



DE-LIST REPORT FOR TOTAL SELENIUM (CHRONIC)

Reach 15060203-022B

East Verde River – Ellison Creek to American Gulch

April 23, 2014

Executive Summary

Water quality data collected by ADEQ from 2009 to 2013 for Reach 15060203-22B of the East Verde River resulted in no exceedances of the chronic total selenium water quality standard of the Aquatic and Wildlife warm water (A&Ww) designated use. In 2004, Reach 15060203-22B of the East Verde River (confluence of Ellison Creek to the confluence of American Gulch) was placed by ADEQ on the state of Arizona's 303(d) Impaired Waters List for total selenium (chronic). This listing was based on two exceedances that occurred at monitoring point VREVR034.80 (East Verde River just below the Highway 87 Bridge). Personnel from the TMDL Unit collected additional water samples at multiple monitoring points along the impaired reach at various hydrologic conditions, ranging from baseflow to flood stage conditions. Analysis of the total selenium was performed by laboratories that had the ability to analyze to a detection level that was at or below the chronic total selenium standard of 2 µg/L. All the data collected at the various sample points since 2009 showed no exceedances of the chronic total selenium standard. The very few detections of total selenium that did occur were usually less than 1 µg/L, and were almost always associated with low flow conditions. Reach 15060203-22B is recommended for de-listing for chronic total selenium impairment based on the documented lack of exceedances throughout the hydrograph. The purpose of this report is to present the rationale for de-listing.

Physiographic Setting

The headwaters for the East Verde are located at an elevation of approximately 7,200 feet along the southern face of the Mogollon Rim. The channel drains in a southerly direction to the confluence with Ellison Creek. Below the confluence of Ellison, the East Verde begins to trend in a southwesterly direction to its confluence with the Verde River. The mouth of the East Verde is 3.4 miles downstream of the confluence of the Verde River and Fossil Creek at an elevation of approximately 2,480 feet. The entire length of the drainage is contained within the Central Highlands physiographic province, and the majority of the watershed is managed by the Tonto National Forest.

The watershed is located in Gila County which has a population of approximately 51,000. The town of Payson is the largest metropolitan area in the boundaries of the project with a population of about 16,000. Although some mining does occur in the watershed, it makes up a very small portion of the counties industry. Occasional small tailings piles indicate that small mining operations existed in the past. Cattle ranching and logging are the two biggest non-point impacts occurring in the watershed. Outdoor activities such as hunting, fishing, camping, etc., are quite popular, and the US Forest Service maintains camping sites and hiking trails to allow for better access to some of the more remote areas of the watershed.

Hydrology

The East Verde River watershed is a sub-watershed of the Verde River. It has a drainage area of 336 square miles and runs perennially along most reaches of the upper to middle sections of its channel. Pine Creek, Ellison Creek and Webber Creek are sub-watersheds of the East Verde River which have spatially interrupted perennial reaches along the course of their channels. USGS discharge data from gauge # 09507980 near the mouth of the East Verde River does

indicate that zero flows or in some cases flows of less than 1.0 cfs were recorded on some site visits, usually during the hottest, driest times of the year. This would seem to indicate that the flow through the East Verde canyon below the confluence of Pine Creek in the lower reaches of its channel may more correctly be described as intermittent based on the bedrock depth and the thickness of alluvial deposition. The two largest sub-watersheds of the East Verde are Pine Creek (watershed area 48 sq miles) and Ellison Creek (watershed area 42 sq miles).

The Tonto National Forest has recently completed inventory work on springs located within their boundaries and the data they have provided indicates that 52 springs have been identified within the East Verde watershed. Some springs vary in discharge quantity based on the rainfall conditions occurring within the watershed, while others can discharge at a fairly consistent rate even in dry weather conditions. Personnel of the Tonto Natural Bridge State Park have indicated that the unnamed spring located south of the parking lot area has discharged at about the same rate for years. A visit to the park to sample the creek below the natural bridge structure allowed a discharge measurement of the unnamed spring which produced a gauged instantaneous flow rate of approximately 78 gallons per minute (0.17 cfs). Because of the ongoing dry conditions within the watershed, other spring sites have been reduced to almost zero discharge conditions.

