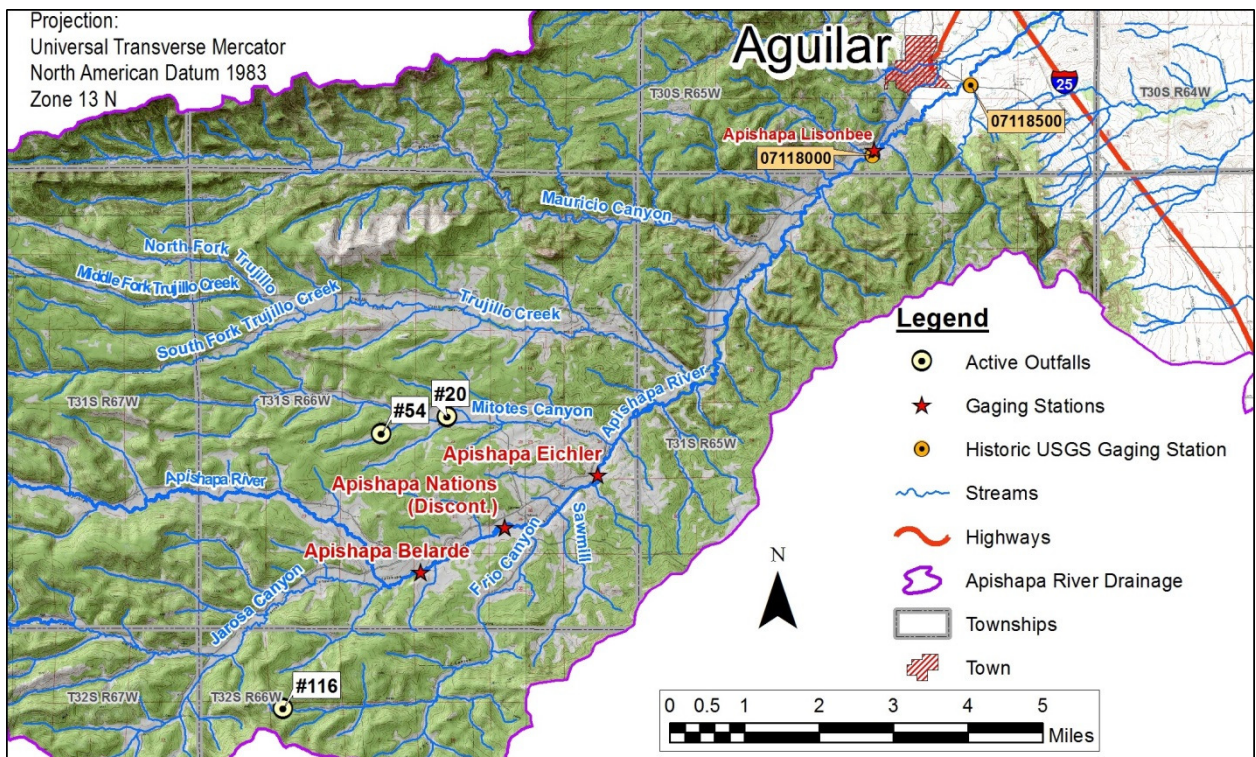


August 2014

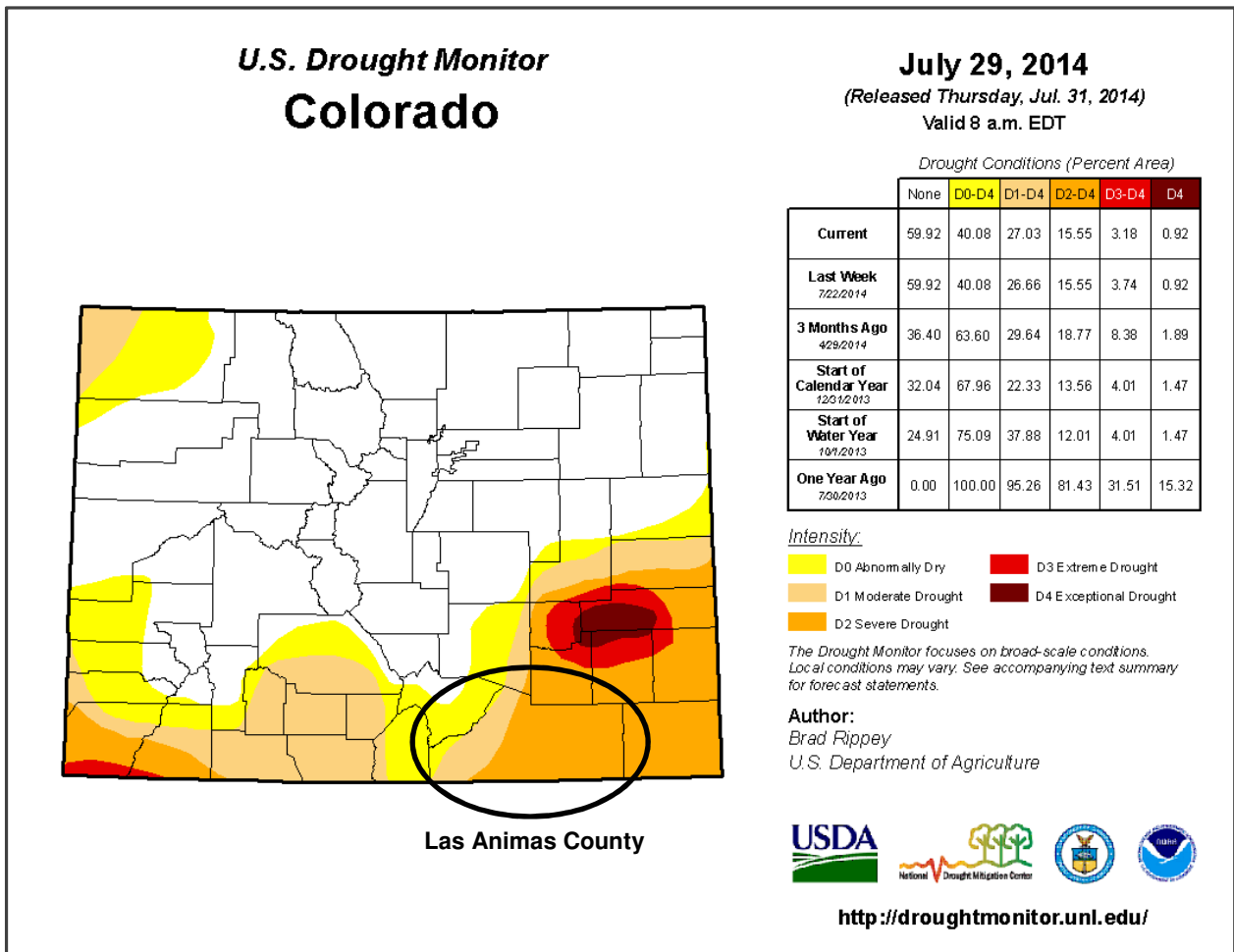
Norwest Corporation (Norwest) maintains three gaging stations for Pioneer Natural Resources USA Inc. (PNR) in the headwaters of the Apishapa River in northern Las Animas County, Colorado. The Apishapa River is a tributary of the Arkansas River. The gaging stations acquire “continuous” data on 15-minute 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](http://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.

