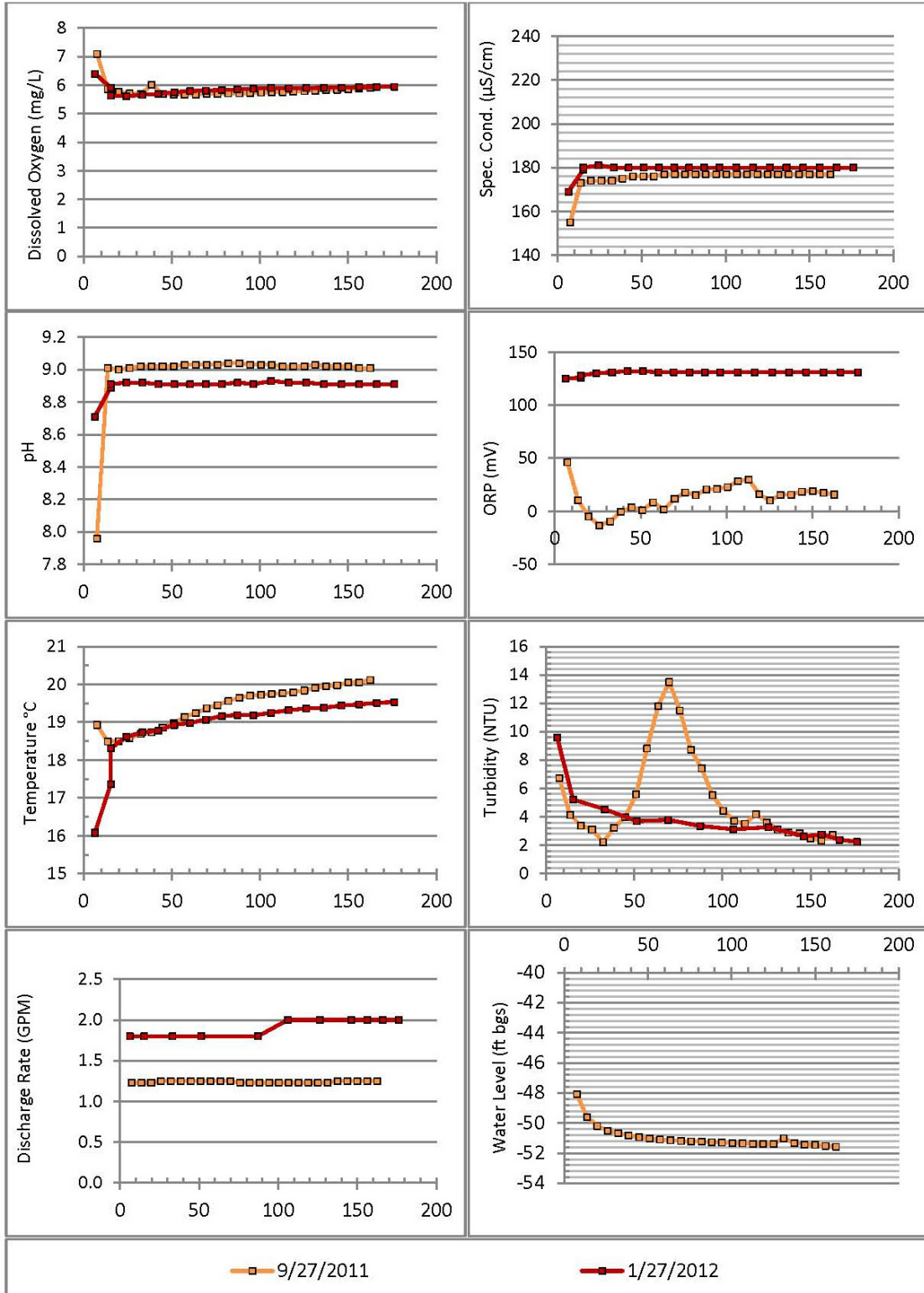
Notes: Water levels for the B-series piezometers are generally higher than those for the shallower C-series piezometers. Piezometer SF-5B is observed to be flowing at the wellhead and has been observed to flow for more than 10 yr. A constant water level equal to the estimated pressure head at the well location is assumed. The blue band shows the elevations of the B-series screens. Elevations are in feet above mean sea level.

Figure 2.0-2 Water levels observed at B- and C-series screens of BWF piezometers SF-3, SF-4, and SF-5



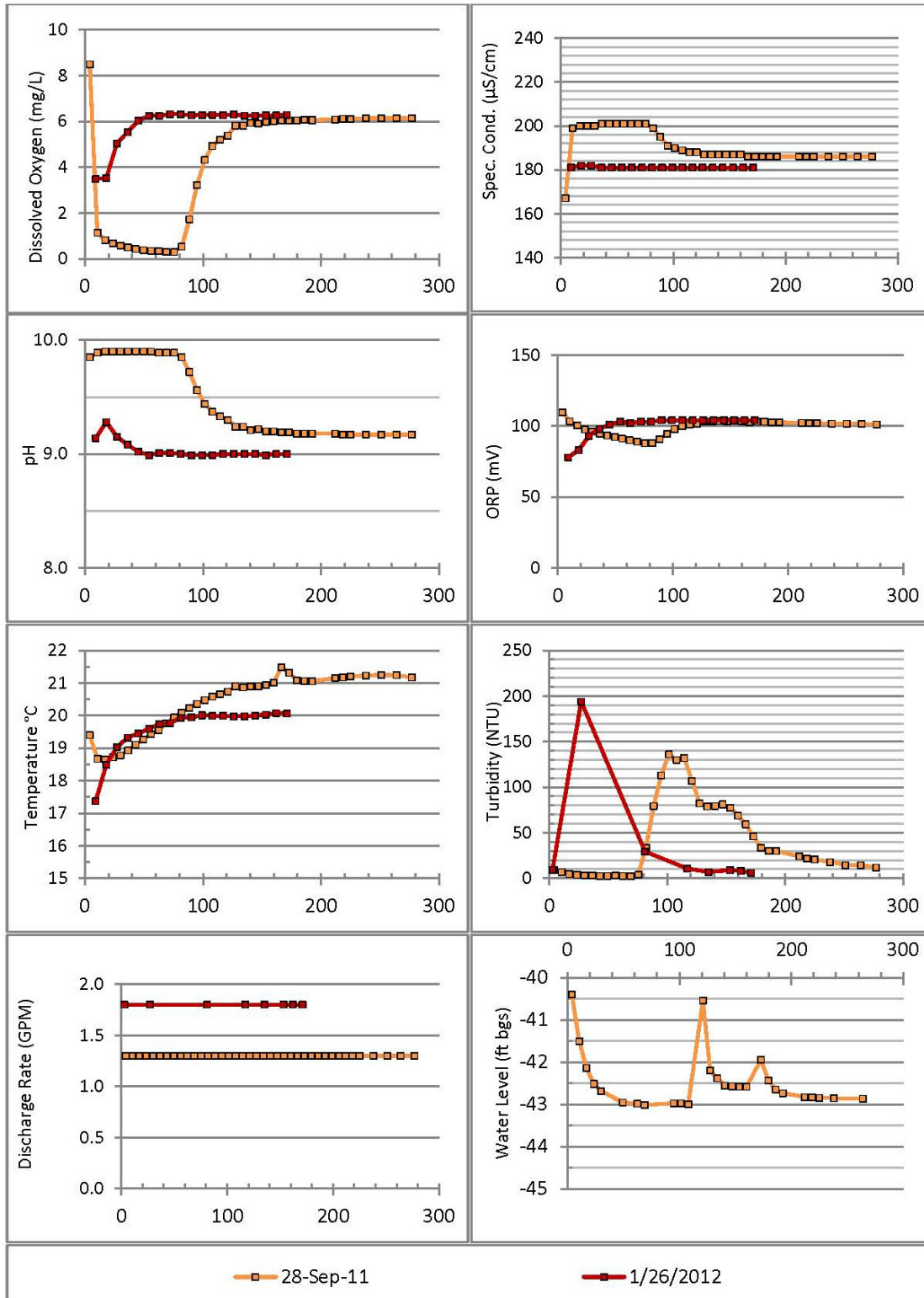
Notes: x-axis = Cumulative volume purged (gal.). GPM = Gallons per minute.

