SOCIOECONOMICS
STUDY REPORT
DON PEDRO PROJECT
FERC NO. 2299



TID WATER & POWER
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MID
Modesto Irrigation District

Prepared for:
Turlock Irrigation District – Turlock, California
Modesto Irrigation District – Modesto, California

Prepared by:
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April 2014

Correction pages to W&AR-15: Socioeconomic Study Report, as provided by the Districts on April 28, 2014.

1. On Page x, add the following to the List of Acronyms:

DP PMP……………………………Don Pedro PMP Model

2. On Pages 5-2 and 5-3, replace the first five paragraphs of Section 5.1.3 (up to but not including Table 5.1.1) with the following:

The Positive Mathematical Programming (PMP) approach was used to develop the Don Pedro PMP (DP-PMP) economic model in order to estimate:

(1) the economic value of the Districts' irrigation water in current uses; and
(2) the potential changes in agricultural production which may result from changes in surface water supplies from Project operations.

The DP-PMP model utilizes the PMP modeling framework used in many other models developed to model California agricultural. The PMP technique has been embraced by agricultural sector model professionals because it addresses the issue of model calibration despite the existence of a large amount of missing information (Howitt, 1995 and Wiborg, B.A et.al.) The technique has been used in the development of the California Value Integrated Network (CALVIN) model (Howitt et al. 2010). Subsequently, PMP-based models have been used in the development of varied planning scenarios and studies, such as those supporting the California Department of Water Resources preparation of the 2009 Water Plan Update (DWR 2009), referenced in (Howitt, et al. 2008).

PMP is a self-calibrating modeling approach applied to agricultural production modeling. PMP is a widely-accepted method for analyzing water demand and analyzing changes in resource policies (Medellin-Azuara et al. 2008; Howitt 1995; and Lund et al. 2007). The calibration method ensures that the initial predicted crop production results from the model match the actual historical data (Howitt 1995).

The DP-PMP model is an annual model and is structured on the assumption that farmers choose cropping patterns that will maximize their profits, subject to constraints on available land and irrigation water supplies. The specific constraints that will be used when the model is run to estimate on-farm cropping patterns on lands in TID and MID under various water-supply scenarios are listed in Table 5.1-1.

Because DP PMP is an annual model, the total predicted crop acreage in any year is constrained to be no greater than the amount of irrigated land at that time. Once calibrated, the model is used to estimate annual changes to cropping patterns, total irrigated acres, crop yield, and/or changes in water use per acre that result from changes in water supply for irrigation.

3. **On Page 5-26, replace the paragraph in Section 5.5.1 with the following:**

   Land holdings are a significant source of wealth particularly for agricultural landowners. Farmland has historically represented about 75 percent of assets held by farm households. The value of farmland is determined primarily by its ability to generate agricultural income. Historically, the Project has provided a high degree of water supply reliability to landowners, supporting investment in high-valued crops and creating relatively high agricultural income per acre. The high degree of water supply reliability is reflected in the land value and the prices that landowners have had to pay for land located within the Project's boundaries. Additionally, urbanization is increasingly affecting farmland values. This speculative value must also be considered along with traditional economic theory. Based on these factors, the potential effect on agricultural operations and related land values from the relicensing of the Don Pedro Project is an important consideration for local agricultural landowners served by the Project.

4. **On Page 8-1, replace the first sentence of first paragraph with the following:**

   Table 8.1-1 shows the gross revenue by crop for a range of irrigation water supplies (for a complete analysis of all estimated economic impacts including impacts to the production of milk and beef as well as the impacts to the agricultural processing sector see Appendix E, Attachment I, Regional Economic impact caused by a Reduction in Irrigation Water Supplied to Turlock Irrigation District and Modesto Irrigation District: Methodology Memorandum)

5. **On Page 10-13, remove the following:**

   Blank, Steven C., et al. 2006. Farm Household Wealth: Where Does it Come From? Agricultural and Resource Economics Update, Vol. 9, No. 6, July/Aug, 2006.

6. **Throughout the report, replace the acronym "SWAP" with the acronym "DP PMP."**

Socioeconomics
Study Report

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List of Acronyms

ac	acres
ACEC	Area of Critical Environmental Concern
AF	acre-feet
ACOE	U.S. Army Corps of Engineers
AFY	acre-feet per year
ADA	Americans with Disabilities Act
ALJ	Administrative Law Judge
APE	Area of Potential Effect
ARMR	Archaeological Resource Management Report
BA	Biological Assessment
BAWSCA	Bay Area Water Supply Conservation Agency
BDCP	Bay-Delta Conservation Plan
BEA	Bureau of Economic Analysis
BLM	U.S. Department of the Interior, Bureau of Land Management
BLM-S	Bureau of Land Management – Sensitive Species
BMI	Benthic macroinvertebrates
BMP	Best Management Practices
BO	Biological Opinion
CAISO	California Independent System Operators
CalEPPC	California Exotic Pest Plant Council
CalSPA	California Sports Fisherman Association
CALVIN	California Value Integrated Network
CAS	California Academy of Sciences
CASFMRA	California Chapter of the American Society of Farm Managers and Rural Appraisers
CCC	Criterion Continuous Concentrations
CCIC	Central California Information Center
CCSF	City and County of San Francisco
CCVHJV	California Central Valley Habitat Joint Venture
CD	Compact Disc
CDBW	California Department of Boating and Waterways

CDEC.........................California Data Exchange Center

CDFA.........................California Department of Food and Agriculture

CDFG.........................California Department of Fish and Game (as of January 2013, Department of Fish and Wildlife)

CDMG........................California Division of Mines and Geology

CDOF.........................California Department of Finance

CDP............................Census Designated Place

CDPH.........................California Department of Public Health

CDPR.........................California Department of Parks and Recreation

CDSOD......................California Division of Safety of Dams

CDWR........................California Department of Water Resources

CE ....California Endangered Species

CEII............................Critical Energy Infrastructure Information

CEQA.........................California Environmental Quality Act

CESA ....California Endangered Species Act

CFR............................Code of Federal Regulations

cfs...............................cubic feet per second

CGS............................California Geological Survey

CMAP ....California Monitoring and Assessment Program

CMC...........................Criterion Maximum Concentrations

CNDDB......................California Natural Diversity Database

CNPS..........................California Native Plant Society

CORP ....California Outdoor Recreation Plan

CPI ....Consumer Price Index

CPUE ....Catch Per Unit Effort

CRAM........................California Rapid Assessment Method

CRLF..........................California Red-Legged Frog

CRRF ....California Rivers Restoration Fund

CSAS..........................Central Sierra Audubon Society

CSBP..........................California Stream Bioassessment Procedure

CT ....Census Tract

CT ....California Threatened Species

CTR............................California Toxics Rule

CTS ....California Tiger Salamander
CUWA ....California Urban Water Agency
CV ....Contingent Valuation
CVP............................Central Valley Project
CVPIA........................Central Valley Project Improvement Act
CVRWQCB ....Central Valley Regional Water Quality Control Board
CWA ....Clean Water Act
CWD ....Chowchilla Water District
CWHR........................California Wildlife Habitat Relationship
CWT...........................hundredweight
Districts......................Turlock Irrigation District and Modesto Irrigation District
DLA ....Draft License Application
DPRA.........................Don Pedro Recreation Agency
DO.............................Dissolved Oxygen
DPS ....Distinct Population Segment
EA ....Environmental Assessment
EC ....Electrical Conductivity
EDD ....Employment Development Department
EFH............................Essential Fish Habitat
EIR ....Environmental Impact Report
EIS..............................Environmental Impact Statement
ENID..........................El Nido Irrigation District
ENSO ....El Nino – Southern Oscillation
EO ....Executive Order
EPA............................U.S. Environmental Protection Agency
ERS ....Economic Research Service (USDA)
ESA............................Federal Endangered Species Act
ESRCD.......................East Stanislaus Resource Conservation District
ESU............................Evolutionary Significant Unit
ET...............................Evapotranspiration
EVC............................Existing Visual Condition
EWUA........................Effective Weighted Useable Area
FERC..........................Federal Energy Regulatory Commission

