December 2014

Norwest Corporation (Norwest) maintains three gaging stations for Pioneer Natural Resources USA Inc. (PNR) in the headwaters of the Apishapa River in northern Las Animas County, Colorado. The Apishapa River is a tributary of the Arkansas River. The gaging stations acquire "continuous" data on 15-minute intervals for pressure, temperature, conductivity, calculated SAR, and calculated flow using an In-Situ Aqua Troll. Communication of the near real-time continuous data is accomplished using Iridium satellite telemetry and is available online at www.apishapawatershed.org. Norwest visits the stations every two weeks to download the data, calibrate the equipment, acquire instantaneous flow measurements, collect field parameters of pH, temperature, conductivity and salinity, and collect water quality samples. All monitoring conducted at each station is voluntary and is not required by any regulatory agency.

The three stations on the Apishapa are shown on **Figure 1**. The Belarde station is furthest upstream and has a contributing watershed of 59.3 square miles. The Eichler station is located downstream, and has a contributing watershed of 72.9 square miles. The Lisonbee station is located further downstream, southwest of Aguilar, slightly upstream of the historic USGS gage 07118000, and has a contributing watershed of 141.7 square miles. The Eichler and Lisonbee stations are located downstream of the Apishapa's confluence with tributaries potentially influenced by coalbed methane discharge waters.

