Master Response 3.5
Agricultural Resources

Overview

This master response addresses comments raised regarding the substitute environmental document (SED) agricultural resources analysis, which is described in Chapter 11, *Agricultural Resources*. Primarily, that analysis evaluates whether the plan amendments could convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (collectively, "Designated Farmland") to nonagricultural uses or involve other changes in the existing environment that, due to their location or nature, could result in the conversion of farmland to nonagricultural use.

If the plan amendments were a construction project on farmland, such as a retail mall or a housing development, the analysis would be straightforward. Building the mall or housing development on the farmland would result in its conversion to nonagricultural use. However, due to the nature of the plan amendments, this analysis is less straightforward. In essence, the SED assumes that an increase in instream flow, as required by the plan amendments to reasonably protect fish and wildlife, would result in a decrease in water available for other uses, including agricultural irrigation, which is the majority (about 65 percent) of the human water use in the plan area. However, not all farmland has to be irrigated (i.e., Unique Farmland), and not all farmland receiving reduced water supplies would be converted to nonagricultural uses because growers often adopt measures to keep land in agricultural production.

The decision to convert to nonagricultural uses or to remain in agricultural production involves many personal and business decisions by the individual grower or rancher. In addition to a grower's personal decision-making, water suppliers' programs and policies can also influence a grower's decision. Irrigation districts' physical capacities, distribution policies, and legal requirements affect the availability and quantity of water. Growers might consider questions such as the following.

- Could irrigation efficiencies and or water conservation measures stretch less water further?
- Could crop shifting, finding alternate water supplies, deficit-irrigation, or instituting other adaptations be used?
- What are the market prospects for a grower or rancher's product?
- Is the land in proximity to development pressure, such as infrastructure and other services, such that conversion is an option, or would it likely be fallowed more often but still remain in agricultural production?

These are a few, but not all, of the questions ultimately determining whether conversion from agricultural use to nonagricultural uses would result. Because the answer to these questions is speculative and unknowable, the SED makes a conservative (i.e., worst case) assumption that a reduction in available water supply for a baseline mix of crop types will result in a conversion to nonagricultural use.

The analysis in Chapter 11 uses the Statewide Agricultural Production (SWAP) model to reflect market-driven behavior. The model estimates how, based on a constraint in water supply and other factors, water frequently shifts away from lower net revenue crops towards higher net revenue crops. The SWAP model is based on "rational" economic behavior, meaning the traditional business objective, which is to maximize crop production profit. The model also reflects observed grower behavior during times when water supplies have been limited. For example, annual crops like grains or safflower may be grown less as the market value of water increases to a point where sales and transfers of water may exceed the net profit of these crops in some areas. That market-based reallocation allows the water to be applied to maintain higher net revenue crops like almonds or vegetables. The SWAP model results, primarily presented in Appendix G, *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, are used in Chapter 11 to illustrate how cropping patterns might shift and change in response to such market-driven factors. However, as noted above, relying on a correlation that that equates a crop reduction in some years to a conversion of Designated Farmland to a nonagricultural uses is a conservative (i.e., worst case) assumption that does not take into consideration how irrigation districts, farmers, and ranchers might adapt in order to maintain land in agricultural production. For discussion of the Water Supply Effects (WSE) model, which provides inputs to the SWAP model, please see Appendix F.1, *Hydrologic and Water Quality Modeling*. However, it should be emphasized that the SWAP model cannot predict the behavior of an individual grower; rather, the SWAP model is a tool for comparing how changes in water supply availability may affect aggregate grower behavior.

The State Water Board reviewed all comments related to agricultural resources and developed this master response to address recurring comments and common comment themes. 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 concerns related to agricultural resources, the plan amendments' potential impacts on agriculture, the approach to the analysis in Chapter 11, and related mitigation measures and includes, for ease of reference, a table of contents after the *Overview* to help guide readers to specific subject areas. In particular, this master response addresses, but is not limited to, the following topics.

- The geographic area, baseline, crop acreage, and crop mix used for the agricultural analysis.
- The methodology of the agricultural analysis, including the use of SWAP model results and the criteria to determine significance.
- The use of the State Water Board Environmental Checklist in Appendix A of the Board's California Environmental Quality Act (CEQA) guidelines (Appendix B of the SED, *State Water Board's Environmental Checklist*) as it relates to the potential conversion Prime Farmland, Unique Farmland, and Farmland of Statewide Importance to nonagricultural use.
- SWAP model results regarding the effects of consecutive dry years on permanent crops.
- The ability of permanent crops to tolerate deficit irrigation.
- The potential effects on lands designated as existing dairy uses.
- The ability, or inability, to apply water demand management techniques, such as dry land farming and deficit irrigation, and the discussion of these techniques in the analysis.
- The potential use of water demand management techniques, such as irrigation efficiency or other irrigation conservation measures as mitigation measures to reduce potentially significant impacts.

For information related to water quality and the protection of agricultural beneficial uses in the southern Delta, please see Master Response 3.3, *Southern Delta Water Quality*. For information regarding groundwater resources and the Sustainable Groundwater Management Act (SGMA) as it relates to assumptions regarding groundwater pumping for agricultural use, see Master Response 3.4, *Groundwater and the Sustainable Groundwater Management Act*. For information regarding agricultural economic effects, please see Master Response 8.0, *Economic Analyses Framework and Assessment Tools*, 8.1, *Local Agricultural Economic Effects and the SWAP Model,* and 8.2, *Regional Agricultural Economic Effects*.

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Geographic Area, Baseline, Acreage, and Crop Mix

There are numerous potential sources of data for acreage and crop mixes in California and the Lower San Joaquin River (LSJR) area of potential effects. The area of potential effects is defined in Chapter 11, Section 11.1, *Introduction,* and generally includes irrigated lands within the service boundaries of those irrigation districts and water suppliers that receive water from the three eastside tributaries. The data sources include: the California Department of Water Resources (DWR), Agricultural Water Management Plans (AWMPs), county agricultural commissioner reports, the California Department of Conservation (DOC), and the U.S. Department of Agriculture's (USDA's) National Agricultural Statistics Service, among others. These different datasets use varying geographies, time periods, and methodologies for classifying crop categories and acreages. The environmental setting section of Chapter 11, *Agricultural Resources*, describes baseline agricultural conditions in the area of potential affects, which includes parts of the plan area and extended plan area, using data from several of these sources.

One dataset commonly used by DWR, the Central Valley Project (CVP), and others is DWR's Detailed Analysis Units (DAUs) land and water use estimates based on surveys conducted by DWR and county level agricultural commissioner reports. DWR subdivides each hydrologic region of the state into many numbered subunits and collects and publishes water and land use information that corresponds to those subunits. The land portion identifies the acreage and crop grown in each DAU and the water portion provides unique applied water rates for the identified crop types in the region. Ultimately, information collected by DWR and compiled into the DAUs for the 2010 base year was used in the SWAP model analysis and, subsequently, in the impact analysis in Chapter 11. This dataset was used because it is the most comprehensive dataset for the plan area that was closest to the baseline year of 2009. In Attachment 1 of Appendix G, *Agricultural Economic Effects of the Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, to help explain its analysis and assumptions in a transparent way, the State Water Resources Control Board (State Water Board) acknowledges that there are differences between data sources and identifies the magnitude of the differences between DWR's DAU crop mixes and irrigation district 2012 AWMP crop mixes.

The programmatic analysis presented in the SED accounts for the total volume of water that is available for irrigation (i.e., applied water) and the volume that could potentially be reduced under the LSJR alternatives as described and evaluated in Chapter 11. The basic concept is that irrigation districts divert water from the tributaries and provide it to growers; if there is insufficient supply to meet all, crop-specific, applied water demands, growers may need to fallow acreage, implement deficit irrigation of their crops, improve irrigation efficiency, or some combination of these actions. Due to the personal preferences of each grower and the policies and regulations of water suppliers in the plan area, the exact combination of outcomes is unknowable. However, it is reasonable to assume that the outcome of reduced water supply would be some combination of fallowing, deficit irrigation, improved irrigation efficiency, or full delivery depending on the crops grown.

Some commenters expressed concern that the total acreage of irrigated land used in the impact analysis in Chapter 11 is less than the actual irrigated acreage and, therefore, does not account for all applied water demands. These commenters claim that not accounting for all applied water demands means impacts are under reported or are not fully disclosed, described, or otherwise accounted for in the impact analysis. Estimates of total irrigated area for the irrigation districts are based on each district's respective 2012 AWMPs. These estimates are intended to represent the irrigated acreage around the baseline period of 2010 and CEQA does not require that the baseline period be continuously updated. Please see Master Response 2.5, *Baseline and No Project*, for further discussion of the baseline and the estimates of baseline land use. However, some commenters pointed out that the estimates of total irrigated area for Modesto, Turlock, and Merced Irrigation Districts were slightly misinterpreted from the 2012 AWMPs. As described in Master Response 8.1, *Local Agricultural Economic Effects and the SWAP Model*, these acre values were updated for the revised SWAP model run, along with refined constraints on silage to better reflect comments regarding the importance of that feed crop to dairies and refined information regarding deficit irrigation, groundwater use, and crop prices. The revised SWAP model run did not result in any change to the significance determinations disclosed for any of the LSJR alternatives under Impact AG-1 in Chapter 11.

California agriculture is dynamic, which commenters have acknowledged when commenting about the changes in crop mix between 2009 and 2016. A constantly changing crop mix is a challenge when analyzing agricultural effects in a CEQA document because CEQA requires an established baseline. For example, during the recent drought, the acreage of some permanent crops increased in some of the irrigation districts, as identified by commenters. In the OID service area, almond acreage increased nearly three-fold, from approximately 3,500 acres to 9,400 acres (OID 2016) between 2005 and 2013. Also during the recent drought, OID's total cropped area significantly increased from 52,011 to 59,008 acres due to annexation of approximately 6,700 additional acres of almond orchards (OID 2016). However, if the crop mix changes from pasture to almonds, the almonds would actually use less water, but may harden demand when compared to pasture. This is evidenced by the statement from Mr. Knell, General Manager of OID, during public testimony.[1]

> But when you change over a pasture, which might use five, five-and-a-half acre-feet per year to a permanent crop like almonds and is using like three-and-half feet per year, there is a conservation component that changes your demand within the District.

Because California agriculture is constantly adapting and changing, it would be impossible to do a comparative analysis if the baseline were required to constantly change. This is why CEQA does not require analysis of a rolling baseline, but requires that the lead agency establish how the existing physical condition without the project can most realistically be measured. Therefore, because the State Water Board issued the Notice of Preparation for the plan amendments in 2009, Chapter 11 evaluates impacts on agricultural resources based on changes from the 2009 baseline, as approximated by using a mix of best available information. For additional information regarding baseline, see Master Response 2.5, *Baseline and No Project*.

