Prepared in cooperation with the U.S. Fish and Wildlife Service

Chemical Quality of Water and Bottom Sediment, Stillwater National Wildlife Refuge, Lahontan Valley, Nevada

Data Series 1072

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

Cover photograph: Tundra swans taking flight from Stillwater Marsh in Still-water National Wildlife Refuge, Lahontan Valley, Nevada. View looking east toward the Stillwater Range. Photo taken January 19, 2017, by Marie Nygren, for the U.S. Fish and Wildlife Service.

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Contents

Figures

Tables

Supplemental Data

Conversion Factors, Datums, and Water-Quality Units

U.S. customary units to International System of Units

Multiply	By	To obtain
	Length	
inch	2.54	centimeter
foot	0.3048	meter
mile	1.609	kilometer
	Area	
acre	0.4047	hectare
acre	0.004047	square kilometer
	Volume	
acre-foot	1,233	cubic meter

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

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

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

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

$$°F = (1.8 \times °C) + 32.$$

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

$$°C = (°F - 32) / 1.8.$$

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

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

Concentrations of chemical constituents in bottom sediments are given in either milligrams per kilogram (mg/kg), or micrograms per kilogram (µg/kg).

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Abstract

The U.S. Geological Survey, in cooperation with the U.S. Fish and Wildlife Service collected data on water and bottom-sediment chemistry to be used to evaluate a new water rights acquisition program designed to enhance wetland habitat in Stillwater National Wildlife Refuge and in Lahontan Valley, Churchill County, Nevada. The area supports habitat critical to the feeding and resting of migratory birds travelling the Pacific Flyway. Information about how water rights acquisitions may affect the quality of water delivered to the wetlands is needed by stakeholders and Stillwater National Wildlife Refuge managers in order to evaluate the effectiveness of this approach to wetlands management. A network of six sites on waterways that deliver the majority of water to Refuge wetlands was established to monitor the quality of streamflow and bottom sediment. Each site was visited every 4 to 6 weeks and selected water-quality field parameters were measured when flowing water was present. Water samples were collected at varying frequencies and analyzed for major ions, silica, and organic carbon, and for selected species of nitrogen and phosphorus, trace elements, pharmaceuticals, and other trace organic compounds. Bottom-sediment samples were collected for analysis of selected trace elements.

Dissolved-solids concentrations exceeded the recommended criterion for protection of aquatic life (500 milligrams per liter) in 33 of 62 filtered water samples. The maximum arsenic criterion (340 micrograms per liter) was exceeded twice and the continuous criterion was exceeded seven times. Criteria protecting aquatic life from continuous exposure to aluminum, cadmium, lead, and mercury (87, 0.72, 2.5, and 0.77 micrograms per liter, respectively) were exceeded only once in filtered samples (27, 40, 32, and 36 samples, respectively). Mercury was the only trace element analyzed in bottom-sediment samples to exceed the published probable effect concentration (1,060 micrograms per kilogram).

Introduction

Stillwater National Wildlife Refuge (SNWR), located in the Carson Desert hydrographic area (Rush, 1968; known locally as Lahontan Valley) consists of a complex system of flow-through and terminal wetlands and ponds in the internally drained Carson River Basin in west-central Nevada (fig. 1). The surrounding high desert Great Basin is characterized as arid, making wetland habitat critical to the feeding and resting of migratory birds protected under the 1918 Migratory Bird Treaty Act (16 U.S.C. 703–712; Ch. 128; July 13, 1918; 40 Stat. 755). The area is also recognized as an important habitat for the Western Hemisphere Shorebird Reserve Network (https://www.whsrn.org/lahontan-valley-wetlands), a “Globally Important Bird Area” by the American Bird Conservancy (http://www.abcbirds.org/abcprograms/domestic/iba/index.html), and an “Important Bird Area” by the National Audubon Society (http://www.audubon.org/important-bird-areas/lahontan-valley-wetlands). However, although water availability is the primary limiting factor for wetland management in Lahontan Valley (Engilis and Reid, 1996), potentially toxic contaminants associated with mining, milling, and irrigation drainage have been shown to adversely affect the ecological health of the area (Hallock and Hallock, 1993; Higgins and Miesner, 2002). Due to their persistence, trace organic compounds (TOCs) associated with treated domestic and industrial wastewater effluent, urban runoff, and leachate from livestock and dairy operations also may affect the ecological health of SNWR (Battaglin and Kolok, 2014) and potentially accumulate in the internally drained watershed.

Concern for the quality and related adverse effects of drainage from irrigated agriculture in the western United States led the Department of the Interior (DOI) to investigate the nature and extent of water-quality problems in National Wildlife Refuges and other areas that receive irrigation drainage from DOI irrigation facilities (Hoffman and others, 1990). Many of the wetlands in Lahontan Valley were found to be adversely affected by hydrological and geochemical processes related to the Newlands Irrigation Project area, with water collected from some agricultural drains found to be acutely toxic to aquatic organisms (Hallock and Hallock, 1993;

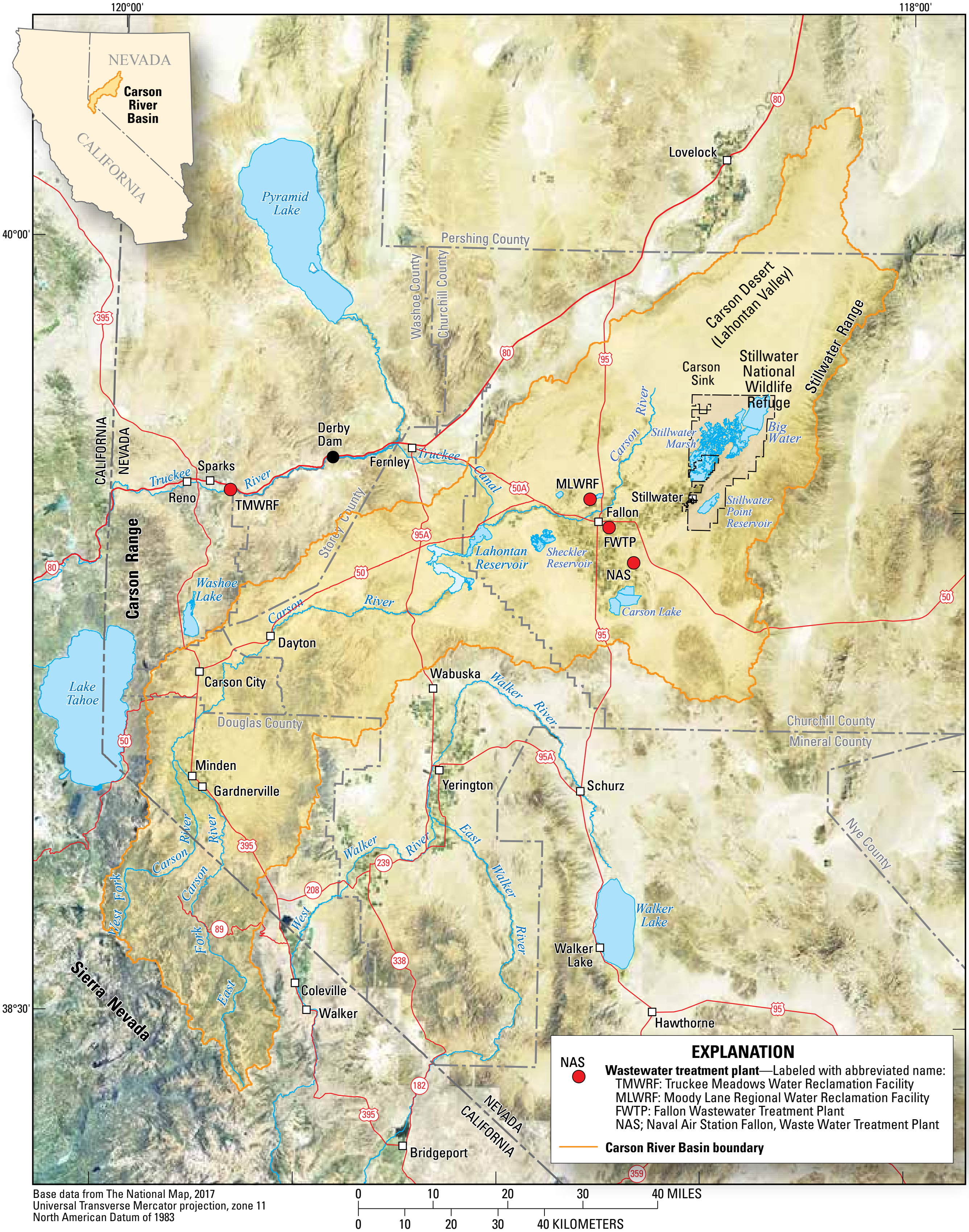


Figure 1. Location of selected hydrologic features and wastewater treatment facilities in the Carson River Basin, Stillwater National Wildlife Refuge and Carson Desert (Lahontan Valley) hydrographic area, Nevada.

Hoffman, 1994; Higgins and Miesner, 2002). Concentrations of dissolved solids, arsenic, boron, lithium, and molybdenum were found to increase in oxygenated water applied to irrigate alkaline agricultural fields due to dissolution and desorption of naturally occurring trace elements (Lico, 1992; Hoffman, 1994).

In addition, the lower Carson River floodplain downstream of Carson City has been on the Federal Superfund National Priority List since 1990 due to mercury contamination from historical milling and amalgamation of silver and gold ore mined from the Comstock Lode (https://yosemite.epa.gov/r9/sfund/r9sfdocw.nsf/vwsoalphabetic/Carson+River+Mercury+Site?OpenDocument). For uncertain reasons, the toxicity of mercury to SNWR wildlife has not been as severe as effects reported for wetlands affected by mercury contamination outside of Lahontan Valley (Henny and Herron, 1989; U.S. Fish and Wildlife Service, 2002; Hill and others, 2008).

Recognizing the environmental decline in critical wetland habitat, Congress included provisions in the 1990 Truckee-Carson-Pyramid Lake Water Rights Settlement Act (Title II of Public Law 101-618; the Act) to assist with restoration and maintenance of wetland ecosystems in Lahontan Valley (Neel and Henry, 1996). The Act authorized the Secretary of the Interior to purchase water rights needed to support a long-term average of 25,000 acres of wetland habitat, including 14,000 acres within SNWR (Tuttle and others, 2001). The U.S. Fish and Wildlife Service (USFWS) implemented a program in 1996 to purchase up to 75,000 acre-feet of water from the Carson Division of the Newlands Project. However, as presently enacted, the water rights acquisition program amount is much less than the 270,000 acre-feet per year estimated to have flowed into Lahontan Valley wetlands during average years before the Newlands Reclamation Project began in 1905 (Kerley and others, 1993). The purposes of acquiring water rights were to ensure that wetland habitat is available during non-drought years and improve the quality of water delivered to the refuge (U.S. Fish and Wildlife Service, 2002). The USFWS has also acquired rights to treated wastewater effluent, and the Truckee Meadows Water Reclamation Facility (TMWRF) is permitted to discharge treated effluent upstream of Derby Dam and the Truckee Canal. The feasibility of using treated municipal wastewater to improve or create wetlands is specified in the Act. To evaluate the effectiveness of this approach to wetland management, information about the quality of water currently being delivered to the wetlands is needed by stakeholders and SNWR managers.

Purpose and Scope

The purpose of this report is to provide data on the quality of water and bottom-sediment samples collected during 2014–16 and provide comparison to historical data in order to inform decision-makers about the water delivered to SNWR for wetland enhancement. The scope of the study focuses on the quality of water and bottom sediment collected from the primary inflows to SNWR. Samples collected during 2014–16 were analyzed for a comprehensive suite of analytes that included dissolved solids, major ions, organic carbon, nitrogen, phosphorus, and more than 100 trace organic compounds associated with treated wastewater effluent, as well as selected constituents with aquatic-life criteria. Historical data collected before implementation of the water rights acquisition program (1971–98) also are presented and when appropriate, compared to the 2014–16 data.

Description of Study Area

The SNWR occupies an area of about 79,570 acres in Lahontan Valley (fig. 1). Precipitation in the Carson Desert is negligible (less than 5 inches per year; http://www.usclimatedata.com/climate/fallon/nevada/united-states/usnv0028) compared to amounts that typically fall in the Sierra Nevada headwaters of the Carson and Truckee Rivers (40 inches per year; Maurer and Berger, 2007). Thus, virtually all of the inflow to SNWR originates as runoff to the Carson River plus diversions from the Truckee River via the Truckee Canal. Annual runoff statistics for selected U.S. Geological Survey (USGS) streamflow gaging stations highlight the range between wet years (maximums) and dry years (minimums), how maximums can skew mean values above median values, and how the Sierra Nevada rain shadow affects runoff contributions from eastern sub-basins of the drainage area (table 1). Runoff at the Truckee Canal station is the exception because it is regulated by diversions from the Truckee River at Derby Dam.

Table 1. Annual runoff for selected U.S. Geological Survey gaging stations, Carson and Truckee River Basins, Nevada and California, water years 1967–2015.

[mi², square miles; ft amsl, feet above mean sea level; NV, Nevada; CA, California; NA, not available]

Station name	Station number	Drainage area (mi^2)	Altitude (ft amsl)	Annual runoff (acre-feet)			
				Mean	Maximum	Median	Minimum
East Fork Carson River near Gardnerville, NV	10309000	356	5,036	261,000	621,000	230,000	66,000
West Fork Carson River at Woodfords, CA	10310000	65.4	5,754	73,000	176,000	64,000	19,000
Carson River near Fort Churchill, NV	10312000	1,302	4,180	270,000	805,000	218,000	26,000
Carson River below Lahontan Reservoir near Fallon, NV	10312150	1,801	4,040	337,000	772,000	325,000	70,000
Truckee River near Farad, CA	10346000	932	5,153	561,000	1,770,000	419,000	143,000
Truckee River at Vista, NV	10350000	1,431	4,368	575,000	2,018,000	415,000	114,000
Truckee Canal near Hazen, NV	10351400	NA	4,166	113,000	239,000	119,000	2,000

Prior to river diversions for irrigated agriculture and milling of ore and timber, the Lahontan Valley wetlands expanded and contracted in response to the natural variability in streamflow of the Carson River. Exceptionally wet periods would inundate much of Carson Sink and Lahontan Valley with water, creating a relatively shallow lacustrine habitat, whereas extended droughts resulted in isolated wetlands maintained by intercepted groundwater. Introduction of irrigated agriculture increased the distribution of groundwater recharge and evapotranspiration in the upper drainage basin and delayed streamflow to Lahontan Valley wetlands.

The Newlands Project was one of the first irrigation projects to be financed under the Reclamation Act and included construction of Derby Dam, Truckee Canal, Lahontan Dam and Reservoir, and a network of irrigation canals, laterals, and drains for irrigated agriculture (figs. 1 and 2). The interbasin transfer of Truckee River water occurs by the conveyance of river water through the Truckee Canal to Lahontan Reservoir on the Carson River. Since 1915, water from the Carson River and the Truckee Canal has been stored in Lahontan Reservoir to support crop irrigation through the typically arid growing season in Lahontan Valley. However, in spite of more than 100,000 acre-feet of water delivered to the reservoir from the Truckee River, estimated total wetland acreage in Lahontan Valley has been reduced from 150,000 acres prior to agricultural development in 1860 to 15,000 acres in 1992 (Hallock and Hallock, 1993). Wetland acreage varies considerably from year to year and unusually wet years can result in inundation of wetlands that are not considered to be viable habitat in normal water years due to irrigation diversions.

The Carson River Diversion Dam is located about 5 miles downstream of Lahontan Reservoir (https://www.usbr.gov/projects/index.php?id=52) (fig. 2). Most of the water released from the Diversion Dam is diverted through the "T Line" Canal on the north side of the river and the "V Line" Canal on the south side. Within Lahontan Valley, a 68-mile network of arterial canals distributes water to more than 300 miles of Newlands Reclamation Project lateral canals that irrigate about 55,000 acres of hay and forage crops. Nearly 350 miles of drains mitigate water-logging of crops and also convey water to other fields and to SNWR, and other wetlands. During wet years, water is allowed to flow out to the Carson Sink, which is the terminus of the internally drained Carson River.

Water availability is acknowledged as the primary limiting factor for wetland management in Lahontan Valley (Engilis and Reid, 1996). Natural variability in streamflow and an arid climate, coupled with competing demands for agriculture, public supplies, and endangered and threatened species have significantly changed the timing and reduced the volume and rate of water flowing into SNWR. Reduced water availability may also affect water quality and wetland habitat.

Approximately 7,500 tons of elemental mercury were lost during the Comstock milling boom (Smith, 1943; Bailey and Phoenix, 1944), making mercury possibly the greatest hazard to SNWR wetland ecosystems (U.S. Fish and Wildlife Service, 2002). During the peak of the boom (about 1860–1900) the Carson River flowed freely into Lahontan Valley until construction of Lahontan Dam and Reservoir in 1915. However, some mercury continues to reach SNWR (Wayne and others, 1996), and samples of water, bottom sediment, and food-web organisms have showed elevated concentrations of mercury in excess of fish and wildlife effect levels (Cooper, 1983; Hoffman and Thomas, 2000; Tuttle and others, 2001). Mercury methylation has been shown to be stimulated in wetlands and the process may be associated with wetland emergent vegetation (Windham-Meyers, 2009). However, toxicity of mercury to SNWR wildlife has not been as severe as effects reported for other mercury contaminated wetlands outside of Lahontan Valley (Henny and Herron, 1989; U.S. Fish and Wildlife Service, 2002; Hill and others, 2008) for yet unknown reasons.

Concentrations of un-ionized ammonia and 12 trace elements have been reported at levels of concern in water, bottom sediment, and biological samples. Aluminum, arsenic, boron, and mercury were identified as the contaminants of greatest concern. Mercury and selenium were found to be transported with living algae and organic detritus suspended in irrigation drainage, and bioaccumulated as much as 10,000 fold in invertebrates when compared to concentrations in water (U.S. Fish and Wildlife Service, 2002). Concentrations of boron, mercury, and selenium also were higher than published adverse effect levels in several juvenile migratory birds (Hallock and Hallock, 1993). The health of the aquatic food web may be at risk due to possible effects of long-term mercury exposure combined with other trace elements (U.S. Fish and Wildlife Service, 2002), pesticides, and other organic compounds (Kilroy and Watkins, 1997; Schoenfuss and others, 2016).

