Work Plan for Alternate Monitoring at the Buckman Well Field

Introduction	This work plan is being prepared in response to the New Mexico Environment Department's (NMED's) agreement to conduct a groundwater study at the Buckman Well Field (BWF) using existing piezometers. These piezometers will be evaluated to determine if they are useful for supplementing Los Alamos National Laboratory's (LANL's or the Laboratory's) ongoing surveillance monitoring program within the BWF and they provide important information about hydrologic conditions in the vicinity of the well field (Figure 1). The deferred requirement for a new sentinel well for the BWF and the new requirement to submit this work plan are pursuant to NMED's letter dated June 15, 2010 (NMED 2010, 110043).
Objectives	The primary objective for enhanced monitoring in the BWF is to characterize groundwater quality in a more stratigraphically discrete manner than is obtained from the direct sampling of BWF water-supply wells with long screens. 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 treatment and distribution system, discrete-horizon data can inform whether a distinct water quality is present within or above the monitored horizon. An additional objective is to further characterize the hydrology within the BWF by evaluating the nature of pressure responses associated water-supply pumping within the BWF along discrete hydrostratigraphic horizons. Water-level data are currently obtained manually from existing piezometers approximately monthly (there are sometimes gaps in the frequency due to scheduling problems). Currently, the data are managed by the U.S. Geological Survey (USGS) and the City of Santa Fe. A more continuous pressure-response record will further refine the understanding of the hydrology within a portion of the BWF closest to the Rio Grande and the Laboratory. The analyses of the data will provide better understanding of the hydraulic connection of the aquifer pumping pumped by BWF with (1) the Rio Grande and its alluvial aquifer, and (2) the aquifer to the west of the Rio Grande. The hydrologic behavior of the BWF may also change as the pumping regime and pumping rates are altered in the coming years as less groundwater is extracted because of offsets from the Buckman surface-water diversion project expected to begin in 2011. Analysis of water-quality data will be combined with hydrologic data to refine the conceptual model in the BWF and support recommendations for how to optimize the long-term monitoring within the well field. Enhancements could include changes in which production wells are used for monitoring, inclusion of one or more existing piezometers into the annual surveillance program in the well field, or addition of a new monitoring point(s).
Conceptual Model	Multiple lines of evidence indicate that the BWF is inherently protected from contamination due principally to artesian conditions that not only isolate shallower groundwaters, but also create upward flow gradients that may inhibit migration toward the deep aquifer pumped by the well field. Four piezometer nests are located in the vicinity of supply wells B-8 and B-2 (Figure 2). Each piezometer nest consists of three discrete screened horizons shown in the illustration in Figure 3. Figures 4 and 5 show a group of hydrographs for each screened horizon in piezometer nests SF-3, SF-4, and SF-5. Review of these hydrographs indicate that the deep piezometer screens ("A"-series) show very similar hydrographs, shown in Figure 3, indicating that the screens in these piezometers monitor pressures in the same hydrostratigraphic zone. The pressure responses in the A-series screens show a muted response to pumping B-1, and are nonresponsive to pumping at B-8. The intermediate zones ("B"-series screens) are under confined conditions and do not show response to pumping (SF-5B, which is at the lowest elevation, is also under artesian conditions). The pressure heads in the B-series screens are higher than those in the deeper (A-series) and shallow (C-series) screens. The C-series screens show consistent variations in water level that have an apparent seasonality, indicating probable hydraulic connection to the Rio Grande. In summary, the hydrostratigraphic zones monitored by the A-, B-, and C-series screens appear to be hydraulically isolated. Water levels in SF-2B are influenced by the pumping of B-1; the pumping influence is much more pronounced than the influence observed SF-2C and

