

September 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.

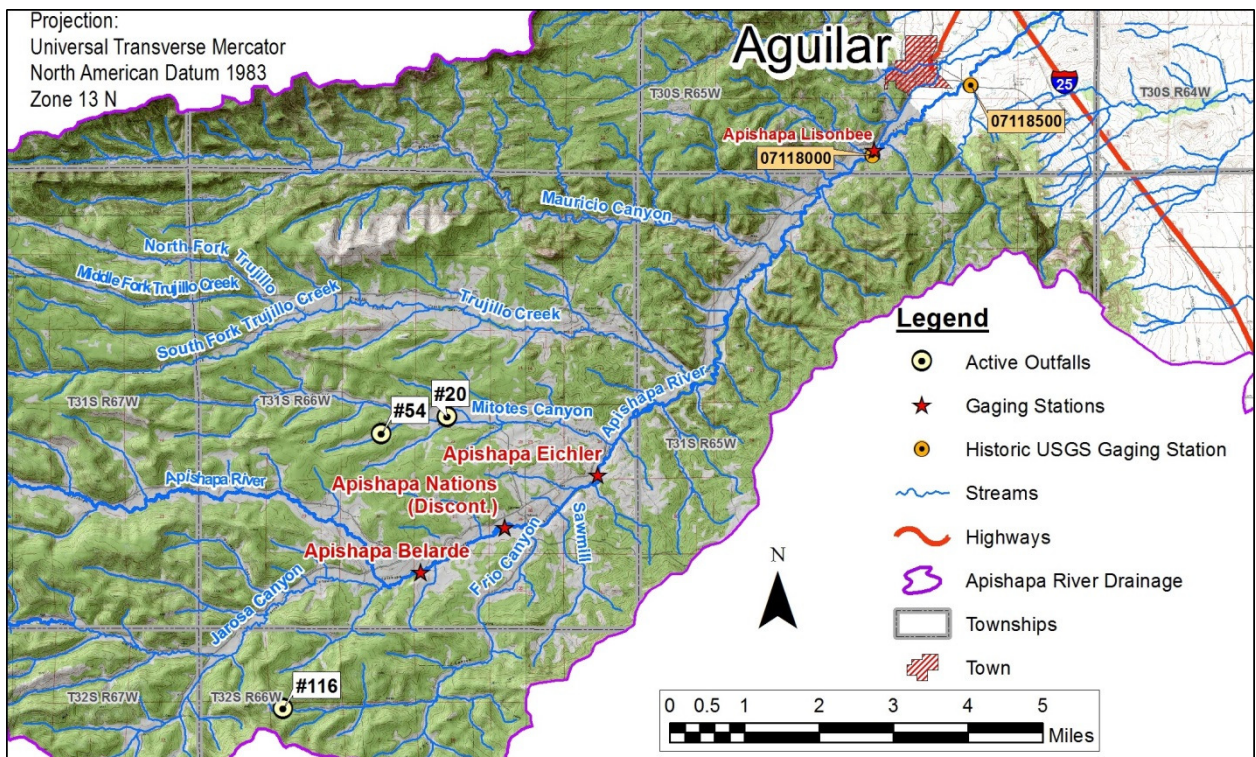


FIGURE 1
APISHAPA WATERSHED

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 2, 2014. **Figure 3** depicts drought conditions in Colorado for data received as of 7 a.m. EST on September 30, 2014. Drought conditions for the month of September remained the same throughout Las Animas County with D0 and D1 drought conditions in the western portion of the county, D1 and D2 drought conditions in the central part of the county, and D2 drought conditions in the eastern part of the county (Drought Monitor, 2014).

