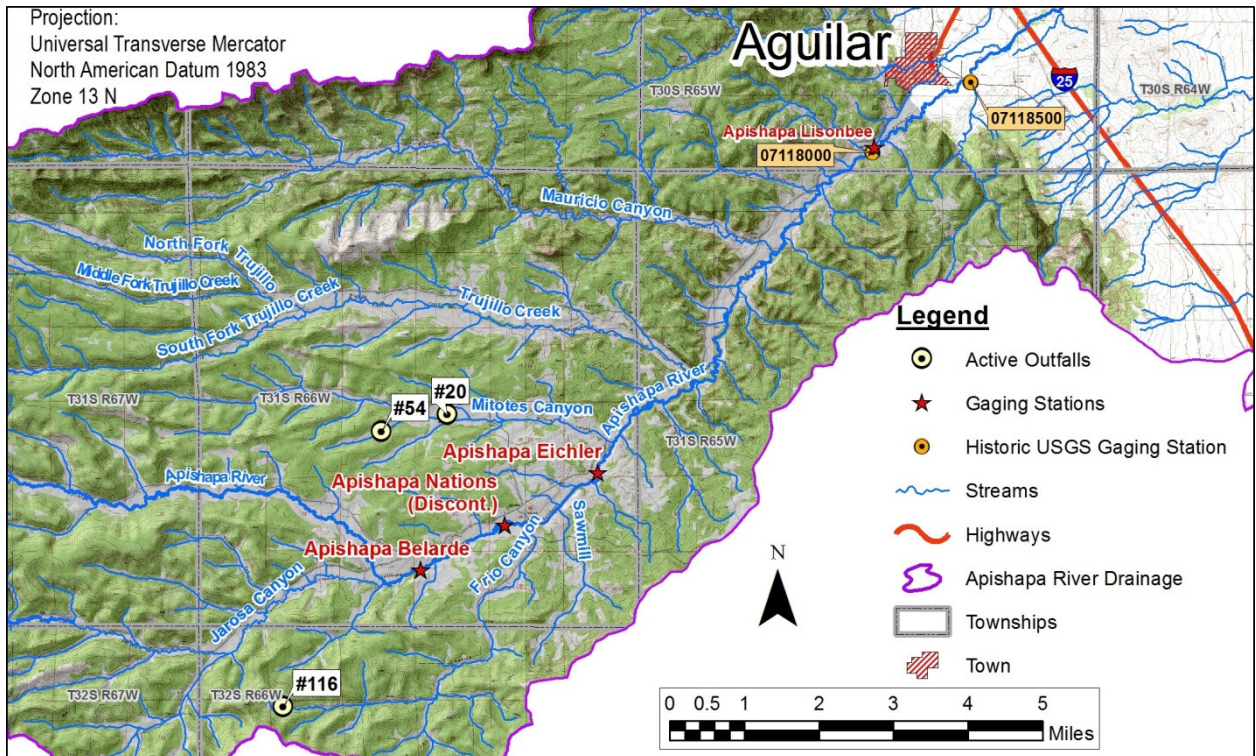


May 2014

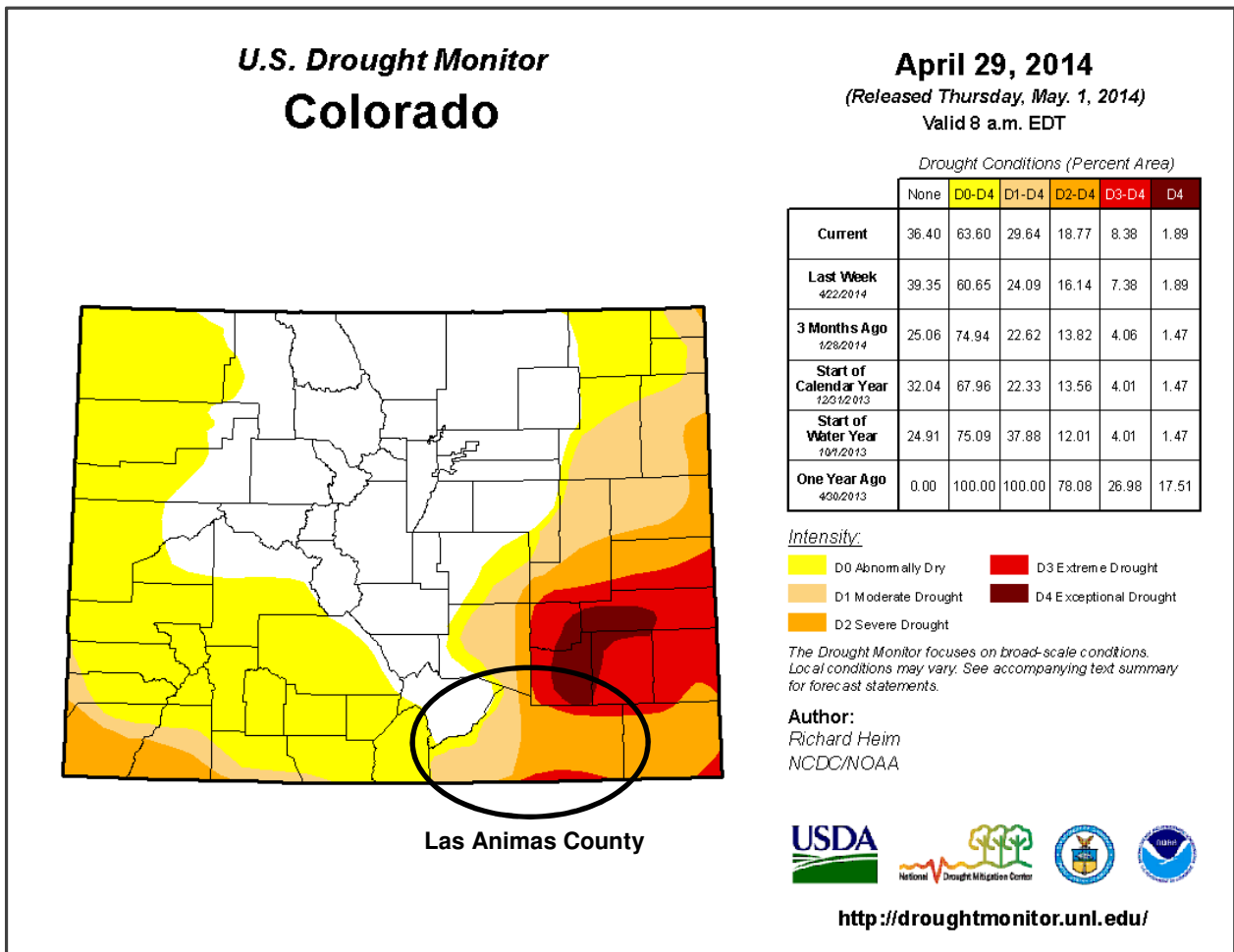
Norwest Corporation (Norwest) maintains three gaging stations for Pioneer Natural Resources USA Inc. (PNR) in the headwaters of the Apishapa River in northern Las Animas County, Colorado. The Apishapa River is a tributary of the Arkansas River. The gaging stations acquire “continuous” data on 15-minute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