Figure 3.0-1 Time-series field parameters for piezometer SF-2B (824 ft below ground surface) (1 CV = 502 gal.)



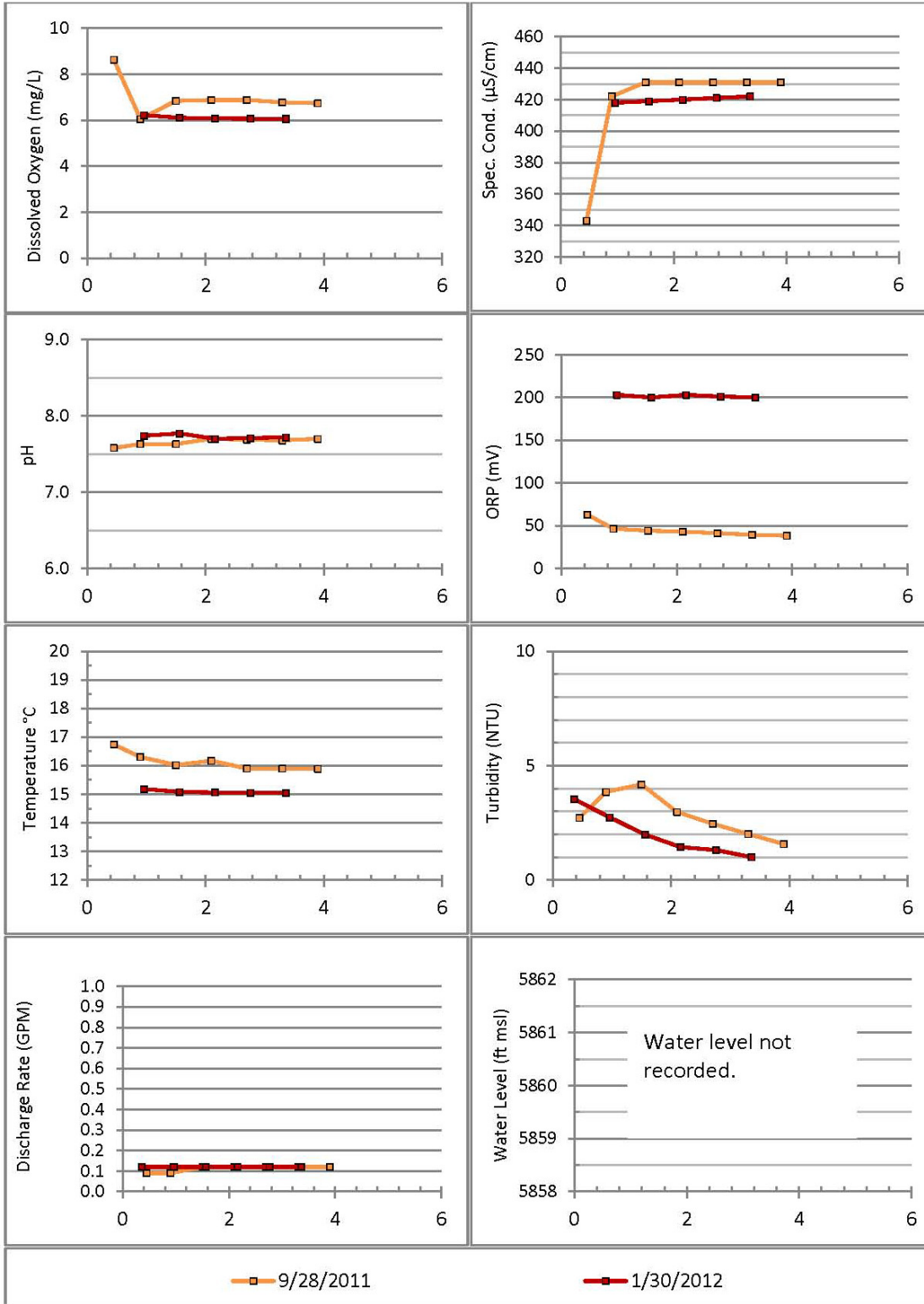
Notes: x-axis = Cumulative volume purged (gal.). GPM = Gallons per minute; bgs = below ground surface.

Figure 3.0-2 Time-series field parameters for piezometer SF-3A (294 ft bgs) (1 CV = 175 gal.)



Notes: x-axis = Cumulative volume purged (gal.). GPM = Gallons per minute; bgs = below ground surface.

Figure 3.0-3 Time-series field parameters for piezometer SF-4A (280 ft bgs) (1 CV = 171 gal.)



Notes: x-axis=Cumulative volume purged (gal.). GPM = Gallons per minute bgs = below ground surface.

Figure 3.0-4 Time-series field parameters for piezometer SF-4C (40 ft) (1 CV = 31.4 gal.)

