

October 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.

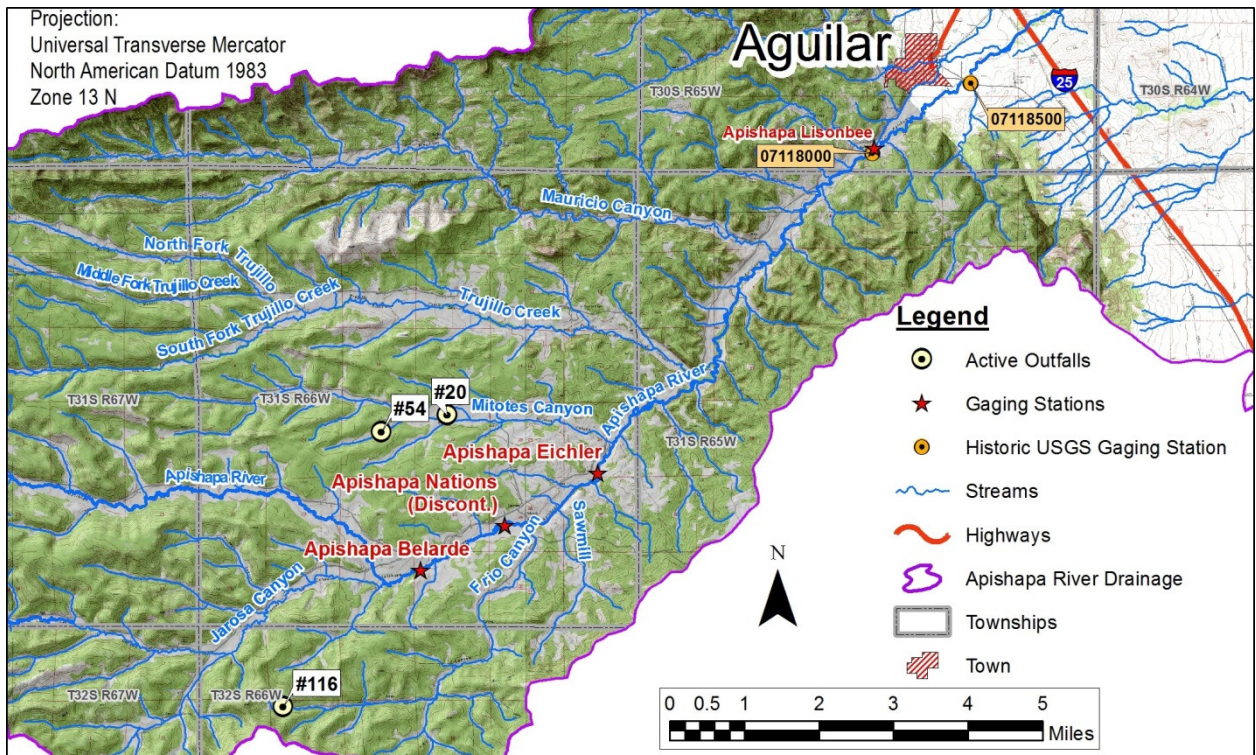


FIGURE 1
APISHAPA WATERSHED

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 September 30, 2014. **Figure 3** depicts drought conditions in Colorado for data received as of 7 a.m. EST on October 28, 2014. Drought conditions in Las Animas County for the month of October remained the same in the western portion of the county with D0 and D1 drought conditions, lessened from D1 and D2 drought conditions in the central part of the county to mostly D1 drought conditions, and lessened from D2 drought conditions to a combination of D1 and D2 drought conditions in the eastern part of the county (Drought Monitor, 2014).