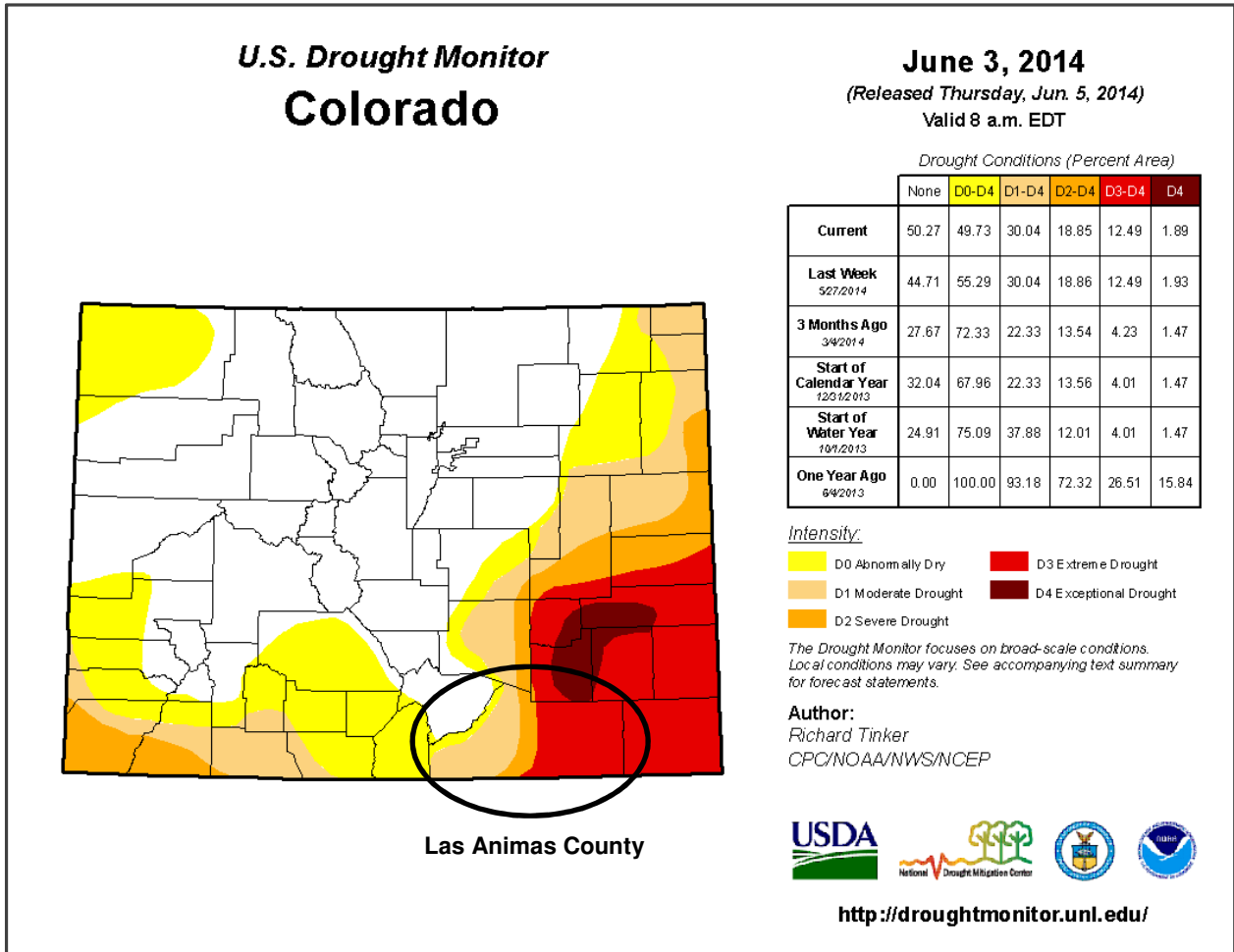


**FIGURE 1**  
**APISHAPA WATERSHED**

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 April 29, 2014. **Figure 3** depicts drought conditions in Colorado for data received as of 7 a.m. EST on June 3, 2014. The D1 drought conditions remained the same throughout the month of May for the western portion of Las Animas County, with a sliver of D0 conditions on the western border of the county. The drought intensity for the central portion of Las Animas County increased from mostly D1 and D2 drought conditions to a combination of D1, D2, and D3 conditions. Drought conditions in the eastern part of the county increased from mostly D2 drought conditions throughout April to D3 drought conditions by early June (Drought Monitor, 2014).



