## February 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.

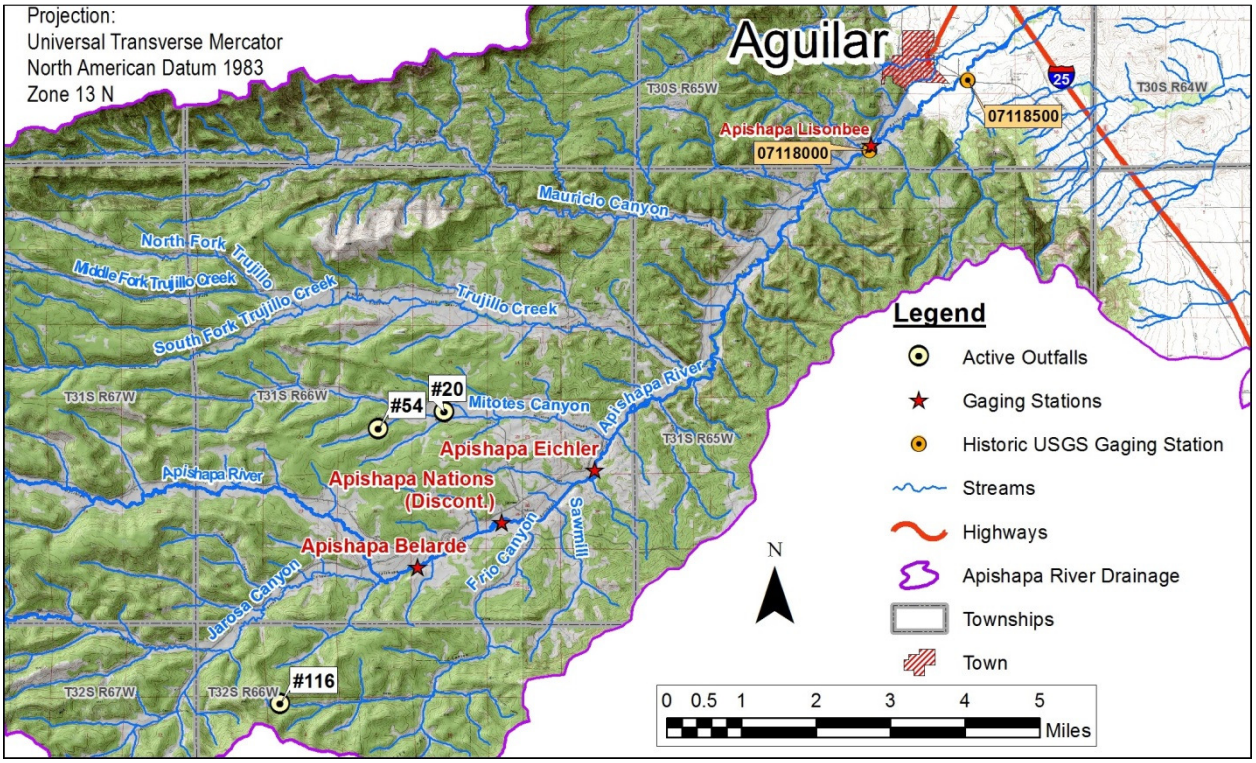


**FIGURE 1**
**APISHAPA WATERSHED**

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 January 28, 2014. **Figure 3** depicts drought conditions in Colorado for data received as of 7 a.m. EST on March 4, 2014. The drought intensity for the western portion of Las Animas County remained the same throughout the month of February with D0 and D1 drought conditions. The central part of the county worsened from D1 and D2 drought conditions to include a small area of D3 conditions at the bottom of the county by the end of February. D2 drought conditions remained throughout February in the eastern part of the county, with a small amount of D3 drought conditions in the top northeast and bottom southeast parts of the county (Drought Monitor, 2014).