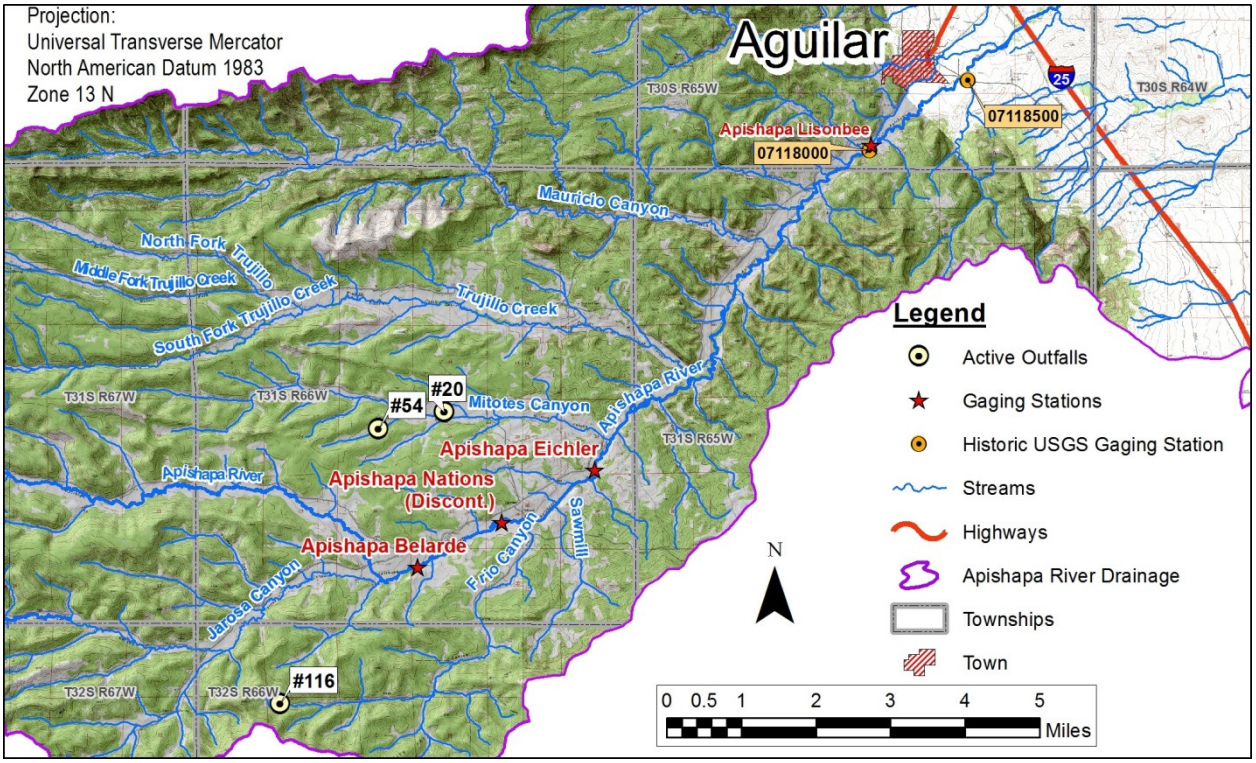

FIGURE 1
APISHAPA WATERSHED

The U.S. Drought Monitor prepares maps weekly for drought conditions throughout the contiguous United States. The U.S. Drought Monitor is produced in partnership between the National Drought Mitigation Center at the University of Nebraska-Lincoln (NDMC-UNL), the United States Department of Agriculture, and the National Oceanic and Atmospheric Administration. **Figure 2** depicts drought conditions in Colorado for data received as of 7 a.m. EST on December 2, 2014. **Figure 3** depicts drought conditions in Colorado for data received as of 7 a.m. EST on December 30, 2014. Drought conditions in Las Animas County remained the same throughout the month of December with D0 and D1 drought conditions in the western portion of the county and a combination of D1 and D2 drought conditions in the central and eastern parts of the county (Drought Monitor, 2014).