**FIGURE 2**  
**U.S. DROUGHT MONITOR COLORADO – APRIL 29, 2014**



**FIGURE 3**  
**U.S. DROUGHT MONITOR COLORADO – JUNE 3, 2014**

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

May 2014 data exhibited a calculated daily average flow of 12.63 cfs at Belarde, 7.20 cfs at Eichler, and 15.86 cfs at Lisonbee. Temperatures were seasonal. The daily average specific conductance at Belarde ranged from 78  $\mu\text{s}/\text{cm}$  to 201  $\mu\text{s}/\text{cm}$ , with a median value of 111  $\mu\text{s}/\text{cm}$  (Table 1). The daily average specific conductance at Eichler ranged from 173  $\mu\text{s}/\text{cm}$  to 323  $\mu\text{s}/\text{cm}$ , with a median value of 202  $\mu\text{s}/\text{cm}$  (Table 1). The daily average specific conductance at Lisonbee ranged from 283  $\mu\text{s}/\text{cm}$  to 354  $\mu\text{s}/\text{cm}$ , with a median value of 325  $\mu\text{s}/\text{cm}$  (Table 1). The calculated daily average sodium adsorption ratio (SAR) values in May 2014 ranged from 0.15 to 0.40 at Belarde, 0.24 to 0.64 at Eichler, and 0.82 to 1.06 at Lisonbee (Table 1).

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