FFS............................Foothills Fault System
FL...............................Fork length
FMU...........................Fire Management Unit
FMV...........................Fair Market Value
FOT............................Friends of the Tuolumne
FPC ....Federal Power Commission
FPPA..........................Federal Plant Protection Act
FPC ....Federal Power Commission
ft.................................feet
ft/mi............................feet per mile
FWCA........................Fish and Wildlife Coordination Act
FYLF..........................Foothill Yellow-Legged Frog
g.................................grams
GAMS........................General Algebraic Modeling System
GIS ....Geographic Information System
GLO ....General Land Office
GPM...........................Gallons per Minute
GPS ....Global Positioning System
HCP............................Habitat Conservation Plan
HHWP........................Hetch Hetchy Water and Power
HORB ....Head of Old River Barrier
HPMP.........................Historic Properties Management Plan
ILP.............................Integrated Licensing Process
IMPLAN ....Impact analysis for planning
I-O.............................Input-Output
ISR ....Initial Study Report
ITA.............................Indian Trust Assets
kV..............................kilovolt
LTAM ....Long-Term Acoustic Monitoring
LTR............................Lower Tuolumne River
m ....meters
M&I............................Municipal and Industrial
MCL...........................Maximum Contaminant Level

mg/kg ....milligrams/kilogram
mg/L...........................milligrams per liter
mgd ....million gallons per day
mi ....miles
mi^2 ....square miles
MID............................Modesto Irrigation District
MOU ....Memorandum of Understanding
MRP ....Monitoring and Reporting Program
MRWTP.....................Modesto Regional Water Treatment Plant
MSCS.........................Multi-Species Conservation Strategy
msl..............................mean sea level
MVA ....Megavolt Ampere
MW ....megawatt
MWh ....megawatt hour
mya............................million years ago
NAE ....National Academy of Engineering
NAHC ....Native American Heritage Commission
NAICS........................North America Industrial Classification System
NAS............................National Academy of Sciences
NASS ....National Agricultural Statistics Service (USDA)
NAVD 88...................North American Vertical Datum of 1988
NAWQA ....National Water Quality Assessment
NCCP ....Natural Community Conservation Plan
NEPA ....National Environmental Policy Act
ng/g ....nanograms per gram
NGOs ....Non-Governmental Organizations
NHI ....Natural Heritage Institute
NHPA.........................National Historic Preservation Act
NISC ....National Invasive Species Council
NMFS.........................National Marine Fisheries Service
NMP...........................Nutrient Management Plan
NOAA ....National Oceanic and Atmospheric Administration
NOI ....Notice of Intent

NPS ............................U.S. Department of the Interior, National Park Service
NRCS ....National Resource Conservation Service
NRHP..........................National Register of Historic Places
NRI.............................Nationwide Rivers Inventory
NTU ....Nephelometric Turbidity Unit
NWI............................National Wetland Inventory
NWIS ....National Water Information System
NWR ....National Wildlife Refuge
NGVD 29...................National Geodetic Vertical Datum of 1929
O&M ....operation and maintenance
OEHHA......................Office of Environmental Health Hazard Assessment
OID ....Oakdale Irrigation District
ORV ....Outstanding Remarkable Value
PAD............................Pre-Application Document
PDO............................Pacific Decadal Oscillation
PEIR...........................Program Environmental Impact Report
PGA............................Peak Ground Acceleration
PHG............................Public Health Goal
PM&E ....Protection, Mitigation and Enhancement
PMF............................Probable Maximum Flood
PMP............................Positive Mathematical Programming
POAOR......................Public Opinions and Attitudes in Outdoor Recreation
ppb.............................parts per billion
ppm ....parts per million
PSP.............................Proposed Study Plan
QA..............................Quality Assurance
QC ....Quality Control
RA ....Recreation Area
RBP ....Rapid Bioassessment Protocol
Reclamation ...............U.S. Department of the Interior, Bureau of Reclamation
RM ....River Mile
RMP ....Resource Management Plan
RP...............................Relicensing Participant

RR ....Recreation Resources
RSP ....Revised Study Plan
RST ....Rotary Screw Trap
RWF...........................Resource-Specific Work Groups
RWG ....Resource Work Group
RWQCB.....................Regional Water Quality Control Board
SC...............................State candidate for listing under CESA
SCD............................State candidate for delisting under CESA
SCE ....State candidate for listing as endangered under CESA
SCT ....State candidate for listing as threatened under CESA
SD1 ....Scoping Document 1
SD2 ....Scoping Document 2
SE...............................State Endangered Species under the CESA
SFP.............................State Fully Protected Species under CESA
SFPUC ....San Francisco Public Utilities Commission
SHPO ....State Historic Preservation Office
SIC ....Standard Industry Classification
SJR.............................San Joaquin River
SJRA ....San Joaquin River Agreement
SJRGA ....San Joaquin River Group Authority
SJTA ....San Joaquin River Tributaries Authority
SPD ....Study Plan Determination
SRA............................State Recreation Area
SRMA ....Special Recreation Management Area or Sierra Resource Management Area (as per use)
SRMP.........................Sierra Resource Management Plan
SRP ....Special Run Pools
SSC ....State species of special concern
ST...............................California Threatened Species under the CESA
STORET ....Storage and Retrieval
SWAMP.....................Surface Water Ambient Monitoring Program
SWAP ....Statewide Agricultural Model
SWE...........................Snow-Water Equivalent

SWP ....State Water Project
SWRCB.......................State Water Resources Control Board
TAC.............................Technical Advisory Committee
TAF ....thousand acre-feet
TC ....Travel Cost
TCP ....Traditional Cultural Properties
TDS ....Total Dissolved Solids
TID..............................Turlock Irrigation District
TMDL ....Total Maximum Daily Load
TOC.............................Total Organic Carbon
TPH ....Total Petroleumhydrocarbon
TRT ....Tuolumne River Trust
TRTAC ....Tuolumne River Technical Advisory Committee
UC ....University of California
UCCE..........................University of California Cooperative Extension
USDA..........................U.S. Department of Agriculture
USDOC .......................U.S. Department of Commerce
USDOI ........................U.S. Department of the Interior
USFS ...........................U.S. Department of Agriculture, Forest Service
USFWS .......................U.S. Department of the Interior, Fish and Wildlife Service
USGS ..........................U.S. Department of the Interior, Geological Survey
USR.............................Updated Study Report
UTM............................Universal Transverse Mercator
VAMP ....Vernalis Adaptive Management Plan
VELB ....Valley Elderberry Longhorn Beetle
VES ....Visual Encounter Surveys
VRM ....Visual Resource Management
W&AR ....Water & Aquatic Resources
WMP ....Waste Management Plan
WPT ....Western Pond Turtle
WSA............................Wilderness Study Area
WSIP ....Water System Improvement Program
WTP ....Willingness to Pay

WWTP ....Wastewater Treatment Plant

WY.............................water year

μS/cm ....microSeimens per centimeter

1.0 INTRODUCTION

1.1 Background

Turlock Irrigation District (TID) and Modesto Irrigation District (MID) (collectively, the Districts) are the co-licensees of the 168-megawatt (MW) Don Pedro Project (Project) located on the Tuolumne River in western Tuolumne County in the Central Valley region of California. The Don Pedro Dam is located at river mile (RM) 54.8 and the Don Pedro Reservoir has a normal maximum water surface elevation of 830 ft above mean sea level (msl; NGVD 29). At elevation 830 ft, the reservoir stores over 2,000,000 acre-feet (AF) of water and has a surface area slightly less than 13,000 acres (ac). The watershed above Don Pedro Dam is approximately 1,533 square miles (mi^2). The Project is designated by the Federal Energy Regulatory Commission (FERC) as project no. 2299.

