



Water Quality Monitoring for the Rito de los Frijoles and Capulin Creek in Bandelier National Monument

2011 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2013/566



ON THE COVER
Capulin Creek, Bandelier NM
Photograph by SCPN

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1 Introduction

The National Park Service Inventory and Monitoring Program was designed to determine the current status and monitor long-term trends in the condition of park natural resources, providing park managers with a scientific foundation for making decisions and working with other agencies and the public to protect park ecosystems. Hydrologic vital signs are the fundamental components defining overall riparian and aquatic ecosystem integrity. The Southern Colorado Plateau Network (SCPN) has identified seven vital signs pertaining to riparian and spring ecosystems: 1) stream water quality, 2) aquatic macroinvertebrates, 3) stream flow and depth to groundwater, 4) spring water quality, 5) fluvial geomorphology, 6) riparian vegetation, composition, and structure, and 7) spring ecosystems. These vital signs are closely related and are all included in the Vital Signs Monitoring Plan for the Southern Colorado Plateau Network (Thomas et al. 2006). The context and ecological significance of these vital signs are further explained in Scott et al. (2005). In this report, we focus on stream water quality.

Specific objectives of stream water quality monitoring for the SCPN parks are

- Determine status and trends in selected core water quality parameters (water temperature, pH, specific conductivity, dissolved oxygen, turbidity and discharge) at selected sites in priority streams within SCPN parks.
- Determine status and trends of selected water quality constituents, including bacteria, nutrients, major elements, and trace metals at selected sites in priority streams within SCPN parks.
- Compare water quality data against state standards for chronic exceedances. Multiple exceedances in a year typically indicate noncompliance.

1.1 Selecting potential water quality monitoring sites

We targeted SCPN streams and springs with potential for water quality monitoring by reviewing (1) water quality data inventory and analysis reports prepared by the Water Resources Division (WRD) of the National Park Service (NPS), (2) a USGS summary and review of available water quality data from streams in SCPN parks (Brown 2008), (3) data collected during a Level 1 water quality inventory of streams in SCPN parks (Macy and Monroe 2006), and (4) results of water quality planning meetings with park staff.

SCPN water bodies were selected for water quality monitoring based on the following criteria:

- 303(d) listed waters¹ - where previous sampling indicates one or more parameters regularly approach or exceed established water quality standards or recommended levels
- waters with demonstrated threat levels – where an analysis of existing data indicate that measured conditions regularly approach or exceed standards or recommended levels, but where the frequency of exceedances or the quality of the database do not support a 303(d) listing
- pristine waters – where there is no direct impact of human activities (provides baseline data)
- ecological significance – presence of unique species or species of concern
- waters of management concern – where past sampling may not indicate constituent values of concern, but where anthropogenic activities indicate that contamination is a significant threat
- historic data – waters identified as important, for which substantial historic water quality data is available
- data gaps – waters identified as important, but where little or no water quality information exists

Water quality monitoring sites are located where a history of water quality data collection exists, and are co-located with SCPN aquatic macroinvertebrate monitoring sites whenever possible. NPS core water quality data and water quality samples are collected at regular intervals throughout the year. Diurnal variation in NPS core water quality parameters are characterized by deploying a multiparameter sonde to collect data for as many

¹ Under section 303(d) of the Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters— waters that are too polluted or otherwise degraded to meet the water quality standards set by states, territories, or authorized tribes (EPA 2011).

days as possible during base flows. Water quality samples are analyzed by SCPN staff and by a qualified contract laboratory.

1.2 Water quality monitoring at Bandelier National Monument

The Rito de los Frijoles is a perennial stream flowing eastward from the Sierra de los Valles of the Jemez Mountains into the Rio Grande. The entire length of this stream lies within the boundaries of Bandelier National Monument (BAND) and much of its watershed is designated wilderness. The watershed is bordered by lands administered by Los Alamos National Laboratory, Valles Caldera National Preserve, and Santa Fe National Forest. The monument's visitor center and numerous archeological sites are located in the lower portion of the watershed, resulting in high levels of visitor use of the riparian area around the stream. In recent years several fires have affected areas in and around this watershed. In 1977 the La Mesa Fire burned about 58% of the Frijoles watershed (Vieira et al 2004); in 2000, the Cerro Grande fire ignited in the upper portion of the watershed, and in June 2011 the Las Conchas Fire severely burned about 35% of Frijoles Canyon. An intense thunderstorm on August 21, 2011 caused a large flood event which deposited massive amounts of sediment and debris into the stream channel and on the floodplain. Water quality concerns in this stream include fecal coliform bacteria, turbidity and radium. Because of these concerns, and additional issues, such as elevated temperatures, DDT in fish tissue, and high aluminum concentrations, the stream has been included on New Mexico's 303(d) list of impaired surface waters since 1998 (New Mexico Environment Department, Surface Water Quality Board (NMED SWQB 1998–2012)).

Capulin Creek is a perennial stream that flows through the southwestern portion of BAND and joins the Rio Grande approximately 8 km south of the Rito de los Frijoles. The upper portion of its watershed lies within the Santa Fe National Forest, while the remainder lies within BAND. Most of the watershed is a designated wilderness area, managed for recreational use within park boundaries. The U.S. Forest Service manages land in the upper reaches of the watershed for recreation and timber harvest. In 1996 the Dome Fire burned approximately 90% of the Capulin watershed (Vieira et al 2004), and in 2011 approximately 32% of the watershed was burned with moderate or high severity fire during the Las Conchas Fire. A large post-fire flood in August 2011 drastically altered the channel morphology and introduced large amounts of sediment and woody debris into the stream channel and floodplain. Previous water quality data from Capulin Creek and the Rito de los Frijoles are summarized in Brown 2008. Water quality concerns in Capulin Creek are mainly due to fire-effects and silvicultural issues. The stream was included on New Mexico's 303(d) list from 1998 to 2004 because of sediment deposition and elevated turbidity levels (NMED SWQB 1998–2012).

In 2011, SCPN continued water quality monitoring that began in 2010 at five sites on two perennial streams in Bandelier National Monument—the Rito de los Frijoles and Capulin Creek (Figure 1):

- Rito de los Frijoles at Headquarters (BANDRIT01), identified in this report as RIT01, is located adjacent to a streamflow gaging station (Los Alamos National Laboratory LANL-E350, USGS #08313350, Rito de los Frijoles in Bandelier Nat Mon, NM) and is co-located with a SCPN aquatic macroinvertebrate monitoring site. The streamflow gaging station was maintained by Los Alamos National Laboratory until it was destroyed by the August 21, 2011 flood.
- Rito de los Frijoles at Upper Crossing (BANDRIT02), identified in this report as RIT02, is located at the Upper Crossing Trail intersection 9.5 km upstream from RIT01, and is co-located with a SCPN aquatic macroinvertebrate monitoring site.
- Rito de los Frijoles above Wilderness Boundary (BANDRIT03), identified in this report as RIT03, is located approximately 2.8 km upstream from RIT01.
- Capulin Creek at Base Camp Gaging Station (BANDCAP01), identified in this report as CAP01, is located less than 0.3 km upstream from the backcountry ranger cabin at a discontinued U.S. Geological Survey streamflow gaging station (Capulin Canyon at Ranger Cabin, station #083133655). This site is co-located with a SCPN aquatic macroinvertebrate monitoring site.
- Capulin Creek above Painted Cave (BANDCAP02), identified in this report as CAP02, is located 1.8 km up

canyon from the Painted Cave and 2.6 km downstream from CAP01. This site is co-located with a SCPN aquatic macroinvertebrate monitoring site.

During 2011 SCPN staff completed ten site visits to RIT01, seven to RIT02 and RIT03, and four to CAP01. Site visits were spaced as evenly throughout the year as possible, though site visits to RIT03 did not start until May. One site visit to CAP02 occurred in October during aquatic macroinvertebrate sampling and consisted only of water quality core parameter measurements. This report documents and summarizes the water quality monitoring activities that occurred in BAND in 2011, and also includes a summary of core parameter measurements collected at eleven sites along the Rito de los Frijoles from 2006 - 2010. These sites are included in Figure 1.

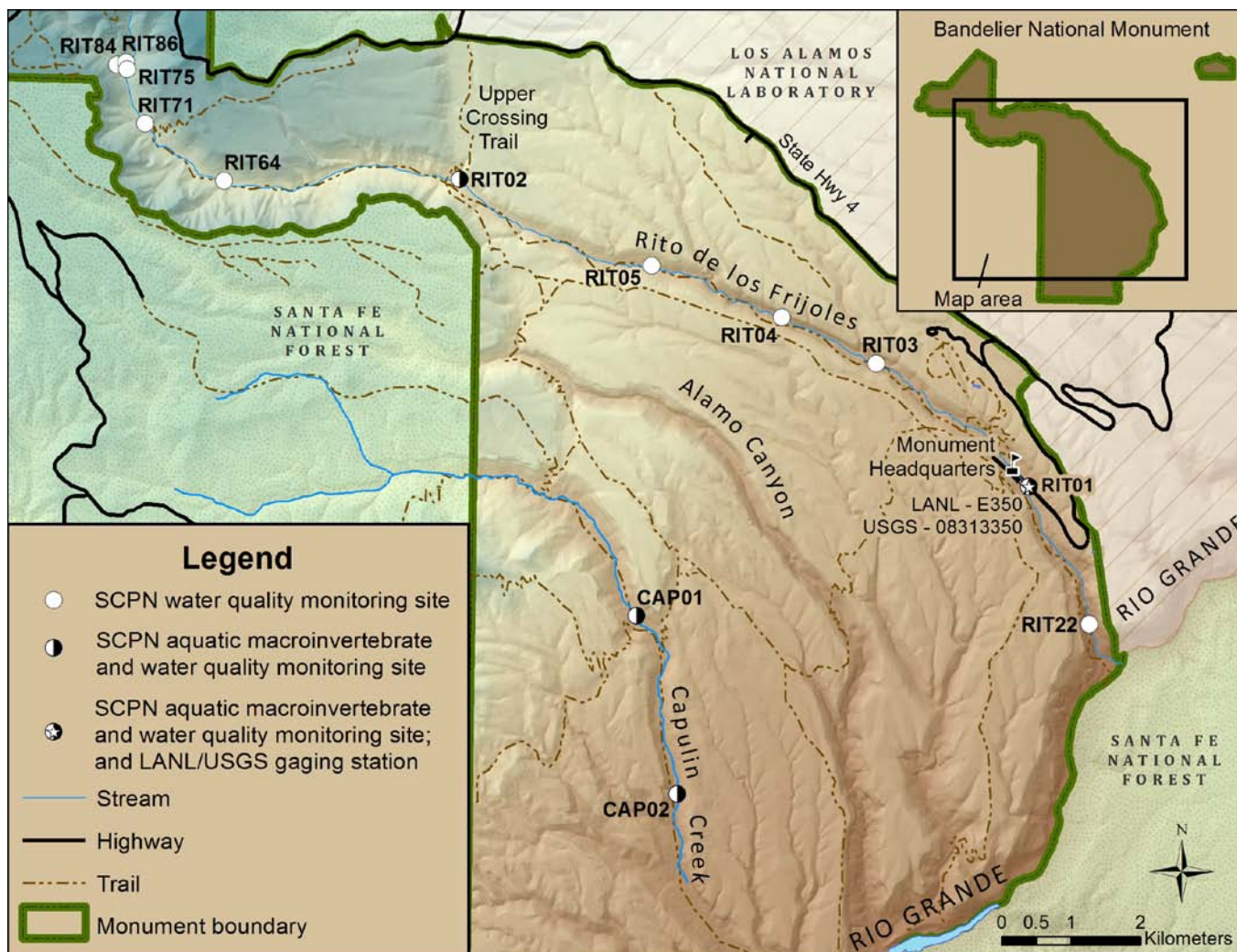


Figure 1. Map of water quality sampling sites on the Rito de los Frijoles and Capulin Creek in Bandelier NM.

2 Methods

A brief description of water quality data collection and processing methods followed by SCPN staff at BAND during 2011 is presented here. Detailed descriptions of these procedures will be available in SCPN's water quality monitoring protocol (Monroe et al. *in preparation*).

2.1 Water quality core parameters

National Park Service core water quality parameters include water temperature, pH, specific conductivity, dissolved oxygen, turbidity, and discharge. During each site visit, we noted the hydrologic conditions and collected water quality core parameter data using the following methods:

- As soon as possible after arrival at the site, a multiparameter sonde (Hydrolab-MS5; Hach Inc.) was calibrated and deployed in a well-mixed part of the stream channel, logging temperature, pH, specific conductivity, and dissolved oxygen data at 5-second intervals. The sonde was left stationary in the stream for the entire site visit.
- Turbidity samples were collected in triplicate, kept on ice, and analyzed with a HACH 2100P Portable Turbidimeter (Hach Inc.) as soon as possible after collection.
- Discharge was measured using either a Pygmy Meter and AquaCalc Pro (Rickly Inc. and JBS Instruments), or a Marsh McBirney Flo-Mate 2000 (Hach Inc.).
- Water and air temperatures were recorded at 15-minute intervals by a HOBO Pendant (Onset Computer Corporation) deployed at the monitoring site. Sensor accuracy was confirmed using a NIST-certified thermometer during each download. Data loggers from all sites were lost in summer floods; however, at RIT01, temperature data were recorded with a multiparameter sonde (Hydrolab MS-5; Hach Inc.) and a pressure transducer (Solinst Levelogger; Solinst Canada Limited) for the remainder of 2011.

We attempted to obtain all measurements and samples as close in time to one another as possible. Streamflow data was recorded at RIT01 by the LANL gage #E350 at 5-minute intervals until August 21, when it was destroyed by a flood. SCPN subsequently installed a pressure transducer (Solinst Levelogger; Solinst Canada Limited) as a temporary replacement, which recorded data from August 27 until December 15.

In addition to the regular site visits, which were generally less than two hours long, at RIT01 we collected temperature, pH, specific conductivity, and dissolved oxygen data at 15-minute intervals from July 13–July 20 to characterize temporal variability of these parameters.

To characterize spatial variability of NPS water quality core parameters on the Rito de los Frijoles, SCPN collected measurements at 11 sites distributed along the entire length of the stream. The objective was to collect all data during a base flow period. In 2006 and 2010 the sites were visited only once. During 2007 each the sites were visited 3 to 5 times.

2.2 Water quality samples

During each site visit, we collected a sample for bacteria analysis by dipping a sample bottle at the center of flow. The sample was then analyzed by SCPN staff for total coliforms and *E. coli* using the Quanti-Tray® 2000 system (IDEXX Inc.). We collected samples for other analytes in a similar manner. The samples were filtered and/or acid-treated (as required), kept on ice, and shipped to the contract laboratory. During 2011, SCPN contracted with the USGS National Water Quality Lab (NWQL) in Denver, Colorado for analyses of selected water quality constituents. These analyses fall into three categories: nutrients, trace metals, and major elements (Table 1). Information documenting NWQL methods are included in the SCPN water quality monitoring protocol (Monroe et al. *in preparation*).

2.2.1 Sampling for special projects.

After the Las Conchas fire, water samples that LANL obtained during a storm event caused concern because of

Table 1. National Water Quality Laboratory and EPA Laboratory sample analytes.

Analytical group	Analytes
Nutrients	ammonia, nitrite, nitrite + nitrate, orthophosphate
Major elements	calcium, chloride, fluoride, magnesium, potassium, silica, sodium, sulfate, acid neutralizing capacity (ANC; as CaCO ₃), total dissolved solids
Trace metals	aluminum, antimony, arsenic, barium, beryllium, boron, cadmium, chromium, cobalt, copper, iron lead, manganese, mercury, molybdenum, nickel, selenium, silver, uranium, vanadium, zinc
Contaminants of emerging concern	pesticides, pharmaceuticals and personal care products, waste indicators
Radionuclides	72-hour and 30-day gross alpha, beta, and gamma; U-234, 235, and 238

elevated alpha radiation levels that exceeded drinking water standards (LANL 2013, NMED 2011a). To further investigate, SCPN conducted one sampling event for radionuclides. Unfiltered water and streambed sediment samples from RIT01 and RIT02 were analyzed by Eberline Services in Richmond, California for gross alpha, beta, and gamma radiation as well as isotopic uranium. Samples were shipped to the lab and analyzed within 72 hours of collection and again after 30 days of collection.

