Master Response 8.4
Non-Agricultural Economic Considerations

Overview

The State Water Resources Control Board (State Water Board) discloses that the plan amendments could have economic effects beyond those related to the agricultural sector in Chapter 20, *Economic Analyses*. The non-agriculture-related economic effects evaluated in Chapter 20 include commercial and recreational fisheries, non-use values related to fisheries, non-fishing recreational opportunities, hydropower generation and revenues, and potential municipal or ratepayer effects. The economic analytical framework described in Chapter 20 and further detailed in Master Response 8.0, *Economic Analyses Framework and Assessment Tools,* compares potential changes in surface water diversion-related economic effects of the Lower San Joaquin River (LSJR) alternatives and describes the potential costs of compliance with updated water quality objectives for the southern Delta. The framework is not intended to draw conclusions across resources or topics concerning the overall net benefits of a particular alternative. The analyses in Chapter 20 often consider different study areas, and information available to conduct the different analyses is highly variable, thereby precluding a net benefit-type analysis. In addition, the economic discussion in the 2016 Recirculated Substitute Environmental Document (SED) is necessarily a programmatic discussion. Thus, this master response addresses comments in a similar fashion.

In response to comments that the SED lacks a quantification of the ecosystem benefits of the plan amendments, this master response explains the difficulty of quantifying benefits, provides additional detail on and value quantification of ecosystem services, and provides additional information on the potential ecosystem service benefits of the plan amendments on fish populations and the natural environment. These benefits are evaluated according to their capacity to provide services that are in four categories: provisioning (i.e., can be directly used by people); supporting (i.e., are necessary for the production of other ecosystem services); regulating (i.e., are outputs of other ecosystem services that directly benefit people); and cultural (i.e., provide non-material benefits to people). These four categories are established by the United Nations' rigorously peer-reviewed effort, the Millennium Ecosystem Assessment. The plan amendments would result in multiple beneficial ecosystem services changes compared to existing conditions; however, the magnitude, frequency, and duration of these benefits cannot be quantified or are unknown. For example, the plan amendments would improve habitat conditions and sustain salmon populations, and the benefits and the resulting effects on the regional economy are realized in part through the commercial fishery (part of the provisioning services) that were substantially hindered by fishery closures in 2008 and 2009 (Chapter 20, Section 20.3.5, *Effects on Fisheries and Associated Regional Economies*). While commercial and recreational fisheries would benefit (Chapter 20 and Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*), the plan amendments are expected to impose costs on commercial agriculture (Master Response 8.1, *Local Agricultural Economic Effects and the SWAP Model,* and *Master Response 8.2, Regional Agricultural Economic Effects*). Along with provisioning services, as discussed in Chapter 20, Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow between February 1 and June 30*, and Chapter 3 of Appendix C, *Technical Report on the Scientific Basis of Alternative San Joaquin River Flow and Southern Delta Salinity Objectives*, the plan amendments are expected to result in improved habitat conditions in freshwater and marine systems. Enhanced biodiversity, a supporting service, can also be expected in the freshwater and marine systems. Also as described in Chapter 20, a non-use/non-consumptive monetary value of just over $115 (in 2012 dollars) annually per household associated is estimated for restoring salmon populations, and other benefits such as benefits to other native species would result from improved salmon habitat. Non-flow measures identified in Appendix K, *Revised Water Quality Control Plan*, and Chapter 20 would be expected to provide supporting service benefits as well. Improved regulating services are expected to occur under the plan amendments in the eastside tributaries for shoreline stabilization and erosion control, storm protection, waste processing, and carbon sequestration. Cultural services, such as recreation through improved sport fishing and aesthetic and tourism benefits of increased salmon runs, would also result from the plan amendments.

This master response also addresses commenter concerns about municipal economic effects in the plan area that could result from the plan amendments, including water supply uncertainty and related difficulty in planning water supply infrastructure, water rates and fiscal effects, obtaining replacement water supplies, and conservation as part of overall planning efforts. The State Water Board addresses these topics in Chapter 20, Section 20.3.3, *Effects on Municipal and Industrial Water Supplies and Affected Regional Economies*, and this master response further addresses commenter concerns about the potential effects on economic growth and development within the plan area. Implementation of the LSJR alternatives could result in surface and groundwater water supply reductions to municipal service providers in the plan area, as described and analyzed in Chapter 13, *Service Providers*, and Chapter 22*, Integrated Discussion of Potential Municipal and Domestic Water Supply Management Options*. Specifically, municipal service providers that rely on surface water contracts with irrigation districts within the plan area or rely solely on groundwater could be particularly affected if they do not have ready access to alternative supplies (Chapter 13, Tables 13-3a and 13-3b). This master response addresses potential economic effects on municipal service providers, identified in Chapter 13, concerning different activities they may undertake to secure reliable water supplies, as well as the potential effects on ratepayers in affected plan area irrigation districts. The discussion illustrates how service providers could enter into a new water purchasing agreement with irrigation districts or purchase water from other entities should current surface water supplies be reduced.

This master response also addresses comments related to the economic effects of hydropower impacts, which are assessed in Chapter 20, Section 20.3.4, *Effects on Hydropower Generation, Revenues and the Regional Economy*. It explains the approach to the analysis in Chapter 20 and why it is appropriate in response to commenter criticisms. Chapter 20 used a consecutive monthly price of power and a price series, selected as the most closely representative of the available period of record and consistent with the pattern of more contemporary price series. The analysis in Chapter 20 also uses monthly price levels, which are generally higher than historical averages, and they reflect seasonal differences. Therefore, the SED accounts for these differences and actually may overstate the revenue effect of the different LSJR alternatives on hydropower generation. Making more specific adjustments to reflect a modified energy market would have a relatively minimal effect on the precise findings of the analysis while not affecting the main conclusions in the SED regarding hydropower effects. In addition, hydropower operators currently have to modify their operations to best respond to changing conditions (e.g., water availability, demand, providers, requirements, price changes); the plan amendments would add an additional element to this set of existing considerations. The State Water Board acknowledges that managing hydropower for optimal pricing requires consideration of many factors, and these factors are beyond the control of the State Water Board and beyond the ability of the State Water Board to forecast and estimate. Nevertheless, the analysis in Chapter 20 sufficiently captures the large-scale changes in power generation under the different LSJR alternatives.

Finally, this master response addresses comments related to the economic effects of recreation and tourism on the local economy in the plan area and extended plan area. This master response clarifies the method used for evaluating local and regional recreational economic effects in the plan area at the rim reservoirs and the rivers in Chapter 20, Section 20.3.6, *Effects on Recreational Opportunities, Activity, and the Regional Economy*. The method accounts for the seasonal recreation period of May through September and for potential effects during drier years under baseline conditions and LSJR alternative conditions. This master response also discusses general characteristics of recreation in the extended plan area and the influencing characteristics of reservoirs on recreational opportunities, to provide context for understanding the potential economic effects.

The State Water Board reviewed all comments related to the potential non-agricultural economic effects of the plan amendments and developed this master response to address recurring comments and common comment themes not addressed more specifically in Master Responses 8.1, *Local Agricultural Economic Effects and the SWAP Model*, 8.2, *Regional Agricultural Economic Effects*, or 8.5, *Assessment of Potential Effects on the San Francisco Bay Area Regional Water System.* This master response references related master responses, as appropriate, where recurring comments and common comment themes overlap with other subject matter areas. This master response addresses comments related to the potential economic effects of ecosystem service contributions, municipal water supply, hydropower, and recreation, and includes, for ease of reference, a table of contents on the following page to help guide readers to specific subject areas. In particular, this master response addresses, but is not limited to, the following topics.

- Potential economic effects related to ecosystem services.
- Potential economic effects to municipalities in the plan area, including effects on water rates and potential effects on growth and economic development.
- Potential economic effects on hydropower generation in the tributary river systems.
- Potential recreation-related economic effects, including potential effects on in the plan area and extended plan area.

Comments concerning the framework, type of tools, and scope of the various economic analysis are addressed in Master Response 8.0, *Economic Analyses Framework and Assessment Tools,* and the regional economic effects are discussed in Master Response 8.2, *Regional Agricultural Economic Effects*. Comments concerning agricultural land values and water reliability as they relate to agricultural uses are addressed in Master Response 8.1, *Local Agricultural Economic Effects and the SWAP Model,* and Master Response 8.2. Comments concerning water reliability and redundancy and cost-related effects on water rates in the Bay-Area are addressed in Master Response 8.5*, Assessment of Potential Effects on the San Francisco Bay Area Regional Water System.* In addition, Master Response 5.2, *Incorporation of Non-Flow Measures*, identifies the costs associated with other potential compliance actions (i.e., non-flow measures) that could be taken to inform the body of scientific literature and assist with adaptive implementation of the plan amendments.

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Economic Contribution of Plan Amendments to Fish and Wildlife Habitat and Other Beneficial Uses

Some commenters expressed concern regarding the lack of quantification of benefits and impacts on the ecosystem. The SED describes anticipated benefits but acknowledges the difficulty in estimating or quantifying some of those benefits in monetary terms. This section provides additional detail on ecosystem services and the potential ecosystem benefits of the plan amendments on fish populations and the natural environment.