	"A"-series screens of SF-3, SF-4, and SF-5. SF-2B is another screen that will be sampled to evaluate the vertical stratification of groundwater geochemistry with the pumped aquifer. The groundwater flow regime near the BWF is expected to change in the near future because less demand may be placed on the BWF after the Buckman Diversion Project is online in 2011. The proposed analyses will also investigate the flow regime under post-diversion conditions.
Proposed Scope	The following scope is proposed. • Install dedicated pressure transducers in all 11 piezometers in the SF-2 (excluding SF-2A), SF-3, SF-4, and SF-5 nests. Collection and analysis of continuous hydrographs from these screened intervals will enhance understanding of the interrelation of these hydrostratigraphic zones in response to supply-well pumping and hydrologic seasonality expressed by variations in stages in the Rio Grande. The analyses will also include analyses of the existing water-level data from the other piezometers and nearby water-supply wells. • Install dedicated pumps in the deep A-series, screens in SF-3, SF-4, and SF-5, and in piezometer SF-2B. These piezometers will be sampled concurrent with the Laboratory's existing quarterly surveillance monitoring program within the BWF. The initial sampling suite is presented in Table 1. This suite will be analyzed for the first four quarters following installation of sampling systems and then modified as appropriate for a second year of monitoring based on the results of the first year of data. The need for continuing this supplemental monitoring beyond the initial two years will be reviewed in consultation with NMED and the City of Santa Fe. The Laboratory proposes to install dedicated low-flow sampling systems (e.g., Well Wizard Groundwater Sampling Pumps Model ST1102M) within each piezometer. The low-flow pumps will be set within the piezometer screened interval. A benefit to these sampling systems will be reduced purging requirements. Based on existing water-supply well data, it is also assumed that the Laboratory will be allowed to discharge minimal purge waters onto the ground. The wells will be subject to initial pumping tests before installation of the low-flow pumps using a submersible pump. The pumping tests will evaluate the hydraulic connection of the screens with the aquifer. The test data will not be applied to evaluate aquifer properties. Total pumping of each well will be limited to 12 h per well. The Laboratory will work with the NMED and the City of Santa Fe to obtain required permits for water discharge during pumping and sampling. • Analyze collected geochemical and water-level data to evaluate the reliability and dependability of existing piezometers to detect contamination for monitoring purposes and to further enhance conceptual understanding of groundwater flow regime near the BWF. • Optimize the future surveillance monitoring program near the BWF. The analyses will evaluate (1) water-supply wells (currently B-1, B-6, and B-8), and (2) piezometer nests that will be monitored (one or more screens). The analyses will also propose an optimal suite of geochemical analytes for sampling. Furthermore, the analyses will evaluate the need for an additional monitoring well (R-58) at the BWF. Data from video logging of each of the piezometers indicate that many of the wells have sediment, pieces of water-level tapes, rocks, glass, and other materials in the sumps. Rocks were identified within the casing of SF-5A substantially above the well screen. A summary of observations is included in Table 2. Any attempts to remove materials or obstructions from these piezometers will only be conducted with concurrence of all relevant parties.

Schedule	The proposed work will include 2 yr of data collection. Field work is expected to begin in late 2010 with the first round of sample collection conducted by December 2010. A report with an analysis of the geochemical and hydrologic data and recommendations for optimizing monitoring in the BWF will be submitted 6 mo after the initial 2 yr of data collection is complete. The target date for the report is June 2013.

REFERENCE

The following list includes all documents cited in this work plan. 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.

NMED (New Mexico Environment Department), June 15, 2010. "Approval, Reprioritization of Fiscal Year 2010 Monitoring Wells," New Mexico Environment Department letter to G.J. Rael (DOE-LASO) and M. Graham (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2010, 110043)