SRP currently discharges between 24 and 33 cfs to the East Verde River about two miles downstream of the headwaters near an area known as Washington Park. This water is piped over the rim from the C.C. Cragin Reservoir in the Little Colorado River Watershed, and runs spring, summer and fall. Flows from the reservoir normally continue until the winter snows cut off access to both the lake and the pipeline that runs about seventeen miles from the source to its discharge point. The pipeline and pumping system was completed in 1965 and began moving water from what was then called the Blue Ridge Reservoir on East Clear Creek into the headwaters of the East Verde River. The original purpose of the pipeline was to replace water that Phelps Dodge was taking from the Black River, a tributary of the Salt River whose water rights were owned by Salt River Project. The city of Payson is currently building a pipeline to capture a portion of the water from the reservoir that will be used to augment their drinking water supply which at present comes from pumped groundwater.

Land Use / Ownership

Land ownership in the East Verde River TMDL Project area is mainly federal with some private land and a very small parcel of State Trust Land located near the Payson airport. The US Forest Service manages the federal land through the Tonto National Forest offices. The main office for the Tonto National Forest is located in Phoenix. There is also a district office located in Payson. Private land ownership makes up a very small portion of the project area, with the 2 largest parcels of private land falling within the city of Payson and the city of Pine boundaries. There is also a small piece of land south of the town of Payson owned and managed by the Tonto Apache Indian Tribe. This parcel is small, but it does sit on the edge of the TMDL Project area. The lower reaches of the East Verde River run through the Mazatzal Wilderness Area which is managed by the US Forest Service, and is inaccessible by vehicle.

Listing

Water quality standards for the state of Arizona (Arizona Administrative Code Title 18; Chapter 11) have been developed in response to the mandates of the Clean Water Act. These standards

define the goals and thresholds for water quality pollution issues and prescribe the criteria necessary to protect the various designated uses ascribed to particular water bodies.

The Arizona Department of Environmental Quality is required under the Clean Water Act Section 305(B) to issue a biennial assessment of the condition and quality of the state's waters. The state also maintains a Section 303(d) list of waters not attaining their designated uses. Water quality assessments are based upon all available, credible, and scientifically defensible data collected by ADEQ or received from participating agencies and stakeholder groups.

For the 2004 assessment period, based on monitoring data collected between November, 1998 and December, 2002, Reach 15060203-022B (East Verde River – Ellison Creek to American Gulch) was identified as impaired for the Aquatic and Wildlife warm-water designated use based upon two exceedances of the State's total selenium water quality standard, and the reach was placed on the State's 303(d) list. The listing was based on two exceedances; both collected at the same monitoring site: VREVR034.80 (East Verde River just below the Highway 87 Bridge). One exceedance was collected on December 21, 1999 and the second on January 18, 2001. The 2006, 2008 and 2010 water quality assessments maintained this listing, though no additional exceedances were reported in subsequent years.