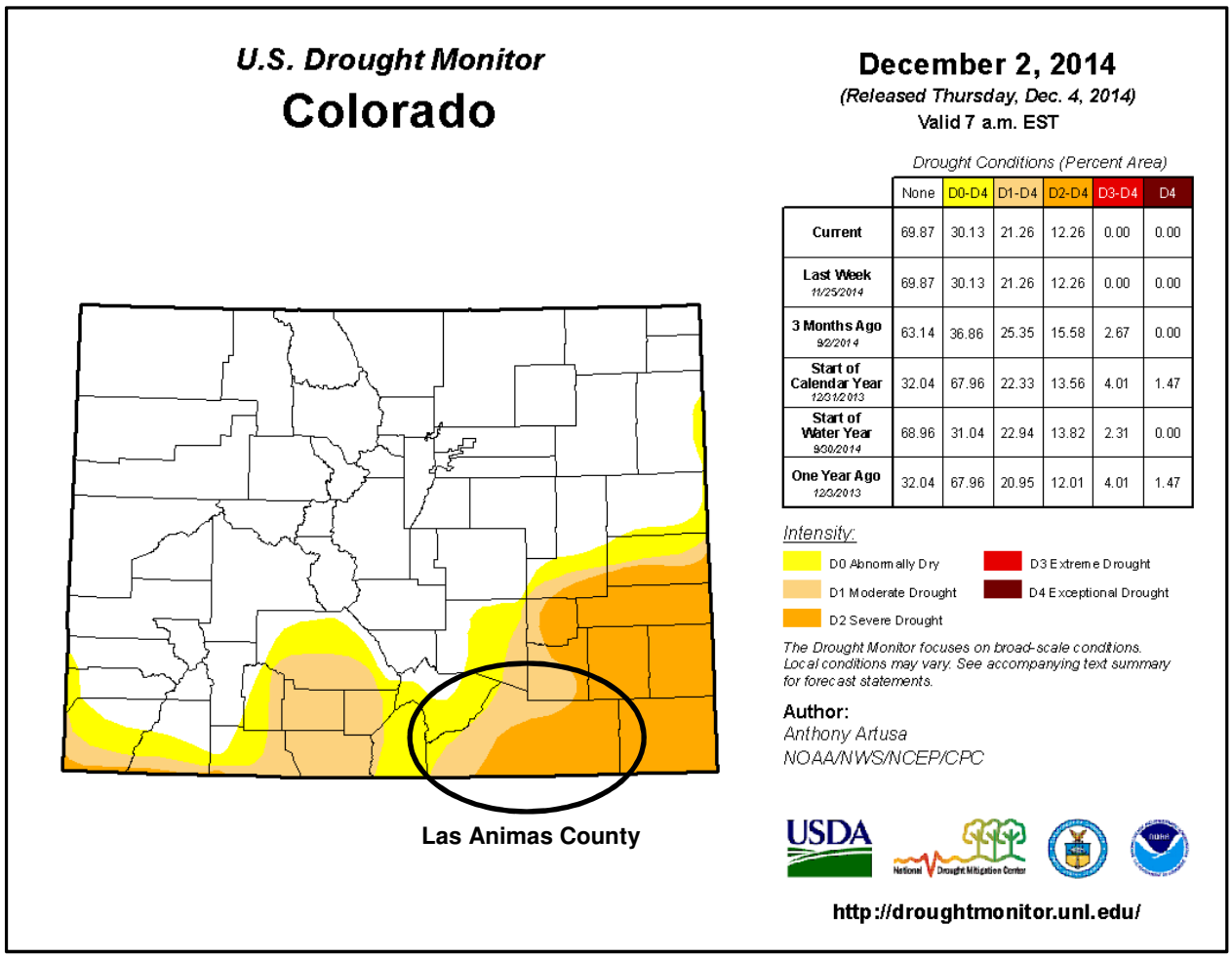

FIGURE 2
U.S. DROUGHT MONITOR COLORADO – DECEMBER 2, 2014

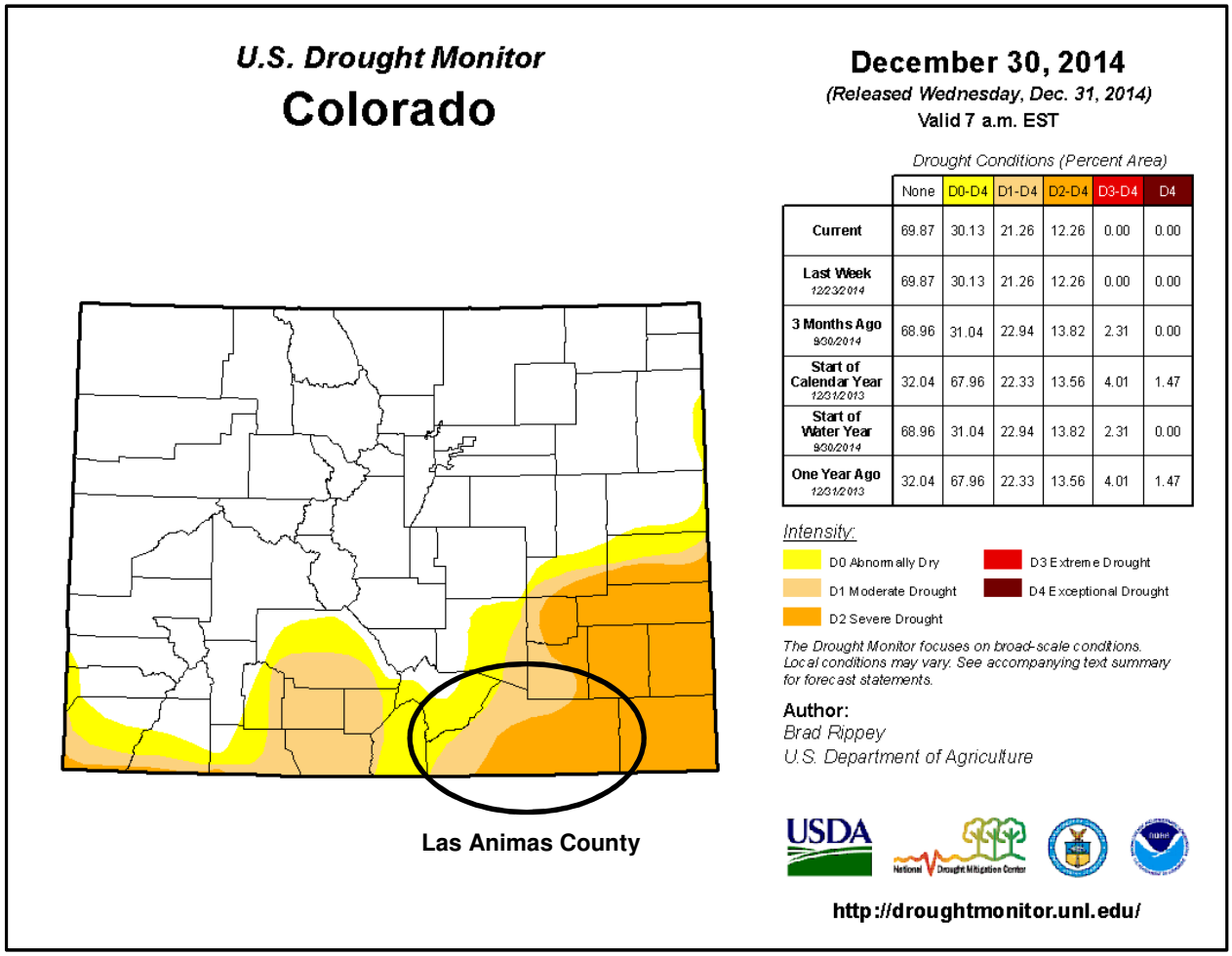

FIGURE 3
U.S. DROUGHT MONITOR COLORADO – DECEMBER 30, 2014

The three gaging stations on the Apishapa River discussed in this report are located in the southwest part of the county with the D0 and D1 drought conditions mentioned above. Recordable flow was present at all three stations the entire month of December 2014. Laboratory water quality samples were collected and streamflow was measured at all three stations during both December 2014 site visits.

December 2014 data exhibited a calculated daily average flow of 1.73 cfs at Belarde, 0.65 cfs at Eichler, and 3.81 cfs at Lisonbee. Temperatures were seasonal. The daily average specific conductance at Belarde ranged from 291 µs/cm to 329 µs/cm, with a median value of 306 µs/cm (**Table 1**). The daily average specific conductance at Eichler ranged from 