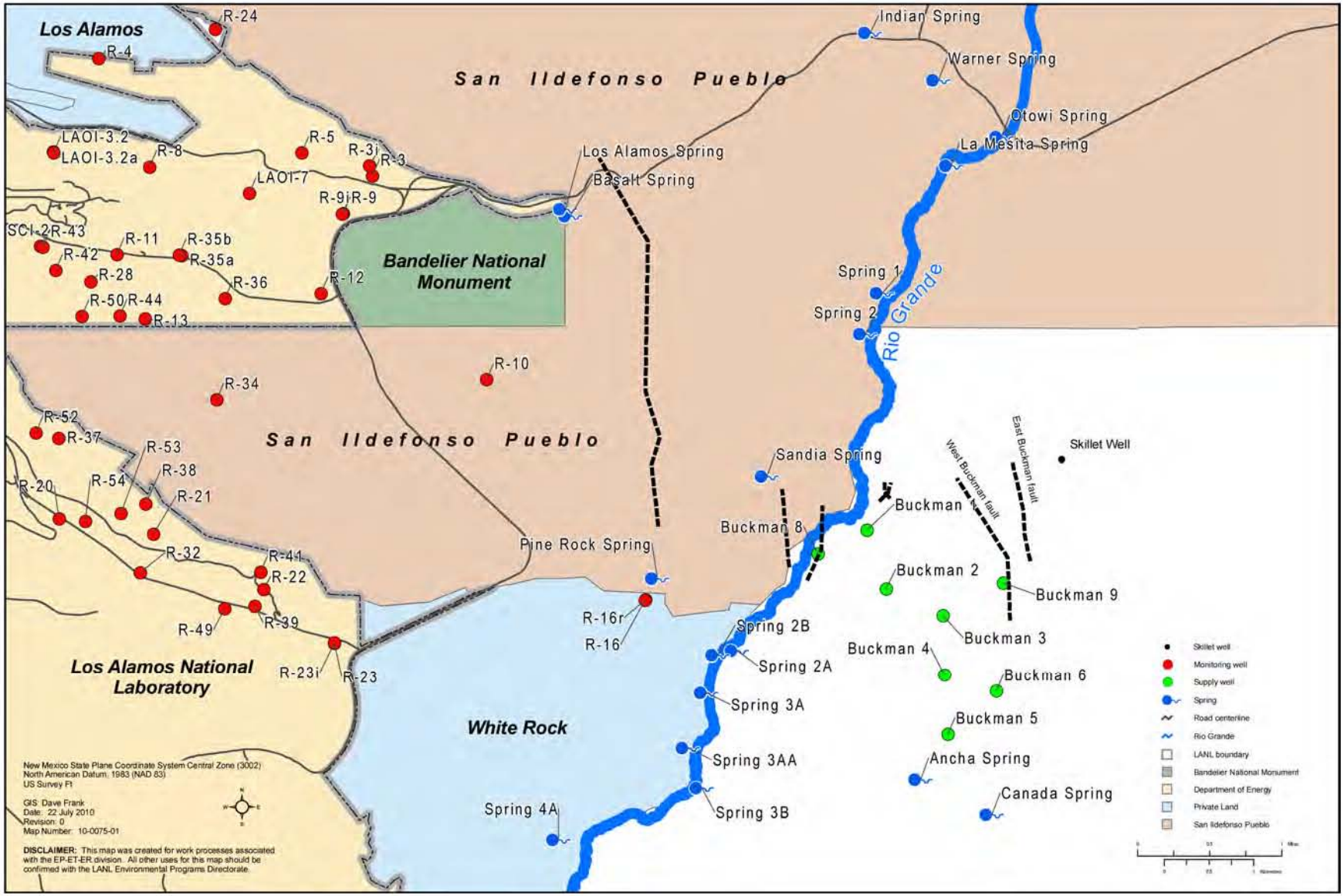


Figure 1 Location of Buckman