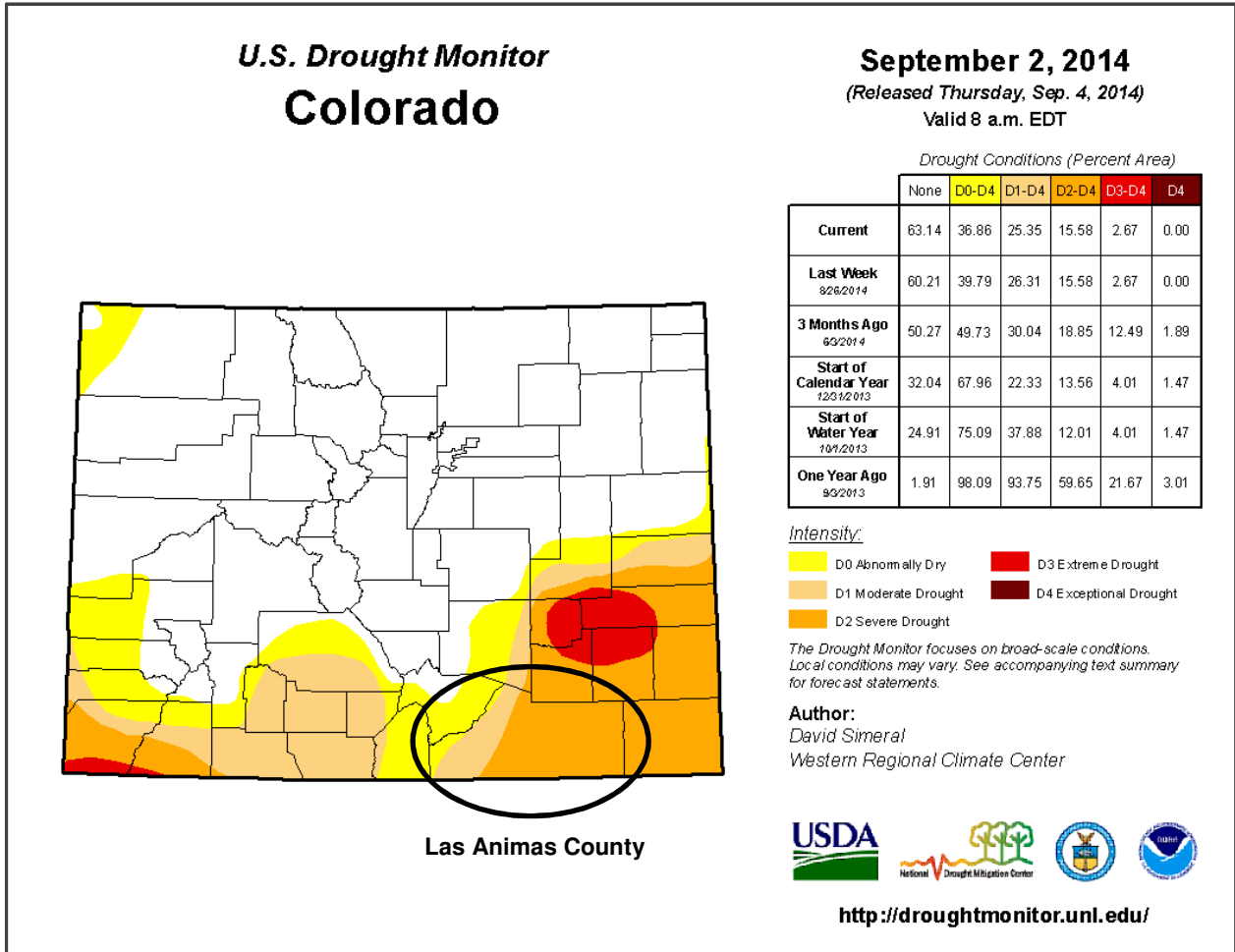


**FIGURE 1**  
**APISHAPA WATERSHED**

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 July 29, 2014. **Figure 3** depicts drought conditions in Colorado for data received as of 7 a.m. EST on September 2, 2014. Drought conditions for the month of August 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 – JULY 29, 2014**



**FIGURE 3**  
**U.S. DROUGHT MONITOR COLORADO – SEPTEMBER 2, 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 August 2014. Laboratory water quality samples were collected and streamflow was measured at all three stations during both August 2014 site visits.