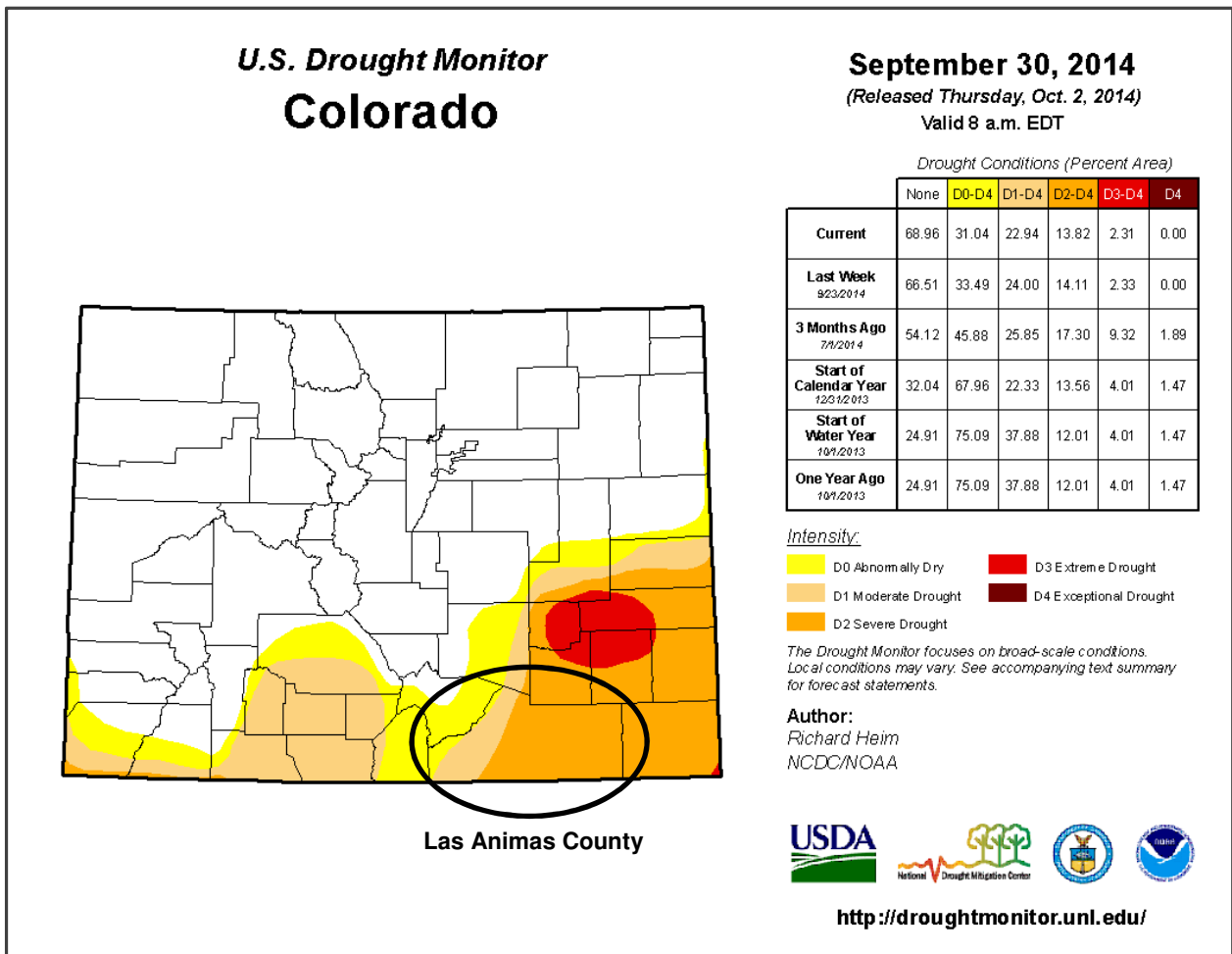


FIGURE 2
U.S. DROUGHT MONITOR COLORADO – SEPTEMBER 30, 2014

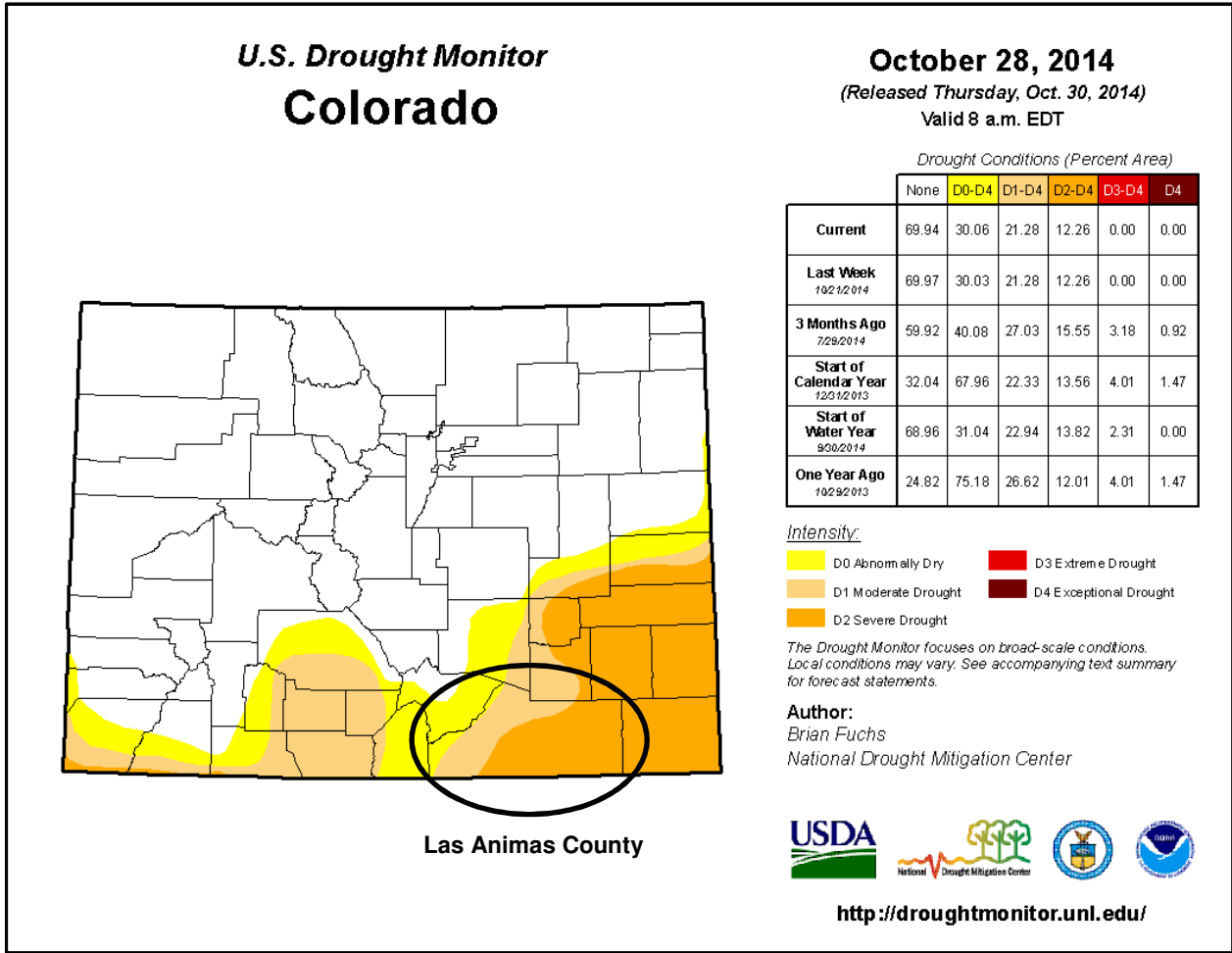


FIGURE 3
U.S. DROUGHT MONITOR COLORADO – OCTOBER 28, 2014

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 the Eichler and Lisonbee stations the entire month of October 2014. The Belarde station was dry October 1, 2014 through October 23, 2014. Laboratory water quality samples were collected and streamflow was measured at the Eichler and Lisonbee stations during both October 2014 site visits, with the Belarde station dry during both site visits.

October 2014 data exhibited a calculated daily average flow of 1.87 cfs at Belarde, 0.07 cfs at Eichler, and 1.00 cfs at Lisonbee. Temperatures were seasonal. The daily average specific conductance at Belarde ranged from 303 $\mu\text{s}/\text{cm}$ to 560 $\mu\text{s}/\text{cm}$, with a median value of 340 $\mu\text{s}/\text{cm}$ (**Table 1**). The daily average specific conductance at Eichler ranged from 514 $\mu\text{s}/\text{cm}$ to 691 $\mu\text{s}/\text{cm}$, with a median value of 531 $\mu\text{s}/\text{cm}$ (**Table 1**). The daily average specific conductance at Lisonbee ranged from 548 $\mu\text{s}/\text{cm}$ to 622 $\mu\text{s}/\text{cm}$, with a median value of 591 $\mu\text{s}/\text{cm}$ (**Table 1**). The calculated daily average sodium adsorption ratio (SAR) values in October 2014 ranged from 0.57 to 0.90 at Belarde, 1.10 to 1.48 at Eichler, and 1.68 to 1.90 at Lisonbee (**Table 1**).