Well Field

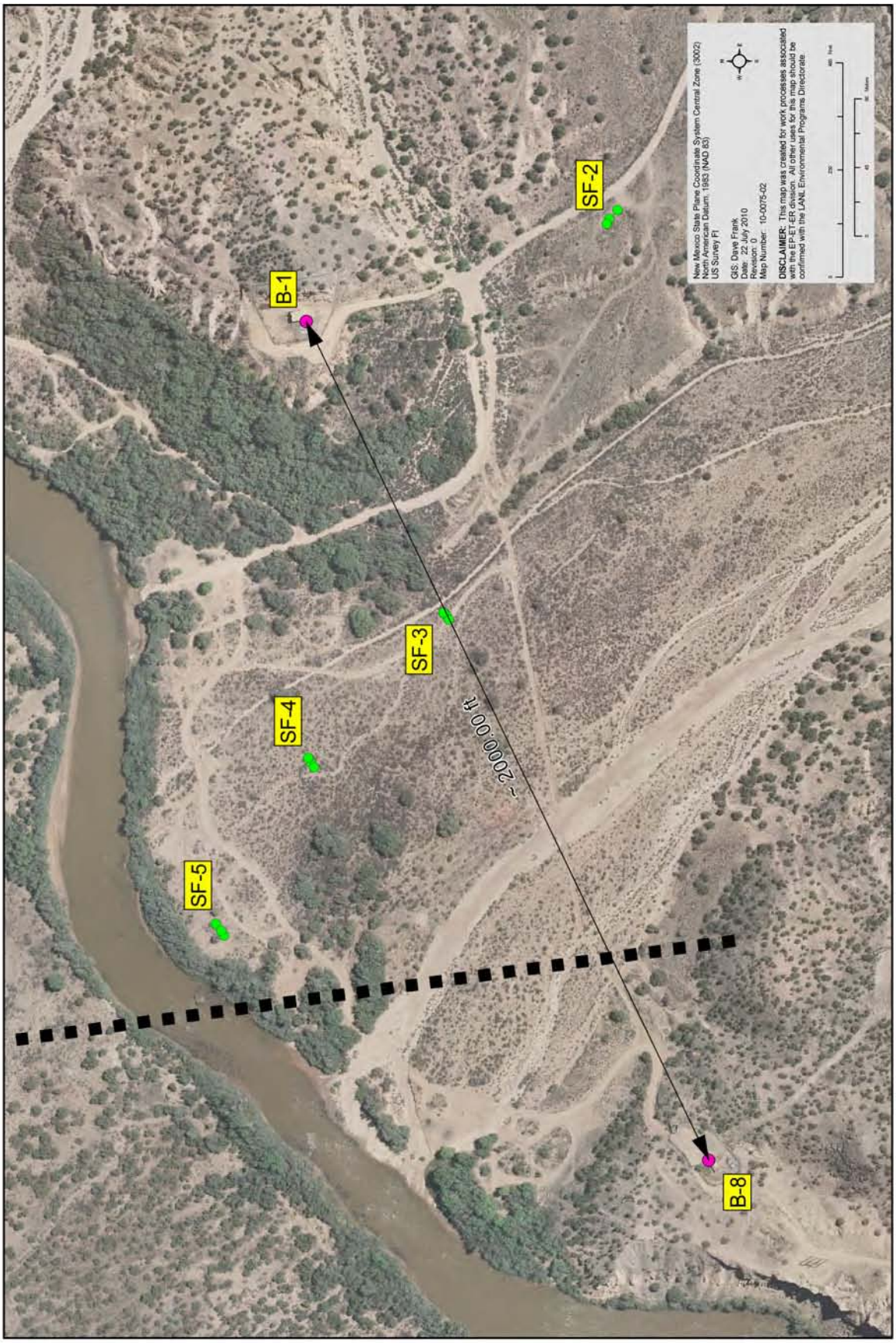