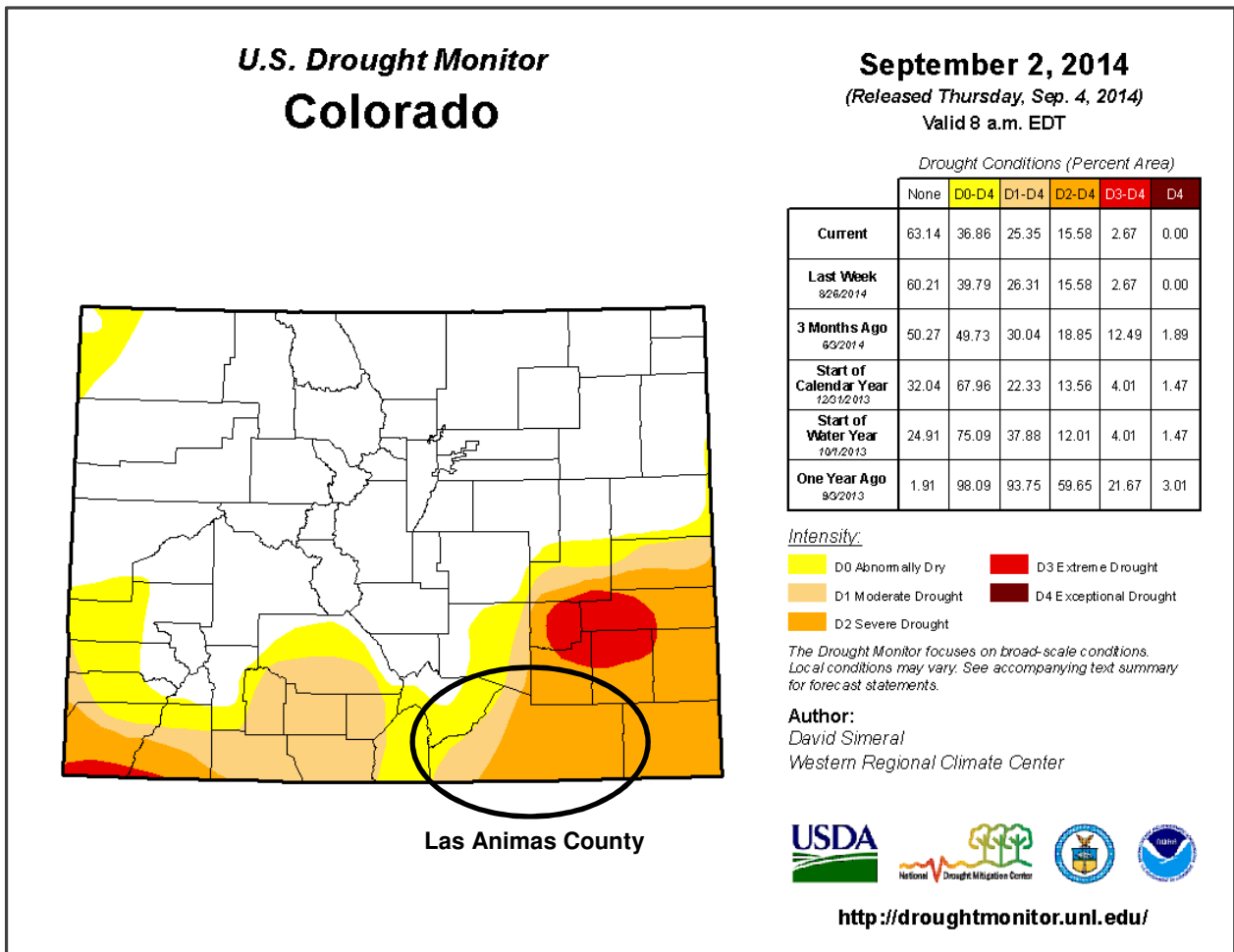


FIGURE 2
U.S. DROUGHT MONITOR COLORADO – SEPTEMBER 2, 2014

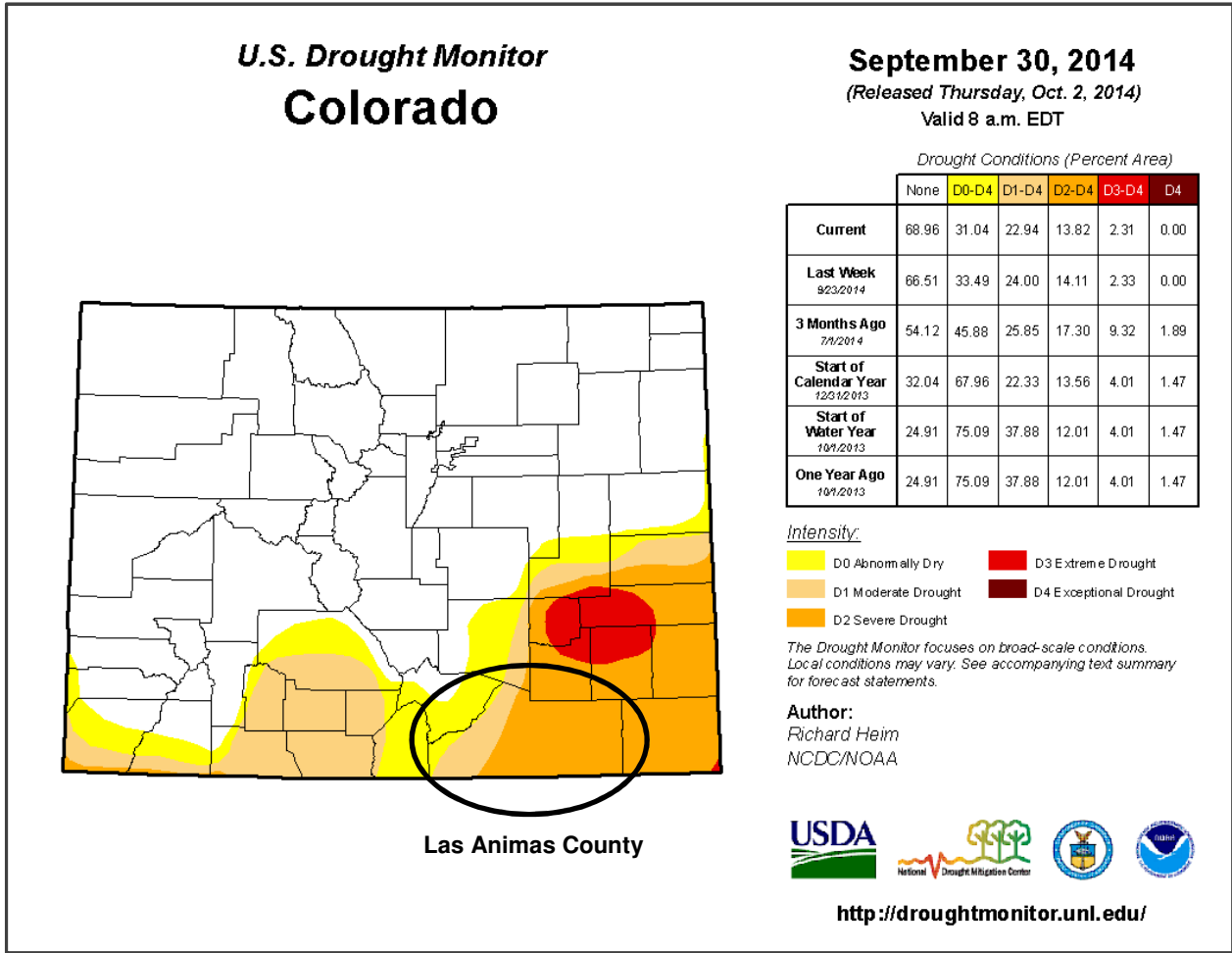


FIGURE 3
U.S. DROUGHT MONITOR COLORADO – SEPTEMBER 30, 2014

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 the Eichler and Lisonbee stations the entire month of September 2014. The Belarde station was dry September 20, 2014 through September 30, 2014. Laboratory water quality samples were collected and streamflow was measured at the Eichler and Lisonbee stations during both September 2014 site visits and at the Belarde station during the September 9, 2014 visit.

September 2014 data exhibited a calculated daily average flow of 0.42 cfs at Belarde, 0.19 cfs at Eichler, and 0.92 cfs at Lisonbee. Temperatures were seasonal. The daily average specific conductance at Belarde ranged from 310 $\mu\text{s}/\text{cm}$ to 486 $\mu\text{s}/\text{cm}$, with a median value of 394 $\mu\text{s}/\text{cm}$ (**Table 1**). The daily average specific conductance at Eichler ranged from 459 $\mu\text{s}/\text{cm}$ to 662 $\mu\text{s}/\text{cm}$, with a median value of 606 $\mu\text{s}/\text{cm}$ (**Table 1**). The daily average specific conductance at Lisonbee ranged from 464 $\mu\text{s}/\text{cm}$ to 568 $\mu\text{s}/\text{cm}$, with a median value of 554 $\mu\text{s}/\text{cm}$ (**Table 1**). The calculated daily average sodium adsorption ratio (SAR) values in September 2014 ranged from 0.60 to 0.82 at Belarde, 0.98 to 1.42 at Eichler, and 1.43 to 1.75 at Lisonbee (**Table 1**).