TABLE 1
OCTOBER 2014 DAILY AVERAGE GAGE DATA

	Average Daily			
	Minimum	Median	Average	Maximum
Belarde - (8 days of flow data)				
Water Level (ft)	0.48	0.55	0.56	0.62
Flow ¹ (cfs)	1.11	1.71	1.87	2.65
Temperature (°C)	6.28	8.11	8.17	11.36
Conductivity (µs/cm)	303	340	361	560
TDS ² (mg/l)	197	221	235	364
Sodium Adsorption Ratio ³ (SAR)	0.57	0.62	0.65	0.90
Eichler - (31 days of flow data)				
Water Level (ft)	0.29	0.39	0.38	0.43
Flow ¹ (cfs)	0.02	0.07	0.07	0.14
Temperature (°C)	6.38	10.18	9.99	12.38
Conductivity (µs/cm)	514	531	572	691
TDS ² (mg/l)	334	345	372	449
Sodium Adsorption Ratio ³ (SAR)	1.10	1.14	1.23	1.48
Lisonbee - (31 days of flow data)				
Water Level (ft)	0.26	0.29	0.30	0.34
Flow ¹ (cfs)	0.53	0.82	1.00	2.05
Temperature (°C)	7.37	10.79	10.49	13.37
Conductivity (µs/cm)	548	591	587	622
TDS ² (mg/l)	356	384	381	404
Sodium Adsorption Ratio ³ (SAR)	1.68	1.82	1.80	1.90

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 October 2014, the water type at the Eichler station was a calcium bicarbonate water, with a sodium-calcium bicarbonate water type at Lisonbee.

October 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
OCTOBER 2014 SAR AND SPECIFIC CONDUCTANCE

Location	Sample Date	SAR	Specific Conductance (µs/cm)
Eichler	10/13/2014	1.19	664
Eichler	10/23/2014	1.21	686
Lisonbee	10/10/2014	1.87	547
Lisonbee	10/23/2014	1.84	596