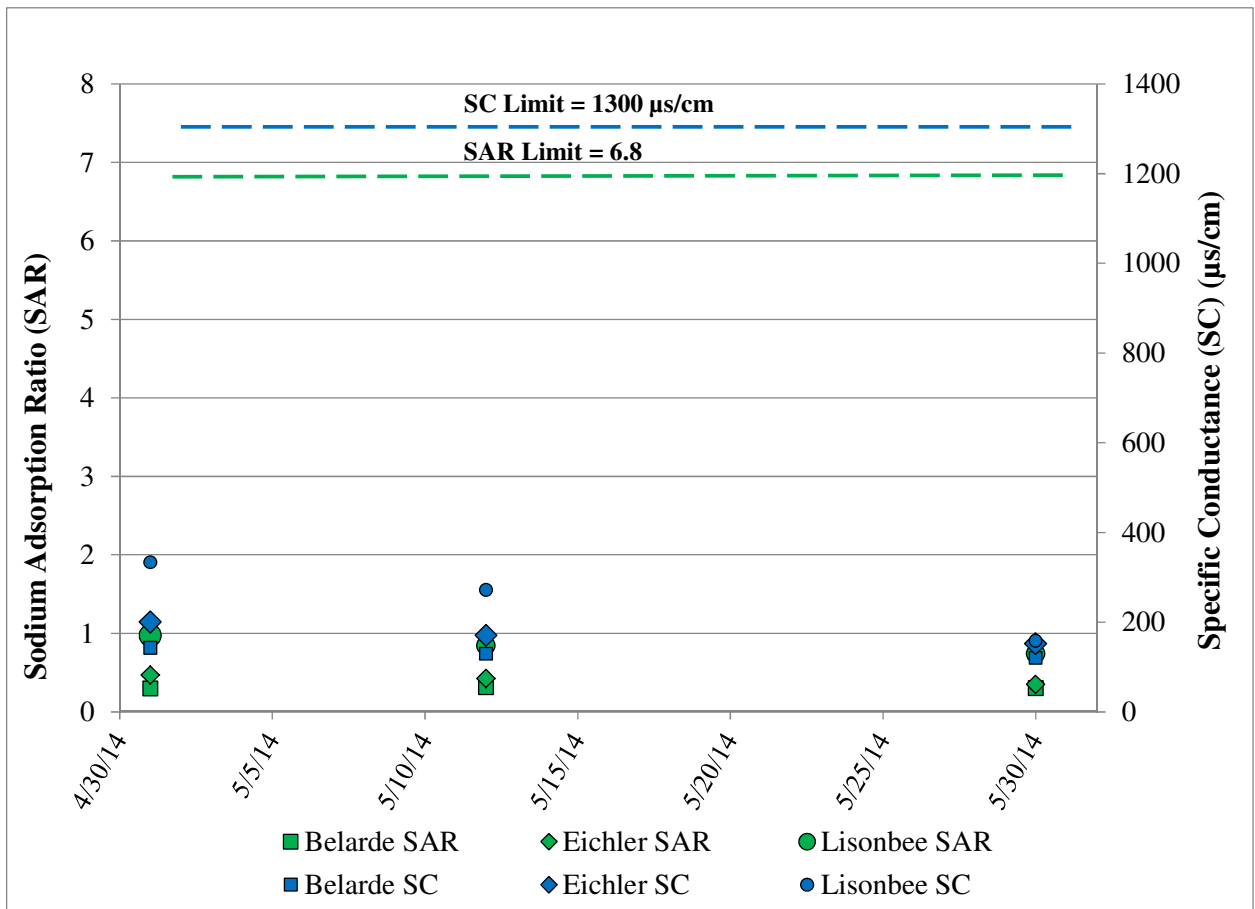
	Average Daily			
	Minimum	Median	Average	Maximum
<b>Belarde - (31 days of flow data)</b>				
Water Level (ft)	0.88	1.36	1.29	1.62
Flow <sup>1</sup> (cfs)	5.83	13.75	12.63	18.81
Temperature (°C)	3.98	11.69	10.70	14.17
Conductivity (µs/cm)	78	111	124	201
TDS <sup>2</sup> (mg/l)	50	72	81	131
Sodium Adsorption Ratio <sup>3</sup> (SAR)	0.15	0.25	0.26	0.40
<b>Eichler - (31 days of flow data)</b>				
Water Level (ft)	0.82	1.07	1.05	1.27
Flow <sup>1</sup> (cfs)	3.50	7.24	7.20	11.18
Temperature (°C)	4.98	13.02	11.99	15.42
Conductivity (µs/cm)	173	202	205	323
TDS <sup>2</sup> (mg/l)	113	131	133	210
Sodium Adsorption Ratio <sup>3</sup> (SAR)	0.24	0.31	0.33	0.64
<b>Lisonbee - (31 days of flow data)</b>				
Water Level (ft)	0.54	0.62	0.62	0.67
Flow <sup>1</sup> (cfs)	10.98	16.12	15.86	19.75
Temperature (°C)	6.92	12.18	11.74	15.04
Conductivity (µs/cm)	283	325	329	354
TDS <sup>2</sup> (mg/l)	184	211	214	230
Sodium Adsorption Ratio <sup>3</sup> (SAR)	0.82	0.94	0.96	1.06
<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 May 2014, the water type at all three stations was a calcium bicarbonate water.