Also in 2011, SCPN partnered with the US Environmental Protection Agency (EPA) to look at “contaminants of emerging concern” in water sources in SCPN parks. The contaminants include pharmaceuticals, personal care products, waste indicators, and pesticides (see Appendix C). The goal was to develop a baseline dataset documenting the occurrence of these contaminants within SCPN parks. We conducted six sampling events at RIT01 and RIT03 from May to October. Samples were kept on ice and sent to the EPA Region 8 Laboratory in Golden, Colorado for analysis within seven days of collection, as required.

2.3 Data handling and analysis

All SCPN water quality data are entered in NPSTORET, v.1.83, a Microsoft Access database created by the Water Resources Division of the National Park Service. All multiparameter sonde and flow meter electronic data files are stored on the SCPN server.

In this report, we only include the median values of a subset of seven consecutive multiparameter sonde measurements taken close in time to sample collection, with the exception of the data presented in section 3.3: Temporal variability of core parameter data from the Rito de los Frijoles. Similarly, only the median values for each set of turbidity triplicate samples are presented. For total coliforms and *E. coli* samples, most probable numbers (MPN/100 mL) are reported; these were determined using a lookup table provided by the manufacturer (IDEXX Inc.).

2.4 Understanding water quality data and standards

The NPS Natural Resource Challenge (NRC) provides funding for water quality monitoring in NPS park units. This funding supports efforts directed towards attainment of NPS’s long-term goal to protect pristine water quality and improve impaired water quality by supporting Clean Water Act protections and provisions for designated unimpaired and impaired waters. Preliminary analysis of data available through the water quality data synthesis (Brown 2008), a Level 1 water quality inventory (Macy and Monroe 2006), and monitoring indicate that water quality conditions at many SCPN parks exceed established USEPA, State or Tribal standards.

The State of New Mexico has developed statewide water quality standards and criteria for surface waters and specific additional criteria relevant to streams to meet requirements of the Federal Clean Water Act (NMED 2011a). This report includes water quality standards and criteria applicable to the streams in BAND. A water quality standard refers to a specific parameter and its associated designated use, in conjunction with a criterion, which is the numeric component against which a result is compared. For example, the standard for chronic mercury (parameter) for aquatic life (designated use) is 0.77 µg/L (numeric criterion).

The SCPN water quality monitoring program collects samples several times per year at regular intervals in order to document the range of hydrologic conditions that occur, with a focus on base flow conditions. Thus, rare and short-term events are often not captured. Grab samples represent conditions at the point and time of sampling; they do not represent the condition of the entire water body, spatially or temporally.

In this report results for each parameter are evaluated against applicable water quality standards as defined for each stream by the State of New Mexico. Six designated uses are identified for the Bandelier streams discussed in this report: domestic water supply, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat, and primary contact (NMED 2011a); however, we did not evaluate the standards for irrigation and livestock watering because these uses are not occurring on these streams. Each designated use may have different criteria for one parameter. Therefore, one parameter measurement from one site visit may apply to multiple designated use evaluations. In these cases we only list the most stringent criterion for each in the Results section. Also, aquatic life criteria are often dependent upon water hardness, which varies at each site visit. In these cases, the criteria are expressed as a range encompassing the lowest and highest values for the year.

SCPN water samples are analyzed for dissolved parameters. This means stream water is passed through a 0.45 µm filter in order to remove the particulate component prior to being shipped for analysis. Water quality criteria may be expressed in terms of either the dissolved or total fraction of a sample. The total fraction concentration will be greater than the dissolved fraction. Because of this, only criteria for dissolved parameters are applicable to our samples, and only these criteria are listed in the Results sections.

For *E. coli*, water quality criteria are expressed as the number of colony forming units per 100 mL (cfu/100 mL). SCPN bacteria data are expressed as a most probable number (MPN) per 100 mL. MPN is a statistical estimate of the number of bacteria per unit volume of a sample, determined by using a lookup table provided by the manufacturer (IDEXX Inc.). Although the New Mexico criteria are expressed as cfu/100 mL and do not assume an estimation, the two units are comparable.

2.4.1 Chronic and acute standards

Numeric criteria for aquatic life water quality standards address potential effects of both chronic exposure to a parameter over an extended period of time (months) and acute exposure over a short period of time (hours or days). New Mexico has two types of aquatic life criteria: one is intended to protect aquatic life, and the other is intended to protect human health in waters where fish or other aquatic organisms are consumed. Compliance with acute criteria is determined from a single grab sample, and compliance with chronic criteria is determined from the mean of consecutive-day samples or the results of individual grab samples collected during hydrologically stable conditions (NMED 2011b). Criteria are much lower for chronic exposure than for acute exposure and are not necessarily comparable to the results obtained from a one-time grab sample. When determining attainment of both acute and chronic standards, the representative nature of the data must be considered. From a compliance standpoint, the acute instantaneous criterion affords the only direct comparison for such data because they apply to a single sample. However, from a resource conservation standpoint, instantaneous grab-sample data, when compared against more stringent chronic criterion, can provide a means of early warning and an indication of a problem that may require more attention. Therefore, we have identified chronic exceedances in the Results section of this report.

2.4.2 Regulatory authority

The National Park Service does not have regulatory authority over waters in the U.S., or even the authority to make assessments for designated use. This report compares water quality data to designated-use criteria without stating whether a designated use was attained. Those designations are reported by the states or tribes in their triennial 305(b) reports to Congress. However, the NPS cooperates with states and tribes in collecting data used in the protection of water bodies under state jurisdiction. Definitions of water quality standards according to the states of Arizona, Colorado, New Mexico, Utah, and the Navajo Nation are provided in the SCPN Streams and Springs Water Quality Monitoring Protocol (Monroe et al. *in preparation*).

3 Results

3.1 Rito de los Frijoles

Data collected by SCPN staff during the water quality monitoring site visits to the Rito de los Frijoles in BAND during 2011 are presented below.

3.1.1 Water quality core parameter data

Summary statistics for water quality core parameter data collected at RIT01, RIT02, and RIT03 during 2011 are presented in Table 2. The 2010 data are included for comparison. Data are also compared to the State of New Mexico's high quality coldwater and Bandelier-specific water quality criteria (NMED 2011a). Complete results for 2011 are provided in Appendix B.

Table 2. Summary of water quality core parameter data from RIT01, RIT02, and RIT03 on the Rito de los Frijoles in Bandelier NM, 2010 and 2011 (dashes indicate that RIT03 was not monitored in 2010). A "n/c" indicates that no water quality criterion exists for a parameter.

Core parameter	Site	2010			2011			N.M. state criteria
		# of measurements	Median	Range	# of measurements	Median	Range	
Water temperature (°C)	RIT01	8	7.8	1.7 – 18.5	10	10.7	0.2 – 22.3	Max. temp <23°, 4T3 = 20 ^{oa}
	RIT02	8	7.0	1.6 – 17.2	7	6.0	0.3 – 17.0	
	RIT03	----	----	----	7	14.8	0.2 – 18.3	
pH	RIT01	8	7.7	7.6 – 8.0	10	8.0	7.7 – 8.4	>6.6 and <8.8
	RIT02	8	8.1	7.7 – 8.1	7	8.1	8.0 – 8.1	
	RIT03	----	----	----	7	8.0	7.7 – 8.4	
Specific conductivity (µS/cm)	RIT01	8	109	98 – 122	10	126	98 – 330	<300
	RIT02	8	106	94 – 117	7	103	98 – 302	
	RIT03	----	----	----	7	190	96 – 352	
Dissolved oxygen (mg/L)	RIT01	8	9.2	7.0 – 10.6	10	8.5	6.4 – 11.7	>6
	RIT02	8	9.0	7.3 – 10.5	7	9.6	7.2 – 11.2	
	RIT03	----	----	----	7	7.5	7.3 – 11.4	
Turbidity (NTU)	RIT01	8	3.0	1.9 – 44	10	4.0	2.0 – 370	n/c
	RIT02	8	2.4	1.4 – 26	7	3.2	1.7 – 250	
	RIT03	----	----	----	7	88	1.8 – 240	
Discharge (cfs)	RIT01	8	0.7	0.2 – 8.4	10	0.7	<0.1 – 1.3	n/c
	RIT02	8	1.3	0.9 – 6.6	7	1.2	0.9 – 1.6	
	RIT03	----	----	----	6	0.8	0.3 – 1.4	

^a"4T3" criterion is the water temperature not to be exceeded for four or more consecutive hours in a 24-hour period on more than three consecutive days.

Median pH results were similar among the three sites in 2011 and did not fall outside the water quality criteria during our site visits. Values for pH ranged from 7.7 to 8.4 at RIT01 and RIT03, and increased slightly after the fire. Measurements were fairly constant at RIT02 (ranging between 8.0 and 8.1) throughout the year.

Two parameters increased substantially after the Las Conchas fire and the subsequent flood. Specific conductivity increased from approximately 100 µS/cm in pre-fire site visits to over 300 µS/cm at all three sites during the September site visit, which was the first sampling event after the flooding which occurred in August. This

exceeded the water quality criterion applicable to BAND streams. Specific conductivity gradually decreased during visits in October and December but did not return to pre-fire levels.

Prior to the fire, turbidity samples were usually below 4 NTU, with the exception of samples collected during periods of high streamflow. Turbidity results were similar to pre-fire levels at RIT01 and RIT03 in July (RIT02 was not sampled), two weeks after the fire. In samples collected in August after the last flood, stream turbidity increased to 370, 250, and 240 NTU at RIT01, RIT02, and RIT03, respectively. Results at RIT02 had decreased to pre-flood levels in October and December; however, turbidity at RIT01 and RIT03 remained high during the September, October, and December sampling events. Turbidity at RIT01 and RIT03 decreased significantly by the December sample event, but remained elevated compared to samples collected prior to the flood.

Dissolved oxygen measurements were near 100% saturation in samples collected at all visits to all sites in BAND in 2011. Measurements ranged from 6.4 to 11.7 mg/L at RIT01, 7.2 to 11.2 mg/L at RIT02, and 7.3 to 11.4 mg/L at RIT03. All measurements were above the high quality coldwater criterion of 6 mg/L during these site visits; however a 7-day multiparameter sonde deployment at RIT01, discussed in Section 3.1.2, showed that dissolved oxygen levels did regularly dip below 6 mg/L in July.

Stream discharge at RIT01 ranged from <0.1 to 1.3 cfs. The lowest measurement occurred on June 9, when a small amount of water was flowing, but the flow was too low to be measured. Discharge at RIT03 was similar to RIT01 and ranged from 0.3 to 1.4 cfs. Median discharge was similar for RIT01 and RIT03, at 0.7 and 0.8 cfs, respectively. Discharge at RIT02 was consistently higher than the downstream sites, with a median of 1.2 cfs and a range of 0.9–1.6 cfs.

Streamflow was documented at RIT01 during most of 2011 by gages maintained by the Los Alamos National Laboratory (LANL), the USGS, and SCPN (Figure 2). However, the LANL gage was lost in a flood on August 21. SCPN installed a pressure transducer on August 27 in order to collect gage height data until a permanent gage could be installed. This data was collected from August 27 until December 15. The USGS gage, which was installed prior to the August 21 flood, only collects data during high flows (>4.7 feet). This gage documented two large streamflow events: August 21 (gage height 11.43 feet; 7,000 cfs) and September 4 (gage height 7.50 feet; 2,160 cfs). Only gage height is presented in Figure 2; discharge could not be accurately calculated due to the frequently shifting streambed conditions prevalent after the August 21 flood. Also shown in Figure 2 are turbidity results for samples collected at RIT01, which show the stable and low turbidity measurements taken until July. Turbidity increased in response to precipitation in the watershed starting in July and remained elevated until December.

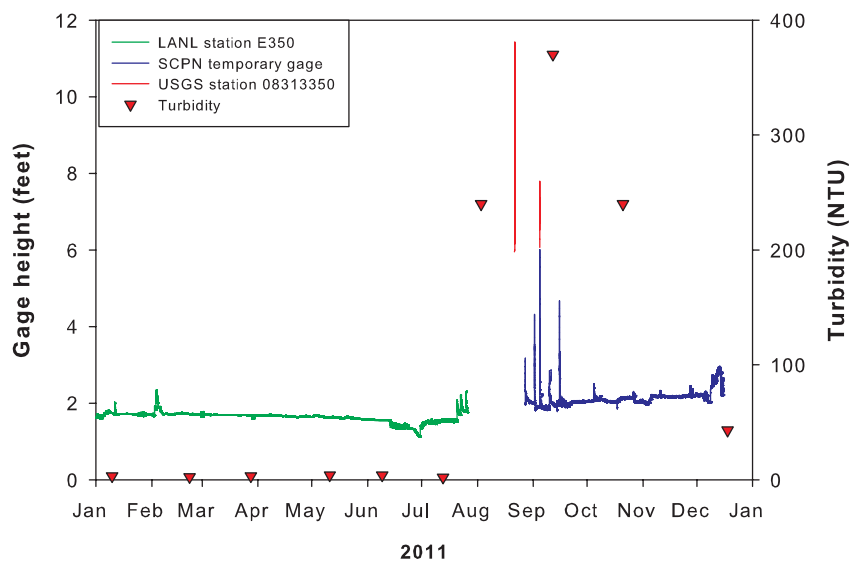


Figure 2. Streamflow gage heights for LANL-E350, USGS 08313350, and the SCPN temporary gage on the Rito de los Frijoles near the visitor center, Bandelier NM, 2011. Turbidity is shown in red.

Daily minimum, maximum, and average stream temperatures at RIT01 are presented in Figure 3, along with the occurrence of SCPN site visits. Data are missing from August 22 through August 27 after a flood dislodged the temperature sensor and before a replacement sensor was installed. Because the Rito de los Frijoles is designated a high-quality coldwater stream, the water temperature criteria applicable at RIT01 are a maximum of 23°C and a 4T3 temperature of 20°C (NMED 2011a), not to be exceeded for four or more consecutive hours on more than three consecutive days. Temperature data was not evaluated at RIT02 because the temperature logger was destroyed in the fire.

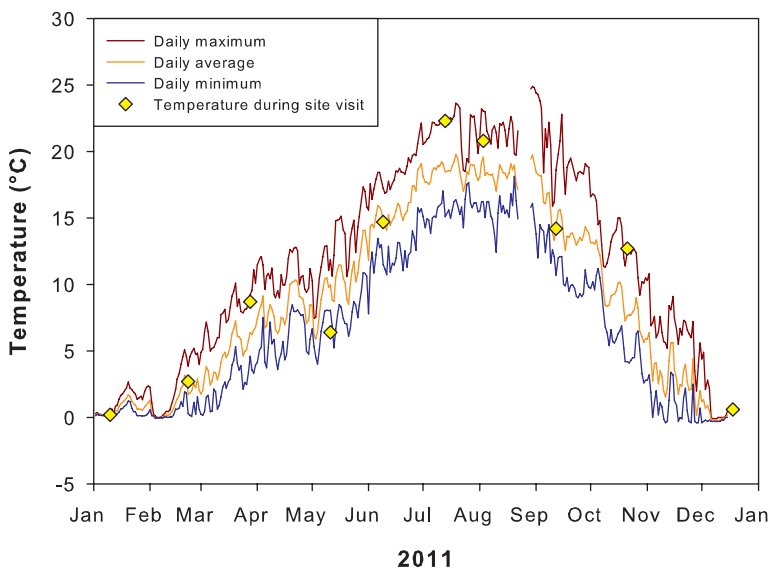


Figure 3. Stream temperature data for RIT01 on the Rito de los Frijoles near the visitor center, Bandelier NM, 2011. Water and air temperatures were recorded at 15-minute intervals by a HOBO Pendant (Onset Computer Corporation) deployed at RIT01. Data are missing for August 22–27 after the pendant was washed away in a flood. Subsequent data was recorded first with a multiparameter sonde (Hydrolab MS-5; Hach Inc.), and later with a pressure transducer (Solinst Levelogger; Solinst Canada Limited) for the remainder of 2011.

Both temperature criteria were exceeded at RIT01 in 2011. The 4T3 criterion was exceeded regularly throughout the summer: from July 4 through July 20, July 31 through August 4, August 6 through August 14, and August 28 through September 3. Many of these temperature exceedances encompassed the majority of the day and far exceeded the four hour period. The stream briefly exceeded 23°C on July 18–20, August 1, and August 28 through September 3. The maximum measured temperature was 24.8°C.