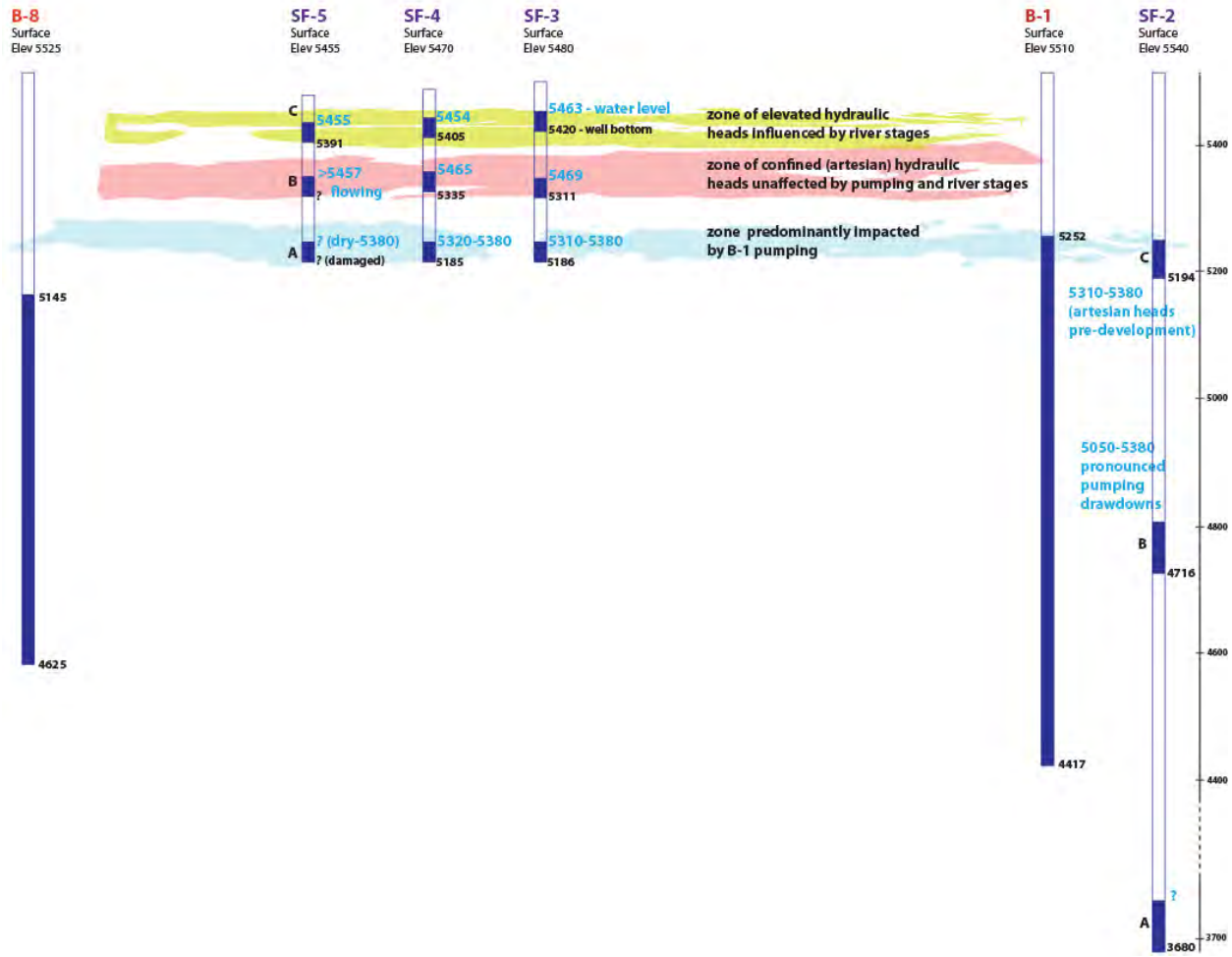
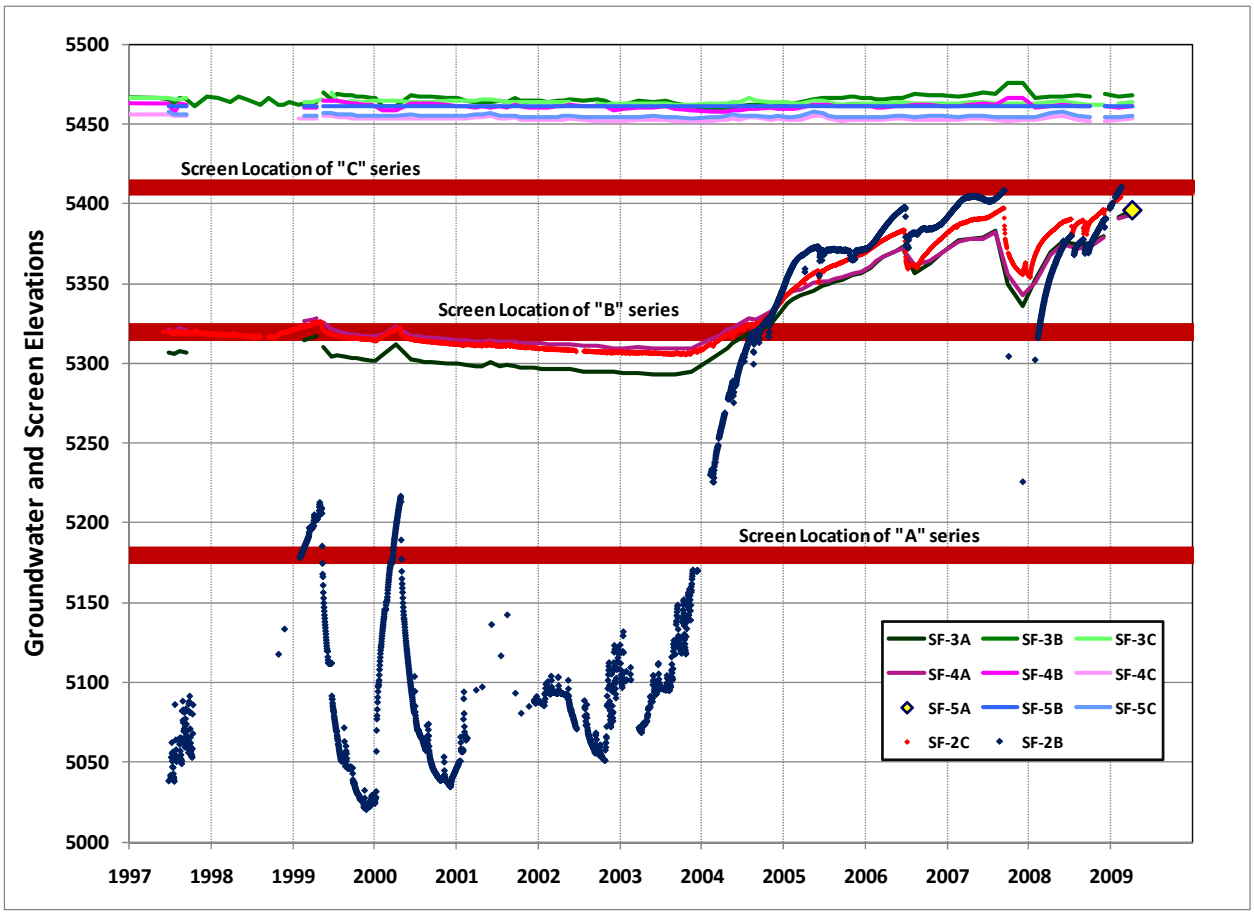