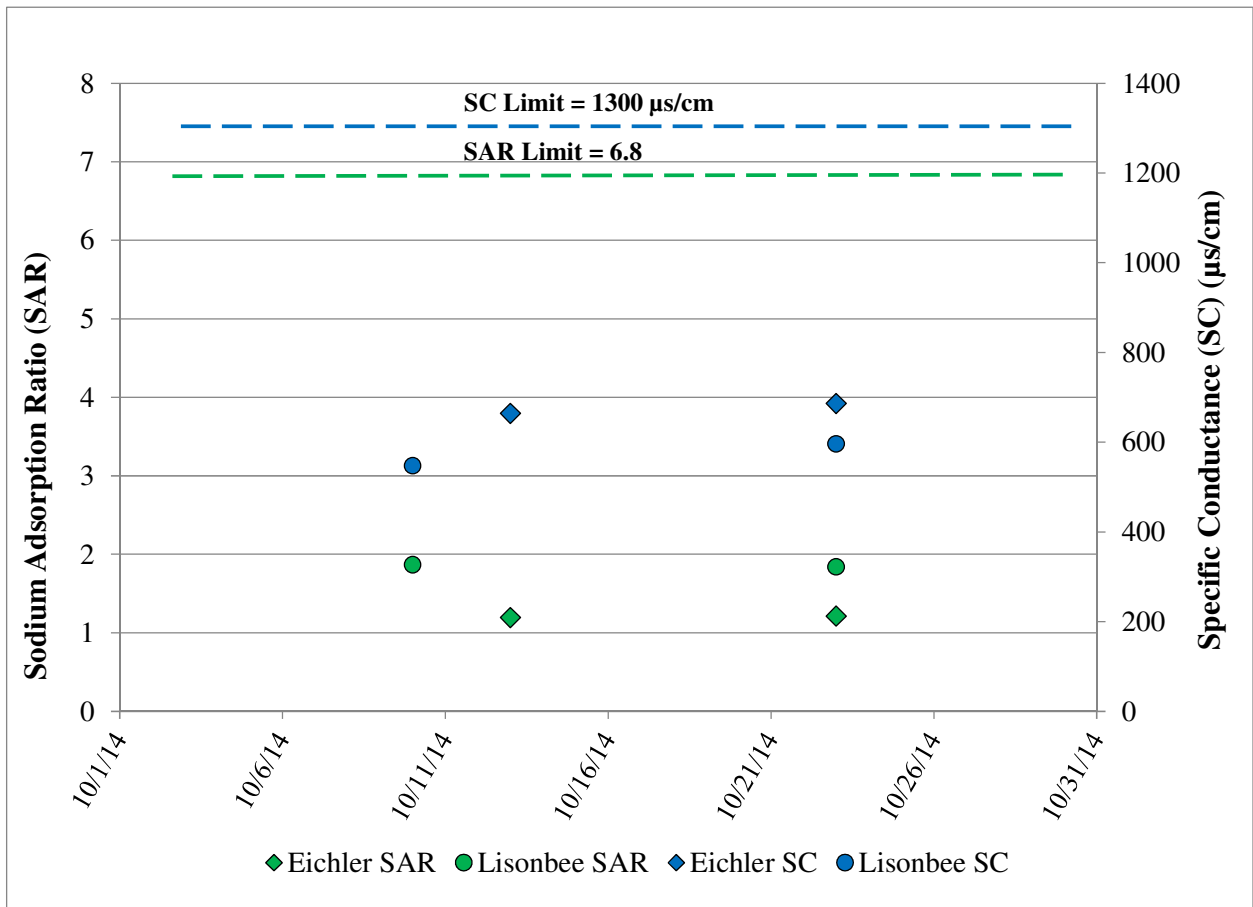


FIGURE 4
OCTOBER 2014 SAR AND SPECIFIC CONDUCTANCE

The water in October exhibits a range of hardness with Eichler ranging from 267 mg/l CaCO₃ to 279 mg/l CaCO₃ hardness and Lisonbee ranging from 172 mg/l CaCO₃ to 202 mg/l CaCO₃ 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 CaCO₃, have lower hardness based metal standards to provide aquatic life protection and higher hardness values, closer to 400 mg/l CaCO₃, 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 October 2014 ranged from 5.2 mg/l to 6.0 mg/l at the Eichler station and ranged from 7.2 mg/l to 15.6 mg/l at the Lisonbee station (**Table 3** and **Figure 5**). Total recoverable iron concentrations were 0.257 mg/l to 0.337 mg/l at Eichler and 0.480 mg/l to 0.272 mg/l at Lisonbee (**Table 3** and **Figure 5**).

TABLE 3
OCTOBER 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)
Eichler	10/13/2014	0.257	5.2
Eichler	10/23/2014	0.337	6.0
Lisonbee	10/10/2014	0.480	7.2
Lisonbee	10/23/2014	0.272	15.6