3.1.2 Temporal variability of water quality core parameter data from the Rito de los Frijoles in BAND

To assess temporal variability in temperature, pH, specific conductivity, and dissolved oxygen at base flow conditions, a multiparameter sonde was placed at the gage site at RIT01 to record data at 15-minute intervals from July 13–20. These data are summarized in Table 3 and Figure 4. We show the New Mexico water quality criteria for water temperature and dissolved oxygen because measurements were either near or in exceedance of the criteria on each of the seven days.

During this deployment, measurements for several parameters fell outside the measurements taken during the ten site visits that occurred in 2011. Therefore, the water samples collected may not be representative of the variety of stream conditions that exist throughout the year, despite efforts to collect samples at regular intervals in all seasons.

Table 3. Summary of water quality core parameter temporal variability at RIT01 on the Rito de los Frijoles in Bandelier NM, July 13-20 2011.

Core parameter	Median	Minimum	Maximum	Range
Water temperature (°C)	19.0	15.0	23.6	8.7
Dissolved oxygen (mg/L)	6.5	5.6	7.3	1.7
pH	7.5	7.3	7.7	0.4
Specific conductivity (µS/cm)	134	131	139	8

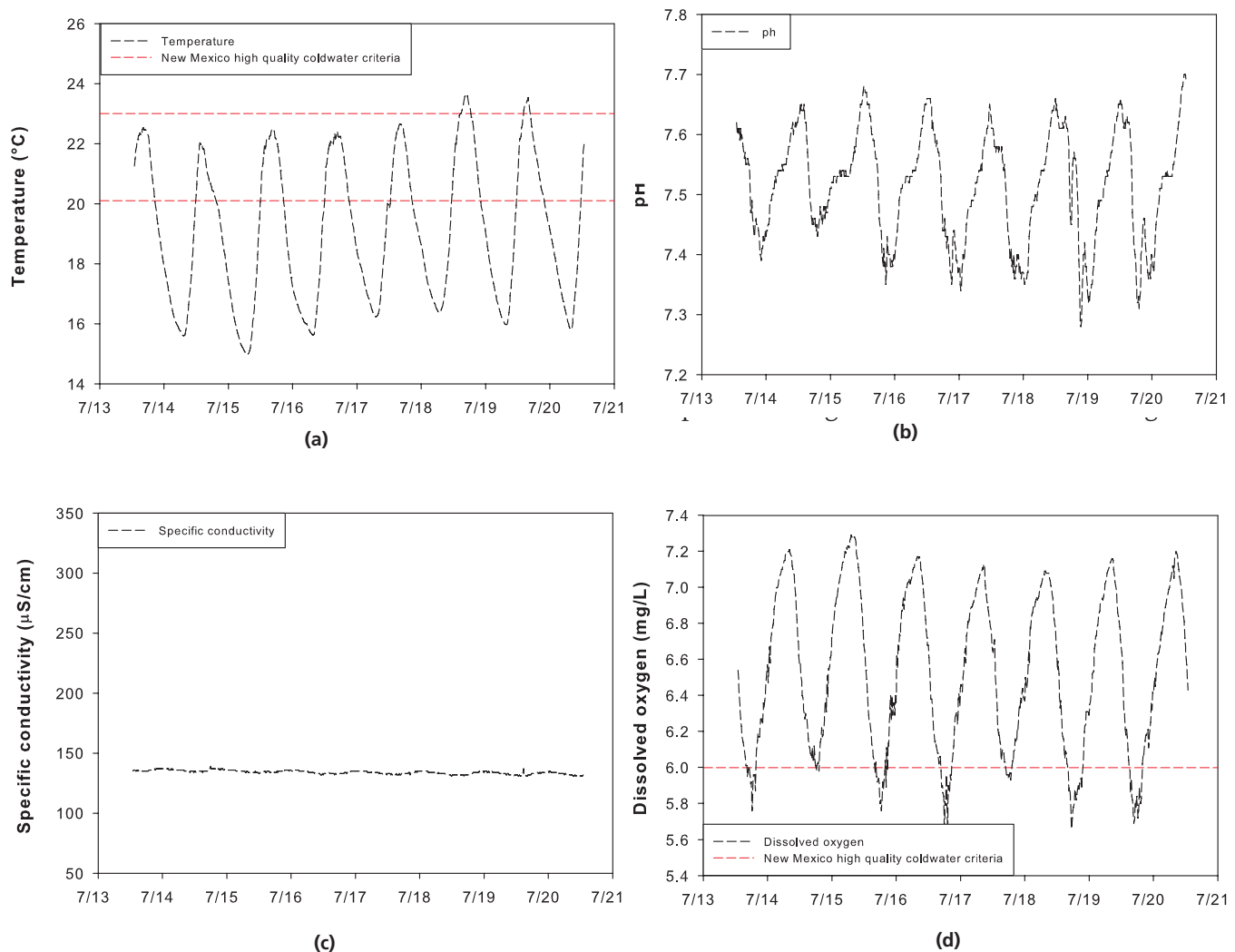


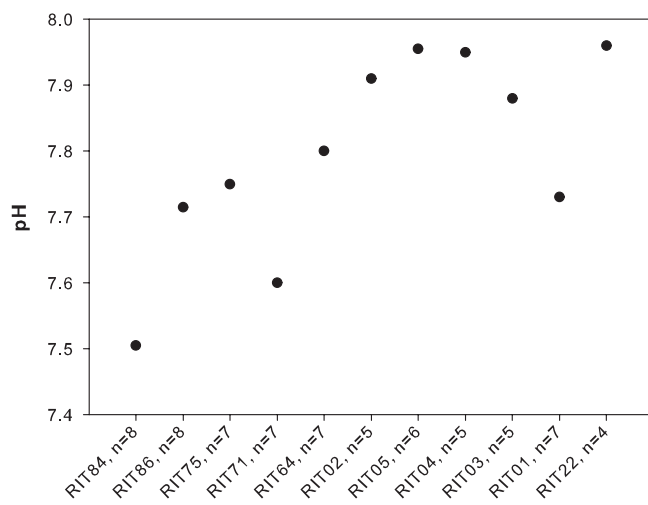
Figure 4. Multiparameter sonde data for water temperature (a), pH (b), specific conductivity (c), and dissolved oxygen (d), taken at 15-minute intervals during a 7-day period from July 13–20 from RIT01 on the Rito de los Frijoles in Bandelier NM, 2011.

Temperatures ranged from 15.0 to 23.6°C during the seven day deployment; the median temperature was 19.0°C. Diel changes in temperature averaged 8.7°C. Values for pH were nearly always lower than the site visit measurements collected at other times of the year, ranging from 7.3–7.7 during the deployment, while the lowest measured value during a site visit was 7.7. They were, however, within the water quality criteria.

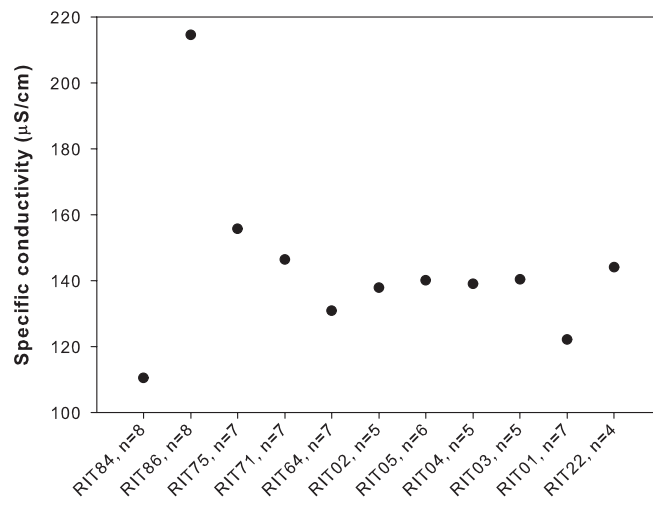
Dissolved oxygen, a parameter whose concentrations are inversely proportional to temperature, ranged from 5.6 to 7.3 mg/L. The median concentration was 6.5 mg/L. The dissolved oxygen measurements were outside the criterion for the high-quality cold water standard during five out of seven days. Specific conductivity did not vary much during the seven days; values were between 131–139 µS/cm and were similar to the values observed at other SCPN visits during 2011 prior to the August flood.

3.1.3 Spatial variability of water quality core parameter data from the Rito de los Frijoles in BAND

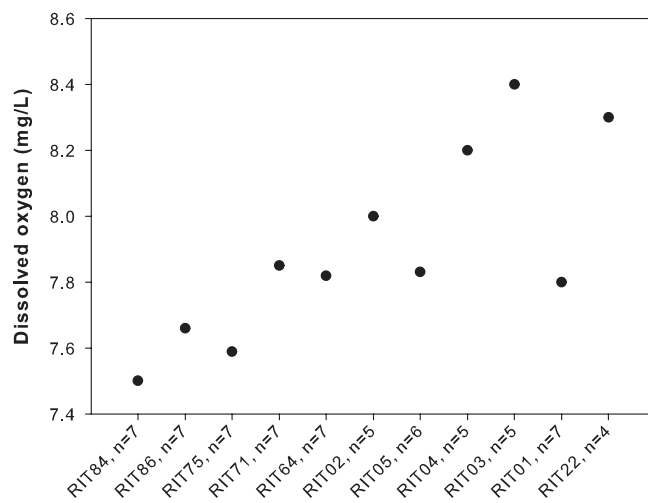
From 2006 to 2010, SCPN staff collected core water quality measurements at multiple locations on the Rito de los Frijoles from the headwaters to below the Lower Falls near the Rio Grande to assess the variability of these parameters along the length of the stream. Median values for all parameters measured during base flow conditions are presented in Figure 5. Measurements that were affected by recent precipitation were omitted.



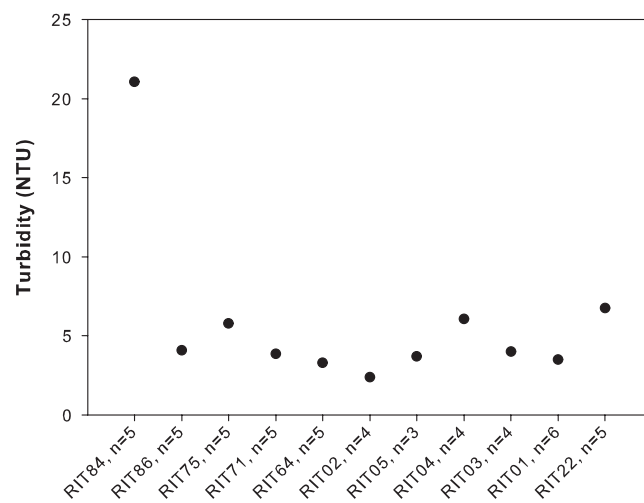
(a)



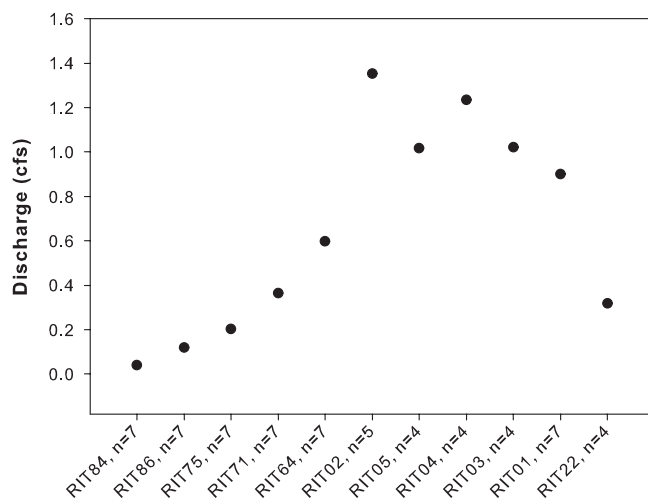
(b)



(c)



(d)



(e)

Figure 5. Median values for core parameters measured during base flow conditions on the Rito de los Frijoles, 2006–2010: (a) pH, (b) specific conductivity, (c) dissolved oxygen, (d) turbidity, and (e) discharge.

Sites are listed in order, from upstream to downstream, except for RIT84 and RIT86 which represent two forks of the Rito de los Frijoles shortly before they converge. All results, including measurements during non-base flow conditions are in Appendix B.

Stream discharge was lowest at the sites near the headwaters, and typically increased at each subsequent site in downstream order. The greatest change occurred between RIT64 and RIT02, where the median stream discharge more than doubled from 0.6 to 1.4 cfs. Discharge at RIT02 was consistently highest among all sites, and flow in the channel generally decreased downstream from that point. Dissolved oxygen and pH tended to increase from upstream to downstream. Specific conductivity and turbidity were both similar between sites, except for at the two furthest upstream sites, RIT84 and RIT86.

3.1.4 Total coliforms and *E. coli*

Bacteria data for samples collected by SCPN at RIT01, RIT02, and RIT03 in 2010 and 2011 are presented in Figure 6. Complete results are presented in Appendix B. SCPN's data are expressed as a most probable number (MPN), a statistical estimate of the number of bacteria per 100 mL of stream water. Water quality criteria are expressed as colony forming units (cfu) per 100 mL and do not assume an estimation, but the two units are comparable. The *E. coli* criteria applicable at Bandelier are a monthly geometric mean of 126 cfu/100 mL or a single-sample maximum of 235 cfu/100 mL. We analyze our samples for total coliforms because theoretically they are indicators of the presence of all coliform groups of bacteria, both vegetative and fecal in origin. For drinking water, total coliforms are still the standard test because their presence indicates contamination of a water supply by an outside source. There are no water quality criteria for total coliforms.

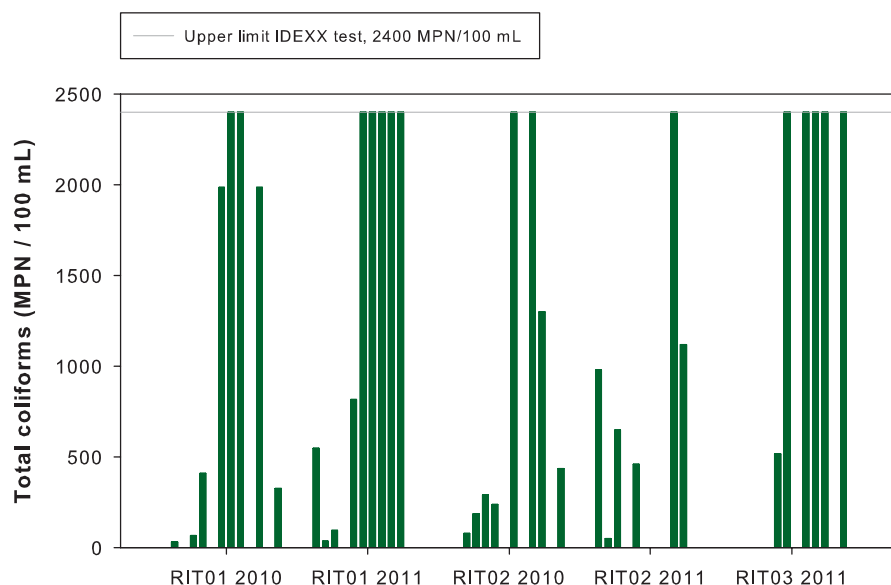


Figure 6. Total coliform results from samples collected in the Rito de los Frijoles in Bandelier NM, 2010–2011.

Total coliform levels frequently exceeded the upper detection limit of the IDEXX test of 2400 MPN/100 mL in the summer and fall 2011 samples collected at RIT01 and RIT03, but were lower in the winter and spring samples at both sites. Only two samples were collected during this time period at RIT02; one exceeded 2400 MPN/100 mL and the other was 1100 MPN/100 mL.