Both TID and MID are local public agencies authorized under the laws of the State of California to provide water supply for irrigation and municipal and industrial (M&I) uses and to provide retail electric service. The Project serves many purposes including providing water storage for the beneficial use of irrigation of over 200,000 ac of prime Central Valley farmland and for the use of M&I customers in the City of Modesto (population 210,000). Consistent with agreements between the Districts and City and County of San Francisco (CCSF), the Project reservoir also includes a “water bank” of up to 570,000 AF of storage that CCSF uses. CCSF may use the water bank to more efficiently manage the water supply from its Hetch Hetchy water system while meeting the senior water rights of the Districts. The “water bank” within Don Pedro Reservoir provides significant benefits for CCSF’s 2.6 million customers in the San Francisco Bay Area.

The Project also provides storage for flood management purposes in the Tuolumne and San Joaquin rivers in coordination with the U.S. Army Corps of Engineers (ACOE). Other important beneficial uses supported by the Project are recreation, protection of aquatic resources in the lower Tuolumne River, and hydropower generation.

The Project Boundary extends from RM 53.2, which is one mile below the Don Pedro powerhouse, upstream to RM 80.8 corresponding to a water surface elevation of 845 ft (31 FPC ¶ 510 [1964]). The Project Boundary encompasses approximately 18,370 ac with 74 percent of the lands owned jointly by the Districts and the remaining 26 percent (approximately 4,800 ac) owned by the United States and managed as a part of the U.S. Bureau of Land Management (BLM) Sierra Resource Management Area.

The primary Project facilities include the 580-foot-high Don Pedro Dam and Reservoir completed in 1971; a four-unit powerhouse situated at the base of the dam; related facilities including the Project spillway, outlet works, and switchyard; four dikes (Gasburg Creek Dike and Dikes A, B, and C); and three developed recreational facilities (Fleming Meadows, Blue Oaks, and Moccasin Point Recreation Areas). The location of the Project and its primary facilities is shown in Figure 1.1-1.

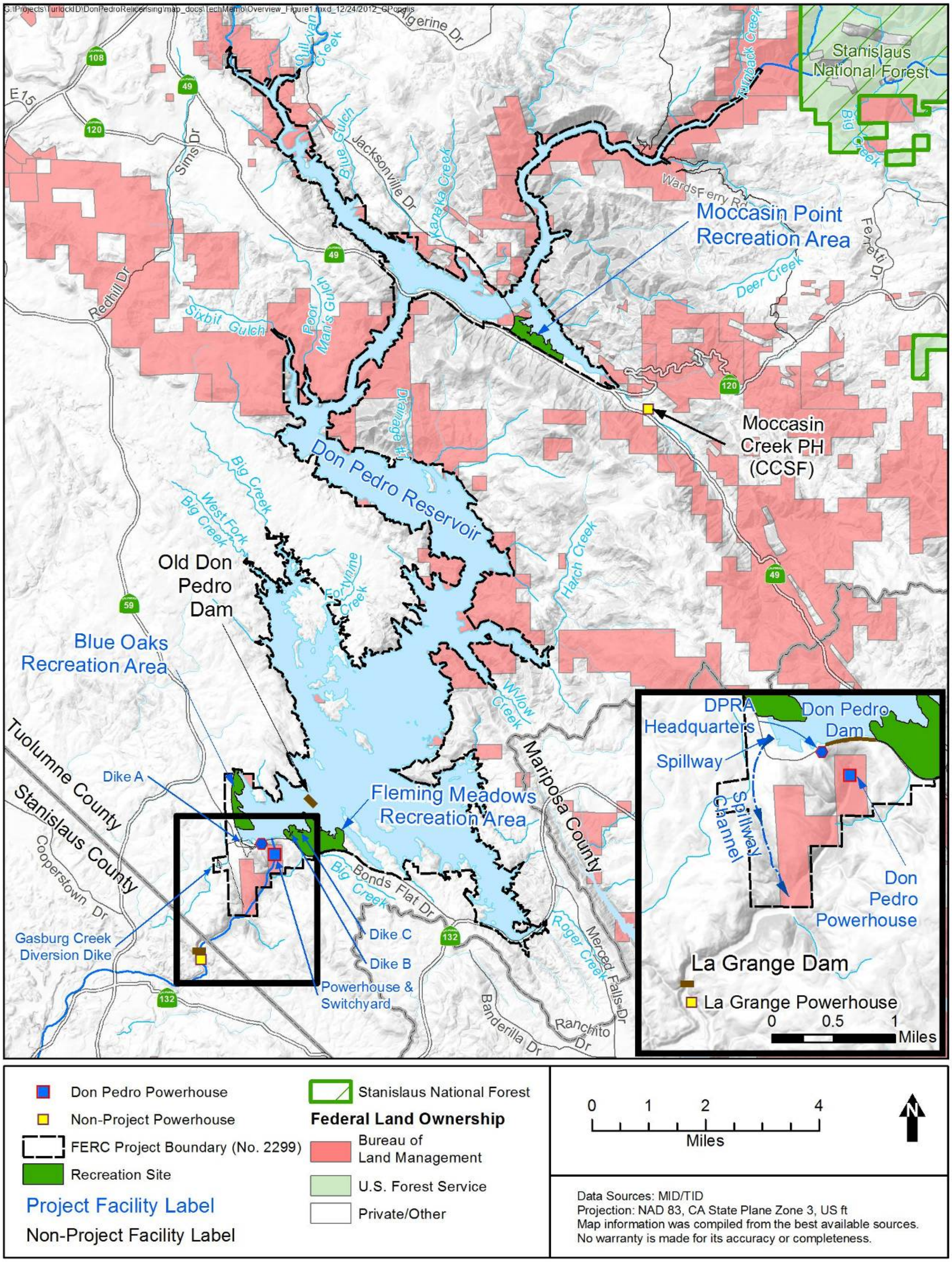

Figure 1.1-1 Don Pedro Project site location map.

1.2 Socioeconomics Study Plan

FERC's Scoping Document (SD) 2 summarized issues raised during the scoping process, which included requests recommending that socioeconomics be treated as a resource issue. In response, FERC modified SD1 to include socioeconomics as a resource issue, identified in SD2 as both a cumulatively- and directly-affected resource area. SD2 specifically stated that FERC's environmental assessment would examine "the socioeconomic effects of any proposed measures to change Don Pedro Project operations on affected governments, residents, agriculture, businesses, and other related interests." SD2 also references the potential for "water supply effects on San Francisco Public Utility Commission's retail and wholesale customers if the CCSF were required to provide additional water to the Districts to support a change in operation for environmental mitigation." Accordingly, the Districts prepared a study plan addressing socioeconomic resources directly affected by Project operations. In addition, CCSF indicated that it would prepare a socioeconomic study of the effects of potential changes in water supplies to its Bay Area customers as a result of relicensing; CCSF filed a study plan with FERC for information purposes on December 8, 2011.