Figure 2 Locations of Buckman piezometers SF-2, SF-3, SF-4, and SF-5 and water supply wells B-1 and B-8



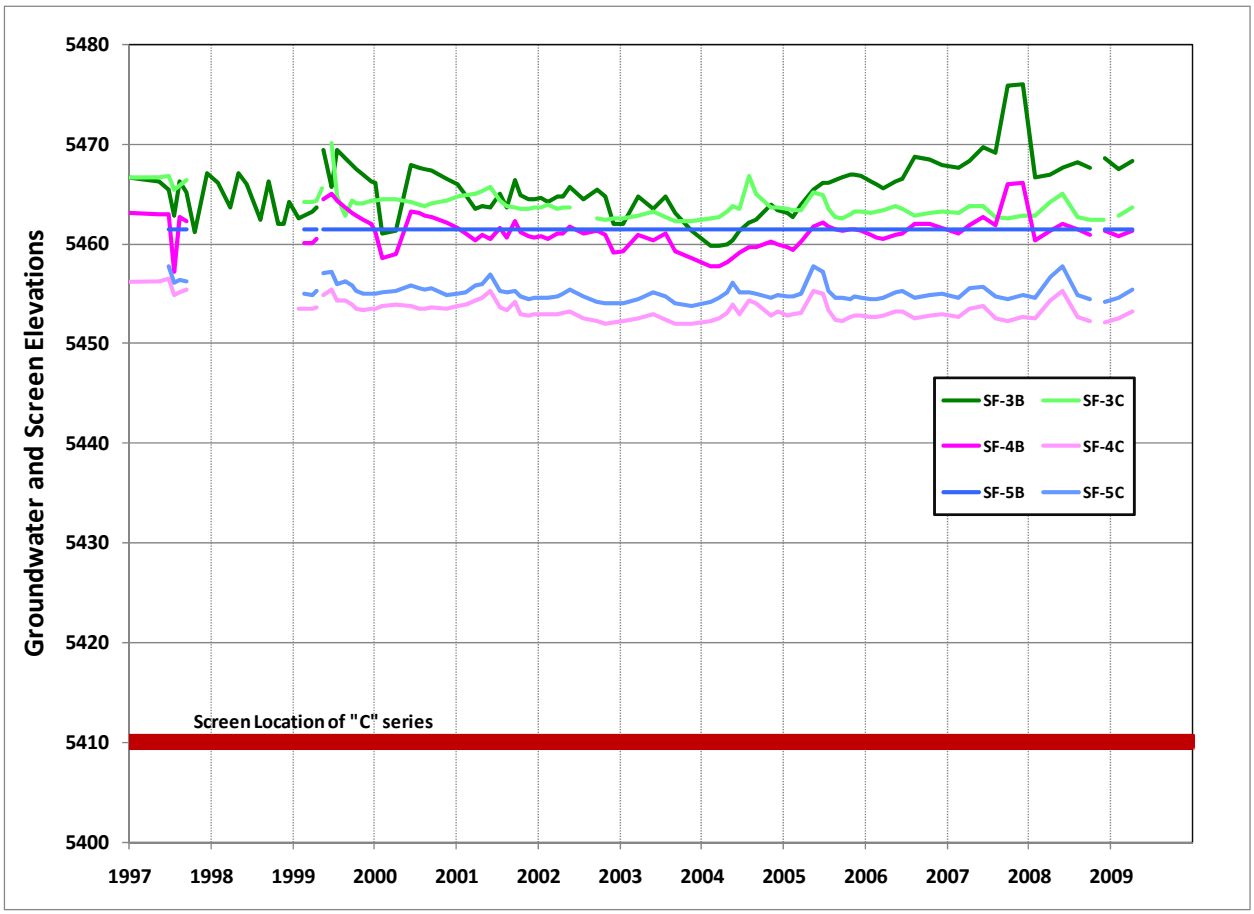
Note: The observed water levels (approximate) are provided in blue type. Screen elevations are provided in black type.