E. coli results for 2010 and 2011 are presented in Figure 7. All sites had exceedances of water quality criteria for *E. coli* in at least one sample. In 2011 *E. coli* levels at RIT01 ranged from 1 to 550 MPN/100 mL, and exceeded the water quality criterion of 235 MPN/100 mL in June, August, and September. One exceedance also occurred in 2010 at this stream, though in that year fewer samples were collected during summer months when bacteria levels tend to be highest. *E. coli* samples collected at RIT03 in 2011 ranged from <1 to 550 MPN/100 mL. Samples were collected on the same dates as RIT01 in June, August, and September, but only the August RIT03 sample

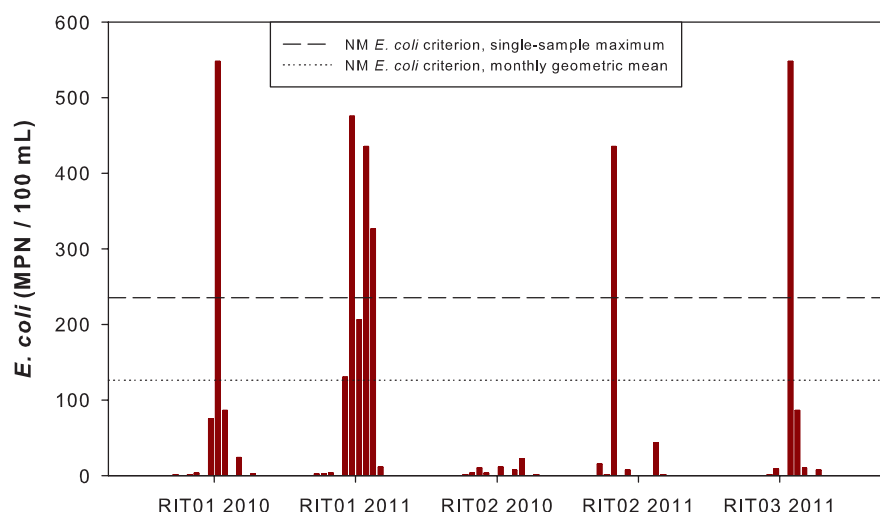


Figure 7. *E. coli* results for samples collected from the Rito de los Frijoles in Bandelier NM, 2010–2011, with New Mexico state water quality criteria.

exceeded the water quality criteria. Due to access limitations, *E. coli* samples were collected less frequently at RIT02 during the summer of 2011. Results ranged from <1 to 440 MPN/100 mL at RIT02; only the March sample exceeded 235 MPN/100 mL.

Although SCPN did not collect samples frequently enough to compute monthly geometric means, Figure 6 includes this criterion level for comparative purposes. In 2011 at RIT01, all five samples from May until September exceeded 126 MPN/100 mL. In 2010, one sample exceeded this level, though only three samples were collected between May and September. This level was exceeded only once at RIT02 and RIT03 in 2011. In 2010, *E. coli* levels were far below 126 MPN/100 mL at RIT02 (RIT03 was not sampled in 2010).

3.1.5 Water quality laboratory data

Nutrient results from RIT01 and RIT02 are summarized below in Table 4. Results for the nitrogen species were similar at both sites and either undetected (<0.0100 mg/L for ammonia and <0.00100 mg/L for nitrite) or at low levels year-round. Ammonia and nitrite were not detected in most samples at both sites. Orthophosphate concentrations increased in the samples collected after the August 21 flood. Maximum orthophosphate concentrations in post-flood samples collected at RIT01 and RIT02 were 0.356 and 0.347 mg/L, while minimum concentrations prior to the flood were 0.0287 and 0.0373 mg/L.

Table 4. Summary of nutrient data collected from RIT01 (n=8) and RIT02 (n=7) at on the Rito de los Frijoles in Bandelier NM, 2011. There are no dissolved criteria for these analytes. Results that were lower than the NWQL reporting levels are noted as "<[reporting level]".

Nutrient (dissolved)	Site	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L) ^a	Standard deviation
Ammonia	RIT01	<0.0100	0.0539	----	0.0155
	RIT02	<0.0100	0.0967	----	0.0323
Nitrite + nitrate as N	RIT01	<0.020	0.205	0.066	0.066
	RIT02	0.088	0.201	0.158	0.041
Nitrite as N	RIT01	<0.00100	0.0304	----	0.0104
	RIT02	<0.00100	0.0302	0.0014	0.0108
Orthophosphate as P	RIT01	0.0287	0.356	0.0734	0.115
	RIT02	0.0373	0.347	0.0509	0.123

^a The missing value symbol indicates that the median was not calculated when more than 70% of the results fell below the laboratory reporting level.

Major elements, acid neutralizing capacity, and total dissolved solids results for samples collected at RIT01 and RIT02 in 2011 are summarized in Table 5. The concentrations of most analytes increased in the samples collected post-fire and results were similar between the two sites. Major ions are plotted in Figure 8 for both 2010 and 2011 at both sites. Results for the early 2011 plots are aligned well with the 2010 plots, but results for the three samples collected after the fire suggest that ion chemistry changed. In these samples, calcium became a more dominant player in cation chemistry relative to sodium and magnesium. Anion chemistry remained dominated by bicarbonate, but more consistently than in the 2010 samples.

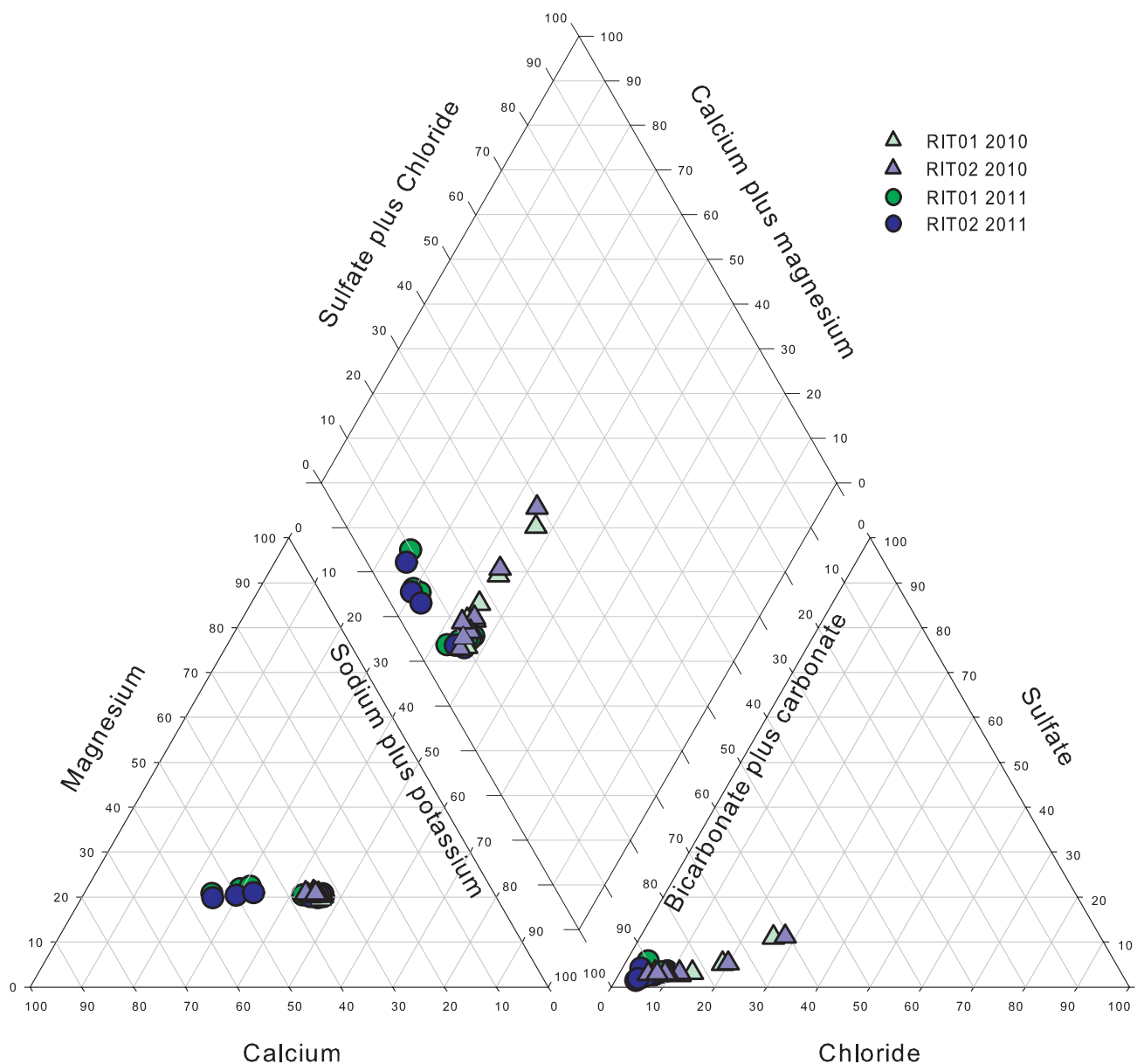
Table 5. Summary of major element data in samples collected at RIT01 (n=8) and RIT02 (n=7) on the Rito de los Frijoles in Bandelier NM, 2011. There are no New Mexico water quality criteria for these analytes.

Major element (dissolved)	Site	Minimum (mg/L)	Maximum (mg/L)	Median (mg/L)	Standard deviation
Calcium	RIT01	7.19	40.2	9.83	12.9
	RIT02	7.39	35.9	8.15	11.3
Chloride	RIT01	2.44	5.48	3.48	1.03
	RIT02	2.18	3.92	2.67	0.60
Fluoride	RIT01	0.145	0.262	0.201	0.041
	RIT02	0.143	0.251	0.167	0.048
Magnesium	RIT01	2.71	9.31	3.35	2.85
	RIT02	2.68	8.05	2.84	2.18
Potassium	RIT01	1.39	8.38	2.13	2.63
	RIT02	1.32	7.70	1.52	2.45
Silica	RIT01	48.1	73.8	61.6	8.0
	RIT02	53.9	67.5	64.9	5.1
Sodium	RIT01	10.7	18.4	12.2	3.0
	RIT02	10.3	14.5	10.8	1.8
Sulfate	RIT01	1.35	10.0	1.88	2.9
	RIT02	1.55	6.83	1.68	1.9
Acid neutralizing capacity, as CaCO ₃ (unfiltered)	RIT01	49.0	162	61.5	47
	RIT02	49.8	143	51.8	38
Total dissolved solids	RIT01	122	269	140	56
	RIT02	117	239	132	47

Trace metal results from RIT01 and RIT02 are summarized in Table 6. While none of these data exceed either the acute or chronic water quality criteria, concentrations of most analytes were elevated in the three samples collected after the fire. Manganese at RIT02 showed the most obvious increase: pre-fire levels were less than one µg/L, while post fire concentrations reached 1000 µg/L. A less dramatic increase of manganese also occurred in the RIT01 samples. Despite the elevated concentrations for many metals in post-fire samples, two metals—mercury and zinc—were not detected in 2011. Cadmium, copper, and silver were only detected once or twice at both sites.

3.1.6 Contaminants of emerging concern

During 2011, SCPN collected seven water samples at RIT01 and RIT03 and sent them to the EPA Region 8 Laboratory to be analyzed for approximately 250 emerging contaminants, which are grouped into three categories: pharmaceuticals and personal care products, waste indicators, and pesticides. The 15 contaminants detected in these samples are summarized in Table 7; complete results and a list of all analytes are presented in



Percentage of Total Milliequivalents per Liter

Figure 8. Major ion composition from samples collected at RIT01 and RIT02 on the Rito de los Frijoles in Bandelier NM, 2010–2011.

Appendix B and C. Contaminant detections were similar between the two sites with a few exceptions; however, detections of these contaminants did not always occur during the same site visit. For example, nonylphenol, tri (2-butoxyethyl) phosphate, and caffeine were detected at both sites, but at different sampling events. There are no aquatic life water quality standards for most of the contaminants listed in Table 7 except for nonylphenol (chronic = 6,600 ng/L) and pentachlorophenol (chronic = 15,000 ng/L). Neither of these criteria were exceeded at RIT01 or RIT03 during 2011.

3.1.7 Radionuclides

SCPN collected unfiltered water and bed sediment samples for radionuclide analyses at RIT01 and RIT02 on December 19, 2011. Results of these analyses are presented in Appendix B. Among the analytes sampled for, only gross alpha had a state drinking water standard (15 pCi/L; NMED 2011a). Samples collected from RIT01 and RIT02 were analyzed within 72 hours of collection and had gross alpha levels of 8.2 pCi/L and 0.911 pCi/L, respectively. Samples were also analyzed for isotopic uranium, which are alpha emitters, (continued on p. 18...)

Table 6. Summary of trace metal data collected from RIT01 (n=8) and RIT02 (n=7) at the Rito de los Frijoles in Bandelier NM, 2011. Of the drinking water supply, aquatic life and wildlife habitat designated uses, only the most stringent criteria are listed. Because SCPN samples were filtered, only criteria based on dissolved samples were used. "n/c" means there are no dissolved criteria for the designated uses evaluated in this report. Results that were lower than the NWQL reporting levels are noted as "<[reporting level]".

Trace metal	Site	Minimum (µg/L)	Maximum (µg/L)	Median ^a (µg/L)	Standard deviation ^a	Most stringent criterion	# of exceedances	Designated use ^b
Aluminum	RIT01	7.07	95.6	30.5	36.2	n/c	n/c	n/c
	RIT02	15.7	90.2	27.9	26.0			
Antimony	RIT01	0.0480	0.240	0.0841	0.063	6	0	DWS
	RIT02	0.0498	0.191	0.0597	0.051		0	
Arsenic	RIT01	0.605	3.94	1.01	1.18	9.0	0	HH-OO
	RIT02	0.705	3.29	0.782	1.03		0	
Barium	RIT01	9.83	63.3	13.0	18.7	2,000	0	DWS
	RIT02	8.87	60.2	9.67	20.4		0	
Beryllium	RIT01	<0.0060	0.0323	0.0155	0.0106	4	0	DWS
	RIT02	<0.0060	0.0429	0.0158	0.0134		0	
Boron	RIT01	5.31	29.9	9.54	8.5	n/c	n/c	n/c
	RIT02	5.55	28.5	7.80	8.4			
Cadmium	RIT01	<0.016	0.034	----	----	0.19–0.57, chronic	0	Aquatic life
	RIT02	<0.016	0.032	----	----		0	
Chromium	RIT01	0.119	0.294	0.167	0.064	11, Cr(IV)	0	Aquatic life
	RIT02	0.223	0.844	0.771	0.295	27–97, Cr(III), chronic	0	
Cobalt	RIT01	0.0232 ^c	1.21 ^c	0.0318 ^c	0.49 ^c	n/c	n/c	n/c
	RIT02	<0.0200 ^c	1.05 ^c	0.0972 ^c	0.45 ^c			
Copper	RIT01	<0.50	0.77	----	----	3–12, chronic	0	Aquatic life
	RIT02	<0.50	1.10	----	----		0	
Iron	RIT01	38.8 ^c	229 ^c	73.2 ^c	71.5 ^c	n/c	0	n/c
	RIT02	14.0 ^c	498 ^c	31.6 ^c	190 ^c		0	
Lead	RIT01	0.0519	0.355	0.101	0.103	1–4, chronic	0	Aquatic life
	RIT02	0.0670	0.249	0.134	0.065		0	
Manganese	RIT01	6.56 ^c	391 ^c	14.7 ^c	144 ^c	1100–1840, chronic	0	Aquatic life
	RIT02	0.329 ^c	1000 ^c	0.887 ^c	471 ^c		0	
Mercury	RIT01	<0.005	<0.005	----	----	0.77, chronic	0	Aquatic life
	RIT02	<0.005	<0.005	----	----		0	
Molybdenum	RIT01	1.01 ^c	9.24 ^c	1.53 ^c	3.01 ^c	n/c	n/c	n/c
	RIT02	0.981 ^c	7.18 ^c	1.04 ^c	2.47 ^c			
Nickel	RIT01	0.145	1.39	0.217	0.49	18–69, chronic	0	Aquatic life
	RIT02	<0.090	1.19	----	----		0	
Selenium	RIT01	0.062	0.312	0.105	0.081	50	0	DWS
	RIT02	0.138	0.309	0.206	0.052		0	
Silver	RIT01	<0.0050	0.0073	----	----	0.4–5.7, chronic	0	Aquatic life
	RIT02	<0.0050	0.0064	----	----		0	
Uranium	RIT01	0.0310	2.17	0.0534	0.74	30	0	DWS
	RIT02	0.128	1.68	0.180	0.57		0	

Table 6 continued

Trace metal	Site	Minimum (µg/L)	Maximum (µg/L)	Median ^a (µg/L)	Standard deviation ^a	Most stringent criterion	# of exceedances	Designated use ^b
Vanadium	RIT01	1.92	4.11	3.44	0.78	n/c	n/c	n/c
	RIT02	2.92	6.59	5.33	1.61			
Zinc	RIT01	<1.40	<1.40	----	----	40–163, chronic	0	Aquatic life
	RIT02	<1.40	<1.40	----	----		0	

^a The missing value symbol indicates that the median was not calculated when more than 70% of the results fell below the laboratory reporting level.