Ecosystem Services

Ecosystem services are defined as the benefits that humans receive from the natural processes and functioning of ecosystems. Humans use and receive value from ecosystem services in diverse ways. Some values generated by ecosystem services are directly tied to market activity, such as human use of timber, raw materials, food, and fuel. Other values generated by ecosystem services may be only indirectly tied to market activity or may not have any ties to market activity. Values of goods and services that fall outside of market activity are called non-market values by economists. Due to a lack of associated market activity, the non-market values of ecosystem services can be extremely difficult to quantify and monetize. De Groot et al. (2010) discuss the main challenges in quantifying the relationship between an ecosystem, its processes, and the subsequent services that generate value to humans. These difficulties include quantifying associated functions performed by ecosystems, benchmarking the capacity of ecosystem services, evaluating maximum sustainable use levels, incorporating the effects of dynamic conditions on ecosystem services, and incorporating critical threshold levels (De Groot et al. 2010).

Economists that seek to quantify and monetize the value of ecosystem services have developed a classification scheme for the values that these services provide. At the highest level, the values attributed to ecosystem services can be described as use or non-use values. Within the set of use values, the most straightforward way in which ecosystem services provide economic value is through direct human use of these services. Some direct uses of ecosystem services involve human consumption, such as harvesting timber and other forest products, food, and fuel. Other direct uses, such as viewing wildlife, hiking, and enjoying scenic vistas, do not involve actual consumption (and are thus called non-consumptive uses).

Human beings also can use ecosystem services indirectly, which occurs when an ecosystem service is an input to something else that is directly used by people. One example of indirect use is the provision of habitat for plants and animal species then used by people, either consumptively or non-consumptively. Other examples of indirect use of ecosystem services include the regulation of water flow, waste assimilation, and climate regulation (i.e., carbon storage and sequestration).

In addition to current use of ecosystem services, people can benefit from (and therefore place a value on) the knowledge that they can use a good or service in the future, which is called option value. One example of option value is the value an individual might place on a wilderness area they hope to visit in the future or the value they place on a species of bird they hope to someday view.

Another way in which ecosystem services generate societal value is through non-use values, which do not involve any actual direct or indirect use. One type of non-use value is existence value, which is the value people place on the knowledge that a particular good exists, even if they have no plans to personally use it. For example, individuals might place a value on the protection of endangered species, natural areas such as old-growth forests, or unique natural areas, even apart from their expected use of those species or areas. Similarly, bequest value refers to the value individuals might place on knowing that a good or service would be available for use by future generations, distinct from their own personal use.

Although the concept of ecosystem services is decades old, a coordinated effort in 2001 by the United Nations launched the Millennium Ecosystem Assessment, an effort designed to meet the needs of decision-makers and the public for scientific information concerning ecosystem change for human well-being and options for responding to those changes. The Millennium Ecosystem Assessment focuses on the benefits people obtain from natural systems; it synthesizes information from the scientific literature, data sets, and scientific models and includes knowledge held by the private sector, practitioners, local communities, and indigenous peoples. The effort took 4 years and involved 1,360 experts in 95 countries in a rigorous peer review. The Millennium Ecosystem Assessment has been adopted internationally and by several federal resource agencies in the United States (Millennium Ecosystem Assessment 2005). Through this study, four main categories of ecosystem services emerged:

- *Provisioning services* provide products that are used directly by people. Examples include food, fuel, fiber, genetic resources, biochemical resources, ornamental resources, and fresh water.
- *Supporting services* are processes necessary for the production of other ecosystem services. Examples include biodiversity, soil formation, primary production, nutrient cycling, water cycling, and photosynthesis.
- *Regulating services* are outputs from the normal functioning of ecosystems that benefit people in direct ways. Examples include regulation of air quality, regulation of climate, water flow, water quality, natural hazards, pests, disease, erosion, and pollination.
- *Cultural services* provide non-material benefits to people through meaningful experiences. Examples include education, cultural heritage, recreation and tourism, aesthetic value, and spiritual enrichment.

Potential Economic Effects of Ecosystem Services

Benefits of some categories of ecosystem services can be difficult to quantify, especially as they pertain to specialized resource such as individual fish species. Using information in the SED, this master response explains the potential ecosystem benefits under the four main categories in response to comments that ecosystem benefits were not quantified or that the plan amendments, primarily the LSJR flow objectives, have little to no economic benefits, only costs. Many of the benefits identified in Chapter 20 and associated with ecosystem services can be viewed in terms of avoided costs, which is the analytical framework used in Chapter 20. However, as described in Section 20.3.5, *Effects on Fisheries and Associated Regional Economies*, improved flow conditions are expected to result in benefits to many native fish, plant, and animal species. It is not possible, however, to fully quantify and monetize these benefits due to a lack of data and, in particular, limited information on the potential effects on native species. Furthermore, consistent with both Master Response 8.0, *Economic Analyses Framework and Assessment Tools*, and Chapter 20, the discussion in this master response should not be interpreted as an attempt to quantify all costs and benefits of the plan amendments. While the topic-specific analyses include certain analytical components common to each discussion (e.g., evaluation of potential effects on the regional economy), it is not possible to determine overall net benefits of a particular LSJR alternative. The topics analyzed in Chapter 20 and discussed here require site-specific information (such as estimates of physical impacts on a corresponding resource topic) that is either highly variable or difficult to quantify adequately, thereby precluding determining a net benefit.

Provisioning Services

The direct use of resources by people drives the values generated by provisioning services. The direct use by humans of fish, agriculture output, and fiber for food and freshwater for storage and retention for different uses are all components of the provisioning services that are offered by both the freshwater ecosystem (i.e., each of the three eastside tributaries) and the marine ecosystem (i.e., the coast and Pacific Ocean).

Holmlund and Hammer describe demand-driven ecosystem services as services formed by humans to serve human values and demands. Food production is an important provisioning service provided by fish populations (Holmlund and Hammer 1999). The benefits of the plan amendments and the resulting effects on the regional economy are realized in part through support for, and benefits to, commercial fishing markets in the marine system. As cited in Chapter 20, Table 20.2-4 (*Summary of Average Annual Cost and Beneficial Effects of LSJR Alternatives 2, 3, 4, Relative to Baseline Conditions: Fisheries and Related Economics*), when fisheries were closed in 2008 and 2009, the costs related to these closures were estimated at $255 million to $290 million annually. As cited in Table 20.3.5-1 (*California Commercial Troll Chinook Salmon Landings (in number of fish) and Prices by Catch Area, 1976-2014*), statewide catches peaked in 1988 at over 1.3 million. The state has not since had a year with even half as many catches as 1988, with the number of catches bottoming out in 2010 at 15,000, excluding 2008 and 2009 when the fisheries were closed. The total value of catches is estimated at $6,098,668 in 1988, as compared to $88,416 in 2010 (both values in 2014 dollars). The state estimated that 4,200 jobs were lost because of the fishery closures in 2008 and 2009, resulting in economic hardships for local residents. These losses represent real dollars in provisioning services, and the plan amendments would be expected to result in positive benefits to the marine system with respect to commercial fishing.

The benefits of the plan amendments and the resulting effects on the local economy are realized in part through sport and recreational fishing, which is another part of provisioning services, to the extent that people directly eat the fish because of these activities. These activities also support cultural services to the extent that people are solely catching fish for recreation without the intent of eating them. As cited in Table 20.3.6-1 (*Estimated Use (in Visitor Days) of Affected Recreation Areas, by Watershed*), an average of 5,200 angler days were recorded for the Lower Stanislaus River in 1999 and 2000, 34,900 angler days were recorded for the Lower Tuolumne River in 2000, and annual sport fishing activity on the LSJR is approximated at 57,500 angler days. The study cited in Table 20.3.6-1 estimated that 51 percent of these angler visitor use days were for local residents. One study cited by the SED (Michael 2010) estimated that the 2008 and 2009 fishery closures resulted in a loss of $70.5 million in income to the local economy from out-of-state anglers alone. These losses represent real dollars that support the provisioning services, and the plan amendments would be expected to result in positive benefits to the freshwater systems with respect to sport and recreational fishing.

Food production and pasturing would be affected by the plan amendments. Cultivated agriculture generally reduces the value of ecosystem regulating and supporting services. Additionally, in some instances, cultivated agriculture can harm ecosystems because the cultivation functions within a highly altered system that has a negative effect on terrestrial and aquatic species and biodiversity in general. Human beings, however, directly use the products provided by agriculture, and these areas thus provide substantial provisioning service values. As disclosed in Chapter 20 and Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results,* the plan amendment's effects on agriculture would include decreases in the overall annual average revenue (direct use value) generated, but may also increase the indirect use and non-use values. Table 20.2-1, *Summary of Average Annual Cost and Beneficial Effects of LSJR Alternatives 2, 3, and 4, Relative to Baseline Conditions: Agricultural Production and Related Economics*, identifies an expected average annual reduction of $39 million related to crop revenues and an annual average reduction of $69 million in the regional economy for LSJR Alternative 3. Appendix G, Table G.4-8, *Baseline Statistics for Annual Agricultural Revenue in the Irrigation Districts based on SWAP Results and the Change in those Statistics for each of the LSJR Alternatives*, provides a full summary of expected reductions in crop revenues, which range from $0 to $149 million for LSJR Alternative 3. Figure G.5-1. *Exceedance Plot of Total Economic Output Related to Agricultural Production in the Irrigation Districts for the LSJR Alternatives and Baseline across 82 Years of Simulation*, shows the range of reduction in revenue for LSJR Alternative 3.

Finally, the storage and retention of water for different uses including domestic, municipal, industrial, and energy, is a direct use by humans of fresh water and considered a provisioning service. As described throughout the SED, changes to these different uses may occur under the plan amendments. These changes could include shifts of these types of uses in the February through June timeframe, or outside of it in the case of energy (Appendix J, *Hydropower and Electric Grid Analysis of Lower San Joaquin River Flow Alternatives* and Chapter 20), or may include a decrease in use for domestic and municipal (Chapter 13, *Service Providers* and Chapter 20).