Trace organic compounds, including antibiotics, human and veterinary pharmaceuticals, fragrances, detergents, fire retardants, disinfectants, and insect repellants are a new focus for environmental research because they are increasingly being detected in the environment (Kolpin and others, 2002; Barnes and others, 2002; Furlong and others, 2014) and also may affect the ecological health of SNWR. Recent advances in analytical methods are now allowing for the measurement of TOCs at concentrations as low as a few parts per trillion, and although they are found in relatively low concentrations, they are increasingly being detected in the environment large distances from municipal wastewater treatment facilities (Furlong and others, 2014). Currently there is little information regarding the toxicological significance of TOCs in ecosystems, particularly effects from long-term, low-level exposures in an aquatic environment affected by other contaminants, but many are known or suspected to disrupt endocrine systems of aquatic organisms (Daughton and Ternes, 1999).

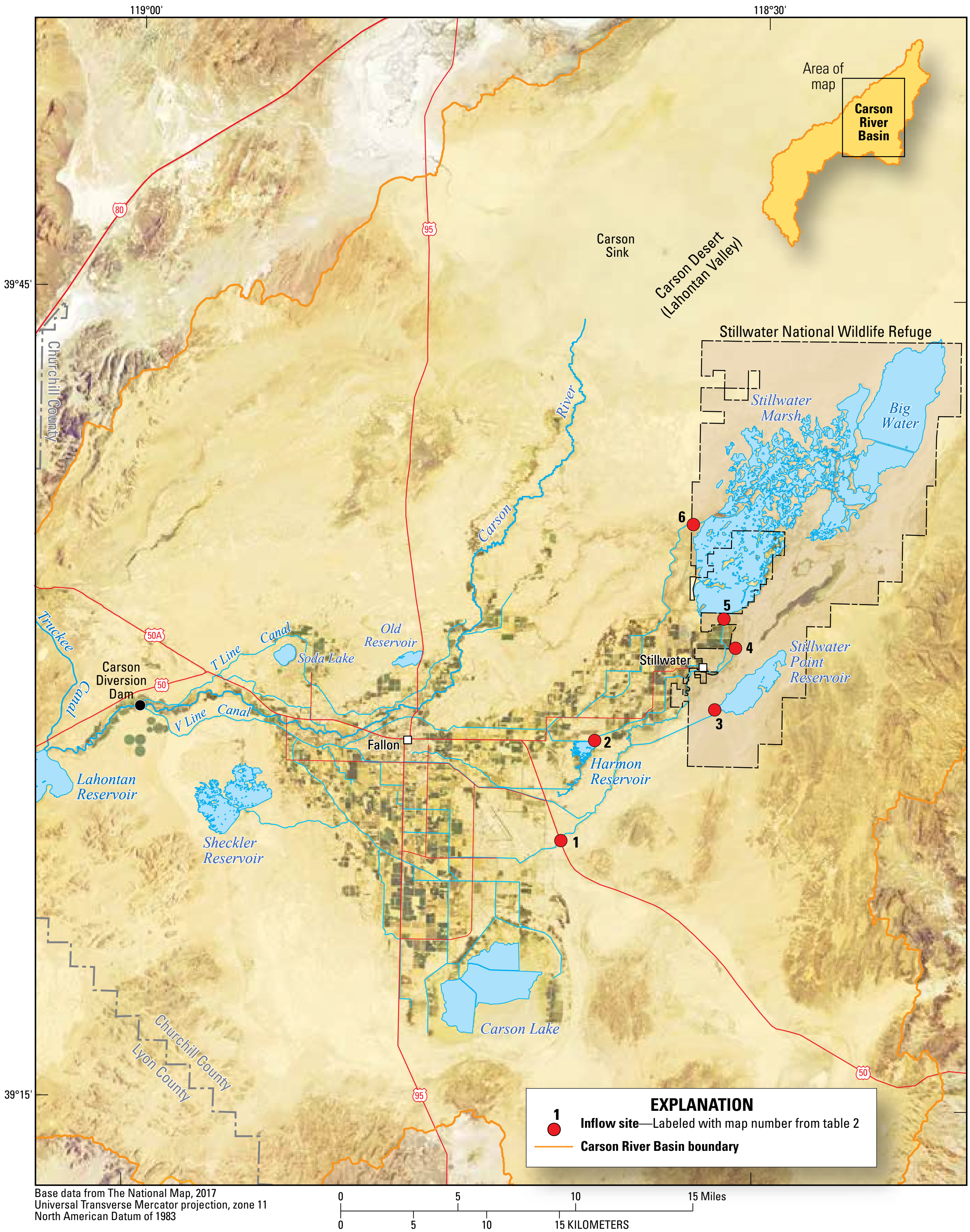


Figure 2. Location of selected hydrologic features, and water and bottom-sediment sampling sites in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada.

Methods

Site Selection and Field Measurements

For the purposes of this investigation, six sites on waterways (fig. 2; table 2) identified by the USFWS to deliver the majority of water to SNWR wetlands were established or re-activated as surface-water monitoring stations in the USGS National Water Information System (NWIS) for data storage, access, and archiving. Historical data were collected as early as 1967 at site 5 to provide information about water deliveries from the Newlands Reclamation Project to SNWR, and sites 1, 2, 4, and 6 were established during the DOI National Irrigation Drainage investigation of Lahontan Valley wetlands between 1986 and 1998. Site 3 was established in 2013 on a canal recently constructed to bypass Stillwater Point Reservoir due to inadequate wetland habitat. Graduated staff plates and crest-stage gages were installed at each site as points of reference for monitoring and as a stable datum to relate stream stage to intermittently measured streamflow and as an indicator of peak streamflow, respectively (Sauer and Turnipseed, 2010; Turnipseed and Sauer, 2010).

Sites were visited about every 6 weeks, and when flowing water was observed, gage height was recorded and instantaneous streamflow was measured using acoustic Doppler methodology with graduated tagline and wading rod (Turnipseed and Sauer, 2010). Water-quality field parameters (temperature, specific conductance, pH, Eh, and dissolved oxygen) were measured using a calibrated multiparameter meter and water-quality probes according to standard USGS protocols (U.S. Geological Survey, variously dated) and manufacturer specifications. Alkalinity, bicarbonate, and carbonate were determined for water samples within 24 hours of sample collection by inflection point-digital titration with sulfuric acid following USGS protocols (U.S. Geological Survey, variously dated; Rounds, 2012).

Collection and Processing of Surface-Water and Bottom-Sediment Samples

Sampling equipment was cleaned prior to sample collection following procedures described by Wilde (2004). Samples of flowing water were collected using a DH81 standard hand-held, depth-integrating sampler following the equal-width-increment method (U.S. Geological Survey, 2006). When flow was minimal, grab samples were collected from the middle of the channel using a clean, 1-liter polyethylene wide-mouth bottle (Wilde and others, 2004; U.S. Geological Survey, 2006). A minimum of six sub-samples collected from designated locations along the stream, canal, or ditch cross section were composited in a clean polypropylene churn splitter used to fill clean sample bottles with homogenized unfiltered sample water.

After processing unfiltered samples from the churn, sample water for TOC analysis was drawn into a sample-rinsed disposable, 20-milliliter (mL) polypropylene syringe fitted with a disposable 25-millimeter (mm), 0.7-micron nominal pore diameter, glass fiber filter from which water was forced through into a 20-mL amber glass vial. Sample vials were sealed with a septa cap and bagged, and immediately chilled to 4 ºC in an ice-filled cooler. A variable-speed peristaltic pump was used to process the remaining samples from the composited water in the churn through tygon tubing and disposable 0.45-micron capsule filters into clean sample bottles. Prior to sample processing, capsule filters were pre-rinsed with 2 liters of de-ionized water to leach any residual trace elements that may be associated with the filter as determined from the manufacturer. Teflon sample bottles and quality-assured hydrochloric acid used during the processing of mercury samples were provided by the USGS Wisconsin Mercury Research Laboratory (WMRL). Samples for filtered and unfiltered mercury and methylmercury analysis were preserved to 1 percent (volume of preservative added per sample volume) with hydrochloric acid. Samples for determination of major cations and trace elements were treated with Ultrex 7.7N nitric acid to a pH of less than 2. Water samples collected for determination of unfiltered concentrations of nitrogen and phosphorus species and filtered organic carbon were treated with 4.5N sulfuric acid to a pH of less than 2. Immediately following sample processing, all samples were stored away from direct sunlight and chilled to 4 ºC in ice-filled coolers. Major constituents, selected species of nitrogen and phosphorus, and selected trace element samples

Table 2. Sampling sites selected for collection of water and bottom-sediment samples, Stillwater National Wildlife Refuge, Lahontan Valley, Nevada.

Map number (figure 2)	U.S. Geological Survey site number	Site name	Year site established
1	10312190	Lower Diagonal Drain at Highway 50	1986
2	1031220130	Harmon Reservoir Outflow	1998
3	103122155	Stillwater Point Reservoir Bypass Canal	2013
4	1031221902	S-Line Diversion Canal	1991
5	10312220	Stillwater Slough Cutoff Drain	1967
6	10312277	Paiute Drain below TJ Drain	1986

were delivered by overnight courier to the USGS National Water Quality Laboratory (NWQL) in Lakewood, Colorado. Samples for determination of total and filtered mercury and methylmercury were shipped overnight to the USGS WMRL in Middleton, Wisconsin.

Samples of bottom sediment were collected from the top 1 to 2 inches of sediment at five to seven randomly distributed depositional areas along a 300-foot reach of channel, passed through a 2-mm polyethylene mesh sieve, and thoroughly composited in a pre-cleaned glass bowl before being transferred into 500-mL acid-rinsed, clear polypropylene wide-mouth jars that were packed in ice-filled coolers for overnight shipment to the NWQL (Radtke, 2005). These samples were analyzed for concentrations of arsenic, boron, cadmium, chromium, copper, iron, lead, manganese, molybdenum, nickel, selenium, and zinc. Bottom-sediment samples collected for analysis of total and methylmercury were transferred into 30-mL vials that were packed in coolers with dry ice for overnight shipment to the WMRL. A list of analytical methods and references describing the methods used to analyze samples for the various constituents evaluated as part of this study is shown in table 3.

Quality Assurance

U.S. Geological Survey procedures, standards, and policies documented in the USGS National field manual for the collection of water-quality data (U.S. Geological Survey, variously dated) were followed to ensure results were not affected by sample collection procedures. As standard laboratory practice, both the USGS National Water Quality Laboratory (http://wwwnwql.cr.usgs.gov/qas.shtml?qcm) and the USGS Mercury Research Laboratory (http://wi.water.usgs.gov/mercury-lab/quality-assurance-manual.html#12) follow documented analytical quality assurance/quality control protocols. Quality assurance samples were collected to assess variability and bias resulting from sample collection, processing, handling, and laboratory analysis.

On November 5, 2013, and May 14, 2014, equipment blanks were processed in the USGS Nevada Water Science Center laboratory to evaluate the effectiveness of the equipment cleaning process. On June 1, 2015, field-blank samples were processed at the Stillwater Point Reservoir Bypass Canal site to ensure that field conditions and sample processing procedures were not introducing any of the analytes into the samples (table 4). Analytical results for two split-replicate water samples, two submissions of National Institute of Standards and Technology (NIST; 2011) Standard Reference Material SRM 1944, New York/New Jersey waterway sediment, and one split-replicate of a bottom-sediment sample collected from the S-Line Diversion Canal are listed in table 5. The NIST reference material was treated with inorganic-free blank water to submit the sample as a sediment rather than a soil to the laboratory. The same inorganic-free blank water was used to process field blanks evaluated for aqueous inorganic constituents (table 4).

The percent relative difference (%RD) was used to evaluate the difference in analytical results between the replicate samples and the analytical results of the SRM material provided by the laboratory, and certified values available from NIST (table 5). To assess variability, gross laboratory processing errors, and other problems related to sample-matrix interferences, surrogate trace organic compounds with chemical and physical properties similar to compounds targeted by laboratory analyses, but not normally found in environmental water, were added to the samples by the NWQL prior to analysis. The results of these surrogate analyses are reported in table 6 as the percentage of the spiked mass recovered.

Analytical results reported for two equipment blank water samples processed for trace metals were less than laboratory reporting limits except for both filtered and unfiltered mercury and methylmercury, where concentrations were measured at the laboratory reporting limits (0.06 and 0.04 ng/L, respectively) for these constituents (table 4*C*). The concentration of nicotine in the field blank sample was reported as detected (34.5 ng/L), but at a level still less than the laboratory reporting limit of 58 ng/L (table 4*D*).

Generally, the variability between replicate-sample analyses is evaluated by calculating the percent relative difference between the sample concentrations, and is presumed acceptable when the difference between the measurements is plus or minus 20 percent, which most replicate analyses satisfy (table 5). Unfiltered concentrations of organic carbon, chromium, and nickel, and filtered concentrations of iron and nickel exceeded the 20-percent criteria by 5 percent or less. Unfiltered ammonia and filtered selenium each had relative differences between 25 and 35 percent, and the relative difference between duplicate filtered manganese analyses was 68 percent. The percent relative difference between analytical results for lidocaine, commonly found in topical anesthetics, was more than 160 percent; however, relative differences often are higher when concentrations are near the limits of an analytical method.

Analytical results of percent recovery reported for 19 trace organic compound surrogates added by the NWQL (table 6) indicate that although most averaged within plus or minus 20-percent recovery, most also exhibited outliers in individual sample analyses. Diltiazem-d3 showed the greatest variability with a maximum recovery of 190 percent and a minimum of 55.4 percent. Median and mean recoveries of sulfamethoxazole (phenyl-13C6) were both more than 130 percent with all 16 analyses reported as more than 100 percent. Fluoxetine-d6 (59.7 percent) and diphenhydramine-d3 (53.3 percent) also had very low recoveries. No individual sample disproportionally accounted for outlying results, indicating various matrix interferences may affect each surrogate differently, and some surrogates are known as poor performers for specific analytical methods (Angela Paul, U.S. Geological Survey, written comm., April 14, 2017).

Table 3. Constituents analyzed in water and bottom-sediment samples, and referenced laboratory analytical methods.

[Gravimetry: residue on evaporation at 180 degrees Celsius (Fishman and Friedman, 1989); Ion chromatography: Fishman and Friedman, 1989; Colorimetry: diazotization, automated-segmented flow (Fishman, 1993; Patton and Truitt, 2000, Patton and Kryskalla, 2003 and 2011); ICP-AES: inductively coupled plasma-atomic emission spectroscopy (Fishman, 1993; Struzeski and others, 1996); ICP-MS: inductively coupled plasma-mass spectrometry (Garbarino and others, 2006); cICP-MS: collision/reaction cell inductively coupled plasma-mass spectrometry (Garbarino and others, 2006); CVAFS: cold vapor atomic fluorescence spectrometry (U.S. Environmental Protection Agency, 2002, method 1631, revision E, DeWild and others, 2002 and 2004; Olund and others, 2004); HTCO: high-temperature combustion method 5310 B (Eaton and others, 1998); IR-spec: ultraviolet (UV) catalyzed persulfate oxidation and infrared (IR) spectrometry (Brenton and others, 1993); HPLC-MS/MS: high performance liquid chromatography-mass spectrometry/mass spectrometry (Furlong and others, 2014); In-bottle acid digestion of unfiltered water for trace element analyses (Hoffman and others, 1996); Sediment preparation for trace element analyses: Fishman and Friedman, 1989; Sediment preparation for boron analyses: Garbarino and Struzeski, 1998. **Abbreviation:** °C, degrees Celsius]

Gravimetry	Ion chromatography	Colorimetry	ICP-AES	ICP-MS	cICP-MS	CVAFS	HTCO	IR-spec	HPLC-MS/MS						
Solids, residue at 180 °C	Sulfate	Nitrogen, total	Calcium	Aluminum	Arsenic	Mercury	Carbon, organic, unfiltered	Carbon, organic, filtered	1,7-Dimethylxanthine (p-Xanthine)	Carbamazepine	Erythromycin	Ketoconazole	Nevirapine	Phenazopyridine	Sulfadimethoxine
	Chloride	Nitrogen, organic	Magnesium	Antimony	Chromium	Methylmercury			10-Hydroxyamitriptyline	Carisoprodol	Ezetimibe	Lamivudine	Nicotine	Phendimetrazine	Sulfamethizole
	Fluoride	Nitrogen, ammonia	Sodium	Cadmium	Copper				Abacavir	Chlorpheniramine	Fadrozole	Lidocaine	Nizatidine	Phenytoin	Sulfamethoxazole
		Nitrogen, nitrite	Potassium	Lead	Nickel				Acetaminophen	Cimetidine	Famotidine	Loperamide	Nordiazepam	Piperonyl butoxide	Tamoxifen
		Nitrogen, nitrate	Silica	Lithium	Selenium				Acyclovir	Citalopram	Fenofibrate	Loratadine	Norethindrone	Prednisolone	Temazepam
		Phosphorus	Boron	Molybdenum	Thallium				Albuterol (Salbutamol)	Clonidine	Fexofenadine	Lorazepam	Norfluoxetine	Prednisone	Theophylline
		Phosphorus, ortho	Iron	Rubidium	Tungsten				Alprazolam	Codeine	Fluconazole	Meprobamate	Norsertraline	Promethazine	Thiabendazole
			Manganese		Zinc				Amitriptyline	Cotinine	Fluoxetine	Metaxalone	Norverapamil	Propoxyphene	Tiotropium
									Amphetamine	Dehydronifedipine	Fluticasone	Metformin	Omeprazole	Propranolol	Tramadol
									Antipyrine	Desmethyldiltiazem	Fluvoxamine	Methadone	Oseltamivir	Pseudoephedrine	Triamterene
									Atenolol	Desvenlafaxine	Glipizide	Methocarbamol	Oxazepam	Quinine	Trimethoprim
									Atrazine	Dextromethorphan	Glyburide	Methotrexate	Oxycodone	Raloxifene	Valacyclovir
									Benztropine	Diazepam (valium)	Hydrocodone	Methyl-1H-benzotriazole	Paroxetine	Ranitidine	Venlafaxine
									Betamethasone	Diltiazem	Hydrocortisone	Metoprolol	Penciclovir	Sertraline	Verapamil
									Bupropion	Diphenhydramine	Hydroxyzine	Morphine	Pentoxifylline	Sitagliptin	Warfarin
									Caffeine	Duloxetine	Iminostilbene	Nadalol			

Table 4. Quality assurance data for analytical results of equipment and field blank water samples processed in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, 2013–15.