On July 25, 2011, the Districts filed a proposed plan to undertake 30 studies on a range of resource areas including Project operations, water quality, fish and other aquatic resources, terrestrial resources, threatened and endangered species, socioeconomics, recreation, aesthetic resources, and cultural resources. The proposed Socioeconomics study is referenced as W&AR-15.

On August 23, 2011, the Districts held their first study plan meeting to discuss the details of their proposed study plans. Thereafter, and until November 3, 2011, the Districts held about 20 additional meetings to discuss and resolve issues related to the proposed studies, including a meeting with interested parties held on September 13, 2011 to specifically discuss the scope and methods for the Socioeconomics study plan. A range of issues and study requests were presented by the public on the Socioeconomics study plan, which were considered in the context of the study objectives and FERC requirements, and the study plan was modified regarding a number of issues. In addition, approximately 30 formal comments were timely filed with FERC regarding the scope of the Socioeconomics study plan by October 22, 2011; however, many of these comments generally covered study requests that were considered to be outside the scope of the proposed Socioeconomics study and FERC requirements for economic analysis, and therefore, were not integrated into the study plan. Following the conclusion of the study plan meetings, and after receipt of comments on its proposed study plan, the Districts filed their Revised Study Plan (RSP) containing 35 studies on November 22, 2011.

On December 22, 2011, FERC issued its Study Plan Determination (SPD) approving or approving with modifications 34 studies proposed in the RSP. FERC's SPD approved the Districts' Socioeconomics study plan (W&AR-15) as provided in the Districts' RSP filing without modification. The Socioeconomics study was carried out in substantial conformance with the approved study. Variances to the approved Socioeconomics study plan are discussed in Attachment A.

The Districts filed the Draft License Application (DLA) with FERC on November 26, 2013, and the Updated Study Report (USR) on January 6, 2014. The draft Socioeconomics Study Report was included in this January filing. Comments on the DLA or USR relevant to the W&AR-15 study report were received from the Conservation Groups[1], the California Department of Fish and Wildlife (CDFW), and the Tuolumne County Board of Supervisors. The Districts filed a response to USR comments on February 28, 2014. A response to comments on the DLA is included in the Final License Application.

The Districts considered comments received from relicensing participants and from representatives from the food processing industry. These comments and the associated review of data sources were the basis for updates to the estimate of economic output generated from the Don Pedro Project, as described in this revised Socioeconomics Study Report. The updates were related to the methods used to estimate agricultural production in the livestock sector and to provide additional details about the estimated value of agriculture production and processing generated by crops grown using Don Pedro Project water. The updates reduced the total estimated value of economic benefits of the Don Pedro Project from $4.8 billion per year to $4.1 billion per year.

In addition to changes in the estimation methods, during the revisions, an oversight in the data analysis for the livestock sector was discovered in the calculation of the direct economic benefits. Details of the methodology changes and the estimation error are described below.

Livestock sector. The estimates of the value of total economic output provided in the Socioeconomic Study Report filed with the USR included the value of output from dairy operations, but did not include an estimate of production value from cattle and calves operations or poultry operations. Since the value of agriculture production from cattle and calves operations and poultry operations consistently ranks in the top five of commodities by value in both Stanislaus and Merced counties (Stanislaus County and Merced County Agricultural Commissioner County Crop Reports, 2011), this update considered expanding the livestock category beyond dairy.

In order to include livestock beyond dairy, it was necessary to review how much of the feed crops grown with Don Pedro Project water are supporting either cattle and calves operations or poultry operations. In the poultry category, consistent with the U.S. poultry industry as a whole, it was determined that chickens in the region are fed mainly high protein diets (USDA ERS 2014a) and much, if not all of these feed stuffs are imported from other regions of the United States (Pelican 2014, Barry 2014). For this reason it is assumed that crops in the Districts service area do not support the poultry industry and therefore the estimate of the value of total agriculture production should not include poultry production.

Cattle and calves operations in the region are supported by rangeland and irrigated pasture. Cattle generally consume the hay and grass harvested from the land, supplemented by purchased

[1] The conservation groups that collectively submitted comments (P-2299-075) are: American Rivers, American Whitewater, California Sportfishing Protection Alliance, California Trout, Inc., Central Sierra Environmental Resource Center, Friends of the River, Golden West Women Flyfishers, Northern California Council Federation of Fly Fishers, Trout Unlimited, and Tuolumne River Trust.

hay, though not generally of the alfalfa variety. In the December 2013 Socioeconomics Study Report irrigated pasture was aggregated into one 'hay' category and was assumed to support dairy cattle. The update disaggregated the 'hay' crop category into two categories; 'hay', consisting primarily of alfalfa, assumed to support dairy operations and 'irrigated pasture' assumed to support cattle and calves operations.

This disaggregation had two effects on the updated estimate of the value of economic production. First, by including cattle and calves, the estimated value of production increased by $334.9 million. Secondly, the estimated percent of the two-county milk production supported by crops grown with Project water was reduced, lowering the estimated value of milk processing from $2.1 billion from $1.1 billion. The updated estimate is considered to be conservative.

Processing Sectors. There is a wide range of food and beverage processing industries in the study area which are dependent on raw crop commodities (e.g. input) that are grown locally. In the December 2013 Socioeconomic Study Report the food and beverage processing sectors are aggregated into one sector call 'crop processing'. These sectors are: Fruit and vegetable canning, pickling, and drying; Snack food manufacturing; Other animal food manufacturing; Wineries; and Frozen food manufacturing. When aggregated, it was estimated that approximately 9.0 percent of local agricultural output is used as input to the local crop processing industry, which seemed like a low estimate based on discussions with stakeholders. The update disaggregated the five sectors in order to provide more specific local information regarding which of the five sectors contributed the most to the value of local processing. By disaggregating the sectors the estimated value of processing locally grown crops increased by $255.0 million from $599.9 million to $854.9 million. The update provides revised estimates of the percent of locally grown food that is processed in the study region. For example, the updated values suggest that 25 percent of the input to the local Wineries sector comes from locally grown grapes, the single largest processing sector by percent.

Calculation Error. In the December 2013 Socioeconomic Study Report the estimated value of the direct impact of crop production was overstated by $534.0 million. This was a result of double counting of values. A portion of the estimated crop production value is included in the dairy production value, as an input of production; therefore, when summing direct impacts, the raw inputs must be netted out of the total. This update corrects this double counting error.

1.3 Public Outreach and Data Sources

Implementation of the Socioeconomics study plan relied on a range of data sources, as well as information collected from local interests and parties at relicensing meetings and through an informal public outreach process. Data used to characterize local economic conditions and support the socioeconomic evaluation of Project water supplies were derived from a number of standardized sources, including federal, state and local government and other quasi-public and private organizations. For this study, federal data sources that were consulted include the U.S. Department of Commerce (Census Bureau and Bureau of Economic Analysis); U.S. Department of Labor (Bureau of Labor Statistics); U.S. Department of Agriculture (National Agricultural Statistical Service and Forest Service); and the Federal Energy Regulatory Commission. State data sources included the California Department of Finance, California Employment

Development Department, University of California, California State Parks, and State Water Resources Control Board. Local data sources included the Stanislaus County and Merced County Agricultural Commissioners.