May 2014 field measured SC values and laboratory measured SAR values at the Belarde, Eichler, and Lisonbee stations are summarized in **Table 2** and illustrated in **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**  
**MAY 2014 SAR AND SPECIFIC CONDUCTANCE**

Location	Sample Date	SAR	Specific Conductance (µs/cm)
Belarde	5/1/2014	0.30	142.4
Belarde	5/12/2014	0.31	129.6
Belarde	5/30/2014	0.30	120
Eichler	5/1/2014	0.47	200.3
Eichler	5/12/2014	0.43	170.3
Eichler	5/30/2014	0.35	152.1
Lisonbee	5/1/2014	0.98	333.6
Lisonbee	5/12/2014	0.84	271.8
Lisonbee	5/30/2014	0.74	158.1



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

The water in May exhibits a range of hardness, with Belarde ranging from 51 mg/l CaCO<sub>3</sub> to 59 mg/l CaCO<sub>3</sub> hardness, Eichler ranging from 64 mg/l CaCO<sub>3</sub> to 78 mg/l CaCO<sub>3</sub> hardness, and Lisonbee ranging from 93 mg/l CaCO<sub>3</sub> to 116 mg/l CaCO<sub>3</sub> hardness (**Table 4**). Based on toxicity testing, aquatic species

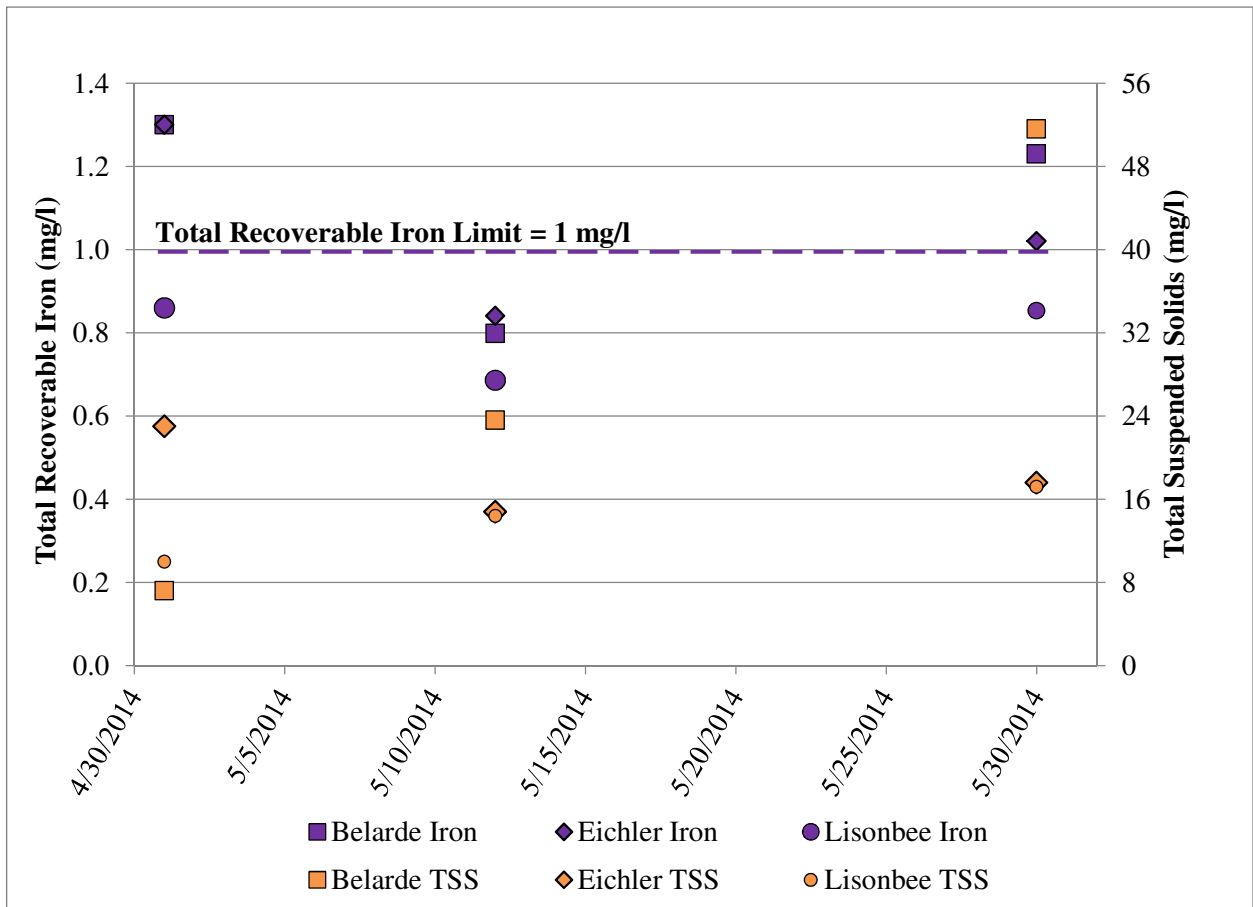
protection from elevated heavy metal concentrations increases as hardness increases (CDPHE WQCC, 2013). Lower hardness values, closer to 25 mg/l CaCO<sub>3</sub>, have lower hardness based metal standards to provide aquatic life protection and higher hardness values, closer to 400 mg/l CaCO<sub>3</sub>, 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 May 2014 ranged from 7.2 mg/l to 51.6 mg/l at the Belarde station, ranged from 14.8 mg/l to 23 mg/l at the Eichler station, and ranged from 10 mg/l to 17.2 mg/l at the Lisonbee station (**Table 3** and **Figure 5**). Total recoverable iron concentrations ranged from 0.798 mg/l to 1.3 mg/l at Belarde, 0.841 mg/l to 1.3 mg/l at Eichler, and 0.686 mg/l to 0.86 mg/l at Lisonbee (**Table 3** and **Figure 5**).