Methodology

Chapter 11, *Agricultural Resources*, uses the State Water Board's Environmental Checklist (Appendix B of the SED, *State Water Board's Environmental Checklist*) regarding agricultural resources and land use to evaluate the potential physical environmental impacts to agricultural resources as a result of the plan amendments. The methodology used and described in Chapter 11, Section 11.4.2, *Methods*

[1] Knell, S. 2016. *Public Hearing Testimony by Oakdale Irrigation District before the State Water Resources Control Board in the Matter of: Amendment to the Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary: San Joaquin River Flows and Southern Delta Water Quality and on the Adequacy of the Supporting Recirculated Draft Substitute Environmental Document (SED)*. Stockton Memorial Civic Auditorium, Friday, December 16.

and Approach, is comprised of a quantitative evaluation of Designated Farmland, which is Prime Farmland, Unique Farmland, and Farmland of Statewide Importance (Table 11-2), using the output of an agricultural–economic model and a qualitative evaluation of physical impacts associated with other changes in the existing environment. This section describes specific aspects of the methodology, based on comments raised by commenters, including the general methodological approach, the use of the checklist questions, use of the criteria established to determine significance, and use of the SWAP model results.

General Approach

Prime Farmland, Unique Farmland, and Farmland of Statewide Importance are monitored on a biannual basis by the Farmland Mapping and Monitoring Program (FMMP) (DOC 2004). The DOC monitors changes to land use from irrigated to non-irrigated land types based on a 4 to 6 year observation cycle of aerial imagery to determine the presence of, and any changes in, irrigated to non-irrigated land types. The criteria used by the FMMP to establish the types of farmland are defined by the USDA's Natural Resources Conservation Service (DOC 2004). The USDA criteria, in part, states that farmland designated as Prime Farmland and Farmland of Statewide Importance must have a dependable water supply, which is defined as one that is available in 8 out of 10 years. In addition, maintaining a designation as Prime Farmland and Farmland of Statewide Importance under the FMMP requires that the land must have been used for irrigated agricultural production during the two update cycles prior to the mapping date. Unique Farmland is land which does not meet the criteria for Prime Farmland or Farmland of Statewide Importance, that has been used for the production of specific high economic value crops at some time during the two update cycles prior to the mapping date. Unique Farmland might be irrigated, but that is not a requirement for maintaining its designation. The FMMP mapping date for this analysis was 2012 because this year is representative of Designated Farmland during the baseline year (DOC 2012).

In the SED, the total acreage of Designated Farmland was determined through a geographic information systems (GIS) analysis of data supplied by the DOC's FMMP and compared with the boundaries of the irrigation districts. The results of this analysis are in Chapter 11, Section 11.2, *Environmental Setting*. Out of the 527,793 acres of Designated Farmland, there are 84,802 acres of Unique Farmland, or approximately 16 percent of the existing land. Because farmland may be designated as Unique Farmland even if it is not irrigated, by including these acres in the Chapter 11 analysis as being acres that could be potentially converted due to a reduction in irrigation water under the plan amendments is another example that illustrates how the State Water Board's conversion estimates are conservative (i.e., worst case). The impact analysis considers all acres of Prime, Unique, and Farmland of Statewide importance together because it is unknown what mix of Designated Farmland is included in the acreage that is reported as fallowed by the SWAP model (described further in the next section of this master response, *Permanent Crops*). For example, if the SWAP model reports that an acre of pasture is fallowed within a certain irrigation district, it is unknown where in the affected district that acre is in relation to the different types of Designated Farmland. In the example regarding pasture, provided in the *Geographic Area, Baseline, Acreage, and Crop Mix* section above, the analysis would consider the impacts as contributing to a potential finding of significance regardless of where exactly they occurred.

Some commenters asserted that agricultural resource impacts should have been evaluated exclusively using water supply reductions in critical water year types and focusing on Prime Farmland and Farmland of Statewide Importance. For example, one commenter used a one-to-one ratio of a percent reduction in the critical water year to a percent reduction of Prime Farmland and Farmland of Statewide Importance. This commenter used SED output to report that during critical year types, there was a 17 percent reduction in water supply for the commenter's district and, therefore, concluded that there would be a 17 percent reduction in the acreage of Prime Farmland and Farmland of Statewide Importance. However, by evaluating impacts in this manner, commenters ignore the important variation of applied water demands by crop and ignore the category of Unique Farmland. Applied water demands vary by crop type and, because it is unknown what crop type is on a particular type of land (Designated Farmland), the resulting applied water reduction by crop is unknown. For example, pasture requires 5 to 5.5 acre-feet per acre (AF/acre) annually of applied water compared to 3.5 AF/acre for almonds (Knell 2016); therefore, from a water supply perspective, every one acre of pasture removed is the equivalent of removing between 1.4 (5 AF/acre/3.5 AF/acre) to almost 1.6 acres of almonds (5.5 AF/acre/3.5 AF/acre). As such, using only water supply as a metric would ignore the type of crop being grown, potentially resulting in an over or under estimation of the amount of land either remaining in production or going out of production. Finally, the analysis considered all Designated Farmland (Prime, Unique, and Farmland of Statewide Importance) in order to be consistent with the State Water Board's checklist for agricultural resources (discussed more below in the section entitled, *Use of Checklist Questions*). As previously stated in this master response, Chapter 11 conservatively estimates the amount of conversion by using the SWAP model to estimate, in aggregate, which crops may not receive water because of a reduction in surface water supply availability and the crop net returns. The analysis then equates that crop reduction to a reduction in Designated Farmland and then to a conversion to nonagricultural use. This approach used in the SED is appropriate because it considers land use information that is consistent with the State Water Board's checklist items and accounts for variations in applied water demands.

In addition to evaluating crop acreage reductions using the SWAP model, the State Water Board used a regional economic model in its analysis of agricultural economic impacts, IMPLAN, for two purposes. The first purpose was to evaluate broader community effects that could be associated with potential physical environmental impacts on agricultural resources. The broader community's dependence on Designated Farmland in the plan area includes different industries (e.g., agronomic input suppliers and commodity processors) that rely on demand by or production from the Designated Farmland categories for products or services. The second purpose was to analyze potential regional economic effects on those communities, which is further discussed in Master Response 8.2, *Regional Agricultural Economic Effects*, and in Appendix G, *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*.

Use of Checklist Questions

Chapter 11 addresses the following State Water Board checklist items (SED Appendix B). Would the project:

- Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance, as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program (FMMP) of the California Resources Agency, to nonagricultural use?
- Involve other changes to the in the existing environment that could result in the conversion of agricultural lands to nonagricultural uses?
- Conflict with existing zoning for agricultural use or a Williamson Act contract?

- Conflict with any applicable plan, policy, or regulation related to agriculture of an agency with jurisdiction over a project adopted for the purpose of avoiding or mitigating and environmental effect?

The purpose of checklist questions, or thresholds, is to help the lead agency identify potentially significant adverse impacts on the physical environment that could result from a project. As such, the State Water Board's checklist questions focus on the conversion of land because the conversion of land could result in a physical environmental impact. However, a project does not necessarily have a significant environmental effect just because it converts Designated Farmland to nonagricultural uses (*Rominger v. County of Colusa* (2014) 229 Cal.App.4th 690, 701-702).

As noted in the *Overview* section of this master response, the ability to evaluate potential impacts is much clearer when Prime Farmland, Unique Farmland, or Farmland of Statewide Importance is, for example, projected to be graded and paved over for a housing development or retail shopping center. Here, however, it is impossible to predict exactly how potential surface water supply reductions under the LSJR alternatives could result in conversions of Designated Farmland because a chain of events would need to occur: the irrigation reduction would have to result in not just a yield reduction, temporary fallowing, or adaptation of the agricultural use (for example a different crop), but an actual conversion with attendant physical impacts. Because of these uncertainties, the State Water Board takes a very conservative approach in its analysis by equating irrigation reductions to Designated Farmland, over a certain threshold, with potential conversions of such land to nonagricultural use.

As explained previously in this master response, this conservative (i.e., worst case) approach likely overstates potential impacts because any actual conversions that would result in physical impacts would depend on many different factors, as outlined above in the *Overview* section of this master response. However, the State Water Board uses a conservative approach as the best way to avoid overlooking potential adverse physical environmental impacts on agricultural resources in the programmatic analysis.

Criteria to Determine Significance

As stated previously under *Use of Checklist Questions* in this master response, Chapter 11 evaluates potential impacts on Prime, Unique, and Farmland of Statewide Importance based on the State Water Board's checklist. To evaluate impacts on Prime, Unique, and Farmland of Statewide Importance, the SED assumes that a reduction in water supplies leads to reductions in crop acreages and that this, in turn, could cause Designated Farmland to be converted to nonagricultural uses. As mentioned in the *Overview* section of this master response, if the plan amendments were the proposed construction and operation of a shopping mall on existing designated Prime, Unique, and Farmland of Statewide Importance, the significance evaluation would be made using a one-to-one conversion ratio. In other words, for every acre of shopping mall built, one acre of Prime, Unique, or Farmland of Statewide Importance would be converted, and the lead agency would make its impact determination based on the anticipated conversion of that specific Designated Farmland to nonagricultural use.

The plan amendments are revisions to an existing water quality control plan. The plan amendments will satisfy the requirement that the State Water Board set and implement water quality objectives to reasonably protect fish and wildlife beneficial uses. Through the plan amendments, the volume of water available in the three eastside tributaries during the February–June time period would increase based on an unimpaired flow requirement. This would potentially reduce the amount of water available for diversions that primarily serve agricultural lands. The absolute conversion of Prime, Unique, and Farmland of Statewide Importance is not a one-for-one ratio as in the shopping mall example because conversion of land to nonagricultural uses depends on numerous factors as described in Chapter 11, including market conditions for the crops that are grown, the rate of urbanization in an area, and the proximity of agricultural land to urban areas.

Because of this complexity, impacts are considered significant if reduced water supplies resulted in greater than a 4 percent reduction in average acreage for any irrigation district under any LSJR alternative. The 4 percent criteria was selected as a conservative threshold because it is reasonable to assume that not all Designated Farmland that would receive reduced water supplies would be converted and, moreover, some existing Designated Farmland would already be converted under the current baseline rate of permanent conversion of agricultural lands in the San Joaquin Valley (Chapter 11, Section 11.2, *Environmental Setting*). The California Water Plan and other studies estimate different rates of conversion in the San Joaquin Valley (Chapter 11, Section 11.4.2, *Methods and Approach*). As those lands are converted to nonagricultural use, they lose their designation and Prime, Unique, or Farmland of Statewide Importance and, therefore, are not susceptible to potential conversion from irrigation water reductions related to the plan amendments as they cannot be converted twice.