August 2014 data exhibited a calculated daily average flow of 4.89 cfs at Belarde, 4.44 cfs at Eichler, and 14.49 cfs at Lisonbee. Temperatures were seasonal. The daily average specific conductance at Belarde ranged from 88  $\mu\text{s}/\text{cm}$  to 291  $\mu\text{s}/\text{cm}$ , with a median value of 115  $\mu\text{s}/\text{cm}$  (**Table 1**). The daily average specific conductance at Eichler ranged from 236  $\mu\text{s}/\text{cm}$  to 541  $\mu\text{s}/\text{cm}$ , with a median value of 390  $\mu\text{s}/\text{cm}$  (**Table 1**). The daily average specific conductance at Lisonbee ranged from 334  $\mu\text{s}/\text{cm}$  to 706  $\mu\text{s}/\text{cm}$ , with a median value of 486  $\mu\text{s}/\text{cm}$  (**Table 1**). The calculated daily average sodium adsorption ratio (SAR) values in August 2014 ranged from 0.14 to 0.58 at Belarde, 0.47 to 1.11 at Eichler, and 0.98 to 2.10 at Lisonbee (**Table 1**).

**TABLE 1**  
**AUGUST 2014 DAILY AVERAGE GAGE DATA**

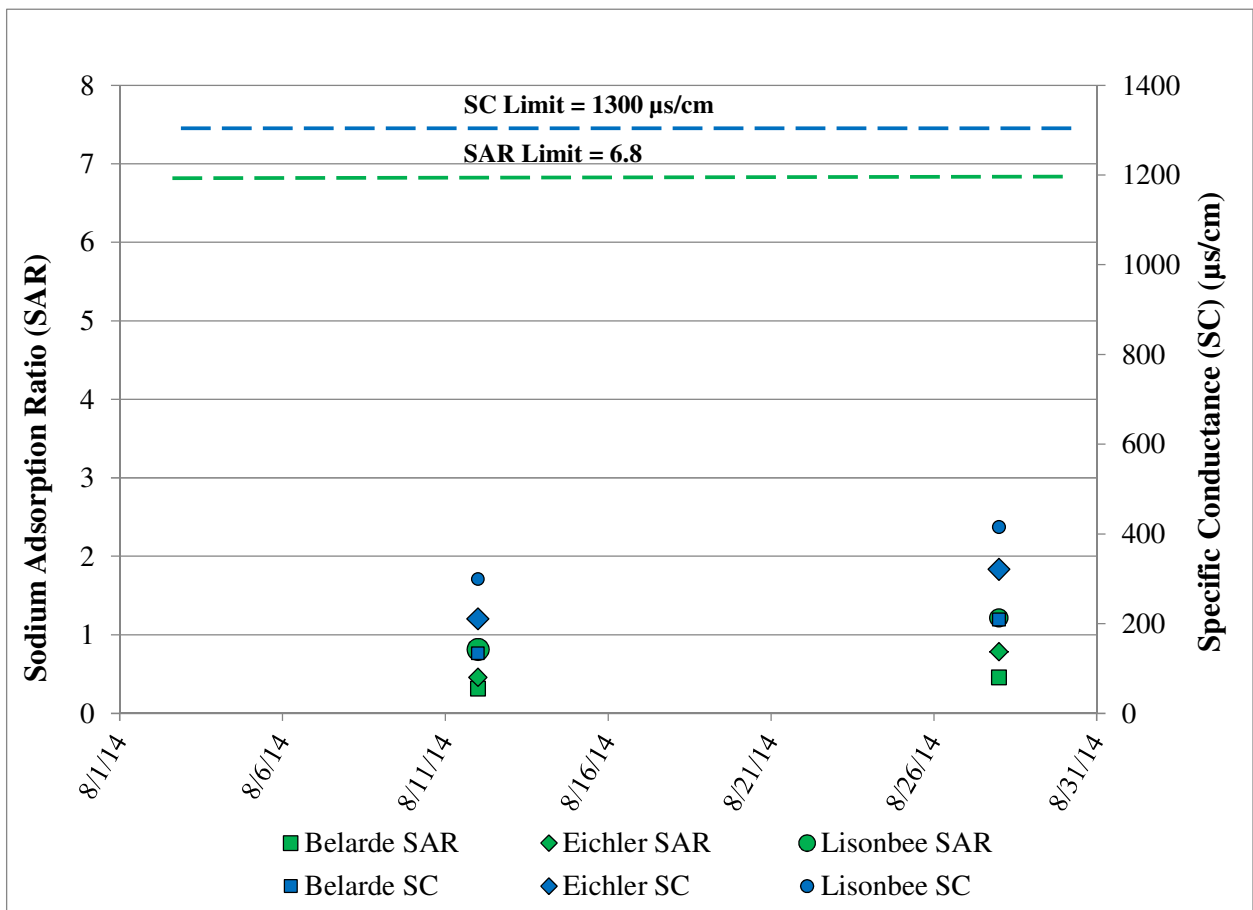
	Average Daily			
	Minimum	Median	Average	Maximum
<b>Belarde - (31 days of flow data)</b>				
Water Level (ft)	0.42	0.57	0.75	1.98