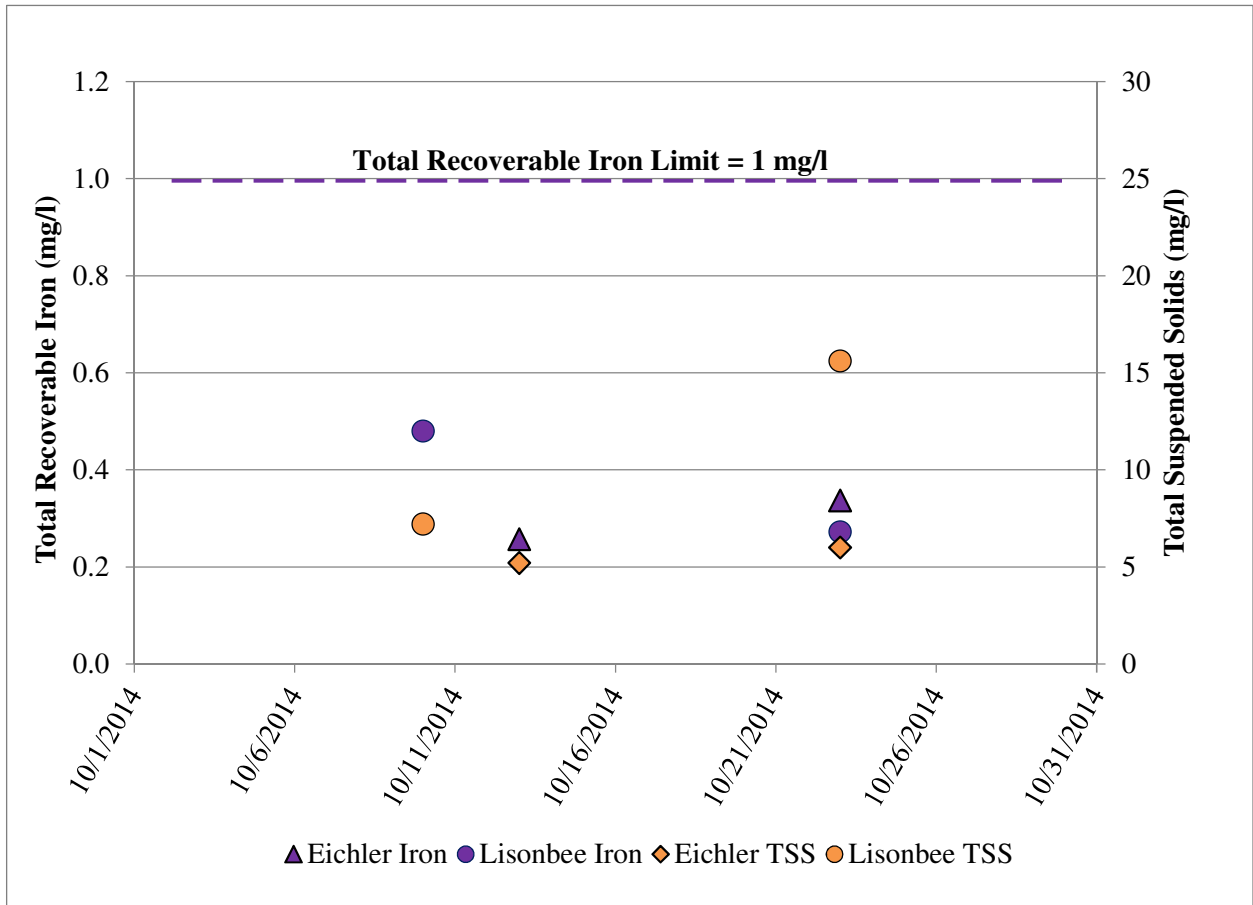


FIGURE 5
OCTOBER 2014 INSTANTANEOUS TOTAL RECOVERABLE IRON (MG/L) AND TOTAL SUSPENDED SOLIDS (MG/L)

Constituents below the detection limit at all three stations in October 2014 include arsenic, boron, chromium, copper, and selenium. Measured concentrations of potentially dissolved copper were below the detection limit of 15 µg/l at the Eichler and Lisonbee stations (**Table 4**). However, the hardness adjusted stream standard for chronic potentially dissolved copper at Lisonbee on October 10, 2014 was lower than the 15 µg/l detection limit (**Table 4**). Measured concentrations of potentially dissolved manganese and potentially dissolved zinc were lower than the hardness adjusted stream standards established by the WQCC (**Table 4**). Chloride and sulfate were below the stream standards at the Eichler and Lisonbee stations (**Table 5**). The field pH values in October 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, OCTOBER 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)
Eichler Hardness Based Standards	10/13/2014	3a	267	33.9	20.7	1	4141	2288	391	296
Eichler Hardness Based Standards	10/23/2014	3a	279	35.3	21.5	1	4202	2322	407	308
Eichler Maximum October Results			NA	<15	<15	0.337	214	214	21.6	21.6
Lisonbee Hardness Based Standards	10/10/2014	3a	172	22.4	14.2	1	3577	1976	262	198
Lisonbee Hardness Based Standards	10/23/2014	3a	202	26.1	16.3	1	3774	2085	303	230
Lisonbee Maximum October Results			NA	<15	<15	0.480	132	132	<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, OCTOBER 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.)
Eichler Standards	10/13/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Eichler Standards	10/23/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Eichler Maximum October Results¹			<15	<0.05	<10	<10	47	<4	<4	21.5	8.39	8.45
Lisonbee Standards	10/10/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Lisonbee Standards	10/23/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Lisonbee Maximum October Results¹			<15	<0.05	<10	<10	8.04	<4	<4	59.5	8.18	8.38

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.

Colorado Department of Public Health and Environment (CDPHE), 2010. Apishapa CBM Facility, Water Quality Assessment, Draft Discharge Permit CO0048313, Pioneer Natural Resources, USA, Inc.

U.S. Drought Monitor, 2014. Weekly maps and reports available from the Internet at <http://droughtmonitor.unl.edu/MapsAndData/MapArchive.aspx>.