504 µs/cm to 677 µs/cm, with a median value of 617 µs/cm (**Table 1**). The daily average specific conductance at Lisonbee ranged from 553 µs/cm to 582 µs/cm, with a median value of 566 µs/cm (**Table 1**). The calculated daily average sodium adsorption ratio (SAR) values in December 2014 ranged from 0.57 to 0.63 at Belarde, 1.07 to 1.44 at Eichler, and 1.69 to 1.79 at Lisonbee (**Table 1**).

TABLE 1
DECEMBER 2014 DAILY AVERAGE GAGE DATA

	Average Daily			
	Minimum	**Median**	**Average**	**Maximum**
Belarde - (31 days of flow data)				
Water Level (ft)	0.50	0.55	0.57	0.66
Flow[1] (cfs)	1.07	1.80	1.73	2.77
Temperature (°C)	-0.06	1.09	1.19	3.48
Conductivity (µs/cm)	291	306	309	329
TDS[2] (mg/l)	189	199	201	214
Sodium Adsorption Ratio[3] (SAR)	0.57	0.60	0.60	0.63
Eichler - (31 days of flow data)				
Water Level (ft)	0.47	0.52	0.53	0.65
Flow[1] (cfs)	0.26	0.61	0.65	1.58
Temperature (°C)	0.22	0.93	1.09	2.92
Conductivity (µs/cm)	504	617	612	677
TDS[2] (mg/l)	328	401	398	440
Sodium Adsorption Ratio[3] (SAR)	1.07	1.31	1.30	1.44
Lisonbee - (31 days of flow data)				
Water Level (ft)	0.32	0.41	0.40	0.42
Flow[1] (cfs)	1.32	4.25	3.81	4.67
Temperature (°C)	0.73	2.32	2.37	4.64
Conductivity (µs/cm)	553	566	566	582
TDS[2] (mg/l)	359	368	368	378
Sodium Adsorption Ratio[3] (SAR)	1.69	1.74	1.73	1.79

[1] Calculated from pressure data

[2] Calculated from conductivity data with a conversion of 0.65 mg/l TDS per µs/cm specific conductance

[3] Derived from a historic multivariate regression analysis of conductivity and flow

The mainstem of the Apishapa River has been classified by the Colorado Water Quality Control Commission (WQCC) as supporting aquatic life, recreation, water supply, and agriculture (CDPHE WQCC, 2014). During the month of December 2014, the water type at the Belarde and Eichler stations was a calcium bicarbonate water, with a calcium-sodium bicarbonate water type at Lisonbee.

