**Chapter 3 – Region Description**

*Note: Only Section 3.11 – Water Quality of the Region Description Chapter was modified, so only Section 3.11 is provided here. The section was largely rewritten so it is not shown in redline/strikeout version for better clarity. The revisions focus on addressing new IRWMP requirements that nitrates, arsenic, perchlorate and hexavalent chromium be specifically addressed in this section.*

**Section 3.11 – Water Quality**

The Southern Sierra RWMG has identified several issues that relate to water quality including:

* Several areas in the Region have drinking water that does not meet California and national standards;
* Some water treatment systems do not meet standards, or have very limited capacity;
* Sediment buildup in storage facilities;
* Agricultural runoff;
* Post-fire sediment;
* Groundwater pollution;
* Septic systems are not updated, serviced or monitored to meet standards;
* Increasing atmospheric nitrogen deposition has potential to cause water nitrogen increases and acidification;
* Rising stream water temperature;
* Toxic algae bloom in lakes and waterways; and
* Water quality impacts from recreation.

These water quality issues are a primary concern for the RWMG and are considered a high priority.

In 2014 the California Legislature signed into law Assembly Bill No. 1249 (AB1249), “an act to amend Section 10541 of, and to add Sections 10544.5 and 10545 to, the Water Code, relating to water quality”. A component of AB1249 requires IRWMPs to address nitrate, arsenic, perchlorate, or hexavalent chromium (Cr6) contamination within the IRWM boundary. Discussion must include the location and extent of any contamination in the region and the impacts caused by any contamination to communities within the region. Assembly Bill 1249 also requires that, to the extent that nitrate, arsenic, perchlorate, or hexavalent chromium contaminants occur, the IRWMP shall describe any actions currently being undertaken to address the contamination, and any additional actions that are needed to address the contamination. This update to the water quality section was undertaken to comply with this regulation, and as such focuses on these four constituents. Additional information is included when it helps provide a more comprehensive understanding of overall water quality.

Numerous resources were consulted during the compilation of this water quality update. Among the most informative was *Groundwater-Quality Data for the Sierra Nevada Study Unit, 2008: Results from the California GAMA Program, USGS Data Series 534 (*Shelton et al., 2010)*.* *A natural resource condition assessment for Sequoia and Kings Canyon National Parks, Appendix 6 – Water Quality* (Day and Conklin, 2013), also provided useful information. A study by the California Department of Water Resources titled *Geology, Hydrology, Quality of Water, and water supply of the Three Rivers area, California* provided relevant information for the Three Rivers area. Minimal information is available from water quality reports for public water supplies, as they are not wide-spread in the sparsely populated southern Sierra Nevada.

Surface Water Quality

Surface waters originating in the Southern Sierra Region are generally of high quality and flow to the Tulare Lake and San Joaquin River Hydrologic Regions of the southern San Joaquin Valley. In fact, water is the single largest export of the SSIRWMP Region. However, several water bodies are listed under the Clean Water Act as impaired (see **Table 1** below). Humans and domesticated livestock have impacted the water supplies with nitrates and other compounds that limit the usefulness of some surface waters and groundwater. These effects have a disproportionate impact on disadvantaged communities (DACs) that do not have the capital resources necessary to drill new wells, treat water, improve wastewater systems, or provide other support to important water projects. For additional discussion concerning DAC refer to the Section 3.11 – Social/ Cultural Makeup and Disadvantaged Communities.

As previously mentioned several water bodies within the Region are impaired, and with funding the RWMG could take measures to help restore the water quality. The current impaired water bodies, which include creeks, rivers and lakes, are listed in **Table 1**.

Table 1 - Impaired Water Bodies in the Southern Sierra Region

|  |  |
| --- | --- |
| **Waterbody Segment** | **Pollutant** |
| **Deer Creek (Tulare County)** | High pH |
| Unknown Toxicity |
| **Hume Lake\*** | Oxygen, Dissolved |
| **Isabella Lake** | Oxygen, Dissolved |
| pH |
| **Kaweah Lake** | Mercury |
| **Kaweah River** | pH |
| Unknown Toxicity |
| **Kings River** | Unknown Toxicity |
| **Millerton Lake** | Mercury |
| **Poso Slough** | Sediment Toxicity |
| **Success Lake** | pH |

These rivers and water bodies lie within or immediately adjacent to the SSIRWM Region boundaries.

The State and Regional Water Boards assess California’s surface waters every two years to determine if they contain pollutants at levels that exceed protective water quality standards. Water bodies that exceed protective water quality standards are placed on the State’s 303(d) List. For several reaches of the rivers, the source of the contamination is unknown, or the type of contamination is unknown. In California this determination is governed by the Water Quality Control Policy for Developing California’s Clean Water Act Section 303(d) List. USEPA must approve the 303(d) List before it is considered final.