Supporting Services

The health and resilience of processes necessary for the production of other ecosystem services drives the benefits generated by supporting services. Components of supporting services (but the following may also fall within regulating services) include maintaining, enhancing, and supporting biodiversity; activities such as nutrient cycling and primary productivity; and providing necessary habitat to maintain, enhance support biodiversity and different important ecosystem cycles. All of these are offered by both the freshwater systems (i.e., each of the three eastside tributaries) and the marine ecosystem (i.e., the coast and Pacific Ocean).

Holmlund and Hammer (1999) describe the supporting services provided by fish populations as key to the functioning and resilience of the ecosystem against shifting out of equilibrium conditions. Holmlund and Hammer (1999) also detail how "salmonids cause bioturbation in streams while spawning and thereby create and maintain their own habitats." Additionally, "repeated salmon spawning over many years at the same location can modify the bottom contour and may lead to the formation of persistent bedforms" (Holmlund and Hammer 1999: 257). Holmlund and Hammer (1999) also analyzed ecosystem services generated by fish populations. They described fundamental ecosystem services as those that are indispensable for continued functioning and resilience of the ecosystems, such as water flow regulation, waste treatment and assimilation, and nutrient cycling. Ecosystems rich in biodiversity are generally more productive, robust, and resistant to external shocks than ecosystems whose biodiversity has been compromised. Additionally, biodiversity benefits humans through contributions to security, resiliency, social relations, health, and freedom of choices and actions (Millennium Ecosystem Assessment 2005).

Under the plan amendments, improved habitat conditions are expected to occur in freshwater systems, and enhanced biodiversity can be expected in freshwater and marine systems.

Chapter 19, *Analyses of Benefits to Native Fish Populations from Increased Flow between February 1 and June 30*, Section 19.3.3, *Results of Floodplain Inundation Evaluation* (Tables 19-22 through 19-27) identifies potential benefits associated with the existing floodplain on the three eastside tributaries.

> The improvements to the frequency of floodplain inundation events primarily occur during April, May, and June, although the higher unimpaired flows (40-60%) provide some benefit in February and March. During April through June, most of the unimpaired flows evaluated provide some benefit compared to baseline, with the lower unimpaired flow providing less benefit and the higher unimpaired flows providing greater benefit.

Similarly, Section 19.2, *Temperature*, documents potential benefits associated with temperature, another component of habitat, on the three eastside tributaries, as compared to baseline conditions for different months and different life stages.

Increased life history diversity and population resiliency of Central Valley Chinook salmon and steelhead are expected under the plan amendments. As discussed in Appendix C, *Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives,* and summarized in Master Response 3.1, *Fish Protection*, the restoration of a more natural hydrograph that includes higher and more variable winter and spring flows is recognized as a powerful driver of life history and genetic diversity and other population attributes needed to promote the viability and resilience of anadromous salmonids (McElhany et al. 2000; Moore et al. 2010; Carlson and Satterthwaite 2011). This is supported by recent studies on the Stanislaus River that show the importance of the natural flow regime in increasing survival, growth, and variable migration strategies of juvenile salmon, and the importance of these attributes in supporting long-term population persistence and viability (Zeug et al. 2014; Miller et al. 2010; Sturrock et al. 2015). In addition, potential benefits to native fish populations such as Chinook salmon would be expected at spatial scales that extend beyond the plan area. For example, there is the potential to improve resiliency and stability of Central Valley Chinook salmon populations as a whole by increasing the contributions of San Joaquin River (SJR) fish populations (Carlson and Satterthwaite 2011). In addition to the indicator species (fall-run Chinook salmon and steelhead), positive responses to a more natural flow regime characterized by higher spring flows and cooler water temperatures have been shown for a number of native fish species, including species of the rainbow trout assemblage, California roach assemblage, and pikeminnow-hardhead-sucker assemblage (Marchetti and Moyle 2001; Brown and Ford 2002; Kiernan et al. 2012). (See Chapter 7, *Aquatic Biological Resources*, Section 7.2.1, *Fish Species*, for a description of native fish species.)

Non-Flow Measures Relationship to Supporting Services

The use of non-flow measures can provide direct benefits to supporting services. The State Water Board recognizes that recommended non-flow measures have a role in comprehensive adaptive implementation of the Delta ecosystem; however, it also acknowledges that it cannot now mandate non-flow measures (Master Response 1.1, *General Comments,* and Master Response 5.2, *Incorporation of Non-Flow Measures*). When non-flow measures are implemented in combination with LSJR flow objectives, they can provide joint benefits that exceed the benefits derived from flow or non-flow measures individually. As described in Master Response 5.2, non-flow measures, in most cases, depend on sufficient flow for successful implementation, and benefits would not accrue from non-flow measures without additional flow. For example, depending on site-specific conditions, in general, gravel augmentation as a non-flow measure would not provide benefits to aquatic species unless there is also an increase in flows.

Non-flow measures such a floodplain and riparian habitat restoration would be expected to restore and enhance habitat to benefit aquatic and terrestrial biological resources and would be expected to provide benefits to supporting services, such as habitat, biodiversity, nutrient cycling, and primary productivity. For example, Jeffres, Opperman, & Moyle (2008) found that ephemeral floodplain habitats support high growth rates for juvenile Chinook salmon. Additional benefits include improved aesthetics, long-term beneficial effects for sensitive aquatic and terrestrial species, and improved hydrology and water quality. In addition, habitat complexity improves ability of juvenile Chinook salmon in floodplain to find optimal rearing locations under different flow conditions (Jeffres, Opperman, & Moyle 2008). The non-flow measure of gravel augmentation yields long-term benefits to Chinook salmon and steelhead spawning habitats, as well as improved habitat for other wildlife species. Merz & Chan (2005) find that, "cleaned gravels from adjacent floodplain materials, used to enhance salmonid spawning sites, are quickly incorporated into the stream ecosystem, benefiting benthic macroinvertebrate densities and dry biomass." Additional benefits derived from gravel augmentation include improved aesthetics due to the enhanced gravel habitat and movement in the channel. Finally, Millidine, Armstrong, & Metcalfe (2006) conclude that the presence of appropriate shelter for salmonids reduces the risk of predation, which, in turn, is likely to improve growth performance for salmonids. The benefits of active habitat restoration described by the cited studies would be expected to increase when coupled with the benefits of floodplain and temperature associated with plan amendments described in Chapter 19. This would contribute to the overall benefit of the supporting service. If non-flow measures are not performed in conjunction with the LSJR flow objectives, the joint benefits would not necessarily be realized.

Regulating Services

The direct use of outputs from the normal functioning of ecosystems that benefit people drives the values generated by regulating services. Components include water flow regulations, waste processing, and natural hazard regulation, and all of these are offered by the freshwater systems. These components are generally provided by the existing regulation of the three eastside tributaries.

Holmlund and Hammer (1999) describe the regulating services associated with fish populations. For example, fish communities can regulate the carbon-fixing capacity of nutrient-rich bodies of water and can thus temper changes in carbon levels in the water and atmosphere. Additionally, feeding patterns can influence the availability of nutrients due to the mineralization of nitrogen and phosphorus through excretion and defecation. This makes nutrients available for primary production. These types of benefits associated with regulating services would be expected under the plan amendments as fish populations experience the benefits described in the supporting services section (e.g., habitat and nutrient cycling). In addition to these types of benefits, it would be expected that some increase in waste processing would occur under the plan amendments, given the change in a pollutant concentration would be the inverse of the change in flow (flow ratio) as described in Impact WQ-3 in Chapter 5, *Surface Hydrology and Water Quality*. For each of the three eastside tributaries and the LSJR, low and median flows generally would increase with LSJR Alternative 3 (Tables 5-17a through 5-17d) and generally would reduce concentrations of pollutants, and flow would still be much higher than baseline summer median flows.

As described throughout the SED, water would continue to be regulated by rim reservoirs and diversions. The plan amendments would affirmatively support and provide stream flows from February through June for the reasonable protection of fish and wildlife. This would be a benefit in regulating services and their interaction with supporting and provisioning services as they relate to fish populations. The plan amendments would not alter the flood control or storm management capabilities or abilities of the three eastside rivers or the LSJR as described in Impact FLO-2 in Chapter 6, *Flooding, Sediment, and Erosion*: "Substantial alterations of the existing drainage patterns would not occur and would not result in flooding. Consequently, people or structures would not be exposed to a significant risk of loss, injury, or death involving flooding."

Cultural Services

Cultural services arise from the use of ecosystems by people for meaningful experiences such as recreation, aesthetic appreciation, education, and spiritual enrichment. The components of cultural services are non-material benefits derived from ecosystems and all of these are offered by the freshwater systems. As described by Holmlund and Hammer (1999), fish populations contribute to recreational values through sport fishing. Fish populations also contribute to aesthetic values through salmon spawning and the tourism driven in part by salmon runs. Additionally, in the long-term, evolving genetic diversity contributes to continued resilient fish populations. The plan amendments are expected to result in an increased contribution from and benefit to science and education through the provisions of Appendix K, *Revised Water Quality Control Plan,* including the development of the Stanislaus, Tuolumne, and Merced Rivers Working Group (STM Working Group), the use of adaptive implementation, and the establishment of the San Joaquin River Monitoring and Evaluation Program. The plan amendments are also expected to result in an increase in river sport and recreation fishing as described in *Provisioning Services*.