In addition to these standardized sources, relevant data were also collected directly from MID and TID, particularly for the agricultural analysis, which requires District-wide information on cropping patterns and water use with the Districts' water service area. Much of the required agricultural information was obtained from the formal Agricultural Water Management Plans prepared by both MID and TID and filed with the State of California. Recreation-related information was collected from the Don Pedro Recreation Agency (DPRA). Information from other related relicensing studies was also reviewed and used where applicable; namely, operations data from W&AR-02 (*Tuolumne River Operations Model*) and RR-01 (*Recreation Facility and Public Accessibility Assessment*).

Information from local stakeholders was obtained at meetings conducted during the relicensing process, including meetings specifically covering the Socioeconomics study plan. Public input was collected at these meetings and integrated into the study plan as relevant to the purposes and objectives of the study. In addition, a formal progress report meeting covering the Socioeconomics study was held on November 9, 2012, which outlined the status of the study and provided another opportunity for local stakeholders to identify data sources and information in support of the study.

Lastly, the study research team actively engaged a number of local entities in an effort to collect and validate data used in the study. Representative organizations included the City of Modesto; other municipalities and organizations that may seek to be served by Project water supplies in the future (i.e., cities of Turlock, Hughson and Ceres, Denair Community Services District, Keyes Community Services District, Hilmar County Water District, and Delhi County Water District); local chambers of commerce; agricultural trade organizations; local real estate professionals, including agents, appraisers, and agricultural lenders; and local economic development organizations.

2.0 STUDY GOALS AND OBJECTIVES

The primary goals of this Socioeconomics study are to quantify the baseline economic values and socioeconomic effects of current Don Pedro Project operations. As the Don Pedro Project is primarily a water supply project serving regional agricultural and municipal and industrial water users, any change in Project operations may have broad socioeconomic effects well beyond changes to hydropower generation. Therefore, consistent with FERC's SD2 and SPD, this study develops a methodological framework which can be used to evaluate the direct socioeconomic effects to affected governments, residents, agriculture, businesses, and other related interests as a result of any proposed changes to Project operations that may be considered as part of the relicensing process (FERC Scoping Document 2 [2011]). The latter may include scenarios proposed during the relicensing process that may affect the availability of agricultural and urban water supplies.

The objectives of the Socioeconomics study are to:

- qualitatively and quantitatively describe local economic conditions in the regions that are directly and indirectly affected by the existing Project operations;
- assess the key factors influenced by Project operations that generate economic activity in affected regions;
- estimate the economic value generated by the Project's water storage in various uses, both consumptive (agriculture and urban) and non-consumptive (reservoir recreation);
- measure the role and significance of the Project in the local economy;
- assess the role and significance of the Project to the general welfare of the local communities served; and
- develop a framework to be able to assess the socioeconomic impacts on affected groups and industries resulting from changes in Project operations, including economic, community welfare, and environmental justice considerations.

The information presented in this study reflects the economic values and socioeconomic contribution attributed to *existing* operations of the Don Pedro Project. However, the analytical tools and models developed as part of this study and the results of the baseline economic analysis can be used to evaluate *future* Project operation scenarios under consideration during the relicensing process. Specifically, the models and analytical framework presented in this study will allow parties to understand potential changes in economic value supported by the Don Pedro Project and the resultant effects on the local economy and those communities, groups, and industries reliant on Project water supplies.

3.0 STUDY AREA

The primary purpose of the Don Pedro Project is to provide a reliable water supply and water storage to meet the irrigation needs of over 200,000 acres of highly-productive farmland in the San Joaquin Valley in Stanislaus and Merced counties and M&I water needs for the 250,000 people residing in the Modesto area in Stanislaus County. The Project is also a critical component of the water supply system for the City and County of San Francisco's 2.6 million customers in the Bay Area who benefit from CCSF's water bank in Don Pedro Reservoir. The Don Pedro Reservoir, along with the Project's hydroelectric generation and recreation facilities, are located in Tuolumne County; while significant, these are secondary purposes of the Project. Collectively, the Don Pedro Project provides direct water-related economic benefits in Stanislaus, Merced, and Tuolumne counties, while also contributing significantly to the reliability of the entire Bay Area's water supply.

The Socioeconomic study area is intended to capture both the direct and indirect economic effects of Project operations (Figure 3-1). The direct effects are associated with use of Project facilities, including the reservoir (recreation) and the hydroelectric plant (power generation), and water use throughout the Districts' water service areas (agriculture and urban uses). The indirect effects of Project operations on the broader economy are also important to recognize and represent a key component of the analysis presented in this study.

3.1 Districts' Irrigation Water Service Area

The Don Pedro Reservoir and the Districts' water-related infrastructure provide water supplies and related benefits throughout the MID and TID irrigation water service area[2] in the San Joaquin Valley. The focus of this study is on the economic value of Project water supplies and their contribution to the welfare of the communities served. Accordingly, relevant background information is based on the combined water service area of MID and TID. The water service area of MID lies completely within Stanislaus County, while the water service area of TID is located in both Stanislaus and Merced counties. (Note that the Districts also provide electrical service throughout the region; however, the focus of this study is on the economic values and benefits attributed to Project water supplies.)

The gross acreage of the MID water service area is 103,733 acres, of which 66,517 acres are currently irrigated (MID 2012a). The MID water service area boundaries include the Stanislaus River on the north, Tuolumne River on the south, San Joaquin River on the west, and Sierra Nevada foothills on the east. Incorporated cities within the MID water service area are Modesto and Waterford. Census Designated Places (CDPs) include Salida and Empire.

[2] Hereafter referred to as "water service area."