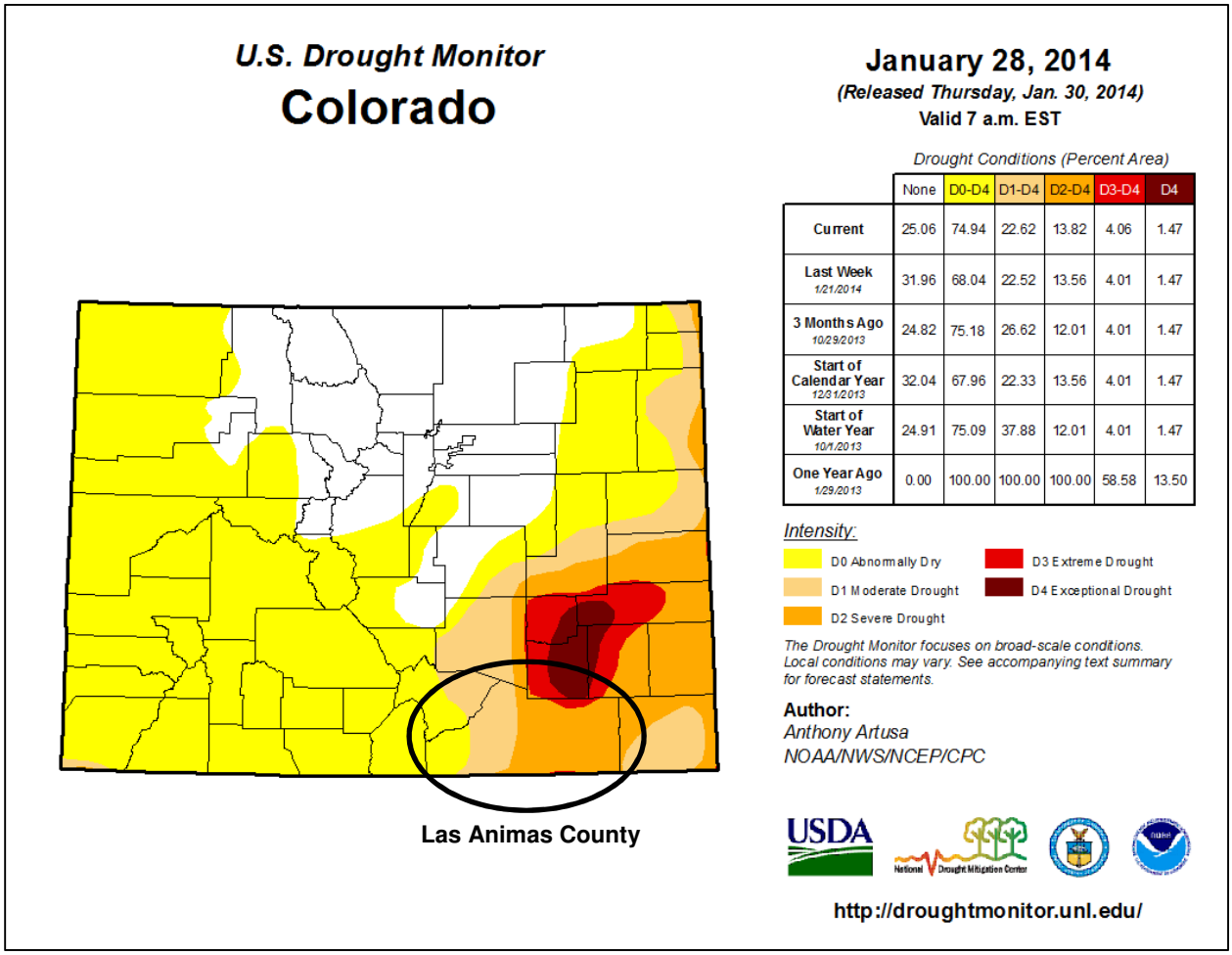


**FIGURE 2**
**U.S. DROUGHT MONITOR COLORADO – JANUARY 28, 2014**

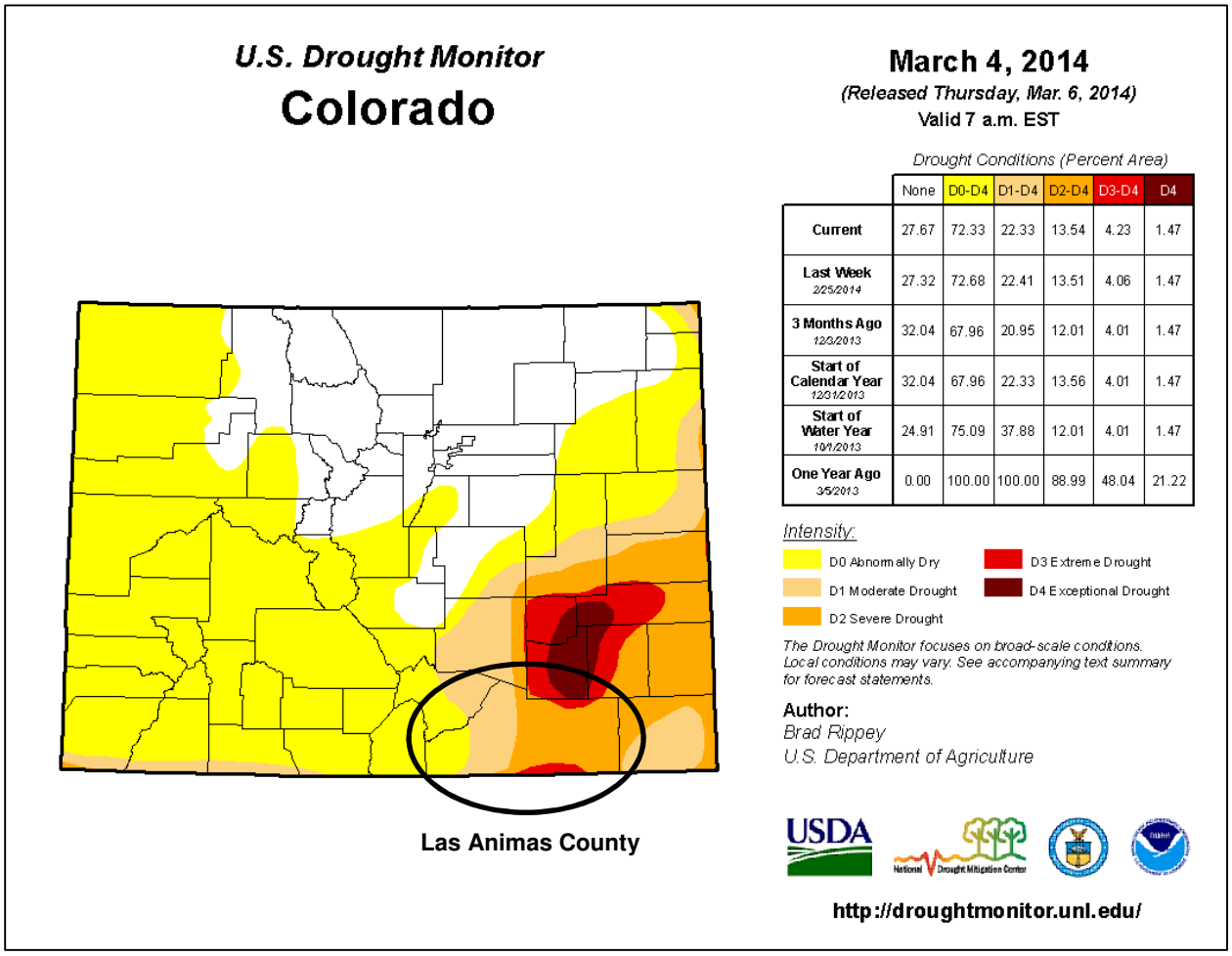


**FIGURE 3**
**U.S. DROUGHT MONITOR COLORADO – MARCH 4, 2014**

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 February 2014. Laboratory water quality samples were collected at all three stations during the two February 2014 site visits. Streamflow was not measured at any of the stations during the first site visit in February due to frozen conditions. Streamflow was measured at all three stations during the second site visit on February 19, 2014.

