

# Appendix E

## Water Quality Sampling Protocols and Results

Background. Water quality standards are established by the Colorado Department of Public Health and Environment and are based on two factors: (1) the waterbody's classification, i.e., its "designated uses"; and (2) numerical water quality standards based on that classification. The classification for the South Arkansas River (COARUA12b) is as follows:

- *Aquatic Life Cold 1*—Class I, Cold Water Aquatic Life: These are waters that (1) currently are capable of sustaining a wide variety of cold water biota, including sensitive species, or (2) could sustain such biota but for correctable water quality conditions. Waters shall be considered capable of sustaining such biota where physical habitat, water flows or levels, and water quality conditions result in no substantial impairment of the abundance and diversity of species.
- *Recreation E*—Class E, Existing Primary Contact Use: These surface waters are used for primary contact recreation or have been used for such activities since November 28, 1975.
- *Water Supply*: These surface waters are suitable or intended to become suitable for potable water supplies. After receiving standard treatment (defined as coagulation, flocculation, sedimentation, filtration, and disinfection with chlorine or its equivalent) these waters will meet Colorado drinking water regulations and any revisions, amendments, or supplements thereto."
- *Agriculture*: "These surface waters are suitable or intended to become suitable for irrigation of crops usually grown in Colorado and which are not hazardous as drinking water for livestock" (CDPHE 2012d, 2013).

## Water Quality Sampling in the South Arkansas River Watershed

As part of the watershed assessment, water samples were gathered from the South Arkansas River at five locations (Figure E-1). These locations were chosen in an attempt to identify whether development and changes in land use above and within the project corridor significantly impact water quality.

- **Site #1** is located approximately 10 meters upstream of the first bridge on Chaffee County Road 231. This is within the San Isabel National Forest near the top of the headwaters of the South Arkansas River. Monarch Park Campground is located about one-half mile upstream. The campground has four pit toilets. Site 1 is also downstream from Monarch Ski area.
- **Site #2** is located approximately 5 meters upstream of where the river flows under Chaffee County Road (CCR) 225. Site #2 is below the Madonna Mine and the town of Garfield.
- **Site #3** is located approximately 20 meters upstream of where the river flows under U.S. 285. Land use between Site #2 and Site #3 changes from undeveloped forest service land and scattered home sites, to the town of Maysville (population 135), to ranch land dominated by cattle grazing.

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- **Site #4** is located downstream of U.S. 285 and approximately 100 meters below the confluence with Poncha Creek. Site #4 was chosen to isolate potential water quality impacts from the Poncha Creek watershed and U.S. 285.
- **Site #5** is located at the confluence of the South Arkansas River and the main stem of the Arkansas River. The sampling site is approximately 2 meters downstream of where the South Arkansas flows under CCR 105. Site #5 was chosen to isolate potential water quality impacts from land use and development between Poncha Springs and Salida.