Non-Use Values and Cultural Services

In addition to the benefits that result from the direct and indirect use of ecosystem services, another category of ecosystem service benefits, non-use values, is generated even in the absence of direct or indirect use of ecosystem services. Because non-use values do not involve any actual use, they are not reflected in any market data and can only be estimated through public opinion surveys aimed at measuring the willingness of individuals to pay for changes in the level of provision of ecosystem services. However, non-use values contribute to cultural services because they contribute to meaningful experiences by people, even if those people never physically experience an actual service but just know they exist or may be available for a possible future experience. Because there is limited data on recovering Chinook salmon in the SJR Watershed, no studies have estimated non-use values in the SJR Watershed. In Chapter 20, Table 20.3.5-3 (*Existing Studies that Estimate the Non-Use Monetary Benefits Associated with Restoring Salmon Populations, as Measured by the Public's Willingness to Pay*), however, identifies four studies that estimated the benefits of comparable salmon restoration programs (Jones & Stokes Associates 1990; Olsen et al. 1991; Loomis 1996; RTI International 2012). An average of the values estimated by each of the four studies results in an estimate of just over $115 (in 2012 dollars) annually per household in non-use values associated with restoring salmon populations. In addition to the benefits resulting from improved salmon populations, additional benefits are generated from improved salmon habitat, such as benefits to other native species.

Municipal Economic Effects

Some commenters were concerned about potential increased costs to municipalities in the plan area, including potential financial effects resulting from changes in supply uncertainty, delays in construction of water supply infrastructure, other changes in water supply planning, potential effects on water rates, and potential effects on growth and economic development, primarily as a result of the LSJR flow objectives. As identified in Chapter 20 and in Master Response 1.1, *General Comments*, the analysis in the SED is necessarily programmatic because the State Water Board is undergoing a water quality control planning process to establish objectives. The State Water Board appropriately used examples and information to evaluate potential economic effects associated with municipalities in Chapter 20 based on impact determinations in the SED (e.g., Chapter 13, *Service Providers*). The State Water Board acknowledges each municipality's circumstances are different, unique, and complex and these factors would contribute to the different options available to the municipality under plan amendment conditions. This section responds to comments regarding potential economic effects within the plan area as they relate to municipal water supplies and the information presented in Chapter 20. As discussed in the next section and in Section 20.3.3, *Effects on Municipal and Industrial Water Supplies and Affected Regional Economies, Potential Effects of LSJR Alternatives*, water service providers facing a reduction in surface water supply may need to pursue alternate supplies that could require additional infrastructure. However, these options, to include expanding groundwater wells, recycling water, or entering water exchange or transfer agreements, may already be components of their planning for future water needs. Based on statewide and regional data, it is unreasonable to conclude the plan amendments would result in a loss of economic growth.

Water Supply Uncertainty and Potential Effects on Infrastructure Planning

Multiple commenters asserted that their efforts to increase their surface water treatment capacity by expanding existing water treatment plants or building new plants (thereby decreasing reliance on groundwater as a source of drinking water) and the associated investment would be wasted because the plan amendments would reduce surface water diversions.

Water for communities and their residents is typically provided by urban water agencies or suppliers. Urban water suppliers are generally responsible for everything from acquiring and developing water supply, creating and managing water storage and conveyance systems, treating water, constructing and maintaining pipelines and distribution infrastructure, and planning for and implementing systems that ensure that water is delivered to customers on an as-needed, uninterrupted, and on-demand basis. The service they provide essentially guarantees firm water is available regardless of weather conditions, hydrologic cycle, or presence of drought.

Urban water suppliers typically minimize risk and ensure reliability of supply by engaging in water supply portfolio strategies, which has several economic implications for urban water suppliers. The portfolio strategy is focused on creating a reserve of multiple sources of water supply—stored surface water, groundwater wells, water recycling, conservation, and exchanges for water—that provides reliability while avoiding risk associated with dependence on one or a few sources of water. A diversified portfolio means that if one supply source is reduced, other sources can be used as replacements, and consumers see no reduction in service. In addition, developing a portfolio of sources means that a temporary reduction in one supply source is more easily managed by other sources. Using the portfolio approach, urban water suppliers plan for an oversupply of water, essentially a reserve of water from all sources available to the supplier that, in sum, exceeds the community needs at any point in time. Ensuring that supplies are always available to consumers requires investment in infrastructure (for example, reservoirs and groundwater wells) that may not always be fully utilized. Nevertheless, capital costs must still be paid and are reflected in water rates charged to customers.

Demand for water, projections of future population growth, and reductions in per capita water use, all factor into the portfolio determination. This can be important in circumstances when the growth projections are not realized (i.e., slower growth than projected). However, a service provider makes infrastructure commitments or water purchase agreements that result in excess capacity even beyond drought protection needs. In these cases, the capital costs remain even when the facilities are underutilized.

With a portfolio of water sources, urban water suppliers can strategically manage their supplies, not on a proportional share basis, but one that follows municipality-determined supply objectives. For example, the City of Stockton states that, "in normal years the City's objective is to minimize the use of groundwater and maximize the use of surface water as part of their conjunctive use program" (Stockton 2016). Subject to overarching objectives, water purveyors then rely on using the least expensive, most cost-effective water sources first. In general, this means that local sources would be used (within seasonal limits) before imported supplies that must account for transit and possibly higher base contract costs. A well-diversified portfolio provides an urban provider with a basic supply and built-in backup supplies, and the utilization of this portfolio is not on a proportional-share basis but a strategic basis, considering all of its sources.

By law, urban water suppliers are required to prepare an urban water management plan (UWMP) every 5 years, according to the Urban Water Management Plan Act of 1983, as amended by the Water Conservation Act of 2009. Required elements include a report on the progress that urban water suppliers are making in meeting their water use targets, current and projected water demands (20 years in the future), current and projected water sources, water management actions to improve supply reliability, and an evaluation of the sufficiency of supplies to meet the forecasted demands under both normal and drought conditions (DWR 2017: 1–2). With its requisite analysis of water supply and demand, the plan provides an opportunity for urban water suppliers to increase consideration of multiple water supplies, including recycled water, desalinated water, and water from stormwater capture. When necessary or advantageous, water providers also enter into contracts and agreements with other water wholesalers, irrigation districts, or municipalities to exchange water. The analysis also considers demand management measures to manage water more effectively (DWR 2017: 2). In general, the UWMPs that have been filed with the California Department of Water Resources (DWR) from the plan area demonstrate a more than adequate secured supply to meet future anticipated demand, combined with a strategic plan for developing new supplies as needed. For example, the City of Stockton plans to expand its Delta Water Supply Program water capacity by 2035 (City of Stockton 2016); the City of Turlock plans to expand groundwater and recycled water use to meet future needs (City of Turlock 2016); the City of Merced intends to pursue groundwater recharge projects to meet future demands (City of Merced 2017), and the City of Modesto plans to maximize the use of available and treated surface water, expansion of groundwater wells, and possible use of aquifer storage and recovery (Modesto 2016).

Market transfers of water entitlements are an increasingly important component for urban water providers. California law allows for water transfers under a variety of transaction structures and encourages transfers as a water management tool. In addition, the state's extensive network of water conveyance infrastructure developed through state, federal, and locally funded projects, most notably the Central Valley Project (CVP) and State Water Project (SWP), is used to facilitate transfers. There are, however, policy and sometimes infrastructure limitations on transfers that may affect the ability for a transfer to proceed. For example, some irrigation districts have internal policies against transferring water to municipal uses. Water is most commonly transferred through single-year (spot-market) and multi-year leases. Permanent transfers also take place, but do so infrequently.

Urban water suppliers that receive and use water in the plan area have different agreements and contracts and they dictate what type of water is delivered, how water is delivered, and how much is delivered. Some of these water suppliers entered into agreements with irrigation districts and began developing infrastructure after the Notice of Preparation was released for the plan amendments (2009 and 2011). The City of Modesto completed Phase II of the Modesto Regional Water Treatment Plant in 2015, which doubled the city's water treatment capacity. The treatment plant treats water purchased from the Modesto Irrigation District (MID). Per the Amended and Restated Treatment and Delivery Agreement between MID and the City of Modesto (October 11, 2005), if MID is required to reduce deliveries, it would cut back its deliveries to its agricultural customers and to the City of Modesto in equal proportions. There is a renegotiation clause, and the contract acknowledges that there could be regulatory changes. However, according to the City of Modesto Urban Water Management Plan, MID would continue to rely on and expand groundwater and surface water resources, and the need for a surface water treatment plant would remain in order to serve its service area (City of Modesto 2016). A renegotiation of the terms of the City's contract with MID may be needed if the timing of the surface water supply changes. The Cities of Turlock and Ceres formed the Stanislaus Regional Water Authority (SRWA) in 2011 and plan to develop a surface water supply project in partnership with the Turlock Irrigation District (TID). Similar to the City of Modesto, the City of Turlock is pursuing the surface water project as an additional future supply source to offset potential constraints on groundwater. In July 2015, SRWA entered into a water sales agreement with TID to provide the terms and conditions under which TID would sell and deliver transfer water to SRWA. Under this agreement, "if at any time before or during a Year the District decides it is necessary to reduce deliveries, it will cut back its deliveries to its agricultural customers and to SRWA in equal proportions" (Water Sales Agreement between TID and SRWA, July 2015). The surface water supply project is planned to be operational in 2022. The City of Turlock claimed that preliminary estimates of the water treatment project would be $200 million and that TID indicated that they would lack an adequate supply of Tuolumne River water to make the SRWA's drinking water project viable, possibly necessitating a renegotiation of terms.