February 2014 data exhibited a calculated daily average flow of 0.75 cfs at Belarde, 0.20 cfs at Eichler, and 2.81 cfs at Lisonbee. Temperatures were seasonal. The daily average specific conductance at Belarde ranged from 277 µs/cm to 366 µs/cm, with a median value of 324 µs/cm (**Table 1**). The daily average specific conductance at Eichler ranged from 701 µs/cm to 788 µs/cm, with a median value of 731 µs/cm (**Table 1**). The daily average specific conductance at Lisonbee ranged from 628 µs/cm to 676 µs/cm, with a median value of 648 µs/cm (**Table 1**). The calculated daily average sodium adsorption ratio (SAR) values in February 2014 ranged from 0.57 to 0.70 at Belarde, 1.54 to 1.71 at Eichler, and 1.92 to 2.06 at Lisonbee (**Table 1**).

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

| | Average Daily | | | |
|---|---|---|---|---|
| | **Minimum** | **Median** | **Average** | **Maximum** |
| **Belarde - (28 days of flow data)** | | | | |
| **Water Level (ft)** | 0.40 | 0.43 | 0.45 | 0.64 |
| **Flow[1] (cfs)** | 0.40 | 0.50 | 0.75 | 2.87 |
| **Temperature (°C)** | -0.02 | 2.47 | 2.11 | 4.36 |
| **Conductivity (µs/cm)** | 277 | 324 | 323 | 366 |
| **TDS[2] (mg/l)** | 180 | 211 | 210 | 238 |
| **Sodium Adsorption Ratio[3] (SAR)** | 0.57 | 0.64 | 0.63 | 0.70 |
| | | | | |
| **Eichler - (28 days of flow data)** | | | | |
| **Water Level (ft)** | 0.37 | 0.41 | 0.44 | 0.55 |
| **Flow[1] (cfs)** | 0.05 | 0.10 | 0.20 | 0.57 |
| **Temperature (°C)** | -0.05 | 2.00 | 1.75 | 4.10 |
| **Conductivity (µs/cm)** | 701 | 731 | 734 | 788 |
| **TDS[2] (mg/l)** | 455 | 475 | 477 | 512 |
| **Sodium Adsorption Ratio[3] (SAR)** | 1.54 | 1.60 | 1.60 | 1.71 |
| | | | | |
| **Lisonbee - (28 days of flow data)** | | | | |
| **Water Level (ft)** | 0.28 | 0.36 | 0.36 | 0.43 |
| **Flow[1] (cfs)** | 0.84 | 2.24 | 2.81 | 5.36 |
| **Temperature (°C)** | 0.83 | 4.21 | 3.60 | 5.69 |
| **Conductivity (µs/cm)** | 628 | 648 | 647 | 676 |
| **TDS[2] (mg/l)** | 408 | 421 | 421 | 439 |
| **Sodium Adsorption Ratio[3] (SAR)** | 1.92 | 1.98 | 1.98 | 2.06 |

[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, 2013 (1)). During the month of February 2014, the water type at the Belarde and Eichler stations was a calcium bicarbonate water, with a sodium bicarbonate water type at the Lisonbee station.

February 2014 field measured SC values and laboratory measured SAR values at the Belarde, Eichler and Lisonbee stations are 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).