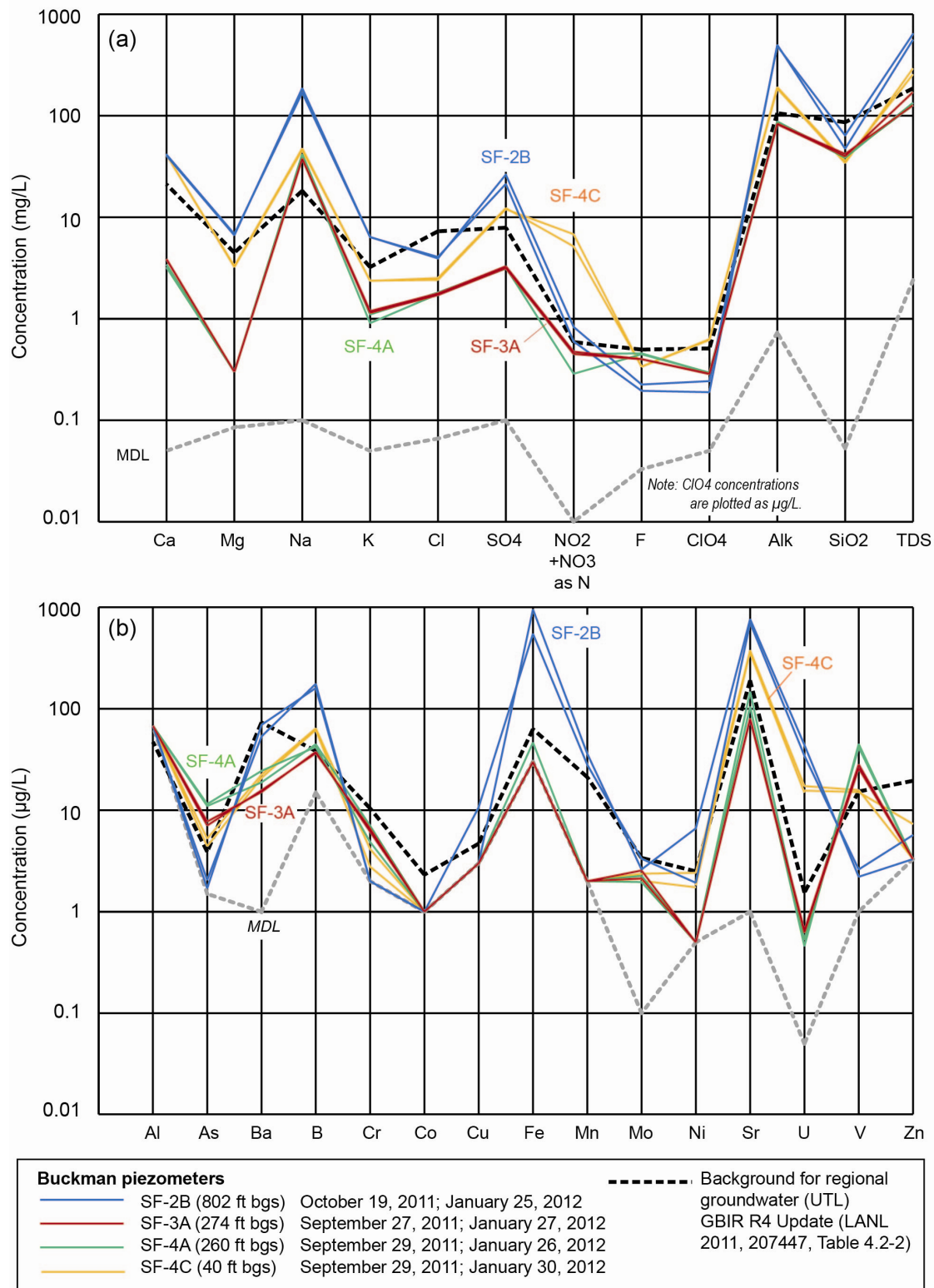


Figure 3.0-5 Concentrations in filtered groundwater samples from BWF piezometers for (a) major ions, perchlorate, silica, and TDS and (b) trace metals

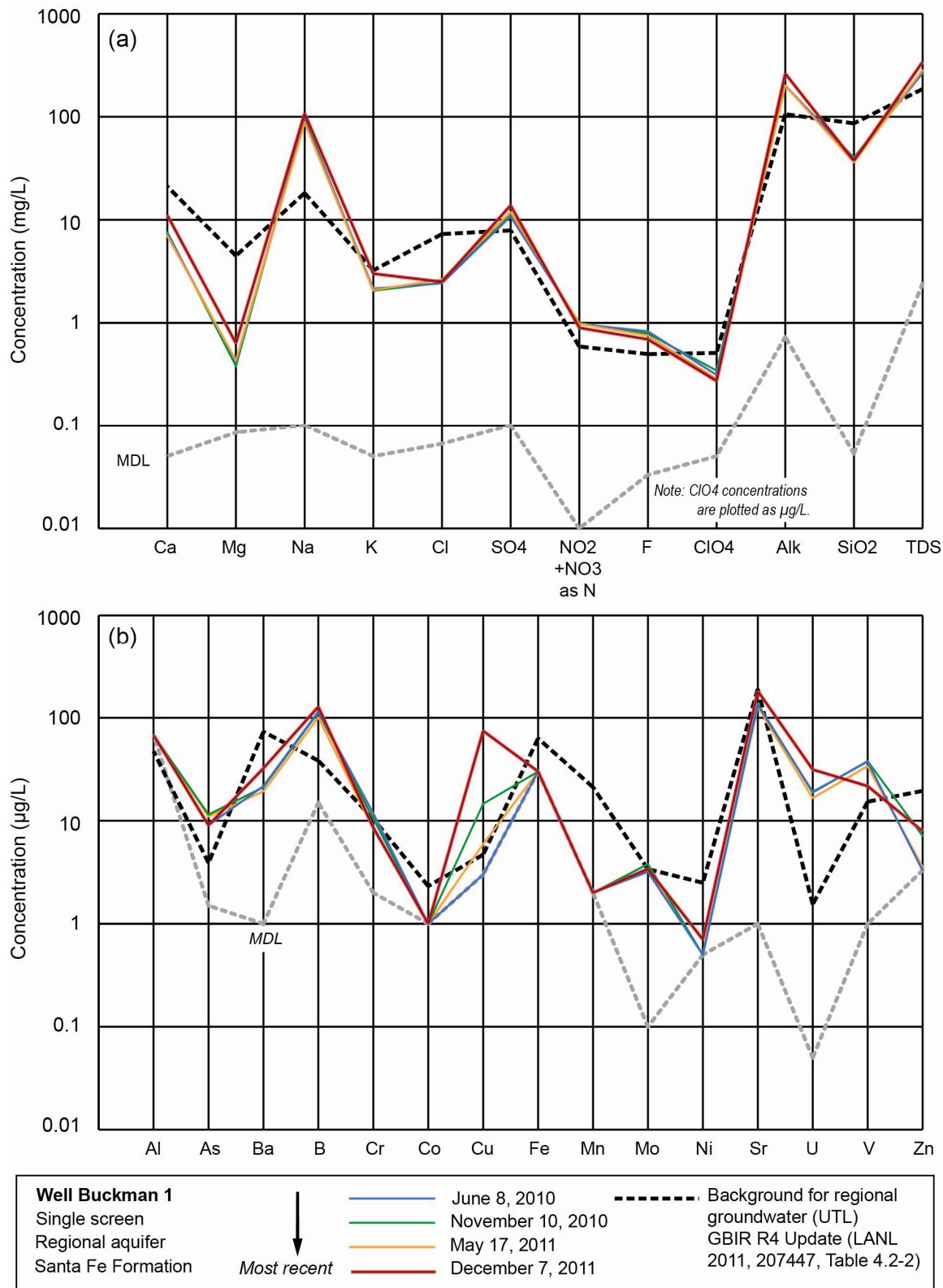


Figure 3.0-6 Concentrations in groundwater samples from well B-1 for (a) major ions, perchlorate, silica, and TDS and (b) trace metals