If the supply of water to urban water suppliers was reduced because of implementing the plan amendments, service providers would pursue or adjust other components of their water portfolio. For example, the City of Merced relies entirely upon groundwater from 20 wells for municipal service and plans to add wells in the future but is also planning to acquire raw surface water from MID and to seek conjunctive use of surface and groundwater (City of Merced 2017). The City may also choose to enter into a new water purchasing agreement with irrigation districts or purchase or lease water from other entities. It is reasonable that the water would be sold at a higher price per unit volume relative to the existing agreement; this possibility was indicated in Section 20.3.3, *Effects on Municipal and Industrial Water Supplies and Affected Regional Economies*. If the price is high enough, it would be more profitable for growers to sell the water to a service provider than to use the water to grow a crop. The revenue from certain crops per acre-foot of water used would be lower than the revenue from selling the same volume of water directly to the service provider. Nothing in the above-mentioned agreements restricts or prohibits cities' rights to acquire from third parties and/or exercise water rights in addition to or apart from those enumerated in the agreements. As noted in Section 20.3.3, adjustments may be necessary in the infrastructure plan, its buildout timing, or the terms of agreement.

Whether the water source is a local surface supply or exchanged water from a third-party provider or irrigation district, the water would undergo treatment in a plant before being delivered to customers. If water supplies from one source are reduced as a result of the plan amendments, it is incumbent on the water provider (or municipality) to adjust their portfolio or, if necessary, locate replacement supplies; the replacement supply would also be treated before delivery. Water purchase agreements, or market transfers of water entitlements, between municipalities and other water users, typically irrigation districts, have increased in importance as a source of replacement water for municipalities. California law allows for water transfers under a variety of transaction structures and encourages transfers as a water management tool. In addition, the state's extensive network of water conveyance infrastructure developed through state, federal, and locally funded projects, most notably the CVP and SWP, is used to facilitate water transfers.

The planning and construction associated with any new or expanded treatment plant is based on the *demand*, or anticipated demand, for water in the provider's service area. Therefore, there is no reason to assume that a change in supply from one source, replaced by another source, should affect the needs or capacity for treatment. The level or type of treatment required may vary depending upon water supply source. However, the overall infrastructure planning effort for water providers should remain essentially unaffected by the plan amendments.

As identified in Master Response 2.1, *Amendments to the Water Quality Control Plan*, Master Response 3.6, *Service Providers*, and Appendix K, *Revised Water Quality Control Plan*, the program of implementation provides that the State Water Board will take actions as necessary to ensure that the LSJR flow objectives do not affect water supplies for minimum health and safety needs, particularly during droughts.

Water Rates and Fiscal Effects

Some commenters asserted municipal water rates would increase or change, or ratepayers would be affected by the plan amendments. Most commenters associated a change, or increase in rates, with potential effects on infrastructure planning (discussed above). To the extent commenters asserted rate changes associated with disadvantaged communities or financial conditions of disadvantaged communities, please see Master Response 2.7, *Disadvantaged Communities*, for a discussion of assistance programs and funding sources. As described in Chapter 20, Section 20.3.3, *Effects on Municipal and Industrial Water Supplies and Affected Regional Economies, M&I Water Supply Conditions in the Plan Area and Potential Water District and Ratepayer Effects*, service areas that substantially rely on surface water diversions from the eastside tributaries, and where current rates do not account for unexpected capital costs, would likely be the service providers most affected by the additional costs of replacing lost surface water supplies. Over the long term, most districts would be expected to recover most, if not all, capital costs through rate adjustments. As highlighted by the differences in sources of water, types of uses, and water rates for the three example water providers characterized in Chapter 20 and in Chapter 13, *Service Providers*, each service provider in the plan area has its own unique set of circumstances (e.g., institutional constraints affected by user types, rate structures, need for new facilities) within which it can react to reduced surface water supplies.

As established by state law, the intent of regularly updating water management plans is to provide districts with an opportunity to consider how changes in supply and demand conditions potentially affect each district and its ratepayers.

As described in the section entitled *Water Supply Uncertainty and Potential Effects on Infrastructure Planning*, water suppliers are required to prepare UWMPs every 5 years. Through this effort, water suppliers can provide reliability while avoiding risk associated with dependence on one or a few sources of water. Water providers are required to demonstrate via the Urban Water Management Plan Act that they have strategies and resources in place to address current and future water needs.

Water providers are generally responsible for everything from acquiring water supply, managing storage and conveyance systems, treating water, maintaining distribution infrastructure, and planning. In general, water rates charged by providers are derived through an accounting of all of these components, including the amortized cost of the water apparatus and daily operation. In this way, the water rates charged already account for the portfolio of water supplies, as well as the cost of conservation incentives and programs. Municipalities and urban water providers typically develop a water management plan that provides details of the water infrastructure and facilities, their condition and maintenance requirements, projects in development, and future needs. The plan also includes budgeting information and requirements for capital improvements. This may include, for example, a water treatment plant expansion. Periodically, the municipality initiates a water rate study that incorporates current and anticipated cost information into a set of cost-of-service estimates and, ultimately, recommended water rates to provide sufficient revenues to cover the costs.

As a plan area example, the City of Merced relies almost entirely on groundwater wells, plus a planned agreement with MID for 4,000 acre-feet of surface water. The cost of this agreement, and for the proposed surface water treatment plant, is already in the future accounting for its rate structure and would be so regardless of the plan amendments. In the case of the City of Modesto, its agreement for increased levels of surface water acquired from MID may involve costs that are already (or will be) built into its rate structure. The City of Turlock (and the SRWA) faces a similar circumstance in its agreement to acquire surface water from TID and with its plan for a water treatment plant. If the plan amendments result in revisions to the timing of the water acquisition, the City may require a renegotiation of the specific terms, with accompanying changes in rates to customers.

The plan amendments could reduce firm water supply for providers, as noted in Chapter 20, Section 20.3.3, Effects on Municipal and Industrial Water Supplies and Affected Regional Economies, Potential Effects of the LSJR Alternatives, Potential Ratepayer Effects. This could cause providers to adjust their planning and require revisions to their water supply portfolios, including instituting new efforts to develop or acquire additional sources of water. However, the planning mechanism is already in place to ensure replacement water can be transitioned into their operations. At the beginning of the plan amendment implementation, the plan may require greater reliance on other supplies within each provider's portfolio as additional water supplies are sought, for example, through water exchange agreements. The plan may require sooner implementation of plans to develop new water supplies, such as water recycling programs. However, the plan amendments would be implemented over a period of time that would allow water providers to make and plan for adjustments in their portfolio and conservation actions, including possible water acquisition, such that water rationing—a short-term strategy associated with droughts identified in many UWMPs—should not be necessary.

In summary, water rates in place may already account for many of the components of addressing and implementing the plan amendments in terms of existing supplies in the portfolio and water conservation efforts. If new acquisitions involve water exchange agreements, water rates charged to customers may be sufficient to cover the cost of the replacement water within the plan area. If new infrastructure, such as a recycled water facility or new well, is required, this would be absorbed by the provider's overall water infrastructure financing plan, which may require some increase in water rates. However, the rate change should reflect only the portion of impact on the entire portfolio cost.

Growth and Economic Development

Several commenters expressed concern that the plan amendments would curtail or hinder growth and economic development in communities and even lead to urban decay in the plan area. Although adequate water supply is, of course, vital to community sustenance and economic development, a reduction in one source does not necessarily provide a barrier to growth or a cause for urban decay.

Water is a scarce resource in nearly all of California, subject to multiple and often competing demands for agriculture, municipalities, and environmental uses. Although the state has an extensive and sophisticated water storage and distribution system, the supply of water is essentially fixed. However, California's economy has managed to expand and remain vibrant despite periodic droughts and high, sustained population growth. This is due in large part to management and technological innovations in water use efficiency, creation of water markets, use of underground storage, and developments for recycling of wastewater. Over time, water use per capita has declined while gross domestic product (GDP) in the state has increased (Figure 8.4-1) (PPIC 2012). According to a 2012 study by the Public Policy Institute of California (PPIC), "California's real economy has grown, even though total business and residential water use appears to have flattened since the early 1980s. Over the past four decades, per capita water use has been halved, while real per capita GDP has doubled. Each unit of water now generates more than four times more economic value than it did in 1967" (PPIC 2012: 5-6). The same study notes that urban water use efficiency is increasing, and urban per capita use fell an estimated 25 percent between 1995 and 2005 and continues to decline as urban water utilities encourage conservation (PPIC 2012: 6).

Even with the decreased water use and increased efficiency, the experience of the recent drought has resulted in even greater reductions in water use. In spring 2015, Governor Jerry Brown asked for a statewide cut of 25 percent, with specific targets given to every water agency. Nearly every agency met or exceeded the goals. This indicated an ability of consumers to adapt to substantially reduced water supply conditions consistent with a long-term drought. Furthermore, economic conditions within the three counties (Merced, San Joaquin, and Stanislaus) of the plan area were not negatively affected by the recent sustained drought. In fact, as indicated in Table 8.4-1, all three counties experienced steady and sustained growth from 2011 through 2016, as indicated by total taxable sales, personal income, and unemployment rate. This indicates that water supply is only one variable among many that influence growth and development in the plan area and in California in general. There are many external factors—personal, local, and global—that affect economic outcomes (Master Response 8.0, *Economic Analyses Framework and Assessment Tools*), and managing for water supply through a combination of planning, infrastructure, and establishment of a supply portfolio can both maintain on-demand service to customers and eliminate water availability as a barrier to growth.