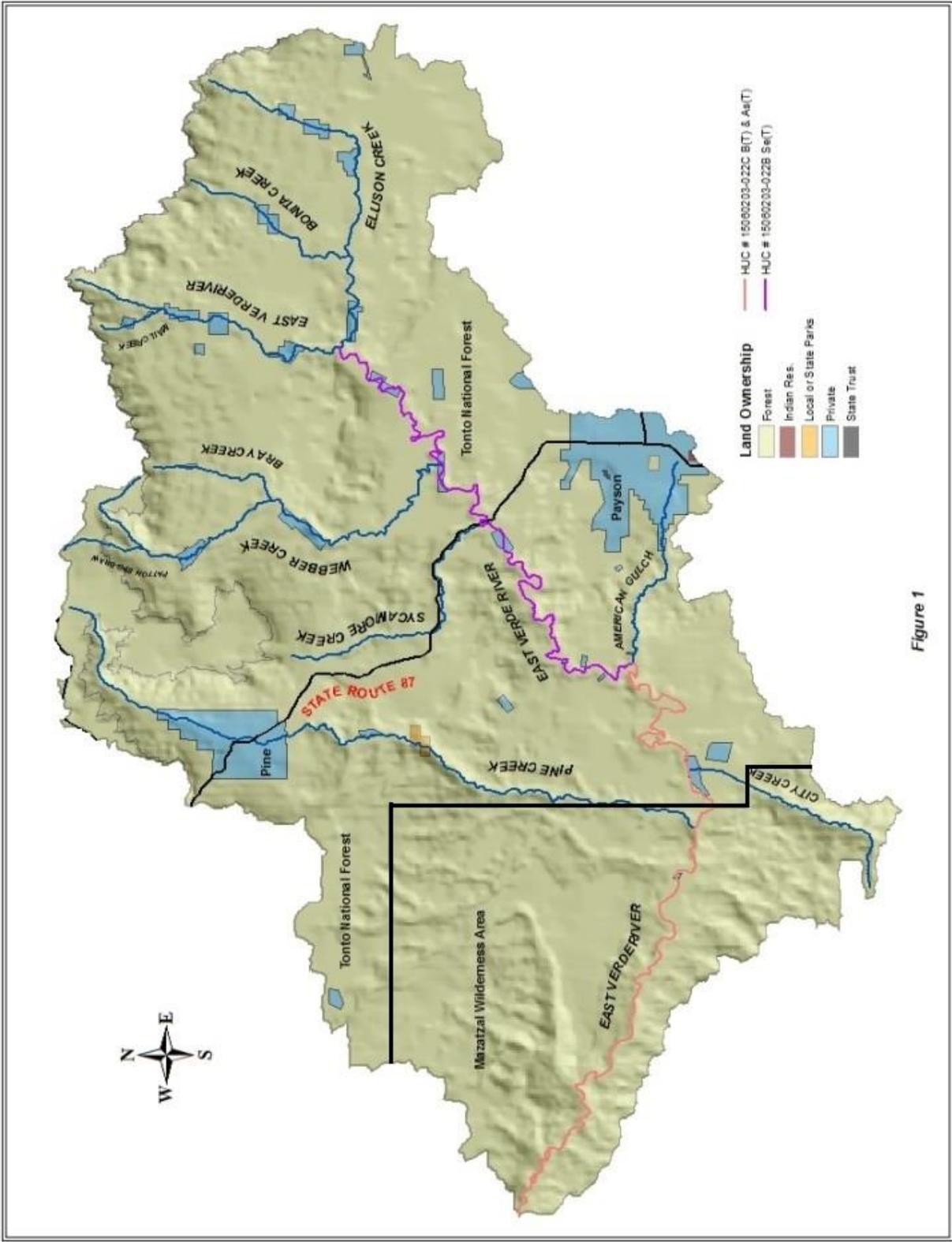


Figure 1

Location of Reach 15060203-022B

Designated Uses

Arizona applies designated uses to waterways in the state to serve as the foundation for applying numeric water quality standards. Designated uses may be broadly grouped into human health uses class and fish and wildlife uses. Parameter standards are then developed based on existing research on toxicity and deleterious effects for each combination of parameter and designated use. Designated uses in Arizona include the following:

- Aquatic and Wildlife uses, cold water (above 5000 feet elevation) – acute and chronic (A&Wc)
- Aquatic and Wildlife uses, warm water (below 5000 feet) – acute and chronic (A&Ww)
- Aquatic and Wildlife uses, ephemeral (A&We)
- Aquatic and Wildlife uses, effluent dependent (A&Wedw)
- Full Body Contact (FBC)
- Partial Body Contact (PBC)
- Domestic Water Source (DWS)
- Agricultural Irrigation (AgI)
- Agricultural Livestock Watering (AgL)
- Fish Consumption (FC)

Any number of these may be combined to adequately and reasonably cover the uses Arizona waters may be put to, excepting the mutually exclusive pairings that might result (e.g., A&Ww and A&Wc would not be found together, nor would FBC and PBC). Typically, any defined Arizona stream reach might have from three to six uses associated with it. Each use has its own set of numeric water quality thresholds or standards associated with it. Dependent upon the parameter, standards may be more or less strict in certain uses than in others, and the limiting use can vary from constituent to constituent based upon the toxicity and natural distribution, among other factors, of the element in question. Selenium's limiting use, because of its tendency to bioaccumulate, is the chronic aquatic and wildlife use for both warm and cold waters. Designated uses for 15060203-022B include A&Ww, FBC, DWS, FC, AgI, and AgL. The A&Ww use was the one of concern for this field investigation on Reach 15060203-022B.

Selenium

Selenium is a trace element essential for human health, but one which has a comparatively low toxic threshold for both humans and wildlife. This coupled with the fact that selenium can bioaccumulate through the food chain has brought selenium issues in water quality to the forefront of research in the past three decades. In 1983, a massive bird kill at the Kesterton National Wildlife Refuge in central California was traced and ultimately attributed to the presence of selenium in high concentrations in the marshes and wetlands of the refuge. Further investigation showed that the waters of the refuge largely originated from agricultural run-off from San Joaquin Valley farms. Agricultural runoff remains today one of the primary contributors to rising selenium concentrations in national waterways where selenium is a problem.