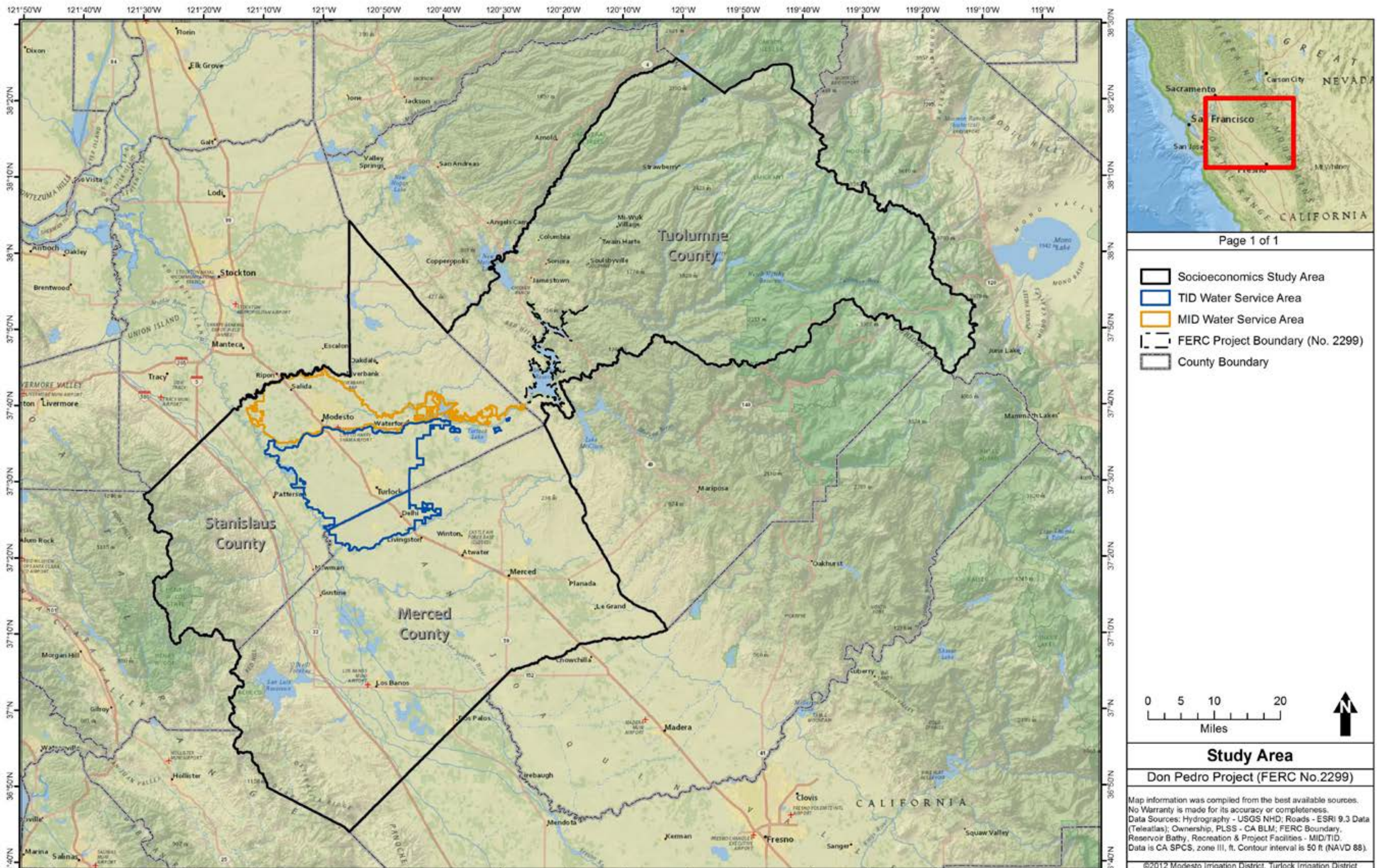

Figure 3.3-1. Socioeconomics study area.

The gross acreage of the TID water service area is 197,261 acres, of which 157,800 acres are irrigable with surface water (TID 2012). The TID water service area boundaries include the Tuolumne River on the north, Merced River on the south, and San Joaquin River on the west. Of the total acreage in the TID water service area, approximately three-quarters of the land area are located in Stanislaus County and one-quarter in Merced County. Incorporated cities within the TID water service area are Turlock, Ceres, and Hughson. CDPs include Keyes, Denair, Delhi, Ballico, and Hilmar.

3.2 Regional Study Area

The regional study area evaluated as part of the Socioeconomics study includes Stanislaus, Merced, and Tuolumne counties, which encompasses the principal hydroelectric and recreational facilities of the Don Pedro Project (in Tuolumne County), as well as the Districts' water service areas (in Stanislaus and Merced counties). This three-county study area also captures many of the inter-industry linkages associated with the use of Project water supplies, including agricultural, urban, and recreational uses. As such, it represents the "functional economic area" for the regional economic analysis presented in Section 6. As mentioned above, CCSF is conducting an independent socioeconomic study related to potential effects to the Bay Area that may result due to changes in Project operations.

3.3 Geographic Scale of Data

The characterization of existing socioeconomic conditions affected by ongoing Project operations is presented for both the regional study area and Districts' water service areas. Accordingly, the underlying data presented in Section 4 are at two different scales. The socioeconomic overview for the regional study area is based primarily on county-level data. Much of the socioeconomic data available from state and federal sources is at the county level, including agricultural crop acreage, yield, and price; and population, housing, income, poverty, employment, and industry makeup. More localized information is required to describe the socioeconomic characteristics of the Districts' water service areas because they do not follow county boundaries. Therefore, socioeconomic data are also presented at the census-tract (CT)[3] level where available.[4] CT-level information is particularly important in describing unique socioeconomic conditions and racial/ethnic makeup of local communities, which is particularly relevant for environmental justice. State-level information for California is also presented for comparative purposes.

[3] Census tracts refer to small, relatively permanent statistical subdivisions of a county.
[4] Only those CTs that are fall entirely or partially within the Districts' water service area are considered in the analysis.

4.0 REGIONAL SOCIOECONOMIC PROFILE

This section presents an overview of existing socioeconomic conditions in the study area. Key demographic and social characteristics of the region are presented first, which provide insight to the local population dependent upon Project water supplies and which serve as the basis for understanding the relationship between the Don Pedro Project and the welfare of local communities dependent upon the water it supplies. This is followed by information on existing economic and social conditions including employment, income, and key industries and employers across communities that comprise the local economic base and drive economic activity. The remainder of this section focuses on the local agricultural industry, namely crop production and dairy operations, including cropping patterns and production values at both the county and District level. The information presented in this section provides context to the evaluation of economic values and regional economic benefits supported by existing operations of the Don Pedro Project as presented in Sections 5 and 6, respectively, as well as potential economic effects associated with future operational scenarios under the relicensing process.

It is also important to understand the history of development in the region, which provides insight on the importance of and demand for Project water supplies, including both agricultural and urban demands. A summary of historical development in the Project area, focusing on the MID service area, is presented in Attachment B.[5]

4.1 Demographic Characteristics and Trends

4.1.1 Historical and Current Population

Table 4.1-1 shows the populations of Stanislaus, Merced and Tuolumne counties, and the State of California, for the period from 1970 through 2012. In 1970, the combined population in the three-county study area was 321,304. By 2012, the combined population grew to 832,510, an increase of 159.1 percent. Population growth rates in the study area were markedly higher in the 1970's and 1980's compared to the past two decades, and have consistently outpaced growth rates across California. Among counties, the greatest population growth since 1970 occurred in Stanislaus County, followed by Merced County and Tuolumne County

The largest population base in the study area is found in Stanislaus County with nearly 520,000 residents in 2012. Population in Merced and Tuolumne counties were substantially lower at 258,700 and 53,800, respectively. Stanislaus County accounted for 62.5 percent of the three-county population in 2012, followed by Merced County at 31.1 percent and Tuolumne County at 6.4 percent. The largest urban area in the study area is the City of Modesto in Stanislaus County with a population of 203,085 in 2012, accounting for nearly a quarter of the population in the region.

[5] Urbanization of the Modesto Irrigation District, Modesto, California, USA (prepared by Ward and Johnston).

Table 4.1-1. Population in the study area, 1970-2012.

Year	Stanislaus County	Merced County	Tuolumne County	Total Study Area	California
Population:					
1970	194,506	104,629	22,169	321,304	19,953,134
1980	265,900	134,558	33,928	434,386	23,667,902
1990	370,522	178,403	48,456	597,381	29,758,213
2000	446,997	210,554	54,504	712,055	33,873,086
2010	514,453	255,793	55,365	825,611	37,253,956
2012	519,940	258,736	53,834	832,510	37,678,563
Percent change:					
1970-1980	36.7%	28.6%	53.0%	35.2%	18.6%
1980-1990	39.3%	32.6%	42.8%	37.5%	25.7%
1990-2000	20.6%	18.0%	12.5%	19.2%	13.8%
2000-2010	15.1%	21.5%	1.6%	15.9%	10.0%
1970-2012	167.3%	147.3%	142.8%	159.1%	88.8%

Source: California Department of Finance undated, 2007, 2012a, and 2012b.

Between 1970 and 2012, population in the incorporated (city) areas of the three-county study area grew more rapidly than that in unincorporated areas (Table 4.1-2). Population in the incorporated areas accounted for 48.1 percent of the combined three-county population in 1970 and 69.9 percent in 2012. Between 1970 and 2012, the proportion of the Stanislaus and Merced populations living in incorporated areas increased from 51.5 percent to 65.1 percent and from 49.1 percent to 78.6 percent, respectively; however, in Tuolumne County, the population in incorporated areas declined from 14.0 percent to 8.9 percent. Overall, the data show that the urban areas within the study area have grown at a faster pace than the rural areas.