Average acreage was used because it is representative of the changes in crops across all water year types. Furthermore, averages are a widely supported metric to characterize the baseline and to evaluate in an impact analysis. As the Supreme Court noted in its *Communities for a Better Environment v. South Coast Air Quality Management District* (2010) 48 Cal.4th 310 decision: *"…Environmental conditions may vary from year to year and in some cases it is necessary to consider conditions over a range of time periods." (Save Our Peninsula Committee v. Monterey County Bd. of Supervisors, supra, 87 Cal.App.4th at p. 125.).* This is particularly true for water in California, which is highly variable. In order to provide full disclosure of the range of effects on different crop types in all years, Chapter 11 included exceedance plots for specific crops in each irrigation district (Chapter 11, Section 11.5, *Impacts and Mitigation Measures*). These exceedance plots reflect the historical frequency of different types of California water years to estimate the frequency and magnitude of irrigation reductions to various crop types, as compared to the baseline water availability, under the implementation of the various LSJR alternatives. In other words, the exceedance plots go beyond averages to show varying degrees of impact and the relative likelihood that the degree of impact may be felt.

As noted, the assumption that a 4 percent or more reduction in annual irrigated acreage would result in a significant impact based on potential conversion of Designated Farmland to nonagricultural uses is conservative (i.e., worst case). It is conservative because growers have options for managing reduced water supplies, including improving water use efficiency, implementing deficit irrigation, crop shifting, land-idling, and dry land farming, and, if available, purchasing additional water supplies. Many of these options were implemented in the drought years of 1987–1992 and 2012–2016 (Nash 1993; DWR 2016). These options are discussed further below in this master response and within the context of the impact analysis in Chapter 11 (Section 11.4.3, *Impacts and Mitigation Measures*). However, identifying the mix of options that growers would implement is too speculative to be precisely modeled or quantified because they are within the control of the individual grower, based on personal and site-specific farming decisions, and are not within the control of the State Water Board. As such, with the exception of LSJR alternative 2 without adaptive implementation, which is almost identical to baseline conditions, potential environmental impacts from the conversion of Designated Farmland to nonagricultural uses were determined to be significant and unavoidable for all LSJR alternatives (Impact AG-1).

Use of the SWAP Model

The Chapter 11 analysis in the 2016 Recirculated SED used results from the SWAP model to evaluate potential physical environmental impacts on Designated Farmland. The SWAP model is a regional agricultural production and economic optimization model that simulates rational economic decisions. "Rational economic decisions" refer to decisions made by California growers to select the crops, water supplies, and other inputs that would maximize profit, subject to resources constraints, agronomic production relationships, and market conditions (Appendix G). The SWAP model was developed under the direction of Professor Richard Howitt of the University of California, Davis, in collaboration with DWR (Appendix G, Section G.4.1, *Description of Statewide Agricultural Production Model*). The model's configuration for this analysis is described in Appendix G. Please see Master Response 8.1, *Local Agricultural Economic Effects and the SWAP Model*, for information related to the SWAP model and the use of it as the best available tool for evaluating agricultural impacts associated with reduced water supply availability on the three eastside tributaries.

The SWAP model output includes cropped land area, applied water amounts, and crop revenue. Impacts on agricultural resources were analyzed using the historic 82-year period from 1922 to 2003, which is the WSE modeling period. This modeling period is long enough to adequately capture the historical variation in hydrologic conditions and how implementation of the LSJR alternatives will affect agricultural resources. Using SWAP model output for cropped land area, the amount of land in production under each LSJR alternative was compared to the amount of land in production modeled under baseline conditions. The impact analysis made a worst-case assumption that land without sufficient water supply was potentially converted to nonagricultural uses, without considering whether grower adaptations could keep Designated Farmland in agricultural production (discussed in Chapter 11, Section 11.4.2, *Methods and Approach*, and in this master response under *Reductions in Water Demand*). The SWAP model is a useful model for comparing cropping patterns between two scenarios within a region; however, it cannot provide more detailed and specific information, such as the location of the field that will be fallowed in response to water supply shortage. As stated previously in this master response, determining the exact locations of where fallowing would occur, where to implement efficiency improvements, or where dry land farming could be implemented is speculative and beyond the scope of a programmatic analysis. Also, for example, on-farm efficiency improvements may require irrigation district–level actions that the State Water Board currently does not require. Given the number of unknowns and the programmatic level of this analysis, the SWAP model is the best available tool with which to compare potential effects of water supply reductions on designated farmland.

Revised SWAP Model and Data Refinements

Commenters reviewing the SWAP model data input and output identified an error in the output, which has subsequently been traced to a model coding error. As described in Master Response 8.1, the State Water Board fixed the model coding error and performed a revised SWAP model run. In addition, several other refinements were made based on review of comments and agricultural water management literature; these changes include updated irrigated areas for MID, TID, and Merced ID, updated corn silage constraints, updated deficit irrigation levels, and updated groundwater replacement constraints. The State Water Board reviewed the revised SWAP model results and updated Chapter 11 and Appendix G accordingly. The revised results showed minimal differences with those presented in the 2016 Recirculated SED and did not change the level or magnitude of significance determinations in Chapter 11. For example, the revised SWAP model results show an annual average reduction in acreage for all water suppliers of 24,902 acres (4.8% of total production), as compared to the 2016 SWAP model results, which showed an annual average acreage reduction of 22,879 acres (4.6% of total production). The quantitative information presented in this master response is based on the revised SWAP model and output, details of which are found in Master Response 8.1.

Permanent Crops

Perennial or permanent crops are ones that live longer than a single growing season, in contrast with annual crops that die after a single growing season. In the SWAP model, permanent crop categories include: Almonds and Pistachios, Other Deciduous crops (orchard crops and other nut trees, such as walnuts), Subtropicals (citrus), and Vines (wine, table grapes, and raisins). Also, in practice, both alfalfa and pasture are permanent crops, with the ability to be established and produce within a year; however, their shorter life spans and lower net revenue per acre make them functionally equivalent to annual crops for the purposes of the SWAP model (Long 2015 and Duncan et al. 2016). While it is important to understand the nuance of effects on permanent crops from an agricultural economics perspective, the analysis in Chapter 11, *Agricultural Resources*, assumes lands with permanent crops are designated as Prime, Unique, or Farmland of Statewide Importance. This is because the criteria for designating farmland is based in part on agricultural productivity, water supply reliability, and other factors that lands sustaining permanent crops share. Significance determination for impacts on agricultural resources, as described earlier under *Criteria to Determine Significance*, is based on the potential reduction in Designated Farmland, including permanent crops. There are no significance criteria being considered for analyzing potential impacts on specific permanent crops by themselves.

Management of Permanent Crops

Commenters expressed concern that permanent crops cannot be fallowed for one or multiple years in a row and then irrigated in a subsequent year. In addition, several commenters expressed concern that the economic modeling of permanent crops did not account for the potential impacts of deficit irrigation over consecutive dry years on crop yields. From a practical point of view, these concerns are understandable. Permanent crops cannot go in and out of production like tomatoes or wheat and may be more susceptible to consecutive dry years because maintaining agronomic productivity and ensuring profitability requires a steady amount of applied water. Commenters have accurately identified that the modeling does not represent exactly what happens on the farm. However, an exact representation of what happens on the farm is not the intent of the SWAP model. The purpose of the State Water Board's SWAP modeling was to help inform a programmatic analysis of whether or not the conversion of Designated Farmland to nonagricultural uses could result in potentially significant adverse physical impacts on the environment. The model was not meant to predict with accuracy how growers might manage permanent crops, but rather to provide a relative idea of the scope of potential acreage that would receive reduced irrigation when compared to a baseline condition. This acreage with reduced irrigation then becomes a proxy for potential conversion in the analysis. In addition, because the actual location and scope of potential conversions to nonagricultural uses cannot be ascertained, potential conversions were equated to potential physical impacts. This likely overstates the impacts but was chosen by the State Water Board as the best method to avoid understating the impacts. This master response addresses how the SWAP model was used to address potential physical impacts. Please see Master Response 8.1, *Local Agricultural Economic Effects and the SWAP Model*, for discussion of the SWAP model and assumptions related to the management and production of permanent crops.

The day-to-day management of permanent crops is complex due to an individual grower's objectives, crop mix, resources, and other factors. Due to these complexities the SWAP model is unable to model all potential outcomes. Permanent crops, such as almonds, mature in 5 to 6 years and have a bearing life of 25–30 years. During the initial years, the water demand is reduced and in later years the retirement of a portion of the perennial crop acres occurs over time as the crop reaches the end of its bearing life. Given the large establishment cost for permanent crops such as almonds, it is rare for growers to retire young trees when facing water or other resource shortages and typically they will manage water supplies to ensure at least crop survival (Fulton 2007). Growers decide how much to replace, when to replace, and what to grow next based on water supply availability and crop prices, among other considerations. As the trees approach the end of their productive lifespan, their yields typically decrease and growers likely replace those acres. Generally speaking, growers try to avoid replacing all of their trees at the same time in order to keep crop production levels relatively stable. Therefore, growers stagger replacement of the permanent crop acres so that only a small percentage of the crop is coming out of production each year and an equal percentage is coming into production (Doll and Schakel 2015). In addition, newly planted trees will take about 3 years to start producing (Duncan et al. 2016). However, during dry periods, growers may choose to retire some acres that were scheduled to be retired in the following year earlier than planned. This helps save water because the applied water requirements for the first several years of newly established plantings are less than the applied water requirements of more mature plantings (Schwank and Prichard n.d.). In contrast, during a very robust market, growers may defer removing low producing trees because even at lower yields net revenues may be high.

Growers also have effective water management measures to preserve permanent crops during water short years (Fulton 2007). Growers with less efficient irrigation systems can switch to more efficient systems and or implement deficit irrigation. Deficit irrigation, also referred to as stress irrigation, involves reducing the amount of applied water for a crop below what is required for full yield. The basic concept of deficit irrigation is to reduce the amount of applied water during the period(s) of plant growth when doing so is less harmful to the plant. When water supplies are limited, deficit irrigation allows growers to keep more acres alive, although it may have some impact on yield. Permanent crops can tolerate stress relatively well compared to some annual crops; however, consecutive years under deficit irrigation can weaken the plants and, even if water supplies return to normal, it may take a few years for the plants to fully recover.