[All samples for analysis of organic compounds processed through 0.7-micron filter. USGS, U.S. Geological Survey; mg/L, milligrams per liter; µg/L, micrograms per liter; ng/L, nanograms per liter; µm, micron; <, less than; —, data not available]

4A. Organic carbon, hardness, major ions, silica, and dissolved solids

Map number (figure 2)	USGS site number	Station name	Date	Time	Category	Organic carbon, water, unfiltered (mg/L)	Organic carbon, water, filtered (mg/L)	Hardness, water (mg/L as $CaCO_3$)	Calcium, water, filtered (mg/L)	Magnesium, water, filtered (mg/L)	Potassium, water, filtered (mg/L)
4	1031221902	S-Line Diversion Canal	11/05/13	10:00	Equipment blank	< 0.7	< 0.23	< 0.10	< 0.022	< 0.011	< 0.03
3	103122155	Stillwater Point Reservoir Bypass Canal	06/01/15	10:30	Field blank	< 0.7	< 0.23	< 0.10	< 0.022	< 0.011	< 0.03

4A. Organic carbon, hardness, major ions, silica, and dissolved solids—Continued

Map number (figure 2)	Category	Sodium, water, filtered (mg/L)	Chloride, water, filtered (mg/L)	Fluoride, water, filtered (mg/L)	Sulfate, water, filtered (mg/L)	Silica, water, filtered (mg/L as SiO_2)	Dissolved solids dried at 180 degrees Celsius, water, filtered (mg/L)
4	Equipment blank	< 0.06	< 0.02	< 0.01	< 0.02	< 0.018	< 20
3	Field blank	< 0.06	< 0.02	< 0.01	< 0.02	< 0.018	< 20

4B. Selected nutrients

Map number (figure 2)	USGS site number	Station name	Date	Time	Category	Total nitrogen (nitrate + nitrite + ammonia + organic-N), water, filtered (mg/L)	Total nitrogen (nitrate + nitrite + ammonia + organic-N), water, filtered, analytically determined (mg/L)	Total nitrogen (nitrate + nitrite + ammonia + organic-N), water, unfiltered, analytically determined (mg/L)	Organic nitrogen, water, unfiltered (mg/L as N)	Organic nitrogen, water, filtered (mg/L as N)
4	1031221902	S-Line Diversion Canal	11/5/13	10:00	Equipment blank	< 0.11	< 0.05	< 0.05	< 0.05	< 0.05
3	103122155	Stillwater Point Reservoir Bypass Canal	6/1/15	10:30	Field blank	< 0.11	< 0.05	< 0.05	< 0.05	< 0.05

4B. Selected nutrients—Continued

Map number (figure 2)	Category	Ammonia plus organic nitrogen, water, unfiltered (mg/L as N)	Ammonia plus organic nitrogen, water, filtered (mg/L as N)	Ammonia, water, filtered (mg/L as N)	Ammonia, water, unfiltered (mg/L as N)	Nitrite, water, filtered (mg/L as N	Nitrate, water, filtered (mg/L as N)	Nitrate plus nitrite, water, filtered (mg/L as N)	Phosphorus, water, unfiltered (mg/L as P)	Phosphorus, water, filtered (mg/L as P)	Orthophosphate, water, filtered (mg/L as P)
4	Equipment blank	< 0.07	< 0.07	< 0.01	< 0.02	< 0.001	< 0.040	< 0.040	0.004	< 0.003	< 0.004
3	Field blank	< 0.07	< 0.07	< 0.01	< 0.02	< 0.001	< 0.040	< 0.040	< 0.004	< 0.003	< 0.004

4C. Selected trace elements

Map number (figure 2)	USGS site number	Station name	Date	Time	Category	Aluminum, water, filtered, (µg/L)	Aluminum, water, unfiltered recoverable (µg/L)	Antimony, water, filtered (µg/L)	Arsenic, water, filtered (µg/L)	Arsenic, water, unfiltered recoverable (µg/L)	Boron, water, filtered (µg/L)
4	1031221902	S-Line Diversion Canal	11/5/13	10:00	Equipment blank	< 2.2	< 3.8	< 0.027	< 0.10	< 0.28	< 2.0
3	103122155	Stillwater Point Reservoir Bypass Canal	6/1/15	10:30	Field blank	< 3.0	< 3.8	< 0.027	< 0.10	< 0.20	< 2.0

4C. Selected trace elements—Continued

Map number (figure 2	Category	Boron, water, unfiltered, recoverable (µg/L)	Cadmium, water, filtered (µg/L)	Cadmium, water, unfiltered recoverable (µg/L)	Chromium, water, filtered (µg/L)	Chromium, water, unfiltered, recoverable (µg/L)	Copper, water, filtered (µg/L)	Copper, water, unfiltered, recoverable (µg/L)	Iron, water, filtered, (µg/L)	Iron, water, unfiltered recoverable (µg/L)	Lead, water, filtered (µg/L)	Lead, water, unfiltered, recoverable (µg/L)
4	Equipment blank	< 2.0	< 0.030	< 0.030	< 0.30	< 0.30	< 0.80	< 0.80	< 4.0	< 4.6	< 0.040	< 0.04
3	Field blank	< 2.0	< 0.030	< 0.030	< 0.30	< 0.40	< 0.80	< 0.80	< 4.0	< 4.6	< 0.040	< 0.04

Table 4. Quality assurance data for analytical results of equipment and field blank water samples processed in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, 2013–15.—Continued

[USGS, U.S. Geological Survey; mg/L, milligrams per liter; µg/L, micrograms per liter; ng/L; nanograms per liter; µm, micron; <, less than; —, data not available]

4C. Selected trace elements—Continued

Map number (figure 2)	Category	Lithium, water, filtered (µg/L)	Lithium, water, unfiltered, recoverable (µg/L)	Manganese, water, filtered (µg/L)	Manganese, water, unfiltered, recoverable (µg/L)	Mercury, water, filtered (ng/L)	Mercury, water, unfiltered (ng/L)	Methylmercury, water, filtered, recoverable (ng/L)	Methylmercury, water, unfiltered, recoverable (ng/L)	Molybdenum, water, filtered (µg/L)	Molybdenum, water, unfiltered, recoverable (µg/L)	Nickel, water, filtered (µg/L)	Nickel, water, unfiltered, recoverable (µg/L)
4	Equipment blank	< 0.10	< 0.40	< 0.020	< 0.40	0.06	0.06	0.04	0.04	< 0.050	< 0.05	< 0.20	< 0.20
3	Field blank	< 0.13	< 0.40	< 0.020	< 0.40	—	—	—	—	< 0.050	< 0.05	< 0.20	< 0.20

4C. Selected trace elements—Continued

Map number (figure 2)	Category	Selenium, water, filtered (µg/L)	Selenium, water, unfiltered recoverable (µg/L)	Thallium, water, filtered (µg/L)	Tungsten, water, filtered (µg/L)	Zinc, water, filtered (µg/L)	Zinc, water, unfiltered, recoverable (µg/L)
4	Equipment blank	< 0.05	< 0.100	< 0.030	< 0.030	< 2.0	< 2.0
3	Field blank	< 0.05	< 0.100	< 0.030	< 0.030	< 2.0	< 2.0

4D. Selected trace organic compounds

Map number (figure 2)	USGS site number	Station name	Date	Time	Category	Abacavir, water, filtered, recoverable (ng/L)	Acetaminophen, water, filtered recoverable (ng/L)	Acyclovir, water, filtered recoverable (ng/L)	Albuterol, water, filtered recoverable (ng/L)	Alprazolam, water, filtered, recoverable (ng/L)	Amitriptyline, water, filtered recoverable (ng/L)
4	1031221902	S-Line Diversion Canal	5/14/2014	12:00	Equipment blank	< 8.21	< 10.0	< 22.2	< 6.70	< 21.3	< 37.2
3	103122155	Stillwater Point Reservoir Bypass Canal	6/1/2015	10:30	Field blank	< 8.21	< 7.13	< 22.2	< 6.70	< 21.3	< 37.2

4D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Amphetamine, water, filtered recoverable (ng/L)	Antipyrine, water, filtered recoverable (ng/L)	Atenolol, water, filtered recoverable (ng/L)	Atrazine, water, filtered, recoverable (ng/L)	Benztropine, water, filtered, recoverable (ng/L)	Betamethasone, water, filtered recoverable (ng/L)	Bupropion, water, filtered recoverable (ng/L)	Caffeine, water, filtered recoverable (ng/L)	Carbamazepine, water, filtered recoverable (ng/L)	Carisoprodol, water, filtered recoverable (ng/L)	Chlorpheniramine, water, filtered recoverable (ng/L)
4	Equipment blank	< 8.14	< 116	< 13.3	< 19.4	< 24.0	< 114	< 17.8	< 90.7	< 11.0	< 12.5	< 4.68
3	Field blank	< 8.14	< 116	< 13.3	< 19.4	< 24.0	< 114	< 17.8	< 90.7	< 11.0	< 12.5	< 4.68

4D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Cimetidine, water, filtered recoverable (ng/L)	Citalopram, water, filtered recoverable (ng/L)	Clonidine, water, filtered recoverable (ng/L)	Codeine, water, filtered recoverable (ng/L)	Cotinine, water, filtered recoverable (ng/L)	Dehydronifedipine, water, filtered recoverable (ng/L)	Desmethyldiltiazem, water, filtered, recoverable (ng/L)	Desvenlafaxine, water, filtered, recoverable (ng/L)	Dextromethorphan, water, filtered recoverable (ng/L)	Diazepam, water, filtered recoverable (ng/L)
4	Equipment blank	< 80.0	< 6.58	< 60.8	< 88.3	< 6.37	< 24.5	< 12.4	< 7.49	< 8.20	< 4.00
3	Field blank	< 27.8	< 6.58	< 60.8	< 88.3	< 6.37	< 24.5	< 12.4	< 7.49	< 8.20	< 2.24

4D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Diltiazem, water, filtered recoverable (ng/L)	1,7-Dimethylxanthine, water, filtered recoverable (ng/L)	Diphenhydramine, water, filtered recoverable (ng/L)	Duloxetine, water, filtered recoverable (ng/L)	Erythromycin, water, filtered recoverable (ng/L)	Ezetimibe, water, filtered recoverable (ng/L)	Fadrozole, water, filtered, recoverable (ng/L)	Famotidine, water, filtered, recoverable (ng/L)	Fenofibrate, water, filtered recoverable (ng/L)	Fexofenadine, water, filtered recoverable (ng/L)
4	Equipment blank	< 10.2	< 87.7	< 5.79	< 36.6	< 53.1	< 80.0	< 7.32	< 10.7	< 6.28	< 19.9
3	Field blank	< 10.2	< 87.7	< 5.79	< 36.6	< 53.1	< 140	< 7.32	< 10.7	< 6.28	< 19.9

Table 4. Quality assurance data for analytical results of equipment and field blank water samples processed in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, 2013–15.—Continued

[USGS, U.S. Geological Survey; mg/L, milligrams per liter; µg/L, micrograms per liter; ng/L; nanograms per liter; µm, micron; <, less than; —, data not available]

4D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Fluconazole, water, filtered recoverable (ng/L)	Fluoxetine, water, filtered recoverable (ng/L)	Fluticasone propionate, water, filtered recoverable (ng/L)	Fluvoxamine, water, filtered recoverable (ng/L)	Glipizide, water, filtered, recoverable (ng/L)	Glyburide, water, filtered, recoverable (ng/L)	Hydrocodone, water, filtered recoverable (ng/L)	Hydrocortisone, water, filtered recoverable (ng/L)	10-Hydroxy-amitriptyline, water, filtered, recoverable (ng/L)	Hydroxyzine, water, filtered, recoverable (ng/L)
4	Equipment blank	< 71.0	< 80.0	< 4.62	< 53.8	< 148	< 4.00	< 10.5	< 147	< 8.30	< 7.43
3	Field blank	< 71.0	< 26.9	< 4.62	< 53.8	< 148	< 3.95	< 10.5	< 147	< 8.30	< 7.43

4D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Iminostilbene, water, filtered recoverable (ng/L)	Ketoconazole, water, filtered, recoverable (ng/L)	Lamivudine, water, filtered, recoverable (ng/L)	Lidocaine, water, filtered recoverable (ng/L)	Loperamide, water, filtered recoverable (ng/L)	Loratadine, water, filtered recoverable (ng/L)	Lorazepam, water, filtered recoverable (ng/L)	Meprobamate, water, filtered recoverable (ng/L)	Metaxalone, water, filtered recoverable (ng/L)	Metformin, water, filtered recoverable (ng/L)
4	Equipment blank	< 145	< 113	< 16.1	< 15.2	< 11.5	< 6.95	< 116	< 86.0	< 15.6	< 13.1
3	Field blank	< 145	< 113	< 16.1	< 15.2	< 11.5	< 6.95	< 116	< 86.0	< 15.6	< 13.1

4D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Methadone, water, filtered recoverable (ng/L)	Metho-carbamol, water, filtered recoverable (ng/L)	Methotrex-ate, water, filtered recoverable (ng/L)	Methyl-1H-benzotri-azole, water, filtered recoverable (ng/L)	Metoprolol, water, filtered recoverable (ng/L)	Morphine, water, filtered recoverable (ng/L)	Nadolol, water, filtered, recoverable (ng/L)	Nevirapine, water, filtered, recoverable (ng/L)	Nicotine, water, filtered recoverable (ng/L)	Nizatidine, water, filtered recoverable (ng/L)	Nordiazepam, water, filtered, recoverable (ng/L)
4	Equipment blank	< 7.61	< 8.72	< 52.4	< 141	< 27.5	< 14.0	< 80.8	< 15.1	< 57.8	< 80.0	< 41.4
3	Field blank	< 7.61	< 8.72	< 52.4	< 141	< 27.5	< 14.0	< 80.8	< 15.1	[1] 34.5	< 19.0	< 41.4

4D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Norethin-drone, water, filtered recoverable (ng/L)	Norfluox-etine, water, filtered recoverable (ng/L)	Norsertra-line, water, filtered recoverable (ng/L)	Norvera-pamil, water, filtered, recoverable (ng/L)	Omeprazole + Esomepra-zole, water, filtered recoverable (ng/L)	Oseltamivir, water, filtered recoverable (ng/L)	Oxazepam, water, filtered recoverable (ng/L)	Oxycodone, water, filtered recoverable (ng/L)	Paroxetine, water, filtered recoverable (ng/L)	Penciclovir, water, filtered, recoverable (ng/L)	Pentoxifyl-line, water, filtered recoverable (ng/L)
4	Equipment blank	< 10.9	< 199	< 192	< 8.58	< 5.62	< 20.0	< 140	< 24.9	< 20.6	< 40.2	< 9.35
3	Field blank	< 10.9	< 199	< 192	< 8.58	< 5.62	< 14.6	< 140	< 24.9	< 20.6	< 40.2	< 9.35

4D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Phenazopyr-idine, water, filtered, recoverable (ng/L)	Phendimetra-zine, water, filtered recoverable (ng/L)	Phenytoin, water, filtered recoverable (ng/L)	Piperonyl butoxide, water, filtered recoverable (ng/L)	Prednisolone, water, filtered recoverable (ng/L)	Prednisone, water, filtered recoverable (ng/L)	Prometha-zine, water, filtered recoverable (ng/L)	Propoxy-phene, water, filtered, recoverable (ng/L)	Propranolol, water, filtered recoverable (ng/L)	Pseudo-ephedrine + Ephedrine, water, filtered recoverable (ng/L)	Quinine, water, filtered, recoverable (ng/L)
4	Equipment blank	< 13.3	< 31.1	< 188	< 4.00	< 150	< 168	< 80.0	< 17.2	< 26.3	< 11.1	< 79.9
3	Field blank	< 13.3	< 31.1	< 188	< 3.07	< 150	< 168	< 50.0	< 17.2	< 26.3	< 11.1	< 79.9

Table 4. Quality assurance data for analytical results of equipment and field blank water samples processed in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, 2013–15.—Continued

[USGS, U.S. Geological Survey; mg/L, milligrams per liter; µg/L, micrograms per liter; ng/L; nanograms per liter; µm, micron; <, less than; —, data not available]

4D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Raloxifene, water, filtered recoverable (ng/L)	Ranitidine, water, filtered recoverable (ng/L)	Sertraline, water, filtered recoverable (ng/L)	Sitagliptin, water, filtered recoverable (ng/L)	Sulfadimethoxine, water, filtered recoverable (ng/L)	Sulfamethizole, water, filtered recoverable (ng/L)	Sulfamethoxazole, water, filtered recoverable (ng/L)	Tamoxifen, water, filtered, recoverable (ng/L)	Temazepam, water, filtered recoverable (ng/L)	Theophylline, water, filtered recoverable (ng/L)	Thiabendazole, water, filtered recoverable (ng/L)
4	Equipment blank	< 10.0	< 192	< 16.2	< 97.3	< 65.5	< 104	< 26.1	< 80.0	< 18.4	< 41.5	< 4.10
3	Field blank	< 9.72	< 192	< 16.2	< 97.3	< 65.5	< 104	< 26.1	< 80.0	< 18.4	< 44.7	< 4.10

4D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Tiotropium, water, filtered recoverable (ng/L)	Tramadol, water, filtered recoverable (ng/L)	Triamterene, water, filtered recoverable (ng/L)	Trimethoprim, water, filtered recoverable (ng/L)	Valacyclovir, water, filtered recoverable (ng/L)	Venlafaxine, water, filtered recoverable (ng/L)	Verapamil, water, filtered recoverable (ng/L)	Warfarin, water, filtered recoverable (ng/L)
4	Equipment blank	< 43.1	< 15.1	< 5.25	< 19.0	< 163	< 4.48	< 15.5	< 6.03
3	Field blank	< 80.0	< 15.1	< 5.25	< 19.0	< 163	< 4.48	< 15.5	< 6.03

[1] Value extrapolated below long-term method detection limit and (or) lowest calibration standard.

Table 5. Quality assurance data for analytical results of replicate surface-water and bottom-sediment samples collected in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, and for National Institute of Standards and Technology (NIST) Standard Reference Material samples (SRM1944).