December 2014 field measured SC values and laboratory measured SAR values at the Eichler and Lisonbee stations are illustrated in **Table 2** and **Figure 4**. Both stations were below the SC threshold limit of 1300 µs/cm and the SAR threshold limit of 6.8 (**Figure 4**). These SC and SAR threshold limits have been identified by the Colorado Department of Public Health and Environment (CDPHE) for protection of downstream alfalfa crops (CDPHE, 2010).

TABLE 2
DECEMBER 2014 SAR AND SPECIFIC CONDUCTANCE

Location	Sample Date	SAR	Specific Conductance (µs/cm)
Belarde	12/5/2014	0.61	305
Belarde	12/19/2014	0.61	330
Eichler	12/5/2014	1.14	678
Eichler	12/19/2014	1.13	669
Lisonbee	12/5/2014	1.77	563
Lisonbee	12/19/2014	1.75	590

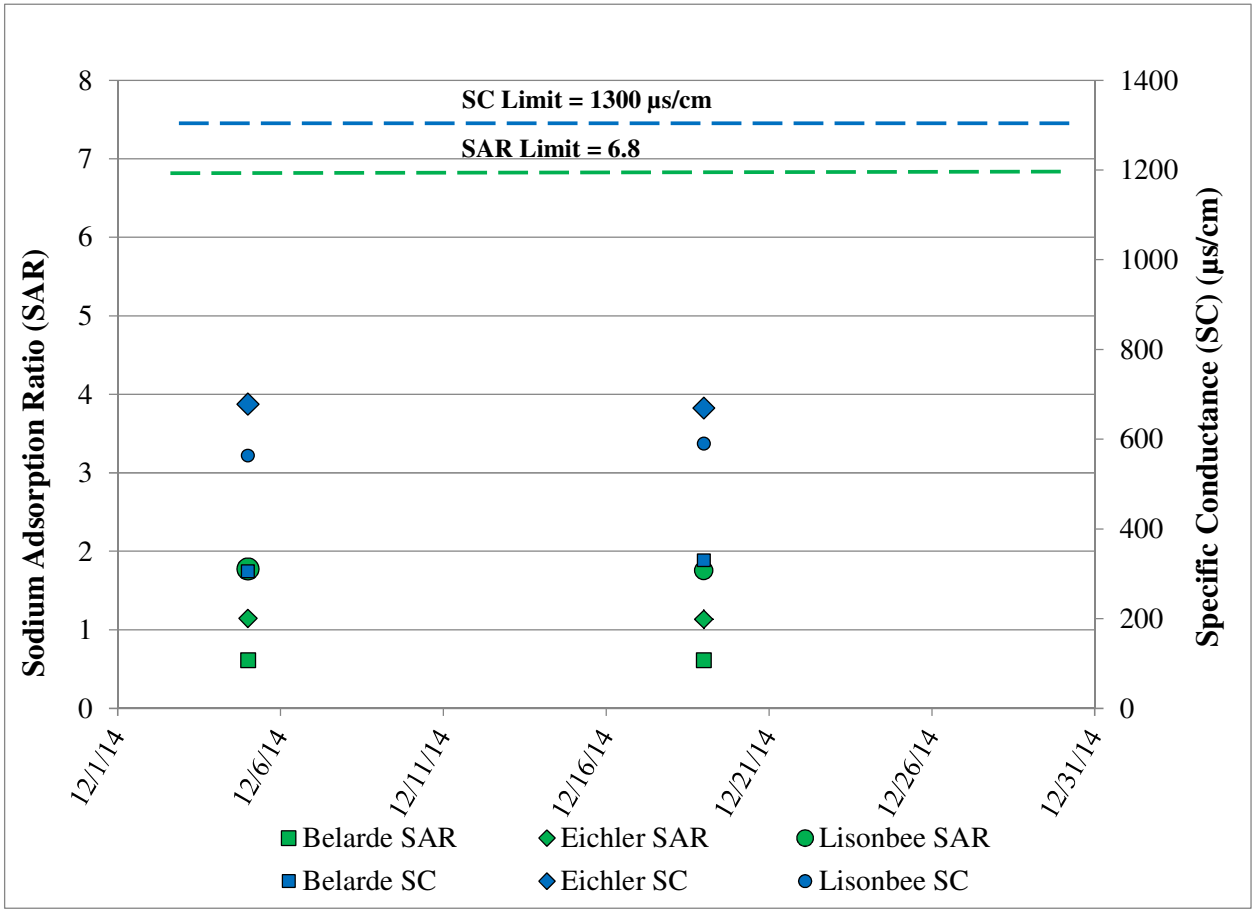

FIGURE 4
DECEMBER 2014 SAR AND SPECIFIC CONDUCTANCE

The water in December exhibits a range of hardness with Belarde ranging from 122 mg/l $CaCO_3$ to 134 mg/l $CaCO_3$ hardness, Eichler ranging from 244 mg/l $CaCO_3$ to 257 mg/l $CaCO_3$ hardness, and Lisonbee ranging from 195 mg/l $CaCO_3$ to 196 mg/l $CaCO_3$ hardness (**Table 4**). Based on toxicity testing, aquatic species protection from elevated heavy metal concentrations increases as hardness increases (CDPHE WQCC, 2013). Lower hardness values, closer to 25 mg/l $CaCO_3$, have lower hardness based metal

standards to provide aquatic life protection and higher hardness values, closer to 400 mg/l $CaCO_3$, can afford higher hardness based metal standards to provide aquatic life protection (CDPHE WQCC, 2013).

Stream water quality is affected by the quantity of sediment in the stream. Sediment concentrations increase during storm events or snowmelt runoff. Analyses of the total recoverable forms of metals typically increase with increased sediment concentrations, as the laboratory analytical digestions dissolve the sediment. Total suspended solids (TSS) in December 2014 ranged from <4 mg/l to 19.2 mg/l at the Belarde station, ranged from <4 mg/l to 21.6 mg/l at the Eichler station, and ranged from 8.8 mg/l to 10.4 mg/l at the Lisonbee station (**Table 3** and **Figure 5**). TSS values less than the detection limit of 4 mg/l are plotted as ½ the detection limit in **Figure 5**. Total recoverable iron concentrations were 0.369 mg/l to 0.597 mg/l at Belarde, 0.192 mg/l to 0.614 mg/l at Eichler, and 0.213 mg/l to 0.394 mg/l at Lisonbee (**Table 3** and **Figure 5**).

TABLE 3
DECEMBER 2014 INSTANTANEOUS TOTAL RECOVERABLE IRON (MG/L) AND TOTAL SUSPENDED SOLIDS (MG/L)

Location	Sample Date	Iron (T-Rec.) (mg/l)	Total Suspended Solids (TSS) (mg/l)
Belarde	12/5/2014	0.369	<4
Belarde	12/19/2014	0.597	19.2
Eichler	12/5/2014	0.192	<4
Eichler	12/19/2014	0.614	21.6
Lisonbee	12/5/2014	0.394	8.8
Lisonbee	12/19/2014	0.213	10.4