Due to concerns over water supply reliability during drought periods, considerable research has gone into almond irrigation water management. Along with improved irrigation efficiency, regulated deficit irrigation is a common irrigation strategy designed to manage the amount of applied water during strategic growth stages to conserve water and reduce impacts on yields (Goldhamer et al. 2005). Fulton in 2007 reported on several studies on almond water management. One of these studies, conducted by University of California, Davis, determined a water allocation of about 85 percent of full supply had no short-term yield loss or effect on nut size (Fulton 2007). This study used a pressure chamber to track midday crop stress and keep it within a specified range. Another study, conducted in Manteca, California, showed that irrigating at a reduced threshold value, beginning in June, resulted in 34 percent less tree water use and had no significant reduction in yield over a 4-year period when compared to trees receiving full irrigation. Vegetative growth declined, however, suggesting continuation of the strategy may have eventually reduced yields. In extreme situations, based on past drought conditions, trees may be kept alive with as little as a foot of applied water (Doll 2014). This strategy maintains trees in their agricultural use, but is only for survival purposes as growth and yield can be substantially reduced. This strategy is also best conducted using a micro-irrigation system that has the potential for more uniform water distribution and that reduces evaporative losses from irrigation (Stetson and Mecham 2011). Research demonstrates that following this severe deficit strategy, at least 2 years of full irrigation are needed for the trees to recover to normal yields (Prichard et al. 1996). Results of a 4-year study by the University of California Cooperative Extension show that 93 percent of full yield can be achieved in almonds through the application of 66 percent of applied water demand (Prichard et al. 1994). Other research (Faber 2015a and 2015b) shows that subtropical crops (citrus) can be deficit irrigated by 25 percent and still achieve full yield.

SWAP Model Results for Permanent Crops

To illustrate the potential effects on permanent crops, Table 3.5-1 presents results of the SWAP model for grown acreage of permanent crops averaged for dry and critical water year types under baseline and LSJR Alternative 3 on the eastside tributaries. Combined, there is a 0.56 and 1.49 percent reduction in total permanent crop acreage across all irrigation districts for dry and critical years, respectively. Based on the deficit irrigation constraints (as described in Master Response 8.1) and the crop water demands, SWAP models what a grower would have in production in each year of the 82-year period of the model run, 1 year at a time. In other words, each year's applied water deliveries are used to develop the annual crop mix independent of any other year. The model has no knowledge of the crop mix in the previous year or what is expected in the future. This limits the SWAP model from modeling crop effects that may extend over more than 1 year, such as yield reductions for permanent crops in successive dry years. However, this is a limitation shared by all similar crop modeling tools reviewed and no other tools were suggested by commenters. Despite this limitation, the SWAP model is the best available tool for modeling the economic and other physical effects of the LSJR alternatives on agricultural resources.

With regards to permanent crops, the SWAP model includes an algorithm that calculates the maximum perennial acreage retirement based on the time horizon of the analysis. In general, the model assumes that when water supplies are adequate to meet crop demands, then there is an equal amount of permanent crop coming out of production and an equal amount coming into production each year; in other words, there is no change in permanent crop acreage. When water supplies are limited the SWAP model allows some acres of permanent crop, up to the annual rate of replacement for permanent crops (about 6 percent) to be fallowed without replacement, which represents early fallowing of the acres scheduled for retirement in the following year. Please see Master Response 8.1 for more information on the SWAP model assumptions for deficit irrigation and fallowing constraints on permanent crops. Master Response 8.1 also provides the SWAP model results for all LSJR alternatives.

Table 3.5-1. Irrigated Area for Permanent Crops in Dry and Critical Years with Respect to Baseline and LSJR Alternative 3 (40% Unimpaired Flow)

Irrigation District	Average for Dry Years				Average for Critical Years			
	Baseline	LSJR Alt 3	Difference		Baseline	LSJR Alt 3	Difference	
	Acres			Percent	Acres			Percent
Almond & Pistachio								
SSJID	27,045	26,890	-156	-0.57	26,900	26,070	-830	-3.09
OID	10,539	10,494	-44	-0.42	10,490	10,270	-220	-2.10
SEWD + CSJWCD	17	17	0	0.00	17	17	0	0.00
MID	15,172	14,968	-205	-1.35	15,009	14,534	-474	-3.16
TID	31,189	30,788	-401	-1.28	30,844	30,194	-650	-2.11
Merced ID	32,026	31,986	-40	-0.13	31,869	31,712	-157	-0.49
Sub-total	115,988	115,143	-845	-0.73	115,129	112,797	-2,332	-2.03
Other Deciduous								
SSJID	6,854	6,813	-42	-0.61	6,816	6,595	-220	-3.23
OID	6,518	6,496	-22	-0.34	6,494	6,496	2	0.03
SEWD + CSJWCD	43,174	43,174	0	0.00	43,174	43,174	0	0.00
MID	9,394	9,293	-102	-1.08	9,313	9,084	-229	-2.46
TID	7,601	7,497	-104	-1.37	7,511	7,344	-167	-2.23
Merced ID	5,109	5,103	-7	-0.13	5,084	5,059	-25	-0.50
Sub-total	78,650	78,374	-276	-0.35	78,391	77,751	-640	-0.82
Subtropical								
SSJID	1,747	1,724	-22	-0.01	1,725	1,652	-73	-0.04
OID	139	136	-2	-0.02	136	131	-5	-0.04
SEWD + CSJWCD	0	0	0		0	0	0	0.00
MID	50	47	-2	-0.04	48	47	-1	-0.02
TID	59	56	-3	-0.05	56	55	-1	-0.02
Merced ID	0	0	0		0	0	0	0.00
Sub-total	1,993	1,964	-30	-1.49	1,965	1,885	-80	-4.07
Vine								
SSJID	5,394	5,380	-14	0.00	5,381	5,307	-74	-0.01
OID	884	880	-4	0.00	880	860	-19	-0.02
SEWD + CSJWCD	9,486	9,486	0	0.00	9,486	9,486	0	0.00
MID	1,275	1,257	-18	-0.01	1,261	1,220	-41	-0.03
TID	1,864	1,835	-29	-0.02	1,839	1,792	-47	-0.03
Merced ID	4,056	4,051	-6	0.00	4,034	4,011	-23	-0.01
Sub-total	22,960	22,889	-71	-0.31	22,880	22,677	-203	-0.89

Irrigation District	Average for Dry Years				Average for Critical Years			
	Baseline	LSJR Alt 3	Difference		Baseline	LSJR Alt 3	Difference	
	Acres			Percent	Acres			Percent
Combined Permanent Crops All Districts								
Total	219,592	218,369	-1,222	-0.56	218,365	215,110	-3,255	-1.49

Potential Effects on Existing Dairy Uses and Cattle

Multiple comments were received suggesting dairies would go out of business due to a variety of factors attributed to the plan amendments. However, commenters did not provide information or substantial evidence that a reduction in dairy feed crops, a reduction in dairy production, or a reduction in dairy water supply would result in a conversion of agricultural lands to nonagricultural use. In general, commenters are concerned that the plan amendments could lead to a loss of feed crops needed for dairy cows; reduced water supply for parlor water, drinking water, and nutrient management; and reduced land availability for nutrient management or waste disposal. Overall, commenters fear a potential decline of dairy viability in the state of California.

As discussed in Chapter 11, *Agricultural Resources* (Section 11.2.2, *Lower San Joaquin River Watershed and Eastside Tributaries: Other Agricultural Production*, and Section 11.5, *Impacts and Mitigation Measures*), dairy viability is influenced by numerous factors that can be more critical than water availability for feed crops, waste disposal, and nutrient management. These include the market (price of milk) and the availability of feed sources. In addition, if water is less available, dairies often have the ability to obtain substitute water supplies. For example, in 2015, a critically dry year, irrigation water cost for dairy feed in the San Joaquin Valley represented about 9 percent of the cost of farm milk production (Chapter 11; Sumner 2016). While years with more water typically have lower dairy feed costs, the cost in 2015 was not dominant when considering other costs associated with dairies (Chapter 11; Sumner 2016; California Department of Food and Agriculture 2014, 2015 and 2016). As discussed in Chapter 11 (Section 11.4.2, *Methods and Approach*) SWAP modeling information can be used to evaluate potential impacts to dairy industry feed acreage. However, because dairies are a function of more than a set of feed crop categories (i.e., Corn, Alfalfa, or Grain) the SWAP model cannot predict potential changes to dairy operations, which often have the ability to adapt using alternative feed crops. Certain SWAP model crop categories (i.e., Alfalfa and Pasture or Corn and Grain) can be combined in order to evaluate effects, as identified in Chapter 11 (Section 11.4.2, *Methods and Approach*). Also as acknowledged in Chapter 11, the SWAP model has limitations in modeling performance of these crops because they tend to have lower net revenues. However, as discussed below (under the *Milk Prices and Feed* section in the *Silage* subsection) and in more detail in Master Response 8.1, *Local Agricultural Economic Effects and the SWAP Model*, to recognize the importance of corn silage in dairy operations, the SWAP model was refined to constrain corn and ensure that no more than 30 percent of the corn silage acreage can be fallowed in a given year.

Chapter 11 presents a qualitative discussion of the combined SWAP model categories (e.g., Pasture and Alfalfa) and the potential effects of a reduce water supply on feed, waste disposal, and nutrient management as it compares to the ability of dairies to purchase water and feed (Chapter 11, Section 11.5, *Impacts and Mitigation Measures*). To provide a further illustration of the ability of dairies to obtain feed, manage water, and manage waste and nutrients with the reduced crop acreage modeled under the SWAP model, additional clarifying information is provided in the following sections. In general, during both wet and dry periods, the price of milk is a dominant factor that determines the availability of irrigation water for feed crops. This information supports the conclusions in Chapter 11 that lands currently designated as dairies would not be converted to nonagricultural uses as a result of the plan amendments, specifically as a result of a reduction in water supply.

Dairy Characteristics

As described in Chapter 11 (Section 11.2.2, *Lower San Joaquin River Watershed and Eastside Tributaries: Other Agricultural Production*), in California, there are approximately 1,563 dairies, of which 578 are located in Merced, Stanislaus, and San Joaquin Counties. This is approximately 36 percent of the state's total dairy operations (USDA 2015). Between 2009 and 2014, a time period which includes multiple drought years, the total number of cows in the area of potential effects has stayed relatively constant with an average of 554,445 (Table 3.5-2); however, the number of dairies has declined somewhat with the average number of cows per dairy slightly increasing (Figure 3.5-1) (USDA 2012, 2013 and 2015). These trends indicate that factors (e.g., milk prices), other than water supply availability, have a greater influence on the dairy industry in the plan area.

Table 3.5-2. Dairy Cows by Year for the Counties in the Plan Area

Year	Merced	San Joaquin	Stanislaus	Total
	Total Cows			
2009	267,362	103,707	184,035	555,104
2010	268,312	105,810	184,161	558,283
2011	262,131	106,012	180,416	548,559
2012	267,728	101,236	187,061	556,025
2013	267,124	98,495	183,901	549,520
2014	276,359	102,934	179,884	559,177
Average	268,169	103,032	183,243	554,445

Source: USDA 2012, 2013, 2015.