Flow <sup>1</sup> (cfs)	0.53	1.89	4.89	26.90
Temperature (°C)	14.61	17.01	16.77	18.65
Conductivity (µs/cm)	88	115	128	291
TDS <sup>2</sup> (mg/l)	57	75	83	189
Sodium Adsorption Ratio <sup>3</sup> (SAR)	0.14	0.34	0.33	0.58
<b>Eichler - (31 days of flow data)</b>				
Water Level (ft)	0.49	0.73	0.82	1.62
Flow <sup>1</sup> (cfs)	0.41	2.47	4.44	19.97
Temperature (°C)	15.84	17.63	17.55	19.50
Conductivity (µs/cm)	236	390	393	541
TDS <sup>2</sup> (mg/l)	153	253	255	352
Sodium Adsorption Ratio <sup>3</sup> (SAR)	0.47	0.79	0.79	1.11
<b>Lisonbee - (31 days of flow data)</b>				
Water Level (ft)	0.35	0.54	0.57	0.93
Flow <sup>1</sup> (cfs)	2.37	11.17	14.49	44.45
Temperature (°C)	16.04	17.14	17.12	18.12
Conductivity (µs/cm)	334	486	491	706
TDS <sup>2</sup> (mg/l)	217	316	319	459
Sodium Adsorption Ratio <sup>3</sup> (SAR)	0.98	1.45	1.46	2.10
<sup>1</sup> Calculated from pressure data				
<sup>2</sup> Calculated from conductivity data with a conversion of 0.65 mg/l TDS per µs/cm specific conductance				
<sup>3</sup> 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 August 2014, the water type at all three stations was a calcium bicarbonate water.