TABLE 1
SEPTEMBER 2014 DAILY AVERAGE GAGE DATA

	Average Daily			
	Minimum	Median	Average	Maximum
Belarde - (19 days of flow data)				
Water Level (ft)	0.26	0.42	0.41	0.48
Flow ¹ (cfs)	0.16	0.41	0.42	0.79
Temperature (°C)	12.38	15.36	15.23	17.60
Conductivity (µs/cm)	310	394	400	486
TDS ² (mg/l)	202	256	260	316
Sodium Adsorption Ratio ³ (SAR)	0.60	0.71	0.71	0.82
Eichler - (30 days of flow data)				
Water Level (ft)	0.27	0.40	0.40	0.63
Flow ¹ (cfs)	0.01	0.08	0.19	1.93
Temperature (°C)	12.58	15.27	15.44	17.44
Conductivity (µs/cm)	459	606	582	662
TDS ² (mg/l)	298	394	379	430
Sodium Adsorption Ratio ³ (SAR)	0.98	1.30	1.25	1.42
Lisonbee - (30 days of flow data)				
Water Level (ft)	0.24	0.29	0.29	0.38
Flow ¹ (cfs)	0.42	0.81	0.92	3.24
Temperature (°C)	12.83	16.05	15.95	18.23
Conductivity (µs/cm)	464	554	544	568
TDS ² (mg/l)	302	360	353	369
Sodium Adsorption Ratio ³ (SAR)	1.43	1.70	1.67	1.75
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 September 2014, the water type at all three stations was a calcium bicarbonate water, with a sodium-calcium bicarbonate water type at Lisonbee on September 23, 2014.

September 2014 field measured SC values and laboratory measured SAR values at the Belarde, Eichler, and Lisonbee stations are illustrated in **Table 2** and **Figure 4**. All three 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
SEPTEMBER 2014 SAR AND SPECIFIC CONDUCTANCE

Location	Sample Date	SAR	Specific Conductance (µs/cm)
Belarde	9/9/2014	0.65	376.6
Eichler	9/9/2014	0.97	513.0
Eichler	9/23/2014	1.08	399.4
Lisonbee	9/9/2014	1.45	470.9
Lisonbee	9/23/2014	1.98	568.0

