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Biosolids, Crop, and Groundwater Data for a Biosolids-Application Area near Deer Trail, Colorado, 2007 and 2008

Data Series 589

U.S. Department of the Interior
U.S. Geological Survey

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Conversion Factors, Vertical Datum, and Abbreviations

Multiply	By	To obtain
	Length	
centimeter (cm)	0.3937	inch (in.)
foot (ft)	0.3048	meter (m)
inch (in.)	2.54	centimeter (cm)
kilometer (km)	0.6214	mile (mi)
meter (m)	3.281	foot (ft)
micrometer (µm)	0.00003937	inch (in.)
mile (mi)	1.609	kilometer (km)
millimeter (mm)	0.03937	inch (in.)
	Area	
acre	0.004047	square kilometer (km^2)
section (640 acres or 1 square mile)	259.0	square hectometer (hm^2)
square foot (ft^2)	0.09290	square meter (m^2)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
liter (L)	33.82	ounce, fluid (fl. oz)
ounce, fluid (fl. oz)	0.02957	liter (L)
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz)
pound, avoirdupois (lb)	0.4536	kilogram (kg)
ton, short (2,000 lb)	0.9072	megagram (Mg)
ton, long (2,240 lb)	1.016	megagram (Mg)

Temperature in degrees Celsius (°C) may be converted to degrees Fahrenheit (°F) as follows:

$$°F=(1.8×°C)+32$$

Vertical coordinate information is referenced to the North American Vertical Datum of 1988 (NAVD 88).

Horizontal coordinate information is referenced to the North American Datum of 1983 (NAD 83).

Altitude, as used in this report, refers to distance above the vertical datum.

Specific conductance is given in microsiemens per centimeter at 25 degrees Celsius (µS/cm at 25°C).

Concentrations of chemical constituents in water are given either in milligrams per liter (mg/L) or micrograms per liter (µg/L).

Biosolids, Crop, and Groundwater Data for a Biosolids-Application Area near Deer Trail, Colorado, 2007 and 2008

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Abstract

During 2007 and 2008, the U.S. Geological Survey monitored the chemical composition of biosolids, crops, and groundwater related to biosolids applications near Deer Trail, Colorado, in cooperation with the Metro Wastewater Reclamation District. This monitoring effort was a continuation of the monitoring program begun in 1999 in cooperation with the Metro Wastewater Reclamation District and the North Kiowa Bijou Groundwater Management District. The monitoring program addressed concerns from the public about potential chemical effects from applications of biosolids to farmland in the area near Deer Trail, Colo. This report presents chemical data from 2007 and 2008 for biosolids, crops, and alluvial and bedrock groundwater. The chemical data include the constituents of highest concern to the public (arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, zinc, and plutonium) in addition to many other constituents. The groundwater section also includes data for precipitation, air temperature, and depth to groundwater at various groundwater-monitoring sites.

Introduction

Since 1993, the Metro Wastewater Reclamation District (Metro District) has been applying biosolids generated from municipal sewage treatment in Denver, Colo., to their property near Deer Trail, Colo. (figs. 1 and 2; these figures and all other figures and tables are located in the Data Section at the back of the report). The biosolids are trucked about 75 miles (mi) east from Denver to the Metro District property (fig. 2) and are applied to nonirrigated farmland. The first property the Metro District acquired near Deer Trail was about 15 square miles (mi^2) (fig. 3). In 1995, the Metro District traded some of the property and acquired additional property in the same area. The resulting boundaries of the original property became known as the Metro District central property (fig. 2). The new properties consisted of about 14.5 mi^2, known as the north property, and about 50 mi^2, known as the south property (fig. 2). In 1999, the three Metro District properties together (known as the METROGRO Farm) encompassed almost 70 mi^2 of farmland in Arapahoe and Elbert Counties. The three Metro District properties and surrounding private property are considered the study area for this report (fig. 2).

Description of Study Area

The study area is located on the eastern plains of Colorado about 10 mi east of Deer Trail (fig.1). The study area is on the eastern margin of the Denver Basin, a bowl-shaped sequence of Cretaceous sedimentary rocks that was formed in an ocean or near-ocean environment. The geology of the study area consists of interbedded shale, siltstone, and sandstone, which may be overlain by clay, windblown silt and sand, or alluvial sand and gravel (Sharps, 1980; Major and others, 1983; Robson and Banta, 1995). The primary water-supply aquifer is the Laramie-Fox Hills aquifer, which is a bedrock aquifer that ranges from 0 to about 200 feet (ft) thick in the study area and is the bottom aquifer in the Denver Basin aquifer sequence (Robson and others, 1981; Robson and Banta, 1995; Yager and Arnold, 2003). Multiple alluvial aquifers are present in the study area. These aquifers are associated with the surficial drainage network and contain water of variable quality, are of limited extent, and generally yield little water (Stevens and others, 2003; Yager and Arnold, 2003).

The study area is within the South Platte River drainage basin; all streams in this area drain northward to the South Platte River (fig. 1; U.S. Geological Survey, 1974; Seaber and others, 1987; Yager and Arnold, 2003). Short segments of some of the streams are intermittent, but in general, the streams are ephemeral and flow only after storms. No surface water flows off the Metro District properties except after storms. Most ponds in the area have been created by detention structures. Soils in the area generally are sandy or loamy on flood plains and stream terraces, clayey to loamy on gently sloping to rolling uplands, and sandy and shaley on steeper uplands (Larsen and others, 1966; Larsen and Brown, 1971).

Land use in the study area was historically rangeland or cropland and pasture (U.S. Geological Survey, 1980). Some petroleum exploration was done in the area (Drew and others, 1979), but no oil or gas exploration or production took place on the Metro District properties during 2007 and 2008 (N. Crews, Metro Wastewater Reclamation District, written commun., April 13, 2011). Land in the study area was used as rangeland or cropland during 2007 and 2008. Cattle and sheep were the primary domesticated animals grazing the area, and wheat was the primary crop. Farmland was not irrigated. Herbicides and other chemicals were applied to the study area during 2007 and 2008 for farming purposes. Pesticides and other fertilizers also may have been applied to the Metro District properties historically, but little information is available about these historical applications. Biosolids were applied as a fertilizer only on the Metro District properties.

Biosolids are applied by the Metro District to their properties near Deer Trail (figs. 2–4) according to agronomic loading rates (table 1; Colorado Department of Public Health and Environment, 2003). Land-applied biosolids must meet Colorado regulatory limits (Colorado Department of Public Health and Environment, 2003); otherwise, agronomic loading rates could be exceeded and soils could become overloaded. Soil quality either can be improved by biosolids applications through increased nutrients and organic matter or degraded through accumulation of excessive nutrients, metals, or other chemical constituents. Animal waste (related to wildlife and grazing domestic livestock) and applications of pesticides and fertilizers (organic and inorganic) can affect soil and water quality (Adeyinka and Mustapha, 2005) and therefore can affect crops, dust, groundwater and surface-water quality, and streambed-sediment chemistry.

Monitoring History

The U.S. Geological Survey (USGS) has collected data in the study area since 1993. From 1993 to 1999, the USGS, in cooperation with the Metro District, monitored the quality of shallow groundwater on the original Metro District property (fig. 3). Public concern about applications of biosolids to farmland increased in the late 1990s after the Metro District agreed to accept treated groundwater from the Lowry Landfill Superfund site in Denver. The concern was that water from the Lowry Superfund site might contain radionuclides that would contaminate the Metro District biosolids and the study area. In January 1999, the USGS began an expanded monitoring program for 1999 through 2003, in cooperation with the Metro District and the North Kiowa Bijou Groundwater Management District, to address this and other concerns from stakeholders. A subsequent phase of the expanded monitoring program near Deer Trail continued with selected monitoring from 2005 through 2010. Conclusions from the 1999–2003 phase (Yager and others, 2004d) were used to determine monitoring components, analytes, sites, and frequency for the 2005–2010 phase. The USGS refers to the 1999–2003 monitoring program and subsequent USGS monitoring efforts in the study area as the “expanded monitoring program.”

The expanded monitoring program near Deer Trail is distinct from, but built on, the first USGS monitoring program near Deer Trail on the Metro District central property (fig. 3; 1993–1999). Compared to the previous program, the expanded program includes a larger study area (fig. 2; all three Metro District properties and private-property locations), more monitoring components (biosolids, soil, crops, and streambed sediments were monitored in addition to groundwater), a more comprehensive list of chemical constituents, expanded statistical analyses of data, and an extended monitoring period (1999–2010). In 2005, the monitoring program was further expanded to include analysis of nitrogen isotopes and organic wastewater compounds in biosolids, biosolids leachates, and groundwater. A monitoring component to characterize dust was included for 2006–2007.

The USGS is doing both the original and expanded monitoring programs in cooperation with the Metro District. Both programs were designed, conducted, and interpreted independently by the USGS, and quality-assured USGS data and reports were released to the public and the Metro District at the same time. Selected monitoring results for 1993 through 1999 and a detailed discussion of hydrogeology of the study area are reported by Yager and Arnold (2003). Monitoring results for 1999 were reported by Stevens and others (2003). Monitoring results for 2000 were reported by Yager and others (2004a). Monitoring results for 2001 were reported by Yager and others (2004b). Monitoring results for 2002 through 2003 were reported by Yager and others (2004c). Monitoring results for 2004 through 2006 were reported by Yager and others (2009). Interpretive information for the 1999 through 2003 data was reported by Yager and others (2004d). Data and interpretations for the dust-monitoring component were reported by Reheis and others (2009). Additional chemical data were reported by Crock and others (2008a, 2008b, 2009a, 2009b, and 2010). Selected data for 1999 through 2008 also were published in the “USGS Expanded Monitoring Program near Deer Trail” progress reports (*http://co.water.usgs.gov/projects/CO406/pubsprogress.html* accessed February 8, 2011).

The expanded monitoring program near Deer Trail addressed concerns about the effects of biosolids applications and other agricultural activities on the environment and increased scientific insight about Denver Basin hydrology. The objectives of this USGS program were to (1) evaluate the combined effects of biosolids applications, land use, and natural processes on soils, crops, dust, the bedrock aquifer, alluvial aquifers, and streambed sediments by comparing chemical data to (a) regulatory standards, (b) data from a site where biosolids are not applied (a control site), or (c) earlier data from the same site (trends); (2) monitor biosolids for trace elements and radioactivity and compare trace-element concentrations and radioactivity with regulatory standards; and (3) characterize the hydrology of the study area. The monitoring of each component (such as crops or groundwater) was a stand-alone study that did not necessarily encompass the entire study area. More detailed information about the monitoring of each component is included later in this report.

Purpose and Scope

The purpose of this report is to present data from the expanded monitoring program near Deer Trail for January 2007 through December 2008. This report presents data for all monitoring components of the program for which data were collected during 2007 and 2008, except the dust component. The report includes information for biosolids, crops, and alluvial-aquifer and bedrock-aquifer groundwater. The groundwater section includes hydrologic data (precipitation, air temperature, and depth to groundwater) and water-quality data (chemistry and field measurements). Data in this report were collected by the USGS after the water transfer from the Lowry Landfill Superfund site to the Metro District plant, which began in July 2000.

This report does not include any statistical comparisons of data to regulatory standards or calculation of trends; plans are to include statistical testing of the data in an interpretive report for the 2004–2010 data prepared after 2010. This report does not include any dust data, organic wastewater-compound data, or isotope data collected during 2007 and 2008 for any monitoring component; plans are to include these data with interpretive information in separate reports. No description, data, or discussion of the soil and streambed-sediment monitoring components are included in this report because no data for these components were collected during 2007 and 2008.

This report is organized by monitoring component because each component is monitored as a separate study. For each monitoring component, the specific objectives, approach, data, and a discussion are included in this report.

Biosolids

Biosolids are solid organic matter recovered from a sewage-treatment process that meets State and Federal regulatory criteria for beneficial use, such as for fertilizer. The regulatory limits for Colorado biosolids are described by Colorado Department of Public Health and Environment (2003) as Table 1 Ceiling Concentration Limits and Table 3 Pollutant Concentration Limits. Table 3 Pollutant Concentration Limits (formerly known as Grade I) are more restrictive than Table 1 Ceiling Concentration Limits (formerly known as Grade II). In this report, “Table 3 biosolids” and “Table 3 Class B biosolids” mean biosolids that meet the criteria in Table 3 of the Colorado biosolids regulation. Land-applied biosolids must meet or exceed Table 1, Class B criteria (Colorado Department of Public Health and Environment, 2003). The Metro District applies Table 3 Class B biosolids to their properties near Deer Trail. The biosolids-application areas, dates of application, and application rates provided by the Metro District for their properties near Deer Trail are listed in table 1 of this report; application areas (called “Destination Codes” [DC]) are shown in figure 4.

Objectives of Monitoring Biosolids

The biosolids must meet regulatory standards for trace elements. Exceeding these standards could adversely affect the quality of soil on which the biosolids are applied and could alter the Metro District plans for the application of biosolids in Arapahoe and Elbert Counties. The composition of biosolids was monitored to provide an independently determined data set against which the Metro District chemical analyses and the regulatory standards for biosolids can be compared. The data also will constitute a chemical baseline against which any future change in the concentration of constituents analyzed for in this study may be recognized, measured, and compared.

Approach for Monitoring Biosolids

Biosolids samples were collected directly from the Metro District facility in Denver rather than from individual trucks or fields near Deer Trail to enable the USGS to obtain a more representative sample. Biosolids samples were analyzed for concentrations of arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, selenium, sulfur, zinc, and plutonium. The concentrations in the samples were compared to applicable Colorado standards for biosolids (Colorado Department of Public Health and Environment, 2003).

Sampling Methods for Biosolids

In 2007 and 2008, the USGS received biosolids samples monthly from the Metro District. Each monthly sample was a composite bottled over 1–2 days at the Metro District wastewater treatment plant in Denver by Metro District personnel. Biosolids samples were collected in acid-washed, rinsed, 1-gallon (gal) plastic or glass bottles. The USGS received one to two bottles from each centrifuge that was active at the treatment plant at the time the sample was collected; the treatment plant had a maximum of four centrifuges active at any time. The USGS combined the contents of all sample bottles into a plastic tray and dried the resulting composited sample in a fume hood in the laboratory. Samples for trace-element or radioactivity analyses were dried under an infrared heat lamp to decrease drying time. When the biosolids sample was dried, an aliquot was removed and ground to less than 150 micro-meters (µm) for chemical analysis. The remaining dried biosolids sample was archived as a single monthly sample.

Analytical Methods for Biosolids

The monthly biosolids samples were processed and analyzed for trace elements at the USGS Mineral Resources Program laboratories (MRPL) in Denver. A single, randomly selected biosolids sample was analyzed each year for radioactivity through a contract with the USGS National Water Quality Laboratory (NWQL) at Eberline Services in California. The methods used to analyze the biosolids for each constituent are listed in table 2.

Quality Assurance for Biosolids

The purpose of the quality-assurance program developed for the biosolids monitoring component was to ensure that the analytical results were within acceptable limits of both precision (the reproducibility of results) and accuracy (the degree of conformity of results for a sample having known concentrations). The precision was determined by analyzing the same biosolids sample multiple times, and accuracy was determined by analyzing a National Institute of Standards and Technology (NIST) standard reference material (SRM). The SRM 2781, a domestic sewage sludge, was prepared by NIST from material collected at the Metro District treatment plant in Denver. The SRM 2781 has been analyzed extensively by many laboratories throughout the world, and the NIST has certified an acceptable range of values for various constituents in the SRM. The constituents include those of interest in this study. Each biosolids sample was submitted to the laboratories with a sample of the SRM. If the analytical results for the constituent of interest in the SRM were within the acceptable range, the results for the biosolids samples were accepted. Additional quality-assurance information for the 2007 and 2008 biosolids samples is provided by Crock and others (2008b and 2009a). The analytical quality-assurance practices and procedures of the MRPL are described by Taggart (2002).

Biosolids Data

Data for trace-element concentrations in the 2007 and 2008 biosolids samples are listed in table 3 of this report along with the Colorado standards (Table 1 Ceiling Concentration Limits and Table 3 Pollutant Concentration Limits) for land-applied biosolids. Quality-control data (NIST SRM 2781) associated with the biosolids samples are listed in table 4. Data for plutonium concentrations in the 2007 and 2008 biosolids samples are listed in table 5.

Discussion of Biosolids Data

All trace-element concentrations in the biosolids samples were less than the Colorado standards established by the Table 1 Ceiling Concentration Limits and Table 3 Pollutant Concentration Limits (Colorado Department of Public Health and Environment, 2003). No plutonium standards are applicable to the biosolids. The plutonium data for biosolids (table 5) are similar to the plutonium data for soil in the study area (Stevens and others, 2003; Yager and others, 2004b). The radioactivity data are reported in the uncensored form as received from the laboratory rather than censored by either the contract or calculated minimum detectable concentration (MDC). Relative to the censored form (data reported as less than the MDC), the uncensored form provides more information about the uncertainty and the very small concentrations of plutonium. The negative activity concentrations reported in table 5 mean the sample count was less than the laboratory background count for that day. Radioactivity data are produced from instruments that detect radioactive decay (disintegrations) in a sample as counts per minute. The background count was subtracted from the sample count, and the resulting value was converted to activity-concentration units of picocuries per gram.

Crops

As previously mentioned, biosolids can contain elevated concentrations of certain trace elements. The application of biosolids to farmland on which grain crops are grown that eventually will be consumed by animals or humans has led to public concern about the composition of the crops grown on the fields receiving biosolids.

Objectives of Monitoring Crops

Crops are monitored for trace elements to establish independent chemical data sets for the composition of the crops before and after the application of biosolids. The data will enable the USGS to recognize and quantify significant changes in the chemical composition of crops caused by the application of biosolids to agricultural soils or by other natural or human-induced processes.

Approach for Monitoring Crops

In the summer of 2000, the USGS began monitoring crops grown in the same two areas where soils were monitored (figs. 2, 5, and 6). Each of the two soil- and crop-monitoring areas included one field that received biosolids and two fields that did not receive biosolids and are used as “control” fields to determine the natural variability of soil and crop composition for the duration of the study (figs. 5–6). The fields at each area are farmed in a way similar to the rest of the Metro District property and have crops planted and harvested approximately every other year. Soils from each of the six fields were sampled in 1999 before biosolids were applied to the two center fields and were sampled again after each harvest through 2003. Crop samples are collected from every harvest, which is in summer.

The primary crop monitored is winter wheat, although millet and corn also have been grown and sampled. The primary form of the crop that is monitored is mature grain at the time of harvest. Crops grown on fields that receive biosolids applications are monitored along with crops grown on fields that do not receive biosolids applications. The crops from fields that do not receive biosolids applications are used as a reference for comparison. Crop samples were obtained from the monitoring areas in 2000, 2001, 2002, 2004, 2006, and 2008. The crop samples were analyzed for arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, and zinc. During 2003, 2005, and 2007, no crops were grown in either the

Arapahoe or Elbert County soil- and crop-monitoring areas. Data will be compared after each sampling and at the conclusion of the study to determine how the concentrations of the constituents of interest vary with time.

Site Selection for Monitoring Crops

The two soil- and crop-monitoring areas were selected in 1999 on the basis of Metro District land that was eligible for biosolids application but where biosolids had never been applied. One area was selected on the Metro District's north property in Arapahoe County, and one area was selected on the Metro District's south property in Elbert County (fig. 2). The Arapahoe County area is located in Township 4 South, Range 58 West, Section 22 and lies about 0.25 mi west of Badger Creek (fig. 5). The Elbert County area is located in Township 6 South, Range 57 West, Section 8 and lies immediately west of Beaver Creek (fig. 6). Each of the two soil- and crop-monitoring areas consist of three 20-acre (933-ft by 933-ft) fields separated by 100-ft buffer strips (figs. 5 and 6). When samples could not be obtained from a designated soil- and crop-monitoring area (such as in the case of crop failure), a sample from a nearby biosolids-applied field was analyzed when possible.

Sampling Methods for Crops

During 2007 and 2008, the crop sample was collected by the Metro District from the machine-harvested and threshed grain obtained from each field. The combine was emptied before harvesting grain from any of the soil- and crop-monitoring fields to ensure that the grain sampled was from only the designated field; no grain from the buffer strips (figs. 5) was included in the wheat-grain sample. The grain harvested from each designated field was collected by hand from the combine hopper about every 100–200 ft of the entire field and composited into a clean bucket. Samples of mature, field-dried wheat grain and corn kernels were provided to the USGS by the Metro District in clean, white, plastic buckets. The USGS received a single, separate, composited crop sample from each of the 20-acre fields harvested (fig. 5) and from an Elbert County biosolids-applied field (fig. 4, DC 454).

Analytical Methods for Crops

The crop samples were processed and analyzed for trace elements at the USGS MRPL in Denver. The crop samples were dried under forced air at room temperature and then cleaned using forced air and sieving. The cleaned crop samples were ground to a flour using a commercial table-top grain mill. A split of each ground sample was ashed in a forced-air muffle furnace at 500°C. The ashed grain samples and the dried, unashed grain samples were analyzed by the protocols described in detail by Yager and others (2004a). The 2008 crop samples were analyzed for arsenic, cadmium, copper, lead, mercury, molybdenum, nickel, and zinc. The analytical methods are summarized in table 2. The analytical quality-assurance practices and procedures of the MRPL are described by Taggart (2002).

Crop Data

In 2008, wheat grain was sampled from the Arapahoe County soil- and crop-monitoring area (fig. 5), and corn kernels were sampled from a biosolids-applied field (DC 454; fig. 4) in Elbert County. Chemical data for the Arapahoe County wheat grain and the Elbert County corn kernels are listed in table 6. No data are available for selenium or sulfur concentration in the 2008 crop samples.

Discussion of Crop Data

All analyses of crop samples met the quality-assurance criteria described by Taggart (2002). The chemical differences between wheat collected from the 20-acre field to which biosolids have been applied and wheat from the control fields where no biosolids have been applied are minimal. Fluctuations in wheat-grain concentration among the 2008 samples are within the normal range of uncertainty associated with the method.

Only one crop cycle took place during the 2007–2008 monitoring period so only one sample was collected from each monitored field. Each sample was a composite from across the entire field, so the single sample is representative of the entire field. Collecting additional composite samples from the same field could have provided information about concentration variability within a field but would not have increased sample representativeness.

Few comparisons can be made between the grain sample of Elbert County relative to the grain samples of Arapahoe County because the Elbert County sample was corn and the Arapahoe County samples were wheat, and because the Elbert County sample was not collected from the soil- and crop-monitoring area. The 2008 corn-kernel sample from the Elbert County biosolids-applied field had smaller concentrations of cadmium, copper, molybdenum, and nickel than the 2008 samples of wheat from the Arapahoe County fields (table 6) and than the 2006 sample of corn kernels from Elbert County (Yager and others, 2009).

Groundwater

Applications of pesticides, herbicides, or fertilizers (including biosolids) to the land surface can affect the quality of shallow groundwater directly by contaminating recharge water at the surface or during infiltration through contaminated soils or sediments (remobilization). These applications also can affect the quality of shallow groundwater indirectly by contributing to natural processes such as nitrification.

Discharge from contaminated alluvial groundwater also could contaminate surface water (ponds or streams) or bedrock water-supply aquifers. For this report, alluvial groundwater is defined as the water contained in subsurface, unconsolidated (uncemented), wind- or water-transported sediments in current or historical stream channels or flood plains. Bedrock groundwater is defined as the water contained in the fractures or pore spaces of the rock (consolidated sediments) that underlies soil or other uncemented materials; the primary bedrock aquifer in the study area is the Laramie-Fox Hills aquifer (Robson and Banta, 1995).

Objectives of Monitoring Groundwater

Groundwater was monitored to characterize the hydrology and water quality of the aquifers; to determine if concentrations of nitrate, arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc in the groundwater are significantly greater than regulatory standards; and to determine if concentrations of these constituents are increasing with time in groundwater at or near the Metro District properties.

Approach for Monitoring Groundwater

Alluvial and bedrock groundwater was monitored during 2007 and 2008 at USGS monitoring wells in the study area that were installed in 1993–2002 during previous phases of monitoring. "D"-numbered wells were drilled before 1999 as part of the first monitoring program (except for wells D6A and D25A, which were drilled in 2002), and "DTX"-numbered wells were drilled in 1999 or 2000 (fig. 2). Lithologic and well-completion information for these well locations are provided by Stevens and others (2003), Yager and Arnold (2003), and Yager and others (2004a). During 2007 and 2008, fewer groundwater sites were monitored routinely than during 1999 through 2003, but all the USGS monitoring wells remaining in the study area (figs. 2 and 3) were visited at least once. Selected information for all the USGS wells monitored during 2007 and 2008 as part of this program is summarized in table 7.

To characterize hydrology, semi-quantitative meteorologic (precipitation and air temperature) data were collected, depth to groundwater was measured monthly, and groundwater altitude was compared at two recharge-evaluation sites. Each recharge-evaluation site consisted of a nested bedrock-aquifer well paired with an alluvial-aquifer well at the same location. Monitoring multiple wells in the same location enabled different zones of groundwater to be monitored without having to consider spatial variability and can enable inferences about vertical directions of groundwater flow between zones. In this study, a nested well consists of a single borehole that has two separate piezometers screened at two separate zones; the shallow zone is designated by "A" and the deep zone is designated by "B" after the well name. Therefore, three different aquifer zones are monitored at each of the two recharge-evaluation sites in Muddy Creek downgradient from the Metro District properties in the northwest part of the study area (fig. 2). A fourth aquifer zone (well DTX11) is monitored at the DTX9 recharge site to provide information about a deeper coarse-grained part of the Muddy Creek alluvial aquifer than is monitored by well DTX9.

To provide detailed information about groundwater hydrology in the study area, electronic equipment (commonly referred to as continuous-recorder equipment) was used at selected well sites. In 2000, electronic data-logger (EDL) equipment was installed at the DTX9/DTX10/DTX11 site to automatically report hourly measurements of cumulative precipitation and instantaneous depth to groundwater. In 2007, this continuous-recorder equipment was upgraded to a data-collection platform (DCP) to transmit the data by satellite into the USGS database. In November 2008, the continuous-recorder equipment again was upgraded, and data collection at 15-minute intervals began. DCPs have been used to collect hourly data at various other locations in the study area (DTX2, DTX5, and D25). However, the recorders were discontinued at wells D25 and DTX5 during 2004 through 2006 and at well DTX2 during 2007 through 2008. During 2007 and 2008, all the study-area DCP data usually were available on the Internet. The data generated from the continuous-recorder equipment is called "continuous data" because the recording equipment runs continuously and records data frequently (hourly or more often).