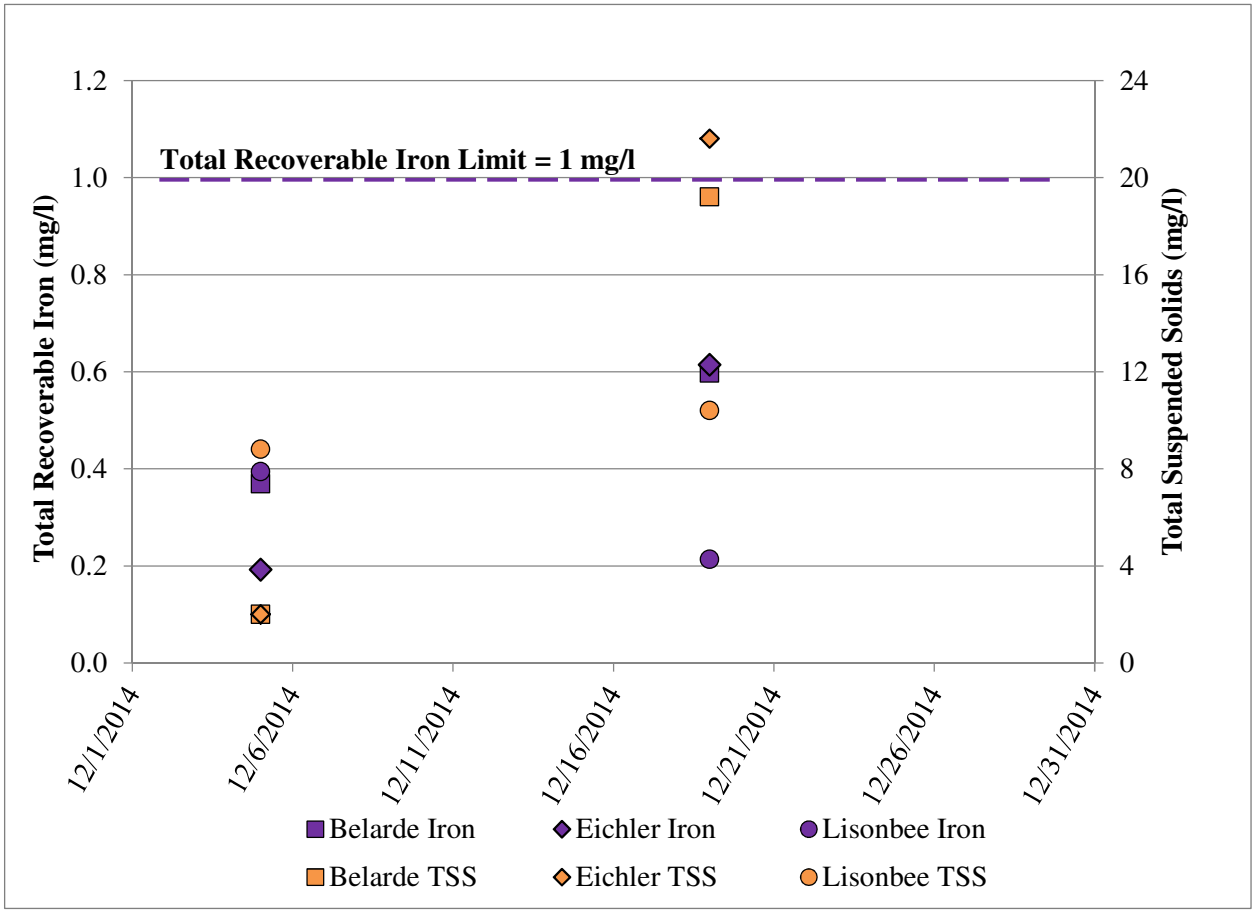

FIGURE 5
DECEMBER 2014 INSTANTANEOUS TOTAL RECOVERABLE IRON (MG/L) AND TOTAL SUSPENDED SOLIDS (MG/L)

Constituents below the detection limit at all three stations in December 2014 include arsenic, boron, chromium, selenium, and zinc. Measured concentrations of potentially dissolved copper were below the detection limit of 15 µg/l at all three stations (**Table 4**). However, the hardness adjusted stream standard for chronic potentially dissolved copper at Belarde in December was lower than the 15 µg/l detection limit (**Table 4**). Measured concentrations of potentially dissolved manganese were lower than the hardness adjusted stream standards established by the WQCC (**Table 4**). Chloride and sulfate were below the stream standards at all three stations (**Table 5**). The field pH values in December 2014 were within the stream standard of between 6.5 and 9.0 at both stations (**Table 5**).