^b Designated use codes: DWS = domestic water supply; HH-OO = Human health-organism only—HH-OO criteria are intended to protect human health when aquatic organisms are consumed. They are not intended for protection of the organisms themselves (NMED 2012)

^c Results of a field blank indicated contamination with small concentrations of cobalt (0.0464 µg/L), iron (4.37 µg/L), manganese (0.154 µg/L), and molybdenum (0.0338 µg/L). Therefore, we have flagged all results for these trace metals except for those that fell below the NWQL reporting levels.

Table 7. Detections of contaminants of emerging concern in samples collected at RIT01 (n=6) and RIT03 (n=6) on the Rito de los Frijoles in Bandelier NM, 2011.

Contaminant	Use	# of detections, RIT01	# of detections, RIT02
Pharmaceuticals and personal care products			
Caffeine		1	1
DEET		1	0
Waste indicators			
Acetophenone	Used to produce resins, inks, adhesives, and fragrances	1	1
Bisphenol A	Used in the production of polycarbonate plastics and epoxy resins (hard plastic bottles and metal food cans)	2	3
Caffeine		1	1
p-Cresol	solvent, disinfectant, and chemical intermediate	2	1
Isoborneol	used in the manufacture of perfume	0	1
Isoquinoline	obtained from coal tar, used to make pharmaceuticals, disinfectants, dyes, paints, insecticides, many other uses	1	1
2-Methylnaphthalene	component of coal and crude oil	1	1
Naphthalene	used in the manufacture of PVC plastics, used in mothballs	1	1
Nonylphenol	breakdown product from detergents	1	1
Pentachlorophenol	wood preservative	1	1
Phenanthrene	byproduct of incomplete combustion, also used to make dyes, plastics, pesticides, explosives, and drugs	1	1
Phenol	obtained from petroleum, precursor to plastics and many other products	2	2
Tri (2-butoxyethyl) phosphate	flame retardant, plasticizer	2	1
Tri (dichloroisopropyl) phosphate	flame retardant in foams, resins, and latexes	1	1
Pesticides			
Propachlor OA	herbicide	1	1

(...continued from page 15) but only contributed slightly to the gross alpha results. 72-hour gross beta results were 11.2 pCi/L at RIT01 and 3.38 pCi/L at RIT02. Results for gross alpha and beta did not change significantly when the samples were re-analyzed after 30 days, indicating significant quantities of radium were not present in our samples. The highest detection levels of gamma radiation emitters analyzed for was potassium-40, a naturally-occurring radioisotope with measurements of 14.9 pCi/L at RIT01 and 1.42 pCi/L at RIT02. Radionuclide results were consistently higher at RIT01 than at RIT02.

Bed sediment results were slightly different between the two sites. Gross alpha results were slightly higher at RIT02 (9.50 pCi/g) than at RIT01 (6.78 pCi/g). As with the water samples, uranium isotopes were slight contributors to the gross alpha results. Gross beta and K-40 results were similar between the two sites.

3.2 Capulin Creek

3.2.1 Water quality core parameter data

NPS core parameter results for CAP01 in 2011 are presented in Table 8. Data collected in 2010 are included for comparison. SCPN visited this site only four times in 2011. We were unable to access this site in the winter and when the BAND backcountry was closed due to the Las Conchas fire. Two water quality criteria applicable to CAP01 were exceeded in samples collected during the September site visit. Water temperature was 23.9°C and specific conductivity was 400 µS/cm. These exceedances were not observed at any of the site visits in 2010 or in early 2011.

Table 8. Summary of NPS core parameter data from measurements taken at CAP01 on Capulin Creek in Bandelier NM, 2010–2011. New Mexico (N.M.) state aquatic life criteria for parameters is provided. A “n/c” indicates that no criteria exists for a parameter.

Core parameter	2010			2011			N.M. state criterion
	# of measurements	Median	Range	# of measurements	Median	Range	
Water temperature (°C)	8	8.3	0.5 – 19.5	4	13.0	8.7 – 23.9	Max. temp <23°, 4T3 temperature = 20° ^a
pH	8	8.1	7.8 – 8.2	4	8.1	8.0 – 8.3	>6.6 and <8.8
Specific conductivity (µS/cm)	8	131	107 – 145	4	201	137 – 400	<300
Dissolved oxygen (mg/L)	8	9.0	7.1 – 11.3	4	8.0	6.5 – 8.6	>6
Turbidity (NTU)	8	2.7	0.6 – 25	4	5.8	3.2 – 296	n/c
Discharge (cfs)	8	0.4	0.2 – 2.1	4	0.4	0.4 – 0.6	n/c

^a“4T3” criterion is the water temperature not to be exceeded for four or more consecutive hours in a 24-hour period on more than three consecutive days.

During 2011 pH at CAP01 ranged between 8.0 and 8.3, which was similar to observations in 2010. Results were within the water quality criteria. Specific conductivity ranged from 137–400 µS/cm, and the measurement made in September exceeded the water quality criterion but by the October site visit, specific conductivity had decreased to 265 µS/cm. Dissolved oxygen ranged between 6.5 and 8.6 mg/L which, despite the high water temperature observed in September, was still above the water quality criterion of 6 mg/L. Turbidity had increased significantly in September from previous measurements, with a measured value of 296 NTU. However, by the October site visit turbidity had decreased to 7.3 NTU, which was much closer to measurements observed prior to the fire in 2010 and 2011. Measured discharge ranged from 0.4 to 0.6 cfs.

Core water quality parameter data collected during fall aquatic macroinvertebrate sample events at CAP02 from 2008 through 2011 are displayed in Table 9. All site visits occurred in October, and measurements presented here are an average of noontime values for the period 2008–2010 as well as the individual 2011 measurement. The

Table 9. Summary of NPS water quality core parameter data from samples collected at CAP02 on Capulin Creek in Bandelier NM from 2008–2011. This data was collected during one aquatic macroinvertebrate sampling visit in each of the four years. The New Mexico (N.M.) state aquatic life criterion for each parameter is listed; “n/c” indicates there is no criterion for a parameter.

Core parameter	Average, 2008 - 2010	2011	N.M. state criterion
Water temperature (°C)	10.3	14.6	Max. temp <23°, 4T3 temperature = 20 ^{aa}
pH	7.8	8.3	>6.6 and <8.8
Specific conductivity (µS/cm)	165	314	<300
Dissolved oxygen (mg/L)	9.2	8.2	>6
Turbidity (NTU)	1.9	79	n/c
Discharge (cfs)	0.1 (2010 only)	0.4	n/c

^a“4T3” criterion is the water temperature not to be exceeded for four or more consecutive hours in a 24-hour period on more than three consecutive days.

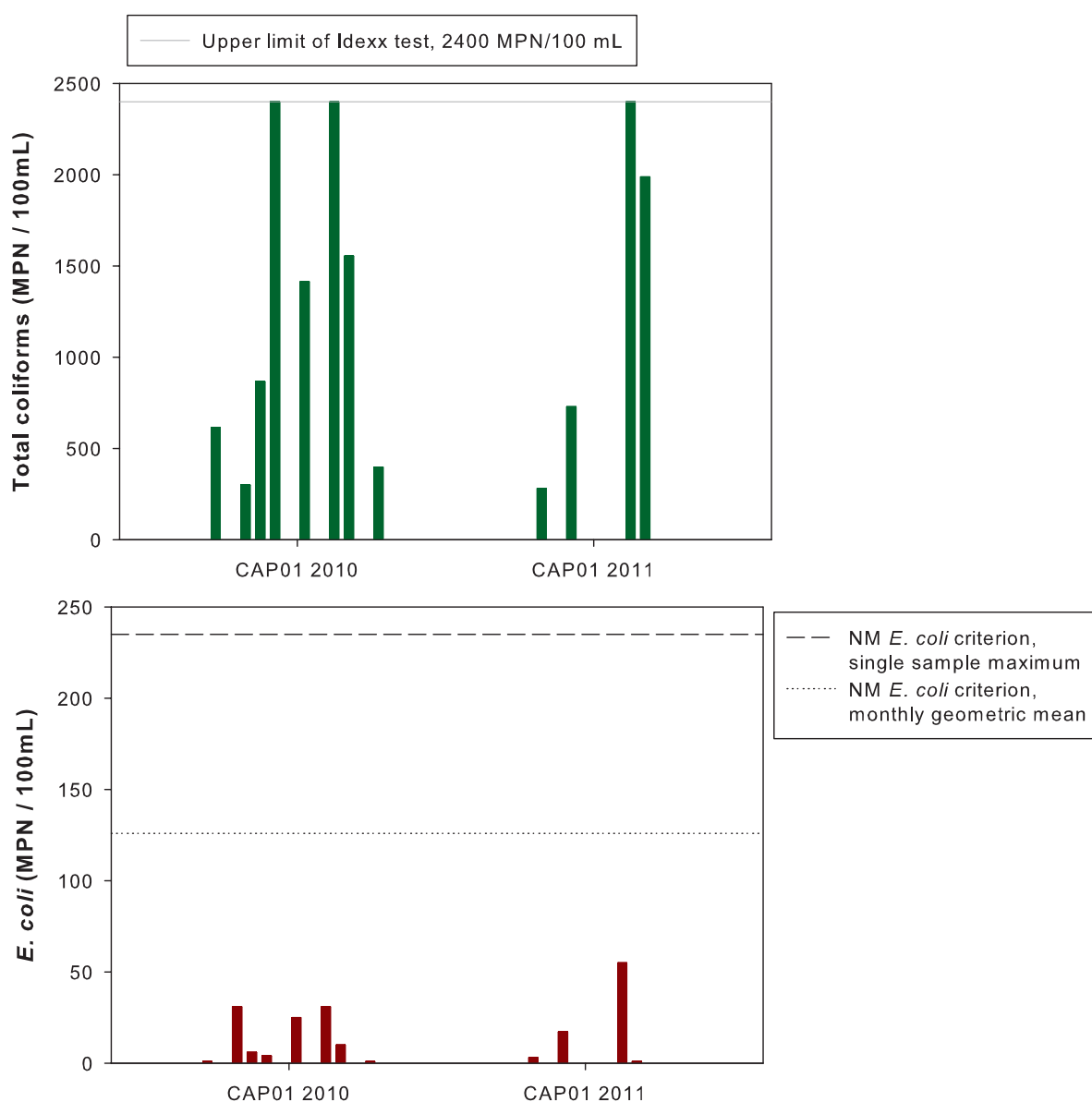


Figure 9. Total coliforms (top) and *E. coli* (bottom) results for samples collected from Capulin Creek in BAND, 2010–2011, with New Mexico water quality criteria.

2011 values were distinctly different than those collected during past years. Water temperature was 14.6°C, which was higher than average. Dissolved oxygen was 8.2 mg/L, which was slightly lower than average but above the water quality criterion. pH was 8.3, also within the water criteria. As with CAP01, specific conductivity was higher than previous results and at 314 µS/cm, exceeded the water quality criterion value of 300 µS/cm. Turbidity was 79 NTU, which was higher than previous years.

3.2.2 Total coliforms and *E. coli*

Total coliforms and *E. coli* data from samples collected at CAP01 in 2010 and 2011 are displayed in Figure 9. Total coliform counts in samples collected in March, May, September, and October of 2011 ranged from 280 to >2400 MPN/100 mL. *E. coli* ranged from <1 to 55 MPN/100 mL in samples collected on the same dates. All results were well below the water quality criteria (NMED 2011a).

3.2.3 Water quality laboratory data

The four water samples collected at CAP01 by SCPN in 2011 were sent to NWQL to be analyzed for nutrients, major elements, and trace metals. After the Las Conchas fire, samples were collected in March, May, September and October only, due to limited accessibility to the site in winter. Complete laboratory results are presented in Tables 10–12. None of the results exceeded State of New Mexico acute or chronic water quality standards for aquatic life.

Nutrient results from samples collected at CAP01 and sent to NWQL are presented in Table 10. All four nutrients were present in low or undetectable concentrations in the two samples collected in March and May, but concentrations were higher in the September and October samples. Ammonia was only detected in the September sample at 0.160 mg/L. Nitrite + nitrate and nitrite concentrations were below or slightly above the laboratory reporting level in March and May, but both were higher relative to pre-fire levels in the September sampling: nitrite + nitrate was 0.443 mg/L and nitrite was 0.0361 mg/L. By the October sampling, levels of both had decreased, particularly for nitrite. Orthophosphate levels ranged between 0.0327 mg/L and 0.543 mg/L. The highest concentrations occurred in samples collected after the fire.

Table 10. Results of nutrient analyses of samples collected at CAP01 on Capulin Creek in Bandelier NM, 2011. There are no criteria for dissolved nutrients. Results that were lower than the NWQL reporting levels are noted as “[reporting level]”.

Analyte	Sample collection date and time			
	3/29/11	5/10/11	9/13/11	10/20/11
	12:45	11:39	14:09	13:40
Ammonia as N	<0.0100	<0.0100	0.155	<0.0100
Nitrite + nitrate as N	<0.020	0.024	0.443	0.231
Nitrite as N	<0.00100	0.00116	0.0361	0.00454
Orthophosphate as P	0.0327	0.0493	0.543	0.389

Major element results for samples collected at CAP01 in 2011 are displayed in Table 11. Concentrations of all ions increased in the two post-fire samples, in particular, calcium, magnesium, potassium, and sulfate. Concentrations for all ions were highest in the September sample and had decreased by the October sample. Silica concentrations did not change significantly throughout the year, ranging from 48.1 to 69.9 mg/L. Acid neutralizing capacity ranged from 67.4 mg/L to 189 mg/L as CaCO₃, with the highest results occurring in September and October. Total dissolved solids ranged from 137 to 278 mg/L; again, the highest levels occurred in September and October.

Major ions results for 2010 and 2011 are shown in Figure 10. For both years, anions were dominated by carbonate/bicarbonate. Cation composition shifted in 2011; the two post-fire samples were more dominated by

Table 11. Results of major element analyses from samples collected at CAP01 on Capulin Creek in Bandelier NM, 2011. There are no New Mexico water quality criteria for these analytes.

Analyte	Sample collection date and time			
	3/29/11 12:45	5/10/11 11:39	9/13/11 14:09	10/20/11 13:40
Calcium	13.0	13.1	48.7	30.9
Chloride	2.64	2.32	4.23	3.38
Fluoride	0.224	0.208	0.332	0.308
Magnesium	3.64	3.92	11.6	7.61
Potassium	2.09	2.17	10.7	6.11
Silica	65	69.9	48.1	57.8
Sodium	10.8	10.6	15.8	14.1
Sulfate	3.13	2.65	11.6	4.51
Acid neutralizing capacity, as CaCO ₃ (unfiltered)	67.4	70.5	189	130
Total dissolved solids	147	137	278	198

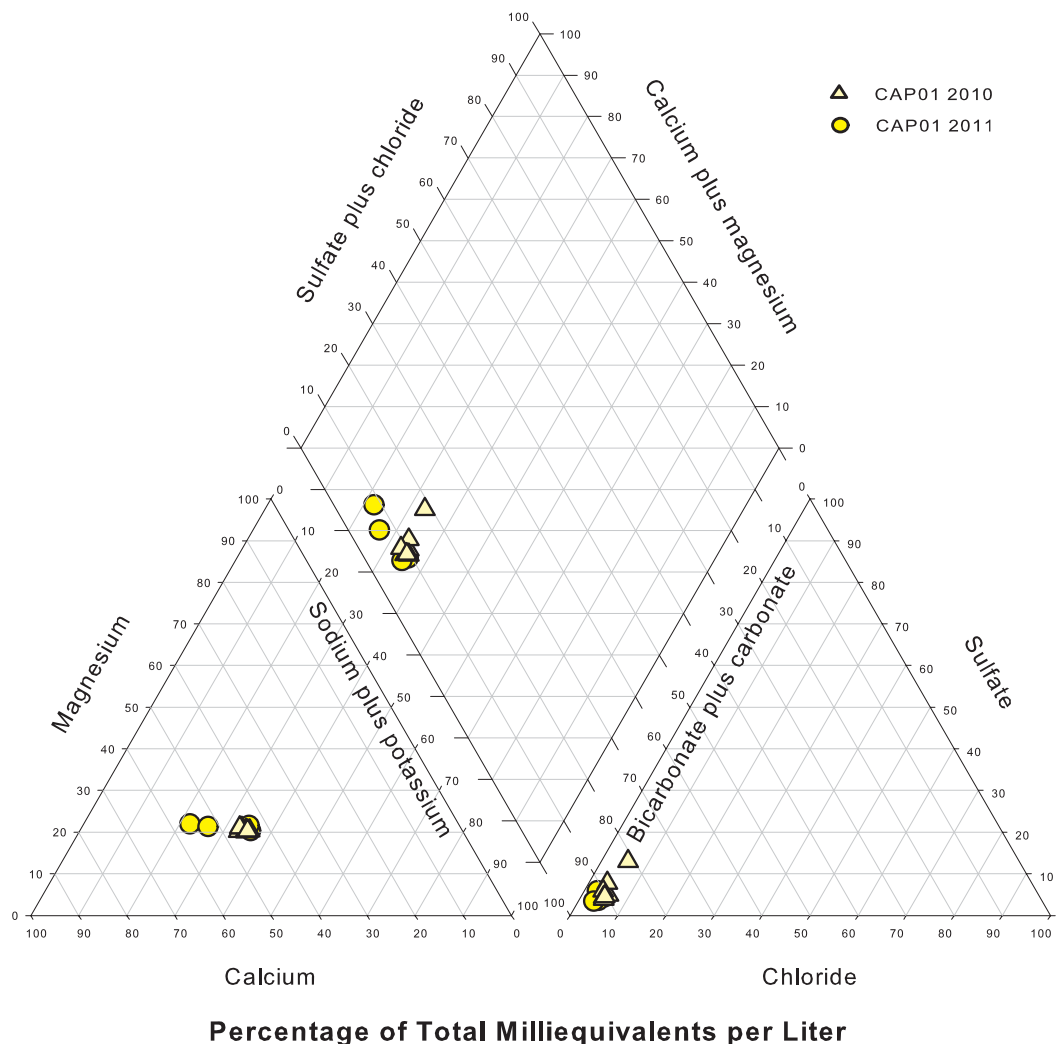


Figure 10. Major ion composition from samples collected at CAP01 on Capulin Creek in Bandelier NM, 2010–2011.

calcium and less by sodium and potassium than any of the pre-fire samples in either year.