Table 4.1-2. Population in incorporated and unincorporated areas, 1970-2012.

Year	Stanislaus County	Merced County	Tuolumne County	Total Study Area
1970				
Incorporated	51.5%	49.1%	14.0%	48.1%
Unincorporated	48.5%	50.9%	86.0%	51.9%
1980				
Incorporated	65.1%	56.5%	9.6%	58.1%
Unincorporated	34.9%	43.5%	90.4%	41.9%
1990				
Incorporated	60.8%	74.2%	8.6%	64.8%
Unincorporated	39.2%	25.8%	91.4%	35.2%
2000				
Incorporated	62.9%	76.1%	8.1%	67.0%
Unincorporated	37.1%	23.9%	91.9%	33.0%
2010				
Incorporated	65.2%	78.6%	8.9%	69.8%
Unincorporated	34.8%	21.4%	91.1%	30.2%
2012				
Incorporated	65.1%	78.6%	8.9%	69.9%
Unincorporated	34.9%	21.4%	91.1%	30.1%

Source: California Department of Finance undated, 2007, 2012a, and 2012b.

Table 4.1-3 shows the estimated 2010 population in the Districts' water service area. In 2010, the estimated population in the Districts' water service area was approximately 466,400, which accounted for just over 60 percent of the total population in Stanislaus and Merced counties. The population in the water service area is concentrated in Stanislaus County (94.6%) relative to Merced County (5.4%). Population in the water service area in Stanislaus County includes the City of Modesto and accounts for nearly 86 percent of the county total, while the population served by the Districts in Merced County accounts for only about 10 percent of the county total.

Table 4.1-3. Population in the Districts' water service area, 2010.

County	Water Service Area[1]	County (Total)	Percent of County
Stanislaus County	441,385	514,453	85.8%
Merced County	24,968	255,793	9.8%
Total	**466,353**	**770,246**	**60.5%**

Source: U.S. Department of Commerce, Census Bureau 2010.
[1] Based on census tracts that fall within or are transected by the Districts' water service area boundaries.

4.1.2 Population Projections

Population in the three-county study area is projected to increase from about 826,000 people in 2010 to nearly 1.6 million in 2060, an increase of over 90 percent. This is substantially greater than projected statewide growth rates (Tables 4.1-4 and 4.1-5). The rate of population growth is expected to peak between 2020 and 2030 (16.1%) and decrease over time through 2060. Among counties, Merced County is projected to experience the most growth, with population more than doubling from 2010 through 2060. Total population growth in the other counties is expected to be more modest, ranging from about 16 percent in Tuolumne County to 85 percent in Stanislaus County.

Table 4.1-4. Population projections in the study area through 2060.

Region	2010	Projections				
		2020	2030	2040	2050	2060
Stanislaus County	514,453	589,156	674,859	759,027	861,984	953,580
Merced County	255,793	301,376	366,352	436,188	496,787	553,114
Tuolumne County	55,365	55,938	57,982	60,593	61,678	63,947
Study Area Total	**825,611**	**946,470**	**1,099,193**	**1,255,809**	**1,420,448**	**1,570,641**
California	37,253,956	40,643,643	44,279,354	47,690,186	50,365,074	52,693,583

Source: California Department of Finance 2013.

Table 4.1-5. Population projections in the study area – growth rates, 2010-2060.

Region	2010-2020	2020-2030	2030-2040	2040-2050	2050-2060	2010-2060
Stanislaus County	14.5%	14.5%	12.5%	13.6%	10.6%	85.4%
Merced County	17.8%	21.6%	19.1%	13.9%	11.3%	116.2%
Tuolumne County	1.0%	3.7%	4.5%	1.8%	3.7%	15.5%
Study Area Total	**14.6%**	**16.1%**	**14.2%**	**13.1%**	**10.6%**	**90.2%**
California	9.1%	8.9%	7.7%	5.6%	4.6%	41.4%

Source: California Department of Finance 2013.

4.1.3 Race and Ethnicity

Race and ethnicity of affected populations are important factors for evaluating community-based environmental justice issues (refer to Section 7.2 for more information). Table 4.1-6 shows the racial and ethnic composition of the population in the three-county study area in 2010. The predominant racial group in the study area is White (Caucasian), comprising about 65 percent of the regional population, with various minority races jointly accounting for the remaining 35 percent. These include other races (19.9%), Asian (5.5%), multi-race (5.1%), Black/African American (3.1%), American Indian/Alaska Native (1.3%), and Native Hawaiian/Pacific Islander (0.5%). In addition, a large proportion (43.9%) of the study area population is of Hispanic ethnicity (of any race).[6] The relatively large proportion of Hispanics living and working in the study area is characteristic of most Central Valley counties, where agriculture supports a large Hispanic workforce.

There is little variation in the racial and ethnic composition between Stanislaus and Merced counties, both of which have relatively high minority and Hispanic populations. Tuolumne County is less diverse, with Whites and Hispanics accounting for 87.2 percent and 10.7 percent of its population, respectively.

Table 4.1-6. Race and ethnicity in the study area, 2010.

Race / Ethnicity	Stanislaus County		Merced County		Tuolumne County		Study Area (Total)	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
White	337,342	65.6%	148,381	58.0%	48,274	87.2%	533,997	64.7%
Black or African American	14,721	2.9%	9,926	3.9%	1,143	2.1%	25,790	3.1%
American Indian and Alaska Native	5,902	1.1%	3,473	1.4%	1,039	1.9%	10,414	1.3%
Asian	26,090	5.1%	18,836	7.4%	572	1.0%	45,498	5.5%
Native Hawaiian and Other Pacific Islander	3,401	0.7%	583	0.2%	76	0.1%	4,060	0.5%
Some Other Race	99,210	19.3%	62,665	24.5%	2,238	4.0%	164,113	19.9%
Two or More Races	27,787	5.4%	11,929	4.7%	2,023	3.7%	41,739	5.1%
Hispanic or Latino of Any Race	215,658	41.9%	140,485	54.9%	5,918	10.7%	362,061	43.9%

Source: U.S Department of Commerce, Census Bureau 2010.

Table 4.1-7 shows patterns of race and ethnicity in the Districts' water service areas. Generally, the racial and ethnic makeup of the Districts' water service area is similar to that at the county level. Minority groups and Hispanics represent about 35 percent and 42 percent of the regional population, respectively.

[6] A discussion of the distinction between race and ethnicity in government statistics may be found in U.S. Department of Commerce, Census Bureau (2003).

Table 4.1-7. Race and ethnicity in the Districts' water service area, 2010.

Race / Ethnicity	Water Service Area[1]					
	Stanislaus County		Merced County		Total	
	Number	Percent	Number	Percent	Number	Percent
White	287,954	65.2%	16,174	64.8%	304,128	65.2%
Black or African American	12,816	2.9%	165	0.7%	12,981	2.8%
American Indian and Alaska Native	5,112	1.2%	295	1.2%	5,407	1.2%
Asian	24,133	5.5%	807	3.2%	24,940	5.3%
Native Hawaiian and Other Pacific Islander	2,983	0.7%	39	0.2%	3,022	0.6%
Some Other Race	84,029	19.0%	6,558	26.3%	90,587	19.4%
Two or More Races	24,358	5.5%	930	3.7%	25,288	5.4%
Hispanic or Latino of Any Race	182,688	41.4%	12,712	50.9%	195,400	41.9%

Source: U.S Department of Commerce, Census Bureau 2010.
[1] Based on census tracts that fall within or are transected by the Districts' Water Service Area boundaries.