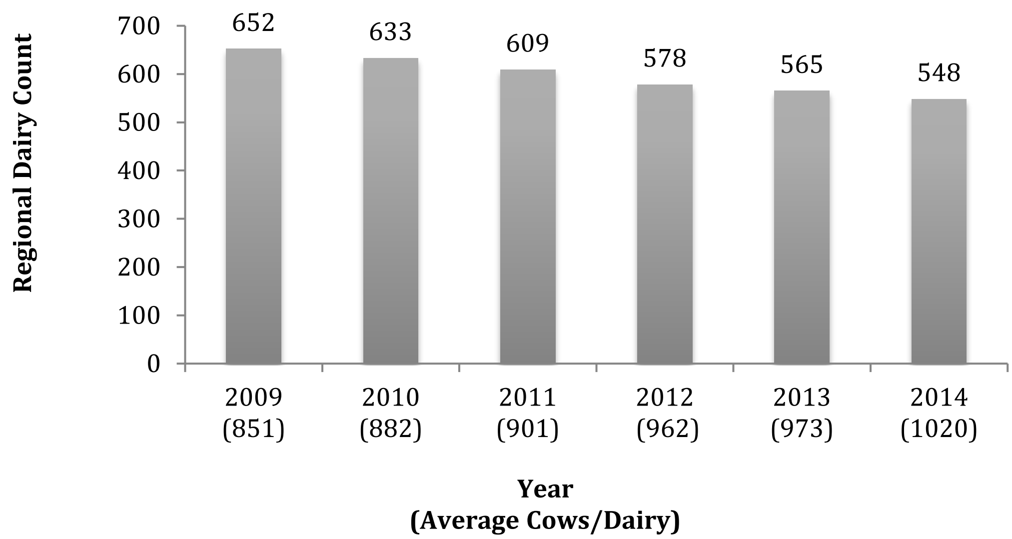

Figure 3.5-1. Average Cows/Dairy for Merced, Stanislaus, and San Joaquin Counties (Source: USDA 2012, 2013, 2015.)

For the 2002–2014 time period, the land area classified as “confined animal operation” increased from 13,140 acres in 2002 to 17,835 acres in 2014 in the plan area (DOC 2017). There was a peak of 18,465 acres in 2006 in land used for animal operations (DOC 2017). These data suggest the area in confined animal operations has been maintained in the past 10 years and has not been dramatically reduced during drier periods.

More broadly, historic trends of dairy and milk production in California, as shown in Figure 3.5-2, further demonstrate that hydrologic conditions do not influence producer decision making. As Figure 3.5-2 shows, the number of milk cows increased steadily from the mid-1980s until about 2008, before leveling off. Milk production per cow increased over the same time period, and overall quantity of milk produced is now double what it was in 1990. These overall increases occurred regardless of, and independent from, water year type.

Milk Prices and Feed

As described in Chapter 11, dairies primarily rely on the following feed crops: silage (typically corn that has been preserved through partial fermentation and is stored in a wet condition); forage (typically alfalfa that has been stored in bales at a low moisture content to prevent spoilage); grain based concentrates (such as dried field corn and wheat); other feed (which may include distiller’s grains, almond hulls, cotton seed, citrus pulp, and many more items); and supplements for feed rations (vitamins and minerals to ensure animal health). The particular mix of ingredients is dependent on the animal’s status (e.g., lactating cows require a different feed mix compared with calves). The exact mix of a feed ration and its source is up to the individual dairy operator and changes depending on market conditions.

During dry periods, milk prices have shown a dominant effect in dairy production decisions (Figure 3.5-2 and Figure 3.5-3). Milk prices typically have been more important than the available quantity of water supply used for producing forages. For example, despite being a critical year, 2014 had the highest milk production on record due to historic high milk prices.

Silage crops for dairies (Figure 3.5-4) have increased and leveled off over the past 25 years, consistent with the pattern for milk cows (Figure 3.5-2), with a slight decline recently through 2015. Alfalfa acreage has declined almost every year since 2006 for reasons not related to dairies or hydrologic conditions. During the period leading up to the recent drought, and then during the drought, milk production has been consistently strong, which demonstrates the ability of the dairy sector to accommodate for reductions in feed availability or increases in feed costs. Feed, and the available water to make feed, is a small portion of the overall costs for dairies. If feed availability is limited but milk prices are high, dairies typically import feed from other locations, or modify ration mix or feeding practices. For example, the 2014 decline in silage and hay production shown in Figure 3.5-4 did not have a bearing on the number of milk cows in 2014 (which remained high, as shown in Figure 3.5-2) or the price of milk (which was at an all-time high, as shown in Figure 3.5-3). In the San Joaquin Valley, alfalfa feed accounts for only about a third of milk production costs. Even so, somewhat higher costs for more imported hay will generally have only a limited effect on overall milk production costs, and less influence on producer decisions than milk prices.

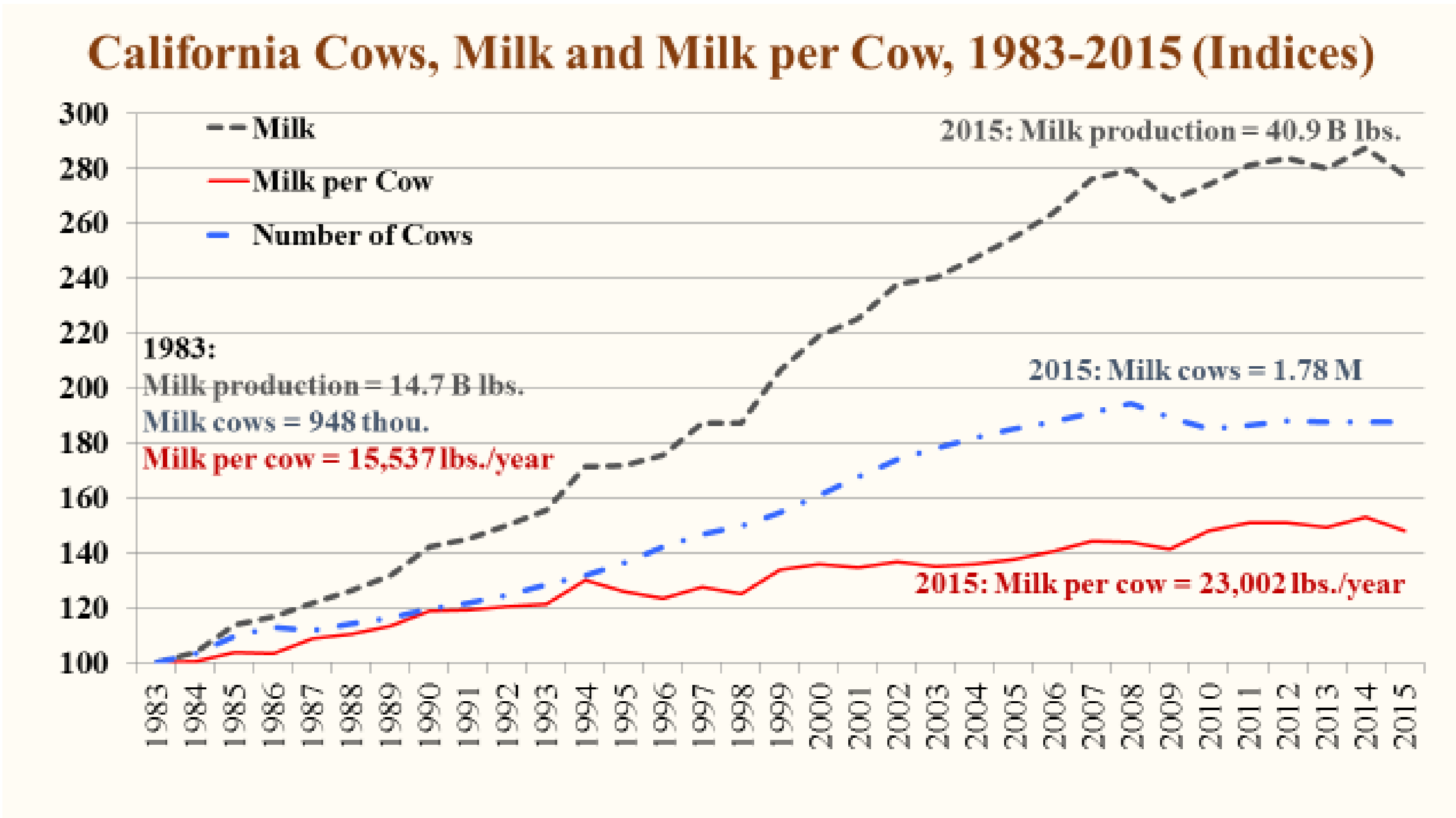

Figure3.5-2. Historical Trends in Milk Production, Milk Per Cow, and Number of Cows (Source: Sumner 2016.)

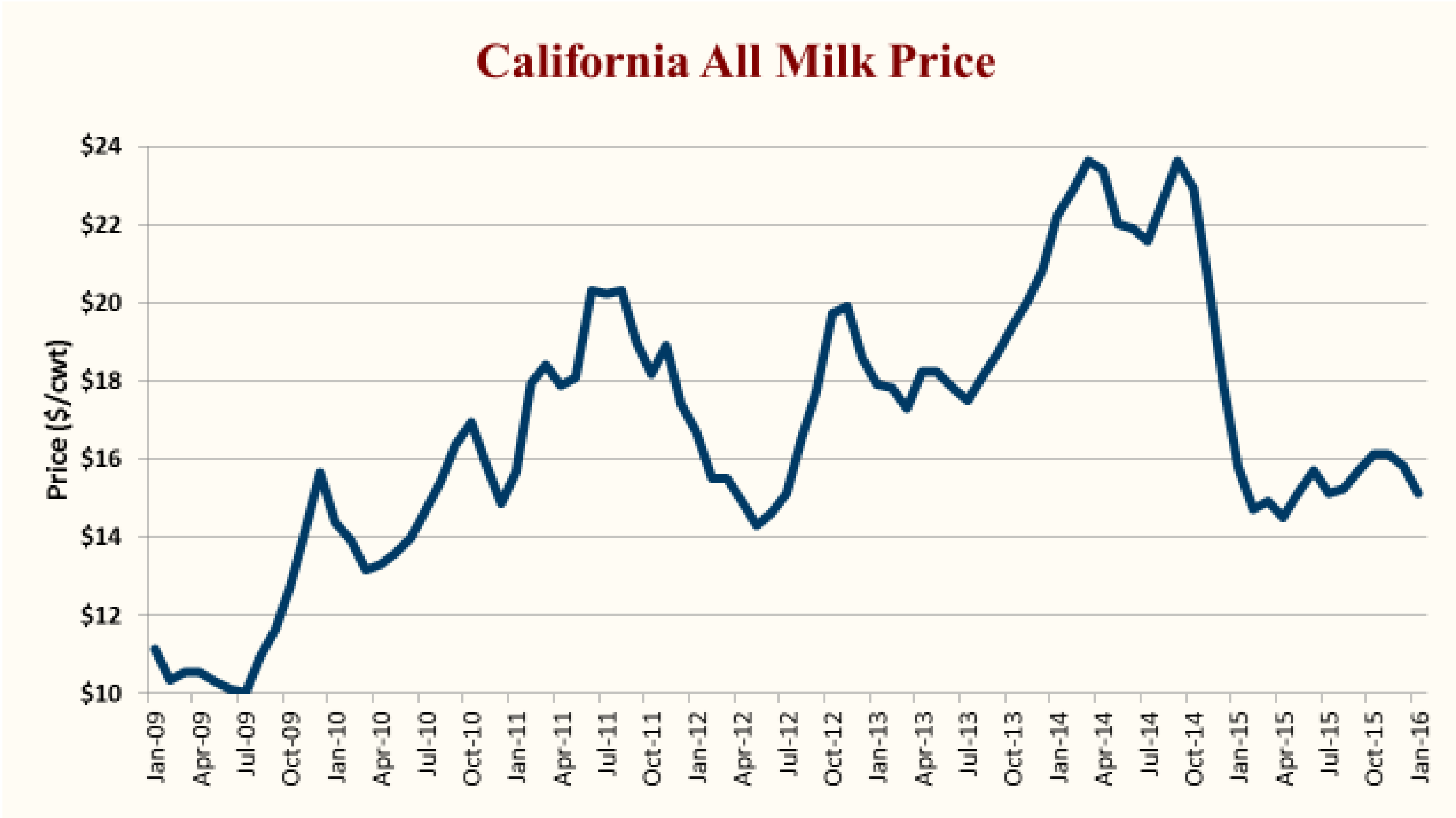

Figure 3.5-3. Milk Prices in California (Source: USDA 2015.)