Results of trace metal analyses for samples collected at CAP01 are presented in Table 12. Of the metals sampled, three were not detected in 2011: mercury, silver, and zinc. Beryllium, cadmium, and copper were detected in some samples, but at levels that were close to the laboratory reporting level. Most trace metal concentrations were higher in the September and October samples as compared to the earlier samples, particularly manganese. No water quality exceedances occurred with these samples.

Table 12. Results of trace metal analyses from samples collected at CAP01 on Capulin Creek in Bandelier NM, 2011 and number of times that the samples exceeded the New Mexico state water quality criteria. "n/c" indicates that no criterion exists for a particular nutrient. All trace metals are dissolved. Results that were lower than the NWQL reporting levels are noted as "<[reporting level]".

Trace metal (µg/L, dissolved)	Sample date and time				Most stringent criterion	Number of exceedances	Designat- ed use ^a
	3/29/11 12:45	5/10/11 11:39	9/13/11 14:09	10/20/11 13:40			
Aluminum	13.9	9.85	37.7	22.0	n/c	n/c	n/c
Antimony	0.0338	0.0517	0.197	0.0916	6	0	DWS
Arsenic	1.24	1.25	5.61	3.67	9.0	0	HH-OO
Barium	31.1	34.5	140	87.5	2,000	0	DWS
Beryllium	0.0082	<0.0060	0.0166	0.0080	4	0	DWS
Boron	8.56	10.6	39.6	20.7	n/c	n/c	n/c
Cadmium	<0.016	<0.016	0.034	<0.016	0.27–0.66, chronic	0	aquatic life
Chromium	0.221	0.188	0.095	0.213	11, Cr(IV) 40–114, Cr(III), chronic	0	aquatic life
Cobalt	0.0334 ^b	0.0229 ^b	0.960 ^b	0.877 ^b	n/c	n/c	n/c
Copper	<0.50	0.63	0.78	<0.80	5–14, chronic	0	aquatic life
Iron	22.0 ^b	19.5 ^b	27.2 ^b	81.7 ^b	n/c	n/c	n/c
Lead	0.0458	0.125	0.0584	0.0595	1–4, chronic	0	aquatic life
Manganese	5.52 ^b	3.64 ^b	385 ^b	483 ^b	1290–1970, chronic	0	aquatic life
Mercury	<0.005	<0.005	<0.005	<0.005	0.77, chronic	0	aquatic life
Molybdenum	0.896 ^b	0.873 ^b	8.83 ^b	3.47 ^b	n/c	n/c	n/c
Nickel	0.278	0.234	2.35	1.35	28–81, chronic	0	aquatic life
Selenium	0.252	0.167	0.475	0.263	50	0	DWS
Silver	<0.0050	<0.0050	<0.0050	<0.0050	0.9–8.0, chronic	0	aquatic life
Uranium	0.0676	0.0523	2.54	0.466	30	0	DWS
Vanadium	4.96	4.47	4.34	3.77	n/c	n/c	n/c
Zinc	<1.40	<1.40	<1.40	<1.40	62–196, chronic	0	aquatic life

^aDWS = domestic water supply. HH-OO = Human health-organism only. HH-OO criteria are intended to protect human health when aquatic organisms are consumed. They are not intended for protection of the organisms themselves (NMED 2012)

^bResults of a field blank indicated contamination with small concentrations of cobalt (0.0464 µg/L), iron (4.37 µg/L), manganese (0.154 µg/L), and molybdenum (0.0338 µg/L). Therefore, we have flagged all results for these trace metals except for those that fell below the NWQL reporting levels.

4 Quality assurance/Quality control

We followed the Quality Assurance/Quality Control procedures described in Monroe et al. (*in preparation*) and in National Park Service 2012 .

The multiparameter sondes were calibrated, maintained, and compared to one another indoors prior to the sampling events. Streamflow instruments were checked according to manufacturer recommendations to ensure they were in proper working condition; and the turbidimeter was checked for calibration drift in the lab prior to each sampling event and in the field prior to each measurement. Fifteen duplicate bacteria samples were collected at several SCPN monitoring sites by filling two sample bottles in succession and comparing tray results after the incubation period. Thirteen blank samples were processed using sterile water provided by IDEXX.

To verify the cleanliness of both the sampling equipment and the sample filtration process for nutrients, major elements, and trace metals, NWQL analyzed one sample set of certified inorganic blank water in December 2011. Most analytes were not detected, but four trace metals were detected at low concentrations: cobalt (0.0464 µg/L, reporting level is 0.0200 µg/L), iron (4.37 µg/L, reporting level is 3.20 µg/L), manganese (0.154 µg/L, reporting level is 0.130 µg/L), and molybdenum (0.0338 µg/L, reporting level is 0.0140 µg/L). Because the blank concentrations were very low, we still included all sample data in this report. All data associated with these analytes are qualified with a footnote.

5 Summary

Starting in 2010, SCPN implemented long-term water-quality monitoring at RIT01 and RIT02 on the Rito de los Frijoles and at CAP01 on Capulin Creek in Bandelier NM (BAND). This monitoring program complements SCPN's aquatic macroinvertebrate monitoring at these sites and at CAP02. In 2011, SCPN collected water quality samples at RIT03 for the purpose of developing baseline data defining levels of bacteria and contaminants of emerging concern in Rito de los Frijoles upstream of the monument's high use area. Data collected during site visits to BAND in 2011 are summarized here and compared against New Mexico aquatic life standards (NMED 2011a).

We made site visits at regular intervals throughout the year when possible, capturing a variety of different seasonal and flow conditions as well as effects from the Las Conchas fire. Water temperature, which was recorded at 15-minute intervals at RIT01, exceeded the temperature criteria throughout much of the summer. Temperature criteria compliance could not be fully determined at Capulin Creek or at RIT02 due to the loss of the data loggers in 2011; however a measurement during a September site visit at CAP01 was 23.9°C, which exceeded the water quality criteria for temperature.

Dissolved oxygen at RIT01, RIT02, RIT03, and CAP01 ranged from 6.4 to 11.7 mg/L during our site visits and was within the high-quality coldwater standard of 6.0 mg/L. However, our long-term measurements from July 13–20 at RIT01 show that dissolved oxygen did fall below this for brief periods. Measurements for pH ranged from 7.7 to 8.4, which was within the applicable water quality criteria. Specific conductivity ranged from 98 to 400 µS/cm; measurements at all four sites exceeded the 300 µS/cm water quality criterion during the September sampling event. Turbidity ranged from 1.7 to 370 NTU; turbidity was normally low, but had increased significantly at all sites after the fire. Discharge ranged from <0.1 to 1.6; the lowest discharge occurred in June when water was barely flowing at RIT01.

Total coliform results ranged from 37 to more than 2400 MPN/100 mL. Results for *E. coli* ranged from less than 1 to 550 MPN/100 mL. The highest results occurred at RIT01 and RIT03. The water quality criteria were exceeded at least once at all sites on the Rito de los Frijoles.

Despite elevated laboratory-measured concentrations for most analytes in the samples collected after the fire, results for nutrients and trace metals were below the applicable water quality criteria for aquatic life at RIT01,

RIT02, and CAP01. Mercury and zinc were not detected in any samples at any of the sites. Radionuclide results for samples collected at RIT01 and RIT02 were below the water quality criteria where applicable, and radionuclide results in stream water were higher at RIT01 than at RIT02. Sixteen contaminants of emerging concern were detected at RIT01 and RIT03 from 6 samples; detection levels were similar between the two sites.

The data in this report should be viewed as a snapshot of water quality conditions existing at the time that the data was collected. Data and analyses in this report are provisional and are subject to change. When sufficient data are available, SCPN plans to produce an interpretive report which will include trend analysis of water quality data for the Rito de los Frijoles and Capulin Creek in Bandelier National Monument.

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Appendices

Appendix A: Southern Colorado Plateau Network water quality monitoring sites

Table A1. Southern Colorado Plateau Network water quality monitoring sites for Bandelier National Monument, 2011

Site code	Common name	Report name	Northing (m) ¹	Easting (m) ¹	Elevation (m) ¹
BANDRIT86	Upper Frijoles – East Fork	RIT86	3966007	372361	2443
BANDRIT84	Upper Frijoles – West Fork	RIT84	3965971	372229	2437
BANDRIT75	Upper Frijoles – Confluence	RIT75	3965904	372371	2426
BANDRIT71	Above Upper Upper Crossing	RIT71	3965123	372631	2372
BANDRIT64	Above Burn	RIT64	3964295	373770	2294
BANDRIT02	Rito de los Frijoles at Upper Crossing	RIT02	3964317	377110	2151
BANDRIT05	Narrows	RIT05	3963074	379932	2023
BANDRIT04	Hoodoo	RIT04	3962472	381507	1968
BANDRIT03	Rito de los Frijoles above Wilderness Boundary	RIT03	3961664	383164	1905
BANDRIT01	Rito de los Frijoles near Visitor Center	RIT01	3959889	385363	1840
BANDRIT22	Below Lower Falls	RIT22	3957901	386236	1691
BANDCAP01	Capulin Creek at Base Camp Gaging Station	CAP01	3958026	379713	1904
BANDCAP02	Capulin Creek above Painted Cave	CAP02	3955457	380300	1791

¹ Horizontal coordinates are reported in Universal Transverse Mercator (UTM) Projection, Zone 13, North American Datum of 1983 (NAD 83). Vertical coordinates are referenced to the North American Vertical Datum of 1988 (NAVD 88).

Appendix B: 2011 Water quality results for Bandelier National Monument

Table B1. Water quality core parameter data for samples collected from RIT01 on the Rito de los Frijoles in Bandelier NM, 2011

Core parameter	Units	Sample collection date and time									
		1/10 17:45	2/22 19:00	3/28 19:20	5/11 8:59	6/9 22:10	7/13 14:10	8/3 12:00	9/12 9:55	10/21 15:15	12/18 17:00
Water temperature	°C	0.2	2.7	8.7	6.4	14.7	22.3	20.8	14.2	12.7	0.6
pH	none	7.8	7.9	7.7	8.0	7.7	8.0	8.4	8.3	8.3	8.0
Specific conductivity	μS/cm	98	99	107	100	115	136	228	330	283	222
Dissolved oxygen	mg/L	11.7	10.6	8.7	9.4	7.2	6.4	7.1	8.1	8.3	11.3
Turbidity	NTU	3.1	2.3	3.3	3.9	4.0	2.0	240	370	240	43
Discharge	cfs	1.1	0.7	0.4	0.5	<0.1	0.2	0.8	1.0	0.6	1.3

Table B2. Total coliforms and *E. coli* in samples collected at RIT01 on the Rito de los Frijoles in Bandelier NM, 2011. The maximum detection level for bacteria is 2400 MPN/100 mL.

Total coli-forms and <i>E. coli</i>	Sample collection date and time									
	1/10 17:45	2/22 19:00	3/28 19:20	5/11 8:59	6/9 22:10	7/13 14:10	8/3 12:00	9/12 9:55	10/21 15:15	12/18 17:00
Total coliforms (MPN/100 mL)	550	37	96	820	>2400	>2400	>2400	>2400	>2400	2400
<i>E. coli</i> (MPN/100 mL)	2	2	3	130	550	210	440	330	11	1

Table B3. Spatial variability of water quality core parameter data from the Rito de los Frijoles in BAND, 2006 – 2011.
Sites are listed in order from upstream to downstream.

Site code	Date	Time	Water temp (°C)	pH	Specific conductivity	Dissolved oxygen (mg/L)	Turbidity (NTU)	Discharge (cfs)
RIT84	9/16/2006	1225	9.3	7.3	94	-	-	0.0
	10/27/2006	1530	3.4	8.5	114	9.3	-	0.2
	4/19/2007	1315	7.9	7.6	187	9.1	26.7	0.5
	6/8/2007	1450	11.9	7.8	139	7.6	10.1	0.0
	7/14/2007	1138	12.4	7.0	106	7.2	6.7	0.0
	8/29/2007	1040	13.0	7.0	132	7.5	21.1	0.0
	10/14/2007	1345	6.6	7.4	100	7.5	21.6	-
	7/15/2010	1149	14.5	7.8	107	7.4	-	0.0
RIT86	9/16/2006	1405	10.3	7.5	267	-	-	0.3
	10/27/2006	1500	5.4	8.1	254	9.3	-	0.1
	4/19/2007	1203	6.2	7.7	214	9.1	12.1	0.1
	6/8/2007	1103	7.0	8.0	237	9.0	2.4	0.1
	7/14/2007	1035	11.1	6.9	195	7.5	5.7	0.1
	8/29/2007	1017	11.8	6.9	211	7.6	4.1	0.0
	10/14/2007	1318	6.7	7.7	215	7.4	2.9	-
	7/15/2010	1323	14.6	8.1	199	7.7	-	0.1
RIT75	9/16/2006	1525	11.7	-	-	-	-	0.4
	10/27/2006	1415	6.1	8.0	166	8.8	-	0.2
	4/19/2007	1355	9.2	7.8	156	8.9	20.0	1.3
	6/8/2007	1603	12.1	8.0	173	7.6	5.1	0.3
	7/14/2007	1250	13.8	7.1	162	7.6	6.1	0.2
	8/29/2007	1105	14.1	7.0	147	7.5	3.7	0.1
	10/14/2007	1250	7.4	7.6	155	7.5	5.8	-
	7/15/2010	1428	16.7	8.0	148	7.1	-	0.2
RIT71	9/16/2006	1610	-	-	-	-	-	1.5
	10/27/2006	1610	6.1	7.3	146	8.8	-	0.4
	4/19/2007	1103	5.5	7.7	151	9.4	16.6	0.9
	6/7/2007	1407	12.4	8.1	156	7.9	3.5	0.5
	7/14/2007	1435	15.0	7.2	172	7.4	4.6	0.2
	8/29/2007	1244	15.6	7.0	141	7.6	3.9	0.3
	10/14/2007	1215	8.0	7.6	138	8.1	3.3	-
	7/15/2010	1614	17.2	8.1	126	7.1	-	0.2
RIT64	9/16/2006	1650	-	-	-	-	-	1.3
	10/27/2006	1630	7.0	8.3	139	9.1	-	1.0
	4/19/2007	1528	10.0	7.8	140	8.7	13.3	1.4
	6/7/2007	1640	12.2	8.0	139	7.8	2.6	0.7
	7/14/2007	1630	15.0	7.2	109	7.1	3.8	0.5
	8/29/2007	1355	15.3	7.0	131	7.8	3.3	0.4