**TABLE 3**  
**MAY 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	5/1/2014	1.300	7.2
Belarde	5/12/2014	0.798	23.6
Belarde	5/30/2014	1.230	51.6
Eichler	5/1/2014	1.300	23.0
Eichler	5/12/2014	0.841	14.8
Eichler	5/30/2014	1.020	17.6
Lisonbee	5/1/2014	0.860	10.0
Lisonbee	5/12/2014	0.686	14.4
Lisonbee	5/30/2014	0.853	17.2





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

Constituents below the detection limit at all three stations in May 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 all stations and acute potentially dissolved copper at all stations except Lisonbee on May 1, 2014 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 the Belarde, Eichler, and Lisonbee stations (**Table 5**). The field pH values in May 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, MAY 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	5/1/2014	3a	59	8.2	5.7	1	2504	1384	99	75
Belarde Hardness Based Standards	5/12/2014	3a	56	7.8	5.5	1	2461	1360	94	72
Belarde Hardness Based Standards	5/30/2014	3a	51	7.1	5.0	1	2386	1318	87	66
<b>Belarde Maximum May Results</b>			<b>NA</b>	<b>&lt;15</b>	<b>&lt;15</b>	<b>1.300</b>	<b>50.3</b>	<b>50.3</b>	<b>&lt;20</b>	<b>&lt;20</b>
Eichler Hardness Based Standards	5/1/2014	3a	78	10.6	7.2	1	2749	1519	128	97
Eichler Hardness Based Standards	5/12/2014	3a	71	9.7	6.7	1	2664	1472	117	89
Eichler Hardness Based Standards	5/30/2014	3a	64	8.8	6.1	1	2573	1422	107	81
<b>Eichler Maximum May Results</b>			<b>NA</b>	<b>&lt;15</b>	<b>&lt;15</b>	<b>1.300</b>	<b>100</b>	<b>100</b>	<b>&lt;20</b>	<b>&lt;20</b>
Lisonbee Hardness Based Standards	5/1/2014	3a	116	15.5	10.2	1	3137	1733	183	139
Lisonbee Hardness Based Standards	5/12/2014	3a	105	14.1	9.3	1	3035	1677	167	127
Lisonbee Hardness Based Standards	5/30/2014	3a	93	12.6	8.4	1	2914	1610	150	113
<b>Lisonbee Maximum May Results</b>			<b>NA</b>	<b>&lt;15</b>	<b>&lt;15</b>	<b>0.86</b>	<b>59.7</b>	<b>59.7</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, MAY 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	5/1/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Belarde Standards	5/12/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Belarde Standards	5/30/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
<b>Belarde Maximum May 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>14</b>	<b>7.91</b>	<b>8.32</b>
Eichler Standards	5/1/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Eichler Standards	5/12/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Eichler Standards	5/30/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
<b>Eichler Maximum May 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>25.7</b>	<b>8.08</b>	<b>8.27</b>
Lisonbee Standards	5/1/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Lisonbee Standards	5/12/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
Lisonbee Standards	5/30/2014	3a	0.02	0.75	16	11	250	18.4	4.6	250	6.5	9
<b>Lisonbee Maximum May Results<sup>1</sup></b>			<b>&lt;15</b>	<b>&lt;0.05</b>	<b>&lt;10</b>	<b>&lt;10</b>	<b>6.40</b>	<b>&lt;4</b>	<b>&lt;4</b>	<b>34</b>	<b>8.12</b>	<b>8.32</b>

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

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