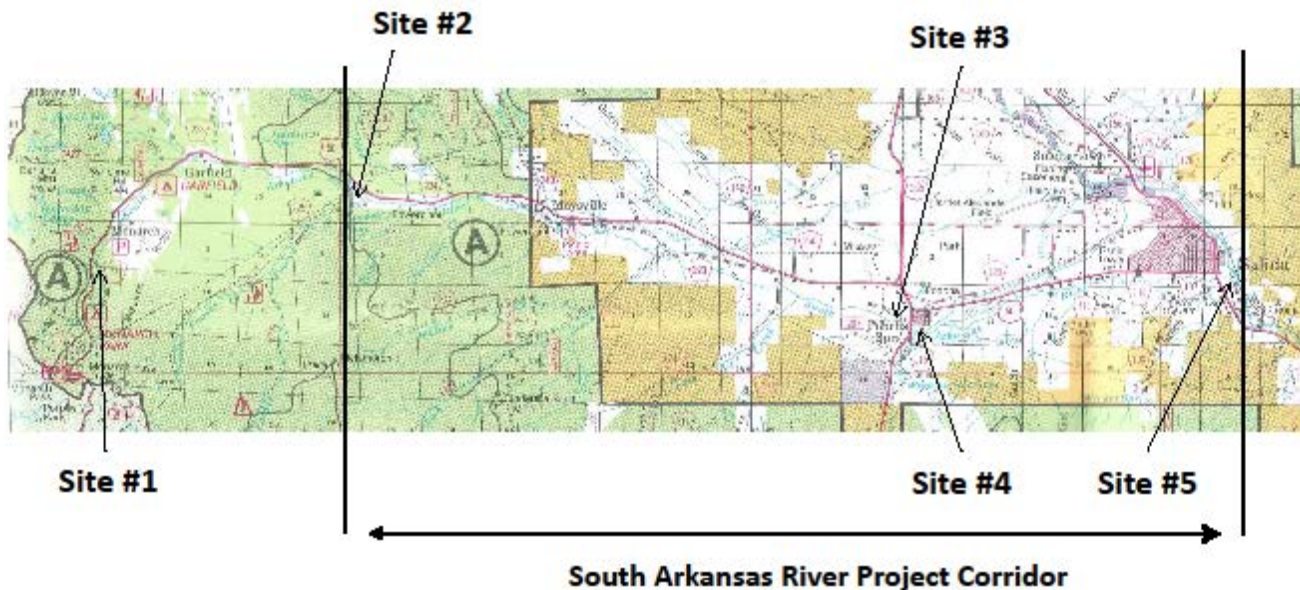


Figure E-1. Location of water quality sampling sites on the South Arkansas River

### Sampling Protocol and Analysis

Sampling was conducted in December-January 2012 and July 2013. Water samples were collected in 12-ounce plastic commercial drinking water bottles. Bottles were opened on site and the original water discarded in an area downstream of the sample site. Bottles were rinsed twice with the source water then filled, capped, and placed in a hard-sided cooler with ice packs for short-term storage.

- On December 12, 2012, samples for all water quality components except *E. coli* were collected between 1:45 p.m. and 3:15 p.m. Samples for *E. coli* were collected on January 2, 2013, between 11:00 a.m. and 12:30 p.m. Water temperatures progressed from 34°F (1°C) at Site 1 and 36°F (2.5°C) at Site 5.
- On July 10, 2013, samples for all water quality components, including *E. coli*, were collected between 10:45 a.m. and 12:00 p.m. Water temperatures progressed from 51°F (11°C) at Site 1 and 64°F (18°C) at Site 5. Results are presented in Table E-2.

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Samples for all water quality components except *E. coli* were analyzed at the Water, Plant and Soil laboratory at Colorado State University (Fort Collins, CO). Water quality parameters in the lab's "fisheries package" were used. Several of these parameters do not have established state standards, but may affect fish populations. Samples for *E. coli* were delivered for analysis within 24 hours at the Pueblo County Health Department (Pueblo, CO).

Results for winter water quality sampling are presented in Table E-1; results for summer water quality sampling are presented in Table E-2. All units are milligrams per liter (mg/L) except where otherwise indicated. Table footnotes are as follows.

- 1/ Temperature (°C) – winter: > 13.0 (ac), > 9.0 (ch); summer: > 21.7 (ac), > 17.0 (ch).
- 2/ pH – recreation, agriculture, and cold water aquatic life = 6.5 to 9.0; pH for drinking water supply = 5.0 to 9.0. pH is a measure of how acidic (< 7.0) or basic (> 7.0) a solution is. The pH of pure water is 7.0.
- 3/ Measured as a 2-month geometric mean.
- 4/ Dissolved oxygen (DO) (mg/L) – 3.0 for recreation, agriculture, and drinking water supply; 6.0 for cold water aquatic life; and 7.0 for spawning.
- 5/ Nitrate as N – no aquatic life standard; 100 mg/L for agriculture; and 10 mg/L for drinking water supply (1-day). Calculation is based on chloride ion concentration which buffers the toxicity of nitrates.
- 6/ Standards for chronic and acute values are for cold water aquatic life only and differ based on whether the early life stages of trout or adult trout are present. Acute values result in 50% mortality with 1-day exposure; chronic values result in 50% mortality with 30-day exposure.
- 7/ Total phosphorus as measured as an annual median. The allowable exceedance frequency is one year in five.
- 8/ Chronic standard for cold water aquatic life = 1,000 µg/L (total recoverable); and 300 µg/L (dis) for drinking water supply (30-day). "dis" refers to dissolved, i.e., the material passes through a 0.40 – 0.45 micron membrane filter.
- 9/ Cold water aquatic life standards (chronic and acute) are based on the hardness of the water (i.e., the amount of dissolved calcium and magnesium); 200 µg/L (30-day) for agriculture; and 50 µg/L (dis) for drinking water supply (30-day).
- 10/ Cold water aquatic life standards (chronic and acute) are based on the hardness of the water; 200 µg/L for agriculture; and 1,000 µg/L for drinking water supply (30-day).
- 11/ Cold water aquatic life standards (chronic and acute) are based on the hardness of the water; 2,000 µg/L for agriculture (30-day); and 5,000 µg/L for drinking water supply (30-day).