Table B3. Spatial variability of water quality core parameter data from the Rito de los Frijoles in BAND, 2006 – 2011
continued

Site code	Date	Time	Water temp (°C)	pH	Specific conductivity	Dissolved oxygen (mg/L)	Turbidity (NTU)	Discharge (cfs)
	10/14/2007	1140	8.3	7.6	122	7.9	3.1	-
	7/15/2010	1730	17.2	8.0	112	7.0	-	0.5
RIT02	9/16/2006	1142	-	-	-	-	-	1.8
	10/27/2006	1745	6.9	7.6	140	9.4	-	1.2
	4/19/2007	1710	10.3	7.9	140	8.7	9.9	2.4
	6/7/2007	1826	12.3	8.2	138	8.0	2.2	1.4
	10/14/2007	1035	8.6	7.7	117	8.0	0.9	-
	7/16/2010	1452	17.2	8.1	114	7.3	2.6	1.3
RIT05	10/28/2006	1121	3.7	8.3	144	10.3		1.3
	4/18/2007	1740	10.3	7.9	140	8.9	11.6	2.0
	6/6/2007	1600	14.7	8.3	-	7.1	3.7	0.7
	7/13/2007	1645	16.4	7.2	170	7.7	-	0.6
	10/13/2007	1640	10.4	7.6	117	8.0	1.5	-
	7/16/2010	1537	17.7	8.0	114	7.3	-	-
RIT04	10/28/2006	1232	4.7	8.1	144	10.2		1.7
	4/18/2007	1605	9.9	8.0	139	9.1	11.5	2.0
	6/6/2007	1418	14.6	8.2	106	7.8	4.1	0.8
	7/13/2007	1445	16.1	7.2	173	7.8	8.0	0.8
	10/13/2007	1550	10.0	7.6	117	8.2	2.6	-
RIT03	10/28/2006	1348	6.0	7.9	144	9.9	-	1.2
	4/18/2007	1320	10.0	7.9	140	9.2	11.5	1.9
	6/6/2007	1220	13.5	8.2	106	8.2	3.4	0.9
	7/13/2007	1255	16.4	7.2	174	6.8	4.4	0.6
	10/13/2007	1456	10.8	7.7	119	8.4	3.6	-
RIT01	10/28/2006	1450	8.5	7.7	148	9.2	-	1.0
	4/18/2007	1933	9.9	7.7	144	8.9	10.6	2.1
	6/6/2007	0940	11.7	7.8	122	8.1	4.3	0.7
	7/13/2007	0904	15.5	7.2	159	7.0	5.8	0.4
	10/13/2007	1119	9.9	7.9	120	7.8	1.0	0.9
	10/15/2007	930	7.3	7.6	121	7.7	0.8	0.9
	7/14/2010	2210	18.5	8.0	122	7.1	2.7	0.4
RIT22	10/26/2006	1610	-	-	-	-	13.1	0.8
	4/17/2007	1930	8.8	8.0	145	9.5	12.6	1.7
	6/5/2007	1910	15.1	8.4	143	7.9	3.8	0.3
	7/13/2007	1045	17.4	7.2	195	7.3	9.7	0.2
	10/13/2007	1320	11.2	7.9	123	8.7	1.2	-

Table B4. Results of laboratory analyses of samples collected from RIT01 on the Rito de los Frijoles in Bandelier NM in 2011. Samples were analyzed by the U.S. Geological Survey National Water Quality Laboratory (NWQL). Results that were lower than the NWQL reporting levels are noted as "<[reporting level]". All analytes were dissolved, except for acid neutralizing capacity.

Analyte	Sample collection date and time							
	1/10/11 17:45	2/22/11 19:00	3/28/11 19:20	5/11/11 8:59	7/13/11 14:10	9/12/11 9:55	10/21/11 15:15	12/18/11 17:00
Nutrients (mg/L)								
Ammonia as N	<0.0100	<0.0100 ^a	<0.0100	<0.0100	<0.0100	0.05	<0.0100	<0.0100
Nitrite + nitrate as N	0.066	0.047 ^a	<0.020	<0.020	<0.020	0.205	0.107	0.128
Nitrite as N	<0.00100	<0.00100 ^a	<0.00100	0.00123	<0.00100	0.0304	<0.00100	0.00127
Orthophosphate as P	0.0429	0.0401 ^a	0.0287	0.0473	0.0994	0.356	0.226	0.111
Major elements (mg/L)								
Calcium	7.39	7.19	7.86	8.56	11.1	40.2	31.5	23.8
Chloride	3.64	3.31	3.28	2.79	2.44	5.48	4.88	4.14
Fluoride	0.145	0.158	0.186	0.168	0.216	0.262	0.235	0.221
Magnesium	2.71	2.73	2.74	2.98	3.71	9.31	8.61	6.98
Potassium	1.45	1.39	1.51	1.65	2.6	8.38	6.3	3.65
Silica	61	73.8	62.1	65.3	70	48.1	58.9	56.1
Sodium	11	10.7	11	11.3	13	16	18.4	16.3
Sulfate	1.91	1.74	1.84	1.64	1.35	10	2.95	3.14
Acid neutralizing capacity, as CaCO ₃ (unfiltered)	49	49.4	52.4	54	68.9	162	147	118
Total dissolved solids	122	126	129	130	149	269	235	186
Trace metals (µg/L)								
Aluminum	36	25	7.07	10.4	9.27	73.9	95.6	82.7
Antimony	0.0501	0.103	0.0535	0.048	0.116	0.24	0.0983	0.0699
Arsenic	0.605	0.643	0.659	0.685	1.33	3.94	2.43	1.33
Barium	10.3	9.83	10.2	10.2	15.7	63.3	33	27.5
Beryllium	0.0155	0.0114	0.0094	<0.0060	0.0100	0.0323	0.0313	0.0266
Boron	5.31	6.60	6.41	7.17	11.9	29.9	19.6	13.3
Cadmium	<0.016	<0.016	<0.016	<0.016	<0.016	0.034	0.02	<0.016
Chromium	0.272	0.294	0.167	0.173	0.119	0.138	0.139	0.167
Cobalt ^b	0.0335	0.0232	0.0259	0.0244	0.0301	1.21	0.843	0.736
Copper	<0.50	<0.50	<0.50	<0.50	0.63	0.77	<0.800	<0.800
Iron ^b	70	48.2	38.8	49.1	76.4	83.5	229	192
Lead	0.106	0.0962	0.0951	0.0722	0.0519	0.233	0.355	0.195
Manganese ^b	16.8	10.9	12.5	9.62	6.56	391	171	226
Mercury	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum ^b	1.01	1.04	1.13	1.1	1.93	9.24	5.88	3.14

Table B4. Results of laboratory analyses of samples collected from RIT01 on the Rito de los Frijoles in Bandelier NM in 2011 *continued*

Analyte	Sample collection date and time							
	1/10/11 17:45	2/22/11 19:00	3/28/11 19:20	5/11/11 8:59	7/13/11 14:10	9/12/11 9:55	10/21/11 15:15	12/18/11 17:00
Nickel	0.155	0.164	0.152	0.145	0.27	1.39	1.05	0.793
Selenium	0.084	0.119	0.083	0.062	0.091	0.312	0.181	0.121
Silver	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0053	<0.0050	0.0073
Uranium	0.0412	0.0427	0.031	0.0312	0.064	2.17	0.709	0.459
Vanadium	3.05	3.85	4.11	3.35	3.99	3.53	2.38	1.92
Zinc	<1.40	<1.40	<1.40	<1.40	<1.40	<1.40	<1.40	<1.40

^a Nutrient samples arrived warm (7°C) to the NWQL, nutrients should be kept <4°C.

^b Results of a field blank indicated contamination with small concentrations of cobalt (0.0464 µg/L), iron (4.37 µg/L), manganese (0.154 µg/L), and molybdenum (0.0338 µg/L).

Table B5. Detections of contaminants of emerging concern for samples collected from RIT01 on the Rito de los Frijoles in BAND, 2011, with lowest applicable water quality criterion. All results are in ng/L.

Analyte	Reporting limit (ng/L)	5/11/11	6/9/11	7/13/11	8/3/11	9/12/11	10/21/11
Pharmaceuticals and Personal Care Products (PCPPS)							
DEET	10.0					33.9	
Caffeine	10.0						12.1
Waste indicators							
Nonylphenol Chronic aquatic life criterion: 6.6 µg/L	50.0	61.6 ^a					
Phenol DWS ^b : 10,500 µg/L	50.0	351 ^a			403		
Tri (2-butoxyethyl) phosphate	50.0	1050 ^a				327	
Bisphenol A	50.0		198 ^a	55.8			
Tri (dichloroisopropyl) phosphate	50.0		81.3 ^a				
Acetophenone	50.0				253 ^c		
Caffeine	50.0				112		
p-Cresol	50.0				293	93.0	
Isoquinoline	50.0				100		
2-Methylnaphthalene	50.0				97.1		
Naphthalene	50.0				240 ^c		
Phenanthrene	50.0				111		
Pentachlorophenol DWS: 1.0 µg/L	50.0					140	
Pesticides							
Propachlor OA	10.0		14.7				

^aLaboratory QA/QC acceptance criterion not met; results are estimates

^bDWS = domestic water supply

^cCalibration acceptance criterion not met; results are estimates

Table B6. Radionuclide results for water and sediment samples collected from RIT01 on the Rito de los Frijoles in Bandelier NM, December 19 2011. The units used for the concentration of a radiological constituent is picocuries per liter (pCi/L). Results below the critical level are considered to be nondetections (ND). New Mexico (N.M.) state drinking water standards only apply to gross alpha.

Radionuclide analysis	Water samples, unfiltered		Sediment samples		N.M. state drinking water standard (pCi/L)
	Result (pCi/L)	Critical level (pCi/L)	Result (pCi/g)	Critical level (pCi/g)	
Gross alpha, 72-hour	8.20 ± 1.2	0.54	6.78 ± 1.2	0.84	15
Gross alpha, 30-day	7.84 ± 1.2	0.53	3.24 ± 0.91	0.91	15
Gross beta, 72-hour	11.2 ± 0.78	0.52	17.4 ± 1.6	1.7	----
Gross beta, 30-day	11.1 ± 0.78	0.50	15.3 ± 1.5	1.7	----
U-233/234	0.633 ± 0.079	0.022	0.165 ± 0.018	0.0082	----
U-235	0.0440 ± 0.018	0.0087	0.0100 ± 0.0040	0.0053	----
U-238	0.532 ± 0.068	0.021	0.190 ± 0.020	0.0053	----
Gamma emitters					
Be-7	ND	0.49	0.352 ± 0.18	0.30	----
K-40	14.9 ± 1.6	2.4	27.2 ± 1.0	0.33	----
Co-60	ND	0.23	ND	0.026	----
Nb-94	ND	0.077	ND	0.012	----
Ru-106	ND	0.58	ND	0.13	----
Sb-125	ND	0.46	ND	0.034	----
Cs-137	ND	0.26	ND	0.017	----
Eu-152	ND	0.18	ND	0.033	----
Eu-154	ND	0.45	ND	0.057	----
Eu-155	ND	0.10	ND	0.025	----
Bi-212	0.643 ± 0.39	0.64	0.610 ± 0.064	0.094	----
Pb-212	1.12 ± 0.27	0.29	0.816 ± 0.066	0.031	----
Bi-214	1.18 ± 0.31	0.51	0.664 ± 0.074	0.048	----
Pb-214	1.24 ± 0.28	0.47	0.681 ± 0.033	0.040	----
Ra-226	1.15 ± 0.30	0.49	0.645 ± 0.069	0.046	----
Th-228	1.10 ± 0.26	0.28	0.799 ± 0.066	0.031	----
Th-232	0.993 ± 0.55	0.94	0.889 ± 0.046	0.088	----
U-238	ND	18	ND	3.4	----
Am-241	ND	0.14	ND	0.030	----

Table B7. Water quality core parameter data for samples collected from RIT02 on the Rito de los Frijoles in Bandelier NM, 2011.

Core parameter	Units	Sample collection date and time						
		1/11 11:53	2/23 12:30	3/30 9:48	5/9 17:56	9/12 17:14	10/18 14:20	12/19 12:30
Water temperature	°C	0.3	5.2	6.0	12.7	17.0	14.0	4.5
pH		8.0	8.0	8.1	8.0	8.1	8.1	8.1
Specific conductivity	µS/cm	99	98	99	103	302	229	165
Dissolved oxygen	mg/L	11.2	9.6	9.6	7.8	7.2	7.9	9.7
Turbidity	NTU	1.7	2.0	2.7	3.3	250	4.2	3.2
Discharge	cfs	1.2	1.1	1.1	0.9	1.3	1.5	1.6

Table B8. Total coliforms and *E. coli* for samples collected at RIT02 on the Rito de los Frijoles in Bandelier NM, 2011. The maximum detection level for bacteria is 2400 MPN/100 mL.

Total coliforms and <i>E. coli</i>	Sample collection date and time						
	1/11 11:53	2/23 12:30	3/30 9:48	5/9 17:56	9/12 17:14	10/18 14:20	12/19 12:30
Total coliforms (MPN/100 mL)	980	51	650	520	>2400	1100	1300
<i>E. coli</i> (MPN/100 mL)	15	<1	440	7	43	1	<1

Table B9. Results of laboratory analyses of samples collected at RIT02 on the Rito de los Frijoles in Bandelier NM in 2011. Samples were analyzed by the U.S. Geological Survey National Water Quality Laboratory (NWQL). Results that were lower than the NWQL reporting levels are noted as "<[reporting level]". All analytes were dissolved, except for acid neutralizing capacity.

Analyte	Sample collection date and time						
	1/11/11 11:53	2/23/11 12:30	3/30/11 9:48	5/9/11 17:56	9/12/11 17:14	10/18/11 14:20	12/19/11 12:30
Nutrients (mg/L)							
Ammonia as N	<0.0100	<0.0100 ^a	<0.0100	<0.0100	0.10	0.04	0.02
Nitrite + nitrate as N	0.188	0.172 ^a	0.153	0.088	0.201	0.111	0.158
Nitrite as N	<0.00100	<0.00100 ^a	<0.00100	0.00141	0.0302	0.00382	0.00226
Orthophosphate as P	0.0475	0.0474 ^a	0.0373	0.0509	0.347	0.253	0.142
Major elements (mg/L)							
Calcium	7.53	7.39	7.49	8.15	35.9	25.7	17.2
Chloride	2.75	2.62	2.46	2.18	3.92	3.39	2.67
Fluoride	0.143	0.153	0.167	0.147	0.25	0.251	0.211
Magnesium	2.8	2.79	2.68	2.84	8.05	6.51	4.81
Potassium	1.39	1.38	1.32	1.52	7.7	4.92	2.85
Silica	66.9	65.7	64.9	67.5	53.9	61.9	57.9
Sodium	10.7	10.8	10.3	10.6	14.4	14.5	12.2
Sulfate	1.68	1.58	1.63	1.55	6.83	2.06	1.95
Acid neutralizing capacity, as CaCO ₃ (unfiltered)	51.1	49.8	50.3	51.8	143	113	85.4
Total dissolved solids	119	117	132	117	239	196	157
Trace metals (µg/L)							
Aluminum	25.6	24.2	55.3	15.7	90.2	27.9	50.9
Antimony	0.0547	0.0625	0.0498	0.057	0.191	0.0976	0.0597
Arsenic	0.705	0.73	0.71	0.782	3.29	2.43	1.46
Barium	9.67	8.97	8.87	9.54	60.2	41.7	25.1
Beryllium	0.0079	0.0092	0.0158	<0.0060	0.0429	0.0274	0.0254
Boron	5.55	6.05	5.9	7.8	28.5	16.9	11.2
Cadmium	<0.016	<0.016	<0.016	<0.016	0.032	<0.016	<0.016
Chromium	0.837	0.844	0.825	0.771	0.223	0.256	0.339
Cobalt ^b	<0.0200	<0.0200	0.0972	<0.0200	0.919	1.05	0.472
Copper	<0.50	1.1	<0.50	<0.50	0.55	<0.800	<0.800
Iron ^b	15.3	14.3	31.6	14	110	498	310
Lead	0.0684	0.134	0.0973	0.067	0.249	0.169	0.162
Manganese ^b	0.329	0.361	0.887	0.608	981	1000	502
Mercury	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Molybdenum ^b	0.995	0.998	0.981	1.04	7.18	4.95	2.61
Nickel	<0.090	<0.090	<0.090	<0.090	1.19	0.82	0.528
Selenium	0.234	0.221	0.191	0.199	0.309	0.206	0.138
Silver	<0.0050	<0.0050	<0.0050	<0.0050	0.0064	<0.0050	<0.0050
Uranium	0.166	0.18	0.178	0.128	1.68	0.763	0.462
Vanadium	5.33	6.16	5.86	6.59	2.92	2.95	3.3
Zinc	<1.40	<1.40	<1.40	<1.40	<1.40	<1.40	<1.40

^a Nutrient samples arrived warm (7°C) to the NWQL, nutrients should be kept <4°C.