To characterize water quality of the alluvial aquifers, samples were collected quarterly from five sites. To characterize water quality of the bedrock aquifer, a sample was collected annually from two sites. Other USGS monitoring wells in the study area also were sampled at least once during 2007 through 2008 to provide additional information about groundwater-quality changes in the study area after biosolids applications began. Groundwater samples were analyzed for physical properties, dissolved major ions and trace elements, and dissolved and total nutrients. Analyses included nitrate, arsenic, cadmium, copper, chromium, lead, mercury, molybdenum, nickel, selenium, and zinc (constituents considered the most important by the stakeholders). Selected analytical data are compared to the Colorado standards (Colorado Department of Public Health and Environment, 2004) annually.

All groundwater data are maintained in the USGS National Water Information System (NWIS) data base. All groundwater data collected for this program during 1999 through 2006 and corresponding interpretive information were published in USGS reports (Stevens and others, 2003; Yager and Arnold, 2003; Yager and others, 2004a, 2004b, 2004c, 2004d, and 2009) and are available on the Internet (*http://co.water.usgs.gov/projects/CO406/pubs.html* accessed February 8, 2011).

Site Selection for Monitoring Groundwater

Site selection for routine groundwater monitoring during 2007 and 2008 was the same as that for 2005 and 2006, which is described in detail by Yager and others (2009). Depth to water was usually measured at all USGS monitoring wells shown in figure 2. Groundwater was routinely sampled at five alluvial property-boundary wells (DTX1, DTX2, D6, D17, and D25) and at the shallowest zones of the bedrock aquifer at two locations (DTX8A and DTX10A) (fig. 2). Recharge interactions were monitored at the two recharge-evaluation sites in the northwest part of the study area, each of which included at least one alluvial-aquifer well and one nested bedrock-aquifer well. Wells DTX7 and DTX8 compose one recharge-evaluation site, and wells DTX9, DTX10, and DTX11 compose the other recharge-evaluation site (fig. 2).

As many as 10 years had elapsed since the other, older USGS monitoring wells in the vicinity (fig. 3) had been visited. In 2007, all USGS monitoring wells remaining in the vicinity of the Metro District property (figs. 2 and 3) were visited, and depth to water was measured. Subsequently, all USGS monitoring wells in the vicinity (figs. 2 and 3) were sampled for inorganic water quality during 2007 or 2008 if in good condition and yielding sufficient water for a complete sample. Wells sampled as part of this decadal sampling effort were DTX5, DTX6, D3, D4, D5, D6A, D7, D8, D10, D13, D14, D15, D16, D19, D20, D21, D22, D23, D25A, D26, D27, D28, D31, D32, and D33 (figs. 2 and 3). Information about all the USGS monitoring wells shown in figures 2 and 3 is listed in table 7.

Sites for continuous-recorder equipment were selected to provide detailed data for evaluating complex or changing interactions. During 2007 and 2008, the interactions between various aquifers and groundwater zones and weather variables were of most interest at the location containing wells DTX9, DTX10, and DTX11 (fig. 2). This location is the nearest recharge-evaluation site downstream from the Metro District property near Deer Trail and is a location where two distinct zones of alluvial aquifer are present above the bedrock aquifer at an ephemeral stream (Stevens and others, 2003; Yager and others, 2004a). Therefore, continuous-recorder equipment was used at the DTX9/DTX10/DTX11 site to collect detailed data in 2007 and 2008. Sufficient detailed data were collected during 1999–2007 at well DTX2 (fig. 2), so the DCP equipment was removed from DTX2 during 2007 through 2008.

Sampling Methods for Groundwater

All data-collection methods used during 2007 and 2008 were the same as the 1999 methods, which are detailed by U.S. Geological Survey (variously dated) and Stevens and others (2003). Monthly depth-to-water measurements were made using a vinyl-coated electric tape. Data from the DCPs automatically were recorded hourly and were checked against the manually measured monthly data.

Water-quality samples were collected using standard USGS methods (Horowitz and others, 1994; U.S. Geological Survey, variously dated). Water levels and field measurements such as pH and specific conductance were recorded with the collection of each groundwater sample. Blank and replicate samples were analyzed to evaluate bias and variability of the groundwater data. All sampling equipment was used exclusively by the USGS and was used only in the study area to prevent cross contamination from other sites in other study areas. All samples and sampling equipment were thoroughly cleaned between sampling events and retained at all times in the custody of the USGS in secured facilities.

Analytical Methods for Groundwater

Groundwater samples were analyzed by the USGS NWQL in Denver. The methods used to analyze the 2007 and 2008 groundwater samples are listed in table 8, which includes laboratory Minimum Reporting Levels (MRLs) for the constituents of interest.

Quality Assurance for Groundwater

Quality-assurance procedures were implemented during the course of the monitoring program to ensure the quality of the data. Procedures were implemented for depth-to-water measurements, DCP-data collection, groundwater-sampling preparation, field-properties measurements, groundwater sampling, and laboratory analysis. Replicate and blank water-quality samples were collected every sampling trip and analyzed for the same constituents and properties as were the environmental groundwater samples. Additional blank samples occasionally were collected for specific topical quality-assurance purposes and therefore were analyzed only for selected constituents and properties. Quality-assurance procedures are detailed in the 1999 data report (Stevens and others, 2003). The analytical quality-assurance practices and procedures of the NWQL are described by Friedman and Erdmann (1982).

Groundwater Data

Monitoring at groundwater sites during 2007 and 2008 produced hydrologic and water-quality data. Hydrologic data included cumulative measurements of precipitation at two sites and instantaneous measurements of hourly air temperature at one site, hourly water temperature at one well, hourly depth to water at four wells, and monthly depth to water at all wells. Water-quality data included analytical results from quarterly or annual sampling, as well as data from a single sampling of 25 monitoring wells.

Hydrologic Data

Hourly precipitation and air-temperature data were collected from the study area during 2007 and 2008. Cumulative precipitation and instantaneous air temperature recorded hourly during 2007 and 2008 at well DTX2 are shown in figure 7. Cumulative precipitation recorded hourly during 2007 and 2008 at the DTX9/DTX10/DTX11 site are shown in figure 8.

Monthly depth-to-water data and hourly depth-to-water and water-temperature data were collected from the study area during 2007 and 2008. The monthly depth-to-water data for the USGS monitoring wells are listed as measurements below the measuring point at a specific time (table 9) to show the maximum precision of the measurements. The measuring point for the USGS monitoring wells generally was about 2–3 ft above land surface (table 7), although land surface fluctuates over time relative to the fixed measuring points and was not remeasured after well installation. Continuous, daily data derived from hourly depth-to-water data for the two DCP sites (DTX2 and DTX9/DTX10/DTX11; fig. 2) are shown in figures 7 and 8 as daily maximum depth to water below land surface. Daily data derived from hourly water-temperature data for DTX2 also are shown in figure 7. No continuous depth-to-water data were collected at wells DTX5 or D25 during 2007 and 2008 because equipment was removed from these sites prior to 2007.

Water-level data can indicate groundwater recharge information. Water-level altitudes for the paired alluvial-aquifer and bedrock-aquifer wells at the northernmost recharge-evaluation site (wells DTX7 and DTX8) are compared for 2007 and 2008 in figure 9. Water-level altitudes for the paired alluvial-aquifer and bedrock-aquifer wells at the other recharge-evaluation site (wells DTX9, DTX10, and DTX11) are compared for 2007 and 2008 in figure 10.

Water-Quality Data

Water-quality data for groundwater samples collected from the study area during 2007 and 2008 are listed in table 10. Data are included for field properties, physical properties, major ions, nutrients, and trace elements for 32 USGS monitoring wells in the study area, including the bedrock-aquifer wells at the recharge-evaluation sites. Graphs of selected groundwater-quality data are provided in figures 11 and 12. Quality-control water-quality data for the blank samples are listed in table 11, and comparison data for groundwater and replicate samples are listed in table 12.

Discussion of Groundwater Data

The precipitation and air-temperature data collected during 2007 and 2008 (figs. 7 and 8) are semi-quantitative. These data were checked by manual measurements when possible during monthly site visits. The tipping-bucket rain gages (the part of the continuous-recorder equipment used to measure precipitation) were deployed throughout the year, but are known to under-report precipitation during winter months. Precipitation data for all months of 2007 and 2008 are included in figures 7 and 8, but the precipitation data for winter months are best used for general indication of magnitude and timing of precipitation in the area. The air-temperature data are accurate to within several degrees year round. The checks indicate that these data for 2007 and 2008 are acceptable for the intended purpose of evaluating the response of groundwater to changes in air temperature and precipitation.

Depth-to-water data (table 9) indicate that water levels fluctuated at most wells during 2007 and 2008. At wells DTX4, DTX5, DTX6, D25, and D25A (fig. 2), water levels generally declined after a spring 2007 recharge period. The water level in well DTX4 was in or above the screened interval during all of 2007 and 2008 (table 9) following substantial recharge that began in late May 2006 (Yager and others, 2009); this well usually was dry October 2001 through April 2006 (Yager and others 2004b, 2004c, and 2009). At a few wells (D11a and D19), no spring 2007 recharge was apparent and water levels generally decreased during 2007 and 2008 (table 9). Water levels generally increased during 2008 at DTX2. Although well DTX3 recharged substantially in 2006 for the first time since 2001 (Yager and others, 2004b, 2004c, and 2009), this well remained dry throughout 2007 and 2008 (table 9).

Hydrologic interactions between alluvial and bedrock aquifers can be inferred using water-level data for the same point in time for wells at the same site (figs. 9 and 10). The direction of the vertical movement of groundwater, or the recharge direction, may be indicated by noting that water moves from areas of high hydraulic head (high water-level altitude) to areas of low hydraulic head (low water-level altitude).

The data included in this report indicate that alluvial- and bedrock-aquifer chemistry is variable in space (from site to site) and in time (from one data-collection time to the next at the same site) in the study area (table 10). The distribution of concentrations at each routinely monitored well for selected constituents during 2007 and 2008 is compared to Colorado regulatory standards (Colorado Department of Public Health and Environment, 2004) in figure 11. Time-series graphs (concentration plotted with time) of selected constituents for selected wells are included as figure 12. All concentrations of nitrite plus nitrate as nitrogen at well D6 were greater than the Colorado Human Health standard (fig. 11), but concentrations did not increase markedly with time during 2007 and 2008 (fig. 12). All concentrations of dissolved selenium at well D6 were greater than the Colorado Agricultural and Human Health standards (fig. 11). Concentrations for most constituents in water samples from well D6A in 2007 and 2008 were similar to those of well D6 (table 10). Concentrations of nitrite plus nitrate as nitrogen in wells D7, D10, D26, D27, D28, and D32 also were greater than the Colorado Human Health standard of 10 μg/L (table 10). Concentrations of selenium in wells D3 and D33 also exceeded the Colorado Agricultural standard (20 μg/L) or Human Health standard (50 μg/L) (table 10). Arsenic concentration in the sample from well D21 exceeded the Colorado Human Health standard of 10 μg/L (table 10). During 2007 and 2008, concentrations of nitrate, arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, nickel, selenium, and zinc in samples from the other wells sampled all were less than regulatory standards (table 10 and fig. 11).

Blank samples were analyzed to evaluate high bias in the low concentration range, which can indicate contamination of field or laboratory supplies or equipment. Concentrations for the blank water-quality samples (table 11) generally indicate little or no contamination bias in the low concentration range for the 2007 and 2008 environmental samples. Only a slight high bias in the low-concentration range is indicated for some major- and trace-element concentrations. The blank samples of type “Q” (table 11) were from the submersible stainless steel pump, and these data indicate occasional slight contamination bias for aluminum, boron, cobalt, copper, lead, nickel, silver, and zinc values in June 2008. This pump was used only at wells DTX8A and DTX10A so only samples from these wells may have been affected, but not substantially. The field blank from September 26, 2008, showed uncharacteristic high bias in the low-concentration range for calcium, magnesium, aluminum, manganese, nickel, strontium, and zinc when an insufficiently cleaned sampling tube was used to prepare the blank sample; this high bias only affected concentration data from the one-time sampling of the older USGS monitoring wells (fig. 3), but not substantially. In general, concentrations for the blank samples were much less than those for the groundwater samples.

The relative percent differences (RPD) between the groundwater samples and the replicate samples were computed to summarize sample variability (table 12). Most of the larger RPDs are due to values or concentrations near the MRL where precision is expected to be poor. In these instances, concentrations may vary little but result in large RPDs. For example, a groundwater sample concentration of 0.04 mg/L and a replicate-sample concentration of 0.03 mg/L results in an RPD of 29 percent, but the difference is considered to be within the precision of the method at that concentration. Variability in the data was highest for analyses of arsenic, barium, copper, manganese, nickel, and selenium, although rerun analyses improved RPDs for some of these constituents in table 12. Note that most if not all of this variability likely is from the analyses and is not inherently present in the groundwater or contributed through field processing. The analytical-method interference that likely caused much of the variability reported for the 2004 through 2006 data (Yager and others, 2009) became markedly better in 2007 and was no longer an issue in 2008. The replicate-sample data indicate generally reproducible analytical results.

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Data Section

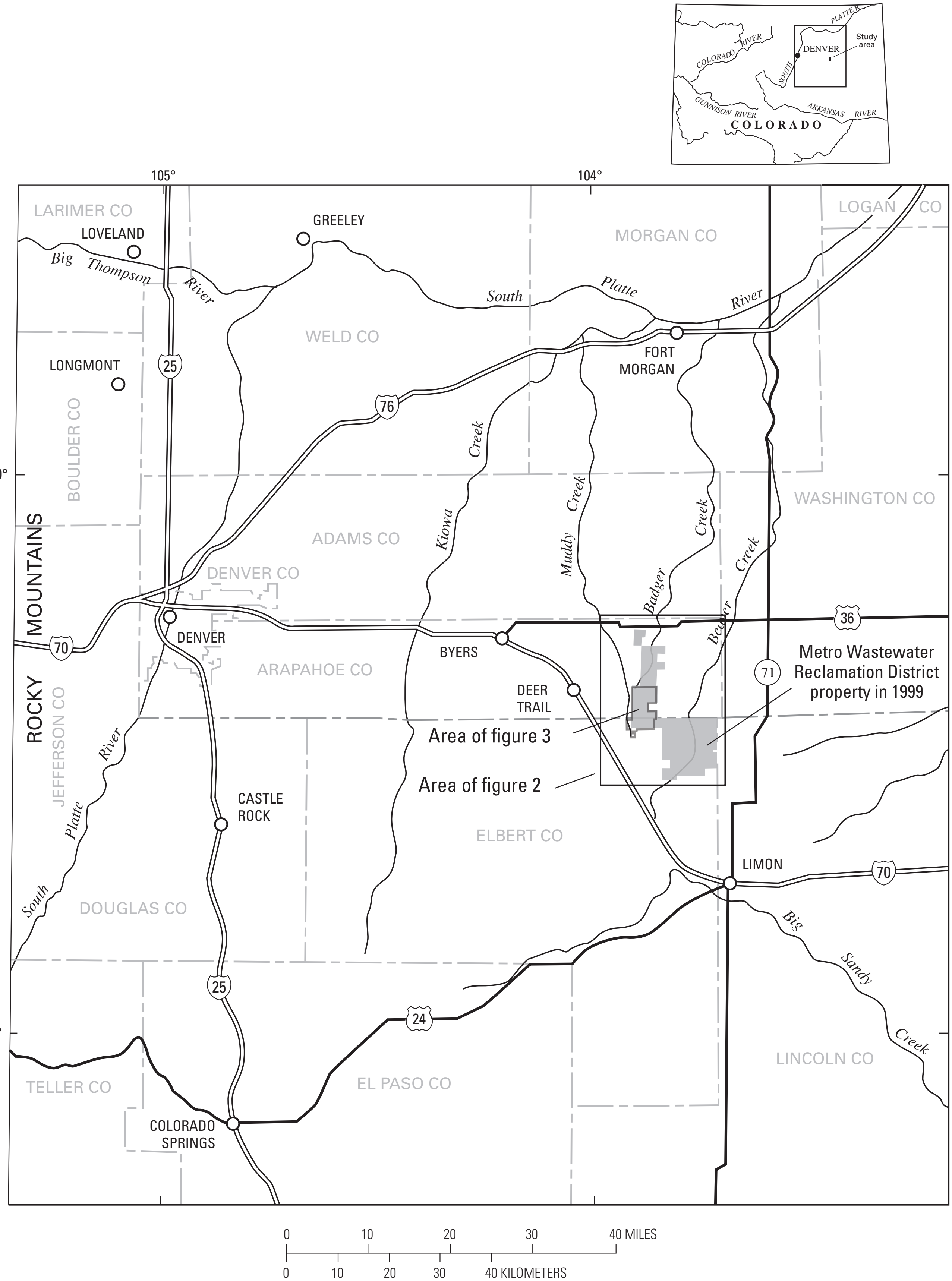


Figure 1. Location of study area near Deer Trail, Colorado.

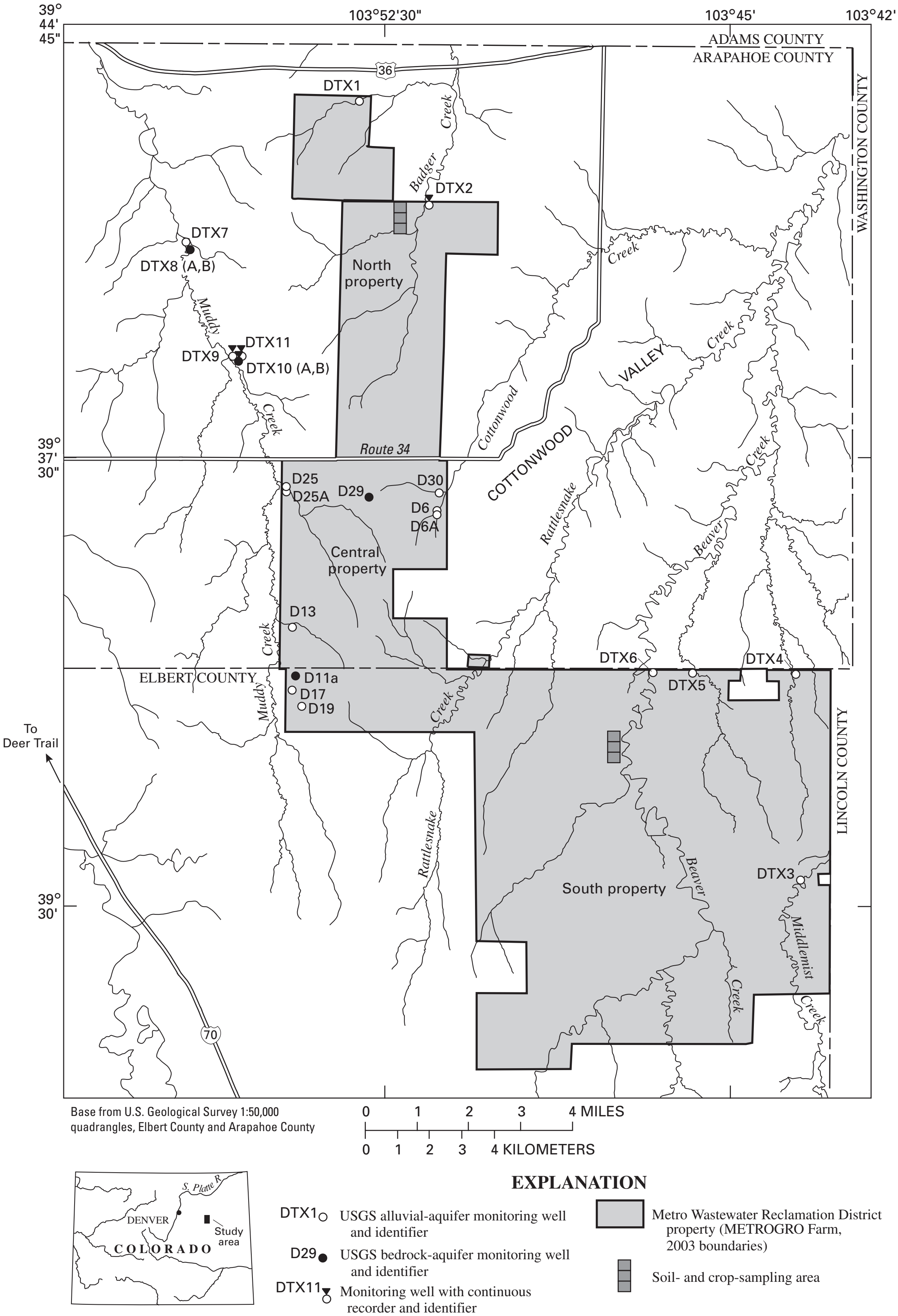


Figure 2. Location of U.S. Geological Survey Expanded Monitoring Program sites near Deer Trail, Colorado, 2007 and 2008.

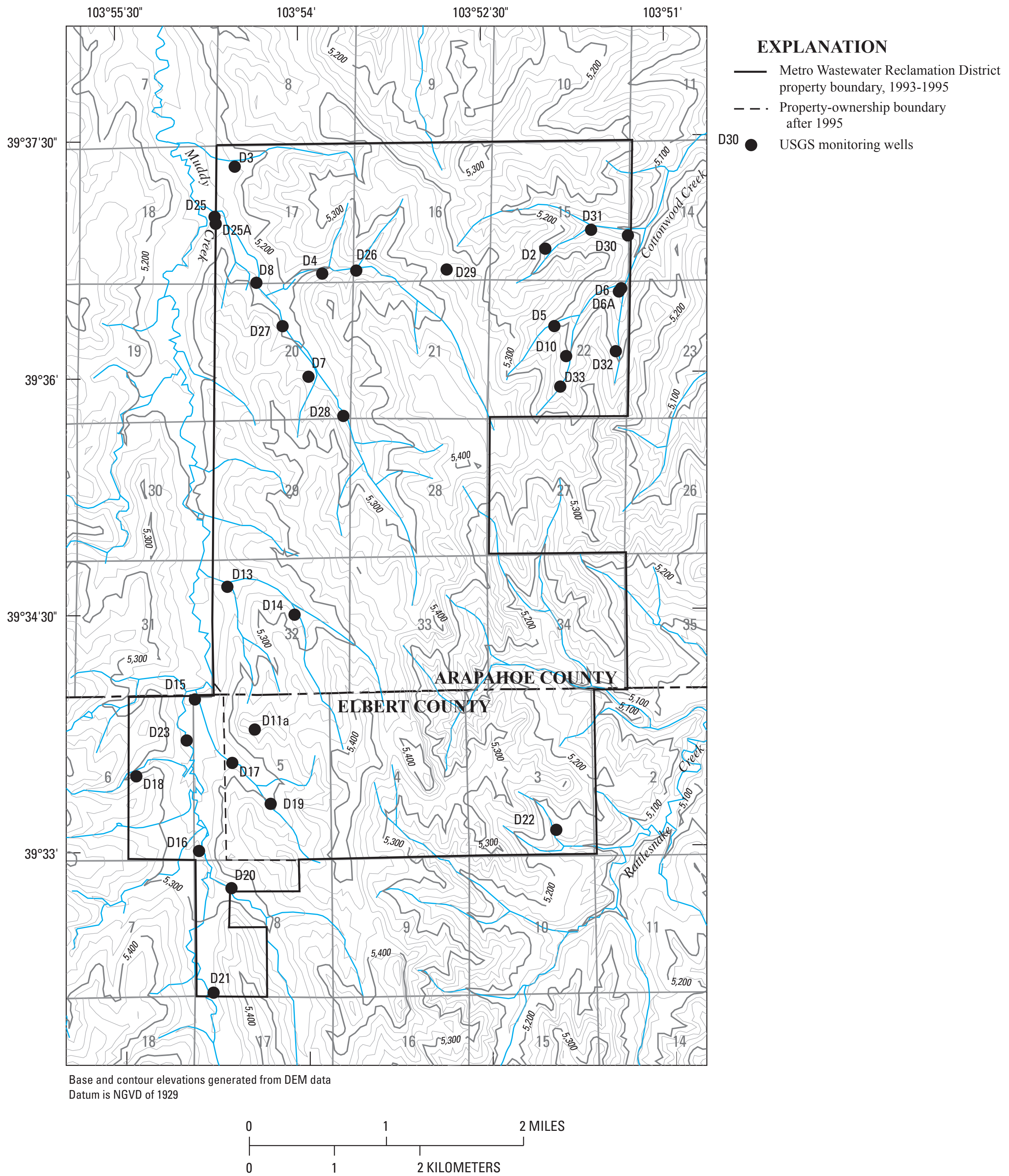


Figure 3. Locations of U.S. Geological Survey monitoring wells during 2007 and 2008 on the original (1993–1995) Metro Wastewater Reclamation District property near Deer Trail, Colorado, now part of the METROGRO Farm central property.