Table E-1  
 South Arkansas River Water Quality Testing Results, Dec., 2012 and Jan., 2013

South Arkansas Water Quality Sampling Criteria	State Water Quality Standard	Site 1 SoArk at Monarch Park	Site 2 SoArk at CR 225	Site 3 SoArk above U.S. 285	Site 4 SoArk below Poncha Creek	Site 5 SoArk at CR 105
Temperature (°C)	1/	1.0	1.0	1.0	1.5	2.5
pH	2/	6.9	7.8	7.9	8.0	7.9
<i>E coli</i> (count per 100 mL)	126 3/	43.5	10.9	2.0	8.5	23.1
Dissolved oxygen (DO)	4/	—	—	—	—	—
Conductivity (µmhos/cm)	n/a	116	176	198	186	252
Sodium	n/a	3.6	2.7	5.2	6.7	9.8
Potassium	n/a	0.45	0.58	0.91	0.95	1.30
Sulfate (SO <sub>4</sub> ) (WS)	250	4.2	15.0	14.7	13.8	19.5
Nitrate (NO <sub>3</sub> )	n/a	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate as N	5/	<0.1	<0.1	<0.1	<0.1	<0.1
Chloride (WS)	250	3.5	1.1	0.88	0.96	1.30
Carbonate	n/a	<0.1	<0.1	<0.1	<0.1	<0.1
Bicarbonate	n/a	65.5	103	126	120	167
Calcium	n/a	12.2	25.4	27.5	25.0	36.1
Magnesium	n/a	5.8	7.5	9.3	8.5	10.9
Alkalinity (CaCO <sub>3</sub> )	n/a	54	84	103	98	137
Hardness (CaCO <sub>3</sub> )	n/a	54	94	107	97	135
Total Suspended Solids	n/a	95	155	184	176	246
Total Ammonia (NH <sub>3</sub> )	n/a	<0.01	<0.01	<0.01	<0.01	<0.01
Total Ammonia – N at 20°C	TVS 6/	<0.01	<0.01	<0.01	<0.01	<0.01
Un-ionized Ammonia	n/a	<0.01	<0.01	<0.01	<0.01	<0.01
Phosphorus (µg/L)	110 7/	59	100	96	4	17
Iron (µg/L)	300 and 1,000 8/	<10	<10	10	30	30
Manganese (µg/L)	TVS 9/	<10	<10	<10	<10	<10
Copper (µg/L)	TVS 10/	<10	<10	<10	<10	<10
Zinc (µg/L)	TVS 11/	<10	<10	<10	<10	<10

"n/a" indicates that a state standard has not been established for that parameter.

"WS" indicates that the state standard applies to drinking water supply.

"TVS" indicates that a table value standard based on a specific formula has been adopted for a particular parameter. See CDPHE (2012d) for more details.

Table E-2  
 South Arkansas River Water Quality Testing Results, July 2013

South Arkansas Water Quality Sampling Criteria	State Water Quality Standard	Site 1 SoArk at Monarch Park	Site 2 SoArk at CCR 225	Site 3 SoArk above U.S. 285	Site 4 SoArk below Poncha Creek	Site 5 SoArk at CCR 105
Temperature (°C)	1/ 2/	11.0 7.3	11.0 7.5	15.0 8.2	15.5 8.2	18.0 8.4
pH				127.4	101.9	114.5
E coli (count per 100 mL)	126	< 1.0	27.2	—	—	—
Dissolved oxygen (DO)	3/	—	—	—	—	—
Conductivity (µmhos/cm)	n/a	81.5	102.0	210.0	192.0	290.0
Sodium	n/a	2.32	1.52	6.00	6.30	15.80
Potassium	n/a	0.23	0.31	1.20	1.14	2.20
Sulfate (SO <sub>4</sub> ) (WS)	250	1.6	15.3	16.5	12.2	21.6
Nitrate (NO <sub>3</sub> )	n/a	< 0.1	< 0.1	< 0.1	< 0.1	0.0
Nitrate as N	5/	< 0.1	< 0.1	< 0.1	< 0.1	0.0
Chloride (WS)	250	8.59	2.76	2.75	3.14	6.58
Carbonate	n/a	< 0.1	< 0.1	< 0.1	< 0.1	0.0
Bicarbonate	n/a	49.0	65.0	181.0	153.0	243.0
Calcium	n/a	12.3	20.7	41.4	34.0	54.6
Magnesium	n/a	4.4	4.35	12.3	10.2	13.9
Alkalinity (CaCO <sub>3</sub> )	n/a	40	53	148	125	199
Hardness (CaCO <sub>3</sub> )	n/a	49	70	154	127	193
Total Suspended Solids	n/a	78	110	261	220	358
Total Ammonia (NH <sub>3</sub> )	n/a	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Total Ammonia – N at 20°C	TVS 6/	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Un-ionized Ammonia	n/a	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Phosphorus (µg/L)	110 7/	300	310	310	310	310
Iron (µg/L)	300 and 1,000 8/	90	10	40	10	40
Manganese (µg/L)	TVS 9/	< 10	< 10	< 10	< 10	< 10
Copper (µg/L)	TVS 10/	< 10	< 10	< 10	< 10	< 10
Zinc (µg/L)	TVS 11/	< 10	< 10	< 10	< 10	< 10

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