Figure 3 Conceptual hydrogeologic cross-section shows the vertical location 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-2 and SF-4 (there is a single observation associated with SF-5A) since 2004 is associated with reduced water supply pumping at B-1.

Figure 4 Water levels and screen elevations of SF-3, SF-4, and SF-5



Notes: The “B” screen water levels are generally higher than the “C” screen water levels. SF-5B is observed to be flowing 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.

Figure 5 Water levels observed at “B” and “C” series screens of SF-3, SF-4, and SF-5

Table 1
Analyte Suite for Buckman Well Field Piezometers

Analytes	Analytical Method	Analytical Method Description
Metals		
TAL metals + U + Sr (total)	EPA:200.7/6010 and EPA:200.8/6020	Inductively coupled plasma atomic emission spectrometry and inductively coupled plasma mass spectrometry
General Inorganic		
Total dissolved solids	EPA:160.1	Gravimetric
Anions: chlorine, fluorine, SO_4, bromine	EPA:300.0	Ion chromatography
Alkalinity	EPA:310.1	Titrimetric
Hardness	SM:A2340B	Titrimetric
Ammonia	EPA:350.1	Colorimetric
Nitrate/nitrite	EPA:353.2	Automated flow injection
Perchlorate	EPA:6850	High-performance liquid chromatography electrospray ionization mass spectrometry
Organics		
Volatile organic analytes	EPA:624/8260B	Gas chromatography mass spectrometry
High explosives	EPA:8321A	High-performance liquid chromatography thermospray mass spectrometry
Radionuclides		
Americium-241	HASL-300	Chemical separation alpha spectroscopy
Isotopic plutonium	HASL-300	Chemical separation alpha spectroscopy
Isotopic uranium	HASL-300	Chemical separation alpha spectroscopy
Cesium-137	EPA:901.1	Gamma spectrometry
Strontium-90	EPA:905.0	Gas flow proportional counting
Tritium	USGS Low-level tritium	Electrolytic enrichment

Note: TAL = Target analyte list.

Table 2
Video Logs from Buckman Well Field Piezometers SF-3, SF-4, and SF-5

Well	Well Condition	Key Features
SF-3A	Well generally in good physical condition. Some dark streaking on inner well-casing wall (mold or grease?). Joints between well casings may be glued or epoxied? There are fingers of grayish brown material extending down from some joints. Well casing is clear of streaking below the water level. The sump filled in to a depth of 296.6 ft with fine sediment, a moth, and a shotgun shell.	Water level is 88.8 ft below top of casing (toc). Water is clear. Well screen is 279.5 ft to 288.5 ft below toc. Well slots are impacted with fine silt or sand, but there are open areas within some slots. Sump is 288.5 ft to 296.5 ft (top of sediment).
SF-3B	Well generally in good physical condition. Some dark streaking on inner well-casing wall (mold or grease?). Streaking on walls decreases with depth and is minor below about 115 ft. The sump is filled in to a depth of 169.8 ft with sediment, insects, and a broken brown beer bottle (?).	Water level is 6.25 ft below toc. Water is clear. Well screen is 152.6 ft to 161.8 ft below toc. Well slots are impacted with fine silt or sand, but there are many open slots. Sump is 161.75 ft to 169.8 ft (top of sediment).
SF-3C	Well generally in good physical condition. Relatively minor dark streaking on inner well- casing wall (mold or grease?). Well casing is generally clear of streaking below the water level. The sump is filled in to a depth of 59.1 ft with fine sediment and a shotgun shell.	Water level is 20.75 ft below toc. Water is clear. Well screen is 43 ft to 52 ft below toc. Well slots are impacted with fine silt or sand, but there are many open slots. Sump is 52 ft to 59.1 ft (top of sediment).
SF-4A	Well generally in good physical condition. Some moderate dark streaking on inner well-casing wall (mold or grease?). Well casing is clear of streaking below the water level. There is a tape-like obstruction below 115.7 ft. It appears to be a corroded metal measuring tape. The tape, which was doubled up, snarls at 126 ft and at 136 ft, but the camera caused the tape to untangle, with the end falling further downhole. At 136 ft the entire tape came loose and fell downhole. A piece became lodged at 141 ft to 146 ft, but the camera easily bypassed it. Another piece at 182 ft to 197 ft was pushed 6 ft down the well by the camera before it was bypassed. More tape obstruction was encountered from 253 ft to >262 ft where the tape is doubled up on itself and becomes a complex snarl at approximately 261 ft.	Water level is 70.6 ft below toc. Water is clear above tape-like obstruction, but there are lots of particulates in the water adjacent to and below the obstruction as the camera moved past it. The camera run was terminated at 262 ft before reaching the well screen.
SF-4B	Well is in good physical condition, except as noted below at 123.8 ft. No streaking on inner well-casing wall that was seen in other wells. Joints between well casings may be glued or epoxied? There are fingers of grayish brown material extending down from some joints. There may be a small (<1 in.) separation of casing joints at 123.8 ft. The sump is filled in to a depth of 129.8 ft with fine sediment, insects, and a coil of measuring tape (?).	Water level is 2.7 ft below toc. Water is clear. Well screen is 113.5 ft to 123 ft below toc. Well slots are impacted with fine silt or sand, but there are many open slots. Sump is 123 ft to 129.8 ft (top of sediment).