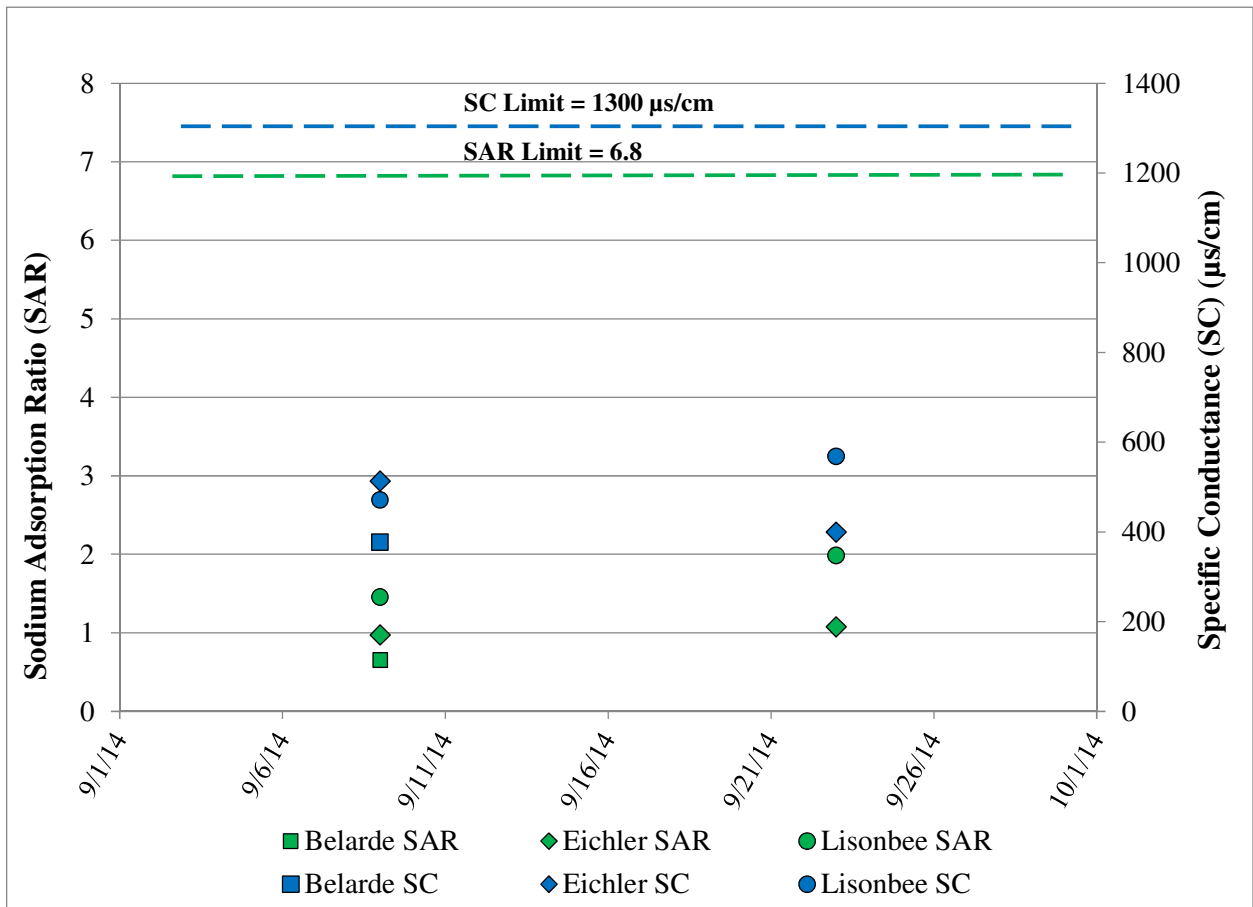


FIGURE 4
SEPTEMBER 2014 SAR AND SPECIFIC CONDUCTANCE

The water in September exhibits a range of hardness, with Belarde at 169 mg/l CaCO₃ hardness, Eichler ranging from 211 mg/l CaCO₃ to 242 mg/l CaCO₃ hardness, and Lisonbee ranging from 175 mg/l CaCO₃ to 195 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 September 2014 was 8.8 mg/l at the Belarde station, ranged from <4 mg/l to 5.2 mg/l at the Eichler station, and ranged from 6 mg/l to 59 mg/l at the Lisonbee station (**Table 3** and **Figure 5**). Total recoverable iron concentrations were 0.849 mg/l at Belarde, 0.232 mg/l to 0.341 mg/l at Eichler, and 0.251 mg/l to 1.850 mg/l at Lisonbee (**Table 3** and **Figure 5**). Concentrations greater than 1 mg/l exceed chronic aquatic standard for total recoverable iron, with the Lisonbee station exceeding the standard in early September. This is not unusual when elevated total suspended solids are present. **Figure 5** illustrates this correlation, with higher total recoverable iron values observed with higher total suspended solids values.

TABLE 3
SEPTEMBER 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	9/9/2014	0.849	8.8
Eichler	9/9/2014	0.341	5.2
Eichler	9/23/2014	0.232	2.0
Lisonbee	9/9/2014	1.850	59.0
Lisonbee	9/23/2014	0.251	6.0