August 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**  
**AUGUST 2014 SAR AND SPECIFIC CONDUCTANCE**

Location	Sample Date	SAR	Specific Conductance (µs/cm)
Belarde	8/12/2014	0.32	133.8
Belarde	8/28/2014	0.46	208.9
Eichler	8/12/2014	0.46	210.4
Eichler	8/28/2014	0.78	320.7
Lisonbee	8/12/2014	0.81	299.0
Lisonbee	8/28/2014	1.21	415.5



**FIGURE 4**  
**AUGUST 2014 SAR AND SPECIFIC CONDUCTANCE**

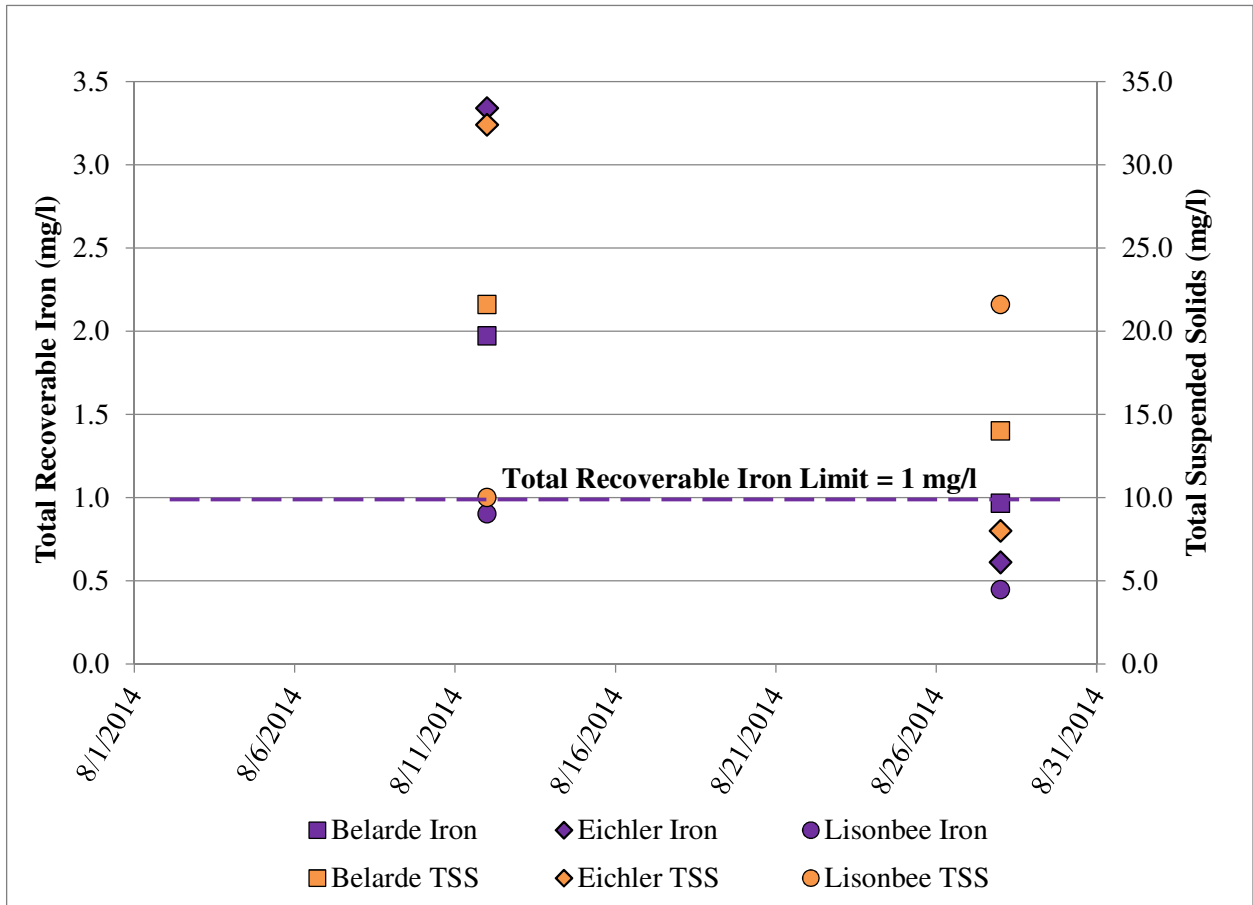
The water in August exhibits a range of hardness, with Belarde ranging from 74 mg/l CaCO<sub>3</sub> to 107 mg/l CaCO<sub>3</sub> hardness, Eichler ranging from 99 mg/l CaCO<sub>3</sub> to 172 mg/l CaCO<sub>3</sub> hardness, and Lisonbee ranging from 116 mg/l CaCO<sub>3</sub> to 163 mg/l CaCO<sub>3</sub> 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<sub>3</sub>, have lower hardness based metal

standards to provide aquatic life protection and higher hardness values, closer to 400 mg/l CaCO<sub>3</sub>, 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 August 2014 ranged from 14 mg/l to 21.6 mg/l at the Belarde station, ranged from 8 mg/l to 32.4 mg/l at the Eichler station, and ranged from 10 mg/l to 21.6 mg/l at the Lisonbee station (**Table 3** and **Figure 5**). Total recoverable iron concentrations were 0.965 mg/l to 1.97 mg/l at Belarde, 0.61mg/l to 3.34 mg/l at Eichler, and 0.446 mg/l to 0.901 mg/l at Lisonbee (**Table 3** and **Figure 5**). Concentrations greater than 1 mg/l exceed chronic aquatic standard for total recoverable iron. This is not unusual when elevated total suspended solids are present.