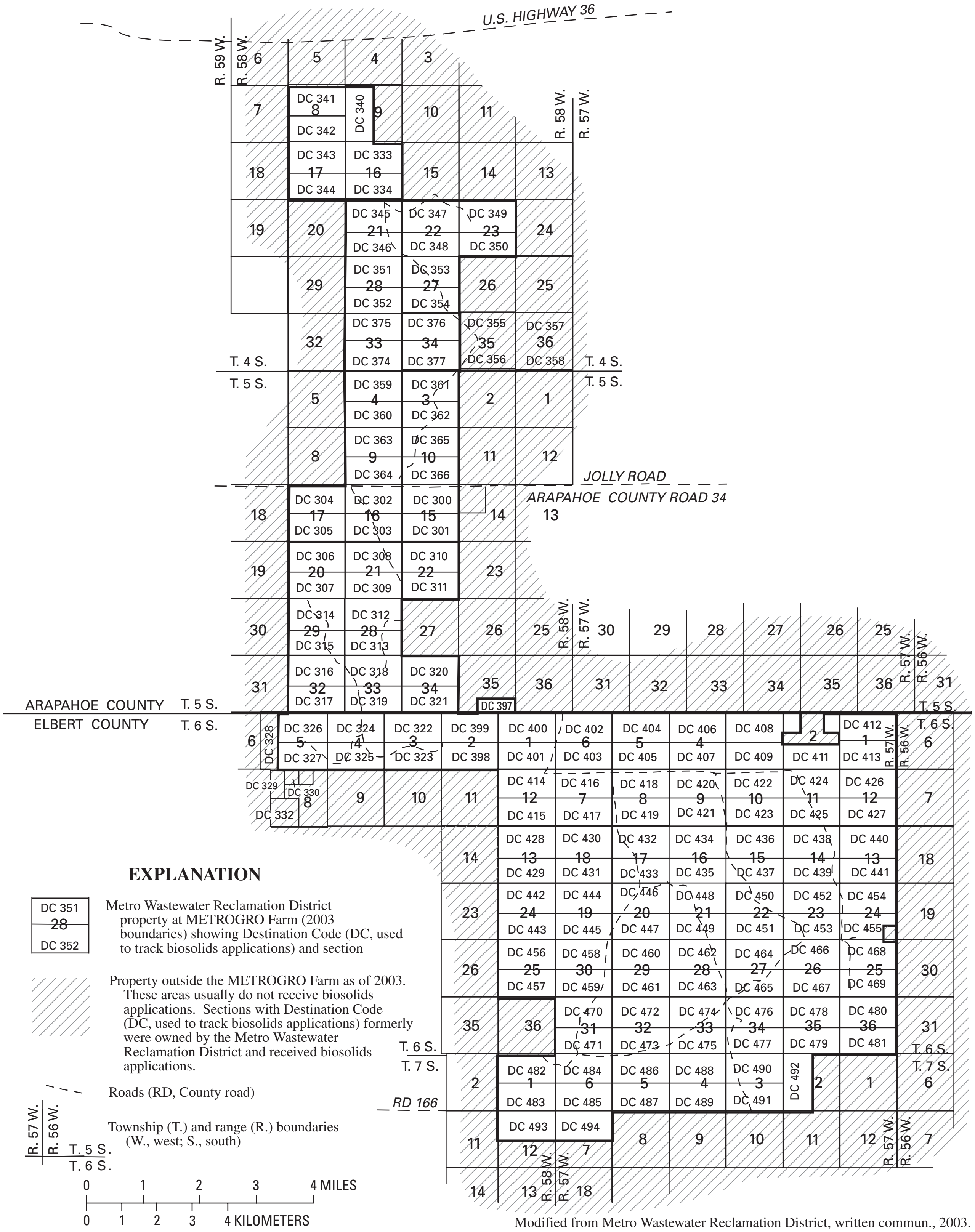


Figure 4. Metro Wastewater Reclamation District biosolids-application areas near Deer Trail, Colorado, 2007 and 2008.

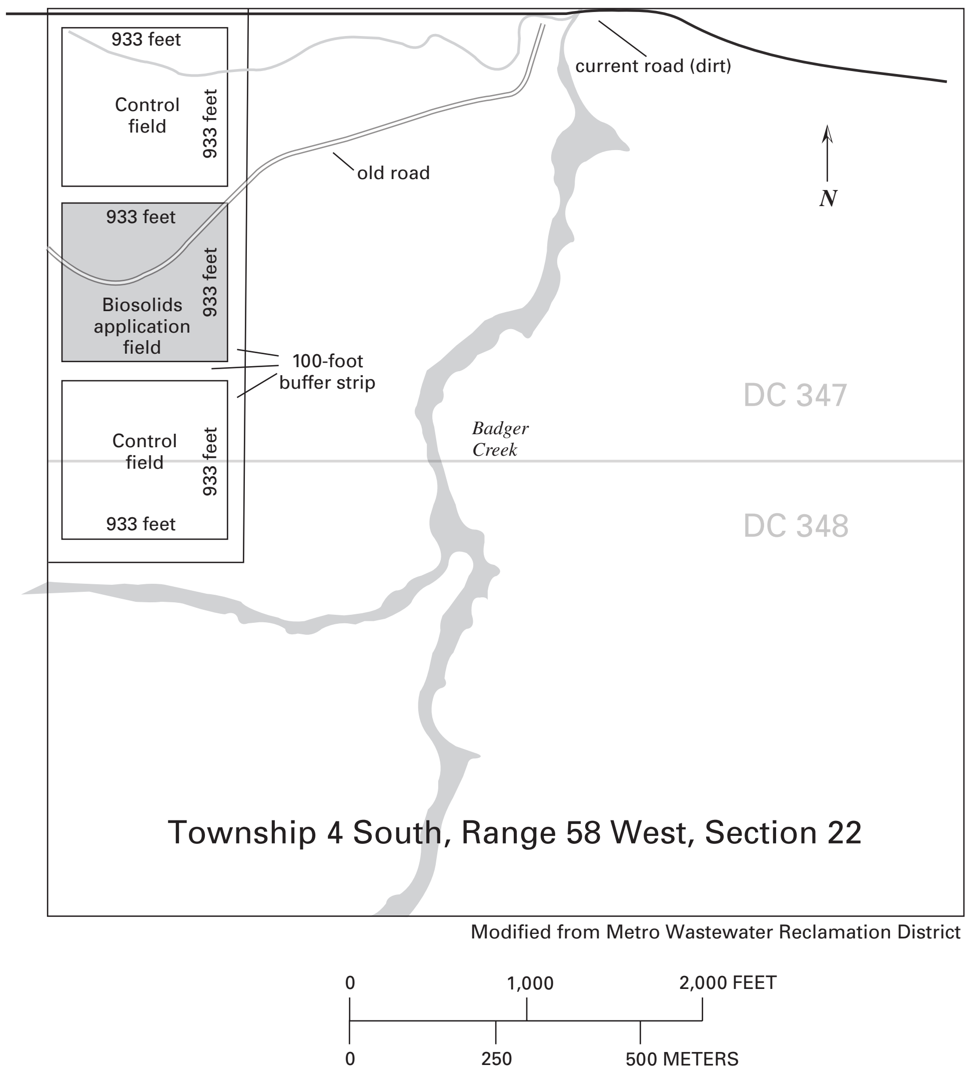


Figure 5. Arapahoe County, Colorado, soil- and crop-sampling area.

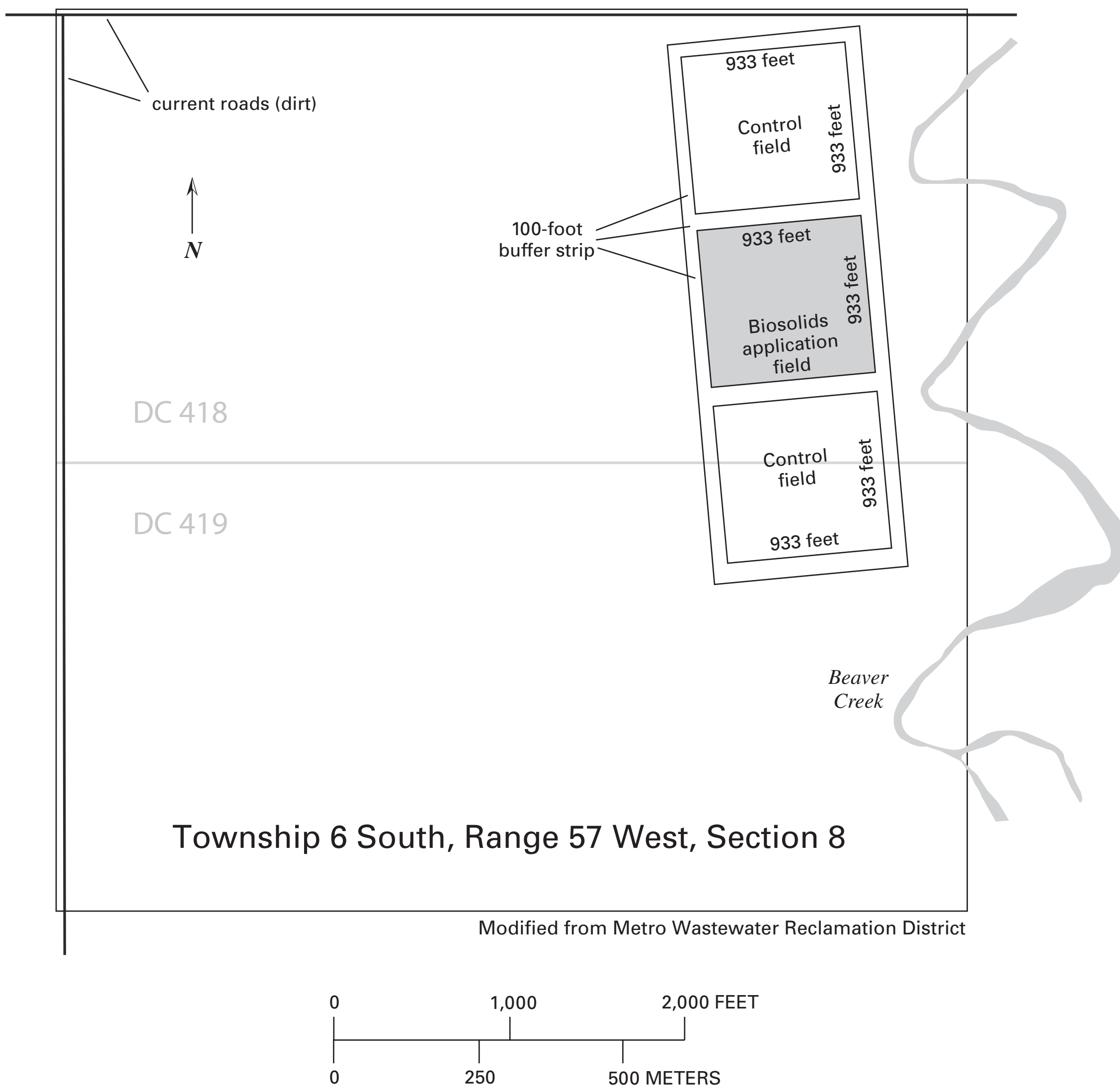


Figure 6. Elbert County, Colorado, soil- and crop-sampling area.

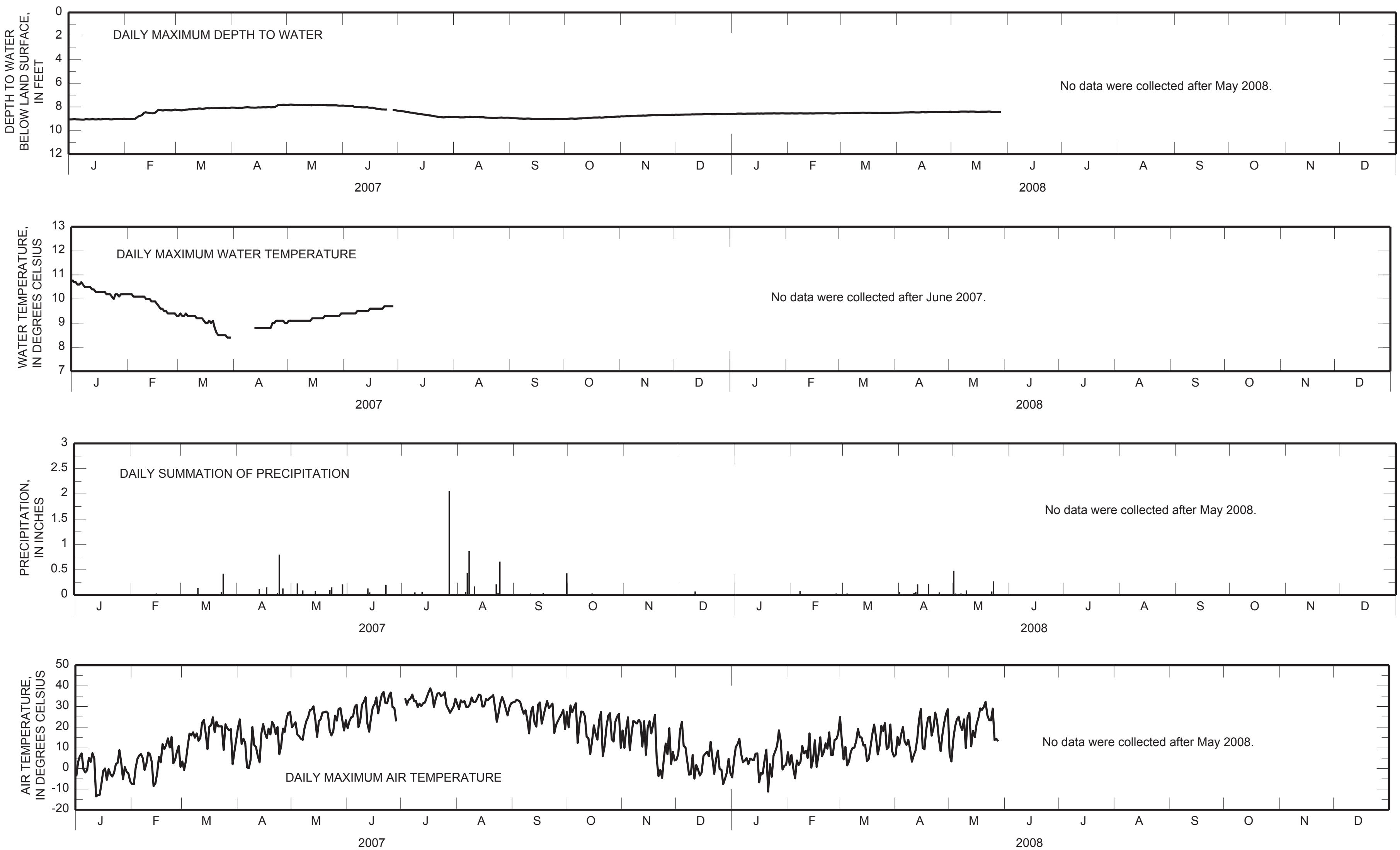


Figure 7. Continuous depth-to-water, water-temperature, precipitation, and air-temperature data for well DTX2 near Deer Trail, Colorado, 2007 and 2008.

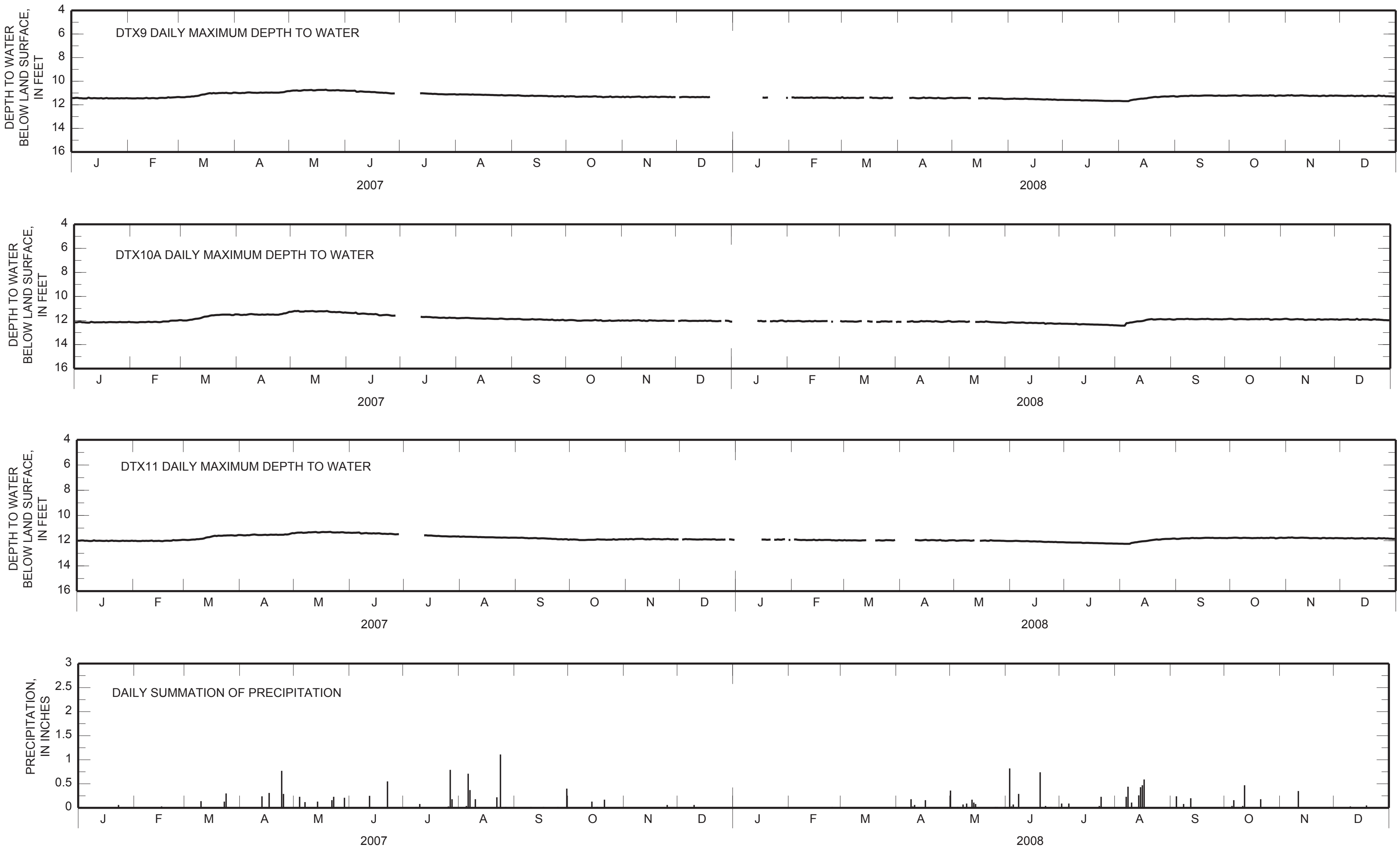


Figure 8. Continuous depth-to-water and precipitation data for wells DTX9, DTX10, and DTX11 (a recharge-evaluation site) near Deer Trail, Colorado, 2007 and 2008.

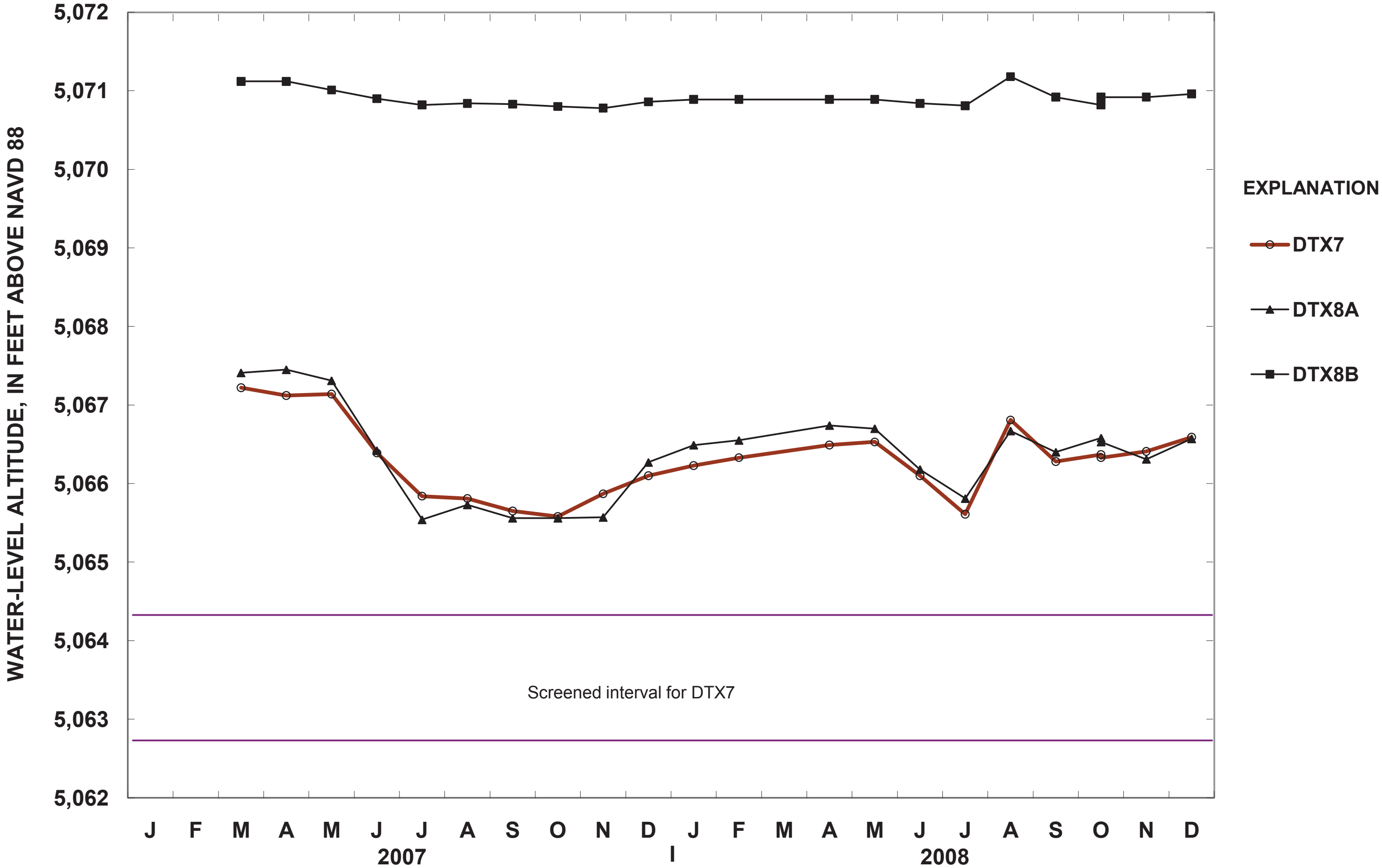


Figure 9. Water-level comparison for the recharge-evaluation site containing wells DTX7, DTX8 near Deer Trail, Colorado, 2007 and 2008.

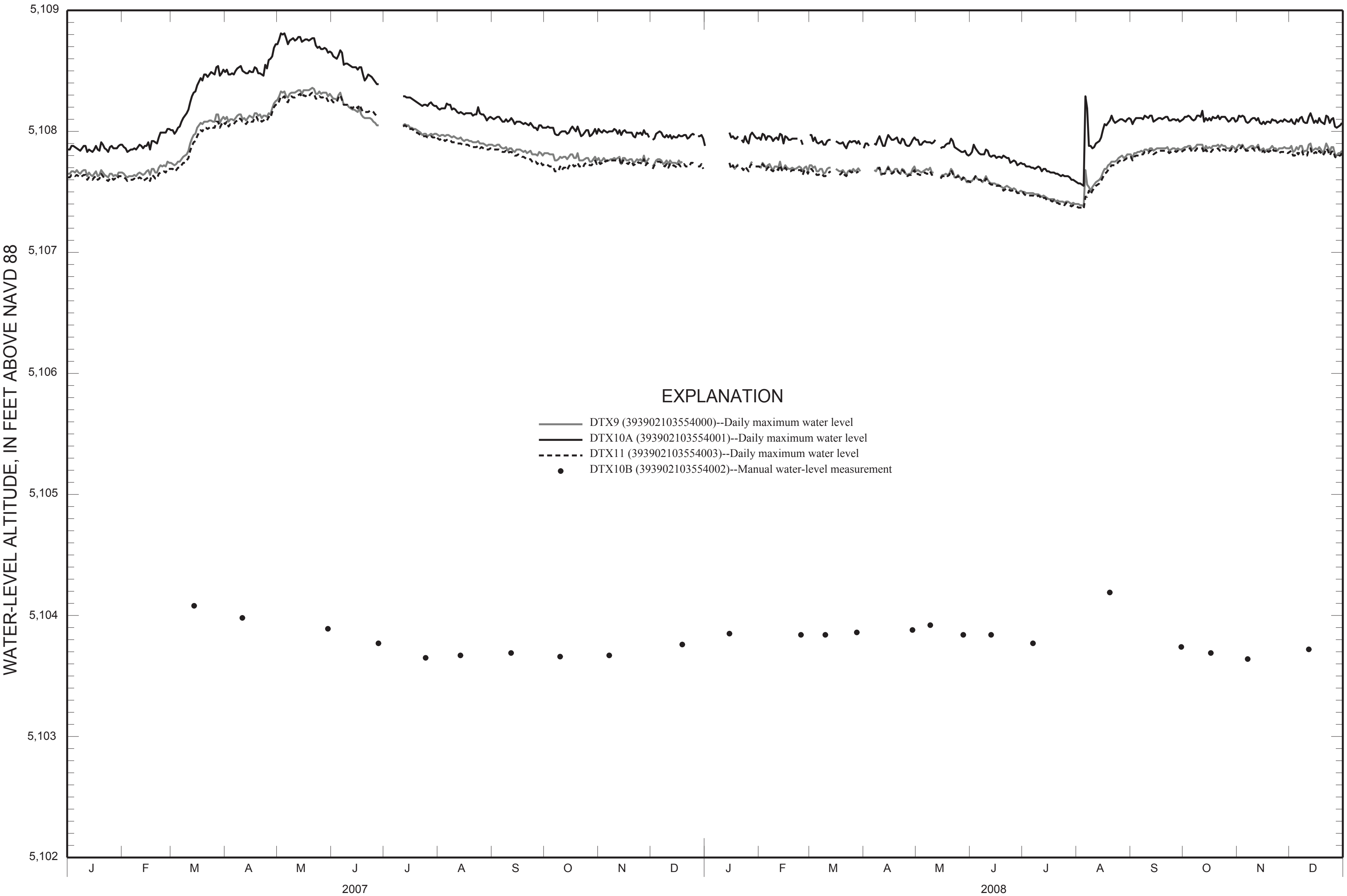


Figure 10. Water-level comparison for the recharge-evaluation site containing wells DTX9, DTX10, and DTX11 near Deer Trail, Colorado, 2007 and 2008.