Table 8.4-1. Economic Indicators for Merced, San Joaquin, and Stanislaus Counties, 2011–2016

Year	Total Sales (billions)	Personal Income (billions)	Unemployment Rate (%)	Total Sales (billions)	Personal Income (billions)	Unemployment Rate (%)	Total Sales (billions)	Personal Income (billions)	Unemployment Rate (%)
2011	$2.4	$7.9	17.7	$8.4	$22.4	16.2	$6.7	$17.2	16.5
2012	$2.5	$8.1	16.3	$9.0	$23.5	14.4	$7.2	$17.9	14.9
2013	$2.7	$8.7	14.5	$9.5	$34.5	12.4	$7.6	$18.5	12.9
2014	$2.8	$9.2	12.8	$10.0	$25.9	10.7	$7.9	$19.9	11.2
2015	$3.0	$9.7	11.3	$10.5	$27.2	8.9	$8.2	$21.2	9.5
2016	$3.0	$9.8	10.5	$11.1	$28.8	8.1	$8.7	$22.2	8.5

Source: Caltrans 2017.

While many municipalities and water supply agencies acknowledge that drought would encourage conservation by residential customers, they often question whether consumers are willing to accept reduced water use on a more permanent basis. This condition is referred to as *demand hardening*, whereby implementing long-term conservation measures means that it becomes increasingly difficult for a utility to induce further reductions in water use during times of drought (Howe and Goemans 2007). Although its prevalence or extent is not well documented, it has been identified as a potential issue. A recent study conducted a comprehensive, rigorous examination of the issues involved by focusing on the historical shortage experiences of seven water suppliers (four in California) throughout the arid southwestern United States. The authors also conducted a single-family household survey of recent past behavior and willingness to address future shortages. The authors concluded that "all these pieces of evidence suggest that considerable 'willingness' to change behavior still remains in place in spite of large investments in water-use efficiency and in spite of significant declines in per-capita demand" (Alliance for Water Efficiency 2015: iv).

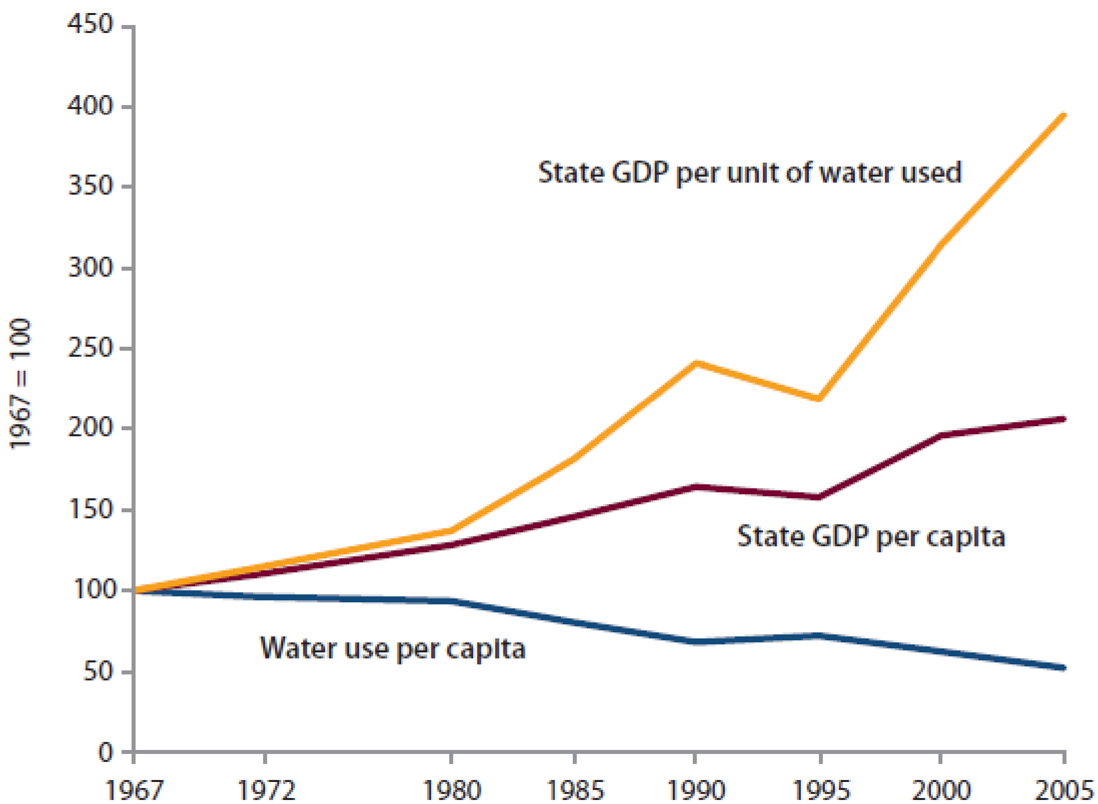

Figure 8.4-1. Water use and California state Gross Domestic Product (GDP) (Source: PPIC 2012).

In California, households account for two-thirds of urban water use and are consequently the target for conservation. Indoor plumbing and appliance improvements yielded the greatest savings in the recent past, but outdoor landscaping represents a "largely untapped reservoir" of savings (PPIC 2012: 6). The key factor in developing increased opportunity for long-term residential savings is for utilities to build a conservation ethic into consumers' lifestyle, combining conservation incentives with education, across a customer base that is found to be interested in saving water (Alliance for Water Efficiency 2015).

Urban water use per capita in California is not directly correlated with economic well-being or economic growth. A variety of factors affect residential per capita water use, including climate characteristics, population growth, population density, socioeconomic measures such as income level and lot size, and water prices (State Water Board 2015). However, a comparison of per capita use across hydrologic region in California demonstrates that water use varies widely by location without being an influence on that area's potential for growth. For example, Table 8.4-2 provides a comparison for August water use by region from 2013 through 2017. Comparisons between Tulare Lake and San Joaquin River, with similar climates, showed a difference of 17 to 40 gallons per capita day each year; comparisons between San Joaquin River and Colorado River show a difference of approximately 50 gallons per capita day each year.

Table 8.4-2. Residential Water Use Hydrologic Region, California, August (2013–2017) (daily gallons per capita per day)

Hydrologic Region	Aug 13	Aug 14	Aug 15	Aug 16	Aug 17
Central Coast	107.3	90.6	76.4	80.2	84.5
Colorado River	243.4	222.1	171.8	195.9	201.7
North Coast	87.3	81.9	75.7	81.6	77.2
North Lahontan	160.9	131.2	117.7	144.0	137.8
Sacramento River	214.8	176.3	147.3	179.9	187.5
San Francisco Bay	103.2	90.7	72.3	82.0	87.6
San Joaquin River	180.7	171.3	131.5	149.5	154.1
South Coast	123.2	112.3	94.8	103.4	105.2
South Lahontan	190.4	178.6	148.3	147.4	149.1
Tulare Lake	224.1	188.9	164.0	187.6	194.3
Statewide r-gpcd	137.7	122.7	102.2	113.8	117.3

Source: State Water Board 2017.
r-gpcd = residential gallons per capita per day

Ultimately, urban water providers can and do take action through planning for growth and water supply to meet those needs. Urban water suppliers minimize risk and ensure reliability of supply by engaging in water supply portfolio strategies. This method is focused on creating a reserve of multiple sources of water supply—stored surface water, groundwater wells, water recycling, conservation, and exchange agreements—that provide reliability while avoiding risk associated with dependence on one or a few sources of water. Through the Urban Water Management Plan Act, municipalities are required to report on the progress that urban water suppliers are making in meeting their water use targets, current and projected water demands, current and projected water sources, and water management actions to improve supply reliability. Municipalities must provide an evaluation of the sufficiency of supplies to meet the forecasted demands under both normal and drought conditions (DWR 2017: 1–2). In this way, municipalities already have the planning mechanism and framework in place to accommodate and address future water needs, and lack of water should not be an impediment to growth.

Effects on Hydropower Generation and Revenues

Multiple commenters stated that the SED did not adequately account for loss of seasonal flexibility of hydropower generation as a result of requiring storage during periods of relatively abundant water and low prices, while reducing ability to generate power when need is high during summer. However, the change in seasonal (and monthly) generation was the primary driver of assessing economic effects in Chapter 20, Section 20.3.4, *Effects on Hydropower Generation Revenues and the Regional Economy*. Multiple commenters also expressed concern that the SED did not account for the relevance of hourly variability in pricing, where daily peaks of power needs could not be met in the late season and especially during drought periods. The comments implied that the selected monthly average rates used in the SED mask the daily price spikes that hydropower can serve. Some commenters suggested that using a price series for energy from 1998 to 2008, as cited and used in the SED, does not sufficiently account for the recent fundamental shifts in renewable energy production, including increased use of solar and wind energy, and their effects on seasonal energy production and prices.

Section 20.3.4 uses data from the hydrology model to estimate monthly changes in water availability for storage and hydropower generation. The estimated change in monthly power generated over the 82-year simulation period is multiplied by an assumed monthly price of hydropower. The monthly price of power in the assessment is conservative: the value at the 80th percentile of average hourly power prices (i.e., the value at which 80 percent of the hourly prices were lower). The price series is obtained from data collected by California Independent System Operators (Cal ISO), an agency that tracks energy prices. Data were available for the period of 1998 through 2008; the monthly price series for the year 2006 was selected as most closely representative of the median for the available period of record.

By using the changes in hydropower generation on a monthly basis for each affected facility, the analysis captures the differences (both upward and downward) in monthly power generation. The monthly volume change is multiplied by the price of power during the same month; the sum total for the year represents the economic effect on hydropower generation. Using the selected monthly price levels, which are generally higher than historical averages, the analysis presents effects that may actually overstate the revenue effect of the different LSJR alternatives on hydropower generation.