Placement of a water body on the 303(d) List initiates the development of a Total Maximum Daily Load (TMDL). Deer Creek’s listing, for example, prompts the Regional Water Quality Control Board to seek improvements along this creek in order to remove the water body from the list.

Of the constituents identified in AB1249, nitrate contamination is a concern in surface waters. In the upper watersheds of the Southern Sierra Region, aerially deposited nitrates from automobile exhaust and agriculture are being studied for their impacts on aquatic and terrestrial ecosystems (Day & Conklin, 2013; Heard & Sickman, 2016; Sickman et al., 2003). Even at concentrations that have no impact on human health, anthropogenically added nitrogen and nitrates can have major impacts on the sensitive ecosystems of the high Sierra Nevada (Heard & Sickman, 2016; Sickman et al., 2003). Little surface water quality data was found for the area, especially for the four constituents requiring evaluation under AB 1249. No evidence was found that any of these four constituents are problematic in surface waters.

Wildfire is a reoccurring threat to surface water quality in the Southern Sierra Region. For several years following wildfire, higher nutrient levels, dissolved organic carbon and turbidity levels may be observed in streamflow. When wildfires are followed by large storm events, sediment production and debris flows can also dramatically increase. This sediment can become trapped in downstream reservoirs, decreasing reservoir capacity and longevity. Due to climate change and higher fuel loads across the Region, large severe wildfires, such as the 2015 Rough Fire in the Kings River watershed, are expected to become more frequent. Mitigating of the effects of wildfire will be increasingly important for preserving surface water quality.

Rising air temperature and subsequent warming of water bodies in lakes and streams is another water quality concern for the region. Water temperatures are rising and will continue to do so in the future (Ficklin et al.,2013; Null et al., 2013; Isaak et al., 2017), causing further loss of cold-water habitat and algae bloom (Derlet et al., 2009).

Groundwater Quality

The majority of domestic, commercial and agricultural water demands in the region are met with groundwater. Therefore, understanding the occurrence and distribution of chemical constituents of significance to water quality is important for the long-term management and protection of groundwater resources (Shelton et al., 2010). The natural chemistry of water from springs in the fractured aquifers within the Region is mixed-cation bicarbonate type (Feth et al, 1964). In a recent study completed by the USGS as part of the Groundwater Ambient Monitoring & Assessment Program (GAMA), the authors (Shelton et al., 2010) indicate that “*All organic and most inorganic constituents that were detected in groundwater samples from the 30 primary grid wells in the Sierra Nevada study unit were detected at concentrations less than drinking water benchmarks*.” Even though they are detected at levels not considered to be a threat to human health there are some naturally occurring mineral constituents present in many hard-rock water supply wells. These include arsenic, uranium, radio nuclei, and others.

The Department of Water Resources (DWR) in technical support of the Southern Sierra Region conducted an initial hydrologic evaluation of the Three Rivers areas as a pilot study for possible future efforts in other watersheds. The results of this study are discussed in the Inorganic Constituents section of this chapter, the Technical Resources Chapter (Chapter 12), and **Appendix D.**

Leaking underground storage sites (LUSTs), while less common than in the densely developed valley floor, can cause water quality problems associated with breakdown products of gasoline and diesel, including fuel oxygenates. These contaminants tend to not break down in a fractured rock aquifer and will preferentially be transported through fractures. The complications of this geological environment pose significant challenges to remediation of groundwater at these sites.

#### Organic Constituents

Volatile organic compounds (VOC) were detected in groundwater samples in the Region, but at concentrations less than their health-based benchmarks. Compounds detected within the Region’s groundwater are methyl-tert-butyl ether, chloroform, dichloro-ethane, and carbon disulfide (Shelton et al., 2010). Pesticides detected in groundwater in the region include simazine, atrazine, deethyl-atrazine, and 3,4-dichloro-aniline. All were detected in concentrations well below the health-based benchmarks for groundwater (Shelton et al., 2010). Since intense cultivation/row or tree crop agricultural activities are not typically undertaken within the region direct application of these constituents is not a major concern, but they are carried in on the wind from agricultural application within the San Joaquin Valley (Heard and Sickman, 2016).

#### Inorganic Constituents

The four constituents identified in Assembly Bill No. 1249 (nitrate, arsenic, perchlorate, and hexavalent chromium) are all present within the region, usually in concentrations not considered to be hazardous for human health. Each is discussed in detail below. Other constituents of concern (COC’s) regulated by the State Water Resources Control Board, Division of Drinking Water (DDW) are also present throughout the Region. Radioactive constituents (primarily Gross-Alpha and Uranium) are the greater portion of the remaining COCs typically found in groundwater in fractured granitic rocks. Other COCs in groundwater in the Region with secondary California maximum contaminant levels (MCLs) are iron, manganese, and pH. In some geologic terrains sodium and chloride can lead to elevated Total Dissolved Solids (TSD). For more details on other constituents the reader is referred to Shelton et al. (2010).