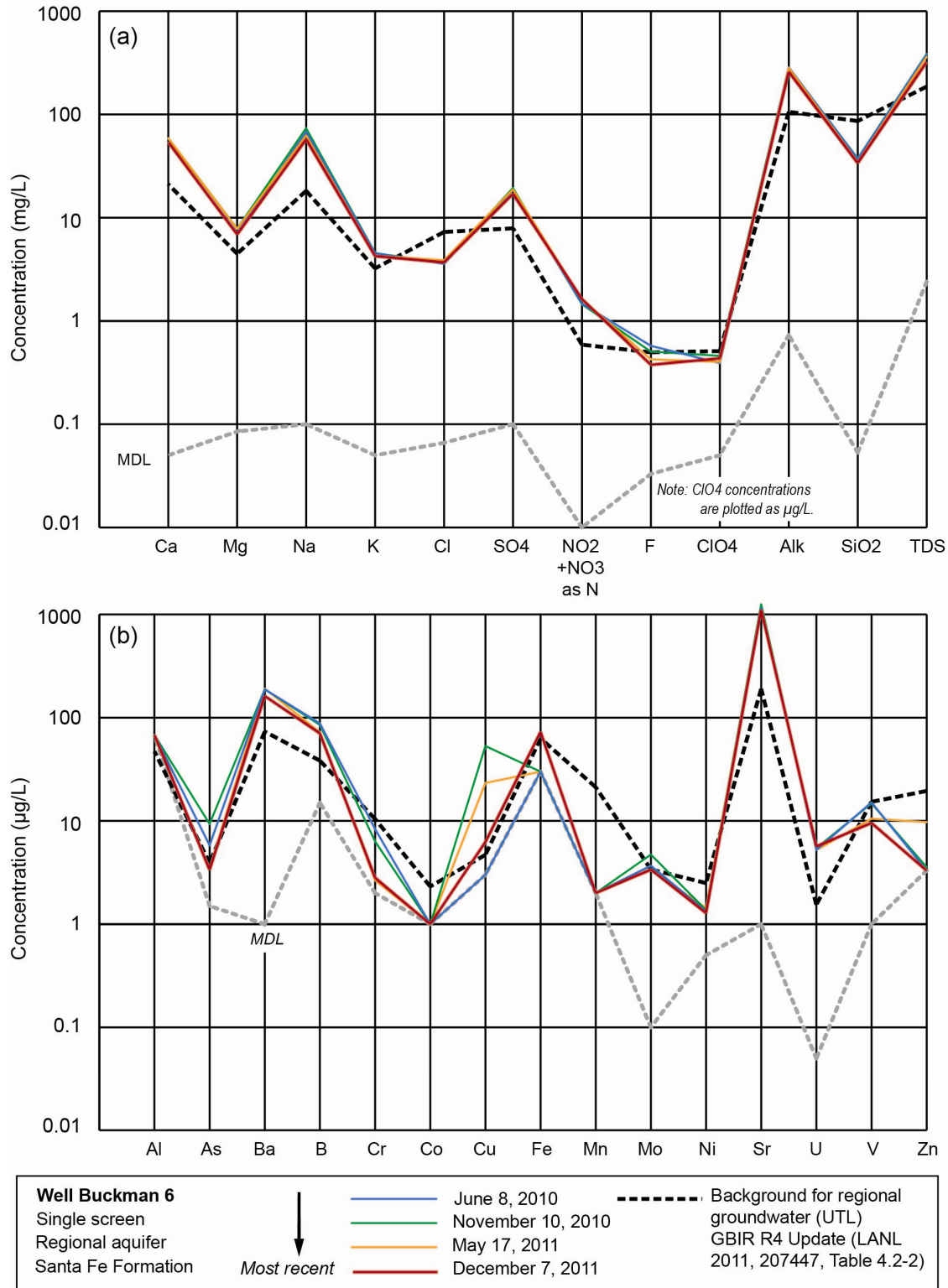


Figure 3.0-7 Concentrations in groundwater samples from well B-6 for (a) major ions, perchlorate, silica, and TDS and (b) trace metals

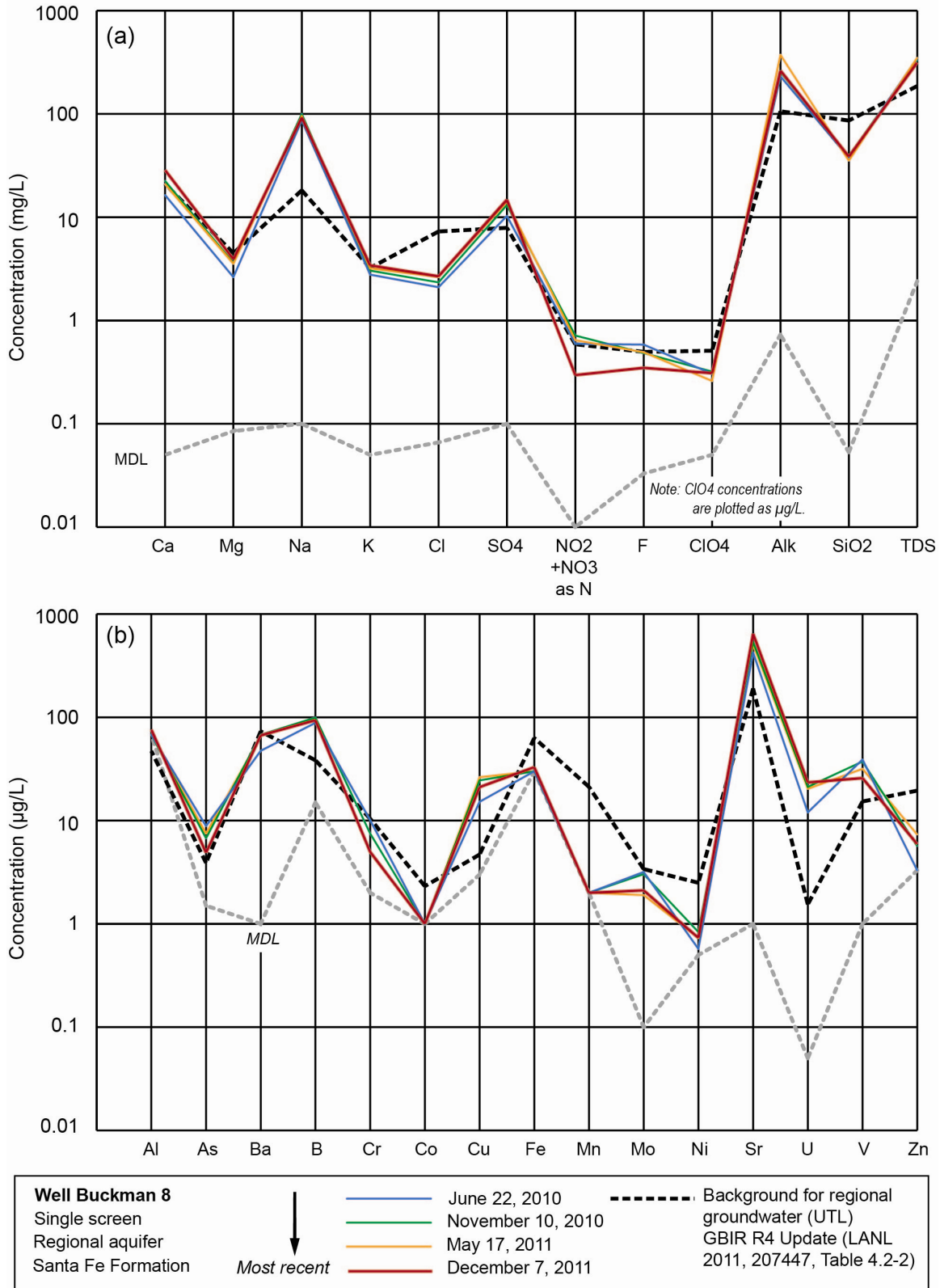
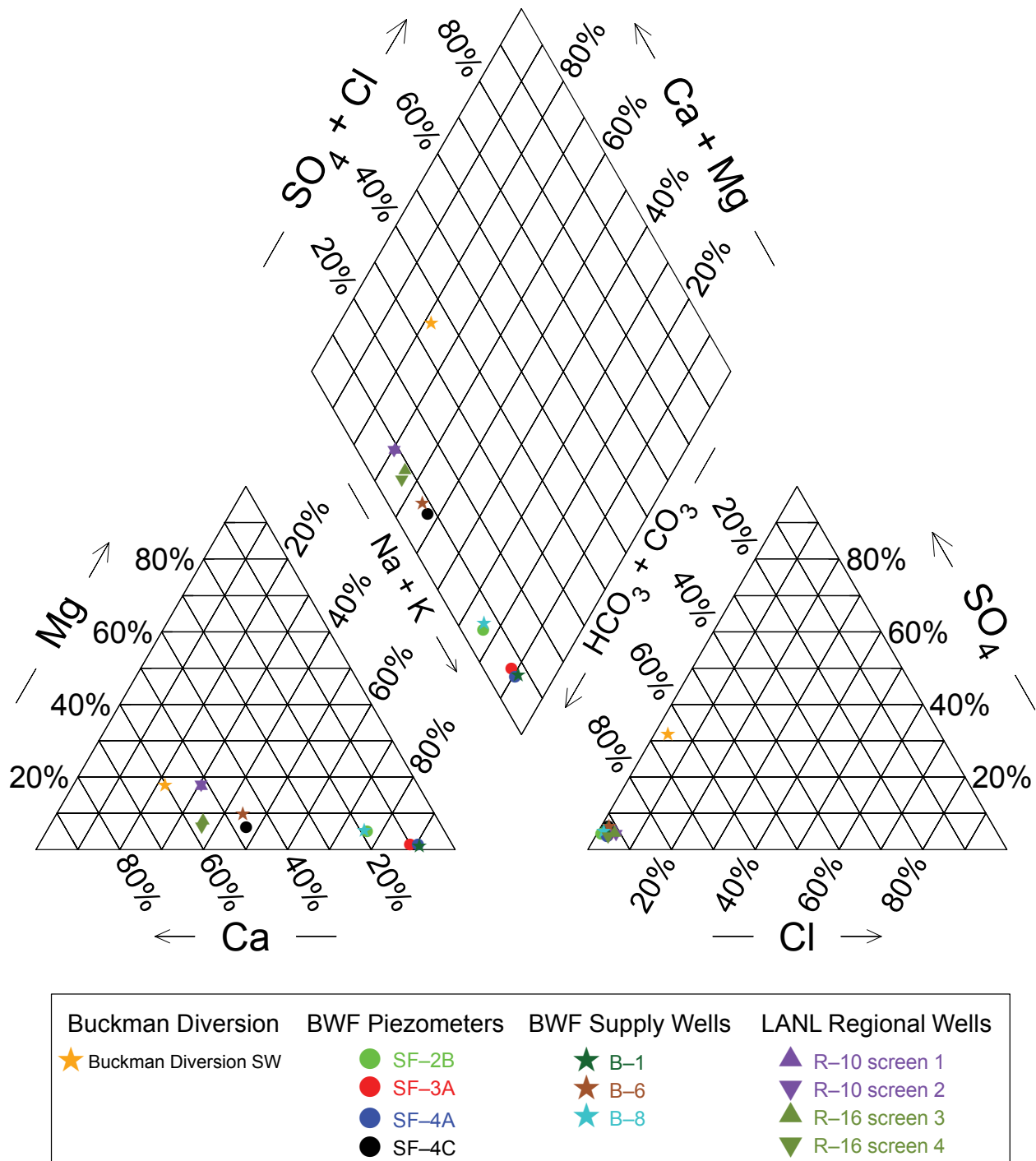