More broadly, hydropower generation operates within a rapidly changing energy market. Historically, California has had a high reliance on natural gas with a moderate contribution from hydropower that varied depending upon water year. The use of renewable energy had been minimal but it is gaining in its proportional share of the state's production. In 2013, more than 60 percent of in-state electricity came from fossil fuels, largely natural gas. Other sources, including solar (2 percent), wind (6 percent), biomass, geothermal, and nuclear, together made up 26 percent of the state's electricity. Hydroelectricity provided approximately 12 percent of in-state electricity that year, a low-water year (Gleick 2015). Of course, hydroelectric power generation is seasonal. Production is typically highest in winter and spring months with increased runoff relative to late summer, fall, and early winter, when it decreases because natural runoff is low.

California is several years into its implementation of a renewal energy program (California PUC 2017), one that is designed to encourage growth in renewable forms of energy, especially solar and wind power, and reduced reliance on fossil fuels. California has installed more renewable energy than any other state with 21,800 megawatts of largescale systems operational (CEC 2018). The state continues to rapidly expand solar, including distributed renewable energy systems; the California Energy Commission recently adopted a rule that in 2 years all new homes will be required to have solar power. As renewable energy increases its contribution to the state's power grid, it has an effect on the market and use of other forms of energy production, including hydropower.

Use of the Price Series

The SED uses a price series from 1998 through 2008 because that time series was chosen as the best representative period capturing a range of water conditions and years, for which hourly energy prices are readily available from Cal ISO. Although portfolios differ across this period, the basic principles of the effects on hydropower production remain essentially the same, as demonstrated in the SED. Of note, the month-to-month variations in power prices during the 1998 through 2008 price series, and indeed the selected 2006 representative year, are consistent with the pattern of more contemporary price series. Specific adjustments for a modified energy market reflecting, for example, California's increased but still modest reliance on renewable energy, would have a relatively minimal effect on the precise findings of the analysis while not affecting the main conclusions. In addition, these adjustments would require price forecasting and modeling that is beyond the scope of what is required for the SED. Furthermore, hydropower operates in a changing energy environment and would necessarily have to adapt; the LSJR alternatives evaluated are an additional reflection of this environment, and power companies can and will adjust their planning accordingly.

Potential Loss of Seasonal Flexibility in Power Generation

While hydropower may be affected in terms of seasonal production, these changes are accounted for in the analysis in Chapter 20, *Economic Analyses*. The analysis considers monthly water storage levels and monthly hydropower production quantity. While the LSJR alternatives would generally increase storage during spring months and reduce storage in late summer, the analysis accounts for these changes explicitly in its reporting. Some commenters expressed concern that the loss of flexibility manifests through lower prices in spring, when flows are abundant, and higher prices in summer, when flows are scarce but demand is greatest. However, the prices used in the analysis reflect these seasonal differences, and as such, the analysis does not understate or fail to account for them in estimating economic effects.

A permanent change, as would occur under the plan amendments, allows the hydropower system to make long-term adjustments and plans that responds to storage requirements. Within the California energy market in general, structural changes have taken place and continue to take place in renewable energy markets. With or without the plan amendments, hydropower operators are currently having to, and will in the future, modify their operations to best respond to changing energy demand, competing energy providers, renewables portfolio standard requirements, and fluctuating prices in the evolving energy environment (California PUC 2017). The plan amendments would add an additional element to considerations of power producers, but power producers have always needed and will continue to need to plan and adjust accordingly.

Effects of Hourly Fluctuations in Power Generation

Commenters highlighted and the State Water Board concurred that managing hydropower for optimal pricing requires consideration of many factors. These factors, such as capturing hourly fluctuations in pricing and responding quickly to peak demands are beyond the control of the State Water Board and beyond the ability of the State Water Board to forecast and estimate. Nevertheless, the analysis in Section 20.3.4, using the selected prices, is sufficient to capture the large-scale changes in power generation under the different LSJR alternatives evaluated in the SED.

Peak capturing capability would remain under the LSJR alternatives and would require long-term planning by power producers, as is needed now. The analysis acknowledges the plan amendments would have some effect on peak pricing or capabilities. The selection of a price series in the SED is made considering that prices can and do change hourly. The use of values at the 80th percentile of average hourly prices in the analysis means that within the monthly period, 80 percent of hourly prices were lower than the selected value. At the high-level scale of the analysis, the selected price is likely to account for the peak pricing periods as well as times of the day when prices are lower but hydroelectric power is still being generated. In other words, the analysis accounts for the peak capturing capability of hydropower.

With the inherent complexity of spot markets reflecting specific capacity and demand conditions, the peak pricing market cannot be reasonably or adequately forecasted by the State Water Board, and the actual response by power producers cannot be estimated. As such, marginal peak prices cannot be incorporated. Even without the plan amendments, power producers use complex modeling and analyses of hourly price forecasts on a daily and seasonal basis. The planning and modeling becomes even more complex in light of competition with alternative energy sources, which has effect of changing the pricing conditions facing hydropower producers.

Replacement of Power

Contrary to comments, there do not appear to be additional, unaccounted-for costs to hydropower suppliers due to the need for replacement power. The SED addresses the effects on hydropower facilities, including changes in revenues to hydropower producers. Irrigation districts and their grower-members typically use at least some of generated power at "preference" pricing, and the balance is sold to other customers. If additional power is needed and therefore purchased by irrigation districts, and because members receive discounted pricing for hydropower, or if there is a demand in excess of the hydropower capacity under the plan amendments, quantifying the cost would be speculative for several reasons. First, it is assumed in Chapter 14, *Energy and Greenhouse Gases,* that 100 percent of the replacement power would come from a natural gas facility; however, this may be an overly conservative assumption with respect to sources of electricity generation. This assumption is applied in the SED for several of the resource evaluations (e.g., greenhouse gases). A study of the California drought and hydroelectric power generation identified natural gas as the most likely source of replacement energy for lost hydroelectric power; however, with California's renewables portfolio standard goals in effect, solar, wind, and other forms of low-carbon energy would enter the grid and market over the long term. The quantity of renewable sources would increase, such that power purchases need not be exclusively from natural gas facilities. Second, in order to estimate the cost of replacement power, the replacement sources would need to be identified, the amount of energy that would come from each individual facility that is sourcing the replacement power would need to be determined, and then a determination made of the increase in additional emissions. Third, the incremental change in emissions associated with the plan amendments would result in a potential finding that the facility may (or may not) exceed their emissions allowance. After all of this is determined, the added cost that facility would need to purchase beyond their current emissions cap would need to be calculated and it would need to be determined whether or not it would result in a required rate increase to capture the additional cost.

Finally, a projected cost of replacement power, should it be necessary, is also speculative within the changing energy production environment in California. As mentioned previously, the quantity of renewable sources would increase such that power purchases need not be exclusively from natural gas facilities. Conditions that negatively affect hydropower generation (e.g., less water) are not likely to have a similar effect on other forms of energy production, including wind and solar. These sources may offset lost hydropower production such that overall energy prices may be muted. In other words, energy consumers may or may not see a change in prices.

Recreation-Related Economic Effects

This section addresses comments related to the economic effects of recreation and tourism on the local economy. Some commenters noted that tourism contributes greatly to the local economy in the plan area and extended plan area and expressed general concern that plan amendments, specifically 40 percent of the unimpaired flow, would harm local recreation and tourism activity.

Plan Area

Chapter 20.3.6, *Effects on Recreational Opportunities, Activity, and the Regional Economy*, describes how recreational opportunities can generate economic benefits. The methods described in Chapter 20 used the results from Chapter 10, *Recreational Resources and Aesthetics*, to inform the scope and scale of the economic effects. The methods in Chapter 10 are based on the recreation season (May through September) as well as a more conservative analysis of years that are drier. Therefore, the economic analysis takes into account both potentially lower reservoir conditions under baseline and the LSJR alternatives and conditions that would be expected during the summer recreation period. The economic benefits to recreation identified in Chapter 20 include those realized by the individuals engaging in recreation as well as benefits to the local economy from recreation-related spending by non-residents. Table 20.3.6-1 of the SED (*Estimated Use (in Visitor Days) of Affected Recreation Areas, by Watershed*) describes the baseline recreational use in the plan area as measured by the number visitor days for various activities. Based on Table 20.3.6-1, the three reservoirs together generate 2.4 million annual visitor days, or days spent participating in a recreational activity, and the tributaries generate more than 700,000 annual visitor days. The SED goes on to estimate a baseline level of spending of $43.7 million per year by residents and $52.5 million per year by non-residents. The spending by non-residents provides additional benefits to residents through expenditures by non-residents in the local economy.

Under all LSJR alternatives, including LSJR Alternative 3 (40 percent unimpaired flow), non-fishing recreational opportunities and activities in river recreation areas are expected to see minor changes in non-fishing recreation depending on the tributary and flow alternative; however, the overall non-fishing recreation opportunities would remain relatively unchanged. Non-fishing recreation in the reservoir recreation areas are expected to remain unchanged or slightly decrease under LSJR Alternatives 2, 3, and 4 in the three rim reservoirs. When these effects are considered together, the economic impacts resulting from changes in recreation are expected to be relatively minor in the plan area. Additionally, the river recreation areas would likely see an increase in commercial and sport fishing, especially under LSJR Alternatives 3 and 4. As identified in Chapter 10 and Chapter 20, the types of recreation in river recreation areas may shift; for example, during some periods there might be an increase in boating and kayaking and a decrease in wading. It is not expected, however, that there would be a decrease in the number of river recreationists or any substantial changes in their spending. In terms of recreation at the rim reservoirs, Chapter 10 and Chapter 20 also identify that impacts on recreation are expected to range between no change and a slight but unsubstantial decrease in recreation under the LSJR alternatives. This is because the reservoir access points would generally remaining unaffected.