TABLE 4
HARDNESS BASED STREAM STANDARDS ASSOCIATED WITH APISHAPA RIVER INSTANTANEOUS SAMPLING, DECEMBER 2014 (CDPHE WQCC, 2013)

Site	Sample Date	Stream Segment	Calculated Hardness[1] (mg/l $CaCO_3$)	Acute Copper (Pot. Diss.) (µg/l)	Chronic Copper (Pot Diss.) (µg/l)	Chronic Iron (T-Rec.) (mg/l)	Acute Manganese (Pot. Diss.) (µg/l)	Chronic Manganese (Pot. Diss.) (µg/l)	Acute Zinc (Pot. Diss.) (µg/l)	Chronic Zinc (Pot. Diss.) (µg/l)
Belarde Hardness Based Standards	12/5/2014	3a	122	16.2	10.6	1	3190	1763	192	145
Belarde Hardness Based Standards	12/19/2014	3a	134	17.7	11.5	1	3291	1819	209	158
Belarde Maximum December Results			**NA**	**<15**	**<15**	**0.597**	**91**	**91**	**<20**	**<20**
Eichler Hardness Based Standards	12/5/2014	3a	244	31.1	19.2	1	4019	2220	360	273
Eichler Hardness Based Standards	12/19/2014	3a	257	32.7	20.1	1	4089	2259	378	286
Eichler Maximum December Results			**NA**	**<15**	**<15**	**0.614**	**320**	**320**	**<20**	**<20**
Lisonbee Hardness Based Standards	12/5/2014	3a	196	25.3	15.9	1	3736	2064	295	223
Lisonbee Hardness Based Standards	12/19/2014	3a	195	25.2	15.8	1	3730	2061	294	222
Lisonbee Maximum December Results			**NA**	**<15**	**<15**	**0.394**	**43.6**	**43.6**	**<20**	**<20**

[1] A hardness value of 400 mg/l CaCO3 is used to calculate the metal standards when the measured hardness values are greater than 400 mg/l CaCO3

TABLE 5
STREAM STANDARDS ASSOCIATED WITH APISHAPA RIVER INSTANTANEOUS SAMPLING, DECEMBER 2014 (CDPHE WQCC, 2013)

Site	Sample Date	Stream Segment	Arsenic (Total) (µg/l)	Boron (Total) (mg/l)	Acute Chromium (Total) (µg/l)	Chronic Chromium (Total) (µg/l)	Chloride (mg/l)	Acute Selenium (T-Rec.) (µg/l)	Chronic Selenium (T-Rec.) (µg/l)	Sulfate (mg/l)	pH-low (s.u.)	pH-High (s.u.)
Belarde Standards	12/5/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Belarde Standards	12/19/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Belarde Maximum December Results[1]			**<15**	**<0.05**	**<10**	**<10**	**5.40**	**<4**	**<4**	**30.6**	**8.14**	**8.20**
Eichler Standards	12/5/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Eichler Standards	12/19/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Eichler Maximum December Results[1]			**<15**	**<0.05**	**<10**	**<10**	**33.1**	**<4**	**<4**	**35.5**	**8.33**	**8.40**
Lisonbee Standards	12/5/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Lisonbee Standards	12/19/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Lisonbee Maximum December Results[1]			**<15**	**<0.05**	**<10**	**<10**	**7.25**	**<4**	**<4**	**45.8**	**8.32**	**8.42**

[1] Minimum result identified for pH-low

References

Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Commission (WQCC), 2013. 5 CCR 1002-31, Regulation No. 31 The Basic Standards and Methodologies for Surface Water, Amended September 11, 2012, Effective January 31, 2013.

Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Commission (WQCC), 2014. 5 CCR 1002-32, Regulation No. 32 Classifications and Numeric Standards for Arkansas River Basin, Amended March 11, 2014, Effective April 30, 2014.

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