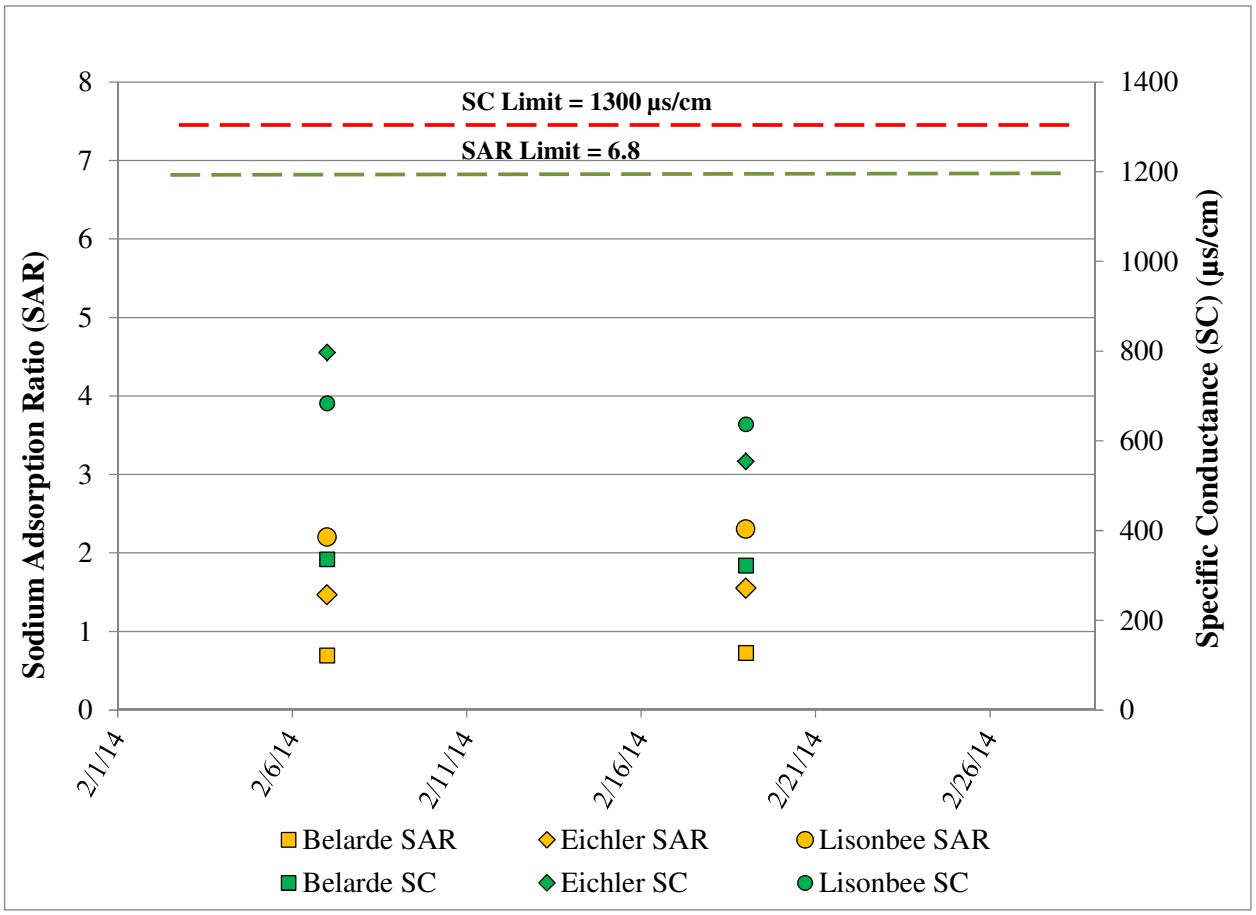


**FIGURE 4**
**FEBRUARY 2014 SPECIFIC CONDUCTANCE AND SAR**

The water in February exhibits a range of hardness, with Belarde ranging from 126 mg/l $CaCO_3$ to 140 mg/l $CaCO_3$ hardness, Eichler ranging from 261 mg/l $CaCO_3$ to 307 mg/l $CaCO_3$ hardness, and Lisonbee ranging from 200 mg/l $CaCO_3$ to 236 mg/l $CaCO_3$ hardness (**Table 2**). Based on toxicity testing, aquatic species protection from elevated heavy metal concentrations increases as hardness increases (CDPHE WQCC, 2013 (2)). 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 (2)).

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 February 2014 ranged from <4 mg/l to 5.6 mg/l at the Belarde station, ranged from <4 mg/l to 12.4 mg/l at the Eichler station, and was <4 mg/l for both samples at the Lisonbee station (**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 ranged from 0.543 mg/l to 0.593 mg/l at Belarde, 0.152 mg/l to 0.467 mg/l at Eichler, and 0.072 mg/l to 0.091 mg/l at Lisonbee (**Figure 5**).