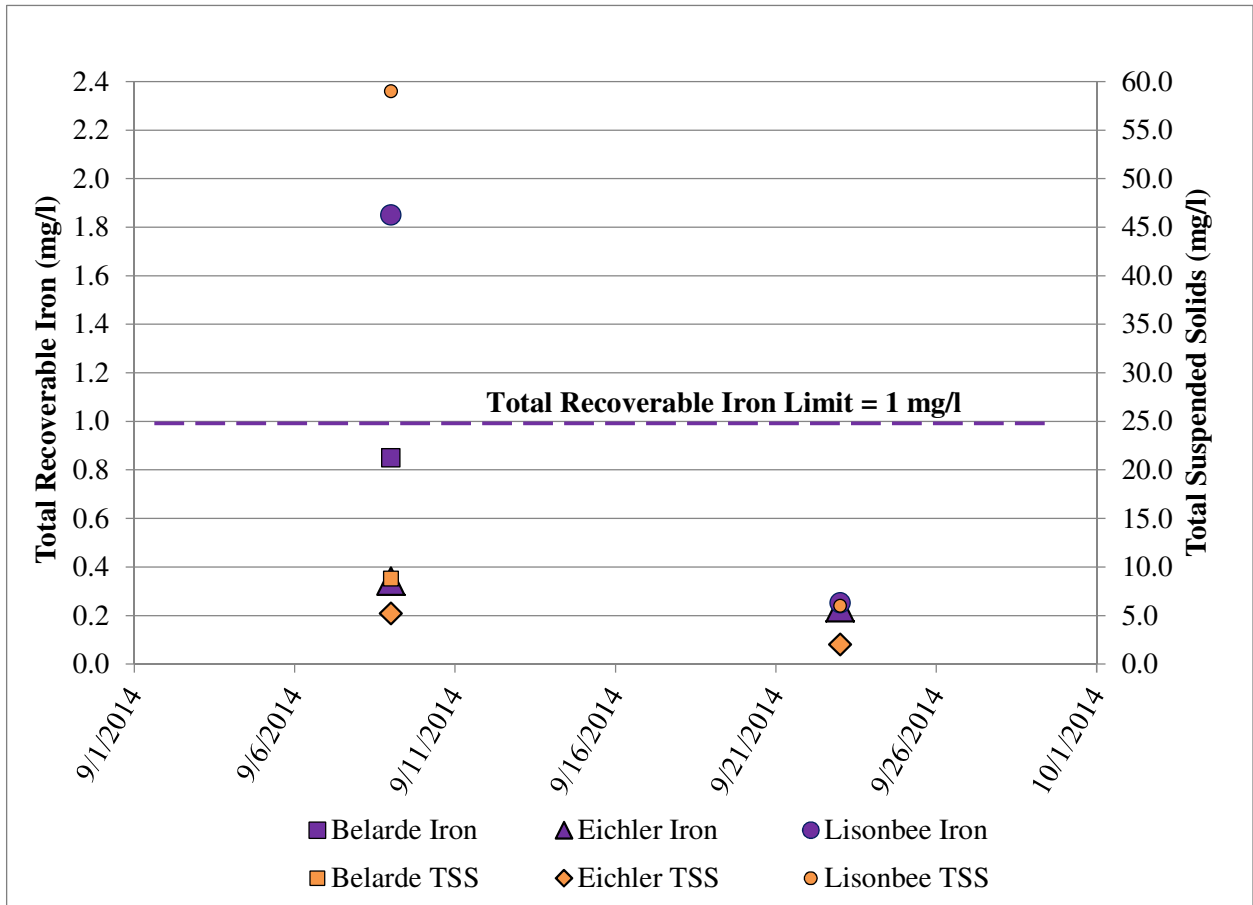


FIGURE 5
SEPTEMBER 2014 INSTANTANEOUS TOTAL RECOVERABLE IRON (MG/L) AND TOTAL SUSPENDED SOLIDS (MG/L)

Constituents below the detection limit at all three stations in September 2014 include arsenic, boron, chromium, copper, 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 and at Lisonbee on September 9, 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 Belarde, Eichler, and Lisonbee stations (Table 5). The field pH values in September 2014 were within the stream standard of between 6.5 and 9.0 at all three stations (Table 5).

TABLE 4

HARDNESS BASED STREAM STANDARDS ASSOCIATED WITH APISHAPA RIVER INSTANTANEOUS SAMPLING, SEPTEMBER 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	9/9/2014	3a	169	22.0	14.0	1	3556	1965	258	195
Belarde Maximum September Results			NA	<15	<15	0.85	189	189	<20	<20
Eichler Hardness Based Standards	9/9/2014	3a	211	27.2	17.0	1	3829	2115	316	239
Eichler Hardness Based Standards	9/23/2014	3a	242	30.9	19.1	1	4008	2214	357	271
Eichler Maximum September Results			NA	<15	<15	0.34	205	205	<20	<20
Lisonbee Hardness Based Standards	9/9/2014	3a	175	22.8	14.4	1	3597	1988	266	202
Lisonbee Hardness Based Standards	9/23/2014	3a	191	24.7	15.6	1	3704	2046	288	218
Lisonbee Maximum September Results			NA	<15	<15	1.85	73.8	73.8	<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, SEPTEMBER 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	9/9/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Belarde Maximum September Results¹			<15	<0.05	<10	<10	8.85	<4	<4	21.7	8.11	8.11
Eichler Standards	9/9/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Eichler Standards	9/23/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Eichler Maximum September Results¹			<15	<0.05	<10	<10	26.1	<4	<4	14.9	8.32	8.35
Lisonbee Standards	9/9/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Lisonbee Standards	9/23/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Lisonbee Maximum September Results¹			<15	<0.05	<10	<10	7.73	<4	<4	48.3	8.02	8.08

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>.