Figure 3.0-8 Concentrations in groundwater samples from well B-8 for (a) major ions, perchlorate, silica, and TDS and (b) trace metals



Note: SW = Surface water.

Figure 3.0-9 Trilinear (Piper) diagram showing the major ion chemistry of specific BWF piezometers, water-supply wells, and select Laboratory regional wells

**Table 3.0-1
Final Field Parameters for BWF Sampling Events in 2011–2012**

| Location | Depth (ft bgs ^a) | Date | Calculated (1 CV) (gal.) | Purge Volume (gal.) | Purged CV | Initial Depth to Water (ft bTOC ^b) | DO (mg/L) | ORP (mV) | Specific Conductance (μS/cm) | Temperature °C | Turbidity (NTU) | Field pH | Alkalinity ^c (mg/L as CaCO ₃) |
|-------------------------|------------------------------|-----------|--------------------------|---------------------|-----------|--|-----------|----------|------------------------------|----------------|-----------------|----------|--|
| SF-2B | 802 | 19-Oct-11 | 494 | 235 | 0.5 | — ^d | 0.9 | -72 | 983 | 21.1 | 209 | 7.1 | 487 |
| SF-2B (DP) ^e | 802 | 25-Jan-12 | 502 | 15 | <0.1 | 54.7 | 1.3 | -122 | 989 | 16.9 | 86 | 7.4 | 715 |
| SF-2B (0.5 CV) | 802 | 25-Jan-12 | 502 | 250 | 0.5 | 54.7 | 1.1 | -72 | 852 | 19.0 | 128 | 7.3 | 613 |
| SF-2B | 802 | 25-Jan-12 | 502 | 502 | 1.0 | 54.7 | 1.1 | -63 | 917 | 20.0 | 101 | 7.1 | 659 |
| SF-3A | 274 | 27-Sep-11 | 164 | 161 | 1.0 | 42.3 | 5.9 | 16 | 177 | 20.1 | 3 | 9.0 | 82 |
| SF-3A | 274 | 27-Jan-12 | 175 | 182 | 1.0 | 26.4 | 5.9 | 131 | 180 | 19.5 | 2 | 8.9 | 84 |
| SF-4A | 260 | 29-Sep-11 | 162 | 250 | 1.5 | 32.8 | 6.1 | 101 | 186 | 21.2 | 12 | 9.2 | 88 |
| SF-4A | 260 | 26-Jan-12 | 171 | 171 | 1.0 | 18.2 | 6.3 | 104 | 181 | 20.1 | 6 | 9.0 | 87 |
| SF-4C | 40 | 29-Sep-11 | 31 | 3.75 | 0.1 | 12.7 | 6.7 | 38 | 431 | 15.9 | 2 | 7.7 | 185 |
| SF-4C | 40 | 30-Jan-12 | 31 | 3 | 0.1 | 13.9 | 6.1 | 200 | 422 | 15.0 | 1 | 7.7 | 192 |
| B-1 | 258 | 14-Mar-11 | — | — | — | — | 7.0 | 190 | 441 | 21.2 | 1 | 8.2 | — |
| B-1 | 258 | 17-May-11 | — | — | — | — | 6.6 | 209 | 435 | 22.1 | < 1 | 8.3 | — |
| B-1 | 258 | 31-Aug-11 | — | — | — | — | 7.1 | 176 | 453 | 23.1 | < 1 | 8.3 | — |
| B-1 | 258 | 07-Dec-11 | — | — | — | — | 5.5 | 39 | 532 | 22.2 | 2 | 8.0 | — |
| B-6 | 291 | 14-Mar-11 | — | — | — | — | 7.2 | 217 | 596 | 22.9 | 2 | 6.9 | — |
| B-6 | 291 | 17-May-11 | — | — | — | — | 6.1 | 255 | 609 | 24.1 | < 1 | 6.7 | — |
| B-6 | 291 | 31-Aug-11 | — | — | — | — | 6.3 | 186 | 639 | 24.6 | 3 | 6.8 | — |
| B-6 | 291 | 07-Dec-11 | — | — | — | — | 6.5 | 80 | 540 | 22.4 | 1 | 7.1 | — |
| B-8 | 380 | 14-Mar-11 | — | — | — | — | 6.1 | 198 | 581 | 25.8 | 2 | 7.4 | — |