[All samples for analysis of organic compounds processed through 0.7-micron filter. USGS, U.S. Geological Survey; mg/L, milligrams per liter; µg/L, micrograms per liter; ng/L, nanograms per liter; µm, micron; mg/kg, milligrams per kilogram; µg/kg, micrograms per kilogram; QA, quality assurance; <, less than; —, data not available; E, estimated]

5A. Organic carbon, hardness, major ions, silica, and dissolved solids

Map number (figure 2)	USGS site number	Station name	Date	Time	Category	Organic carbon, water, unfiltered (mg/L)	Organic carbon, water, filtered (mg/L)	Hardness, water (mg/L as $CaCO_3$)	Calcium, water, filtered (mg/L)	Magnesium, water, filtered (mg/L)	Potassium, water, filtered (mg/L)	Sodium, water, filtered (mg/L)
2	1031220130	Harmon Reservoir Outflow	7/10/14	11:45	Environmental water sample	6.3	3.85	104	28.4	8.05	5.31	45.5
2	1031220130	Harmon Reservoir Outflow	7/10/14	12:00	QA-Split water replicate	5.1	3.91	101	27.5	7.95	5.1	43.9
					Percent relative difference	21.1	1.5	2.9	3.2	1.3	4.0	3.6
4	1031221902	S-Line Diversion Canal	7/12/16	10:00	Environmental water sample	6.7	5.53	77	22.1	5.3	3.71	30.3
4	1031221902	S-Line Diversion Canal	7/12/16	10:10	QA-Split water replicate	6.2	5.37	76.4	21.7	5.41	3.71	31.1
					Percent relative difference	7.8	2.9	0.8	1.8	2.1	0.0	2.6

5A. Organic carbon, hardness, major ions, silica, and dissolved solids—Continued

Map number (figure 2)	Category	Sodium adsorption ratio (SAR), water	Sodium fraction of cations, water (percent in equivalents of major cations)	Chloride, water, filtered (mg/L)	Fluoride, water, filtered (mg/L)	Sulfate, water, filtered (mg/L)	Silica, water, filtered (mg/L as SiO_2)	Dissolved solids dried at 180 degrees Celsius, water, filtered (mg/L)
2	Environmental water sample	1.94	47	24.7	0.29	53.9	19	268
2	QA-Split water replicate	1.9	47	24.6	0.29	53.7	18.6	281
	Percent relative difference	2.1	0.0	0.4	0.0	0.4	2.1	4.7
4	Environmental water sample	1.5	45	15.4	0.22	32.1	10.1	170
4	QA-Split water replicate	1.55	45	15.4	0.22	32.1	9.89	178
	Percent relative difference	3.3	0.0	0.0	0.0	0.0	2.1	4.6

5B. Selected nutrients

Map number (figure 2)	USGS site number	Station name	Date	Time	Category	Total nitrogen [nitrate + nitrite + ammonia + organic-N], water, unfiltered (mg/L)	Total nitrogen [nitrate + nitrite + ammonia + organic-N], water, filtered (mg/L)	Total nitrogen [nitrate + nitrite + ammonia + organic-N], water, unfiltered, analytically determined (mg/L)	Total nitrogen [nitrate + nitrite + ammonia + organic-N], water, filtered, analytically determined (mg/L)	Organic nitrogen, water, unfiltered (mg/L as N)	Organic nitrogen, water, filtered (mg/L as N)
2	1031220130	Harmon Reservoir Outflow	7/10/2014	11:45	Environmental water sample	< 0.74	< 0.37	0.7	0.32	0.67	0.31
2	1031220130	Harmon Reservoir Outflow	7/10/2014	12:00	QA-Split water replicate	—	< 0.37	0.65	0.3	0.62	0.31
					Percent relative difference	—	—	7.4	6.5	7.8	0.0
4	1031221902	S-Line Diversion Canal	7/12/16	10:00	Environmental water sample	< 0.64	< 0.40	0.45	0.43	< 0.60	< 0.36
4	1031221902	S-Line Diversion Canal	7/12/16	10:10	QA-Split water replicate	—	< 0.47	0.49	0.41	< 0.64	< 0.43
					Percent relative difference	—	—	8.5	4.8	—	—

Table 5. Quality assurance data for analytical results of replicate surface-water and bottom-sediment samples collected in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, and for National Institute of Standards and Technology (NIST) Standard Reference Material samples (SRM1944).—Continued

[All samples for analysis of organic compounds processed through 0.7-micron filter. USGS, U.S. Geological Survey; mg/L, milligrams per liter; µg/L, micrograms per liter; ng/L, nanograms per liter; µm, micron; mg/kg, milligrams per kilogram; µg/kg, micrograms per kilogram; QA, quality assurance; <, less than; —, data not available; E, estimated]

5B. Selected nutrients—Continued

Map number (figure 2)	Category	Ammonia plus organic nitrogen, water, unfiltered (mg/L as N)	Ammonia plus organic nitrogen, water, filtered (mg/L as N)	Ammonia, water, filtered (mg/L as N)	Ammonia, water, unfiltered (mg/L as N)	Ammonia (un-ionized), water, unfiltered, calculated (mg/L as N)	Nitrite, water, filtered (mg/L as N)	Nitrate, water, filtered (mg/L as N)	Nitrate plus nitrite, water, filtered (mg/L as N)	Phosphorus, water, unfiltered (mg/L as P)	Phosphorus, water, filtered (mg/L as P)	Orthophosphate, water, filtered (mg/L as PO_4)	Orthophosphate, water, filtered (mg/L as P)
2	Environmental water sample	0.7	0.33	0.02	0.03	< 0.01	< 0.001	< 0.040	< 0.040	0.298	0.137	0.413	0.135
2	QA-Split water replicate	0.66	0.33	0.02	0.04	—	< 0.001	< 0.040	< 0.040	0.277	0.134	—	0.134
	Percent relative difference	5.9	0.0	0.0	28.6	—	—	—	—	7.3	2.2	—	0.7
4	Environmental water sample	0.6	0.36	< 0.01	< 0.02	< 0.01	< 0.001	< 0.040	< 0.040	0.151	0.124	0.33	0.108
4	QA-Split water replicate	0.64	0.43	< 0.01	< 0.02	—	< 0.001	< 0.040	< 0.040	0.144	0.124	—	0.112
	Percent relative difference	6.5	17.7	—	—	—	—	—	—	4.7	0.0	—	3.6

5C. Selected trace elements

Map number (figure 2)	USGS site number	Station name	Date	Time	Category	Aluminum, water, filtered (µg/L)	Aluminum, water, unfiltered, recoverable (µg/L)	Antimony, water, filtered (µg/L)	Arsenic, water, filtered (µg/L)	Arsenic, water, unfiltered recoverable (µg/L)	Boron, water, filtered (µg/L)	Boron, water, unfiltered, recoverable (µg/L)	Cadmium, water, filtered (µg/L)
2	1031220130	Harmon Reservoir Outflow	7/10/14	11:45	Environmental water sample	3	2,300	0.541	17.4	18.6	430	408	0.032
2	1031220130	Harmon Reservoir Outflow	7/10/14	12:00	QA-Split water replicate	3.3	1,980	0.522	18	18.7	408	410	0.036
					Percent relative difference	9.5	15.0	3.6	3.4	0.5	5.3	0.5	11.8
4	1031221902	S-Line Diversion Canal	7/12/16	10:00	Environmental water sample	24.9	236	0.393	12.3	12.5	250	242	< 0.030
4	1031221902	S-Line Diversion Canal	7/12/16	10:10	QA-Split water replicate	23.4	236	0.409	12.2	12.6	245	238	0.033
					Percent relative difference	6.2	0.0	4.0	0.8	0.8	2.0	1.7	—

5C. Selected trace elements—Continued

Map number (figure 2)	Category	Cadmium, water, unfiltered recoverable (µg/L)	Chromium, water, filtered (µg/L)	Chromium, water, unfiltered, recoverable (µg/L)	Copper, water, filtered (µg/L)	Copper, water, unfiltered, recoverable (µg/L)	Iron, water, filtered (µg/L)	Iron, water, unfiltered, recoverable (µg/L)	Lead, water, filtered (µg/L)	Lead, water, unfiltered, recoverable (µg/L)	Lithium, water, filtered (µg/L)	Lithium, water, unfiltered, recoverable (µg/L)	Manganese, water, filtered (µg/L)
2	Environmental water sample	0.035	< 0.30	1.5	1.6	4.7	< 4.0	2,770	0.25	1.95	42.6	45.9	2.66
2	QA-Split water replicate	0.033	< 0.30	1.2	1.9	4.2	< 4.0	2,650	< 0.040	1.84	42.3	46.4	1.31
	Percent relative difference	5.9	—	22.2	17.1	11.2	—	4.4	—	5.8	0.7	1.1	68.0
4	Environmental water sample	< 0.03	< 0.30	< 0.4	2.1	2.4	36.4	257	0.061	0.27	24.4	17.1	3.03
4	QA-Split water replicate	< 0.03	< 0.30	< 0.4	2.2	2.5	29.5	257	0.062	0.27	25	18.3	3.01
	Percent relative difference	—	—	—	4.7	4.1	20.9	0.0	1.6	0.0	2.4	6.8	0.7

Table 5. Quality assurance data for analytical results of replicate surface-water and bottom-sediment samples collected in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, and for National Institute of Standards and Technology (NIST) Standard Reference Material samples (SRM1944).—Continued

[All samples for analysis of organic compounds processed through 0.7-micron filter. USGS, U.S. Geological Survey; mg/L, milligrams per liter; µg/L, micrograms per liter; ng/L, nanograms per liter; µm, micron; mg/kg, milligrams per kilogram; µg/kg, micrograms per kilogram; QA, quality assurance; <, less than; —, data not available; E, estimated]

5C. Selected trace elements—Continued

Map number (figure 2)	Category	Manganese, water, unfiltered, recoverable (µg/L)	Mercury, water, filtered (ng/L)	Mercury, water, unfiltered (ng/L)	Methylmercury, water, filtered, recoverable (ng/L)	Methylmercury, water, unfiltered, recoverable (ng/L)	Molybdenum, water, filtered (µg/L)	Molybdenum, water, unfiltered, recoverable (µg/L)	Nickel, water, filtered (µg/L)	Nickel, water, unfiltered, recoverable (µg/L)	Selenium, water, filtered (µg/L)	Selenium, water, unfiltered recoverable (µg/L)
2	Environmental water sample	145	3.66	259	0.24	0.82	7.33	6.88	1	2.2	0.2	0.216
2	QA-Split water replicate	135	—	—	—	—	7.19	7	1	2	0.21	0.23
	Percent relative difference	7.1	—	—	—	—	1.9	1.7	0.0	9.5	4.9	6.3
4	Environmental water sample	14.1	36.2	66.5	1.4	1.8	4.75	4.94	0.85	0.7	0.07	< 0.1
4	QA-Split water replicate	14.2	37.7	64.1	1.6	1.8	4.78	4.98	0.69	0.9	0.1	0.1
	Percent relative difference	0.7	4.1	3.7	13.3	0.0	0.6	0.8	20.8	25.0	35.3	—

5C. Selected trace elements—Continued

Map number (figure 2)	Category	Thallium, water, filtered (µg/L)	Tungsten, water, filtered (µg/L)	Zinc, water, filtered (µg/L)	Zinc, water, unfiltered, recoverable (µg/L)
2	Environmental water sample	< 0.030	3.6	< 2.0	8.7
2	QA-Split water replicate	< 0.030	3.82	< 2.0	7.9
	Percent relative difference	—	5.9	—	9.6
4	Environmental water sample	< 0.030	—	< 2.0	< 2
4	QA-Split water replicate	< 0.030	—	< 2.0	< 2
	Percent relative difference	—	—	—	—

5D. Selected trace organic compounds

Map number (figure 2)	USGS site number	Station name	Date	Time	Category	Abacavir, water, filtered, recoverable (ng/L)	Acetaminophen, water, filtered recoverable (ng/L)	Acyclovir, water, filtered recoverable (ng/L)	Albuterol, water, filtered recoverable (ng/L)	Alprazolam, water, filtered, recoverable (ng/L)	Amitriptyline, water, filtered recoverable (ng/L)
4	1031221902	S-Line Diversion Canal	7/12/16	10:00	Environmental water sample	< 8.21	< 20.0	< 22.2	< 6.70	< 21.3	< 37.2
4	1031221902	S-Line Diversion Canal	7/12/16	10:10	QA-Split water replicate	< 8.21	< 20.0	< 22.2	< 6.70	< 21.3	< 37.2
					Percent relative difference	—	—	—	—	—	—

5D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Amphetamine, water, filtered recoverable (ng/L)	Antipyrine, water, filtered recoverable (ng/L)	Atenolol, water, filtered recoverable (ng/L)	Atrazine, water, filtered, recoverable (ng/L)	Benztropine, water, filtered, recoverable (ng/L)	Betamethasone, water, filtered recoverable (ng/L)	Bupropion, water, filtered recoverable (ng/L)	Caffeine, water, filtered recoverable (ng/L)	Carbamazepine, water, filtered recoverable (ng/L)	Carisoprodol, water, filtered recoverable (ng/L)
2	Environmental water sample	< 8.14	< 116	< 140	< 19.4	< 140	< 114	< 17.8	< 90.7	5.77	< 12.5
2	QA-Split water replicate	< 8.14	< 116	< 140	< 19.4	< 140	< 114	< 17.8	[1]35.4	5.66	< 12.5
	Percent relative difference	—	—	—	—	—	—	—	—	1.9	—

Table 5. Quality assurance data for analytical results of replicate surface-water and bottom-sediment samples collected in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, and for National Institute of Standards and Technology (NIST) Standard Reference Material samples (SRM1944).—Continued

[All samples for analysis of organic compounds processed through 0.7-micron filter. USGS, U.S. Geological Survey; mg/L, milligrams per liter; µg/L, micrograms per liter; ng/L, nanograms per liter; µm, micron; mg/kg, milligrams per kilogram; µg/kg, micrograms per kilogram; QA, quality assurance; <, less than; —, data not available; E, estimated]

5D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Chlorphenira-mine, water, filtered recoverable (ng/L)	Cimetidine, water, filtered recoverable (ng/L)	Citalopram, water, filtered recoverable (ng/L)	Clonidine, water, filtered recoverable (ng/L)	Codeine, water, filtered recoverable (ng/L)	Cotinine, water, filtered recoverable (ng/L)	Dehydronife-dipine, water, filtered recoverable (ng/L)	Desmethyl-diltiazem, water, filtered, recoverable (ng/L)	Desvenla-faxine, water, filtered, recoverable (ng/L)	Dextromethorphan, water, filtered recoverable (ng/L)
2	Environmental water sample	< 4.68	< 27.8	< 6.58	< 60.8	< 88.3	E 5.00	< 24.5	< 12.4	< 7.49	< 8.20
2	QA-Split water replicate	< 4.68	< 27.8	< 6.58	< 60.8	< 88.3	E 5.85	< 24.5	< 12.4	< 7.49	< 8.20
	Percent relative difference	—	—	—	—	—	—	—	—	—	—

5D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Diazepam, water, filtered recoverable (ng/L)	Diltiazem, water, filtered recoverable (ng/L)	1,7-Dimethylxan-thine, water, filtered recoverable (ng/L)	Diphenhydramine, water, filtered recoverable (ng/L)	Duloxetine, water, filtered recoverable (ng/L)	Erythromycin, water, filtered recoverable (ng/L)	Ezetimibe, water, filtered recoverable (ng/L)	Fadrozole, water, filtered, recoverable (ng/L)	Famotidine, water, filtered, recoverable (ng/L)	Fenofibrate, water, filtered recoverable (ng/L)
2	Environmental water sample	< 4.00	< 10.2	< 87.7	< 5.79	< 36.6	< 53.1	< 200	< 7.32	< 20.0	< 10.0
2	QA-Split water replicate	< 4.00	< 10.2	< 87.7	< 5.79	< 36.6	< 53.1	< 200	< 7.32	< 20.0	< 10.0
	Percent relative difference	—	—	—	—	—	—	—	—	—	—

5D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Fexofenadine, water, filtered recoverable (ng/L)	Fluconazole, water, filtered recoverable (ng/L)	Fluoxetine, water, filtered recoverable (ng/L)	Fluticasone propionate, water, filtered recoverable (ng/L)	Fluvoxamine, water, filtered recoverable (ng/L)	Glipizide, water, filtered, recoverable (ng/L)	Glyburide, water, filtered, recoverable (ng/L)	Hydrocodone, water, filtered recoverable (ng/L)	Hydrocorti-sone, water, filtered recoverable (ng/L)	10-Hydroxy-amitripty-line, water, filtered, recoverable (ng/L)
2	Environmental water sample	< 19.9	< 80.0	< 26.9	< 80.0	< 53.8	< 148	< 4.00	< 20.0	< 200	< 8.30
2	QA-Split water replicate	< 19.9	< 80.0	< 26.9	< 80.0	< 53.8	< 148	< 4.00	< 20.0	< 200	< 8.30
	Percent relative difference	—	—	—	—	—	—	—	—	—	—

5D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Hydroxyzine, water, filtered, recoverable (ng/L)	Iminostilbene, water, filtered recoverable (ng/L)	Ketoconazole, water, filtered, recoverable (ng/L)	Lamivudine, water, filtered, recoverable (ng/L)	Lidocaine, water, filtered recoverable (ng/L)	Loperamide, water, filtered recoverable (ng/L)	Loratadine, water, filtered recoverable (ng/L)	Lorazepam, water, filtered recoverable (ng/L)	Meprobamate, water, filtered recoverable (ng/L)	Metaxalone, water, filtered recoverable (ng/L)
2	Environmental water sample	< 7.43	< 145	< 113	< 16.1	3.87	< 11.5	< 6.95	< 140	< 86.0	< 20.0
2	QA-Split water replicate	< 7.43	< 145	< 113	< 16.1	0.42	< 11.5	< 6.95	< 140	[1]6.07	< 20.0
	Percent relative difference	—	—	—	—	160.8	—	—	—	—	—

Table 5. Quality assurance data for analytical results of replicate surface-water and bottom-sediment samples collected in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, and for National Institute of Standards and Technology (NIST) Standard Reference Material samples (SRM1944).—Continued

[All samples for analysis of organic compounds processed through 0.7-micron filter. USGS, U.S. Geological Survey; mg/L, milligrams per liter; µg/L, micrograms per liter; ng/L, nanograms per liter; µm, micron; mg/kg, milligrams per kilogram; µg/kg, micrograms per kilogram; QA, quality assurance; <, less than; —, data not available; E, estimated]