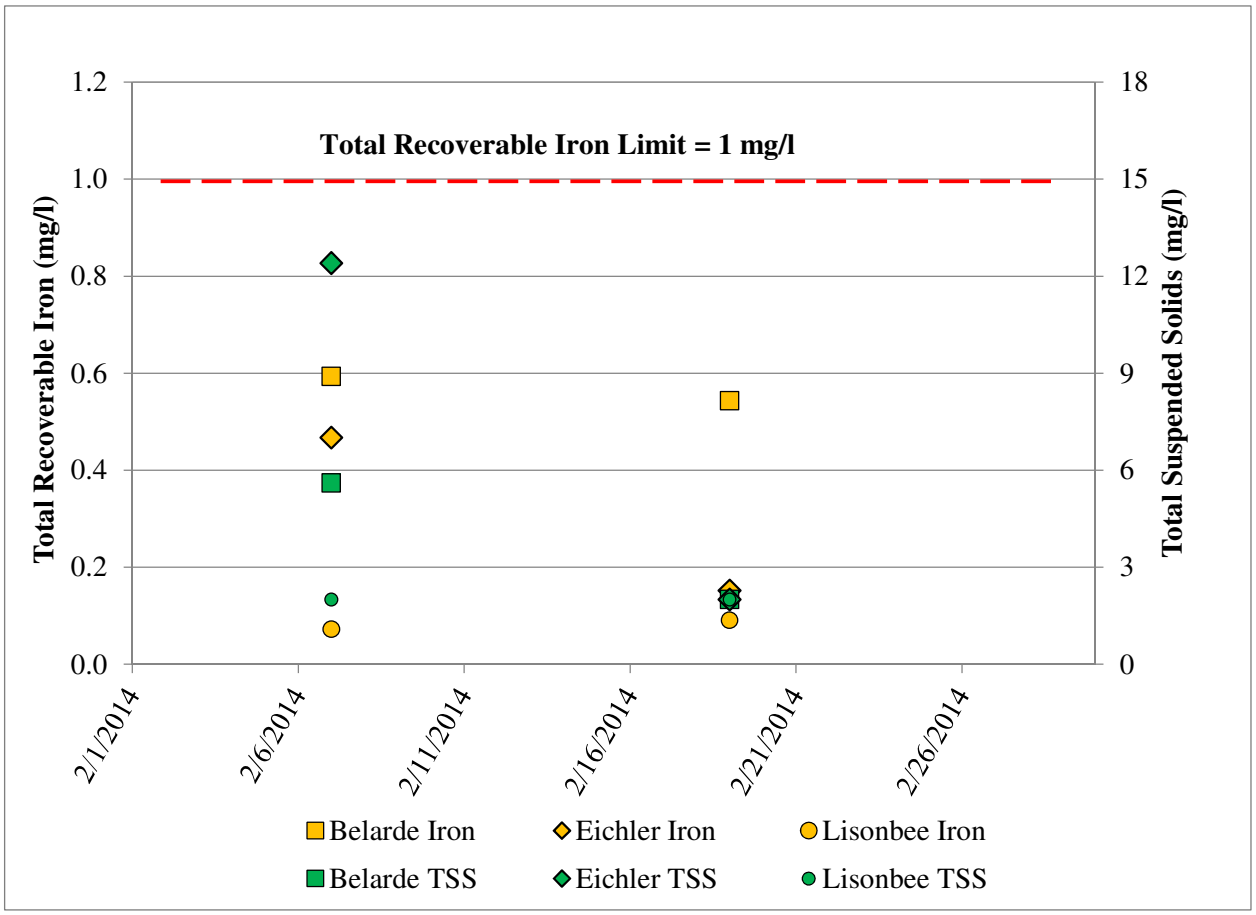


**FIGURE 5**
**FEBRUARY 2014 INSTANTANEOUS TOTAL RECOVERABLE IRON (MG/L) AND TOTAL SUSPENDED SOLIDS (MG/L)**

Constituents below the detection limit at all three stations in February 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 2**). However, the hardness adjusted stream standard for chronic potentially dissolved copper at Belarde was lower than the 15 µg/l detection limit during both sampling events (**Table 2**). Measured concentrations of potentially dissolved manganese were lower than the hardness adjusted stream standards established by the WQCC (**Table 2**). Chloride and sulfate were compliant with the stream standards at the Belarde, Eichler, and Lisonbee stations (**Table 3**). The field pH values in February 2014 were compliant with the stream standard of between 6.5 and 9.0 at all three stations (**Table 3**).