Table 3.0-1 (continued)

| Location | Depth (ft bgs ^a) | Date | Calculated (1 CV) (gal.) | Purge Volume (gal.) | Purged CV | Initial Depth to Water (ft bTOC ^b) | DO (mg/L) | ORP (mV) | Specific Conductance (µS/cm) | Temperature °C | Turbidity (NTU) | Field pH | Alkalinity ^c (mg/L as CaCO ₃) |
|----------|------------------------------|-----------|--------------------------|---------------------|-----------|--|-----------|----------|------------------------------|----------------|-----------------|----------|--|
| B-8 | 380 | 17-May-11 | — | — | — | — | 5.1 | 210 | 564 | 25.7 | < 1 | 7.4 | — |
| B-8 | 380 | 31-Aug-11 | — | — | — | — | 5.2 | 202 | 536 | 26.2 | 2 | 7.4 | — |
| B-8 | 380 | 07-Dec-11 | — | — | — | — | 5.4 | 74 | 543 | 24.3 | 1 | 7.4 | — |

Source: Attachment 1 (for water-quality data); field summary reports (for purge volumes and CV calculations).

^a bgs = Below ground surface.

^b bTOC = Below top of casing.

^c Alkalinity measured by Earth and Environmental Sciences 14.

^d — = Not available.

^e Yellow shading indicates results of time-series samples were collected during purging and analyzed by Earth and Environmental Sciences 14. SF-2B (DP) is the sample collected from the drop pipe (DP), and SF-2B (0.5 CV) is the sample collected after purging 0.5 CV.

**Table 3.0-2
General Inorganic Constituents and Total Organic Carbon**

| Location | Depth (ft bgs ^a) | Date | Na (mg/L) | K (mg/L) | Ca (mg/L) | Mg (mg/L) | Hardness (mg/L as CaCO ₃) | SO ₄ (mg/L) | Cl (mg/L) | F (mg/L) | NO ₃ +NO ₂ -N (mg/L) | ClO ₄ (µg/L) | SiO ₂ (mg/L) | TDS (mg/L) | Total Organic Carbon (mg/L) | Alkalinity (mg/L as CaCO ₃) | Lab pH |
|-------------------------|------------------------------|-----------|-----------|----------|-----------|-----------|---------------------------------------|------------------------|-----------|----------|--|-------------------------|-------------------------|------------|-----------------------------|---|--------|
| SF-2B | 802 | 19-Oct-11 | 169 | 6.4 | 41.5 | 6.8 | 132 | 26.3 | 3.9 | <0.22 | 0.8 | 0.24 | 64 | 640 | | 487 | 7.2 |
| SF-2B (DP) ^b | 802 | 25-Jan-12 | 175 | 6.7 | 36.9 | 7.9 | | 15.4 | 5.1 | 0.21 | <0.0 | | 32 | | 3.2 | 715 | 7.6 |
| SF-2B (0.5 CV) | 802 | 25-Jan-12 | 162 | 5.9 | 25.1 | 5.4 | | 14.7 | 5.0 | 0.22 | 0.4 | | 24 | | 2.5 | 613 | 7.3 |
| SF-2B (1 CV) | 802 | 25-Jan-12 | 167 | 5.9 | 36.5 | 6.2 | | 22.7 | 5.1 | 0.23 | 0.7 | | 31 | | 9.2 | 659 | 7.2 |
| SF-2B | 802 | 25-Jan-12 | 187 | 6.4 | 40.5 | 6.6 | 128 | 21.3 | 4.1 | 0.20 | 0.6 | 0.19 | 47 | 561 | 2.6 | 500 | 7.5 |
| SF-3A | 274 | 27-Sep-11 | 38 | 1.1 | 3.8 | <0.3 | 10 | 3.1 | 1.7 | 0.40 | 0.4 | 0.28 | 40 | 171 | | 82 | 8.9 |
| SF-3A | 274 | 27-Jan-12 | 38 | 1.2 | 3.9 | <0.3 | 10 | 3.3 | 1.8 | 0.40 | 0.5 | 0.29 | 42 | 127 | 0.5 | 84 | 8.9 |
| SF-4A | 260 | 29-Sep-11 | 39 | 0.9 | 3.2 | <0.3 | 8 | 3.1 | 1.8 | 0.46 | 0.4 | 0.29 | 38 | 134 | | 88 | 9.0 |
| SF-4A | 260 | 26-Jan-12 | 42 | 1.1 | 3.4 | <0.3 | 9 | 3.2 | 1.8 | 0.45 | 0.3 | 0.29 | 40 | 127 | 0.5 | 87 | 9.0 |
| SF-4C | 40 | 29-Sep-11 | 46 | 2.4 | 41.2 | 3.2 | 116 | 12.0 | 2.4 | 0.34 | 6.8 | 0.62 | 34 | 293 | | 185 | 7.9 |
| SF-4C | 40 | 30-Jan-12 | 48 | 2.4 | 41.1 | 3.3 | 116 | 12.3 | 2.5 | 0.34 | 5.2 | 0.63 | 36 | 256 | 0.6 | 192 | 7.9 |
| B-1 | 258 | 17-May-11 | 88 | 2.1 | 7.0 | 0.4 | 19 | 11.9 | 2.6 | 0.75 | 1.0 | 0.28 | 36 | 284 | 0.4 | 201 | 8.3 |
| B-1 | 258 | 07-Dec-11 | 108 | 3.0 | 11.1 | 0.6 | 30 | 13.8 | 2.5 | 0.69 | 0.9 | 0.27 | 38 | 341 | 0.8 | 263 | 8.1 |
| B-6 | 291 | 17-May-11 | 63 | 4.3 | 59.1 | 7.8 | 180 | 18.8 | 3.9 | 0.42 | 1.6 | 0.40 | 35 | 362 | 0.6 | 282 | 7.3 |
| B-6 | 291 | 07-Dec-11 | 57 | 4.2 | 53.8 | 6.9 | 163 | 17.0 | 3.7 | 0.38 | 1.6 | 0.43 | 34 | 321 | 0.8 | 258 | 7.2 |
| B-8 | 380 | 17-May-11 | 95 | 3.2 | 20.9 | 3.5 | 67 | 14.1 | 2.6 | 0.49 | 0.6 | 0.26 | 35 | 350 | 0.6 | 373 | 7.4 |
| B-8 | 380 | 07-Dec-11 | 93 | 3.4 | 28.6 | 3.9 | 87 | 14.8 | 2.7 | 0.35 | 0.3 | 0.31 | 39 | 314 | 0.8 | 263 | 7.5 |

Source: Attachment 1.

Note: Gray-shaded cells indicate this analyte was not measured.

^a bgs = Below ground surface.

^b Yellow shading indicates results of time-series samples were collected during purging and submitted to Earth and Environmental Sciences 14 for analysis. SF-2B (DP) is the sample collected from the drop pipe (DP), SF-2B (0.5 CV) is the sample collected after purging 0.5 CV, and SF-2B (1 CV) is the sample collected after purging 1 CV.