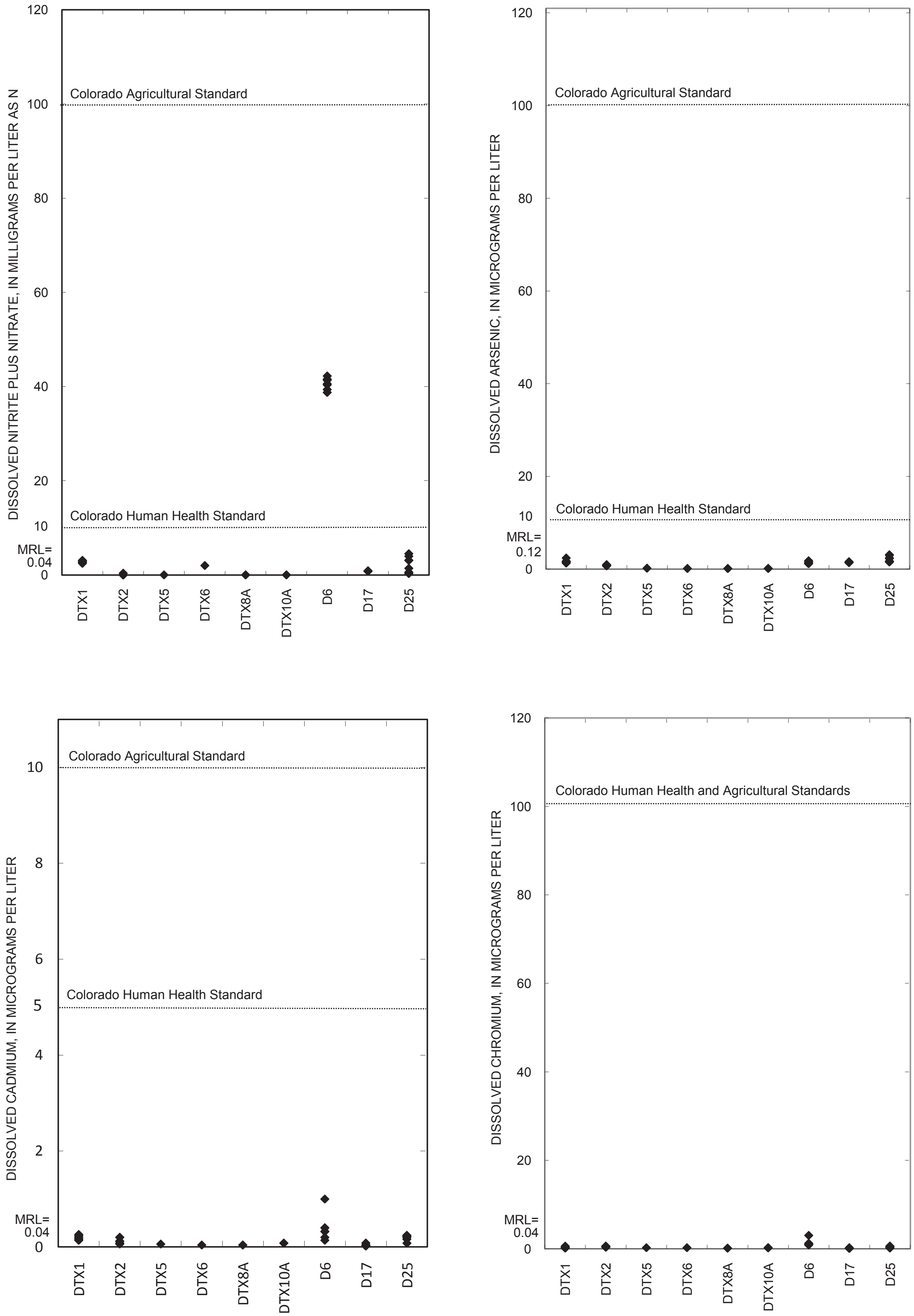


Figure 11. Distribution of groundwater constituent data collected near Deer Trail, Colorado, compared to regulatory standards for selected constituents, 2007 and 2008.

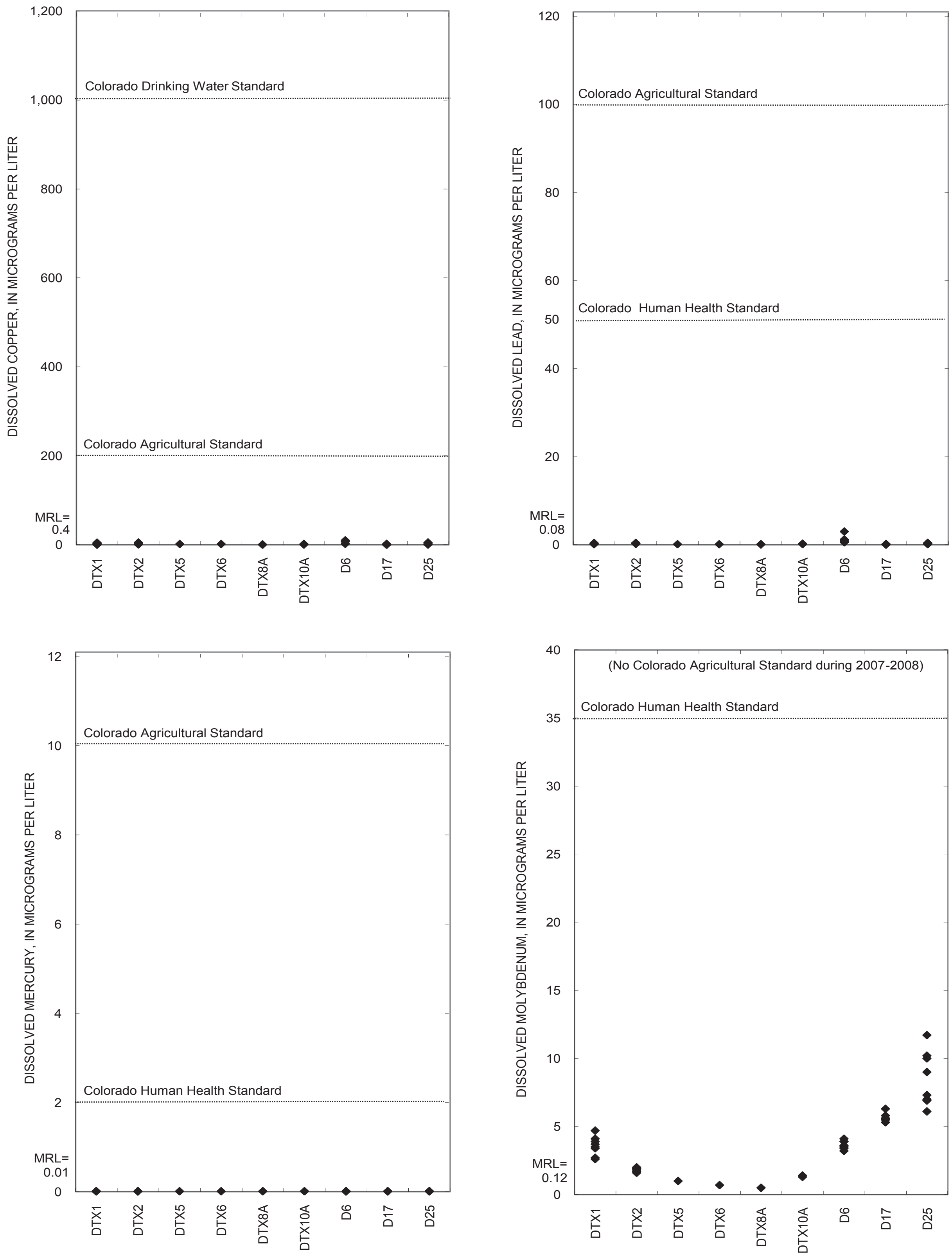
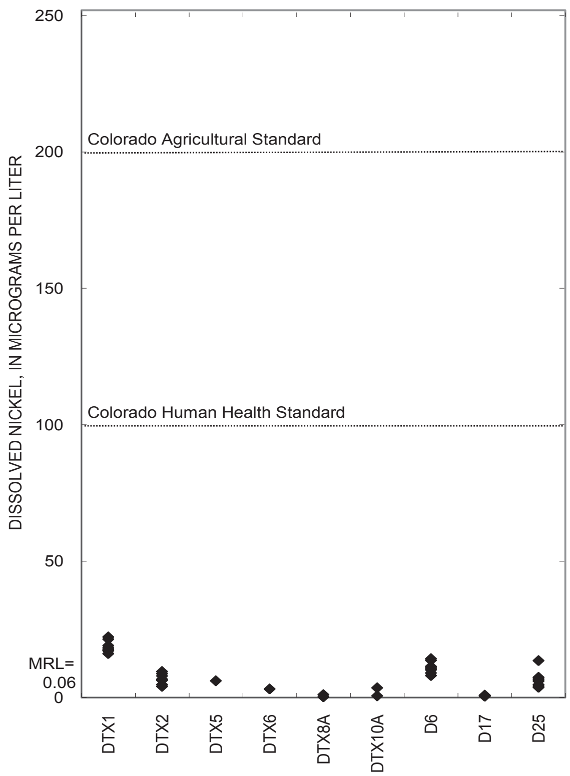
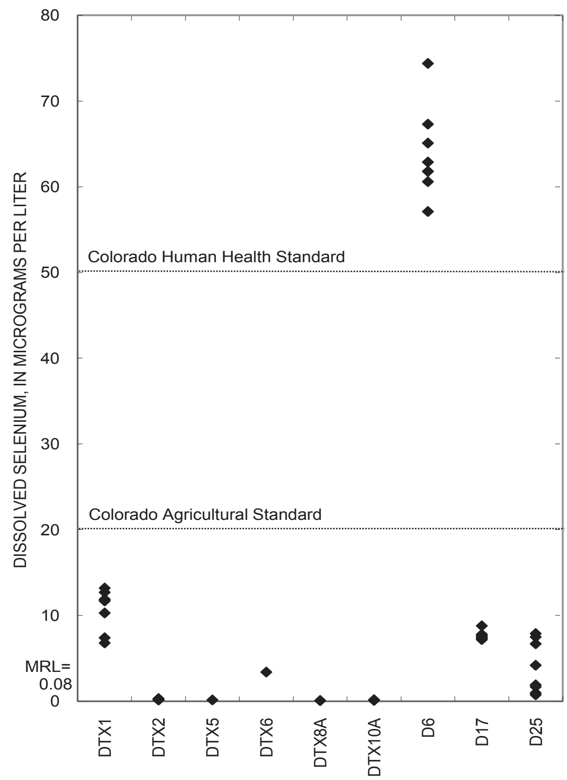


Figure 11. Distribution of groundwater constituent data collected near Deer Trail, Colorado, compared to regulatory standards for selected constituents, 2007 and 2008.—Continued





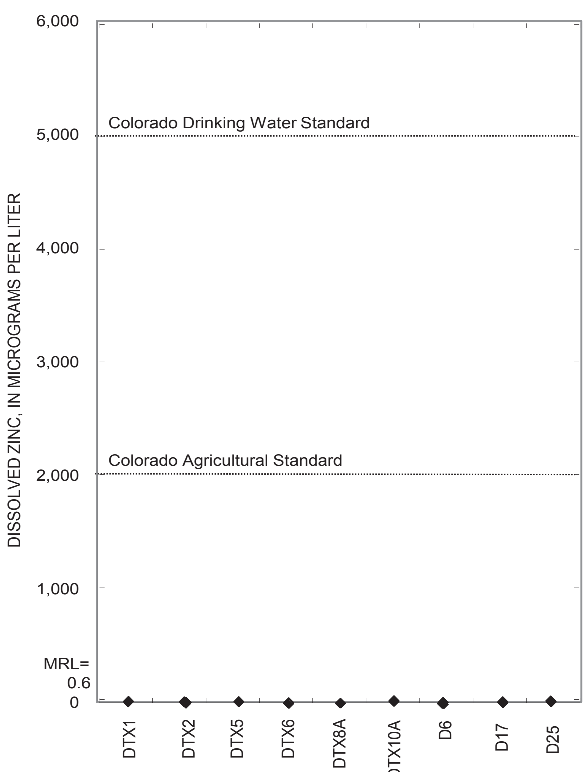


Figure 11. Distribution of groundwater constituent data collected near Deer Trail, Colorado, compared to regulatory standards for selected constituents, 2007 and 2008.—Continued

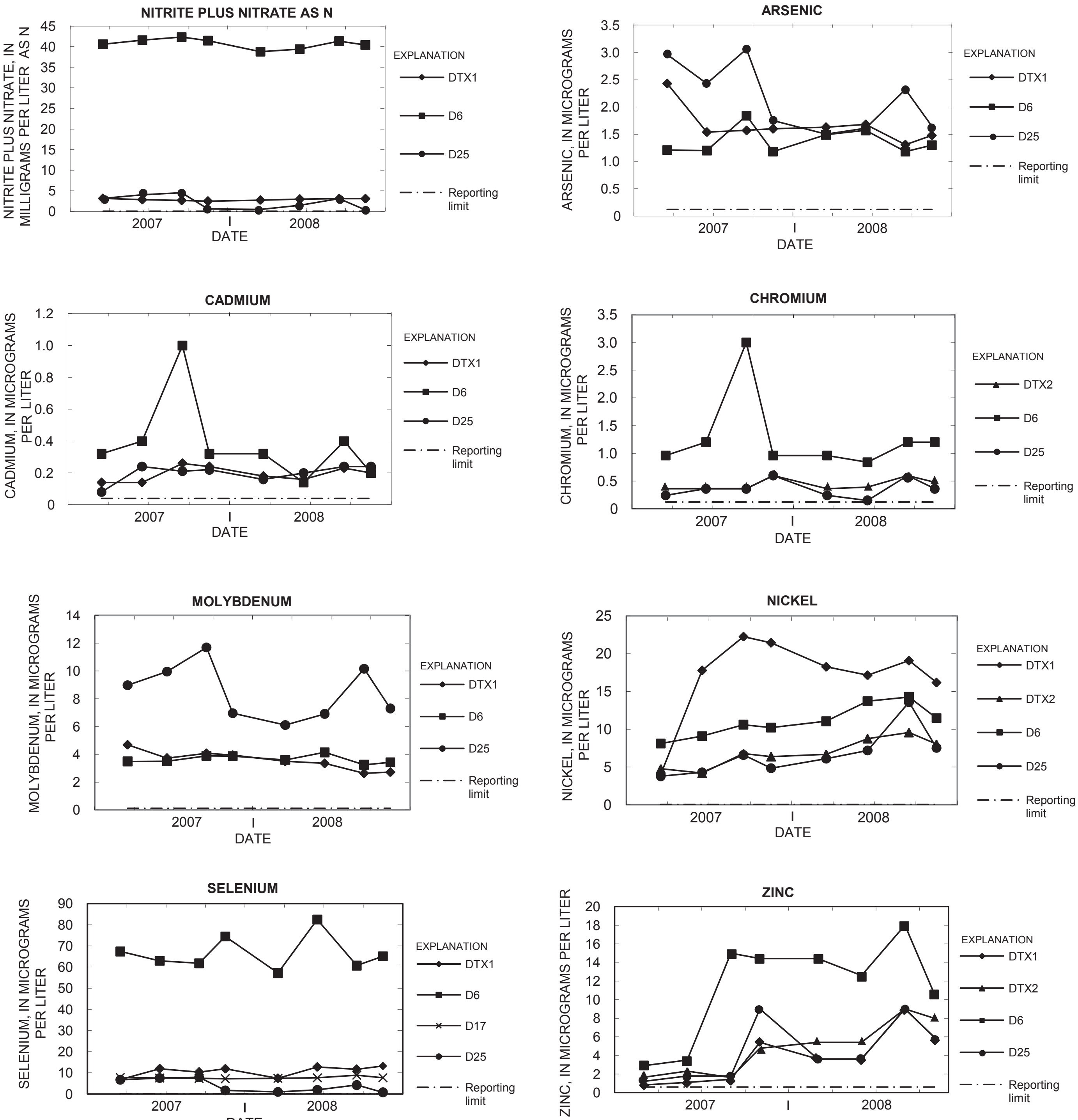


Figure 12. Groundwater concentrations near Deer Trail, Colorado, for selected constituents, 2007 and 2008. (N, nitrogen)

Table 1. Biosolids applications by Metro Wastewater Reclamation District to the study area near Deer Trail, Colorado, 2007 and 2008.

[All information provided by the Metro Wastewater Reclamation District; DC, destination code; Ac, acre; wT, wet tons; dT, dry tons; CAKE, Table 3 Class B biosolids; Rec, recommended; N, nitrogen; lbs, pounds; %, percent; P, phosphorous; K, potassium; TKN, Total Kjeldahl Nitrogen; PAN, plant available nitrogen; incorporated, biosolids are pushed down into the soil 4 to 8 inches after application by the tines of a rotating implement pulled by a tractor; surface, no incorporation step]

DC (fig. 4)	Total DC area, Ac	Application start date	Application stop date	Area applied, Ac	Product applied	Application method	Total wT applied	Actual loading rate, wT/Ac	Total dT applied	Actual loading rate, dT Cake/ Ac	Rec N loading rate, lbs/Ac	Rec N-based loading rate, dT/Ac	% of Rec N applied	Actual N loading rate, lbs/Ac	Total P applied, lbs/Ac	Total K applied, lbs/Ac	Crop	Reclamation project?	Total Rec N/Crop, lbs/field	TKN fraction of CAKE	PAN, lbs/dT
300	320	07/10/08	07/11/08	153.90	Cake	Incorporated	630.83	4.10	144.82	0.94	40	1.12	80	32.18	41.59	2.41	Wheat	No	6,156	0.0626	34.20
301	320	07/11/08	07/14/08	159.90	Cake	Incorporated	653.66	4.09	150.34	0.94	40	1.12	80	32.16	41.56	2.41	Wheat	No	6,396	0.0626	34.20
333	320	06/25/08	06/28/08	314.05	Cake	Incorporated	1,273.78	4.06	289.91	0.92	40	1.16	82	32.86	42.09	2.58	Wheat	No	12,562	0.0658	35.60
334	320	06/21/08	06/25/08	283.76	Cake	Incorporated	1,139.32	4.02	250.66	0.88	40	1.16	79	31.45	40.28	2.47	Wheat	No	11,350	0.0658	35.60
340	320	06/13/07	07/09/07	267.21	Cake	Surface	1,052.16	3.94	249.07	0.93	40	1.22	87	34.67	43.44	2.87	Wheat	No	10,688	0.0654	37.20
341	320	05/25/07	05/29/07	220.95	Cake	Surface	878.55	3.98	217.30	0.98	40	1.10	81	32.26	46.22	3.03	Wheat	No	8,838	0.0614	32.80
341	320	07/07/08	07/07/08	60.99	Cake	Incorporated	240.44	3.94	54.10	0.89	40	1.12	76	30.34	39.21	2.27	Wheat	No	2,440	0.0626	34.20
342	320	05/25/07	05/2/507	48.16	Cake	Surface	176.39	3.66	43.74	0.91	40	1.10	75	29.84	42.69	2.80	Wheat	No	1,926	0.0615	32.85
342	320	07/07/08	07/10/08	243.46	Cake	Incorporated	1,002.25	4.12	220.88	0.91	40	1.12	78	31.03	40.10	2.32	Wheat	No	9,738	0.0626	34.20
344	279	11/30/07	12/04/07	273.03	Cake	Incorporated	1,074.81	3.94	217.96	0.80	40	1.12	75	30.02	40.87	2.59	Wheat	No	10,921	0.0690	37.60
359	320	06/05/08	06/10/08	259.96	Cake	Incorporated	1,063.55	4.09	229.49	0.88	40	1.16	79	31.43	40.26	2.47	Wheat	No	10,398	0.0658	35.60
360	320	06/10/08	06/11/08	83.36	Cake	Incorporated	319.73	3.84	72.27	0.87	40	1.16	77	30.86	39.53	2.43	Wheat	No	3,334	0.0658	35.60
361	320	06/11/08	06/17/08	208.90	Cake	Incorporated	841.32	4.03	189.31	0.91	40	1.16	81	32.26	41.32	2.54	Wheat	No	8,356	0.0658	35.60
362	320	06/11/08	06/13/08	171.16	Cake	Incorporated	696.20	4.07	144.64	0.85	40	1.16	75	30.08	38.53	2.37	Wheat	No	6,846	0.0658	35.60
363	320	06/13/08	06/13/08	80.83	Cake	Incorporated	323.32	4.00	60.14	0.74	40	1.16	66	26.49	33.93	2.08	Wheat	No	3,233	0.0658	35.60
364	320	06/18/08	06/20/08	139.76	Cake	Incorporated	569.46	4.07	131.07	0.94	40	1.16	83	33.39	42.76	2.63	Wheat	No	5,590	0.0658	35.60
365	320	06/13/08	06/18/08	149.74	Cake	Incorporated	614.25	4.10	137.25	0.92	40	1.16	82	32.63	41.80	2.57	Wheat	No	5,990	0.0658	35.60
366	320	06/20/08	06/23/08	140.12	Cake	Incorporated	566.82	4.05	133.53	0.95	40	1.16	85	33.93	43.46	2.67	Wheat	No	5,605	0.0658	35.60
440	320	11/06/07	11/08/07	204.85	Cake	Incorporated	842.64	4.11	164.40	0.80	40	1.12	71	28.57	43.18	2.74	Wheat	No	8,194	0.0656	35.60
441	320	10/31/07	11/06/07	291.10	Cake	Incorporated	1,212.93	4.17	259.55	0.89	40	1.12	80	31.92	43.51	2.78	Wheat	No	11,644	0.0652	35.80
454	320	10/27/07	10/31/07	290.92	Cake	Incorporated	1,107.54	3.81	229.46	0.79	40	1.16	71	28.24	36.60	2.35	Wheat	No	11,637	0.0647	35.80
468	320	10/24/07	10/27/07	232.89	Cake	Incorporated	975.25	4.19	213.44	0.92	40	1.16	82	32.81	42.52	2.73	Wheat	No	9,316	0.0647	35.80
469	320	10/16/07	10/24/07	284.66	Cake	Incorporated	1,163.60	4.09	236.35	0.83	40	1.16	74	29.72	38.53	2.47	Wheat	No	11,386	0.0647	35.80
480	320	10/11/07	10/16/07	275.19	Cake	Incorporated	1,336.67	4.86	243.80	0.89	50	1.45	63	31.72	41.11	2.64	Corn	No	13,760	0.0647	35.80
481	320	10/05/07	10/10/07	254.87	Cake	Incorporated	1,323.54	5.19	279.08	1.09	50	1.45	78	39.20	50.81	3.26	Corn	No	12,744	0.0647	35.80

Table 2. Methods used to analyze biosolids samples collected at the Metro Wastewater Reclamation District and crop samples collected near Deer Trail, Colorado, 2007 and 2008.

[HG, hydride generation; AAS, atomic absorption spectrophotometry; ICP, inductively coupled plasma; MS, mass spectrometry; AES, atomic emission spectrometry; CV-AFS, continuous flow-cold vapor-atomic fluorescence spectrometry; IR, infrared]

Constituent	Medium	Analytical method	Reference
Arsenic	Biosolids and crops	HG-AAS	Taggart (2002)
Cadmium	Biosolids	ICP-MS	Taggart (2002)
Cadmium	Crops	ICP-AES	Taggart (2002)
Copper	Biosolids	ICP-MS	Taggart (2002)
Copper	Crops	ICP-AES	Taggart (2002)
Lead	Biosolids	ICP-MS	Taggart (2002)
Lead	Crops	ICP-AES	Taggart (2002)
Mercury	Biosolids and crops	CV-AFS	Hageman (2007)
Molybdenum	Biosolids	ICP-MS	Taggart (2002)
Molybdenum	Crops	ICP-AES	Taggart (2002)
Nickel	Biosolids	ICP-MS	Taggart (2002)
Nickel	Crops	ICP-AES	Taggart (2002)
Selenium	Biosolids and crops	HG-AAS	Taggart (2002)
Sulfur	Biosolids and crops	Combustion, IR detection	Brown and Curry (2002)
Zinc	Biosolids	ICP-MS	Taggart (2002)
Zinc	Crops	ICP-AES	Taggart (2002)
Plutonium-238, Total	Biosolids	Radiological method	Whittaker and Grothaus (1979); Lyon (1980)
Plutonium-239+240, Total	Biosolids	Radiological method	Whittaker and Grothaus (1979); Lyon (1980)

Table 3. Chemical data for biosolids samples collected at the Metro Wastewater Reclamation District, 2007 and 2008.

[“Table 1 Ceiling Concentration Limits” and “Table 3 Pollutant Concentration Limits” from Colorado Department of Public Health and Environment (2003); ppm, parts per million; %, percent]

Sample date	Arsenic, ppm	Cadmium, ppm	Copper, ppm	Lead, ppm	Mercury, ppm	Molybdenum, ppm	Nickel, ppm	Selenium, ppm	Sulfur, %	Zinc, ppm
January 2007	0.3	1.9	714	44	0.61	22.4	20	11	1.57	787
February 2007	0.6	2.1	634	43	0.63	20.9	20	9.1	1.56	705
March 2007	0.7	2.3	600	43	0.83	19.8	19	9.8	1.59	683
April 2007	0.5	2.6	748	54	0.76	24.7	23	12	1.64	822
May 2007	1.1	2.5	824	55	1.42	25.3	26	13	1.62	935
June 2007	1.2	2.4	801	68	0.73	23.8	24	17	1.64	899
July 2007	1.3	2.9	952	68	1.03	34.0	28	11	1.88	1,160
August 2007	1.4	2.6	851	61	1.04	34.2	26	14	1.62	1,060
September 2007	1.0	2.4	820	59	1.26	32.5	24	14	1.72	986
October 2007	0.8	2.3	816	58	2.38	26.5	26	16	1.67	962
November 2007	0.4	1.9	698	56	0.92	22.2	22	12	1.60	811
December 2007	0.5	2.2	754	56	0.85	22.2	21	12	1.59	868
January 2008	2.8	2.0	706	38	0.96	19.8	18	12	1.61	745
February 2008	1.4	2.1	755	37	1.18	20.8	19	11	1.60	768
March 2008	1.2	1.9	706	36	0.97	18.0	17	8.6	1.53	754
April 2008	2.6	1.8	666	41	1.02	19.3	18	8.8	1.57	714
May 2008	4.0	2.2	767	45	1.18	18.8	19	10	1.59	779
June 2008	3.5	3.0	800	42	1.25	22.6	19	11	1.70	880
July 2008	3.6	3.1	670	38	1.30	22.8	17	10	1.65	805
August 2008	4.4	3.4	861	46	1.22	26.0	21	11	1.72	990
September 2008	4.5	3.2	689	41	1.30	21.2	18	12	1.68	860
October 2008	3.8	2.6	679	38	1.16	21.1	18	11	1.60	850
November 2008	3.8	2.8	728	43	1.40	21.8	19	12	1.66	861
December 2008	3.8	2.5	733	41	0.95	24.5	19	12	1.60	870
Table 1 Ceiling Concentration Limits	75	85	4,300	840	57	75	420	100	None	7,500
Table 3 Pollutant Concentration Limits	41	39	1,500	300	17	None	420	100	None	2,800

Table 4. Quality-control data associated with biosolids samples collected at the Metro Wastewater Reclamation District, 2007 and 2008.