5D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Metformin, water, filtered recoverable (ng/L)	Methadone, water, filtered recoverable (ng/L)	Methocarbamol, water, filtered recoverable (ng/L)	Methotrexate, water, filtered recoverable (ng/L)	Methyl-1H-benzo-triazole, water, filtered recoverable (ng/L)	Metoprolol, water, filtered recoverable (ng/L)	Morphine, water, filtered recoverable (ng/L)	Nadolol, water, filtered, recoverable (ng/L)	Nevirapine, water, filtered, recoverable (ng/L)	Nicotine, water, filtered recoverable (ng/L)
2	Environmental water sample	29.4	< 7.61	15.5	< 80.0	< 141	< 27.5	< 20.0	< 80.8	< 15.1	< 57.8
2	QA-Split water replicate	25.9	< 7.61	16.2	< 80.0	[1] 76.7	< 27.5	< 20.0	< 80.8	< 15.1	< 57.8
	Percent relative difference	12.7	—	4.4	—	—	—	—	—	—	—

5D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Nizatidine, water, filtered recoverable (ng/L)	Nordiazepam, water, filtered, recoverable (ng/L)	Norethindrone, water, filtered recoverable (ng/L)	Norfluoxetine, water, filtered recoverable (ng/L)	Norsertraline, water, filtered recoverable (ng/L)	Norverapamil, water, filtered, recoverable (ng/L)	Omeprazole + Esomeprazole, water, filtered recoverable (ng/L)	Oseltamivir, water, filtered recoverable (ng/L)	Oxazepam, water, filtered recoverable (ng/L)	Oxycodone, water, filtered recoverable (ng/L)
2	Environmental water sample	< 20.0	< 41.4	< 80.0	< 199	< 192	< 8.58	< 5.62	< 14.6	< 200	< 24.9
2	QA-Split water replicate	< 20.0	< 41.4	< 80.0	< 199	< 192	< 8.58	< 5.62	< 14.6	< 200	< 24.9
	Percent relative difference	—	—	—	—	—	—	—	—	—	—

5D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Paroxetine, water, filtered recoverable (ng/L)	Penciclovir, water, filtered, recoverable (ng/L)	Pentoxifylline, water, filtered recoverable (ng/L)	Phenazopyri-dine, water, filtered, recoverable (ng/L)	Phendimetrazine, water, filtered recoverable (ng/L)	Phenytoin, water, filtered recoverable (ng/L)	Piperonyl butoxide, water, filtered recoverable (ng/L)	Prednisolone, water, filtered recoverable (ng/L)	Prednisone, water, filtered recoverable (ng/L)	Promethazine, water, filtered recoverable (ng/L)
2	Environmental water sample	< 20.6	< 40.2	< 9.35	< 13.3	< 31.1	< 188	< 3.07	< 150	< 168	< 50.0
2	QA-Split water replicate	< 20.6	< 40.2	< 9.35	< 13.3	< 31.1	< 188	< 3.07	< 150	< 168	< 50.0
	Percent relative difference	—	—	—	—	—	—	—	—	—	—

5D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Propoxyphene, water, filtered, recoverable (ng/L)	Propranolol, water, filtered recoverable (ng/L)	Pseudoephedrine + Ephedrine, water, filtered recoverable (ng/L)	Quinine, water, filtered, recoverable (ng/L)	Raloxifene, water, filtered recoverable (ng/L)	Ranitidine, water, filtered recoverable (ng/L)	Sertraline, water, filtered recoverable (ng/L)	Sitagliptin, water, filtered recoverable (ng/L)	Sulfadimeth-oxine, water, filtered recoverable (ng/L)
2	Environmental water sample	< 17.2	< 26.3	< 11.1	< 79.9	< 9.72	< 192	< 16.2	< 97.3	< 65.5
2	QA-Split water replicate	< 17.2	< 26.3	< 11.1	< 79.9	< 9.72	< 192	< 16.2	< 97.3	< 65.5
	Percent relative difference	—	—	—	—	—	—	—	—	—

Table 5. Quality assurance data for analytical results of replicate surface-water and bottom-sediment samples collected in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, and for National Institute of Standards and Technology (NIST) Standard Reference Material samples (SRM1944).—Continued

[All samples for analysis of organic compounds processed through 0.7-micron filter. USGS, U.S. Geological Survey; mg/L, milligrams per liter; µg/L, micrograms per liter; ng/L, nanograms per liter; µm, micron; mg/kg, milligrams per kilogram; µg/kg, micrograms per kilogram; QA, quality assurance; <, less than; —, data not available; E, estimated]

5D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Sulfamethizole, water, filtered recoverable (ng/L)	Sulfamethoxazole, water, filtered recoverable (ng/L)	Tamoxifen, water, filtered, recoverable (ng/L)	Temazepam, water, filtered recoverable (ng/L)	Theophylline, water, filtered recoverable (ng/L)	Thiabendazole, water, filtered recoverable (ng/L)	Tiotropium, water, filtered recoverable (ng/L)	Tramadol, water, filtered recoverable (ng/L)	Triamterene, water, filtered recoverable (ng/L)	Trimethoprim, water, filtered recoverable (ng/L)
2	Environmental water sample	< 140	< 26.1	< 140	< 20.0	< 80.0	< 20.0	< 43.1	< 15.1	< 5.25	< 19.0
2	QA-Split water replicate	< 140	< 26.1	< 140	< 20.0	< 80.0	< 20.0	< 43.1	< 15.1	< 5.25	< 19.0
	Percent relative difference	—	—	—	—	—	—	—	—	—	—

5D. Selected trace organic compounds—Continued

Map number (figure 2)	Category	Valacyclovir, water, filtered recoverable (ng/L)	Venlafaxine, water, filtered recoverable (ng/L)	Verapamil, water, filtered recoverable (ng/L)	Warfarin, water, filtered recoverable (ng/L)
2	Environmental water sample	< 163	< 20.0	< 15.5	< 6.03
2	QA-Split water replicate	< 163	< 20.0	< 15.5	< 6.03
	Percent relative difference	—	—	—	—

5E. Selected trace elements in National Institute of Standards and Technology Standard Reference Material samples

Map number (figure 2)	USGS site number	Station name	Date	Time	Category	Arsenic, recoverable, dry weight (mg/kg)	Boron, recoverable, dry weight (mg/kg)	Cadmium, recoverable, dry weight (mg/kg)	Chromium, recoverable, dry weight (mg/kg)	Copper, recoverable, dry weight (mg/kg)
2	1031220130	Harmon Reservoir Outflow	4/10/14	14:10	QA-SRM1944 bottom sediment analyses	15.2	31	9.4	242	391
					NIST SRM1944 bottom sediment reported	18.9	—	8.8	266	—
					Percent relative difference	21.7	—	6.6	9.4	—
3	103122155	Stillwater Point Reservoir Bypass Canal	6/1/15	10:30	QA-SRM1944 bottom sediment analyses	21.2	24	10.7	235	412
					NIST SRM1944 bottom sediment reported	18.9	—	8.8	266	—
					Percent relative difference	11.5	—	19.5	12.4	—

5E. Selected trace elements in National Institute of Standards and Technology Standard Reference Material samples—Continued

Map number (figure 2)	Category	Iron, total digestion, dry weight (mg/kg)	Lead, recoverable, dry weight (mg/kg)	Manganese, recoverable, dry weight (mg/kg)	Mercury, solids, total, dry weight (µg/kg)	Methylmercury, solids, total, dry weight (µg/kg)	Molybdenum, recoverable, dry weight (mg/kg)	Nickel, recoverable, dry weight (mg/kg)	Selenium, recoverable, dry weight (mg/kg)	Zinc, recoverable, dry weight (mg/kg)
2	QA-SRM1944 bottom sediment analyses	27,000	350	410	—	4.7	2.9	66.1	1.4	730
	NIST SRM1944 bottom sediment reported	35,300	330	505	3.65	—	—	76.1	1.4	656
	Percent relative difference	26.6	5.9	20.8	—	—	—	14.1	0.0	10.7
3	QA-SRM1944 bottom sediment analyses	29,800	355	343	3,100	3.65	3.1	74.1	1.63	681
	NIST SRM1944 bottom sediment reported	35,300	330	505	3,400	—	—	76.1	1.4	656
	Percent relative difference	16.9	7.3	38.2	9.2	—	—	2.7	15.2	3.7

Table 5. Quality assurance data for analytical results of replicate surface-water and bottom-sediment samples collected in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, and for National Institute of Standards and Technology (NIST) Standard Reference Material samples (SRM1944).—Continued

[All samples for analysis of organic compounds processed through 0.7-micron filter. USGS, U.S. Geological Survey; mg/L, milligrams per liter; µg/L, micrograms per liter; ng/L, nanograms per liter; µm, micron; mg/kg, milligrams per kilogram; µg/kg, micrograms per kilogram; QA, quality assurance; <, less than; —, data not available; E, estimated]

5F. Selected trace elements in replicate bottom-sediment samples

Map number (figure 2)	USGS site number	Station name	Date	Time	Category	Arsenic, recoverable, dry weight (mg/kg)	Boron, recoverable, dry weight (mg/kg)	Cadmium, recoverable, dry weight (mg/kg)	Chromium, recoverable, dry weight (mg/kg)	Copper, recoverable, dry weight (mg/kg)	Iron, total digestion, dry weight (mg/kg)
4	1031221902	S-Line Diversion Canal	7/12/16	10:00	Environmental bottom sediment sample	8.03	—	0.22	12.8	32	19,500
4	1031221902	S-Line Diversion Canal	7/12/16	10:10	QA-Split bottom sediment replicate	7	—	0.19	11.6	30.7	16,900
					Percent relative difference	13.7	—	15	10	4	14

5F. Selected trace elements in replicate bottom-sediment samples—Continued

Map number (figure 2)	Category	Lead, recoverable, dry weight (mg/kg)	Manganese, recoverable, dry weight (mg/kg)	Mercury, solids, total, dry weight (µg/kg)	Methylmercury, solids, total, dry weight (µg/kg)	Molybdenum, recoverable, dry weight (mg/kg)	Nickel, recoverable, dry weight (mg/kg)	Selenium, recoverable, dry weight (mg/kg)	Zinc, recoverable, dry weight (mg/kg)
4	Environmental bottom sediment sample	14.1	474	2,500	2.07	0.16	11.5	0.34	70.4
4	QA-Split bottom sediment replicate	12.8	441	2,400	3.24	0.15	10.7	0.31	80
	Percent relative difference	10	7	4.1	44.1	6	7	9	13

[1] Value extrapolated below long-term method detection limit and (or) lowest calibration standard.

Table 6. Percent recovery of spiked surrogate compounds added to trace organic compound samples collected from surface-water sites in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, 2014–16.

[All samples processed through 0.7-micron filter. All values in percent recovery. **Abbreviation:** USGS, U.S. Geological Survey]

Map number	USGS site number	Station name	Date	Acetaminophen-d3, surrogate, water, filtered	Albuterol-d9, surrogate, water, filtered	Amphetamine-d6, surrogate, water, filtered	Caffeine (trimethyl-13C3), surrogate, water, filtered	Codeine-d6, surrogate, water, filtered
1	10312190	Lower Diagonal Drain at Hwy 50	5/14/14	109	97.3	86.5	94	104
1	10312190	Lower Diagonal Drain at Hwy 50	6/3/15	110	120	87.1	104	121
1	10312190	Lower Diagonal Drain at Hwy 50	7/1/16	119	103	91.1	114	97.1
2	1031220130	Harmon Reservoir Outflow	5/14/14	107	102	99.9	101	94
2	1031220130	Harmon Reservoir Outflow	6/3/15	135	134	108	103	124
2	1031220130	Harmon Reservoir Outflow	7/12/16	113	108	105	97.5	98.6
3	103122155	Stillwater Point Reservoir Bypass Canal	5/14/14	108	100	98.4	94.8	103
3	103122155	Stillwater Point Reservoir Bypass Canal	6/3/15	131	137	110	103	126
3	103122155	Stillwater Point Reservoir Bypass Canal	6/30/16	130	114	98.7	108	111
4	1031221902	S-Line Diversion Canal	5/14/14	104	102	96.1	94.9	96.5
4	1031221902	S-Line Diversion Canal	6/2/15	120	131	104	106	123
4	1031221902	S-Line Diversion Canal	7/12/16	121	120	107	107	109
5	10312220	Stillwater Slough Cutoff Drain	5/14/14	105	101	90.8	96.2	101
5	10312220	Stillwater Slough Cutoff Drain	6/2/15	141	136	97.6	111	133
5	10312220	Stillwater Slough Cutoff Drain	6/30/16	139	118	99	111	118
6	10312277	Paiute Drain below TJ Drain	5/14/14	117	105	85.5	104	102
			Median	118	111	98.6	103.5	106.5
			Mean	119.3	114.3	97.8	103.1	110.1
			Maximum	141	137	110	114	133
			Minimum	104	97.3	85.5	94	94
			Count	16	16	16	16	16

Table 6. Percent recovery of spiked surrogate compounds added to trace organic compound samples collected from surface-water sites in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, 2014–16.—Continued

[All samples processed through 0.7-micron filter. All values in percent recovery. **Abbreviation:** USGS, U.S. Geological Survey]

Map number	Date	Cotinine-d3, surrogate, water, filtered	Diazepam-d5, surrogate, water, filtered	Diltiazem-d3, surrogate, water, filtered	Diphenhydramine-d3, surrogate, water, filtered	Fluoxetine-d6, surrogate, water, filtered	Hydrocodone-d3, surrogate, water, filtered	Methadone-d9, surrogate, water, filtered	Norfluoxetine-d6, surrogate, water, filtered
1	5/14/14	109	102	88.1	90.3	96.6	105	95	101
1	6/3/15	110	99.9	167	112	107	107	127	94.5
1	7/1/16	119	99	97.9	84.5	81.6	83.5	85.7	77.5
2	5/14/14	107	100	80.9	60.8	81.7	98.6	87.1	107
2	6/3/15	135	104	153	86.5	80.2	96.5	120	101
2	7/12/16	113	98.2	55.4	84.6	59.7	102	83.5	86.9
3	5/14/14	108	99.4	71.8	59.5	61.3	106	84.8	98.6
3	6/3/15	131	107	174	72.3	104	100	131	100
3	6/30/16	130	103	109	93.1	87	91.8	100	83.6
4	5/14/14	104	98.2	77.3	53.3	71.8	109	88.4	94.1
4	6/2/15	120	105	174	93	118	102	134	94.6
4	7/12/16	121	107	70.5	95.8	66.1	92.7	91.8	89.9
5	5/14/14	105	96.6	86.9	90.1	82.1	109	95.2	82.2
5	6/2/15	141	107	190	128	119	101	146	95.2
5	6/30/16	139	107	113	110	80.9	86.5	106	74.9
6	5/14/14	117	104	88.7	104	78	113	104	70.2
	Median	118	102.5	93.3	90.2	81.6	101.5	97.6	94.3
	Mean	119.3	102.3	112.3	88.6	85.9	100.2	105.0	90.7
	Maximum	141	107	190	128	119	113	146	107
	Minimum	104	96.6	55.4	53.3	59.7	83.5	83.5	70.2
	Count	16	16	16	16	16	16	16	16

Table 6. Percent recovery of spiked surrogate compounds added to trace organic compound samples collected from surface-water sites in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, 2014–16.—Continued

[All samples processed through 0.7-micron filter. All values in percent recovery. **Abbreviation:** USGS, U.S. Geological Survey]

Map number	Date	Oxycodone-d3, surrogate, water, filtered	Pseudoephedrine-d3, surrogate, water, filtered	Sulfamethoxazole (phenyl-13C6), surrogate, water, filtered	Temazepam-d5, surrogate, water, filtered	Thiabendazole-d4, surrogate, water, filtered	Trimethoprim-d9, surrogate, water, filtered
1	5/14/14	98.8	102	145	97.9	98.6	88.5
1	6/3/15	113	102	182	105	89.4	107
1	7/1/16	123	112	156	107	88.2	106
2	5/14/14	98	106	108	91.8	99.1	91.5
2	6/3/15	127	112	131	104	99.6	114
2	7/12/16	105	100	115	94.9	85.9	92.5
3	5/14/14	95.8	106	111	92.7	96.6	90.9
3	6/3/15	118	115	138	111	103	115
3	6/30/16	124	109	138	103	88.2	108
4	5/14/14	92	107	110	94	93.9	89.2
4	6/2/15	116	111	127	105	97.1	116
4	7/12/16	113	108	116	100	91.7	106
5	5/14/14	90.1	100	118	95.1	94.6	91.8
5	6/2/15	122	112	147	109	103	122
5	6/30/16	130	112	153	107	89.1	111
6	5/14/14	99.7	104	144	104	99.8	95.1
	Median	113	107.5	134.5	103.5	95.6	106
	Mean	110.3	107.4	133.7	101.3	94.9	102.8
	Maximum	130	115	182	111	103	122
	Minimum	90.1	100	108	91.8	85.9	88.5
	Count	16	16	16	16	16	16

Results

A statistical summary of the results of field and laboratory analytical measurements is shown in table 7, and all of the data from individual samples are listed in tables 10 to 15 in the supplemental data section. Data in table 7 are grouped as before (pre-program) and after (post-program) the initiation of the water rights acquisition program. Factors, including changed reporting limits, varying contributions of groundwater to streamflow, drought, and seasonal differences may be influencing these results. Aquatic-life criteria promulgated for designated water in the State of Nevada and recommended by the U.S. Environmental Protection Agency are listed for selected constituents in table 8.

Statistical distributions and the number of observations of selected water-quality parameters and solutes measured in pre-program (1971–98) site visits are compared graphically to those measured in post-program (2014–16) visits on figures 3 to 5. Also included with each graph are charts of the number of measurements made at each of the six monitoring sites to indicate the relative influence individual sites may have on each dataset. Mean, median, and maximum values of field measurements (table 7*A*; fig. 3) indicate minimal differences in temperature (fig. 3*A*), specific conductance (fig. 3*B*), dissolved oxygen (fig. 3*C*), pH (fig. 3*D*), and alkalinity (fig. 3*E*), but show measurable decreases in instantaneous streamflow measurements (fig. 3*F*).