**Table 3.0-3
Trace Metals in Filtered Samples**

| Location | Depth (ft bgs ^a) | Date | Aluminum | Antimony | Arsenic | Barium | Boron | Cadmium | Chromium | Cobalt | Copper | Iron | Manganese | Molybdenum | Nickel | Lead | Strontium | Thallium | Uranium | Vanadium | Zinc | |
|-------------------------|---------------------------------|-----------|----------------|------------|------------|----------|-----------|-------------|-----------|----------|-----------|------------|-----------|------------|------------|------------|-----------|------------|-------------|----------|------------|--|
| MDL^b | | | 68 | 0.5 | 1.5 | 1 | 15 | 0.11 | 2 | 1 | 3 | 30 | 2 | 0.1 | 0.5 | 0.5 | 1 | 0.3 | 0.05 | 1 | 3.3 | |
| PQL | | | 200 | 3 | 5 | 5 | 50 | 1 | 10 | 5 | 10 | 100 | 10 | 0.5 | 2 | 2 | 5 | 1 | 0.2 | 5 | 10 | |
| SF-2B | 802 | 19-Oct-11 | — ^c | — | — | 69 | 160 | — | — | — | — | 952 | 36 | 2.6 | 6.6 | 0.6 | 764 | — | 44 | 2 | — | |
| SF-2B (DP) ^d | 802 | 25-Jan-12 | — | — | 0.4 | 84 | 181 | — | 1.7 | — | 4 | 3272 | 53 | 1.8 | 3.0 | 0.3 | 694 | 0.3 | 16 | 5 | 6 | |
| SF-2B (0.5 CV) | 802 | 25-Jan-12 | 6 | — | 0.4 | 51 | 158 | — | 1.1 | — | 4 | 320 | 19 | 5.2 | 2.3 | 1.7 | 434 | 1.7 | 29 | 4 | 12 | |
| SF-2B (1 CV) | 802 | 25-Jan-12 | 2 | — | 0.4 | 70 | 151 | — | — | — | 4 | 490 | 23 | 3.7 | 3.5 | 0.4 | 624 | 0.4 | 42 | 3 | 9 | |
| SF-2B | 802 | 25-Jan-12 | — | — | 2 | 53 | 176 | — | — | — | 11 | 548 | 28 | 3.3 | 1.9 | — | 702 | — | 34 | 3 | 6 | |
| SF-3A | 274 | 27-Sep-11 | — | — | 7 | 16 | 36 | — | 6.6 | — | — | — | — | 2.6 | — | — | 80 | — | 0.7 | 28 | — | |
| SF-3A | 274 | 27-Jan-12 | — | — | 8 | 15 | 38 | — | 6.2 | — | — | — | — | 2.1 | — | — | 79 | — | 0.6 | 26 | — | |
| SF-4A | 260 | 29-Sep-11 | — | — | 12 | 24 | 42 | — | 4.9 | — | — | 46 | — | 2.3 | — | — | 147 | 0.6 | 0.5 | 42 | — | |
| SF-4A | 260 | 26-Jan-12 | — | — | 11 | 19 | 45 | — | 7.0 | — | — | — | — | 2.0 | — | 0.6 | 105 | — | 0.5 | 45 | — | |
| SF-4C | 40 | 29-Sep-11 | — | — | 5 | 22 | 64 | — | 4.2 | — | — | — | — | 2.4 | 2.4 | — | 377 | — | 17 | 16 | — | |
| SF-4C | 40 | 30-Jan-12 | — | — | 4 | 21 | 62 | — | 2.8 | — | — | — | — | 2.1 | 1.8 | — | 369 | — | 16 | 15 | 7 | |
| B-1 | 258 | 17-May-11 | | | | | | | 8.3 | | | | | | | | | | | | | |
| B-1 | 258 | 07-Dec-11 | | | | | | | 8.6 | | | | | | | | | | | | | |
| B-6 | 291 | 17-May-11 | | | | | | | 2.7 | | | | | | | | | | | | | |

Table 3.0-3 (continued)

| Location | Depth (ft bgs ^a) | Date | Aluminum | Antimony | Arsenic | Barium | Boron | Cadmium | Chromium | Cobalt | Copper | Iron | Manganese | Molybdenum | Nickel | Lead | Strontium | Thallium | Uranium | Vanadium | Zinc | |
|------------------------|------------------------------|-----------|------------|------------|------------|----------|-----------|-------------|-----------|----------|-----------|------------|-----------|------------|------------|------------|-----------|------------|-------------|----------|------------|--|
| MDL^b | | | 68 | 0.5 | 1.5 | 1 | 15 | 0.11 | 2 | 1 | 3 | 30 | 2 | 0.1 | 0.5 | 0.5 | 1 | 0.3 | 0.05 | 1 | 3.3 | |
| PQL | | | 200 | 3 | 5 | 5 | 50 | 1 | 10 | 5 | 10 | 100 | 10 | 0.5 | 2 | 2 | 5 | 1 | 0.2 | 5 | 10 | |
| B-6 | 291 | 07-Dec-11 | | | | | | | 2.8 | | | | | | | | | | | | | |
| B-8 | 380 | 17-May-11 | | | | | | | 4.9 | | | | | | | | | | | | | |
| B-8 | 380 | 07-Dec-11 | | | | | | | 5.0 | | | | | | | | | | | | | |

Source: Attachment 1.

Notes: Units are (µg/L). Gray-shaded cells indicate this analyte was not measured.

^a bgs = Below ground surface.

^b MDL = Minimum detection limit. The values listed apply to validated data from an outside analytical laboratory and are from Appendix C of the 2011 Interim Facility-Wide Groundwater Monitoring Plan, Revision 1 (LANL 2011, 208811).

^c — = Analyte was measured but not detected.

^d Yellow shading indicates results of time-series samples were collected during purging and submitted to Earth and Environmental Sciences 14 for analysis. SF-2B (DP) is the sample collected from the drop pipe (DP), SF-2B (0.5 CV) is the sample collected after purging 0.5 CV, and SF-2B (1 CV) is the sample collected after purging 1 CV. MDLs applicable to Earth and Environmental Sciences 14 analyses are generally lower than those applicable to the outside laboratory.