Extended Plan Area

In-river recreational activities in the extended plan area (i.e., on the stretches of rivers above the three rim dams) are described in Chapter 10, *Recreational Resources and Aesthetics*, Section 10.2.3, *Extended Plan Area*. As described in that chapter (National Wild and Scenic River Systems 2016):

> In-river recreation is typically influenced by the operation of the upstream reservoirs on the Stanislaus and Tuolumne Rivers, similar to the plan area below the three rim dams. For example, the Tuolumne River is well known for some of the most noted whitewater in the high Sierras and is an extremely popular rafting stream below the national park boundary of Yosemite. It is one of the most challenging river runs in California. All private floaters, kayakers, and rafters must obtain permits between May 1 and October 15. Typically, the best floating occurs May through September. However, river flows can be particularly high in the spring, and between the end of the high spring runoff and the beginning of September, the flows on the river are heavily determined by the releases from the Hetch Hetchy Reservoir. Generally flows are high for boaters in the early morning and remain high, and then are reduced to minimum flows in the afternoon. In addition to the in-water activities on the upper Tuolumne River, there are many campsites available to private citizens on a first-come, first-serve basis.

Also described in Section 10.3.3, reservoir-based recreation opportunities exist in the extended plan area on reservoirs generally open to the public. There are at least seven reservoirs upstream of New Melones Reservoir on the Stanislaus River and at least three reservoirs upstream of New Don Pedro Reservoir on the Tuolumne River, all of which provide recreational opportunities. The seven upstream reservoirs on the Stanislaus River vary in size and public access, ranging from 180 to about 2,000 acres in surface area (Martin and Hanson 1966). Additionally, some of the reservoirs, such as Lyons Reservoir, Beardsley Lake, and Lake Alpine, are close to State Route (SR) 4 and SR 108 and thus easily accessible (USDA Forest Service 2018a, 2018b, 2018c). Other reservoirs, such as Donnell Lake, are more difficult to access. Most of the reservoirs provide recreational activities, including camping, hiking, photography, swimming, fishing, and winter sports. The three upstream reservoirs on the Tuolumne River, Cherry Lake, Lake Eleanor, and Hetch Hetchy Reservoir are larger on average and further from neighboring highways. These three reservoirs range in size from 950 to 1,960 acres (Martin and Hanson 1966). The recreational activities offered at these reservoirs also vary. Cherry Lake and Lake Eleanor both offer camping, boating, fishing, swimming, hiking, and wildlife viewing (USDA Forest Service 2018d; AllTrips 2018). Hetch Hetchy Reservoir does not allow boating or swimming in order to help maintain water quality standards. (NPS 2007). Little information is known about the number of people who visit the reservoirs annually, with the exception of Hetch Hetchy, which is the lone reservoir within Yosemite National Park and is 18 miles from the Big Oak Flat Entrance (GoogleMaps 2018).

Reservoir Characteristics and Recreational Opportunities

Reservoirs in the extended plan area support multiple uses, including a range of water-based recreational activities. The recreational uses of reservoirs, in general, and those in the extended plan area, are affected by various reservoir characteristics. These characteristics, also generally discussed in Chapter 10 and presented here, include physical characteristics, water access facilities, water level and recreation opportunities, recreation substitutes, and seasonality.

Physical characteristics, including the contours of a reservoir and slope of a shoreline, greatly influence the range of recreational activities that occur at a given reservoir. For example, a reservoir with a more gradual slope will expose large areas of mud flats when water levels change as compared to a reservoir with a steeper slope. Another important physical characteristic of reservoirs that can influence recreation is the presence of physical obstructions, which can be uncovered and become hazards if there is a large decrease in water levels (Platt 2000). There are diverse physical characteristics at the reservoirs in the extended plan area, including both steep and gradual slopes.

The presence of water access facilities and the ability of recreationists to access and use these facilities influence recreation in terms of the mix and amount of recreational activities that would occur at a reservoir (Platt 2000). Fluctuations in water levels (i.e., elevations of the water at a reservoir) can affect recreation if the water levels affect the usability of any water access facilities, which could occur due to either a decrease or an increase in water levels. Declining water levels can expose hazards or physical obstructions (Platt 2000). Some recreational activities are more affected by changing water levels than other activities. An individual reservoir might be less affected if the mix of recreation at this reservoir includes mostly activities that are immune to changing water levels (Platt 2000). As described in Chapter 10, these reservoirs undergo substantial annual water level and volume fluctuations as water is released from the reservoirs for hydropower production, consumptive use, and instream flow requirements (USGS 2016a 2016b, 2016c, 2016d, 2016e). Under baseline conditions, these fluctuating reservoir volumes affect recreation at individual reservoirs by reducing the lake area available for boating or fishing, potentially isolating boat ramps and thereby limiting boat access to the reservoir, and potentially isolating swimming beaches from the reservoir.

The amount of recreation at a reservoir and the degree to which recreation will change with changing water levels is also influenced by the presence of substitute sites for water-based recreation. Substitute sites provide other options for recreationists if conditions change at a preferred reservoir. In general, the presence of substitute sites would cause recreation at a given reservoir to decrease more than recreation at a reservoir where there are no or few other substitute sites (Platt 2000). The multiple reservoirs in the extended plan area can generally serve as substitutes for one another.

The last factor is the preferences of recreationists in relation to water levels during a particular season. If there are large seasonal fluctuations in water levels at a reservoir, for example, recreationists at that site might be accustomed to changing water levels and these changes may not greatly affect their use of a site or the value they derive from recreating at that site. The preferences of recreationists may also vary by recreational activity. Some recreational activities, such as hiking, picnicking, or other activities, would likely be more affected by changing water levels that resulted in exposed mud flats than other activities that depend less on the aesthetic qualities of the site. The preferences of recreationists for changing water levels may also be affected by the presence of substitute sites, with recreationists at sites with few or no available substitute sites having a greater tolerance for changing water levels at a given site (Platt 2000). As noted previously, a number of the reservoirs in the extended plan area already experience large daily fluctuations and fluctuations through different seasons.

Hydrologic Changes and Potential Economic Effects

Expected hydrologic changes in the extended plan area related to instream flows and reservoir elevations are explained in Chapter 5, *Surface Hydrology and Water Quality,* Section 5.4.2, *Methods and Approach, Extended Plan Area*:

> Under baseline, junior water rights holders who divert water to storage, including February through June, must cease diversion to storage if there is not enough water to satisfy the water rights of more senior water rights downstream. The frequency with which these junior water rights holders must cease diversion to storage would increase during some months of some years under LSJR Alternatives 2, 3, and 4 if water needed to meet the February–June flow requirements reduces the amount of water that can be diverted. A reduction in diversion to storage in the upstream reservoirs can result in reduced reservoir levels, which already occur in the baseline condition. The increased frequency with which reservoirs in the extended plan area are drawn down to lower storage levels would depend on seniority of water rights and how water rights are conditioned to implement the flow objectives in a future water right proceeding. While the effects may be greatest in critically dry and dry years, there may be some effects in below normal, above normal, and wet years. Table 5-19b shows the distribution of changes to annual average diversions under each of the LSJR alternatives.

Based on these potential hydrologic changes, the environmental impacts in the extended plan area that could affect recreational resources and aesthetics are explained in Section 10.4.4, *Impacts and Mitigation Measures: Extended Plan Area*. Visually, the sections of the three rivers above the rim reservoirs may be degraded because of the flow fluctuations on the Stanislaus and Tuolumne Rivers, but the Merced River is unlikely to see flow reductions. Section 10.4.4 states that, "River flows on the Stanislaus and Tuolumne Rivers could potentially impact recreational resources in the extended plan area on the Stanislaus and Tuolumne Rivers similar to the impacts described in the plan area." As stated in Section 20.3.6, *Effects on Recreational Opportunities, Activity, and the Regional Economy*, when the expected impacts in the plan area are applied to the extended plan area, "benefits to local residents and potential effects on visitor spending in the region associated with recreational activity on the tributaries would be relatively unchanged under LSJR Alternatives." Economic impacts resulting from changes to recreational opportunities and activities in the extended plan area's river recreation areas are thus expected to be relatively minor.

As for the reservoirs in the extended plan area, fluctuation of reservoir volumes could occur more frequently and be more pronounced during drought conditions. These fluctuations may affect the aesthetic quality of the reservoirs, as unvegetated land around the reservoir may be exposed more frequently. As stated in Section 10.4.4, *Impacts and Mitigation Measures: Extended Plan Area*, "it is unclear to what extent any significant impacts on recreation and aesthetics could be fully mitigated." Because many factors influence recreation at reservoirs, the mix of recreational activities and the amount of these activities are highly dependent on the characteristics of the reservoir. Additionally, the degree to which recreation at a given reservoir changes because of changing water levels is also highly dependent on these individual reservoir characteristics and their interaction with water levels. As a general trend, there is a positive correlation between water levels at a reservoir and the amount of recreation, with more recreation expected at sites with higher water levels. This positive correlation, however, is only applicable within a range of water levels. As water levels decrease, for example, recreation may decrease by a gradual amount and then fall off sharply if water levels decrease past certain thresholds (such as points where physical hazards or exposed or access facilities become unusable). Additionally, as water levels increase, recreation may increase at a proportionate rate but then start to decrease if rising water levels affect the usability of access facilities or decrease the access to recreation sites along the shoreline (Platt 2000; USBR 2011). Variations in levels of reservoir recreation are therefore relative to the deviation of water levels and specific to the characteristics of an individual reservoir. As such, the economics of reservoir recreation in the extended plan area could be affected by the LSJR alternatives. However, the potential economic effects and their full extent cannot be quantified.

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