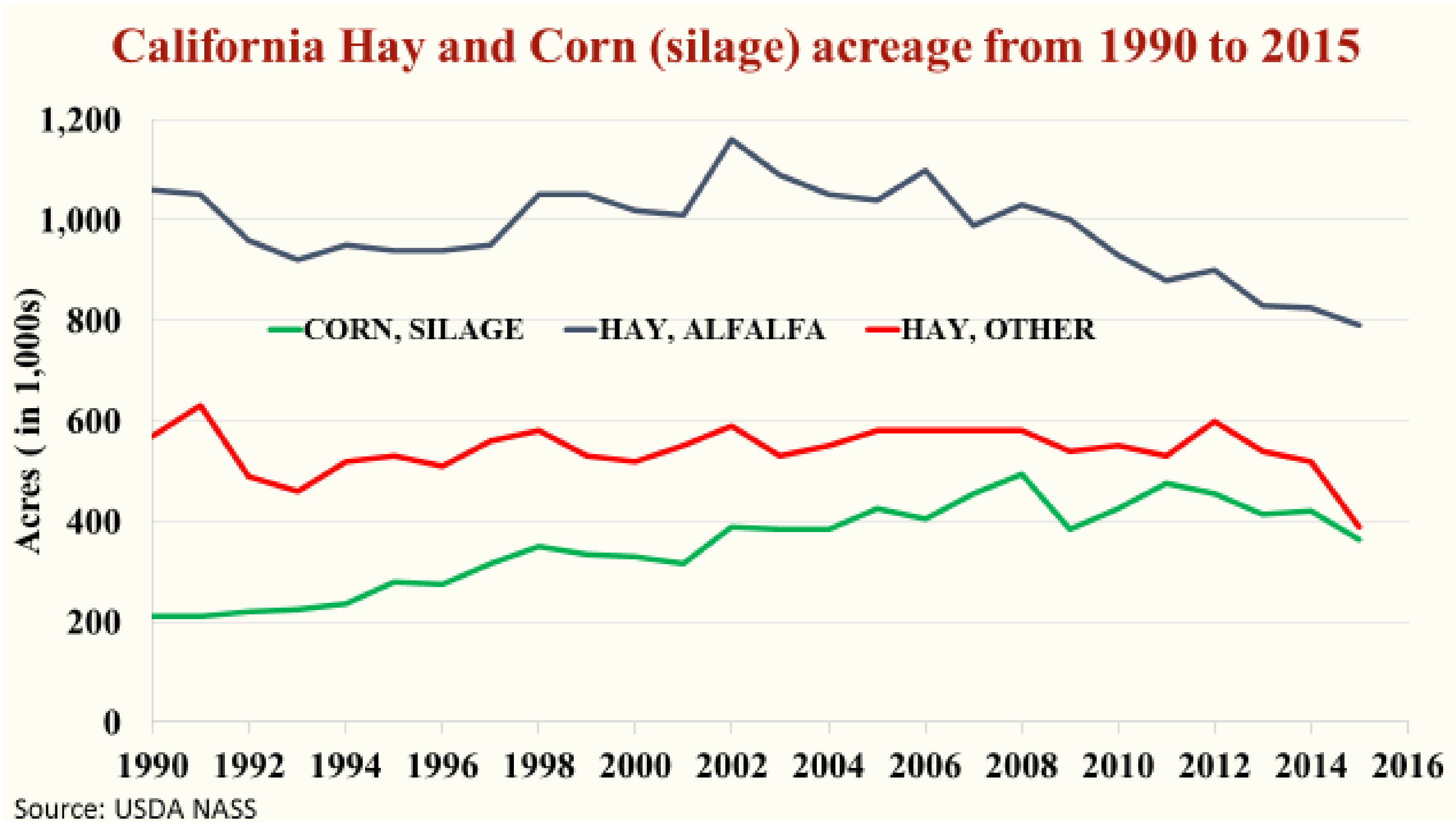

Figure 3.5-4. California Production of Feed Crops for Dairies (Source: USDA 2017)

Silage

The SWAP model includes silage in the Corn crop category. The importance of silage as a dairy feed crop is recognized in the SWAP model by limiting the amount of corn that can be fallowed during years of reduced water supply. For more information regarding the application of the silage constraint in the SWAP model, please see Master Response 8.1, and for more information regarding the potential economic effects on dairies, please see Master Response 8.2, *Regional Agricultural Economic Effects*. By limiting the amount of corn silage that can be fallowed, the SWAP model artificially increases its "value" relative to other crops, which may force some higher net revenue crops to come out of production during times of water shortage to provide water for the corn silage. The State Water Board refined the SWAP model as part of the response to comments process, updating the constraint to maintain 70 percent of the annual corn silage acreage in each irrigation district (as opposed to the 25 percent silage constraint used in the SWAP model for the Recirculated 2016 SED). As discussed in Master Response 8.2, silage is considered "undervalued" in the SWAP model. Limiting how much silage can be taken out of production in the SWAP model reflects the higher value of silage in the real world. Ultimately, the silage constraint in the SWAP model provides a conservative estimate of the amount of silage likely to be maintained in the plan area because a high proportion of the corn grown in the region goes to silage (California Department of Food and Agriculture 2016). Consequently, this constraint provides a "low-end limit" for silage production in drier years with reduce surface water supply availability; that is, production would not fall below this acreage level, even in the driest years.

Ability and Availability of Feed Substitutes

Alternative feed crops can include substitution for wet roughage and the modification of diet to include other feed sources, such as distillers' grains and almond hulls (Lee 2014). Silage corn may be substituted depending on the individual dairy operator's calculations of feed ration. Growers could choose to grow other silage crops, such as sudan grass (sorghum hybrid or Egyptian corn). Sudan grass requires less water; however, because its feed quality is lower, dairy rations must be fortified with additional feed inputs. Additional feed inputs may include more rolled corn, dry distillers' grains, or almond hulls. Typically, these inputs do not affect milk production (Lee 2014).

During droughts, dairy farmers who grow all or some of their own feed have to be more strategic about what they plant. For example, in 2014, dairies along Highway 43 near Selma and Bakersfield were hit hard by the drought and responded by planting less corn and growing more acres of other feed crops. Some dairies cut corn silage acreage to less than 50 percent and instead grew sorghum, which uses 30 percent less water than corn silage (Lee 2014).[2] Therefore, based on the potential ability for dairies to substitute silage with sudan grass, and the fact that dairies in California have used sudan grass as a substitute in the past, it is not reasonable to assume that a reduction in diary silage equates to an elimination of dairies that would result in a conversion of Designated Farmland to nonagricultural use.

To illustrate the potential value of replacement crops in preserving dairy feed supplies, the following example shows how replacing corn acreage in TID with sudan grass would affect water demand.

[2] Sorghum is not an equivalent substitute for corn silage, but with U.S. grain prices falling, dairy farmers have been able to import more corn from the Midwest to make up the nutrient differences (Lee 2014). This is another example of how feed is influenced by many variables other than the availability of water.

Acreage amounts corresponding to TID have been selected because this is the irrigation district that has the greatest reduction in corn under LSJR Alternative 3 (40 percent unimpaired flow). For the purposes of this illustration, it is assumed that all corn in TID is used to supply dairy feed. This example is not meant to reflect TID's actual operations.

This example assumes that the applied water demand per acre for sudan grass (1.76 AF/acre) is 70 percent (Lee 2014) of the demand for corn (2.51 AF/acre)(SWAP). Under baseline conditions, 39,998 acres of corn are grown on average each year in TID (Appendix G, *Agricultural Economic Effects of Lower San Joaquin River Flow Alternatives: Methodology and Modeling Results*, Table G.4-6e), and the average annual total applied water demand is 100,460 AF. On average for critical years, 4,250 acres of corn are fallowed annually in TID under LSJR Alternative 3, relative to Baseline conditions. This reduction in acreage, in turn, reduces total district water demand by 10,676 AF. The average annual water use, in critical years, for corn in TID was 86,625 AF under LSJR Alternative 3 (Table 3.5-3).

If, instead, the baseline acreage for corn in TID was changed to sudan grass, then the total applied water demand for the average annual acreage would be:

39,998 acres * 1.76 AF/acre = 70,396 AF

The applied water demand for sudan grass is already 16,228 AF less (86,625 – 70,396 AF) than the average annual water used in critical years for corn under LSJR Alternative 3, but without any need for fallowing or deficit irrigation.

Table 3.5-3. Applied Water for Corn Acreage by Year Type in TID

	Applied Water used for Corn	
	Baseline	LSJR Alternative 3 (40% unimpaired flow)
Year Type	Acre-feet	
Wet	101,256	101,256
Above Normal	101,256	100,842
Below Normal	101,256	99,331
Dry	100,978	96,754
Critical	97,403	86,625
Average	100,460	97,301

Growers may also harvest all corn planted as silage. However, this practice requires a greater level of management and, consequently, could reduce net revenues. Many growers identify corn silage fields during the growing season, selecting fields that are late planted or stressed. This approach can be effective when stresses such as drought are frequently encountered. It allows growers to obtain greater yields of dry matter and energy from fields with limited potential for high-grain yields. Using these management practices to improve silage yields can result in fewer acres required to fill the silo and more corn acres available for shelled or ear corn harvest (Roth and Heinrichs 2017). Therefore, based on the sudan grass substitution example, the commenter concern that dairies will cease operations and go out of business as a result of the plan amendments is unreasonable.