Concentrations of dissolved solids and major ions (chloride, sulfate, potassium, calcium, magnesium, and sodium; fig. 4) in the pre-program dataset include maximum concentrations that were much larger than values measured in samples collected during the post-program, but minimum concentrations are nearly identical (table 7*B*). This may be due in part, to more samples being collected from Paiute Drain in the pre-program dataset than in the post-program dataset.

Total nitrogen data indicate decreased concentrations between pre- and post-programs, but the difference in phosphorus concentrations is small except for one outlier in the post-program dataset (table 7*C*).

Over time, methods of analysis have improved, resulting in lower detection limits for many trace elements (table 13, supplemental data). Concentrations of some trace elements, such as chromium, silver, and thallium, have largely remained below reporting limits (table 13). Mean unfiltered arsenic concentrations show a decrease in the post-program dataset although the maximum concentration is higher (table 7*D*). Similarly, mean and median filtered boron and molybdenum concentrations are also lower in the post-program dataset (table 7*D*; fig. 5).

Concentrations of eight TOCs were above reporting limits (table 9). Eighteen other TOCs also were detected at concentrations that were less than laboratory reporting limits but were included in the data tables because most are pharmaceuticals (including antibiotics) and currently have unknown ecotoxicological significance (Daughton and Ternes, 1999; Battaglin and Kolok, 2014). Although treated wastewater effluent has been included in the water rights acquisition program, permits for discharge of treated effluent to both the Truckee and Carson Rivers had been granted prior to enactment of the acquisition program.

Considering the dataset as a whole, aquatic-life criteria and (or) guidelines (table 8) were exceeded at least once for aluminum, arsenic, boron, cadmium, copper, molybdenum, and mercury (tables 11 to 13, supplemental data). The aluminum criterion was exceeded primarily in unfiltered samples. The arsenic criterion was most frequently exceeded in samples collected from Paiute Drain (fig. 2, site 6), represented in the pre-program dataset; the one post-program sample collected from site 6 did not exceed the criterion. Two samples from Lower Diagonal Drain (site 1) had the highest arsenic concentrations (greater than 350 µg/L), but most samples (including most from site 6) did not exceed the continuous National Recommended Criterion (150 µg/L). Concentrations of boron exceeded the aquatic-life criterion (550 µg/L) adopted by the State of Nevada most frequently, and in at least one sample collected at each site; however, currently there are no National Recommended Criteria. Cadmium concentrations exceeded the National Recommended Continuous Criterion (0.72 µg/L) in all post-program samples from site 1, and the State of Nevada 96-hour criterion (2 µg/L) was exceeded in two pre-program samples from site 6, with one exceeding the 1-hour criterion (8 µg/L). The aquatic-life 96-hour criterion for copper (10 µg/L) was exceeded in two pre-program samples from site 6, one post-program sample from site 1, and two post-program samples from site 3. The aquatic-life 1-hour criterion (15 µg/L) was exceeded in most samples from site 1 (10/11), site 3 (3/5), site 5 (6/6), and site 6 (33/38). The 96-hour average aquatic-life criterion for mercury (0.012 µg/L) was exceeded in all 20 unfiltered samples analyzed with a reporting limit of less than 0.00004 µg/L (less than 0.04 ng/L), and 14 of the 17 filtered samples also exceeded the criterion. Nine of 30 samples analyzed with a 0.1 µg/L (less than 100 ng/L) reporting limit exceeded the mercury criterion, and the National Recommended Maximum Criterion (1.4 µg/L) was exceeded in four samples (three from site 5 and one from site 6). Guidance for concentrations of methylmercury has not been promulgated.

Bottom-sediment concentrations (table 15, supplemental data) of arsenic, chromium, copper, lead, nickel, and zinc all were less than published probable effect concentrations (33, 111, 149, 128, 48.6, and 459 milligrams per kilogram (mg/kg), respectively; Ingersoll and others, 2000), but concentrations of mercury in six of nine bottom-sediment samples exceeded the probable effect concentration (1,060 micrograms per kilogram [1.06 mg/kg]).

Table 7. Summary statistics for selected constituents in water and bottom-sediment samples collected for the pre- (water years 1971–98) and post- (water years 2014–16) water rights acquisition program, Stillwater National Wildlife Refuge, Lahontan Valley, Nevada.

[**Abbreviations:** ft^3/s, cubic feet per second; °C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; mv, millivolts; mm, millimeters; µg/L, micrograms per liter; ng/L, nanograms per liter; mg/kg, milligrams per kilogram; µg/kg, micrograms per kilogram; NA, not applicable; <, less than]

7A. Field measurements

	Discharge, instantaneous (ft^3/s)	Temperature, water (°C)	Specific conductance, water, unfiltered (µS/cm at 25 °C)	pH, water, unfiltered, field (standard units)	Dissolved oxygen, water, unfiltered (mg/L)	Oxidation reduction potential, reference electrode not specified (mv)	Barometric pressure (mm of mercury)	Alkalinity, water, filtered, inflection-point (incremental) titration method, field (mg/L as $CaCO_3$)	Bicarbonate, water, filtered, inflection-point (incremental) titration method, field (mg/L)	Carbonate, water, filtered, inflection-point (incremental) titration method, field (mg/L)
WY1971–98										
Mean	16.1	18.1	3,672	8.5	9.8	NA	657	175	178	12
Minimum	0.07	4.5	262	7.7	3	NA	541	76	58	0
Maximum	77	30.0	19,700	9.9	20	NA	670	530	647	62
Count	63	66	70	62	61	0	57	51	47	47
WY2014–16										
Mean	7.8	17	2,720	8.5	10	154	663	174	202	4.6
Minimum	0.01	3.3	272	7.8	1	20.5	657	78	63	0
Maximum	56	29	16,800	9.3	23.3	281	677	503	600	16.2
Count	21	52	52	51	52	42	26	21	21	21

7B. Organic carbon, hardness, major ions, silica, and dissolved solids in water samples

	Organic carbon, unfiltered (mg/L)	Organic carbon, filtered (mg/L)	Hardness, water (mg/L as $CaCO_3$)	Calcium, water, filtered (mg/L)	Magnesium, water, filtered (mg/L)	Potassium, water, filtered (mg/L)	Sodium, water, filtered (mg/L)	Chloride, water, filtered (mg/L)	Fluoride, water, filtered (mg/L)	Sulfate, water, filtered (mg/L)	Silica, water, filtered (mg/L as SiO_2)	Dissolved solids dried at 180 °C, water, filtered (mg/L)
WY1971–98												
Mean	6.4	7.4	501	76	76	16	806	1,057	0.58	621	15	1,605
Minimum	5.1	6.9	101	28	7.6	5.4	44	21	0.3	56	0.9	156
Maximum	7.5	8	1,800	210	310	52	3,400	4,500	1.1	2,600	29	13,700
Count	3	2	21	21	21	21	21	21	18	21	22	41
WY2014–16												
Mean	9.3	7.0	174	45	16	11	284	240	0.47	228	20	945
Minimum	4.9	3.85	77	22	5.27	3.2	29	14	0.21	32	7.8	170
Maximum	26.7	13.9	532	130	50	36	1,250	1,010	0.89	978	30	3,710
Count	21	21	21	21	21	21	21	21	21	21	21	21

7C. Selected species of nitrogen and phosphorus in water samples

	Total nitrogen [nitrate + nitrite + ammonia + organic-N], water, unfiltered (mg/L)	Total nitrogen [nitrate + nitrite + ammonia + organic-N], water, filtered (mg/L)	Total nitrogen [nitrate + nitrite + ammonia + organic-N], water, unfiltered, analytically determined (mg/L)	Total nitrogen [nitrate + nitrite + ammonia + organic-N], water, filtered, analytically determined (mg/L)	Organic nitrogen, water, unfiltered (mg/L as N)	Organic nitrogen, water, filtered (mg/L as N)	Ammonia plus organic nitrogen, water, unfiltered (mg/L as N)	Ammonia plus organic nitrogen, water, filtered (mg/L as N)	Ammonia, water, filtered (mg/L as N)	Ammonia, water, unfiltered (mg/L as N)
WY1971–98										
Mean	2.5	2.2	NA	NA	1.6	0.88	2.4	2.0	0.62	0.13
Minimum	1.4	0.7	NA	NA	0.88	0.55	1	0.6	0.04	0.08
Maximum	6.6	5.3	NA	NA	2.6	1.3	6.5	5.2	3.9	0.15
Count	9	5	0	0	7	5	8	5	10	3
WY2014–16										
Mean	1.1	0.78	1.1	0.78	0.91	0.64	1.0	0.71	0.07	0.10
Minimum	0.64	0.35	0.45	0.31	0.54	0.29	0.58	0.31	0.01	0.02
Maximum	2.4	2.3	3.41	2.4	2	1.9	2.4	2.3	0.35	0.43
Count	21	21	21	21	21	21	21	21	21	21

Table 7. Summary statistics for selected constituents in water and bottom-sediment samples collected for the pre- (water years 1971–98) and post- (water years 2014–16) water rights acquisition program, Stillwater National Wildlife Refuge, Lahontan Valley, Nevada.—Continued

[**Abbreviations:** ft^3/s, cubic feet per second; °C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; mv, millivolts; mm, millimeters; µg/L, micrograms per liter; ng/L, nanograms per liter; mg/kg, milligrams per kilogram; µg/kg, micrograms per kilogram; NA, not applicable; < , less than]

7C. Selected species of nitrogen and phosphorus in water samples—Continued

	Ammonia (un-ionized), water, unfiltered, calculated (mg/L as N)	Nitrite, water, filtered (mg/L as N)	Nitrate, water, filtered (mg/L as N)	Nitrate plus nitrite, water, filtered (mg/L as N)	Orthophosphate, water, filtered (mg/L as PO_4)	Orthophosphate, water, filtered (mg/L as P)	Phosphorus, water, unfiltered (mg/L as P)
WY1971–98							
Mean	NA	0.04	0.19	0.21	1.7	0.54	0.74
Minimum	< 0.01	0.01	0.03	0.07	0.03	0.01	0.06
Maximum	0.01	0.08	0.63	0.71	8.6	2.8	3.1
Count	3	9	9	10	9	9	7
WY2014–16							
Mean	NA	0.02	0.06	0.08	1.5	0.48	0.71
Minimum	< 0.01	0.001	0.02	0.04	0.29	0.10	0.15
Maximum	0.08	0.13	0.32	0.34	13	4.1	5.9
Count	21	21	21	21	21	21	21

7D. Selected trace elements in water samples

	Arsenic, water, filtered (µg/L)	Arsenic, water, unfiltered recoverable (µg/L)	Aluminum, water, filtered (µg/L)	Aluminum, water, unfiltered, recoverable (µg/L)	Antimony, water, filtered (µg/L)	Boron, water, filtered (µg/L)	Boron, water, unfiltered, recoverable (µg/L)	Cadmium, water, filtered (µg/L)	Cadmium, water, unfiltered recoverable (µg/L)	Copper, water, filtered (µg/L)	Copper, water, unfiltered, recoverable (µg/L)	Iron, water, filtered (µg/L)	Iron, water, unfiltered, recoverable (µg/L)
WY1971–98													
Mean	NA	79	25	4,650	NA	2,616	NA	NA	NA	NA	12	48	NA
Minimum	< 8	17	6	2,700	< 1	160	NA	< 1	< 1	< 1	12	10	NA
Maximum	360	200	57	6,600	6	17,000	NA	12	< 1	10	12	80	NA
Count	[1] 54(1)	15	6	2	4	54	0	[1] 19(13)	[1] 2(2)	[1] 24(13)	2	3	1
WY2014–16													
Mean	51	55	NA	2,048	0.58	1,866	1,965	0.20	0.11	1.97	5.43	NA	2,370
Minimum	7.1	8	< 3	236	0.29	225	216	< 0.03	< 0.03	3.7	1.6	< 4	257
Maximum	343	388	266	10,200	1.4	8,050	10,200	1.58	0.483	0.93	18.7	359	8,930
Count	21	21	[1] 21(4)	21	21	21	21	[1] 21(3)	[1] 21(3)	[1] 21(1)	21	[1] 21(4)	21

7D. Selected trace elements in water samples—Continued

	Lead, water, filtered (µg/L)	Lead, water, unfiltered, recoverable (µg/L)	Lithium, water, filtered (µg/L)	Lithium, water, unfiltered, recoverable (µg/L)	Manganese, water, filtered (µg/L)	Manganese, water, unfiltered, recoverable (µg/L)	Mercury, water, filtered (µg/L)	Mercury, water, filtered (ng/L)	Mercury, water, unfiltered (µg/L)	Mercury, water, unfiltered (ng/L)	Methylmercury, water, filtered, recoverable (ng/L)	Methylmercury, water, unfiltered, recoverable (ng/L)
WY1971–98												
Mean	NA	NA	112	NA	336	NA	NA	NA	NA	95	NA	1.6
Minimum	< 1	< 5	10	NA	40	NA	< 0.1	NA	< 0.1	13	NA	0.85
Maximum	3	7	510	NA	726	NA	0.70	NA	2.2	222	NA	2.4
Count	[1.] 11(8)	[1] 2(1)	51	0	6	1	[1] 20(14)	0	[1] 17(12)	3	0	3
WY2014–16												
Mean	NA	2.00	78	85	103	251	NA	28	NA	561	0.77	3.9
Minimum	0.395	0.27	23	15	3	14	NA	3.7	NA	40	0.24	0.82
Maximum	< 0.04	9.11	447	506	805	1,630	NA	66	NA	5,250	1.6	13
Count	[1] 21(3)	21	21	21	21	21	0	17	0	16	8	14

Table 7. Summary statistics for selected constituents in water and bottom-sediment samples collected for the pre- (water years 1971–98) and post- (water years 2014–16) water rights acquisition program, Stillwater National Wildlife Refuge, Lahontan Valley, Nevada.—Continued

[**Abbreviations:** ft³/s, cubic feet per second; °C, degrees Celsius; µS/cm, microsiemens per centimeter; mg/L, milligrams per liter; mv, millivolts; mm, millimeters; µg/L, micrograms per liter; ng/L, nanograms per liter; mg/kg, milligrams per kilogram; µg/kg, micrograms per kilogram; NA, not applicable; < , less than]

7D. Selected trace elements in water samples—Continued

	Molybdenum, water, filtered (µg/L)	Molybdenum, water, unfiltered, recoverable (µg/L)	Nickel, water, filtered (µg/L)	Nickel, water, unfiltered, recoverable (µg/L)	Selenium, water, filtered (µg/L)	Selenium, water, unfiltered recoverable (µg/L)	Tungsten, water, filtered (µg/L)	Zinc, water, filtered (µg/L)	Zinc, water, unfiltered, recoverable (µg/L)
WY1971–98									
Mean	84	NA	NA	9	NA	NA	NA	14.4	15
Minimum	5	74	< 1	6	< 1	< 1	NA	< 10	10
Maximum	900	160	4	12	1	< 2	NA	54	20
Count	54	2	[1] 11(3)	2	[1] 24(23)	[1] 15(15)	0	[1] 10(1)	2
WY2014–16									
Mean	66	67	1.6	2.6	0.37	NA	7.2	NA	NA
Minimum	5	5	0.7	0.7	0.07	< 0.1	2.2	< 2	< 2
Maximum	486	529	3.6	10.4	1.5	0.973	42	6.0	34.6
Count	21	21	21	21	21	21	16	[1] 21(19)	[1] 21(3)

7E. Selected trace elements in bottom-sediment samples

	Arsenic, recoverable, dry weight, (mg/kg)	Boron, recoverable, dry weight, (mg/kg)	Cadmium, recoverable, dry weight, (mg/kg)	Chromium, recoverable, dry weight, (mg/kg)	Copper, recoverable, dry weight, (mg/kg)	Iron, total digestion, dry weight, (mg/kg)	Lead, recoverable, dry weight, (mg/kg)	Manganese, recoverable, dry weight, (mg/kg)	Mercury, solids, total, dry weight, (µg/kg)	Methylmercury, solids, total, dry weight, (µg/kg)
WY2014–16										
Mean	14	46	0.24	14	27	22,309	12	681	1,837	4.8
Minimum	4.7	9.6	0.1	4.6	5.2	6,600	2.5	170	200	0.17
Maximum	32.9	110	0.51	22.3	47.2	37,000	24	1,400	4,700	20
Count	11	11	11	11	11	11	11	11	6	11

7E. Selected trace elements in bottom-sediment samples—Continued

	Molybdenum, recoverable, dry weight, (mg/kg)	Nickel, recoverable, dry weight, (mg/kg)	Selenium, recoverable, dry weight, (mg/kg)	Zinc, recoverable, dry weight, (mg/kg)	Bottom sediment, dry weight, percent of wet weight	Loss on ignition, percent	Moisture content, fraction of dry weight, percent
WY2014–16							
Mean	1.9	12	0.37	64	55	4.6	40
Minimum	0.11	3.2	0.1	14.8	28.4	1.06	15
Maximum	10	18.2	1.3	107	69.7	8.82	66
Count	11	11	11	11	16	11	11

[1] Parenthetic value is the number of values censored by analytical reporting limits.

Table 8. Selected aquatic-life criteria established for designated water of the State of Nevada and National recommended water-quality criteria.

[All constituent values in micrograms per liter, except where indicated. **Abbreviations:** —, criterion not established or determined according to footnote; <, less than; mg/L, milligrams per liter; °C, degrees Celsius]

Chemical constituent	Aquatic-life criteria [1]		National recommended water-quality criteria [2]	
	1-hour average	96-hour average	Criterion maximum	Criterion continuous
Aluminum	—	—	750	87
Ammonia, un-ionized [3]	—	—	—	—
Arsenic	340	150	340	150
Cadmium	[4] 8	[4] 2	1.8	0.72
Chromium	[5] 15/ [4,6] 1,500	[5] 10/ [4,6] 180	[5] 16/ [6] 570	[5] 11/ [6] 74
Copper	[4] 15	[4] 10	([7])	([7])
Iron	—	1,000	—	1,000
Lead	[4] 41	12	65	2.5
Mercury	2	0.012	1.4	0.77
Molybdenum	6,160	1,650	—	—
Nickel	[4] 1,200	[4] 130	470	52
Oxygen, dissolved	—	< 5.0	—	—
Selenium	20	5	([8])	[8] 1.5/ [8] 3.1
Zinc	[4] 99	[4] 90	120	120
Solids, dissolved (mg/L)	—	500	—	—
Temperature (°C)	—	34	—	—
pH (standard units)	—	6.5–9	—	6.5–9

[1] Nevada Administrative Code 445A (last updated January 6, 2015); accessed December 3, 2016, at https://www.leg.state.nv.us/nac/NAC-445A.html.