Selenium is a metalloid which shares many chemical characteristics with sulphur and may frequently be found interchangeably with sulphur in natural environments where both exist. Selenium is not as prevalent as sulphur in the natural environment, comprising less than one part

per million of average composition of the major geologic rock classes worldwide (Hem, 1985). It is usually found in sandstones and organic shales of Tertiary age, particularly of marine origin. In the continental United States, these formations are exposed in the arid and semi-arid West (Seiler, 1999). Selenium-bearing formations are not as frequently found in temperate and humid locations, in part due to paleogeographic considerations including the locations and extents of shallow seas and depositional environments in the Mesozoic era. The weathering of the source geologic units creates seleniferous soils which can be vulnerable to selenium liberation upon exposure to running water. Irrigation activities have been identified as one of the prime mechanisms by which selenium enters natural waters in higher concentrations than are naturally found in the waters.

The most stringent applicable Arizona water quality standard for selenium violations is 2.0 ug/l for chronic A&W designated uses. Standards for selenium are much higher for other designated uses, ranging from 20 ug/l (AgI criteria) to 9000 ug/l (FC criteria). Many prior sampling events leading to the listing were inconclusive for assessment purposes since the default detection limit used for routine ambient sampling (5.0 ug/l) was not low enough to detect a standards violation at the A&W chronic level. The sampling associated with this project addressed this deficiency, allowing water quality determinations in most cases down to the required 2.0 ug/l. Storm events of higher turbidity and suspended solid concentrations required dilution of some samples to reporting limits higher than the water quality standard until trace element methods (EPA 1638 with dynamic reaction cell technology) were employed, which allowed selenium concentrations to be determined even in samples with high sediment loads.

Sampling History

The listing of the reach in Arizona's 2004 305(b) report was based solely on samples that were collected at site VREVR034.80 (East Verde River at the Highway 87 Bridge). Between November of 1998 and December of 2002, 18 sampling events took place. Analysis for total selenium resulted in two exceedances of the A&Ww designated use. The other sixteen sample events were recorded as non-detect and were analyzed at a detection limit of 5 µg/L which is higher than the standard, and therefore were unusable for assessment purposes. Several other sites within the reach had total selenium as a component of the sample suite. These results were also not used for assessment because of the detection limit being higher than the applicable standard.

ADEQ's TMDL monitoring of the reach for total selenium impairment began in December of 2009. Monitoring sites on the East Verde River were also sampled above and below the impaired reach, as well as sites within the sub-basins that make up the overall East Verde River basin. In February of 2013 an auto-sampler was installed at site VREVR023.39 (East Verde River above Forest Service Road 502) in order to collect storm water samples. This site is not within the impaired reach, but is located approximately 1.63 miles below the confluence of American Gulch at a bedrock outcrop. All samples were analyzed at lower detection limits down to the required 2.0 µg/L. In 2010, ADEQ modified its selenium analysis approach and contracted with Brooks Rand Laboratory (BRL) of Seattle Washington for selenium analysis to detection limits lower than 2.0 µg/L.

Sample collection from the established sampling sites within the East Verde watershed was normally done with the intent to gather data that would represent any seasonal variations in water quality. Sampling of storm events that usually occur in the winter or summer was also part of the monitoring regime, in order to collect samples of storm water flood stage events.

Data Analysis

Of the 122 samples collected at the various sites throughout the watershed, only 8 samples produced results that were not reported as less than the method detection limit (MDL) which was approximately 6.6% of the total number of samples. None of the 8 results were exceedances of the A&Ww chronic total selenium standard. 110 samples were reported as non-detect, where the MDL was 2 µg/L or less. There were 4 samples that were reported as non-detect where the MDL was 3µg/L. All results were requested to be reported down to the MDL instead of the method reporting limit. Table 1 lists the 8 results and at which sample sites they were collected. All results are reported as µg/L. Of the 8 sample results, 7 were reported by the analyzing lab with a lab code of E4. A result that is labeled as E4 is considered below the laboratories reporting limit, but above or at the method detection limit. It is interesting to note the range of discharge values. Low level detections of selenium occurred at extremely low flows and also at flows above normal base flow levels. The majority of storm flow influenced samples were collected after the switch to Brooks Rand for analysis. Other TMDL projects had encountered problems with selenium analysis in high sediment load samples that usually are associated with storm water run-off. High sediment loads necessitate the dilution of samples to determine analytical values and thus create difficulties in seeing down to the chronic standard.