Water Demand

Water demand for cattle and cows (drinking, washing) varies depending on life stage and objective. For example, lactating cows require about 2.5 times the amount of water that cattle require. Cow population data collected by the county agricultural commissioners (Merced 2017; San Joaquin 2017; and Stanislaus 2017) in the area of potential effects can be used to estimate the average water demand of dairy cows. The average water demand is just over 94,401 AF, or 6.22 percent, of available baseline irrigation water supply (Table 3.5-4). This information can be used to illustrate potential water demand under the LSJR flow objectives. For example, under LSJR Alternative 3 (40 percent unimpaired flow), the dairy and cattle water demand is assumed to stay the same; however, it now represents a slightly larger portion of the available water supply, about 6.71 percent. This change is less than a 1 percent difference from the baseline and overestimates the dairy and cattle water demand. This is because it does not factor in the reduced water demand of the portion of the dairy cow population that is not lactating, the portion of the cattle population that is transient and may only be in the county for slaughter, and cattle within a county's boundary but outside of the area of potential effects. This slight change in water demand would also be further reduced by taking into account all parlor water and some portion of the drinking water that is available, once diluted, for use in crop irrigation. Because cow and cattle water demands are a relatively small portion of the water supply, the reduction in water supply would likely not result in dairies going out of business, especially when other factors influencing the business are taken into account (e.g., milk prices, availability of feed substitutes).

Table 3.5-4. Summary of Dairy and Cattle Water use and Percent of Applied Water by County

Category	Population	# Daily Water Demand (gallons)	Annual Water Demand (AF)	% of Annual Average Baseline Water Supply (1,518,852 AF)	% of LSJR Alt 3 Water Supply (1,406,979 AF)	Change from Baseline
*Dairy drinking	554,455	50	31,053	2.04	2.21	0.16
**Parlor washing		77	47,822	3.15	3.40	0.25
*Cattle drinking	692,974	20	15,525	1.02	1.10	0.08
Total	1,247,429		94,400	6.22	6.71	0.49

Source: University of California, Davis, 2012.

*Some portion of this water is recovered through urine and diverted to holding tanks for eventual land disposal through cropping.

**Once used in the parlor, this water source is then diverted to holding tanks for eventual land disposal through cropping.

[a] Population statistics for dairy cows: Table 3.5-2.

Notes: Water needs by cow vary; in 90 degrees Fahrenheit heat, 50 gallons per day is the typically need limit for mature lactating cows, with 20 gallons per day being the typical need limit for cattle under the same heat conditions.

Dairy and cattle water use is county-wide, it is not known what portion of the water demand is satisfied through deliveries from the affected water suppliers.

Nutrient Management

Commenters expressed a concern that the implementation of the plan amendments would result in insufficient land available for waste disposal; however, they did not provide information or substantial evidence that a reduction in cropped area utilized for nutrient management would result in a conversation of agricultural land to nonagricultural uses. . Dairy waste management in the area of potential effects is regulated under waste discharge permits issued by the Central Valley Regional Water Quality Control Board (Cady and Francesconi 2010). Under these orders, dairies must, in part, quantify the volume of water required for daily operations, nutrient loading, and identify a nutrient application area or waste-hauling plan. Although nutrient management plans are required and must be available at the dairy, these plans are not publicly available (Central Valley Water Board 2013). Waste discharge permits do not restrict the types of crop land to which solid waste and wastewater can be applied; however, there is a requirement that the nitrogen content of the applied waste is no greater than 1.4 times the plant uptake of nitrogen. For example, if nitrogen-containing waste is applied to a crop of oats at 300 pounds (lbs)/acre, and the uptake is 220 lbs/acre, then the *applied* to *removed* ratio is 1.36 (300/220lbs), which is below the 1.4 target ratio (Chang et al. 2005). Wet waste disposal typically occurs on crop categories such as Corn and Grain that are adjacent to dairy facilities. Wet and solid waste is typically not applied to alfalfa, tree, or vegetable crops because there is potential to harm the crops. Solid waste disposal can take place on the same cropland or can be hauled away from the dairy and applied on lands as fertilizer elsewhere, potentially inside or outside of the plan area. Approximately 121,000 acres serve as land for manure application in San Joaquin, Merced and Stanislaus Counties (Harter et al. 2017).

Because nutrient management plans are not publicly available, for illustration purposes, information from an environmental impact report for a dairy expansion project in Merced County is presented below, along with the SWAP model acreage results under LSJR Alternative 3 (40% unimpaired flow) for crop categories that are amenable to dairy waste application (i.e., Corn, Grain, and Other Field). This illustration was done to compare amenable crop type and acreage with land area required for disposal (SWAP model results are in Chapter 11, Section 11.5 *Impacts and Mitigation Measures*, and Appendix G, Tables G.4-6a through 6f). The example below shows that even if the plan area experiences a reduction in water supply, there would still be enough acreage of various crops in production under LSJR Alternative 3 to provide waste disposal and nutrient management for the amount of waste expected to be disposed of by the current number of dairies in the plan area.

In the Merced County dairy expansion environmental impact report, 2,760 wet (actively being milked or producing milk) and dry (not actively being milked or producing milk) cows were used to estimate fresh water (i.e., irrigation delivery water) demand and disposal land area (Cardoso 2011). Although the size of this dairy is larger than the average in the region (Figure 3.5-1), it is assumed that the rates of water use and disposal are relatively constant. On this dairy, 442 acres of land were used for solid and liquid waste disposal from milking barn operations (Cardoso 2011). The ratio of acres per cow is:

442 acres/2,760 cows = 0.16 acres/cow

Although manure waste can be, and is, trucked out of the area for disposal, if it were all disposed of within the area of potential effects, the land area required for nutrient disposal would be:

554,455 cows (Table 3.5-2) * 0.16 acres/cow = 88,793 acres

As shown in Table 3.5-5, the SWAP model results for LSJR Alternative 3 indicate that there is sufficient acreage of Corn, Grain, and Other Field Crops to provide for waste disposal in all year types.

Table 3.5-5. Cropland Suitable for Dairy Waste Disposal under LSJR Alternative 3 (40 percent Unimpaired Flow)

	Wet	Above Normal	Below Normal	Dry	Critical	All Years
Crop	Average Acres					
Corn	106,770	106,522	105,945	104,653	94,912	103,941
Grain	14,434	14,425	14,414	14,371	14,090	14,352
Other Field	54,256	52,745	49,103	40,239	12,908	42,854
Total	175,460	173,692	169,462	159,263	121,911	161,148

A dairy's decision for where the manure is applied in relation to the dairy's location would involve many personal and business considerations by the individual operator. Although the specific fields that will be used for waste disposal are not known, based on application criteria and availability of amenable land, there is sufficient land available in the plan area to meet estimated waste disposal needs.

Cattle and Pasture

Commenters suggested that the implementation of the plan amendments would result in a reduction in herd size; however they did not provide information or substantial evidence that a reduction in heard size as a result of a reduction in water supply would result in a conversion of agricultural land to nonagricultural uses. As with other agricultural enterprises, cattle requires land and water resources for production; however, unlike crop production, cattle are often moved throughout the area of potential effects and throughout California and the western United States to accommodate grazing needs. Collectively, during the drought years of 2011–2016 (data through 2015), within the area of potential effects the number of cattle remained relatively constant, ranging from a low 748,217 head in 2013 to a high of 788,645 head in 2011 (a difference of 40,000 cattle) with an average of 768,593 head (Table 3.5-6) (Merced 2017; San Joaquin 2017; Stanislaus 2017). Not all counties report statistics the same way; for example, Stanislaus County reports that the counts include transient cattle that may only be in the county for slaughtering. Also, the statistics are county-wide, which means the statistics are only representative or approximate the number of cattle in the area of potential effects.

Total gross value of cattle increased each year (Table 3.5-7) during the recent drought. Initially, the revenue per unit cattle increased significantly between 2011 and 2014 from $723/head to $1,116/head but then decreased $11/head between 2014 and 2015 (Figure 3.5-5). (Revenue shown is for the reported year.)

Table 3.5-6. Cattle Population in Stanislaus, Merced, and San Joaquin Counties 2011–2015

Year	San Joaquina	Mercedb	Stanislausc	Total	% Change from Previous Year
2011	119,700	337,231	331,714	788,645	
2012	107,000	342,366	326,790	776,156	-1.58
2013	113,000	317,977	317,240	748,217	-3.60
2014	112,000	312,752	327,031	751,783	0.48
2015	126,000	330,565	321,600	778,165	3.51
Average	115,540	328,178	324,875	768,593	

Sources: Merced 2012, 2013, 2014, 2015; 2016; San Joaquin 2012, 2013, 2014, 2015, 2016; Stanislaus 2012, 2013, 2014, 2015, 2016.

[a] Cattle and calves.

[b] Includes calves, cull bulls, cull cows, replacement heifers, and stocker cattle.

[c] Includes feed lots, beef steers, beef heifers, beef replacement heifers, transient cattle, beef cows, beef bulls dairy beef.

Table 3.5-7. Gross Revenue for Cattle Population in Stanislaus, Merced, and San Joaquin Counties 2011–2015

	San Joaquin	Merced	Stanislaus	Total	Ratio of Revenue to Herd Size
Year	Gross Value $				$/Head
2011	71,479,000	290,823,000	207,649,000	569,951,000	723
2012	66,987,000	296,891,000	214,217,000	578,095,000	745
2013	76,043,000	283,729,000	235,460,000	595,232,000	796
2014	97,320,000	350,092,000	391,803,000	839,215,000	1,116
2015	152,388,000	357,426,000	350,209,000	860,023,000	1,105
Average	92,843,400	315,792,200	279,867,600	688,503,200	896

Sources: Merced 2012, 2013, 2014, 2015; 2016; San Joaquin 2012, 2013, 2014, 2015, 2016; Stanislaus 2012, 2013, 2014, 2015, 2016.