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

<b>Location</b>	<b>Sample Date</b>	<b>Iron (T-Rec.) (mg/l)</b>	<b>Total Suspended Solids (TSS) (mg/l)</b>
Belarde	8/12/2014	1.970	21.6
Belarde	8/28/2014	0.965	14.0
Eichler	8/12/2014	3.340	32.4
Eichler	8/28/2014	0.610	8.0
Lisonbee	8/12/2014	0.901	10.0
Lisonbee	8/28/2014	0.446	21.6



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

Constituents below the detection limit at all three stations in August 2014 include arsenic, boron, chromium, copper, and selenium. 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 all stations and acute potentially dissolved copper at Belarde and at Lisonbee on August 12, 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 August 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, AUGUST 2014 (CDPHE WQCC, 2013)**

Site	Sample Date	Stream Segment	Calculated Hardness <sup>1</sup> (mg/l CaCO <sub>3</sub> )	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	8/12/2014	3a	74	10.1	6.9	1	2701	1492	122	92
Belarde Hardness Based Standards	8/28/2014	3a	107	14.3	9.5	1	3054	1687	170	129
<b>Belarde Maximum August Results</b>			<b>NA</b>	<b>&lt;15</b>	<b>&lt;15</b>	<b>1.97</b>	<b>41</b>	<b>41</b>	<b>20.3</b>	<b>20.3</b>
Eichler Hardness Based Standards	8/12/2014	3a	99	13.3	8.9	1	2976	1644	159	120
Eichler Hardness Based Standards	8/28/2014	3a	172	22.4	14.2	1	3577	1976	262	198
<b>Eichler Maximum August Results</b>			<b>NA</b>	<b>&lt;15</b>	<b>&lt;15</b>	<b>3.34</b>	<b>195</b>	<b>195</b>	<b>&lt;20</b>	<b>&lt;20</b>
Lisonbee Hardness Based Standards	8/12/2014	3a	116	15.5	10.2	1	3137	1733	183	139
Lisonbee Hardness Based Standards	8/28/2014	3a	163	21.3	13.6	1	3513	1941	250	189
<b>Lisonbee Maximum August Results</b>			<b>NA</b>	<b>&lt;15</b>	<b>&lt;15</b>	<b>0.90</b>	<b>38</b>	<b>38</b>	<b>&lt;20</b>	<b>&lt;20</b>

<sup>1</sup> A hardness value of 400 mg/l CaCO<sub>3</sub> is used to calculate the metal standards when the measured hardness values are greater than 400 mg/l CaCO<sub>3</sub>



**TABLE 5**  
**STREAM STANDARDS ASSOCIATED WITH APISHAPA RIVER INSTANTANEOUS SAMPLING, AUGUST 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	8/12/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Belarde Standards	8/28/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
<b>Belarde Maximum August Results<sup>1</sup></b>			<b>&lt;15</b>	<b>&lt;0.05</b>	<b>&lt;10</b>	<b>&lt;10</b>	<b>&lt;3</b>	<b>&lt;4</b>	<b>&lt;4</b>	<b>12.7</b>	<b>8.18</b>	<b>8.43</b>
Eichler Standards	8/12/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Eichler Standards	8/28/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
<b>Eichler Maximum August Results<sup>1</sup></b>			<b>&lt;15</b>	<b>&lt;0.05</b>	<b>&lt;10</b>	<b>&lt;10</b>	<b>10.2</b>	<b>&lt;4</b>	<b>&lt;4</b>	<b>13.8</b>	<b>8.28</b>	<b>8.50</b>
Lisonbee Standards	8/12/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Lisonbee Standards	8/28/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
<b>Lisonbee Maximum August Results<sup>1</sup></b>			<b>&lt;15</b>	<b>&lt;0.05</b>	<b>&lt;10</b>	<b>&lt;10</b>	<b>4.9</b>	<b>&lt;4</b>	<b>&lt;4</b>	<b>25.4</b>	<b>8.13</b>	<b>8.22</b>

<sup>1</sup> Minimum result identified for pH-low

## References

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