[Data from Crock and others, 2008b and 2009a. Data are for NIST 2781, a standard reference material prepared by the National Institute of Standards and Technology from domestic sewage sludge; ppm, parts per million; %, percent; +/-, plus or minus the analytical uncertainty; --, no value]

Analysis date	Arsenic, ppm	Cadmium, ppm	Copper, ppm	Lead, ppm	Mercury, ppm	Molybdenum, ppm	Nickel, ppm	Selenium, ppm	Sulfur, %	Zinc, ppm
2007	7.2	13.1	670	215	2.78	47.1	82	18	1.54	1310
2008	7.3	12.2	631	188	3.35	40.7	74	17	1.59	1270
NIST 2781 Recommended or Certified Value										
	7.82 +/- 0.28	12.78 +/-0.72	627.4 +/- 13.5	202.1 +/- 6.5	3.64 +/- 0.25	46.7 +/- 3.2	80.2 +/- 2.3	16.0 +/- 1.6	--	1273 +/- 53

Table 5. Plutonium data for biosolids samples collected at the Metro Wastewater Reclamation District, 2007 and 2008.

[pCi/g, picocuries per gram; +/-, plus or minus the analytical uncertainty; analytical uncertainty is the 1-sigma total combined standard uncertainty provided by the laboratory]

Sample date	Plutonium 238, pCi/g	Plutonium 238, minimum detectable concentration, pCi/g	Plutonium 239+240, pCi/g	Plutonium 239+240, minimum detectable concentration, pCi/g
June 2007	-0.003 +/- 0.017	0.1	0.0018 +/- 0.0018	0.1
June 2008	-0.003 +/- 0.017	0.1	-0.0023 +/- 0.0034	0.1

Table 6. Chemical data for crop samples collected near Deer Trail, Colorado, 2007 and 2008.

[No samples were collected in 2007; sampled fields are shown in figure 4 (DC 454 field) or figure 5 (Arapahoe County fields); data are reported as dry weight; DC, Destination Code, which is shown in figure 4; ppm, parts per million; <, less than]

Location	Sample type	Harvest year	Arsenic, ppm	Cadmium, ppm	Copper, ppm	Lead, ppm	Mercury, ppm	Molybdenum, ppm	Nickel, ppm	Zinc, ppm
Arapahoe County north field (control)	Wheat grain	2008	< 0.02	0.03	2.4	<0.008	<0.03	0.69	0.56	22.0
Arapahoe County middle field (biosolids applied)	Wheat grain	2008	<0 .02	0.03	4.1	<0.008	<0.03	0.94	0.74	24.7
Arapahoe County south field (control)	Wheat grain	2008	< 0.02	0.03	4.3	<0.008	<0.03	0.80	0.80	34.9
Elbert County DC 454 field (biosolids applied)	Corn kernels	2008	<0.02	0.01	2.0	<0.008	<0.03	0.30	0.30	23.9

Table 7. Selected information for U.S. Geological Survey monitoring wells near Deer Trail, Colorado, 2007 and 2008.

[Wells shown in bold routinely are sampled for water quality; all wells have 2-inch-diameter casing; latitude and longitude are in the format degrees minutes seconds referenced to North American Datum of 1983; Alt., altitude in feet above North American Vertical Datum of 1988; stickup,the length of well casing above ground (fluctuates because land surface is uneven and changes height over time), and measuring point is at the top of the stickup; bmp, below measuring point; sump, the nonperforated closed casing below the screen; HUC, Hydrologic Unit Code (Seaber and others, 1987); NWIS, U.S. Geological Survey National Water Information System database; ID, identification number; Metro, Metro Wastewater Reclamation District; L, alluvial; R, bedrock; S, shallow (not known if alluvial or bedrock)]

Well name	Latitude	Longitude	Alt. of stickup (feet)	Alt. of land surface (feet)	Property owner	County	Drill date	Measured stickup[1] (feet)	Total depth (feet bmp)	Depth of screen top (feet bmp)	Depth of screen bottom (feet bmp)	Screen-slot size (inch)	Screen length (feet)	Sump length (feet)	Aquifer type	HUC	NWIS station ID
DTX1	39 43 33	103 52 51	4,909	4,906	Metro	Arapahoe	2/16/1999	2.56	25.50	20.59	22.19	0.010	1.60	3.31	L	10190012	394333103525100
DTX2[2]	39 41 49	103 51 38	4,903	4,900	Metro	Arapahoe	2/16/1999	3.23	20.50	15.59	17.19	0.010	1.60	3.31	L	10190012	394148103513300
DTX3	39 30 24	103 43 28	5,195	5,192	Metro	Elbert	2/12/1999	3.11	18.71	13.80	15.40	0.010	1.60	3.31	L	10190013	393024103432800
DTX4	39 33 58	103 43 42	4,957	4,954	Metro	Elbert	2/10/1999	2.70	16.72	11.81	13.41	0.010	1.60	3.31	L	10190013	393358103434200
DTX5	39 33 58	103 45 48	4,975	4,973	Metro	Elbert	2/10/1999	2.30	20.90	16.09	17.69	0.010	1.60	3.21	L	10190013	393358103454800
DTX6	39 33 58	103 46 48	4,970	4,968	Metro	Elbert	2/9/1999	[3]2.36	39	34	36	0.010	1.60	3.31	L	10190013	393358103464800
DTX7	39 40 54	103 56 46	5,076	5,073	Price	Arapahoe	2/18/1999	2.77	16.10	11.19	12.79	0.010	1.60	3.31	L	10190011	394054103564600
DTX8A[4]	39 40 54	103 56 45	5,076	5,074	Price	Arapahoe	3/2/1999	2.46	77.52	67.56	71.83	0.010	4.27	5.69	R	10190011	394054103564501
DTX8B[4]	39 40 54	103 56 45	5,076	5,074	Price	Arapahoe	3/2/1999	2.49	177.48	167.52	171.79	0.010	4.27	5.69	R	10190011	394054103564502
DTX9[2]	39 39 02	103 55 40	5,121	5,119	Weisensee	Arapahoe	2/17/1999	2.46	30.15	22.72	24.32	0.010	1.60	5.83	L	10190011	393902103554000
DTX10A[2,4]	39 39 02	103 55 40	5,122	5,120	Weisensee	Arapahoe	3/4/1999	2.03	61.97	52.01	56.28	0.010	4.27	5.69	R	10190011	393902103554001
DTX10B[4]	39 39 02	103 55 40	5,122	5,120	Weisensee	Arapahoe	3/4/1999	2.11	121.73	111.77	116.04	0.010	4.27	5.69	R	10190011	393902103554002
DTX11[2]	39 39 02	103 55 40	5,122	5,120	Weisensee	Arapahoe	1/19/2000	2.24	32	28	30	0.020	1.85	2.35	L	10190011	393902103554003
D2	39 36 47	103 51 59	5,172.89	5,170	Metro	Arapahoe	9/7/1993	3.29	25	15	25	0.010	10	< 1	S	10190013	393649103515600
D3	39 37 21	103 54 31	5,191.29	5,188	Metro	Arapahoe	9/11/1993	2.83	46	36	46	0.010	10	< 1	S	10190011	393723103535400
D4	39 36 41	103 53 51	5,212.51	5,210	Metro	Arapahoe	9/10/1993	2.11	34	24	34	0.010	10	< 1	S	10190011	393622103542900
D5	39 36 19	103 51 55	5,198.29	5,195	Metro	Arapahoe	9/11/1993	3.45	30	20	30	0.010	10	< 1	S	10190013	393619103515500
D6	39 36 33	103 51 22	5,128.78	5,126	Metro	Arapahoe	9/12/1993	2.65	25	15	25	0.010	10	0.3	L	10190013	393633103512300
D6A	39 36 33	103 51 22	5,129	5,126	Metro	Arapahoe	2/6/2002	2.42	32.96	28.42	30.71	0.010	2.29	2.25	L	10190013	393633103512301
D7	39 36 01	103 53 56	5,223.28	5,221	Metro	Arapahoe	9/10/1993	2.62	25	15	25	0.010	10	< 1	S	10190011	393622103540900
D8	39 36 37	103 54 22	5,189.14	5,186	Metro	Arapahoe	9/10/1993	2.79	20	10	20	0.010	10	< 1	S	10190011	393637103542400
D10	39 36 08	103 51 50	5,199.79	5,197	Metro	Arapahoe	9/11/1993	2.40	20	10	20	0.010	10	< 1	S	10190013	393609103514600
D11a	39 33 45	103 54 23	5,377	5,374	Metro	Elbert	10/23/1997	2.46	143.03	112.65	122.65	0.010	10	20.38	R	10190011	393334103543600
D13	39 34 42	103 54 38	5,235.33	5,234	Metro	Arapahoe	4/4/1994	1.81	16	6	16	0.010	10	0.3	L	10190011	393439103543400
D14	39 34 29	103 54 03	5,272.13	5,271	Metro	Arapahoe	4/4/1994	1.39	24	14	24	0.010	10	< 1	S	10190011	393427103540000
D15	39 33 59	103 54 54	5,246.77	5,245	Keen	Elbert	4/7/1994	1.86	25	15	25	0.010	10	< 1	S	10190011	393357103545200
D16	39 33 06	103 54 56	5,279	5,277	Keen	Elbert	4/7/1994	1.88	25	15	25	0.010	10	< 1	S	10190011	393307103545500
D17	39 33 34	103 54 36	5,277.73	5,276	Metro	Elbert	4/5/1994	1.90	21	11	21	0.010	10	0.3	L	10190011	393327103541200
D18	39 33 29	103 55 20	5,298	5,295	Keen	Elbert	4/16/1994	2.50	15	10	15	0.010	5	< 1	S	10190011	393325103552500
D19	39 33 17	103 54 18	5,304.24	5,303	Metro	Elbert	4/5/1994	1.69	30	20	30	0.010	10	0.3	R	10190011	393311103541800
D20	39 32 46	103 54 42	5,282	5,280	Keen	Elbert	4/6/1994	2.27	22	12	22	0.010	10	< 1	S	10190011	393247103543800
D21	39 32 09	103 54 46	5,319	5,317	Keen	Elbert	4/5/1994	1.71	20	10	20	0.010	10	< 1	S	10190011	393207103544800
D22	39 33 08	103 52 00	5,157.66	5,154	Metro	Elbert	4/8/1994	3.58	41	31	41	0.010	10	< 1	S	10190013	393307103515900
D23	39 33 42	103 55 01	5,256.05	5,254	Keen	Elbert	4/8/1994	2.54	15	10	15	0.010	5	< 1	S	10190011	393330103545300
D25	39 37 02	103 54 42	5,167.13	5,165	Metro	Arapahoe	5/1/1995	2.23	23	13	23	0.010	10	0.3	L	10190011	393702103544100
D25A	39 37 02	103 54 42	5,167	5,165	Metro	Arapahoe	2/5/2002	2.28	24.39	19.85	22.14	0.010	2.29	2.25	L	10190011	393702103544102
D26	39 36 40	103 53 30	5,233.34	5,231	Metro	Arapahoe	5/3/1995	2.44	44	34	44	0.010	10	< 1	S	10190011	393639103533000
D27	39 36 21	103 54 09	5,207.20	5,204	Metro	Arapahoe	5/2/1995	2.77	26	16	26	0.010	10	< 1	S	10190011	393621103540900
D28	39 35 45	103 53 40	5,239.11	5,237	Metro	Arapahoe	5/2/1995	2.12	30	20	30	0.010	10	< 1	S	10190011	393545103534000
D29	39 36 41	103 52 48	5,371	5,369	Metro	Arapahoe	11/4/1997	2.38	183.19	147.81	157.81	0.010	10	25.38	R	10190013	393632103524300
D30[5]	39 36 55	103 51 22	5,096.43	5,094	Metro	Arapahoe	5/5/1995	2	19	9	19	0.010	10	0.3	L	10190013	393655103512200
D31	39 36 56	103 51 39	5,119.76	5,118	Metro	Arapahoe	5/4/1995	1.84	26	11	21	0.010	10	5	L	10190013	393656103513900
D32	39 36 09	103 51 26	5,188.93	5,187	Metro	Arapahoe	5/9/1995	1.99	40	30	40	0.010	10	< 1	S	10190013	393609103513900
D33	39 35 56	103 51 53	5,229.08	5,227	Metro	Arapahoe	5/5/1995	1.73	25	10	20	0.010	10	5	L	10190013	393556103515300

[1]Stickup measured at a specific date and time soon after well was installed, but this measurement is relative to land surface, which is not uniform or constant over time.

[2]Well had continuous-recorder equipment any time during 2007 and 2008.

[3]DTX6 stickup went from 2.43 to 2.36 feet between mid-October 2002 and early November 2002 when well was vandalized.

[4]DTX8 and DTX10 are nested wells that consist of a single borehole that has two separate piezometers screened at two separate zones; the shallow zone is designated by “A” and the deep zone is designated by “B” after the well name.

[5]Well D30 was closed 9/5/2008 because of damages.

Table 8. Methods used to analyze groundwater samples collected near Deer Trail, Colorado, 2007 and 2008.

[MRL, minimum reporting level (dilutions for samples having high specific conductance may result in higher MRLs for some samples); µS/cm, microsiemens per centimeter at 25°C; mg/L milligrams per liter; ICP, inductively coupled plasma; AES, atomic-emission spectrometry; IC, ion chromatography; °C, degrees Celsius; ASF, automated segmented-flow spectrophotometry; µg/L, micrograms per liter; MS, mass spectroscopy; cICP, collision-cell inductively coupled plasma; CVAF, cold-vapor atomic fluorescence spectrometry]

Property or constituent	Units	Analytical method	MRL	Method reference
Major ions and mineral characteristics				
Specific conductance, laboratory	µS/cm	Wheatstone bridge	2.6–8	Fishman and Friedman (1989)
pH, laboratory	units	Electrometric electrode	0.1	Fishman and Friedman (1989)
Calcium, dissolved	mg/L	ICP-AES	.02–.04	Fishman (1993)
Magnesium dissolved	mg/L	ICP-AES	.012–.02	Fishman (1993)
Sodium, dissolved	mg/L	ICP-AES	.12–.2	Fishman (1993)
Potassium, dissolved	mg/L	ICP-AES	.02–.06	American Public Health Association (1998), Fishman and Friedman (1989)
Acid-neutralizing capacity, lab, as $CaCO_3$	mg/L	Electrometric titration	5–8	Fishman and Friedman (1989)
Sulfate, dissolved	mg/L	IC	.18	Fishman and Friedman (1989)
Chloride, dissolved	mg/L	IC	.12	Fishman and Friedman (1989)
Fluoride, dissolved	mg/L	ASF, ion-selective electrode	.08–.12	Fishman and Friedman (1989)
Bromide, dissolved	mg/L	Ion chromatography	.02	Fishman and Friedman (1989)
Silica, dissolved	mg/L	ICP-AES	.018–.02	Fishman (1993)
Dissolved solids, residue at 180°C	mg/L	Gravimetric	10	Fishman and Friedman (1989)
Nutrients				
Nitrite plus nitrate, dissolved as N	mg/L	Colorimetry, ASF, cadmium reduction, diazotization	.04	Fishman (1993)
Nitrogen, ammonia, dissolved as N	mg/L	Colorimetry, ASF, salicylate-hypochlorite	.04	Fishman (1993)
Nitrogen, ammonia plus organic, total as N	mg/L	Colorimetry, ASF, microkjeldahl digestion	.10–.14	Patton and Truitt (2000)
Nitrogen, ammonia plus organic, dissolved as N	mg/L	Colorimetry, ASF, microkjeldahl digestion	.10–.14	Patton and Truitt (2000)
Phosphorus, total as P	mg/L	Colorimetry, ASF, microkjeldahl digestion	.04	Patton and Truitt (1992)
Phosphorus, dissolved as P	mg/L	Colorimetry, ASF, microkjeldahl digestion	.04	Patton and Truitt (1992)
Trace elements				
Aluminum, dissolved as Al	µg/L	ICP-MS	1.6–4	Garbarino and others (2006)
Antimony, dissolved as Sb	µg/L	ICP-MS	.04–.14	Garbarino and others (2006)
Arsenic, dissolved as As	µg/L	cICP-MS	.06–.12	Garbarino and others (2006)
Barium, dissolved as Ba	µg/L	ICP-MS	.08–.4	Garbarino and others (2006)
Beryllium, dissolved as Be	µg/L	ICP-MS	.008–.06	Garbarino and others (2006)
Boron, dissolved as B	µg/L	ICP-AES	1.2–2	Struzeski and others (1996)
Cadmium, dissolved as Cd	µg/L	ICP-MS	.02–.04	Garbarino and others (2006)

Table 8. Methods used to analyze groundwater samples collected near Deer Trail, Colorado, 2007 and 2008.—Continued

[MRL, minimum reporting level (dilutions for samples having high specific conductance may result in higher MRLs for some samples); µS/cm, microsiemens per centimeter at 25°C; mg/L milligrams per liter; ICP, inductively coupled plasma; AES, atomic-emission spectrometry; IC, ion chromatography; °C, degrees Celsius; ASF, automated segmented-flow spectrophotometry; µg/L, micrograms per liter; MS, mass spectroscopy; cICP, collision-cell inductively coupled plasma; CVAF, cold-vapor atomic fluorescence spectrometry]

Property or constituent	Units	Analytical method	MRL	Method reference
Chromium, dissolved as Cr	µg/L	cICP-MS	.12	Garbarino and others (2006)
Cobalt, dissolved as Co	µg/L	cICP-MS	.02–.04	Garbarino and others (2006)
Copper, dissolved as Cu	µg/L	cICP-MS	.4–1	Garbarino and others (2006)
Iron, dissolved as Fe	µg/L	ICP-AES	4–8	Fishman (1993)
Lead, dissolved as Pb	µg/L	ICP-MS	.06–.12	Garbarino and others (2006)
Manganese, dissolved as Mn	µg/L	ICP-MS	.2	Garbarino and others (2006)
Mercury, dissolved as Hg	µg/L	CVAF	.01	Gabarino and Damrau (2001)
Molybdenum, dissolved as Mo	µg/L	ICP-MS	.02–.12	Garbarino and others (2006)
Nickel, dissolved as Ni	µg/L	cICP-MS	.06–.2	Garbarino and others (2006)
Selenium, dissolved as Se	µg/L	cICP-MS	.04–.08	Garbarino and others (2006)
Silver, dissolved as Ag	µg/L	ICP-MS	.008–.1	Garbarino and others (2006)
Strontium, dissolved as Sr	µg/L	ICP-AES	.4–.6	Fishman (1993)
Tungsten, dissolved as W	µg/L	cICP-MS	.02–.06	Garbarino and others (2006)
Zinc, dissolved as Zn	µg/L	cICP-MS	.6–.2	Garbarino and others (2006)
		Radioactivity		
Uranium, natural, dissolved	µg/L	ICP-MS	.006–.04	Garbarino and others (2006)

Table 9. Monthly depth-to-water data for U.S. Geological Survey monitoring wells near Deer Trail, Colorado, 2007 and 2008.

[Uncertainty of the depth-to-water measurements is 0.02 foot or less. No access to wells January and February of 2007 due to weather; W.L. bmp, depth to water level below measuring point, in feet, measured with an electric tape; --, no data; *, water level is below the screened interval of the well; closed, well was closed 9/5/08]

Well name	March (3/14/2007) W.L. bmp	April (4/11/2007) W.L. bmp	May (5/30/2007–5/31/2007) W.L. bmp	June (06/28/2007–6/29/2007) W.L. bmp	July (7/25/2007) W.L. bmp	August (08/14/2007) W.L. bmp	September (09/12/2007) W.L. bmp	October (10/10/2007) W.L. bmp	November (11/07/2007) W.L. bmp	December (12/19/2007) W.L. bmp	January (1/15/2008) W.L. bmp
DTX1	14.30	14.23	14.29	14.38	14.47	13.37	13.50	13.59	13.70	13.85	13.93
DTX2	11.13	11.03	10.89	11.24	11.85	11.84	11.97	11.96	11.74	11.59	11.53
DTX3	*	*	*	*	*	*	*	*	*	*	*
DTX4	8.07	8.71	9.15	5.80	8.33	9.08	9.55	10.21	10.27	10.44	No Access
DTX5	--	--	6.98	4.89	7.10	8.22	9.17	9.83	10.02	10.21	10.27
DTX6	19.71	20.69	20.29	20.13	20.71	20.45	20.35	20.84	21.10	21.39	21.49
DTX7	8.30	8.40	8.38	9.13	9.68	9.71	9.87	9.94	9.65	9.42	9.29
DTX8A	8.59	8.55	8.69	9.58	10.46	10.27	10.44	10.44	10.43	9.73	9.51
DTX8B	4.93	4.93	5.04	5.15	5.23	5.21	5.22	5.25	5.27	5.19	5.16
DTX9	13.58	13.43	13.24	13.49	13.55	13.60	13.66	13.74	13.76	13.78	13.77
DTX10A	13.70	13.52	13.37	13.61	13.79	13.85	13.91	14.02	14.01	14.04	14.01
DTX10B	18.01	18.11	18.20	18.32	18.44	18.42	18.40	18.43	18.42	18.33	18.24
DTX11	13.93	13.77	13.59	13.72	13.89	13.95	14.01	14.17	14.09	14.13	14.10
D2	--	--	--	--	--	--	--	--	--	--	--
D3	--	--	--	--	--	--	--	--	--	--	--
D4	--	--	--	--	--	--	--	--	--	--	--
D5	--	--	--	--	--	--	--	--	17.09	-	--
D6	8.00	8.10	7.95	8.36	8.76	8.13	8.15	8.64	8.86	9.12	9.16
D6A	8.01	7.85	7.75	8.21	8.61	7.71	8.00	8.51	8.72	8.97	9.02
D7	--	--	--	--	--	--	--	--	--	--	--
D8	--	--	--	--	--	--	--	--	--	--	--
D10	--	--	--	--	--	--	--	--	9.46	--	--
D11a	113.48	113.63	113.78	113.64	113.60	113.63	113.49	113.61	113.55	113.61	113.33
D13	6.75	6.94	7.24	8.11	8.89	8.74	9.06	9.16	8.72	8.33	8.13
D14	--	--	--	--	--	--	--	--	--	--	--

Table 9. Monthly depth-to-water data for U.S. Geological Survey monitoring wells near Deer Trail, Colorado, 2007 and 2008.—Continued

[Uncertainty of the depth-to-water measurements is 0.02 foot or less. No access to wells January and February of 2007 due to weather; W.L. bmp, depth to water level below measuring point, in feet, measured with an electric tape; --, no data; *, water level is below the screened interval of the well; closed, well was closed 9/5/08]

Well name	March (3/14/2007) W.L. bmp	April (4/11/2007) W.L. bmp	May (5/30/2007–5/31/2007) W.L. bmp	June (06/28/2007–6/29/2007) W.L. bmp	July (7/25/2007) W.L. bmp	August (08/14/2007) W.L. bmp	September (09/12/2007) W.L. bmp	October (10/10/2007) W.L. bmp	November (11/07/2007) W.L. bmp	December (12/19/2007) W.L. bmp	January (1/15/2008) W.L. bmp
D15	--	--	--	--	--	--	--	--	--	--	--
D16	--	--	--	--	--	--	--	--	--	--	--
D17	12.83	12.54	11.96	11.94	12.25	12.56	13.10	13.26	13.26	13.22	13.19
D18	--	--	--	--	--	--	--	--	--	--	--
D19	22.59	22.61	22.61	22.61	22.60	22.57	22.55	22.58	22.57	22.59	22.58
D20	--	--	--	--	--	--	--	--	--	--	--
D21	--	--	--	--	--	--	--	--	--	--	--
D22	--	--	--	--	--	--	--	--	--	--	--
D23	--	--	--	--	--	--	--	--	--	--	--
D25	10.28	10.35	10.41	10.81	11.33	11.61	11.79	12.17	12.19	12.13	12.10
D25A	10.21	--	10.32	10.71	11.23	11.51	11.78	12.07	12.09	12.05	12.01
D26	--	--	--	--	--	--	--	--	--	--	--
D27	--	--	--	--	--	--	--	--	--	--	--
D28	--	--	--	--	--	--	--	--	--	--	--
D29	153.88	153.74	154.07	154.07	153.83	153.95	153.80	153.96	153.83	153.67	153.60
D30	4.00	4.17	4.43	5.55	6.02	5.65	6.02	6.07	5.90	5.51	5.23
D31	--	--	--	--	--	--	--	--	--	--	--
D32	--	--	--	--	--	--	--	--	29.08	--	--
D33	--	--	--	--	--	--	--	--	12.39	--	--

Table 9. Monthly depth-to-water data for U.S. Geological Survey monitoring wells near Deer Trail, Colorado, 2007 and 2008.—Continued

[Uncertainty of the depth-to-water measurements is 0.02 foot or less. No access to wells January and February of 2007 due to weather; W.L. bmp, depth to water level below measuring point, in feet, measured with an electric tape; --, no data; *, water level is below the screened interval of the well; closed, well was closed 9/5/08]