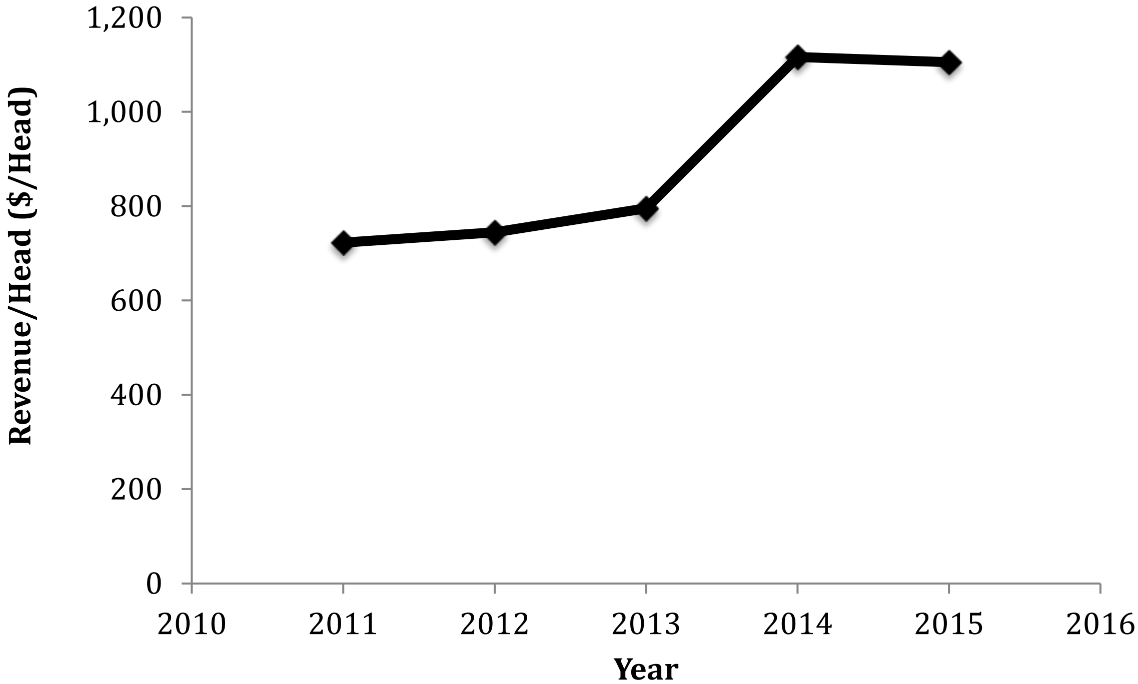

Figure 3.5-5. Average Revenue per Unit Head in Counties Potentially Affected by the Plan Amendment in Dollars per Given Year (Sources: Merced 2012, 2013, 2014, 2015; 2016; San Joaquin 2012, 2013, 2014, 2015, 2016; Stanislaus 2012, 2013, 2014, 2015, 2016.)

California cattle operations are accustomed to varying water supplies and have management strategies to ensure adequate pasture and feed. The University of California Cooperative Extension recommends pasture management to reduce drought impacts, including the following strategies (McDougald et al. 2001).

- **Manage irrigation**. Generally, plant productivity and consumptive water use is higher in the spring; therefore, it is recommended that available irrigation water be used in spring months with cut backs during the summer months.
- **Graze pasture more intensely**. A higher stocking density results in more thorough consumption of edible plants whereas a lower density results in less grazing of less desirable forage.
- Utilize rotational grazing over continuous grazing. This practice allows better plant recovery.
- **Utilize fertilizers.** This practice increases forage production.

Therefore, it is unreasonable to assert that the potential reduction in surface water supply used by cattle and pasture would result in a potential conversion of Designated Farmland to nonagricultural uses. Impacts identified in Chapter 11, Section 11.5, *Impacts and Mitigation Measures*, already reflect a conservative (i.e., worst case) estimate of impacts, and commenters have provided no substantial evidence to support an alternative conclusion.

Reductions in Water Demand

Commenters suggested that implementing demand management practices could mitigate or reduce significant impacts attributed to reduced water supply on Prime, Unique, and Farmland of Statewide Importance disclosed in Chapter 11, *Agricultural Resources*, or that certain practices to reduce water demand (i.e., dry land farming, deficit irrigation) are not economically feasible agricultural practices. Demand management is the implementation of water management practices to increase the amount of water used for consumptive use of irrigation (evapotranspiration) while reducing the non-consumptive uses, such as deep percolation and runoff. Demand management involves both the water supplier and the irrigator. In Chapter 11, demand management is incorporated into the analysis in two ways: (1) it is recognized in the applied water rates for the crop categories analyzed with the SWAP model, and (2) it is incorporated as mitigation measures to reduce potential conversion of Designated Farmland to nonagricultural uses. In Chapter 11, demand management is discussed in Section 11.3.1 under the *Water Conservation Bill of 2009* and under Section 11.5, *Impacts and Mitigation Measures*. Under Section 11.5, the following mitigation measures were identified.

- Increase the use of irrigation management services to better determine how much water is needed by a crop and when to apply it.
- Convert less efficient irrigation systems (e.g., surface irrigation) to more efficient ones (e.g., microirrigation).
- Increase the capability of irrigation water suppliers to provide delivery flexibility, such as the use of irrigation district regulating reservoirs, to allow flexible delivery durations, scheduling, and flow rates.

As discussed in Master Response 1.1, *General Comments,* the State Water Board incorporated and evaluated potential mitigation measures in Chapter 11 as identified above to meet its obligations under CEQA and the Certified Regulatory Program (section 15126.4 of the State CEQA Guidelines and section 3777(b)(3) and (b)(4)(D)). However, the ultimate impact determination depends upon the feasibility for the State Water Board to legally implement the mitigation measure or the obligations of the State Water Board and other third parties under other programs or regulations. In the case of the impacts identified in Chapter 11, the potential for impacts determined to be significant to be mitigated to less-than-significant levels rests with third parties, such as an individual or other entity, because CEQA does not grant agencies new, discretionary powers independent of the powers granted to the agencies (i.e., the State Water Board) by other laws. Accordingly, a mitigation measure may be legally infeasible if the lead agency does not have the authority to require or implement it.

In this case, the impact determination is conservatively characterized as significant and unavoidable in the SED because the State Water Board, as the CEQA lead agency, cannot be certain that the other parties will (1) undertake the exact action that the State Water Board is describing, and (2) implement the proposed mitigation to reduce potentially significant environmental effects. In other words, “significant and unavoidable” means that State Water Board could not be certain that the proposed mitigation will be implemented and ultimately succeed in mitigating an impact to a level below significance because the mitigation is reliant on the action of a third party. Furthermore, the actual effects of the demand management measures identified in Chapter 11 cannot be fully described or quantified because there are many factors that could influence a grower’s decision to implement one of the measures. These decisions would be based on considerations such as crop mix, acres grown, market conditions, actual applied water needs, and actual water supply. The demand management methods of crop substitution, dry land farming, deficit irrigation, and irrigation efficiencies are discussed in the following subsections based on comments received regarding their ability to be used by growers or the need to quantify the effects of these methods as mitigation.

Crop Substitution

As discussed in Chapter 11 and under *Ability and Availability of Feed Substitutes* in this master response, crop substitution is an appropriate demand management technique that allows agricultural production to continue, and to be profitable, while reducing the overall use of water. The example shown earlier in this master response shows that the applied water demand for sudan grass is 16,228 AF less (86,625 – 70,396 AF) than the average annual water used in critical years for corn under LSJR Alternative 3, but without any need for fallowing or deficit irrigation. This is a clear example of how crop substitution could be used in the area of potential effects to maintain land in agricultural production even with a reduced water supply as modeled under LSJR Alternative 3.

Dry Land Farming

Dry land farming involves the use of stored soil water to produce a crop, typically a winter grain such as wheat or oats. As discussed in Chapter 11, dry land farming constitutes an agricultural activity practiced in the area of potential effects and in California. However, because dry land farming is an individual's decision that is based on numerous factors, and because the State Water Board cannot legally enforce dry land farming, potential impacts of the conversion of Designated Farmland to nonagricultural uses remain significant and unavoidable. Furthermore, no conversion credit or changes to revenue were taken in the SWAP model results related to dry land farming.

Deficit Irrigation

As discussed previously under *Management of Permanent Crops* in this master response, deficit irrigation is a feasible and accepted irrigation management practice whereby the plant is deliberately stressed at strategic times to reduce its consumptive use of water. Deficit irrigation is a feasible management practice, even for permanent crops, which allows crop survival and some level of productivity. Typically deficit irrigation is performed when water supplies are reduced particularly during droughts. However, for some crops, particularly wine grapes, deficit irrigation is a standard practice. Deficit irrigation can be implemented to minimize yield impacts for some crops by carefully timing irrigation events at certain stages of plant growth to make sure the crop receives water when it is most important (Goldhamer et al. 2005). For example, spring cuttings of alfalfa are higher in yield and nutrient quality compared with summer cuttings, so it may be preferable to deficit irrigate in the summer when yield and quality are already lower. In addition, consumptive use during spring for alfalfa is lower than in summer. Growers prudently utilizing a limited water supply for alfalfa could allocate more of their surface water supply for early season irrigations and cut back on summer watering (Orloff et al. 2015). As mentioned under the *Management of Permanent Crops* section above, studies have shown that strategic deficit irrigation of almonds has still allowed for a relatively high yield (Fulton 2007; Prichard et al. 1996).

Irrigation Efficiencies

As identified in Chapter 11, Section 11.5, *Impacts and Mitigation Measures*, increasing the efficiency of district and on-farm level irrigation would likely reduce the significant impacts associated with Designated Farmland conversion to nonagricultural uses. For example, the 2015 MID AWMP states that there were 184,700 AF of crop evapotranspiration from applied water and 108,500 AF of the applied water flowing to deep percolation. Considering only these two factors, the consumptive use fraction is 63 percent (184,700/ [184,700 + 108,500]), with the other 37 percent going to deep percolation. Reducing the applied water going to deep percolation would increase the water supply available for crop consumptive use. Reducing deep percolation to 25 percent of the total applied water would increase the amount of water available for consumptive use by 35,000 AF. To put this number in context, under LSJR Alternative 3 (40 percent unimpaired flow), MID has an average reduction of 41,000 AF of reduced surface water supply (Appendix G). In other words, almost the entire volume of reduced modeled surface water for MID could be replaced by improving the consumptive use fraction from the reported 63 percent to 75 percent.

However, as described in Chapter 11, the decision to implement irrigation efficiency measures is an individual grower decision that cannot be quantified with any accuracy because it would depend on many site-specific assumptions. It would depend on identifying exactly where reduced water supply would occur, for which crops, and, subsequently, when the land would be idle and where to implement efficiency improvements. Also, on-farm efficiency improvements may require irrigation district–level actions that the State Water Board has no legal authority to implement, nor is it known where or what type of improvements would be required, because it is not known what grower efficiency measures might be implemented. Given the number of unknowns, the effect of the irrigation efficiency cannot be quantified. As discussed in Chapter 11, Section 11.5, the State Water Board has authority to take action to prevent waste, unreasonable use, unreasonable method of use, and unreasonable method of diversion of water. The State Water Board may exercise this authority through quasi-adjudicative or quasi-legislative proceedings. However, such proceedings are case-specific. Therefore, it is infeasible for the State Water Board to impose mitigation measures at this time because it is undertaking a programmatic analysis of the potential agricultural resource impacts, does not currently have specific facts associated with an individual project to legally and technically impose requirements related to waste and unreasonable use, and it is speculative whether irrigation efficiencies would reduce conversions of agricultural lands. In addition, while the State Water Board may impose water conservation or efficiency requirements through the adoption of regulations, the amount of time, high cost, and commitment of staff resources associated with such rule-making proceedings also render adopting the mitigation measures now infeasible. As such, impacts were determined to be significant and unavoidable.

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