###### Nitrate

Nitrate is commonly present throughout the region’s groundwater in concentrations not recognized as a threat to human health (Shelton et al., 2010). Occasional exceedances of the California MCL have been reported. The DWR hydrologic investigation found that two water systems in the Three Rivers area had periodic exceedances of nitrate from 1974 to 2014. Two sites of high nitrate were identified in Day and Conklin (2013) within the Region’s national parks. One site in Kings Canyon National Park was historically subjected to unrestricted grazing. The other site, on the border of Sequoia National Park, is at the location of a parking lot and public toilets. In the water quality reports of public water supplies for communities surrounding Lake Isabella from 2014-2016, nitrate was commonly detected within drinking water supplies but was not reported in amounts exceeding the MCL.

Anthropogenic sources of nitrate in the region are failing or failed septic tanks, improperly managed rangeland, and improperly sealed wells. Once nitrate enters groundwater there are minimal denitrifying bacteria to break it down. It is highly mobile and can spread through the fractured rock media, potentially causing contamination in wells distant from the source. Nitrate is soluble in water, can easily leach through soil, and can persist in shallow groundwater for decades (Nolan, 2001).

The impacts caused by nitrate contamination in the groundwater supply include acute toxicity resulting from the natural conversion of nitrate to nitrite which inhibits the oxygen-carrying abilities of the blood, colloquially referred to as “bluebaby syndrome”. These impacts are most often observed in the very young or elderly segments of the population. None of these symptoms have been reported within the Region in the information consulted for this study.

Methods for mitigating nitrate in drinking water supplies include blending or treatment techniques. Blending involves combining a water supply without nitrate contamination and a water supply with nitrate contamination to achieve a blended water supply that meets drinking water standards. Treating water for nitrate is an expensive and complicated process, and generally not implemented in the region.

###### Arsenic

Concentrations of arsenic well below the California MCL were detected in most wells in the GAMA study. Of wells containing arsenic, levels exceeding the MCL-US benchmark were detected in three wells throughout the Region (Shelton et al., 2010). Two of the water systems in the DWR hydrologic investigation of Three Rivers had exceedances of the MCL-US benchmark for arsenic during the period between 1974 and 2014. In the water quality reports of public water supplies for communities surrounding Lake Isabella from 2014-2016, arsenic is often present within water systems but in levels compliant with the MCL.

Arsenic is a naturally occurring substance within the crust, and commonly makes its way into groundwater through erosion. It is also a component in some pesticides and herbicides.

The impacts caused by arsenic contamination in the groundwater supply include acute and chronic toxicity that can result in damage to the liver and kidney or blood hemoglobin decline. Long-term consumption of drinking water with arsenic contamination is carcinogenic. None of these symptoms have been reported within the Region in the information consulted for this study.

###### Perchlorate

Perchlorate was detected in samples from ten of the wells in the Region during the GAMA study. Detected concentrations ranged from 0.11 to 1.20 μg/L, all less than the MCL-CA of 6 μg/L, and most concentrations were below 1/10 of the benchmark. These detections were primarily in wells drawing from granitic and metamorphic rocks (Shelton et al., 2010).

Perchlorate can occur naturally in small amounts, though the process via which it is naturally formed is poorly understood. Most perchlorate found in drinking water is the result of anthropogenic activities. It is used primarily as a component of rocket fuel for its oxidizing properties.

The impacts caused by perchlorate contamination in the groundwater supply include eye and skin irritation, coughing, nausea, vomiting and diarrhea. None of these symptoms have been reported within the Region in the information consulted for this study.

###### Hexavalent Chromium

Cr6 is mentioned as a contaminant in the water quality reports of public water supplies for communities surrounding Lake Isabella from 2014-2016. It appears in several of the water supplies during multiple years, always in levels compliant with the MCL. It is not mentioned as a contaminant found anywhere else within the Region in any other source.

Most hexavalent chromium found in groundwater is produced anthropogenically by an industrial process. Essentially all chromium ore is processed via Cr6. It is also used during the production of textile dyes, wood preservation, and anti-corrosion products. Hexavalent chromium can be formed during a natural process whereby Cr(III) within chromite that is associated with birnessite (a Mn mineral) is oxidized (Oze et al. 2007).

The impacts caused by Cr6 contamination in the groundwater supply include liver and kidney damage, internal hemorrhaging, respiratory damage, dermatitis, and ulcers on the skin at high concentrations. These symptoms have not been reported within the Region in the information consulted for this study.

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