Well name	February (2/25/2008) W.L. bmp	March (3/10/2008) W.L. bmp	April (4/9/2008) W.L. bmp	May (5/9/2008) W.L. bmp	June (6/13/2008) W.L. bmp	July (7/7/2008) W.L. bmp	August (8/20/2008-8/28/2008) W.L. bmp	September (9/17/2008-9/30/2008) W.L. bmp	October (10/16/2008) W.L. bmp	November (11/7/2008) W.L. bmp	December (12/12/2008) W.L. bmp
DTX1	14.07	14.11	14.11	14.15	14.26	14.39	14.40	14.33	14.44	14.46	14.47
DTX2	11.54	11.50	11.43	11.38	11.51	11.79	8.19	8.86	9.31	9.46	9.53
DTX3	*	*	*	*	*	*	*	*	*	*	*
DTX4	10.81	10.90	10.88	11.08	11.70	11.17	10.09	11.01	11.55	11.72	11.78
DTX5	10.64	10.70	10.62	10.68	10.93	11.10	9.95	10.41	10.76	10.89	10.96
DTX6	21.71	21.76	21.81	21.93	22.30	21.29	20.91	21.13	21.41	21.52	21.66
DTX7	9.19	9.15	9.03	8.99	9.42	9.91	8.71	9.24	9.19	9.11	8.93
DTX8A	9.45	9.42	9.26	9.30	9.82	10.19	9.33	9.60	9.47	9.69	9.43
DTX8B	5.16	5.23	5.16	5.16	5.21	5.24	4.87	5.13	5.13	5.13	5.09
DTX9	13.88	13.88	13.83	13.85	13.96	14.05	13.80	13.68	13.68	13.67	13.65
DTX10A	14.10	14.13	14.08	14.10	14.23	14.31	13.91	13.92	13.92	13.93	13.91
DTX10B	18.25	18.25	18.18	18.17	18.25	18.32	17.90	18.35	18.40	18.45	18.37
DTX11	14.21	14.22	14.16	14.18	14.29	14.38	14.15	14.02	14.02	14.01	14.01
D2	--	--	--	--	--	--	10.80	--	--	--	--
D3	--	--	--	--	--	--	39.72	--	--	--	--
D4	--	--	--	--	--	--	26.19	--	--	--	--
D5	--	--	--	--	--	--	--	--	--	--	--
D6	9.46	9.51	9.48	9.53	9.61	9.71	9.31	9.08	9.27	9.39	9.50
D6A	9.31	9.43	9.29	9.37	9.49	9.54	9.20	9.18	9.17	9.32	9.42
D7	--	--	--	--	--	--	9.29	--	--	--	--
D8	--	--	--	--	--	--	10.05	--	--	--	--
D10	--	--	--	--	--	--	--	--	--	--	--
D11a	113.88	113.88	113.52	113.74	113.96	113.79	113.73	113.89	113.98	113.93	113.65
D13	7.91	7.82	7.67	7.59	7.81	8.22	7.48	8.08	8.08	8.00	7.77
D14	--	--	--	--	--	--	12.21	--	--	--	--

Table 9. Monthly depth-to-water data for U.S. Geological Survey monitoring wells near Deer Trail, Colorado, 2007 and 2008.—Continued

[Uncertainty of the depth-to-water measurements is 0.02 foot or less. No access to wells January and February of 2007 due to weather; W.L. bmp, depth to water level below measuring point, in feet, measured with an electric tape; --, no data; *, water level is below the screened interval of the well; closed, well was closed 9/5/08]

Well name	February (2/25/2008) W.L. bmp	March (3/10/2008) W.L. bmp	April (4/9/2008) W.L. bmp	May (5/9/2008) W.L. bmp	June (6/13/2008) W.L. bmp	July (7/7/2008) W.L. bmp	August (8/20/2008-8/28/2008) W.L. bmp	September (9/17/2008-9/30/2008) W.L. bmp	October (10/16/2008) W.L. bmp	November (11/7/2008) W.L. bmp	December (12/12/2008) W.L. bmp
D15	--	--	--	--	--	--	8.05	--	--	--	--
D16	--	--	--	--	--	--	9.20	--	--	--	--
D17	13.12	13.12	13.07	13.03	13.01	13.13	13.09	13.09	13.14	13.13	13.10
D18	--	--	--	--	--	--	*	--	--	--	--
D19	22.61	22.63	22.64	22.65	22.67	22.68	22.70	22.70	22.73	22.72	22.73
D20	--	--	--	--	--	--	10.40	--	--	--	--
D21	--	--	--	--	--	--	11.27	--	--	--	--
D22	--	--	--	--	--	--	--	18.21	--	--	--
D23	--	--	--	--	--	--	6.05	--	--	--	--
D25	12.06	12.07	11.99	11.97	12.18	12.41	12.39	12.73	12.76	12.63	12.46
D25A	11.99	11.98	11.91	11.91	12.09	12.31	12.31	12.62	12.66	12.51	12.35
D26	--	--	--	--	--	--	33.23	--	--	--	--
D27	--	--	--	--	--	--	10.31	--	--	--	--
D28	--	--	--	--	--	--	12.81	--	--	--	--
D29	153.90	154.16	153.54	153.73	154.10	153.80	153.65	153.65	153.92	153.76	153.62
D30	4.98	4.92	4.81	4.73	4.96	5.48	3.31	closed	closed	closed	closed
D31	--	--	--	--	--	--	3.93	--	--	--	--
D32	--	--	--	--	--	--	--	--	--	--	--
D33	--	--	--	--	--	--	--	--	--	--	--

Table 10. Water-quality data for groundwater samples collected at U.S. Geological Survey monitoring wells near Deer Trail, Colorado, 2007 and 2008.

[°C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; $CaCO_3$, calcium carbonate; SiO_2, silicon dioxide; N, nitrogen; µg/L micrograms per liter; E, value estimated by laboratory; --, no data available; n, value is less than the minimum reporting level; <, less than; M, presence verified at very small concentration that could not be quantified]

Well name	Sample date	Sample time (hhmm)	Air temperature (°C)	Depth to water below measuring point before sampling (feet)	Oxygen, dissolved (mg/L)	pH, field (standard units)	Specific conductance, field (µS/cm)	Water temperature (°C)	Acid neutralizing capacity, titration, field (mg/L as $CaCO_3$)	pH, laboratory (standard units)	Specific conductance, laboratory (µS/cm)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)
DTX1	3/20/2007	1145	20	14.26	0.5	7.0	4,000	11.8	291	7.2	4,030	2,000	463	194
DTX1	6/25/2007	1340	40	14.38	.4	7.2	4,110	12.9	299	7.0	4,060	2,000	467	191
DTX1	9/7/2007	0915	16.5	13.52	.6	6.8	4,050	11.9	275	6.8	4,030	1,900	465	184
DTX1	11/20/2007	0915	0	13.76	.4	6.9	4,050	11.8	263	7.3	4,020	1,900	463	190
DTX1	3/25/2008	1000	11	14.12	.4	7.1	4,090	11.6	288	7.3	4,050	1,900	463	190
DTX1	6/25/2008	1415	--	14.34	.4	6.8	4,190	12.5	[1]281	7.2	3,930	2,000	479	197
DTX1	9/17/2008	1000	21.5	14.33	.4	7.0	4,080	12.3	[1]275	7.2	4,040	2,000	479	198
DTX1	11/18/2008	1015	19.5	14.47	.5	6.9	4,080	13.3	[1]286	7.2	4,080	2,000	485	200
DTX2	3/20/2007	0930	--	11.09	.6	6.8	5,180	9.5	412	7.1	5,290	2,200	509	221
DTX2	6/25/2007	1045	29	11.2	.7	7.1	5,500	11.6	422	7.2	5,390	2,100	488	212
DTX2	9/7/2007	1125	24.5	11.96	.6	6.7	5,100	12.1	417	7.0	5,120	2,000	472	204
DTX2	11/20/2007	1145	3	11.7	.4	6.7	5,330	11.5	403	7.2	5,280	2,200	501	224
DTX2	3/25/2008	1245	20	11.53	.4	7.0	5,550	10.5	432	7.1	5,470	2,200	494	228
DTX2	6/24/2008	1415	--	11.61	.3	6.8	5,770	12.4	[1]432	7.2	5,500	2,200	490	232
DTX2	9/17/2008	1200	28	8.86	.3	6.8	5,890	12.9	[1]420	7.1	5,840	2,300	504	250
DTX2	11/18/2008	1200	25.5	9.52	.3	6.9	5,760	13.3	[1]447	7.1	5,750	2,300	495	250
DTX5	11/21/2008	1015	13	10.85	.6	6.9	3,210	11.8	[1]309	7.1	3,150	2,000	625	102
DTX6	11/21/2008	1215	10	21.57	.8	7.0	3,710	12.6	[1]318	7.2	3,720	2,100	442	240
DTX8A	6/20/2007	0945	24	9.45	.3	7.4	1,880	14.5	212	7.7	1,880	480	141	30.3
DTX8A	6/24/2008	1100	28	10.02	.5	7.5	1,970	14.2	[1]220	7.6	1,880	540	156	34.7
DTX10A	6/19/2007	1330	38	13.55	.2	7.1	3,210	15.7	226	7.2	3,210	1,800	442	163
DTX10A	6/23/2008	1200	36	14.24	.5	7.0	3,350	15.7	[1]225	7.2	3,150	1,800	450	168
D3	9/18/2008	1515	29.5	39.71	4.1	6.7	2,430	18.3	[1]120	7.2	2,410	1,500	421	107
D4	9/17/2008	1400	32.5	25.96	4.7	6.4	1,030	15.9	[1]118	6.9	1,210	540	158	35.2
D5	11/18/2007	1030	14.5	17.13	1.9	7.0	4,300	13.4	229	7.5	4,130	2,500	490	304
D6	3/19/2007	1100	--	8.01	.5	6.8	17,300	11.3	599	7.2	E17,600	11,000	436	2,460
D6	6/21/2007	0945	29	8.24	.4	7.0	17,800	13.5	636	7.2	E17,600	11,000	424	2,350
D6	9/5/2007	1000	22	7.95	.6	6.8	17,700	14.4	639	7.2	E17,700	11,000	436	2,430
D6	11/19/2007	0945	18.5	8.94	.5	6.9	17,900	13.2	594	7.3	E17,300	11,000	458	2,450
D6	3/26/2008	1045	14	9.45	.4	7.1	17,800	11.7	650	7.3	E17,500	11,000	453	2,450
D6	6/23/2008	1545	33	9.6	.4	6.9	17,500	13.5	[1]652	7.2	E17,400	10,000	438	2,270
D6	9/18/2008	1045	27.5	9.08	.4	6.9	17,600	12.8	[1]629	7.3	E17,600	10,000	437	2,160
D6	11/19/2008	1100	20.5	9.44	<.5	6.9	17,000	12.6	[1]665	7.2	E17,500	11,000	443	2,490

Table 10. Water-quality data for groundwater samples collected at U.S. Geological Survey monitoring wells near Deer Trail, Colorado, 2007 and 2008.—Continued

[°C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; $CaCO_3$, calcium carbonate; SiO_2, silicon dioxide; N, nitrogen; µg/L micrograms per liter; E, value estimated by laboratory; --, no data available; n, value is less than the minimum reporting level; <, less than; M, presence verified at very small concentration that could not be quantified]

Well name	Sample date	Sample time (hhmm)	Air temperature (°C)	Depth to water below measuring point before sampling (feet)	Oxygen, dissolved (mg/L)	pH, field (standard units)	Specific conductance, field (µS/cm)	Water temperature (°C)	Acid neutralizing capacity, titration, field (mg/L as $CaCO_3$)	pH, laboratory (standard units)	Specific conductance, laboratory (µS/cm)	Hardness, total (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)
D6A	11/19/2007	1230	29	8.82	0.7	6.9	17,600	12.3	599	7.3	E17,400	11,000	439	2,400
D6A	9/18/2008	1300	29	9.18	.2	7.0	17,500	11.9	[1]655	7.3	E17,400	10,000	437	2,150
D7	9/23/2008	1245	23	9.25	3.8	7.2	2,530	14.1	[1]194	7.6	2,380	1,600	418	133
D8	9/25/2008	1520	29	10.31	.3	6.8	4,470	13.8	[1]352	7.3	4,390	2,400	555	242
D10	11/18/2007	1300	24	9.53	2.6	6.9	4,570	13.8	309	7.5	4,390	2,700	472	361
D13	9/29/2008	1520	25	8.08	1.1	7.1	1,080	14.8	[1]248	7.6	1,030	500	138	37.3
D14	9/26/2008	1325	30.5	12.01	.6	7.0	864	12.5	[1]214	7.5	802	390	121	21.4
D15	9/25/2008	1245	27	8.48	.7	6.5	4,500	13.4	[1]548	7.0	4,210	2,300	481	266
D16	9/26/2008	1100	29	9.95	.2	6.8	4,220	13.2	[1]412	7.2	4,080	2,200	541	214
D17	3/19/2007	1440	--	12.75	.4	7.4	490	11.4	190	7.8	484	220	58.8	18.8
D17	6/19/2007	0930	21	11.92	.7	7.5	490	12.3	200	7.7	483	220	57.1	17.7
D17	9/5/2007	1400	32	12.99	.6	7.5	500	14.4	190	7.7	490	230	60.4	18.2
D17	11/20/2007	1430	5	13.27	.3	7.6	491	13.4	[1]188	7.8	490	220	59	18.4
D17	3/25/2008	1530	21	13.1	.6	7.5	477	11.7	202	7.9	486	230	60.2	19.1
D17	6/25/2008	1000	34	13.06	.3	7.4	490	12.4	[1]199	7.8	477	230	61.6	18.9
D17	9/19/2008	0930	20	13.09	.3	7.5	479	13.5	[1]184	7.8	480	230	60.7	18.0
D17	11/18/2008	1430	26.5	13.12	.4	7.6	480	14.1	[1]203	7.8	475	230	60.6	18.5
D19	9/19/2008	1115	23	22.7	6.5	7.3	361	14.8	[1]130	7.6	354	170	59.1	4.90
D20	9/29/2008	1240	22.5	10.9	.8	7.1	3,070	15.3	[1]230	7.5	3,030	1,800	467	154
D21	9/29/2008	1030	15.5	11.69	.9	7.0	1,190	13.5	[1]508	7.0	1,900	660	200	39.1
D22	9/24/2008	1225	--	18.32	.4	6.9	10,500	17.6	[1]586	7.3	E10,600	5,200	399	1,020
D23	9/25/2008	1015	23	6.91	.9	6.9	5,150	13.8	[1]470	7.3	4,890	2,200	560	205
D25	3/20/2007	1445	23	10.27	.8	7.0	4,600	12	437	7.2	4,530	2,600	669	218
D25	6/21/2007	1430	39	10.67	.7	7.0	4,600	15.5	473	7.3	4,580	2,600	664	224
D25	9/5/2007	1645	34	11.81	.8	6.8	4,800	14.3	475	7.2	4,590	2,600	665	226
D25	11/20/2007	1600	4	12.21	.6	6.9	4,350	11.5	[1]347	7.3	4,450	2,500	688	184
D25	3/26/2008	1350	22	12.02	.5	7.0	4,410	12.6	372	7.3	4,490	2,600	728	179
D25	6/25/2008	1215	34	12.3	.7	6.8	4,580	15.1	[1]377	7.3	4,390	2,700	748	196
D25	9/16/2008	1315	28.5	12.51	.6	6.9	4,460	14.9	[1]395	7.3	4,460	2,500	663	211
D25	11/19/2008	1515	20	12.59	<.8	7.0	4,510	13.6	[1]366	7.2	4,420	2,600	733	188
D25A	3/26/2008	1530	26	11.96	.9	7.0	4,420	12.7	336	7.3	4,440	2,500	724	160
D26	9/16/2008	1040	27	32.71	8.2	7.3	707	13.1	[1]251	7.6	708	330	101	19.3
D27	9/23/2008	1015	20	10.51	.7	7.2	3,040	13.5	[1]245	7.6	2,970	1,900	555	129
D28	9/23/2008	1445	27.5	12.93	1.0	6.8	3,040	12.8	[1]256	7.3	2,900	1,800	460	167
D31	11/19/2008	1330	--	6.06	<.5	7.2	7,800	12.5	[1]533	7.3	7,710	4,800	465	871
D32	12/20/2007	1120	13	29.06	2.4	6.9	3,500	12.8	285	7.4	3,640	2,500	551	265
D33	11/18/2007	1500	24	12.51	4.3	7.0	4,560	13.8	230	7.6	4,380	2,800	526	352

Table 10. Water-quality data for groundwater samples collected at U.S. Geological Survey monitoring wells near Deer Trail, Colorado, 2007 and 2008.—Continued

[°C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; $CaCO_3$, calcium carbonate; SiO_2, silicon dioxide; N, nitrogen; µg/L micrograms per liter; E, value estimated by laboratory; --, no data available; n, value is less than the minimum reporting level; <, less than; M, presence verified at very small concentration that could not be quantified]

Well name	Sample date	Sample time (hhmm)	Potassium, dissolved (mg/L)	Sodium adsorption ratio	Sodium, dissolved (mg/L)	Acid neutralizing capacity, titration to pH4.5, laboratory (mg/L as $CaCO_3$)	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L as SiO_2)	Sulfate, dissolved (mg/L)	Nitrogen, ammonia plus organic, dissolved (mg/L as N)	Nitrogen, ammonia plus organic, total (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrite plus nitrate, dissolved (mg/L as N)
DTX1	3/20/2007	1145	3.36	3.3	337	301	0.77	51.4	0.69	35.0	2,300	<1.0	0.23	<0.080	3.13
DTX1	6/25/2007	1340	3.41	3.3	332	296	.79	50.9	.67	33.3	2,280	.24	.23	.05	2.84
DTX1	9/7/2007	0915	3.65	3.3	331	296	.76	49.5	.60	31.5	2,290	.22	.17	.042	2.67
DTX1	11/20/2007	0915	3.86	3.5	355	297	.77	52.1	.65	34.4	2,370	.21	.22	E,n .035	2.49
DTX1	3/25/2008	1000	3.67	3.2	324	292	.79	53.6	.66	32.7	2,320	.23	.23	E,n .030	2.73
DTX1	6/25/2008	1415	3.82	3.3	341	292	.78	53.0	.61	32.4	2,300	.22	.24	E,n .028	2.97
DTX1	9/17/2008	1000	3.81	3.4	350	290	.8	52.4	.67	31.4	2,300	.24	.24	.041	3.08
DTX1	11/18/2008	1015	3.9	3.4	350	291	.8	54.7	.66	34.0	2,340	.21	.24	<.200	3.08
DTX2	3/20/2007	0930	9.88	5.9	628	435	1.32	110	.58	15.9	2,930	1.1	1.2	.920	E,n .02
DTX2	6/25/2007	1045	9.8	6.0	633	429	1.30	110	.61	15.7	2,910	1.2	1.3	.942	<.04
DTX2	9/7/2007	1125	9.66	5.5	563	431	1.10	94.3	.61	14.3	2,750	1.2	1.2	.974	<.04
DTX2	11/20/2007	1145	10.4	5.8	618	438	1.18	108	.62	16.4	2,850	1.3	1.2	1.03	<.04
DTX2	3/25/2008	1245	10.4	6.1	658	436	1.21	116	.61	15.2	2,940	1.2	1.3	.955	<.04
DTX2	6/24/2008	1415	10.8	6.4	688	432	1.23	116	.59	14.8	3,010	1.4	1.3	1.04	<.04
DTX2	9/17/2008	1200	12.1	6.8	744	428	1.39	121	.66	14.8	3,200	1.5	1.5	1.25	<.04
DTX2	11/18/2008	1200	12.2	6.8	749	442	1.34	121	.64	16.6	3,140	1.5	1.6	1.27	<.40
DTX5	11/21/2008	1015	4.86	1.3	138	304	.33	17.0	.35	11.5	1,810	.19	.17	.064	<.04
DTX6	11/21/2008	1215	12.8	2.4	250	316	.11	13.4	.54	11.8	2,190	.14	.10	.047	2.03
DTX8A	6/20/2007	0945	6.08	4.8	242	222	.28	27.0	.43	12.8	761	1.4	1.5	1.45	<.04
DTX8A	6/24/2008	1100	6.49	4.3	228	224	.28	27.1	.35	13.4	775	1.5	1.5	1.41	<.04
DTX10A	6/19/2007	1330	8.87	1.7	168	225	.24	18.4	1.03	16.3	1,890	1.3	1.3	1.32	<.04
DTX10A	6/23/2008	1200	9.29	1.6	160	224	.25	18.3	.94	15.3	1,920	1.4	1.4	1.3	<.04
D3	9/18/2008	1515	4.96	.7	61	126	.3	27.1	1.17	28.3	1,370	E,n .11	E,n .12	E,n .038	3.21
D4	9/17/2008	1400	3.02	.5	27	119	.06	4.34	1.24	37.7	461	<.14	<.14	<.040	.81
D5	11/18/2007	1030	5.75	2.2	246	241	.37	27.9	.57	19.0	2,670	.22	.21	<.040	8.75
D6	3/19/2007	1100	14.7	9.5	2,300	649	4.60	387	1.20	21.6	13,500	1.5	1.7	.123	40.6
D6	6/21/2007	0945	14.6	9.8	2,330	648	4.49	387	1.23	20.8	13,400	1.6	1.6	.076	41.6
D6	9/5/2007	1000	13.5	9.4	2,280	650	4.42	390	1.13	20.9	13,700	1.6	1.7	.079	42.3
D6	11/19/2007	0945	14.5	9.7	2,360	650	4.45	385	1.16	21.8	14,000	1.6	1.6	.068	41.5
D6	3/26/2008	1045	15.1	9.4	2,300	650	4.37	382	1.28	21.4	13,800	1.5	1.6	.086	38.8
D6	6/23/2008	1545	14.2	9.2	2,160	654	4.26	381	1.18	19.4	13,800	1.7	1.5	.080	39.4
D6	9/18/2008	1045	14.8	11	2,410	648	4.30	372	1.24	18.1	13,900	1.5	1.7	.072	41.4
D6	11/19/2008	1100	14.8	9.6	2,350	650	4.27	368	1.22	20.8	13,800	1.6	1.6	<1.00	40.4

Table 10. Water-quality data for groundwater samples collected at U.S. Geological Survey monitoring wells near Deer Trail, Colorado, 2007 and 2008. —Continued

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Well name	Sample date	Sample time (hhmm)	Potassium, dissolved (mg/L)	Sodium adsorption ratio	Sodium, dissolved (mg/L)	Acid neutralizing capacity, titration to pH4.5, laboratory (mg/L as $CaCO_3$)	Bromide, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L as SiO_2)	Sulfate, dissolved (mg/L)	Nitrogen, ammonia plus organic, dissolved (mg/L as N)	Nitrogen, ammonia plus organic, total (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrite plus nitrate, dissolved (mg/L as N)
D6A	11/19/2007	1230	14.4	9.4	2,270	651	4.21	385	1.14	21.5	13,900	1.6	1.6	0.071	37.3
D6A	9/18/2008	1300	14.8	10	2,390	646	4.26	368	1.26	18	13,800	1.6	1.7	.077	43.2
D7	9/23/2008	1245	3.69	.6	58.9	200	.25	11.7	.78	29.1	1,260	.32	.31	.041	29.9
D8	9/25/2008	1520	6.36	3.2	364	348	.86	40.5	1.06	27.2	2,630	.63	.55	.269	<.04
D10	11/18/2007	1300	16.6	2.2	261	350	.17	11.6	.74	20.3	2,660	.64	.61	E,n .022	10.8
D13	9/29/2008	1520	2.64	1.0	51.3	246	.10	2.55	1.40	14.2	315	E,n .12	E,n .13	.049	<.04
D14	9/26/2008	1325	2.3	.6	28.7	214	.16	5.96	1.07	22.6	182	.22	E,n .1	<.040	7.91
D15	9/25/2008	1245	5.72	3.1	343	547	.62	15.3	1.80	17.1	2,360	1.3	1.2	1.07	<.04
D16	9/26/2008	1100	5.07	2.8	309	398	.65	29.1	1.31	20.1	2,360	.89	.86	.691	<.04
D17	3/19/2007	1440	1.62	.5	17.3	203	.05	2.21	1.34	17.9	52.1	<.10	.11	<.040	.83
D17	6/19/2007	0930	1.54	.5	17.7	203	.05	2.36	1.42	17.8	48.1	E,n .08	E,n .08	E,n .029	.90
D17	9/5/2007	1400	1.62	.5	17.7	203	.07	2.32	1.37	18.2	50.6	E,n .06	E,n .07	<.040	.83
D17	11/20/2007	1430	1.81	.5	18.5	203	.06	2.46	1.36	18.6	49.9	E,n .10	<.14	<.040	.88
D17	3/25/2008	1530	1.62	.5	17.3	202	.06	2.44	1.41	18.7	49.6	E,n .07	<.14	<.040	.85
D17	6/25/2008	1000	1.76	.5	18.3	202	.06	2.37	1.36	17.6	49.6	E,n .13	<.14	<.040	.85
D17	9/19/2008	0930	1.7	.5	17.2	201	.07	2.33	1.44	18.4	47.9	<.14	E,n .11	<.040	.88
D17	11/18/2008	1430	1.75	.5	18.0	203	.07	2.40	1.38	19.0	48.4	.14	E,n .07	<.040	.89
D19	9/19/2008	1115	0.48	.2	7.03	131	.07	4.12	.20	16.8	20.5	E,n .12	E,n .12	<.040	6.53
D20	9/29/2008	1240	6.24	1.5	146	236	.25	6.15	.93	30.3	1,810	.37	.38	.224	<.04
D21	9/29/2008	1030	5.90	.7	40.3	497	.10	3.30	.92	24.6	467	3.3	3.9	2.98	<.04
D22	9/24/2008	1225	13.8	8.4	1,390	579	.85	72.3	1.31	9.05	7,500	1.3	1.2	.818	5.24
D23	9/25/2008	1015	9.71	5.0	541	471	.48	50.2	1.00	15.3	2,800	2.0	1.8	.613	.07
D25	3/20/2007	1445	7.07	2.5	291	464	1.77	102	1.02	27.9	2,550	.63	.79	.088	3.16
D25	6/21/2007	1430	6.79	2.4	280	483	1.73	99.1	1.12	26.4	2,570	.72	.79	.063	4.00
D25	9/5/2007	1645	7.21	2.4	283	506	1.73	98.5	.99	27.2	2,560	.74	.75	.062	4.54
D25	11/20/2007	1600	8.16	2.5	289	383	1.84	131	1.04	25.7	2,590	.61	.50	.072	.61
D25	3/26/2008	1350	7.52	2.3	269	370	1.96	127	1.05	23.9	2,560	.54	.52	.066	.50
D25	6/25/2008	1215	8.42	2.3	276	387	1.90	120	1.01	24.5	2,570	.62	.59	.073	1.44
D25	9/16/2008	1315	7.61	2.3	266	422	1.94	113	1.15	25.8	2,500	.69	.68	.059	3.11
D25	11/19/2008	1515	8.11	2.3	271	370	2.03	132	1.05	25.6	2,560	.55	.56	.063	.32
D25A	3/26/2008	1530	7.48	2.3	263	352	1.99	134	1.08	25.5	2,530	.47	.46	.085	<.04
D26	9/16/2008	1040	3.75	.3	12.1	259	.07	5.12	.58	17.3	57	.29	.28	<.040	13.6
D27	9/23/2008	1015	9.53	.9	85.7	122	.38	22.7	.20	36.8	1,710	.47	.47	.061	17.0
D28	9/23/2008	1445	7.49	.9	91.0	247	.45	33.5	.89	20.7	1,580	.27	.33	.040	18.7
D31	11/19/2008	1330	5.45	4.5	713	530	1.07	115	1.41	14.9	5,160	.55	.57	<.400	<.40
D32	12/20/2007	1120	2.0	1.0	120	335	0.47	32.5	0.82	26.4	2,150	.17	.16	E .038	16.7
D33	11/18/2007	1500	14.6	1.8	213	261	1.06	61.6	.65	31.3	2,880	.31	.34	E,n .023	.99