[2] U.S. Environmental Protection Agency (2014); accessed December 3, 2016, at http://water.epa.gov/scitech/swguidance/standards/criteria/current/index.cfm#altable.

[3] Criterion is pH and temperature dependent (NAC445A.118).

[4] Criterion is hardness dependent. Values shown are computed for a hardness of 100 milligrams per liter as calcium carbonate. Greater hardness concentrations mitigate toxicity.

[5] Criterion is for chromium (VI).

[6] Criterion is for chromium (III).

[7] Criterion is calculated using the Biotic Ligand Model and 10 water-quality constituents; accessed December 1, 2016, at http://water.epa.gov/scitech/swguidance/standards/criteria/aqlife/copper/2007_index.cfm.

[8] Criterion calculated using “intermittent exposure equation”; accessed December 1, 2016, at https://www.epa.gov/sites/production/files/2016-06/documents/se_2016_fact_sheet_final.pdf.

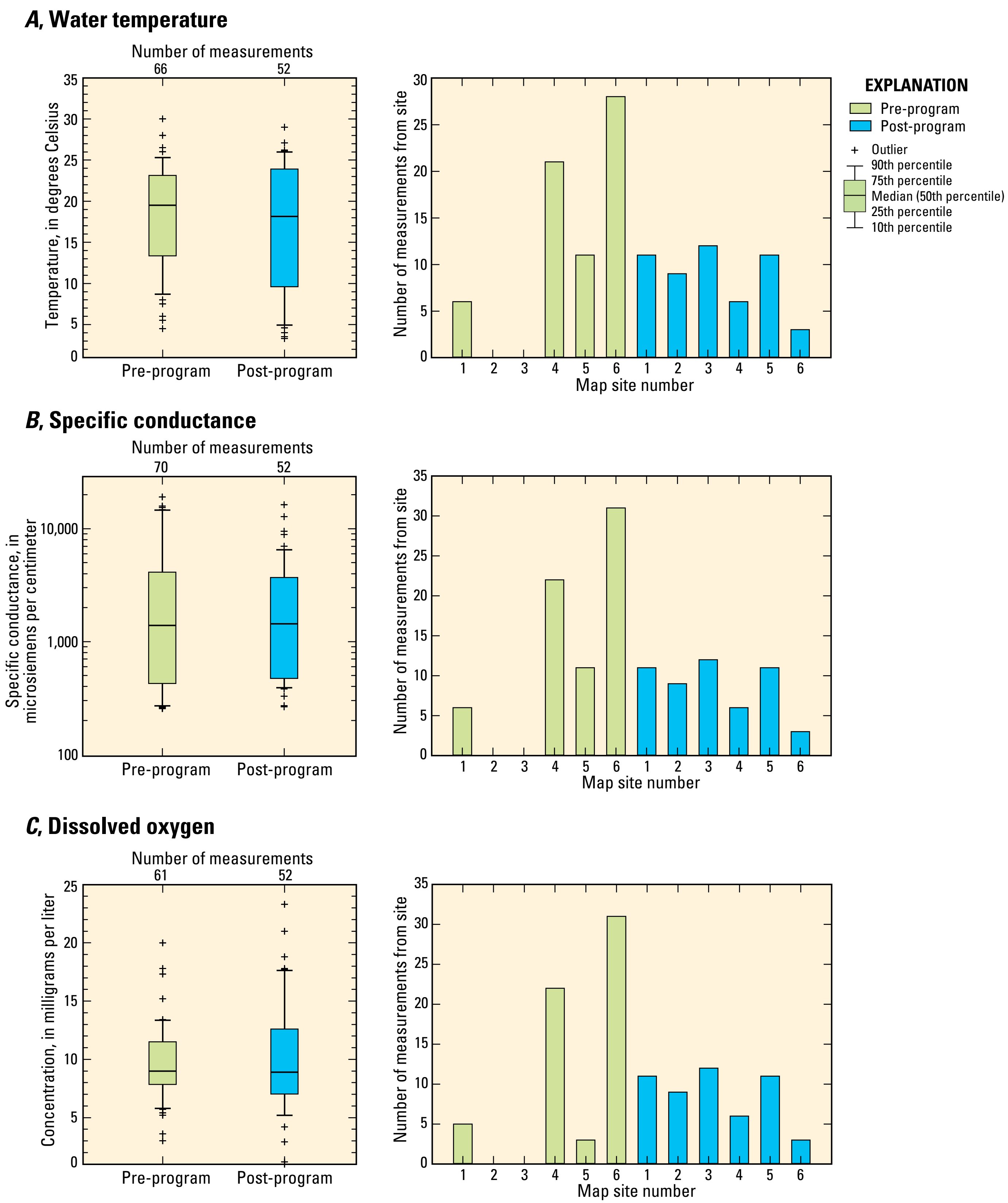


Figure 3. Statistical distribution comparisons of field measurements made during the pre-program (1971–98) and post-program (2014–16) in and near Stillwater National Wildlife Refuge. *A*, water temperature, *B*, specific conductance, *C*, dissolved oxygen, *D*, pH, *E*, alkalinity, and *F*, instantaneous streamflow.

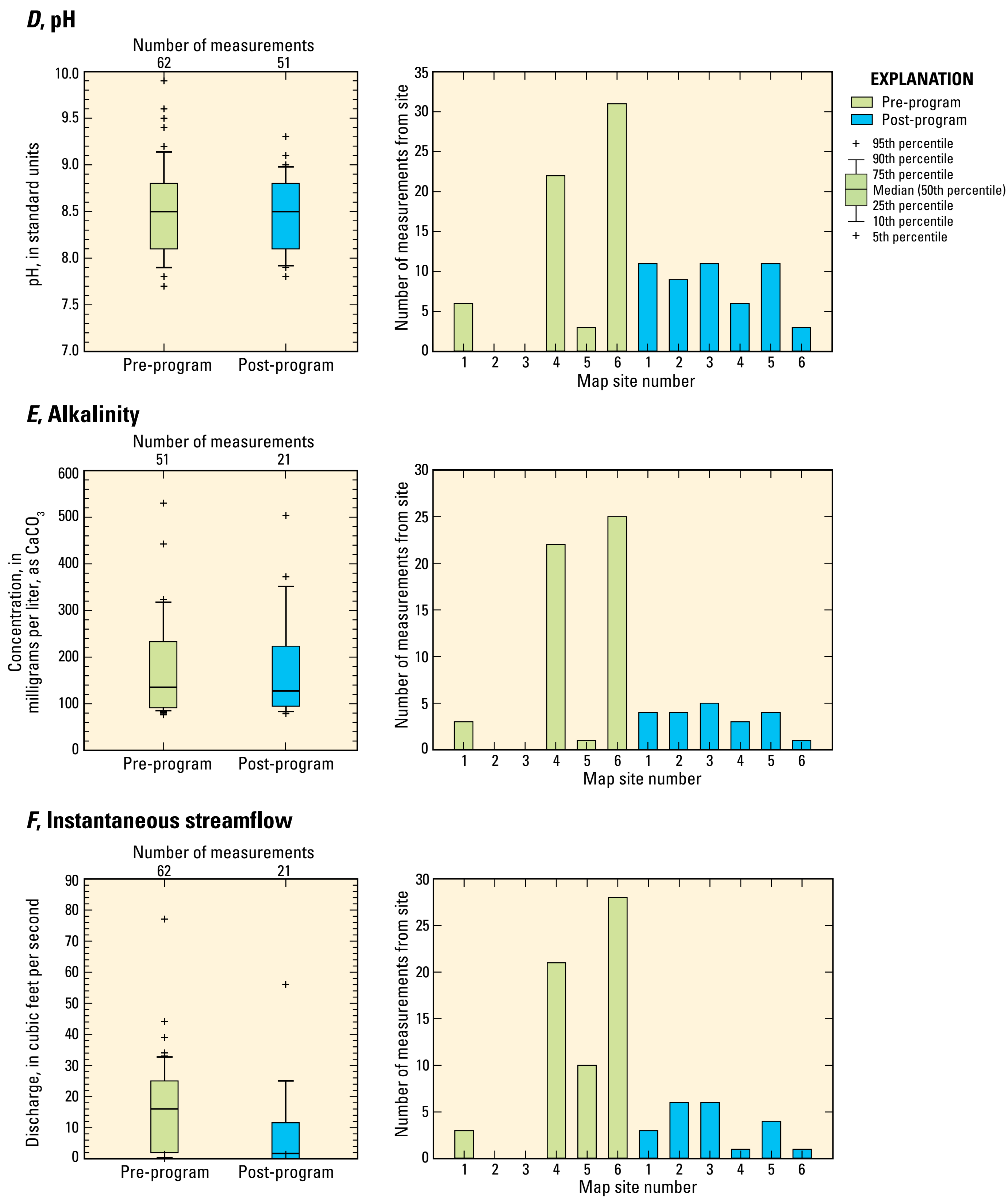


Figure 3. Statistical distribution comparisons of field measurements made during the pre-program (1971–98) and post-program (2014–16) in and near Stillwater National Wildlife Refuge. *A*, water temperature, *B*, specific conductance, *C*, dissolved oxygen, *D*, pH, *E*, alkalinity, and *F*, instantaneous streamflow.—Continued

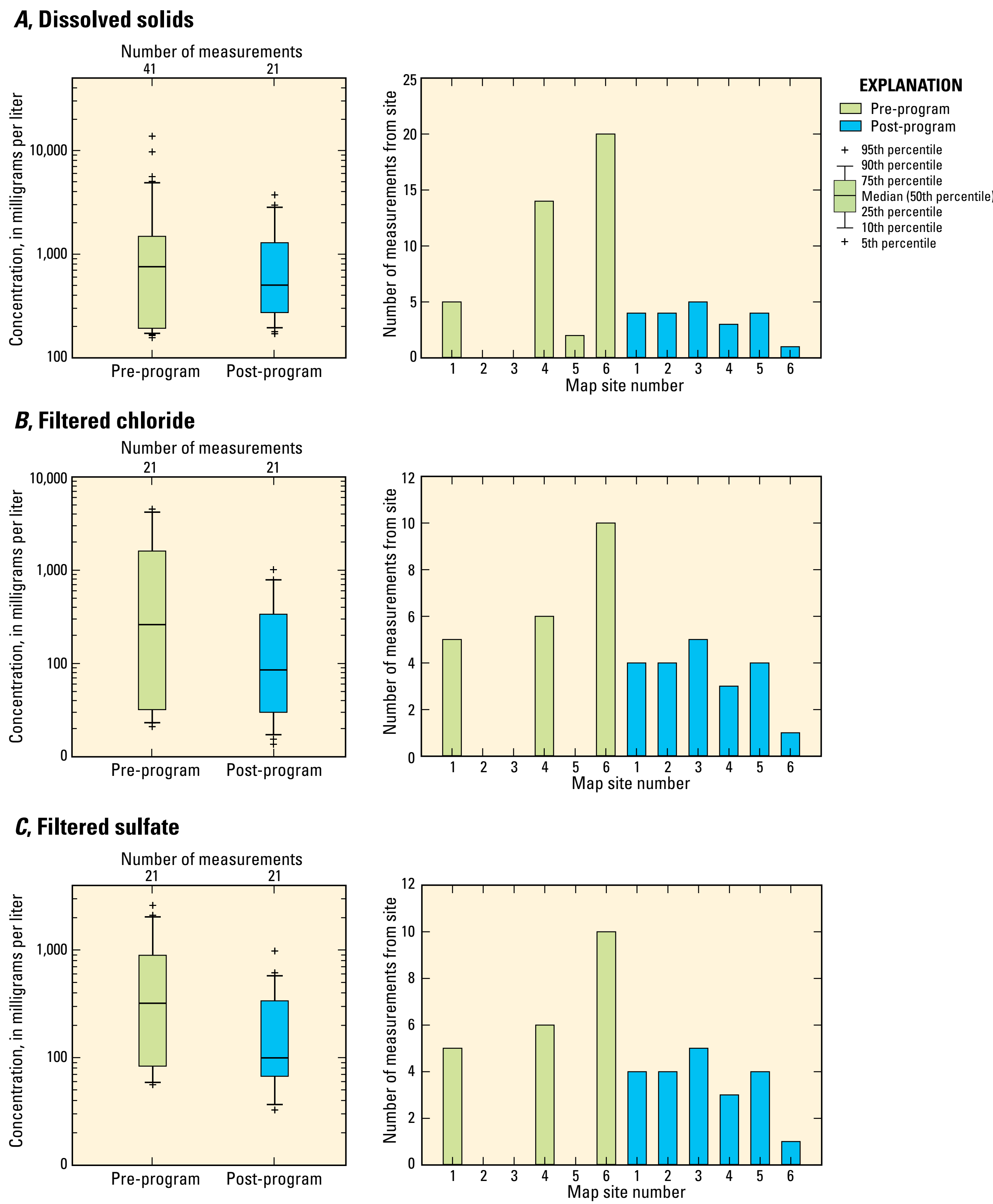
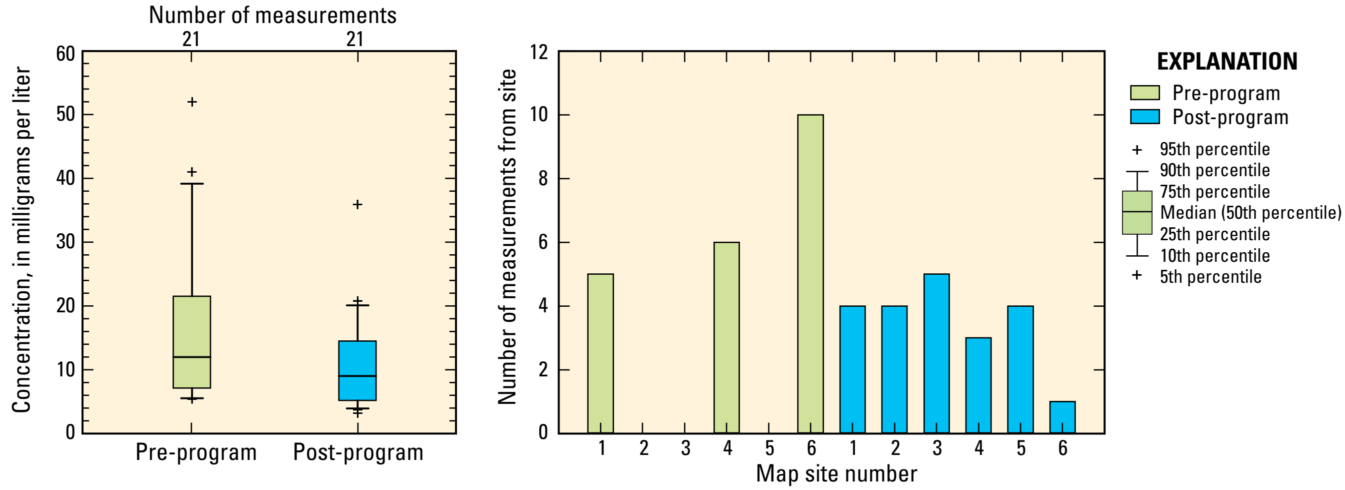
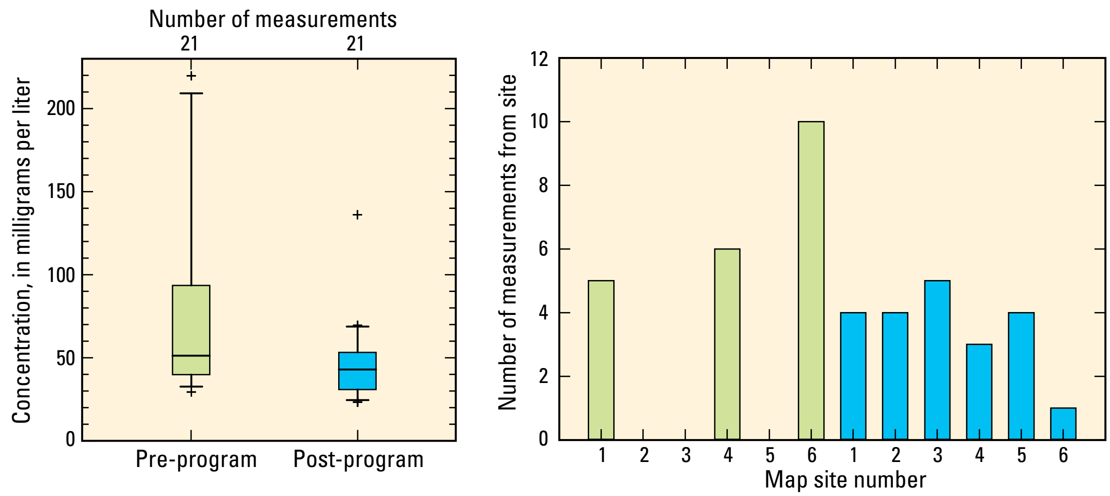


Figure 4. Statistical distribution comparisons of laboratory analyses of dissolved solids and major ions made during the pre-program (1971–98) and post-program (2014–16), Stillwater National Wildlife Refuge. *A*, dissolved solids, *B*, filtered chloride, *C*, filtered sulfate, *D*, filtered potassium, *E*, filtered calcium, *F*, filtered magnesium, and *G*, filtered sodium.