Table 2 (continued)

Well	Well Condition	Key Features
SF-4C	Well is in good physical condition. No streaking on inner well-casing wall that was seen in other wells. The sump is filled in to a depth of 57.6 ft with fine sediment and insects.	Water level is 16.6 ft below toc. Water is clear. Well screen is 42 ft to 51.1 ft below toc. Well slots are largely open and free of fine silt or sand. Sump is 51.1 ft to 57.6 ft (top of sediment).
SF-5A	Well generally is in good physical condition. Dark streaking on inner well-casing wall (mold or grease?), particularly near the water level. Well-casing wall has oil-stained appearance from 58 ft to 59 ft. Joints between well casings may be glued or epoxied? There are fingers of grayish brown material extending down from some joints. Well casing has mottled, dirty appearance below the water level. Obstruction (pieces of basalt [?]) were encountered at 81 ft.	Water level is 59 ft below toc. Water has oil-like sheen at the water surface, but becomes clear below approximately 59.5 ft. Because of the obstructions, the camera run was terminated at 81 ft before reaching the well screen.
SF-5B	The well casing begins 1.5 ft below the ground surface. It looks like the surface casing was removed from the well and there is an open borehole down to 1.5 ft. Below 1.5 ft the well is in good physical condition, except at 143.5 ft where the casing is nearly unthreaded (lots of threads showing). No streaking on inner well-casing wall that was seen in other wells. Joints between well casings may be glued or epoxied? There are fingers of grayish brown material extending down from some joints. The sump is filled in to a depth of 161.6 ft with fine sediment and gravel-sized rock fragments.	Water level is at the land surface (artesian). Water is clear. Well screen is 144 ft to 153.6 ft below toc. Well slots are largely open and free of fine silt or sand. Sump is 153.6 ft to 161.6 ft (top of sediment).
SF-5C	Well is in good physical condition. Not much streaking on inner well-casing wall that was seen in other wells. Joints between well casings may be glued or epoxied? There are fingers of grayish brown material extending down from some joints. The casing/screen joint at 51 ft is nearly unthreaded (lots of threads showing). There is a thin 6-in.-long metal strip suspended in the well screen from 51.5 ft to 52 ft. There are obstructions in the sump at a depth of 62 ft. These obstructions include basalt cobbles and brown glass (probably part of a beer bottle).	Water level is 8.5 ft below toc. Water is clear. Well screen is 51.5 ft to 61.5 ft below toc. Well slots are impacted with fine silt or sand, but there are many open slots. Sump is 61.5 ft to 62 ft (top of obstruction).

Notes: Footage on video logs is measured from the top of casing. All wells, except SF-5B, have approximately 1.5 ft of steel casing coupled to the polyvinyl chloride (PVC) well string at the surface.

Piezometer nests SF-3, SF-4, and SF-5 are composed of three individual wells approximately 20 ft apart in a north-south line, constructed of 4-in.-inside diameter (I.D.) PVC casing inside a 6-in.-I.D. common steel surface protective casing with hinged, locking flat steel caps and with poured concrete 4 ft × 4 ft pads flush with the ground surface. The 6-in.-I.D. protective steel casing extends approximately 2 ft above the cement pads.

Piezometer nest SF-2 is composed of three individual wells in an east-west line constructed of 4-in.-I.D. common steel casing with a surface outer pipe of 4 5/8-in.-I.D. inside a 10-in.-I.D. common steel surface protective casing. The 10-in. casing extends approximately 1 ft above the ground surface and the top of the 4 5/8-in.-I.D. pipe extends approximately 3 ft above the ground surface.