Site ID	Sample Date	Sample Time	Lab Code	Result µg/L	Detection Limit	Flow in cfs
VRAMG003.62	03/30/11	1530	E4	0.227	2.0	0.03
VREVR002.62	05/04/10	1300	E4	0.2	2.0	20.8
VREVR023.39	04/18/13	1030		0.103	0.072	6
VREVR034.80	01/29/13	1445	E4	0.72	0.6	73
VREVR043.98	01/29/13	1530	E4	0.79	0.6	65
VREVR051.15	01/30/13	1110	E4	0.6	0.6	7.9
VRPIE016.49	05/11/09	1200	E4	1.2	2.0	0.77
VRPSD001.63	05/11/09	1415	E4	0.8	2.0	0.0022

Table 1. Selenium detections for East Verde River TMDL project

Conclusion

The purposes of this delisting report are to put on the record the findings of the recent TMDL monitoring results and to present the rationale for the delisting of chronic impairment of total selenium. The data listed in Table 1 show that although detections of total selenium did occur, none of the results constitute an exceedance of the A&Ww chronic selenium standard. Those sites located in the impaired reach were sampled a total of 19 times with no exceedances. Thus, the reach is attaining selenium standards for all designated uses.

Re-evaluation of the listing data used in the 2004 assessment indicates that both of the data results that caused the impairment listing were at or very close to the detection limit of 5 µg/L, and that both were analyzed using EPA Method 200.9 (Graphite Furnace Atomic Absorption). Due to the fact that the samples were collected and analyzed by the USGS over ten years ago, review of the sampling methods and lab methods is difficult. Discussion of the selenium results from VREVR034.80 with personnel from Brooks Rand Laboratory has shed a small amount of light on what may have caused the detections where selenium would not be expected to be seen. Most of the information they provided addressed issues that might cause suppression of the selenium results, and not situations which would lead to over reporting of ambient conditions. It should be noted that many labs recommend newer analysis methods instead of EPA Method 200.9. One of the arguments against 200.9 is that false positives are a possibility due to unanticipated species that can't be accounted for. One aspect may be that the readings were due to selenium contamination from an outside source. At this point in time any possible theory is basically pure speculation. The fact that the very few detections of selenium which did occur during the TMDL study showed up at levels significantly lower than the standard of 2.0 µg/L suggests that the two exceedances which caused the reach to be listed as impaired may have been erroneous.

The methods used in this project had very low detection limits and consideration of the water quality representations made by the entire body of data, and the addition of higher quality data collected more intensively during this TMDL project leads one to the conclusion that Reach 15060203-022B (East Verde River – Ellison Creek to American Gulch) does not warrant its continued presence on Arizona's 303(d) list for chronic selenium water quality violations. In evaluating a surface water for delisting, ADEQ in accordance with Arizona Administrative Code R18-11-605(E).2.a "shall remove a pollutant from a surface water or segment from the 303(d) List based on one or more of the following criteria". The pertinent and applicable criteria subsequently listed (R18-11-605(E).2.a.v.) states:

"A re-evaluation of the data indicates that the surface water or segment does not meet the criteria for impairment because of a deficiency in the original analysis."

The more recent and scientifically credible data for Reach 15060203-022B of the East Verde River shows that the listing does not meet the criteria for continued listing under the applicable numeric water quality standard for chronic total selenium when considered under a weight of evidence approach. An informed recommendation is hereby made to officially remove the reach from the Arizona 303(d) list.

REFERENCES

Arizona Administrative Code. (2003). Title 18 Environmental Quality, Chapter 11 Department of Environmental Quality, Water Quality Standards. Supp. 03-01.

Arizona Department of Environmental Quality. (2005). *The Status of Arizona's Water Quality in Arizona -- 2004: Arizona's 2004 Integrated 305(b) Assessment and 303(d) Listing Report*. ADEQ Publication # EQR0501. Phoenix, AZ.

Arizona Department of Environmental Quality. (2007). *Draft 2006 Status Of Ambient Surface Water Quality In Arizona -- Arizona's Integrated 305(B) Assessment And 303(D) Listing Report*. ADEQ Publication # EQR 07-02. Phoenix, AZ.

Arizona Department of Environmental Quality. (2008). *Surface Water Assessment Methods and Technical Suppor*. Phoenix, AZ.

Hem, John D. (1985). *Study and Interpretation of the Chemical Characteristics of Natural Water*. United States Geological Survey Water-Supply Paper 2254. Third Edition. Washington, D.C.

Seiler, Ralph L. et al. (1999). *Areas Susceptible to Irrigation-Induced Selenium Contamination of Water and Biota in the Western United States*. U.S. Geological Survey Circular 1180. Carson City, Nevada.