***D*, Filtered potassium**



***E*, Filtered calcium**



***F*, Filtered magnesium**

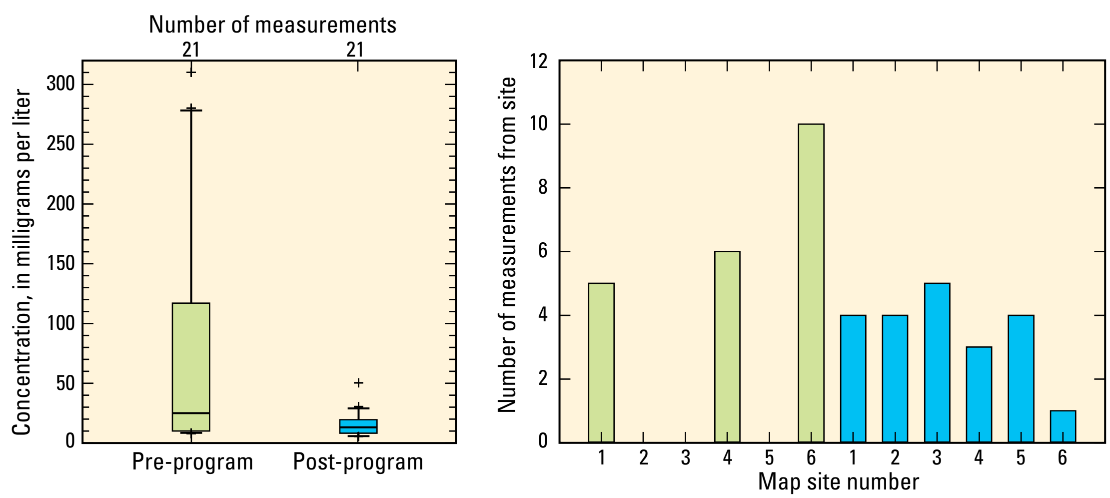


Figure 4. Statistical distribution comparisons of laboratory analyses of dissolved solids and major ions made during the pre-program (1971–98) and post-program (2014–16), Stillwater National Wildlife Refuge. *A*, dissolved solids, *B*, filtered chloride, *C*, filtered sulfate, *D*, filtered potassium, *E*, filtered calcium, *F*, filtered magnesium, and *G*, filtered sodium.—Continued

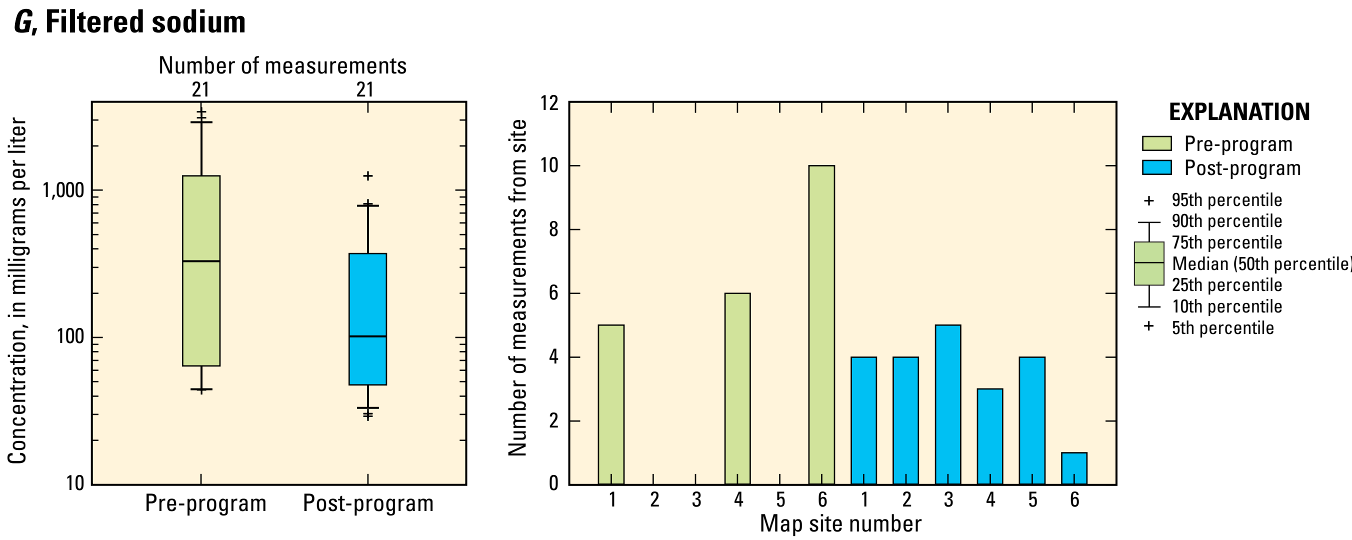


Figure 4. Statistical distribution comparisons of laboratory analyses of dissolved solids and major ions made during the pre-program (1971–98) and post-program (2014–16), Stillwater National Wildlife Refuge. *A*, dissolved solids, *B*, filtered chloride, *C*, filtered sulfate, *D*, filtered potassium, *E*, filtered calcium, *F*, filtered magnesium, and *G*, filtered sodium.—Continued

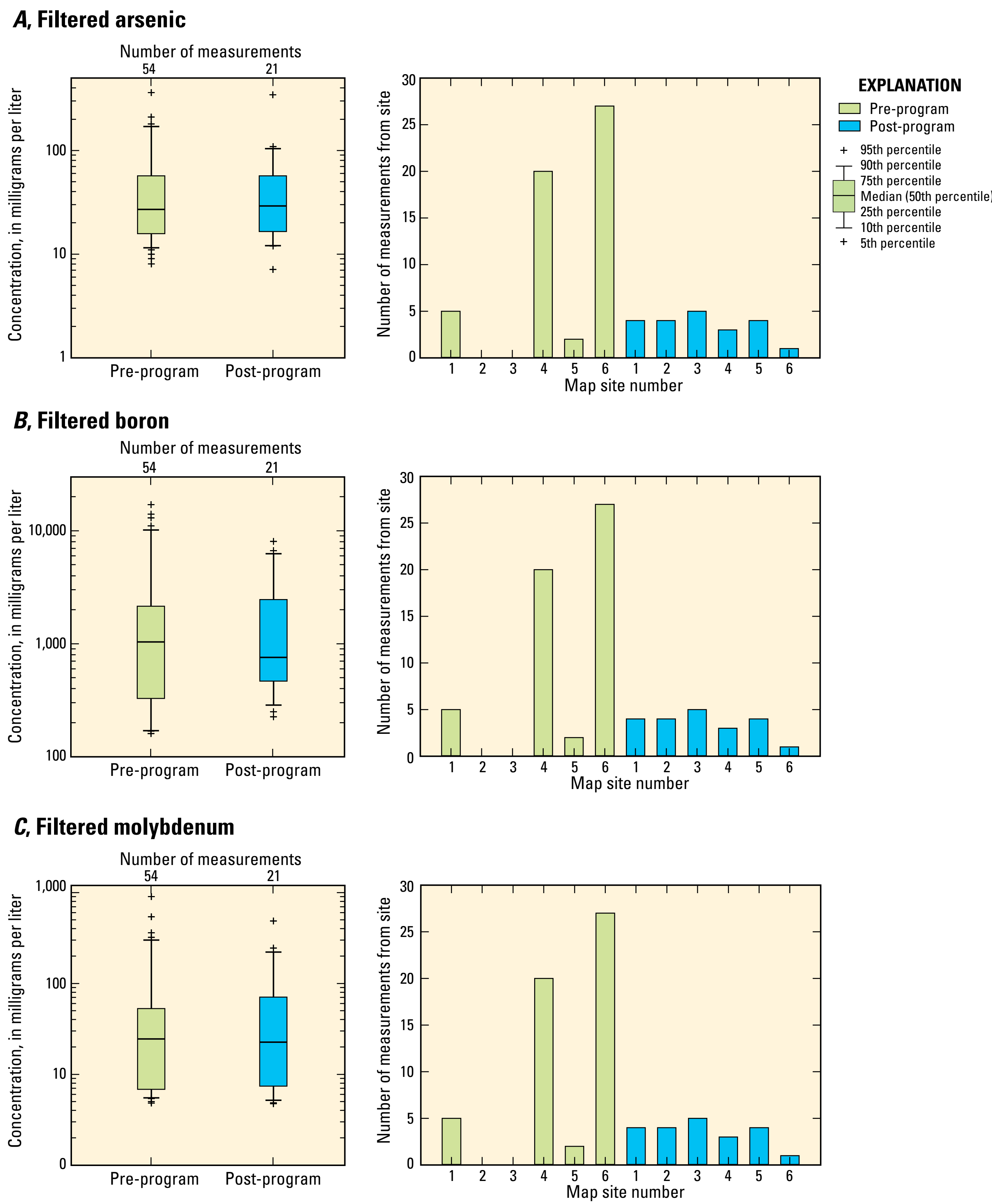


Figure 5. Statistical distribution comparisons of laboratory analyses of selected trace elements made during the pre-program (1971–98) and post-program (2014–16), Stillwater National Wildlife Refuge. *A*, filtered arsenic, *B*, filtered boron, and *C*, filtered molybdenum.

Table 9. Concentrations and classification of selected trace organic compounds measured or estimated in samples collected from surface-water sites in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, 2014–16.

[1 (10312190), Map number and (U.S. Geological Survey site number). All concentrations are in nanograms per liter (parts per trillion). <, less than laboratory reporting limit]

Constituent	Sample date	1 (10312190)	2 (1031220130)	3 (103122155)	4 (1031221902)	5 (10312220)	6 (10312277)	Classification (https://pubchem.ncbi.nlm.nih.gov/)
Bupropion	May 2014	[1]2.17	< 17.8	< 17.8	< 17.8	< 17.8	< 17.8	antidepressant/smoke cessation aid
	June 2015	< 17.8	< 17.8	< 17.8	< 17.8	< 17.8		
	June and July 2016	[1]1.19	< 17.8	< 17.8	< 17.8	< 17.8		
Caffeine	May 2014	< 90.7	[1]10.7	< 210	< 90.7	< 90.7	< 90.7	stimulant (coffee, tea, chocolate)
	June 2015	< 90.7	< 90.7	< 90.7	< 90.7	< 90.7		
	June and July 2016	< 90.7	< 90.7	< 90.7	< 90.7	< 90.7		
Carbamazepine	May 2014	15.9	17.3	18.2	18.7	[1]4.91	[1]10.6	anti-epilepsy/anticonvulsant
	June 2015	[1]7.19	15.7	16.8	14.6	[1]10.6		
	June and July 2016	[1]6.37	[1]4.25	[1]7.05	[1]5.77	[1]5.51		
Cotinine	May 2014	39.1	19	18.8	18.9	5.38	16	nicotine metabolite
	June 2015	74.3	17.8	22.1	21.2	9.13		
	June and July 2016	5.71	[1]4.02	7.17	[1]5.00	[1]3.13		
Sulfamethoxazole	May 2014	[1]23.1	[1]35.7	[1]37.8	[1]40.9	[1]12.3	[1]13.2	antibiotic/bacteriocide
	June 2015	[1]14.7	[1]19.4	[1]19.5	[1]17.9	[1]13.8		
	June and July 2016	< 26.1	< 26.1	< 26.1	< 26.1	< 26.1		
Thiabendazole	May 2014	< 4.10	< 4.10	< 4.10	< 4.10	< 4.10	< 4.10	fungicide and parasiticide
	June 2015	< 4.10	< 4.10	< 4.10	[1]1.3	< 4.10		
	June and July 2016	< 4.10	< 20.0	< 4.10	< 20.0	< 4.10		
Hydrocortisone	May 2014	< 147	< 147	< 147	< 147	< 147	< 147	treatment of severe allergic reactions and gout
	June 2015	< 147	< 147	< 147	< 147	< 147		
	June and July 2016	< 147	< 200	[1]84.9	< 200	< 147		
Pseudoephedrine	May 2014	[1]8.22	< 11.1	< 11.1	< 11.1	< 11.1	< 11.1	decongestant
	June 2015	[1]4.47	< 11.1	< 11.1	< 11.1	< 11.1		
	June and July 2016	< 11.1	< 11.1	< 11.1	< 11.1	< 11.1		
Lidocaine	May 2014	[1]2.29	[1]1.8	[1]1.78	[1]1.54	< 15.2	< 15.2	topical anesthesia
	June 2015	[1]2.37	[1]2.53	[1]2.82	[1]2.5	[1]0.83		
	June and July 2016	[1]3.16	< 15.2	< 15.2	[1]3.87	[1]1.54		
Meprobamate	May 2014	[1]19	[1]40.1	[1]38.5	[1]35.7	[1]7.66	[1]34.7	muscle relaxer/metabolite of carisoprodol
	June 2015	[1]28.8	[1]35.9	[1]40.2	[1]33	[1]17.2		
	June and July 2016	< 86.0	< 86.0	[1]8.39	< 86.0	[1]4.09		
Phenytoin	May 2014	< 188	< 188	[1]53.2	[1]50.9	< 188	[1]51.5	anticonvulsant/Dilantin
	June 2015	< 188	[1]9.92	[1]19.4	< 188	< 188		
	June and July 2016	< 188	< 188	< 188	< 188	< 188		
Dextromethorphan	May 2014	[1]3.4	< 8.20	< 8.20	< 8.20	< 8.20	< 8.20	cough suppressant
	June 2015	< 8.20	< 8.20	< 8.20	< 8.20	< 8.20		
	June and July 2016	< 8.20	< 8.20	< 8.20	< 8.20	< 8.20		
Temazepam	May 2014	< 18.4	< 18.4	< 18.4	< 18.4	< 18.4	< 18.4	treat insomnia
	June 2015	< 18.4	< 18.4	< 18.4	[1]8.96	< 18.4		
	June and July 2016	< 18.4	< 20	< 18.4	< 20.0	< 18.4		
Triamterene	May 2014	[1]3.43	< 5.25	< 5.25	< 5.25	< 5.25	< 5.25	diuretic
	June 2015	[1]1.85	[1]0.52	< 5.25	< 5.25	< 5.25		
	June and July 2016	< 5.25	< 5.25	< 5.25	< 5.25	< 5.25		
Fluconazole	May 2014	[1]49.4	[1]17.3	[1]21	< 71.0	< 71.0	< 71.0	antifungal
	June 2015	[1]68.4	[1]14.9	[1]11.1	[1]11.3	< 71.0		
	June and July 2016	< 71.0	< 80.0	[1]4.93	< 80.0	[1]4.61		
Acyclovir	May 2014	39.1	< 22.2	< 22.2	< 22.2	< 22.2	< 22.2	antiviral (herpes)
	June 2015	26.7	< 22.2	< 22.2	< 22.2	< 22.2		
	June and July 2016	< 22.2	< 22.2	< 22.2	< 22.2	< 22.2		
Metformin	May 2014	78.5	122	98.3	121	[1]6.7	35.6	antidiabetic; oral
	June 2015	41.4	131	87.6	115	41.5		
	June and July 2016	24.7	26.6	25.8	29.4	[1]9.45		

Table 9. Concentrations and classification of selected trace organic compounds measured or estimated in samples collected from surface-water sites in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, 2014–16.—Continued

[1 (10312190), Map number and (U.S. Geological Survey site number). All concentrations are in nanograms per liter (parts per trillion). <, less than laboratory reporting limit]

Constituent	Sample date	1 (10312190)	2 (1031220130)	3 (103122155)	4 (1031221902)	5 (10312220)	6 (10312277)	Classification (https://pubchem.ncbi.nlm.nih.gov/)
Nicotine	May 2014	[1]36.3	[1]21	[1]10.4	< 57.8	< 57.8	< 57.8	tobacco
	June 2015	64	[1]55.6	[1]52	116	[1]47.7		
	June and July 2016	< 57.8	< 57.8	< 57.8	< 57.8	< 57.8		
Carisoprodol	May 2014	< 12.5	[1]3.36	< 12.5	< 12.5	< 12.5	[1]4.9	muscle relaxer
	June 2015	[1]9.86	[1]7.03	[1]9.06	[1]8.29	< 12.5		
	June and July 2016	< 12.5	< 12.5	[1]2.08	< 12.5	< 12.5		
Methocarbamol	May 2014	74.3	70.3	67.3	70.3	13.3	38.7	muscle relaxer
	June 2015	170	91.2	102	76.1	36.4		
	June and July 2016	25.4	13	21.5	15.5	6.08		
Metaxalone	May 2014	[1]21.8	< 15.6	13.05	< 15.6	< 15.6	< 15.6	muscle relaxer
	June 2015	< 15.6	< 15.6	< 15.6	< 15.6	< 15.6		
	June and July 2016	< 15.6	< 20.0	< 15.6	< 20.0	< 15.6		
Fexofenadine	May 2014	424	26.4	22.9	22	< 19.9	[1]12.3	antihistamine
	June 2015	268	[1]19.1	[1]12.1	[1]14.3	[1]6.26		
	June and July 2016	75.5	< 19.9	[1]16.4	< 19.9	< 19.9		
Methyl-1h-benzo-triazole	May 2014	5,230	799	1,090	913	[1]104	200	corrosion inhibitor/aircraft de-icer
	June 2015	21,100	[1]132	230	[1]111	[1]61.5		
	June and July 2016	1,550	[1]52.9	494	< 141	[1]31.8		
Tramadol	May 2014	32.1	[1]10.8	[1]9.06	[1]11.1	< 15.1	< 15.1	opioid/pain killer
	June 2015	[1]13.9	< 15.1	[1]5.79	[1]5.97	[1]2.25		
	June and July 2016	[1]10.6	< 15.1	< 15.1	< 15.1	< 15.1		
Metoprolol	May 2014	[1]5.9	[1]1.5	< 27.5	< 27.5	< 27.5	< 27.5	blood pressure/angina
	June 2015	< 27.5	< 27.5	< 27.5	< 27.5	< 27.5		
	June and July 2016	[1]1.87	< 27.5	< 27.5	< 27.5	< 27.5		
Desvenlafaxine	May 2014	[1]4.85	< 7.49	< 7.49	< 7.49	< 7.49	< 7.49	antidepressant
	June 2015	[1]3.8	< 7.49	< 7.49	< 7.49	< 7.49		
	June and July 2016	[1]4.88	< 7.49	< 7.49	< 7.49	< 7.49		

[1] Value extrapolated below long-term method detection limit and (or) lowest calibration standard.

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Supplemental Data

The following tables are distributed as part of this report in Microsoft® Excel 2010 format and are available for download at https://doi.org/10.3133/ds20171072.

Table 10. Data from field measurements of physical and chemical parameters made at surface-water sites in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, 1986–2016.

Table 11. Results of analyses for organic carbon, water hardness, major dissolved chemical constituents, and dissolved solids in samples collected from surface-water sites in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, 1986–2016.

Table 12. Results of analyses for selected nutrients in samples collected from surface-water sites in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, 1986–2016.

Table 13. Results of analyses for selected trace elements in samples collected from surface-water sites in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, 1971–2016.

Table 14. Results of analyses for selected trace organic compounds in samples collected from surface-water sites in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, 2014–16.

Table 15. Results of analyses for selected trace elements and moisture content in bottom-sediment samples collected from surface-water sites in and near Stillwater National Wildlife Refuge, Lahontan Valley, Nevada, 2014–16.

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