## TABLE 2

### HARDNESS BASED STREAM STANDARDS ASSOCIATED WITH APISHAPA RIVER INSTANTANEOUS SAMPLING, FEBRUARY 2014 (CDPHE WQCC, 2013 (2))

| 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 | 2/7/2014 | 3a | 140 | 18.5 | 11.9 | 1 | 3340 | 1845 | 217 | 165 |
| Belarde Hardness Based Standards | 2/19/2014 | 3a | 126 | 16.7 | 10.9 | 1 | 3225 | 1782 | 197 | 150 |
| **Belarde Maximum February Results** | | | **NA** | **<15** | **<15** | **0.593** | **128** | **128** | **<20** | **<20** |
| Eichler Hardness Based Standards | 2/7/2014 | 3a | 307 | 38.7 | 23.4 | 1 | 4338 | 2397 | 444 | 336 |
| Eichler Hardness Based Standards | 2/19/2014 | 3a | 261 | 33.2 | 20.3 | 1 | 4110 | 2271 | 383 | 290 |
| **Eichler Maximum February Results** | | | **NA** | **<15** | **<15** | **0.467** | **632** | **632** | **<20** | **<20** |
| Lisonbee Hardness Based Standards | 2/7/2014 | 3a | 236 | 30.2 | 18.7 | 1 | 3974 | 2196 | 349 | 265 |
| Lisonbee Hardness Based Standards | 2/19/2014 | 3a | 200 | 25.8 | 16.2 | 1 | 3761 | 2078 | 301 | 228 |
| **Lisonbee Maximum February Results** | | | **NA** | **<15** | **<15** | **0.0907** | **51.5** | **51.5** | **<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 3
## STREAM STANDARDS ASSOCIATED WITH APISHAPA RIVER INSTANTANEOUS SAMPLING, FEBRUARY 2014 (CDPHE WQCC, 2013 (2))

| 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 | 2/7/2014 | 3a | 0.02 | 0.75 | 16 | 11 | 250 | 18.4 | 4.6 | 250 | 6.5 | 9 |
| Belarde Standards | 2/19/2014 | 3a | 0.02 | 0.75 | 16 | 11 | 250 | 18.4 | 4.6 | 250 | 6.5 | 9 |
| **Belarde Maximum February Results[1]** | | | **<15** | **<0.05** | **<10** | **<10** | **7.27** | **<4** | **<4** | **48.3** | **7.86** | **8.40** |
| Eichler Standards | 2/7/2014 | 3a | 0.02 | 0.75 | 16 | 11 | 250 | 18.4 | 4.6 | 250 | 6.5 | 9 |
| Eichler Standards | 2/19/2014 | 3a | 0.02 | 0.75 | 16 | 11 | 250 | 18.4 | 4.6 | 250 | 6.5 | 9 |
| **Eichler Maximum February Results[1]** | | | **<15** | **<0.05** | **<10** | **<10** | **54.9** | **<4** | **<4** | **57.3** | **7.92** | **8.68** |
| Lisonbee Standards | 2/7/2014 | 3a | 0.02 | 0.75 | 16 | 11 | 250 | 18.4 | 4.6 | 250 | 6.5 | 9 |
| Lisonbee Standards | 2/19/2014 | 3a | 0.02 | 0.75 | 16 | 11 | 250 | 18.4 | 4.6 | 250 | 6.5 | 9 |
| **Lisonbee Maximum February Results[1]** | | | **<15** | **<0.05** | **<10** | **<10** | **12.0** | **<4** | **<4** | **82.3** | **8.45** | **8.70** |

[1] Minimum result identified for pH-low

## References

Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Commission (WQCC), 2013 (1). 5 CCR 1002-32, Regulation No. 32 Classifications and Numeric Standards for Arkansas River Basin, Amended August 12, 2013, Effective December 31, 2013.

Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Commission (WQCC), 2013 (2). 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), 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.