Table 10. Water-quality data for groundwater samples collected at U.S. Geological Survey monitoring wells near Deer Trail, Colorado, 2007 and 2008.—Continued

[°C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; $CaCO_3$, calcium carbonate; SiO_2, silicon dioxide; N, nitrogen; µg/L micrograms per liter; E, value estimated by laboratory; --, no data available; n, value is less than the minimum reporting level; <, less than; M, presence verified at very small concentration that could not be quantified]

Well name	Sample date	Sample time (hhmm)	Phosphorus, dissolved (mg/L)	Phosphorus, total (mg/L)	Solids, residue on evaporation at 180°C, dissolved (mg/L)	Dissolved solids, sum of constituents (mg/L)	Aluminum, dissolved (µg/L)	Antimony, dissolved (µg/L)	Arsenic, dissolved (µg/L)	Barium, dissolved (µg/L)	Beryllium, dissolved (µg/L)	Boron, dissolved (µg/L)	Cadmium, dissolved (µg/L)	Chromium, dissolved (µg/L)	Cobalt, dissolved (µg/L)
DTX1	3/20/2007	1145	<0.40	0.08	4,040	E3,580	E,n 1.8	0.15	2.4	8	<0.12	418	0.14	E,n 0.17	0.16
DTX1	6/25/2007	1340	.06	.07	3,900	E3,560	E,n 2.2	E,n .06	1.5	8	<.12	430	.14	<.24	.10
DTX1	9/7/2007	0915	.07	.07	3,980	E3,530	<3.2	E,n .11	1.6	9	<.12	408	.26	E,n .16	.34
DTX1	11/20/2007	0915	.07	.07	4,000	E3,640	<4.8	<.42	1.6	9	<.02	457	.24	<.36	.31
DTX1	3/25/2008	1000	.08	.07	3,920	E3,580	<3.2	<.28	1.6	8	<.02	429	.18	<.24	.31
DTX1	6/25/2008	1415	.07	.07	3,980	E3,600	<3.2	<.28	1.7	8	<.02	385	.16	E,n .15	.32
DTX1	9/17/2008	1000	.06	.07	3,950	3,590	<8.0	<.70	1.3	8	<.04	379	.23	<.60	.32
DTX1	11/18/2008	1015	.08	.07	3,970	E3,660	<12.0	.2	1.5	9	<.06	403	.20	<.36	.41
DTX2	3/20/2007	0930	<.04	<.04	5,090	E4,680	<4.8	.37	.70	13	<.18	261	<.12	<.36	4.6
DTX2	6/25/2007	1045	<.04	E,n .02	5,080		E,n 2.5	<.18	.69	14	<.18	274	<.12	<.36	4.7
DTX2	9/7/2007	1125	<.04	<.04	4,850	E4,370	<4.8	E,n .12	.75	14	<.18	273	<.12	<.36	5.9
DTX2	11/20/2007	1145	<.04	<.04	5,040	E4,590	<8.0	<.70	.94	15	<.04	301	<.20	<.60	5.4
DTX2	3/25/2008	1245	E,n .03	E,n .02	5,160	E4,730	<4.8	E,n .23	.84	14	<.02	278	E,n .06	<.36	5.8
DTX2	6/24/2008	1415	<.04	E,n .02	5,360	E4,830	<4.8	<.42	.78	14	<.02	252	E,n .07	.39	5.6
DTX2	9/17/2008	1200	<.04	<.04	5,530	5,110	<8.0	<.70	.72	14	<.04	267	<.20	<.60	4.9
DTX2	11/18/2008	1200	E,n .02	<.04	5,530	E5,070	<16.0	.21	.94	14	<.08	284	<.08	<.48	5.9
DTX5	11/21/2008	1015	<.04	<.04	3,080	E2,900	<8.0	.15	.20	13	<.04	481	.06	<.24	.65
DTX6	11/21/2008	1215	<.04	<.04	3,640	E3,360	<8.0	.09	.14	9	<.04	356	<.04	<.24	.26
DTX8A	6/20/2007	0945	<.04	<.04	1,430	E1,350	1.9	E,n .05	E,n .12	11	<.06	249	<.04	.13	.31
DTX8A	6/24/2008	1100	<.04	<.04	1,420	E1,380	E,n 1.3	<.14	.12	11	M	258	<.04	.13	.23
DTX10A	6/19/2007	1330	<.04	<.04	3,020	E2,860	<3.2	<.12	E,n .12	12	<.12	235	<.08	E,n .18	.10
DTX10A	6/23/2008	1200	<.04	<.04	3,160	2,890	<3.2	<.28	.15	12	.02	219	<.08	.25	.34
D3	9/18/2008	1515	.04	.07	2,280	E2,100	E2.8	<.42	.26	8	.04	115	E.09	.98	.65
D4	9/17/2008	1400	.31	.31	884	E802	E,n 1.2	<.14	1.0	7	<.01	52	<.04	.50	.11
D5	11/18/2007	1030	<.04	<.04	4,250	E3,940	<4.8	<.42	.38	10	<.02	314	<.12	.49	.17
D6	3/19/2007	1100	E,n .02	.04	22,800	E19,700	<12.8	E,n .40	1.2	5	<.48	792	<.32	<.96	6.8
D6	6/21/2007	0945	.04	.04	21,400	E19,600	<16.0	<.60	1.2	6	<.60	809	<.40	<1.2	6.7
D6	9/5/2007	1000	E,n .03	.04	21,400	E19,900	<16.0	<1.50	E,n 1.8	6	<1.50	848	<1.00	<3.0	7.9
D6	11/19/2007	0945	E,n .04	E,n .04	22,500	20,200	<12.8	<1.12	1.2	6	<.06	855	<.32	<.96	7.1
D6	3/26/2008	1045	.04	E,n .03	22,500	20,100	<12.8	<1.12	1.5	6	<.06	871	<.32	<.96	7.4
D6	6/23/2008	1545	.04	E,n .04	22,600	E19,700	<11.2	<.98	1.6	6	<.06	760	E,n .14	<.84	8.0
D6	9/18/2008	1045	E,n .03	E,n .03	22,700	19,900	<16.0	<1.40	1.2	5	<.08	708	<.40	<1.2	7.4
D6	11/19/2008	1100	E,n .04	E,n .04	22,000	E20,100	<40.0	E,n .40	1.3	5	<.20	707	<.20	<1.2	7.2

Table 10. Water-quality data for groundwater samples collected at U.S. Geological Survey monitoring wells near Deer Trail, Colorado, 2007 and 2008.—Continued

[°C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; $CaCO_3$, calcium carbonate; SiO_2, silicon dioxide; N, nitrogen; µg/L micrograms per liter; E, value estimated by laboratory; --, no data available; n, value is less than the minimum reporting level; <, less than; M, presence verified at very small concentration that could not be quantified]

Well name	Sample date	Sample time (hhmm)	Phosphorus, dissolved (mg/L)	Phosphorus, total (mg/L)	Solids, residue on evaporation at 180°C, dissolved (mg/L)	Dissolved solids, sum of constituents (mg/L)	Aluminum, dissolved (µg/L)	Antimony, dissolved (µg/L)	Arsenic, dissolved (µg/L)	Barium, dissolved (µg/L)	Beryllium, dissolved (µg/L)	Boron, dissolved (µg/L)	Cadmium, dissolved (µg/L)	Chromium, dissolved (µg/L)	Cobalt, dissolved (µg/L)
D6A	11/19/2007	1230	E,n 0.04	E,n 0.04	22,400	20,000	<12.8	<1.12	1.0	6	<0.06	856	<0.32	<0.96	11.4
D6A	9/18/2008	1300	E,n .03	E,n .03	22,200	19,800	<12.8	<1.12	.92	5	<.06	709	<.32	<.96	8.9
D7	9/23/2008	1245	.09	.09	2,280	2,170	<1.6	E,n .09	.86	16	<.01	175	.11	.17	.92
D8	9/25/2008	1520	E,n. 04	.04	4,450	E4,080	E,n 1.9	<.28	.85	14	<.02	151	.29	.49	1.8
D10	11/18/2007	1300	.16	.16	4,510	E4,050	<4.8	<.42	1.7	13	<.02	423	<.12	.41	.18
D13	9/29/2008	1520	<.04	E,n .02	736	E713	<1.6	<.14	.48	17	<.01	87	<.04	E,n .08	.33
D14	9/26/2008	1325	E,n .03	E,n .03	562	E549	E,n .9	E,n .09	.95	46	<.01	96	E,n .03	.50	.31
D15	9/25/2008	1245	E,n .02	E.,n 03	4,170	E3,840	<3.2	<.28	4.0	13	E,n .01	389	<.08	E,n .18	11.3
D16	9/26/2008	1100	E,n .03	E,n .03	4,100	3,740	<3.2	<.28	4.8	17	<.02	132	.10	<.24	5.6
D17	3/19/2007	1440	.05	.08	297	E288	<1.6	<.06	1.4	55	<.06	53	.04	E,n .07	.16
D17	6/19/2007	0930	.08	.08	293	E288	E,n 1.1	.08	1.4	58	<.06	53	E,n .02	<.12	.11
D17	9/5/2007	1400	.07	.09	300	E289	<1.6	.06	1.4	60	<.06	58	<.04	<.12	.13
D17	11/20/2007	1430	.08	.09	305	288	<3.2	<.28	1.5	58	<.02	61	<.08	<.24	.12
D17	3/25/2008	1530	.08	.07	300	296	<1.6	<.14	1.4	58	<.01	60	<.04	<.12	.10
D17	6/25/2008	1000	.09	.08	303	E295	<1.6	<.14	1.5	55	<.01	53	E,n .02	<.12	.11
D17	9/19/2008	0930	.09	.08	292	283	<1.6	<.14	1.6	59	<.01	57	<.04	<.12	.12
D17	11/18/2008	1430	.08	.09	300	E297	<4.0	.08	1.5	58	<.02	51	E,n .02	<.12	.13
D19	9/19/2008	1115	.25	.25	222	E220	E,n 1.0	E,n .10	1.4	75	<.01	9.8	E,n .02	.37	.08
D20	9/29/2008	1240	.15	.15	2,940	E2,760	<8.0	<.70	6.5	16	<.04	95	<.20	<.60	.57
D21	9/29/2008	1030	.32	.60	937	E1,110	<3.2	<.14	11.0	82	E,n .01	156	<.04	E,n .07	.36
D22	9/24/2008	1225	<.04	<.04	12,700	10,800	<8.0	<.70	.68	9	<.04	1,160	<.20	1.1	4.9
D23	9/25/2008	1015	.89	.88	4,880	E4,480	E,n 1.6	.39	8.7	22	<.02	418	.22	.90	3.8
D25	3/20/2007	1445	.09	.14	4,650	4,150	<3.2	.12	3.0	15	<.12	415	<.08	<.24	1.5
D25	6/21/2007	1430	.14	.14	4,540	E4,180	<4.8	E,n .15	2.4	16	<.18	426	.24	<.36	1.62
D25	9/5/2007	1645	.15	.16	4,710	E4,180	<4.8	E,n .15	3.1	17	<.18	546	.21	E,n .36	2.0
D25	11/20/2007	1600	.09	.09	4,500	4,130	<8.0	<.70	1.7	18	<.04	224	.22	<.60	2.1
D25	3/26/2008	1350	.08	.08	4,540	4,130	<3.2	<.28	1.5	17	<.02	180	.16	<.24	2.4
D25	6/25/2008	1215	.09	.09	4,510	E4,180	<3.2	<.28	1.6	15	<.02	199	.20	E,n .15	2.2
D25	9/16/2008	1315	.12	.13	4,500	4,040	<8.0	<.70	2.3	14	<.04	334	.24	<.60	1.5
D25	11/19/2008	1515	.09	.08	4,490	4,150	<12.0	.2	1.7	16	<.06	163	.24	<.36	2.0
D25A	3/26/2008	1530	.07	.07	4,520	E4,050	<3.2	<.28	.94	20	<.02	153	E,n .04	<.24	3.0
D26	9/16/2008	1040	.10	.09	443	E428	<1.6	<.14	.37	13	<.01	71	<.04	.52	.14
D27	9/23/2008	1015	.14	.15	2,970	E2,770	<3.2	E,n .16	1.7	16	<.02	194	E,n .05	.39	.38
D28	9/23/2008	1445	E,n .03	.05	2,820	E2,600	<3.2	<.28	.49	13	<.02	146	<.08	.50	.29
D31	11/19/2008	1330	E,n .03	<.04	8,420	E7,680	<20.0	.3	1.0	8	<.10	628	E,n .05	<.60	.79
D32	12/20/2007	1120	<.04	E .02	3,680	E3,400	<4.8	<.42	0.45	10	<.02	403	<.12	2.0	0.28
D33	11/18/2007	1500	.05	.06	4,610	E4,230	<4.8	<.42	1.2	14	<.02	277	<.12	1.7	.17

Table 10. Water-quality data for groundwater samples collected at U.S. Geological Survey monitoring wells near Deer Trail, Colorado, 2007 and 2008.—Continued

[°C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; $CaCO_3$, calcium carbonate; SiO_2, silicon dioxide; N, nitrogen; µg/L micrograms per liter; E, value estimated by laboratory; --, no data available; n, value is less than the minimum reporting level; <, less than; M, presence verified at very small concentration that could not be quantified]

Well name	Sample date	Sample time (hhmm)	Copper, dissolved (µg/L)	Iron, dissolved (µg/L)	Lead, dissolved (µg/L)	Manganese, dissolved (µg/L)	Mercury, dissolved (µg/L)	Molybdenum, dissolved (µg/L)	Nickel, dissolved (µg/L)	Selenium, dissolved (µg/L)	Silver, dissolved (µg/L)	Strontium, dissolved (µg/L)	Tungsten, dissolved (µg/L)	Zinc, dissolved (µg/L)	Uranium, dissolved (µg/L)
DTX1	3/20/2007	1145	E,n 0.56	<18	<0.24	225	<0.010	4.7	17.4	6.8	<0.2	5,400	E,n 0.07	E,n 1.1	36.3
DTX1	6/25/2007	1340	1.0	<18	E,n .15	250	<.010	3.7	17.8	11.9	<.2	5,470	<.12	E,n 1.1	34.2
DTX1	9/7/2007	0915	E,n .59	<18	<.24	264	<.010	4.1	22.3	10.3	<.2	5,520	<.12	1.4	38.2
DTX1	11/20/2007	0915	<3.0	<24	<.24	270	<.010	3.9	21.4	11.8	<.3	5,700	<.18	<5.4	36.6
DTX1	3/25/2008	1000	<2.0	<24	<.16	210	<.010	3.5	18.3	7.4	<.2	5,440	<.12	<3.6	35.4
DTX1	6/25/2008	1415	<2.0	<16	<.16	157	<.010	3.4	17.2	12.7	<.2	5,920	<.12	<3.6	39.4
DTX1	9/17/2008	1000	<5.0	<24	<.40	169	<.010	2.6	19.1	11.7	<.5	5,550	<.30	<9.0	38.0
DTX1	11/18/2008	1015	<3.0	E,n 8	<.18	179	<.010	2.7	16.2	13.2	M	5,600	<.06	<6.0	38.9
DTX2	3/20/2007	0930	<1.2	542	<.36	4,600	<.010	1.7	4.8	E,n .23	<.3	5,500	<.18	E,n 1.7	29.1
DTX2	6/25/2007	1045	E,n 1.1	480	E,n .24	5,130	<.010	1.6	4.2	<.24	<.3	5,300	<.18	2.3	29.9
DTX2	9/7/2007	1125	<1.2	552	<.36	4,740	<.010	1.9	6.8	E,n .16	<.3	5,260	<.18	E,n 1.6	32.3
DTX2	11/20/2007	1145	<5.0	662	<.40	5,500	<.010	1.9	6.4	E,n .16	<.5	5,700	<.30	E,n 4.8	30.7
DTX2	3/25/2008	1245	<3.0	582	<.24	5,670	<.010	1.8	6.7	.30	<.3	5,420	<.18	<5.4	29.9
DTX2	6/24/2008	1415	<3.0	462	<.24	5,150	<.010	2.0	8.8	.29	<.3	5,740	<.18	<5.4	32.8
DTX2	9/17/2008	1200	<5.0	589	<.40	5,120	<.010	1.8	9.6	.23	<.5	5,480	<.30	<9.0	29.3
DTX2	11/18/2008	1200	<4.0	649	<.24	5,650	<.010	1.9	8.0	E,n .17	M	5,350	<.08	<8.0	29.5
DTX5	11/21/2008	1015	<2.0	<8	.13	187	<.010	1.0	6.2	.15	M	5,470	<.04	<4.0	49.3
DTX6	11/21/2008	1215	<2.0	<8	<.12	E,n .2	<.010	.7	3.2	3.4	M	5,300	<.04	<4.0	37.6
DTX8A	6/20/2007	0945	<.40	738	<.12	88.1	<.010	.5	.37	<.08	<.1	2,410	.26	<.60	.15
DTX8A	6/24/2008	1100	<1.0	948	<.08	100	<.010	.5	1.1	.07	<.1	2,790	<.06	<1.8	.15
DTX10A	6/19/2007	1330	<.80	4,510	<.24	266	<.010	1.3	.74	E,n .10	<.2	5,360	<.12	<1.2	.16
DTX10A	6/23/2008	1200	<2.0	4,510	<.16	279	<.010	1.4	3.6	.17	<.2	5,900	<.12	<3.6	.14
D3	9/18/2008	1515	<3.0	E,n 15	<.24	397	<.010	1.1	13.6	46.9	<.3	848	<.18	<5.4	6.23
D4	9/17/2008	1400	E,n .58	E,n 4	<.08	0.5	<.010	.8	1.5	19.6	<.1	222	E,n .03	E,n 1.7	1.76
D5	11/18/2007	1030	<3.0	<24	<.24	<.6	<.010	1.1	1.9	12.1	<.3	6,110	<.18	E,n 4.6	13.9
D6	3/19/2007	1100	E,n 2.4	<120	<.96	4,650	<.010	3.5	8.1	67.3	<.8	16,800	<.48	E,n 2.9	173
D6	6/21/2007	0945	E,n 2.8	<90	<1.20	4,230	<.010	3.5	9.1	62.9	<1.0	16,700	<.60	E,n 3.5	173
D6	9/5/2007	1000	<10.0	<120	<3.00	3,900	<.010	3.9	10.6	61.8	<2.5	17,300	<1.5	<15.0	179
D6	11/19/2007	0945	<8.0	<120	<.64	4,690	<.010	3.9	10.2	74.4	<.8	18,100	<.48	<14.4	200
D6	3/26/2008	1045	<8.0	<120	<.64	4,460	<.010	3.6	11.0	57.1	<.8	17,900	<.48	<14.4	167
D6	6/23/2008	1545	<7.0	<80	<.56	4,590	<.010	4.1	13.7	61.8	<.7	17,600	<.42	<12.6	187
D6	9/18/2008	1045	<10.0	<80	<.80	4,190	<.010	3.2	14.3	60.6	<1.0	17,500	<.60	<18.0	196
D6	11/19/2008	1100	<10.0	<40	<.60	3,940	<.010	3.4	11.5	65.1	E,n .1	17,000	<.20	<16.0	179

Table 10. Water-quality data for groundwater samples collected at U.S. Geological Survey monitoring wells near Deer Trail, Colorado, 2007 and 2008.—Continued

[°C, degrees Celsius; mg/L, milligrams per liter; µS/cm, microsiemens per centimeter at 25 degrees Celsius; $CaCO_3$, calcium carbonate; SiO_2, silicon dioxide; N, nitrogen; µg/L micrograms per liter; E, value estimated by laboratory; --, no data available; n, value is less than the minimum reporting level; <, less than; M, presence verified at very small concentration that could not be quantified]

Well name	Sample date	Sample time (hhmm)	Copper, dissolved (µg/L)	Iron, dissolved (µg/L)	Lead, dissolved (µg/L)	Manganese, dissolved (µg/L)	Mercury, dissolved (µg/L)	Molybdenum, dissolved (µg/L)	Nickel, dissolved (µg/L)	Selenium, dissolved (µg/L)	Silver, dissolved (µg/L)	Strontium, dissolved (µg/L)	Tungsten, dissolved (µg/L)	Zinc, dissolved (µg/L)	Uranium, dissolved (µg/L)
D6A	11/19/2007	1230	2.8	<120	<0.64	5,060	<0.010	4.1	13.3	56.9	<0.8	17,100	<0.48	<14.4	210
D6A	9/18/2008	1300	<8.0	<80	<.64	4,140	<.010	3.5	14.9	64.6	<.8	17,100	<.48	<14.4	196
D7	9/23/2008	1245	<1.0	<16	<.08	598	<.010	1.0	3.4	5.4	<.1	1,810	<.06	<1.8	24.2
D8	9/25/2008	1520	<2.0	<24	<.16	3,600	<.010	4.5	8.4	.20	<.2	3,500	<.12	<3.6	17.8
D10	11/18/2007	1300	E,n 1.9	<24	<.24	<.6	<.010	2.4	1.1	14	<.3	7,280	<.18	E,n 2.9	27.9
D13	9/29/2008	1520	<1.0	17	<.08	96.6	<.010	1.2	1.0	.12	<.1	778	<.06	<1.8	4.46
D14	9/26/2008	1325	<1.0	<8	<.08	196	<.010	3.3	1.4	16.7	<.1	437	<.06	<1.8	9.22
D15	9/25/2008	1245	<2.0	3,500	E,n .10	6,220	<.010	4.7	12.7	.21	<.2	5,820	<.12	E,n 2.8	28.7
D16	9/26/2008	1100	<2.0	3,330	<.16	2,880	<.010	6.4	8.4	.14	<.2	4,420	<.12	<3.6	26.7
D17	3/19/2007	1440	<.40	<6	<.12	256	<.010	6.3	.55	7.8	<.1	302	<.06	<.60	3.73
D17	6/19/2007	0930	<.40	<6	<.12	342	<.010	5.8	.61	7.5	<.1	297	<.06	<.60	4.11
D17	9/5/2007	1400	E,n .21	<6	<.12	359	<.010	5.6	.82	7.3	<.1	314	<.06	<.60	3.95
D17	11/20/2007	1430	<2.0	<8	<.16	349	<.010	5.5	.82	7.2	<.2	314	<.12	<1.8	3.93
D17	3/25/2008	1530	<1.0	<8	<.08	192	<.010	5.3	.66	7.4	<.1	314	<.06	<1.8	3.68
D17	6/25/2008	1000	<1.0	<8	<.08	243	<.010	5.5	.88	7.6	<.1	306	<.06	<1.8	4.28
D17	9/19/2008	0930	<1.0	<8	<.08	309	<.010	5.5	.78	8.8	<.1	319	<.06	<1.8	4.07
D17	11/18/2008	1430	<1.0	E,n 2	<.06	355	<.010	5.6	.88	7.7	<.008	308	<.02	<2.0	3.97
D19	9/19/2008	1115	<1.0	<8	<.08	<.2	<.010	1.7	.55	8.8	<.1	195	<.06	<1.8	2.05
D20	9/29/2008	1240	<5.0	<16	<.40	644	<.010	4.3	6.0	E,n .15	<.5	1,860	<.30	<9.0	6.99
D21	9/29/2008	1030	<1.0	17,700	<.08	3,710	<.010	4.0	.95	.19	<.1	2,130	<.06	<1.8	.34
D22	9/24/2008	1225	<5.0	74	<.40	1,540	<.010	2.1	10.9	2.3	<.5	8,850	<.30	<9.0	221
D23	9/25/2008	1015	3.4	48	<.16	9,020	<.010	13.3	13.2	3.1	<.2	5,790	<.12	E,n 3.3	92.1
D25	3/20/2007	1445	.98	<18	<.24	1,870	<.010	9.0	3.8	6.7	<.2	3,480	0.2	<1.2	35.7
D25	6/21/2007	1430	E,n 1.1	<18	<.36	2,340	<.010	10.0	4.3	7.5	<.3	3,660	<.18	<1.8	39.0
D25	9/5/2007	1645	1.3	E,n 4	<.36	2,580	<.010	11.7	6.6	7.9	<.3	3,560	<.18	<1.8	41.3
D25	11/20/2007	1600	<5.0	<24	<.40	2,640	<.010	7.0	4.8	1.7	<.5	3,460	<.30	<9.0	28.4
D25	3/26/2008	1350	<2.0	<24	<.16	2,610	<.010	6.1	6.1	.97	<.2	3,480	<.12	<3.6	26.9
D25	6/25/2008	1215	<2.0	<24	<.16	2,950	<.010	6.9	7.2	1.9	<.2	3,820	<.12	<3.6	31.2
D25	9/16/2008	1315	<5.0	<24	<.40	2,410	<.010	10.2	13.6	4.2	<.5	3,350	<.30	<9.0	40.8
D25	11/19/2008	1515	<3.0	<12	<.18	3,050	<.010	7.3	7.5	.75	<.024	3,370	<.06	<6.0	30.7
D25A	3/26/2008	1530	<2.0	266	<.16	3,430	<.010	5.2	6.0	.24	<.2	3,340	<.12	<3.6	23.1
D26	9/16/2008	1040	E,n .60	<8	<.08	.9	<.010	2.5	.82	7.1	<.1	568	<.06	<1.8	14.1
D27	9/23/2008	1015	<2.0	<16	<.16	6.4	<.010	1.0	3.4	2.4	<.2	2,030	<.12	<3.6	19.4
D28	9/23/2008	1445	E,n 1.1	<16	<.16	10.0	<.010	.8	2.8	16.8	<.2	2,440	<.12	<3.6	17.2
D31	11/19/2008	1330	<5.0	<16	<.30	270	<.010	3.8	6.3	1.9	M	9,260	<.10	<10.0	52.4
D32	12/20/2007	1120	<3	E,n 9.9	E,n .13	E,n .43	<.010	1.1	4.1	16.0	<.3	6,290	<.18	<5.4	34.7
D33	11/18/2007	1500	<3.0	<24	<.08	1.9	<.010	1.3	1.0	106	<.3	5,410	<.18	E,n 1.1	11.4

[1]Inflection-point titration done in Denver within 24 hours of sample collection.