**Table 3.0-4
Trace Metals in Unfiltered Samples**

| Location | Depth (ft bgs ^a) | Date | Aluminum | Antimony | Arsenic | Barium | Boron | Cadmium | Chromium | Cobalt | Copper | Iron | Manganese | Molybdenum | Nickel | Lead | Strontium | Thallium | Uranium | Vanadium | Zinc |
|-------------------------|------------------------------|-----------|------------|------------|----------------|----------|-----------|-------------|-----------|----------|-----------|------------|-----------|------------|------------|------------|-----------|------------|-------------|----------|------------|
| MDL^b | | | 68 | 0.5 | 1.5 | 1 | 15 | 0.11 | 2 | 1 | 3 | 30 | 2 | 0.1 | 0.5 | 0.5 | 1 | 0.3 | 0.05 | 1 | 3.3 |
| PQL | | | 200 | 3 | 5 | 5 | 50 | 1 | 10 | 5 | 10 | 100 | 10 | 0.5 | 2 | 2 | 5 | 1 | 0.2 | 5 | 10 |
| SF-2B | 802 | 19-Oct-11 | 3650 | 3.9 | — ^c | 69 | 160 | 0.13 | 3.7 | 2.0 | 127 | 47700 | 861 | — | 6.6 | 526 | 937 | — | 52 | 17 | 801 |
| SF-2B (DP) ^d | 802 | 25-Jan-12 | 32 | — | 0.4 | 93 | 146 | — | 2.5 | — | 5 | 14482 | 88 | — | 4.9 | 276 | 767 | — | 45 | 9 | 260 |
| SF-2B (0.5 CV) | 802 | 25-Jan-12 | 247 | — | 0.8 | 74 | 170 | — | 4.2 | 1.2 | 57 | 13298 | 411 | 1.8 | 9.9 | 1758 | 482 | — | 39 | 9 | 788 |
| SF-2B (1 CV) | 802 | 25-Jan-12 | 240 | — | 0.8 | 84 | 152 | — | 3.4 | — | 20 | 6743 | 96 | 1.7 | 5.9 | 207 | 675 | — | 50 | 11 | 275 |
| SF-2B | 802 | 25-Jan-12 | 2410 | 1.6 | 2 | 53 | 176 | — | 3.3 | — | 46 | 10700 | 203 | 2.1 | 1.9 | 229 | 781 | — | 39 | 10 | 298 |
| SF-3A | 274 | 27-Sep-11 | 117 | — | 7 | 16 | 36 | — | 6.7 | — | — | 83 | — | 2.6 | — | 1.5 | 82 | — | 0.7 | 28 | 33 |
| SF-3A | 274 | 27-Jan-12 | 72 | — | 7 | 15 | 38 | — | 5.6 | — | — | 75 | — | 2.3 | — | 8.4 | 84 | — | 0.6 | 28 | 61 |
| SF-4A | 260 | 29-Sep-11 | 259 | — | 11 | 24 | 42 | — | 5.6 | — | — | 885 | 15 | 2.3 | — | 9.7 | 191 | — | 0.6 | 41 | 7 |
| SF-4A | 260 | 26-Jan-12 | 97 | — | 13 | 19 | 45 | — | 7.0 | — | — | 699 | 10 | 2.0 | — | 16 | 121 | — | 0.5 | 43 | 12 |
| SF-4C | 40 | 29-Sep-11 | — | — | 6 | 22 | 64 | — | 3.6 | — | — | — | — | 2.2 | 2.4 | 0.8 | 395 | — | 17 | 16 | — |
| SF-4C | 40 | 30-Jan-12 | — | — | 5 | 21 | 62 | — | 2.2 | — | — | — | — | 2.3 | 1.8 | 0.5 | 402 | — | 16 | 16 | 9 |
| B-1 | 258 | 17-May-11 | — | — | 11 | 19 | 101 | — | 8.8 | — | 6 | — | — | 3.3 | — | 0.5 | 128 | — | 17 | 34 | 4 |
| B-1 | 258 | 07-Dec-11 | — | — | 9 | 32 | 128 | — | 7.8 | — | 75 | 30 | — | 3.4 | 0.7 | 6.6 | 182 | — | 31 | 22 | 8 |
| B-6 | 291 | 17-May-11 | — | — | 4 | 191 | 72 | — | 3.2 | — | 23 | — | — | 3.3 | 1.4 | 1.0 | 1220 | — | 5.2 | 10 | 10 |
| B-6 | 291 | 07-Dec-11 | — | — | 3 | 162 | 70 | — | 3.5 | — | 6 | 73 | — | 3.4 | — | 0.7 | 1110 | — | 5.7 | 10 | — |
| B-8 | 380 | 17-May-11 | — | — | 7 | 66 | 94 | — | 5.2 | — | 26 | — | — | 1.9 | 0.7 | 1.6 | 505 | — | 20 | 32 | 7 |
| B-8 | 380 | 07-Dec-11 | 76 | — | 5 | 67 | 94 | — | 4.5 | — | 21 | 33 | — | 2.1 | 0.7 | 1.7 | 645 | — | 23 | 26 | 6 |

Source: Attachment 1.

Note: Units are (µg/L).

^a bgs = Below ground surface.

^b MDL = Minimum detection limit. The values listed apply to validated data from an outside analytical laboratory and are from Appendix C of the 2011 Interim Facility-Wide Groundwater Monitoring Plan, Revision 1 (LANL 2011, 208811).

^c — = Analyte was measured but was not detected.

^d Yellow shading indicates results of time-series samples were collected during purging and submitted to Earth and Environmental Sciences 14 for analysis. SF-2B (DP) is the sample collected from the drop pipe (DP), SF-2B (0.5 CV) is the sample collected after purging 0.5 CV, and SF-2B (1 CV) is the sample collected after purging 1 CV. MDLs applicable to EES-14 analyses are generally lower than those applicable to the outside laboratory.

**Table 3.0-5
Radionuclides (pCi/L) in Unfiltered Samples**

| Location | Depth (ft bgs ^a) | Date | Americium- 241 | Cesium- 137 | Plutonium- 238 | Plutonium- 239/240 | Radium- 226 | Radium- 228 | Strontium- 90 | Uranium- 234 | Uranium- 235/236 | Uranium- 238 | Tritium |
|------------------------|---------------------------------|-----------|-------------------|----------------|-------------------|-----------------------|----------------|----------------|------------------|-----------------|---------------------|-----------------|------------|
| MDA^b | | | 0.05 | 8 | 0.05 | 0.05 | 1 | 1 | 0.5 | 0.05 | 0.05 | 0.05 | 2.1 |
| SF-2B | 802 | 19-Oct-11 | — ^c | — | — | — | 1.0 | 2.5 | — | 27.8 | 1.20 | 16.9 | — |
| SF-2B | 802 | 25-Jan-12 | — | — | — | — | — | 0.9 | — | 21.8 | 0.68 | 12.2 | — |
| SF-3A | 274 | 27-Sep-11 | — | — | — | — | — | — | — | 0.3 | — | 0.2 | — |
| SF-3A | 274 | 27-Jan-12 | — | — | — | — | — | — | — | 0.4 | — | 0.2 | — |
| SF-4A | 260 | 29-Sep-11 | — | — | — | — | — | — | — | 0.3 | — | 0.2 | — |
| SF-4A | 260 | 26-Jan-12 | — | — | — | — | 0.5 | — | — | 0.3 | — | 0.2 | — |
| SF-4C | 40 | 29-Sep-11 | — | — | — | — | — | — | — | 7.8 | 0.18 | 5.4 | 16.1 |
| SF-4C | 40 | 30-Jan-12 | — | — | — | — | 1.5 | — | — | 8.0 | 0.24 | 5.6 | 16.1 |
| B-1 | 258 | 17-May-11 | — | — | — | — | — | — | — | 8.2 | 0.29 | 5.8 | — |
| B-1 | 258 | 07-Dec-11 | — | — | — | — | — | — | — | 12.6 | 0.70 | 9.0 | — |
| B-6 | 291 | 17-May-11 | — | — | — | — | — | 0.8 | — | 8.0 | 0.14 | 2.1 | — |
| B-6 | 291 | 07-Dec-11 | — | — | — | — | — | — | — | 6.5 | 0.25 | 1.6 | — |
| B-8 | 380 | 17-May-11 | — | — | — | — | — | — | — | 11.6 | 0.36 | 6.9 | — |
| B-8 | 380 | 07-Dec-11 | — | — | — | — | — | 0.6 | — | 11.4 | 0.55 | 6.8 | — |

Source: Attachment 1.

^a bgs = Below ground surface.

^b MDAs from Appendix C of the 2011 Interim Facility-Wide Groundwater Monitoring Plan, Revision 1 (LANL 2011, 208811).

^c — = Analyte was measured but was not detected.

Attachment 1

*Water-Quality Data for Buckman Well Field Piezometers
(on CD included with this document)*