^b Results of a field blank indicated contamination with small concentrations of cobalt (0.0464 µg/L), iron (4.37 µg/L), manganese (0.154 µg/L), and molybdenum (0.0338 µg/L).

Table B10. Radionuclide results from water and sediment samples at RIT02 on the Rito de los Frijoles in Bandelier NM, December 19 2011. The units used for the concentration of a radiological constituent is picocuries per liter (pCi/L). The critical level is the concentration below which results are considered to be nondetections (ND). New Mexico (N.M.) state drinking water standards only apply to gross alpha.

Radionuclide analysis	Water samples, unfiltered		Sediment samples		N.M. state drinking water criterion
	Result (pCi/L)	Critical level (pCi/L)	Result (pCi/g)	Critical level (pCi/g)	
Gross alpha, 72-hour	0.911 ± 0.30	0.31	9.50 ± 1.5	0.97	15
Gross alpha, 30-day	ND	0.51	9.00 ± 1.4	0.55	15
Gross beta, 72-hour	3.38 ± 0.41	0.51	18.5 ± 1.6	1.4	----
Gross beta, 30-day	3.11 ± 0.50	0.68	16.2 ± 1.6	1.8	----
U-233/234	0.250 ± 0.043	0.017	0.230 ± 0.022	0.0085	----
U-235	ND	0.019	0.0160 ± 0.0060	0.0051	----
U-238	0.181 ± 0.036	0.015	0.218 ± 0.021	0.0057	----
Gamma emitters					
Be-7	ND	0.96	ND	0.21	----
K-40	1.42 ± 1.5	2.4	27.1 ± 1.0	0.30	----
Co-60	ND	0.17	ND	0.023	----
Nb-94	ND	0.040	ND	0.0068	----
Ru-106	ND	0.47	ND	0.26	----
Sb-125	ND	0.50	ND	0.016	----
Cs-137	ND	0.17	ND	0.019	----
Eu-152	ND	0.17	ND	0.030	----
Eu-154	ND	0.17	ND	0.036	----
Eu-155	ND	0.15	ND	0.022	----
Bi-212	ND	0.48	0.953 ± 0.055	0.065	----
Pb-212	ND	0.19	1.12 ± 0.053	0.025	----
Bi-214	ND	0.35	0.913 ± 0.038	0.044	----
Pb-214	ND	0.38	0.968 ± 0.042	0.038	----
Ra-226	ND	0.34	0.886 ± 0.037	0.043	----
Th-228	ND	0.19	1.10 ± 0.052	0.025	----
Th-232	ND	0.61	1.29 ± 0.10	0.073	----
U-235	ND	1.1	ND	0.27	----
U-238	ND	16	ND	3.5	----
Am-241	ND	0.33	ND	0.11	----

Table B11. Water quality core parameter data for samples collected from RIT03 on the Rito de los Frijoles in Bandelier NM, 2011.

Core parameter	Units	Sample collection date and time						
		5/11 11:20	6/9 20:25	7/13 11:40	8/3 9:50	9/12 12:15	10/21 16:35	12/20 11:43
Water temperature	°C	7.4	14.8	18.0	17.7	18.3	10.2	0.2
pH		8.0	7.7	7.7	8.3	8.4	8.2	8.0
Specific conductivity	µS/cm	96	108	134	227	352	265	190
Dissolved oxygen	mg/L	9.4	7.3	7.3	7.5	7.4	8.9	11.4
Turbidity	NTU	2.3	2.9	1.8	230	190	240	88
Discharge	cfs	0.8	0.3	---- ^a	0.8	1.2	0.8	1.4

^a No measurement was taken

Table B12. Total coliforms and *E. coli* in samples collected at RIT03 on the Rito de los Frijoles in Bandelier NM, 2011. The maximum detection level for bacteria is 2400 MPN/100 mL.

	Sample collection date and time						
	5/11 11:20	6/9 20:25	8/3 9:50	9/12 12:15	10/21 16:35	12/20 11:43	
Total coliforms (MPN/100 mL)	517	>2400	2400	>2400	>2400	2400	
<i>E. coli</i> (MPN/100 mL)	<1	11	550	86	10	7	

Table B13. Detections of contaminants of emerging concern for samples collected from RIT03 on the Rito de los Frijoles in Bandelier NM, 2011. All results are in ng/L.

Analyte	Reporting limit (ng/L)	Sample collection date and time					
		5/11/11 11:20	6/9/11 20:25	7/13/11 11:40	8/3/11 9:50	9/12/11 12:15	10/21/11 16:35
Pharmaceuticals and Personal Care Products (PPCPs)							
Caffeine	10.0					13.8	
Waste indicators							
Phenol, DWS ^a = 10,500 µg/L	50.0	274 ^b				231	
Bisphenol A	50.0		61.4 ^b	70.7		114	
Tri (dichloroisopropyl) phosphate)	50.0		58.0 ^b				
Acetophenone	50.0				201 ^c		
p-Cresol	50.0				243		
Isoborneol	50.0				95.0		
Isoquinoline	50.0				92.1		
2-Methylnaphthalene	50.0				84.9		
Naphthalene	50.0				206 ^b		
Nonylphenol, chronic aquatic life criterion: 6.6 µg/L	50.0				1660		

Table B13. Detections of contaminants of emerging concern for samples collected from RIT03 on the Rito de los Frijoles in Bandelier NM, 2011 *continued*

Analyte	Reporting limit (ng/L)	Sample collection date and time					
		5/11/11 11:20	6/9/11 20:25	7/13/11 11:40	8/3/11 9:50	9/12/11 12:15	10/21/11 16:35
Phenanthrene	50.0				99.4		
Caffeine	50.0					72.4	
Pentachlorophenol DWS: 1.0 µg/L	50.0					80.2	
Tri (2-butoxyethyl) phosphate	50.0					272	
Pesticides							
Propachlor OA	10.0		11.3				

^aDWS = domestic water supply

^bLaboratory QA/QC acceptance criterion not met; results are estimates

^cCalibration acceptance criterion not met; results are estimates

Table B14. Water quality core parameter data for samples collected from CAP01 on Capulin Creek in Bandelier NM, 2011.

Core parameter	Units	Sample collection date and time			
		3/29 12:45	5/10 11:39	9/13 14:09	10/20 13:40
Water temperature	°C	8.7	10.3	23.9	15.7
pH		8.0	8.0	8.3	8.2
Specific conductivity	µS/cm	137	137	400	265
Dissolved oxygen	mg/L	8.5	8.6	6.5	7.6
Turbidity	NTU	3.2	4.2	296	7.3
Discharge	cfs	0.4	0.4	0.5	0.6

Table B15. Total coliforms and *E. coli* for samples collected at CAP01 on Capulin Creek in Bandelier NM, 2011. The maximum detection level for bacteria is 2400 MPN/100 mL

Total coliforms and <i>E. coli</i>	Sample collection date and time			
	3/29 12:45	5/10 11:39	9/13 14:09	10/20 13:40
Total coliforms (MPN/100 mL)	280	730	>2400	2000
<i>E. coli</i> (MPN/100 mL)	3	17	55	<1

Appendix C: List of analytes and reporting limits for pesticides, pharmaceuticals and personal care products, and wastewater indicators

Table C1. Target analytes and reporting limits for pesticides

Analyte	Reporting limit (ng/L)	Analyte	Reporting limit (ng/L)
2,4,5-T	10.0	EPTC	20.0
2,4,5-TP	10.0	Ethoprop	10.0
2,4-D	10.0	Fipronil	20.0
3-Hydroxycarbofuran	10.0	Fipronil sulfide	10.0
Acetochlor	20.0	Hexazinone	10.0
Acetochlor OA	20.0	Imazaquin	20.0
Alachlor	20.0	Imazethapyr	10.0
Alachlor OA	50.0	Imidacloprid	20.0
Aldicarb	10.0	Linuron	20.0
Aldicarb sulfone	20.0	Malathion	10.0
Aldicarb sulfoxide	10.0	MCPP	20.0
Atrazine	10.0	Metalaxyl	10.0
Atrazine de-ethyl	20.0	Methiocarb	10.0
Atrazine de-isopropyl	20.0	Methomyl	20.0
Atraton	50.0	Metolachlor	10.0
Azoxystrobin	20.0	Metolachlor ESA	20.0
Bentazon	10.0	Metribuzin	20.0
Bromacil	50.0	Monuron	10.0
Bromoxynil	10.0	Neburon	50.0
Butachlor ESA	10.0	Oryzalin	20.0
Carbaryl	10.0	Oxamyl	10.0
Carbofuran	10.0	Pentachlorophenol	50.0
Chlorimuron ethyl	20.0	Prometon	10.0
Cyanazine	10.0	Propachlor	10.0
3-Hydroxycarbofuran	10.0	Propachlor ESA	20.0
Dacthal monoacid	20.0	Propazine	50.0
Diazinon	10.0	Propiconazole	20.0
Dichloroprop	10.0	Propoxur	10.0
Dimethachlor	10.0	Simazine	20.0
Dimethenamid	10.0	Sulfometuron methyl	20.0
Dimethenamid ESA	20.0	Tebuconazole	50.0
Disulfoton sulfone	20.0	Tebuthiuron	10.0
Diuron	50.0	Terbuthylazine	10.0
Diuron Metabolite	50.0	Thiamethoxam	20.0

Table C2. Target analytes and reporting limits for pharmaceuticals and personal care products

Analyte	Reporting limit (ng/L)	Analyte	Reporting limit (ng/L)
Acebutolol	10.0	Fenbufen	10.0
Albuterol	10.0	Fentanyl	10.0
Alprazolam	10.0	Flunitrazepam	10.0
Amitriptyline	10.0	Furosemide	10.0
Amitriptyline, (+/-)-E-10-hydroxylated	10.0	Gabapentin	25.0
Amphetamine	10.0	Gemfibrozil	10.0
Atenolol	10.0	Glipizide	10.0
Atrazine	10.0	Glyburide	10.0
Benzoylecgonine	10.0	Hydrocodone	10.0
Benzphetamine	10.0	Hydromorphone	10.0
Bezafibrate	10.0	m-Hydroxybenzoylecgonine	10.0
Brombuterol	10.0	Ibuprofen	10.0
Butabarbital	25.0	Levorphanol	10.0
Butalbital	10.0	Loratadine	10.0
n-Butylparaben	25.0	Mefenamic acid 3-carboxy	10.0
Carbamazepine 10,11 epoxide	10.0	MDA	10.0
Caffeine	10.0	MDEA	10.0
Cannabidiol	25.0	MDMA	10.0
Cannabinol	25.0	Meperidine	10.0
Carbamazepine	10.0	Mephobarbital	25.0
Carisoprodol	10.0	Meprobamate	10.0
Chloramphenicol	10.0	Metformin	10.0
Chlordiazepoxide	10.0	Methamphetamine	10.0
Chlorpheniramine	10.0	Methaqualone	10.0
Cimetidine	10.0	Methylparaben	10.0
Clenbuterol	10.0	Methypylon	10.0
Clobazam	10.0	Metoprolol	10.0
Clonazepam	10.0	Monensin	10.0
Clonidine	10.0	Morphine	10.0
Cocaethylene	10.0	Naproxen	10.0
Cocaine	10.0	Nifedipine	10.0
Codeine	10.0	Nifedipine oxidized	10.0
DEET	10.0	Nitrazepam	10.0
Dextromethorphan	10.0	Norfentanyl	10.0
Diazepam	10.0	Norfluoxetine	10.0
Diclofenac	10.0	Norverapamil	10.0
aDiltiazem	10.0	Omeprazole	10.0
Diphenhydramine	10.0	Oxycodone	10.0
Ecognine Methyl Ester	10.0	Oxymorphone	10.0
Erythromycin	10.0	Paroxetine	10.0
Famotidine	10.0	Pentazocine	10.0
Fenbendazole	10.0	Phencyclidine	10.0

Table C2. Target analytes and U.S. Environmental Protection Agency reporting limits for pharmaceuticals and personal care products, *continued*

Analyte	Reporting limit (ng/L)	Analyte	Reporting limit (ng/L)
Phenmetrazine	10.0	Temazepam	10.0
Phenobarbital	10.0	Testosterone	10.0
Phentermine	10.0	(+/-)11-nor-9-carboxy-delta-THC	10.0
Phenylpropanolamine	10.0	THC	25.0
Phenytoin	10.0	Thebaine	10.0
Pindolol	10.0	Thiabendazole	10.0
Prazepam	10.0	Tramadol	10.0
Progesterone	10.0	Trazodone	10.0
Propranolol	10.0	Triamterene	10.0
Pseudoephedrine	10.0	Triazolam	10.0
Ranitidine	10.0	Triclocarban	10.0
Secobarbital	10.0	Triclosan	10.0
Sildenafil	10.0	Trimethoprim	10.0
Simvastatin	10.0	Tylosin	10.0
Sotalol	10.0	Venlafaxine	10.0
Sulfamethazine	10.0	Verapamil	10.0
Sulfamethoxazole	10.0	Warfarin	10.0
Talbutal	25.0		

Table C3. Target analytes and U.S. Environmental Protection Agency reporting limits for wastewater indicators.

Analyte	Reporting limit (ng/L)	Analyte	Reporting limit (ng/L)
Acetophenone	50.0	17beta-Estradiol	50.0
Benzophenone	50.0	Estrone	50.0
Bisphenol A	50.0	Ethynylestradiol	50.0
Bromacil	50.0	Fluoranthene	50.0
Butylated Hydroxyanisole	50.0	Galaxolide	50.0
Caffeine	50.0	Indole	50.0
Camphor	50.0	Isoborneol	50.0
Carbaryl	50.0	Isophorone	50.0
Carbazole	50.0	Isoquinoline	50.0
Celestolide	50.0	Menthol	50.0
Chlorpyrifos	50.0	3-Methyl Indole	50.0
p-Cresol	50.0	Methyl Salicylate	50.0
4-Cumylphenol	50.0	2-Methylnaphthalene	50.0
Dacthal	50.0	1-Methylnaphthalene	50.0
Diazinon	50.0	2,6-Dimethylnaphthalene	50.0
1,4-Dichlorobenzene	50.0	Metolachlor	50.0
Dichlorvos	50.0	Musk ketone	50.0
Equilenin	50.0	Naphthalene	50.0
Nonylphenol	50.0	Tonalide	50.0
4-n-Octylphenol	50.0	Tributyl Phosphate	50.0
4-tert-Octylphenol	50.0	Triclosan	50.0
Pentachlorophenol	50.0	Tri(dichloroisopropyl) Phosphate	50.0
Phantolide	50.0	Triethyl Citrate	50.0
Phenanthrene	50.0	Tri(2-butoxyethyl) Phosphate	50.0
Phenol	50.0	Tri(2-chloroethyl) Phosphate	50.0
Prometon	50.0	Triphenyl phosphate	50.0
Pyrene	50.0		

Appendix D. Abbreviations, chemical formulas, and symbols used in this report

Term	Definition
ANC	acid neutralizing capacity of solutes plus particulates in an unfiltered water sample
CaCO ₃	chemical formula for calcium carbonate
cfs	cubic feet per second
cfu/100 ml	colony forming units, for bacteria sampling, a measure of the number of viable bacteria per 100 mL
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter at 25°C, a measure of specific conductivity
mg/L	milligrams per liter
Milliequivalents per liter	an expression of the concentration of substances that is chemically equivalent in terms atomic weight and electrical charge
MPN/100 mL	most probable number, for sampling bacteria, a statistical estimation of the number of coliform that would give the results shown by the laboratory examination
N	chemical symbol for the element nitrogen
NTU	nephelometric turbidity unit, a measure of turbidity
P	chemical symbol for the element phosphorous
pCi/L	picocuries per liter, the units used for the concentration of a radiological constituent