Table 11. Quality-control data for blank samples associated with groundwater samples collected near Deer Trail, Colorado, 2007 and 2008.

[Site name refers to site where sample was processed or, for equipment blank, site where equipment was last used; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; SiO_2, silicon dioxide; N, nitrogen; ºC, degrees Celsius; µg/L, micrograms per liter; F, field blank; <, less than; E, value estimated by laboratory; n, value is less than the minimum reporting level; Q, equipment blank; S, source-water blank; --, no sample submitted; M, presence of material verified but not quantified]

Blank type	Sample date	Sample time (hhmm)	Site name	Specific conductance, laboratory (µS/cm)	pH, laboratory (standard units)	Calcium, dissolved (mg/L)	Magnesium, dissolved (mg/L)	Potassium, dissolved (mg/L)	Sodium, dissolved (mg/L)	Acid neutralizing capacity, titration to pH 4.5 laboratory, (mg/L as $CaCO_3$)	Chloride, dissolved (mg/L)
F	3/20/2007	0830	DTX2	6	8.4	<0.02	<0.014	<0.04	<0.20	<5	<0.12
Q	6/20/2007	1515	DTX8A	6	8.3	E,n.02	E,n.009	<.04	<.20	<5	<.12
F	6/25/2007	1000	DTX2	3	8.2	<.02	E,n.013	<.04	<.20	<5	<.12
F	9/5/2007	1315	D17	5	6.6	<.02	<.014	<.04	<.20	<5	<.12
F	11/20/2007	1045	DTX2	<3	7.4	<.04	<.020	<.02	<.12	<6	<.12
S[1]	12/26/2007	1350	DTX2	--	5	<.04	<.020	<.02	<.12	--	<.12
F	3/26/2008	1230	D25	<3	8.2	<.04	<.020	<.02	<.12	<6	<.12
Q	6/24/2008	1730	DTX8A	<8	7.6	E,n.02	<.020	<.02	<.12	<6	<.12
Q	6/24/2008	1745	DTX8A	--	--	<.04	<.020	<.02	<.12	--	<.12
S	6/24/2008	1930	DTX8A	--	--	<.04	<.020	<.02	<.12	--	<.12
F	6/24/2008	1245	DTX2	<8	7.6	<.04	<.020	<.02	<.12	E,n3	<.12
F	9/17/2008	0845	DTX1	<8	8.2	<.04	<.020	<.02	<.12	<6	<.12
F	9/26/2008	1059	D16	<8	7.5	.37	.026	<.02	<.12	E,n4	<.12
F	11/18/2008	1345	D17	<5	7.9	<.02	<.012	<.06	<.12	<8	<.12

Table 11. Quality-control data for blank samples associated with groundwater samples collected near Deer Trail, Colorado, 2007 and 2008.—Continued

[Site name refers to site where sample was processed or, for equipment blank, site where equipment was last used; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; SiO_2, silicon dioxide; N, nitrogen; ºC, degrees Celsius; µg/L, micrograms per liter; F, field blank; <, less than; E, value estimated by laboratory; n, value is less than the minimum reporting level; Q, equipment blank; S, source-water blank; --, no sample submitted; M, presence of material verified but not quantified]

Blank type	Sample date	Fluoride, dissolved (mg/L)	Silica, dissolved (mg/L as SiO_2)	Sulfate, dissolved (mg/L)	Nitrogen, ammonia plus organic, dissolved (mg/L as N)	Nitrogen, ammonia plus organic, total (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrite plus nitrate, dissolved (mg/L as N)	Phosphorus, dissolved (mg/L)	Phosphorus total (mg/L)	Solids, residue on evaporation at 180°C, dissolved (mg/L)	Aluminum, dissolved (µg/L)
F	3/20/2007	<0.10	<0.02	<0.18	<0.10	<0.10	<0.040	<0.04	<0.04	<0.04	<10	<1.6
Q	6/20/2007	E,n.06	<.02	<.18	<.10	<.10	<.040	<.04	<.04	<.04	<10	E,n1.2
F	6/25/2007	<.10	E,n.01	<.18	E,n.08	<.10	<.040	<.04	<.04	<.04	<10	<1.6
F	9/5/2007	<.10	<.02	<.18	<.10	<.10	<.040	<.04	<.04	<.04	<10	<1.6
F	11/20/2007	<.12	<.02	<.18	<.14	<.14	<.040	<.04	<.04	<.04	<10	<3.2
S[1]	12/26/2007	<.12	<.02	<.18	--	--	--	--	--	--	--	<1.6
F	3/26/2008	<.12	<.02	<.18	<.14	<.14	<.040	<.04	<.04	<.04	<10	<1.6
Q	6/24/2008	<.12	<.02	<.18	<.14	<.14	<.040	<.04	<.04	<.04	<10	E,n1.0
Q	6/24/2008	<.12	<.02	<.18	--	--	--	--	--	--	<10	3.3
S	6/24/2008	<.12	<.02	<.18	--	--	--	--	--	--	<10	<1.6
F	6/24/2008	<.12	<.02	<.18	<.14	<.14	<.040	<.04	<.04	<.04	<10	<1.6
F	9/17/2008	<.12	<.02	<.18	<.14	<.14	<.040	<.04	<.04	<.04	<10	<1.6
F	9/26/2008	<.12	E,n.02	<.18	<.14	<.14	<.040	<.04	<.04	<.04	<10	1.6
F	11/18/2008	<.08	<.02	<.18	<.10	<.10	<.040	E,n.02	<.04	<.04	<10	<4.0

Table 11. Quality-control data for blank samples associated with groundwater samples collected near Deer Trail, Colorado 2007 and 2008.—Continued

[Site name refers to site where sample was processed or, for equipment blank, site where equipment was last used; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; SiO_2, silicon dioxide; N, nitrogen; ºC, degrees Celsius; µg/L, micrograms per liter; F, field blank; <, less than; E, value estimated by laboratory; n, value is less than the minimum reporting level; Q, equipment blank; S, source-water blank; --, no sample submitted; M, presence of material verified but not quantified]

Blank type	Sample date	Antimony, dissolved (µg/L)	Arsenic, dissolved (µg/L)	Barium, dissolved (µg/L)	Beryllium, dissolved (µg/L)	Boron, dissolved (µg/L)	Bromide, dissolved (µg/L)	Cadmium, dissolved (µg/L)	Chromium, dissolved (µg/L)	Cobalt, dissolved (µg/L)	Copper, dissolved (µg/L)	Iron, dissolved (µg/L)
F	3/20/2007	<0.06	<0.12	<0.08	<0.06	<1.8	<0.02	<0.04	<0.12	<0.04	<0.40	<6
Q	6/20/2007	<.06	<.12	M	<.06	<1.8	<.02	<.04	<.12	<.04	E,n.29	<6
F	6/25/2007	<.06	<.12	<.08	<.06	<1.8	<.02	<.04	<.12	<.04	<.40	<6
F	9/5/2007	<.06	<.12	<.08	<.06	<1.8	<.02	<.04	<.12	<.04	<.40	<6
F	11/20/2007	<.28	<.12	<.8	<.02	<1.2	<.02	<.08	<.24	<.04	<2.0	<8
S[1]	12/26/2007	<.14	<.06	<.4	<.01	<1.2	<.02	<.04	<.12	<.02	<1.0	<8
F	3/26/2008	<.14	<.06	<.4	<.01	<1.2	<.02	<.04	<.12	<.02	<1.0	<8
Q	6/24/2008	<.14	<.06	<.4	<.01	2.3	<.02	<.04	<.12	.08	1.1	<8
Q	6/24/2008	<.14	<.06	<.4	<.01	4.1	--	<.04	<.12	.03	<1.0	<8
S	6/24/2008	<.14	<.06	<.4	<.01	E,n1.1	--	<.04	<.12	<.02	<1.0	<8
F	6/24/2008	<.14	<.06	<.4	<.01	<1.2	<.02	<.04	<.12	<.02	<1.0	<8
F	9/17/2008	<.14	<.06	<.4	<.01	<1.2	<.02	<.04	<.12	<.02	<1.0	<8
F	9/26/2008	<.14	<.06	<.4	<.01	<1.2	<.02	<.04	<.12	<.02	E,n.75	<8
F	11/18/2008	<.04	<.06	<.4	<.02	<2.0	<.02	<.02	<.12	<.02	<1.0	<4

Table 11. Quality-control data for blank samples associated with groundwater samples collected near Deer Trail, Colorado, 2007 and 2008.—Continued

[Site name refers to site where sample was processed or, for equipment blank, site where equipment was last used; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; $CaCO_3$, calcium carbonate; SiO_2, silicon dioxide; N, nitrogen; ºC, degrees Celsius; µg/L, micrograms per liter; F, field blank; <, less than; E, value estimated by laboratory; n, value is less than the minimum reporting level; Q, equipment blank; S, source-water blank; --, no sample submitted; M, presence of material verified but not quantified]

Blank type	Sample date	Lead, dissolved (µg/L)	Manganese, dissolved (µg/L)	Mercury, dissolved (µg/L)	Molybdenum, dissolved (µg/L)	Nickel, dissolved (µg/L)	Selenium, dissolved (µg/L)	Silver, dissolved (µg/L)	Strontium, dissolved (µg/L)	Tungsten, dissolved (µg/L)	Zinc, dissolved (µg/L)	Uranium, dissolved (µg/L)
F	3/20/2007	<0.12	<0.2	<0.010	<0.1	<0.06	<0.08	<0.1	<0.6	<0.06	<0.60	<0.04
Q	6/20/2007	<.12	<.2	<.010	<.1	E,n.04	<.08	<.1	<.6	<.06	<.60	<.04
F	6/25/2007	<.12	E,n.2	<.010	<.1	<.06	<.08	<.1	<.6	<.06	<.60	<.04
F	9/5/2007	<.12	<.2	<.010	<.1	<.06	<.08	<.1	<.6	<.06	<.60	<.04
F	11/20/2007	<.16	<.4	<.010	<.4	<.40	<.08	<.2	<.4	<.12	<3.6	<.04
S[1]	12/26/2007	<.08	<.2	<.010	<.2	<.20	<.04	<.1	<.4	E,n.03	<1.8	<.02
F	3/26/2008	<.08	<.2	<.010	<.2	<.20	<.04	<.1	<.4	<.06	<1.8	<.02
Q	6/24/2008	.10	<.2	<.010	<.2	.31	<.04	<.1	<.4	<.06	3.6	<.02
Q	6/24/2008	<.08	<.2	<.010	<.2	<.20	<.04	.4	<.4	<.06	<1.8	<.02
S	6/24/2008	<.08	<.2	<.010	<.2	<.20	<.04	<.1	<.4	<.06	<1.8	<.02
F	6/24/2008	<.08	<.2	<.010	<.2	<.20	<.04	<.1	<.4	<.06	<1.8	<.02
F	9/17/2008	<.08	<.2	<.010	<.2	<.20	<.04	<.1	<.4	<.06	<1.8	<.02
F	9/26/2008	E,n.04	1.5	<.010	<.2	.27	<.04	<.1	2.0	<.06	3.0	<.02
F	11/18/2008	<.06	<.2	<.010	<.02	<.12	<.06	<.008	<.4	<.02	<2.0	<.01

[1]Deionized water used to clean equipment

Table 12. Comparison of water-quality data for groundwater and replicate samples collected near Deer Trail, Colorado, 2007 and 2008.

[RPD, relative percent difference, which is defined as [(sample value - replicate value)/[(sample value + replicate value)/2]] x 100; µS/cm, microsiemens per centimeter; ºC, degrees Celsius; mg/L, milligrams per liter; E, value estimated by laboratory; $CaCO_3$, calcium carbonate; SiO_2, silicon dioxide; N, nitrogen; n, value less than the minimum reporting level; <, less than; ND, not determined because data were less than the minimum reporting level: µg/L, micrograms per liter]

Well name	D6			D6			D6			D6		
Sample date	3/19/2007			6/21/2007			9/5/2007			11/19/2007		
Property or constituent	Sample	Replicate	RPD	Sample	Replicate	RPD	Sample	Replicate	RPD	Sample	Replicate	RPD
pH, laboratory (standard units)	7.2	7.2	0	7.2	7.2	0	7.2	7.2	0	7.3	7.3	0
Specific conductance, lab (µS/cm at 25°C)	E 17,600	E 17,500	1	E 17,600	E 17,700	-1	E 17,700	E 17,600	1	E 17,300	E 17,300	0
Calcium, dissolved (mg/L)	436	412	6	424	417	2	436	457	-5	458	439	4
Magnesium, dissolved (mg/L)	2,460	2,350	5	2,350	2,310	2	2,430	2,540	-4	2,450	2,400	2
Potassium, dissolved (mg/L)	14.7	14.1	4	14.6	13.7	6	13.5	14.6	-8	14.5	14.2	2
Sodium, dissolved (mg/L)	2,300	2,420	-5	2,330	2,310	1	2,280	2,360	-3	2,360	2,270	4
Acid neutralizing capacity, titration to pH 4.5, lab (mg/L as $CaCO_3$)	649	648	<1	648	648	0	650	650	0	650	649	<1
Bromide, dissolved (mg/L)	4.60	4.53	2	4.49	4.35	3	4.42	4.21	5	4.45	4.46	<1
Chloride, dissolved (mg/L)	387	388	<1	387	388	<1	390	392	-1	385	393	-2
Fluoride, dissolved (mg/L)	1.20	1.20	0	1.23	1.28	-4	1.13	1.13	0	1.16	1.16	0
Silica, dissolved (mg/L as SiO_2)	21.6	19.8	9	20.8	20.7	<1	20.9	20.9	0	21.8	21.7	<1
Sulfate, dissolved (mg/L)	13,500	13,600	-1	13,400	13,600	-1	13,700	13,700	0	14,000	14,100	-1
Solids, residue on evaporation at 180°C, dissolved (mg/L)	22,800	22,900	<1	21,400	21,300	<1	21,400	22,500	-5	22,500	22,900	-2
Nitrogen ammonia plus organic, dissolved (mg/L as N)	1.5	1.6	-6	1.6	1.5	6	1.6	1.5	6	1.6	1.6	0
Nitrogen ammonia plus organic, total (mg/L as N)	1.7	1.7	0	1.6	1.6	0	1.7	1.6	6	1.6	1.6	0
Nitrogen ammonia, dissolved (mg/L as N)	0.123	0.132	-7	0.076	0.081	-6	0.079	0.079	0	0.068	0.065	5
Nitrite plus nitrate, dissolved (mg/L as N)	40.6	40.8	<1	41.6	43.0	-3	42.3	43.4	-3	41.5	43.4	-4
Phosphorus, dissolved (mg/L)	E,n 0.02	< .04	ND	0.04	E,n 0.04	0	E,n 0.03	E,n 0.03	0	E,n 0.04	E,n 0.03	29
Phosphorus, total (mg/L)	0.04	0.04	0	0.04	E,n 0.04	0	0.04	E,n 0.03	29	E,n 0.04	E,n 0.04	0
Aluminum, dissolved (µg/L)	< 12.8	12.4	ND	< 16.0	< 16.0	ND	< 16.0	< 40.0	ND	< 12.8	< 12.8	ND
Antimony, dissolved (µg/L)	E,n 0.40	< 0.42	ND	< 0.60	E,n 0.40	ND	< 1.50	< 1.50	ND	< 1.12	< 1.12	ND
Arsenic, dissolved (µg/L)	1.2	1.2	0	1.2	E,n 1.1	9	E,n 1.8	< 3.0	ND	1.2	1.2	0
Barium, dissolved (µg/L)	5	5	0	6	7	-15	6	6	0	6	6	0
Beryllium, dissolved (µg/L)	< 0.48	< 0.42	ND	< 0.60	< 0.60	ND	< 1.50	< 1.50	ND	< 0.06	< 0.06	ND
Boron, dissolved (µg/L)	792	774	2	809	802	1	848	854	-1	855	853	<1
Cadmium, dissolved (µg/L)	< 0.32	< 0.28	ND	< 0.40	< 0.40	ND	< 1.00	< 1.00	ND	< 0.32	< 0.32	ND
Chromium, dissolved (µg/L)	< 0.96	< 0.84	ND	< 1.2	< 1.2	ND	< 3.0	< 3.0	ND	< 0.96	< 0.96	ND
Cobalt, dissolved (µg/L)	6.8	7.0	-3	6.7	6.5	3	7.9	7.7	2	7.1	7.0	2
Copper, dissolved (µg/L)	E,n 2.4	2.3	3	E,n 2.8	E,n 3.1	-9	< 10.0	< 10.0	ND	< 8.0	< 8.0	ND
Iron, dissolved (µg/L)	< 120	< 120	ND	< 90	< 90	ND	< 120	< 120	ND	< 120	< 120	ND
Lead, dissolved (µg/L)	< 0.96	< 0.24	ND	< 1.20	< 1.20	ND	< 3.00	< 3.00	ND	< 0.64	< 0.64	ND
Manganese, dissolved (µg/L)	4,650	4,110	12	4,230	3,880	9	3,900	4,440	-13	4,690	4,530	3
Mercury, dissolved (µg/L)	< 0.010	< 0.010	ND	< 0.010	< 0.010	ND	< 0.010	< 0.010	ND	< 0.010	< 0.010	ND
Molybdenum, dissolved (µg/L)	3.5	3.6	-3	3.5	3.5	0	3.9	4.0	-3	3.9	4.0	-3
Nickel, dissolved (µg/L)	8.1	8.2	-1	9.1	8.5	7	10.6	11.8	-11	10.2	12.8	-23
Selenium, dissolved (µg/L)	67.3	68.9	-2	62.9	63.6	-1	61.8	61.0	1	74.4	66.0	12
Silver, dissolved (µg/L)	< 0.8	< 0.7	ND	< 1.0	< 1.0	ND	< 2.5	< 2.5	ND	< 0.8	< 0.8	ND
Strontium, dissolved (µg/L)	16,800	16,500	2	16,700	16,600	1	17,300	17,800	-3	18,100	17,400	4
Tungsten, dissolved (µg/L)	< 0.48	< 0.1	ND	< 0.60	< 0.60	ND	< 1.5	< 1.5	ND	< 0.48	< 0.48	ND
Zinc, dissolved (µg/L)	E,n 2.9	< 4.2	ND	E,n 3.5	E,n 3.3	6	< 15.0	< 15.0	ND	< 14.4	< 14.4	ND
Uranium, natural, dissolved (µg/L)	173	181	-5	173	174	-1	179	185	-3	200	198	1

Table 12. Comparison of water-quality data for groundwater and replicate samples collected near Deer Trail, Colorado, 2007 and 2008.—Continued

[RPD, relative percent difference, which is defined as [(sample value - replicate value)/[(sample value + replicate value)/2]] x 100; µS/cm, microsiemens per centimeter; ºC, degrees Celsius; µg/L, milligrams per liter; E, value estimated by laboratory; $CaCO_3$, calcium carbonate; SiO_2, silicon dioxide; N, nitrogen; n, value less than the minimum reporting level; <, less than; ND, not determined because data were less than the minimum reporting level; µg/L, micrograms per liter]

Well name	D6			D6			D6			D6		
Sample date	3/26/2008			6/23/2008			9/18/2008			11/19/2008		
Property or constituent	Sample	Replicate	RPD	Sample	Replicate	RPD	Sample	Replicate	RPD	Sample	Replicate	RPD
pH, laboratory (standard units)	7.3	7.3	0	7.2	7.2	0	7.3	7.3	0	7.2	7.2	0
Specific conductance, lab (µS/cm at 25°C)	E 17,500	E 17,600	-1	E 17,400	E 17,300	1	E 17,600	E 17,600	0	E 17,500	E 17,600	-1
Calcium, dissolved (mg/L)	453	453	0	438	433	1	437	428	2	443	443	0
Magnesium, dissolved (mg/L)	2,450	2,520	-3	2,270	2,340	-3	2,160	2,130	1	2,490	2,490	0
Potassium, dissolved (mg/L)	15.1	15.3	-1	14.2	13.8	3	14.8	14.9	-1	14.8	14.8	0
Sodium, dissolved (mg/L)	2,300	2,320	-1	2,160	2,160	0	2,410	2,340	3	2,350	2,350	0
Acid neutralizing capacity, titration to pH 4.5, lab (mg/L as $CaCO_3$)	650	650	0	654	654	0	648	648	0	650	650	0
Bromide, dissolved (mg/L)	4.37	4.38	<1	4.26	4.22	1	4.30	4.31	<1	4.27	4.24	1
Chloride, dissolved (mg/L)	382	383	<1	381	381	0	372	371	<1	368	371	-1
Fluoride, dissolved (mg/L)	1.28	1.30	-2	1.18	1.18	0	1.24	1.23	1	1.22	1.21	1
Silica, dissolved (mg/L as SiO_2)	21.4	21.2	1	19.4	19.3	1	18.1	18.1	0	20.8	21.1	-1
Sulfate, dissolved (mg/L)	13,800	13,900	-1	13,800	13,800	0	13,900	13,800	1	13,800	13,700	1
Solids, residue on evaporation at 180°C, dissolved (mg/L)	22,500	22,400	<1	22,600	22,800	-1	22,700	22,700	0	22,000	22,400	-2
Nitrogen ammonia plus organic, dissolved (mg/L as N)	1.5	1.5	0	1.7	1.6	6	1.5	1.5	0	1.6	1.5	6
Nitrogen ammonia plus organic, total (mg/L as N)	1.6	1.6	0	1.5	1.6	-6	1.7	1.7	0	1.6	1.6	0
Nitrogen ammonia, dissolved (mg/L as N)	0.086	0.086	0	0.080	0.080	0	0.072	0.074	-3	< 1.00	< 1.00	ND
Nitrite plus nitrate, dissolved (mg/L as N)	38.8	40.0	-3	39.4	39.3	<1	41.4	41.4	0	40.4	42.5	-5
Phosphorus, dissolved (mg/L)	0.04	E,n 0.04	0	0.04	E,n 0.04	0	E,n 0.03	E,n 0.03	0	E,n 0.04	0.04	0
Phosphorus, total (mg/L)	E,n 0.03	E,n 0.03	0	E,n 0.04	0.04	0	E,n 0.03	E,n 0.04	-29	E,n 0.04	E,n 0.03	29
Aluminum, dissolved (µg/L)	< 12.8	E,n 8.9	ND	< 11.2	< 11.2	ND	< 16.0	< 16.0	ND	< 40.0	< 40.0	ND
Antimony, dissolved (µg/L)	< 1.12	< 1.12	ND	< 0.98	< 0.98	ND	< 1.40	< 1.40	ND	E,n 0.40	0.50	-22
Arsenic, dissolved (µg/L)	1.5	1.5	0	1.6	1.5	6	1.2	1.3	-8	1.3	1.4	-7
Barium, dissolved (µg/L)	6	6	0	6	6	0	5	5	0	5	6	-18
Beryllium, dissolved (µg/L)	< 0.06	< 0.06	ND	< 0.06	< 0.06	ND	< 0.08	< 0.08	ND	< 0.20	< 0.20	ND
Boron, dissolved (µg/L)	871	876	-1	760	767	-1	708	714	-1	707	715	-1
Cadmium, dissolved (µg/L)	< 0.32	< 0.32	ND	E,n 0.14	< 0.28	ND	< 0.40	< 0.40	ND	< 0.20	E,n 0.14	ND
Chromium, dissolved (µg/L)	< 0.96	< 0.96	ND	< 0.84	< 0.84	ND	< 1.2	< 1.2	ND	< 1.2	< 1.2	ND
Cobalt, dissolved (µg/L)	7.4	7.0	5	8.0	8.1	-1	7.4	7.2	3	7.2	7.2	0
Copper, dissolved (µg/L)	< 8.0	< 8.0	ND	< 7.0	< 7.0	ND	< 10.0	< 10.0	ND	< 10.0	< 10.0	ND
Iron, dissolved (µg/L)	< 120	< 120	ND	< 80	< 80	ND	< 80	< 80	ND	< 40	< 40	ND
Lead, dissolved (µg/L)	< 0.64	E,n 0.48	ND	< 0.56	< 0.56	ND	< 0.80	< 0.80	ND	< 0.60	E,n 0.30	ND
Manganese, dissolved (µg/L)	4,460	4,320	3	4,590	4,570	<1	4,190	4,200	<1	3,940	4,000	-2
Mercury, dissolved (µg/L)	< 0.010	< 0.010	ND	< 0.010	< 0.010	ND	< 0.010	< 0.010	ND	< 0.010	< 0.010	ND
Molybdenum, dissolved (µg/L)	3.6	3.4	5	4.1	4.1	0	3.2	3.4	-6	3.4	3.5	-3
Nickel, dissolved (µg/L)	11	10.8	2	13.7	13.1	4	14.3	13.8	4	11.5	11.6	-1
Selenium, dissolved (µg/L)	57.1	55.0	4	61.8	64.6	-4	60.6	61.0	-1	65.1	65.6	-1
Silver, dissolved (µg/L)	< 0.8	< 0.8	ND	< 0.7	< 0.7	ND	< 1.0	< 1.0	ND	E 0.1	E 0.1	0
Strontium, dissolved (µg/L)	17,900	18,100	-1	17,600	17,600	0	17,500	16,900	3	17,000	17,100	-1
Tungsten, dissolved (µg/L)	< 0.48	< 0.48	ND	< 0.42	< 0.42	ND	< 0.60	< 0.60	ND	< 0.20	< 0.20	ND
Zinc, dissolved (µg/L)	< 14.4	< 14.4	ND	< 12.6	< 12.6	ND	< 18.0	< 18	ND	< 16.0	< 16	ND
Uranium, natural, dissolved (µg/L)	167	164	2	187	192	-3	196	194	1	179	181	-1

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