4.2 Employment

Information on employment characteristics in the study area is presented in Table 4.2-1. Between 2007 and 2011, the total civilian labor force averaged approximately 374,800 people with approximately 320,600 employed; which equates to an unemployment rate of 14.5 percent. The unemployment rate ranged from 13.1 percent in Tuolumne County to 15.2 percent in Merced County.

Table 4.2-1. Employment status in the study area, 2007-2011 (annual average).

Employment Type	Stanislaus County	Merced County	Tuolumne County	Study Area (Total)	California
Civilian labor force	240,165	110,941	23,645	374,751	18,472,288
Employed	205,958	94,066	20,559	320,583	16,603,417
Unemployed	34,207	16,875	3,086	54,168	1,868,871
Unemployment Rate	14.2%	15.2%	13.1%	14.5%	10.1%

Source: U.S Department of Commerce, Census Bureau (American Community Survey) 2012.

Comparable employment data for the Districts' water service areas are presented in Table 4.2-2.[7] The unemployment rate for the Districts' water service area has averaged approximately 12.7 percent between 2006 and 2010 and generally has been lower than county-wide figures, although still significantly higher than state unemployment rates.

Table 4.2-2. Employment status in the Districts' water service area, 2006-2010 (annual average).

Employment Type	Water Service Area[1]			California
	Stanislaus County	Merced County	Total	
Civilian labor force	204,626	11,375	216,001	18,274,871
Employed	178,767	9,823	188,590	16,632,466

[7] Note that data for the Districts' water service areas are available for the period 2006-2010, while county-level data are for 2007 and 2011.

Employment Type	Water Service Area[1]			California
	Stanislaus County	Merced County	Total	
Unemployed	25,859	1,552	27,411	1,642,405
Unemployment Rate	12.6%	13.6%	12.7%	9.0%

Source: U.S Department of Commerce, Census Bureau (American Community Survey) 2011.
[1] Based on census tracts that fall within or are transected by the Districts' water service area boundaries.

4.3 Personal Income

Total personal income[8] levels across the study area between 2007 and 2011 are presented in Table 4.3-1. Total personal income in the three-county study area during this period averaged $26.2 billion per year. In real terms, total income in the study area counties has been relatively constant since 2007, declining by less than one percent from then through 2011. Stanislaus County had the highest personal income ($16.8 billion annually) followed by Merced County ($7.3 billion) and Tuolumne County ($2.1 billion). Of the three counties, only Stanislaus experienced an increase in real personal income between 2007 and 2011.

Table 4.3-1. Total personal income in the study area, 2007-2011 ($millions).[1]

Area	2007	2008	2009	2010	2011	2007-2011 Average	Percent Change, 2007-2011
Stanislaus County	$17,227	$16,767	$16,386	$16,772	$17,026	$16,836	0.8%
Merced County	$7,511	$7,156	$6,996	$7,301	$7,573	$7,307	-1.2%
Tuolumne County	$2,151	$2,148	$2,008	$2,028	$2,061	$2,079	-4.2%
Study Area Total	**$26,889**	**$26,072**	**$25,390**	**$26,101**	**$26,659**	**$26,222**	**-0.9%**
State of California	$1,715,754	$1,706,334	$1,611,727	$1,641,662	$1,682,042	$1,671,504	-2.0%

Source: U.S. Department of Commerce, Bureau of Economic Analysis 2012a.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI) as reported by the California Department of Industrial Relations (2013).

As a derivative of personal income, per-capita income is a key economic indicator of social well-being. Between 2007 and 2011, average per-capita personal income in the three-county study area was $31,910 per year (Table 4.3-2). Across counties, per-capita income levels were highest in Tuolumne County ($37,301) followed by Stanislaus County ($32,854) and Merced County ($28,816). For comparison, per-capita income for the state averaged $45,229 during the same period. Per-capita income levels (in real terms) have declined across the study area and state between 2007 and 2011.

[8] Personal income is defined as the income that is received by persons participating in production, from both government and business transfer payments, and from government interest (which is treated like a transfer payment). It is calculated as the sum of wage and salary disbursements, other labor income, proprietors' income with inventory valuation and capital consumption adjustments, rental income of persons with capital consumption adjustment, personal dividend and interest income, and transfer payments to persons, less personal contributions for social insurance.

Table 4.3-2. Per-capita income levels in the study area, 2007-2011.[1]

Area	2007	2008	2009	2010	2011	Average (2007-2011)	Percent Change (2007-2011)
Stanislaus County	$33,923	$32,939	$32,033	$32,541	$32,835	$32,854	-3.2%
Merced County	$30,221	$28,564	$27,727	$28,433	$29,136	$28,816	-3.6%
Tuolumne County	$38,172	$38,146	$35,953	$36,730	$37,503	$37,301	-1.8%
Study Area Total	**$33,085**	**$31,955**	**$30,975**	**$31,546**	**$31,990**	**$31,910**	**-3.3%**
State of California	$47,331	$46,616	$43,606	$43,967	$44,626	$45,229	-5.7%

Source: U.S. Department of Commerce, Bureau of Economic Analysis 2012a.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

Income measures at the District level, including median household income, per-capita income, and poverty status,[9] are presented in Table 4.3-3. As shown for the period from 2006-2010, the median household income levels in the Districts' water service areas within Stanislaus County ($54,413) and Merced County ($54,152) were lower than statewide levels. Per-capita income levels in Districts' water service areas were also lower than state levels. Considering these figures, as expected, poverty rates in the Districts' water service areas are higher than California overall. The percentages of persons below the poverty level in the Stanislaus and Merced county parts of the water service area were 17.2 percent and 15.2 percent, respectively, compared to the statewide average of 13.7 percent.

Table 4.3-3. Income measures in the Districts' water service area, 2006-2010 (annual average).[1]

Measure	Water Service Area[2]		
	Stanislaus County	Merced County	Total[3]
Median Household Income	$54,413	$54,152	$54,399
Per Capita Income	$22,924	$20,760	$22,808
Poverty Rate (Families)	14.2%	10.8%	14.0%
Poverty Rate (All People)	17.2%	15.2%	17.1%

Source: U.S. Department of Commerce, Census Bureau (American Community Survey) 2011.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
[2] Based on census tracts that fall within or are transected by the Districts' water service area boundaries.
[3] Weighted by population in the water service areas in each county.

[9] Poverty status is based on a definition from the Federal Office of Management and Budget. Families and persons are below the poverty level if their total family income or unrelated individual income was less than the poverty threshold specified for the applicable family size, age of householder, and number of related children present under age 18 years. For persons not in families, poverty status is determined by their income in relation to the appropriate poverty threshold. The 2010 poverty threshold for a family of four persons was $22,050; and for a family of eight persons it was $37,010 (U.S. Department of Health and Human Services 2010).

4.4 Economic Base and Key Industries

Key industries that comprise the economic base in the three-county study area are identified below based on employment and earnings by industry.[10] Data on total and industry employment and earnings provide important insights into the size, strength, and diversity of a local economy.

4.4.1 Employment by Industry

Employment by industry for the study area is presented in absolute numbers in Table 4.4-1 and as percentages in Table 4.4-2. In total, the study area supported an average of 332,100 part- and full-time jobs between 2007 and 2011. The economy in the study area is generally diverse. Overall, the largest sector (based on number of jobs) in the study area is *Government*, which supported about 51,200 jobs and accounted for about 15.4 percent of the regional job base. Other leading sectors in the regional economy included *Retail Trade* (38,300 jobs), *Health Care and Social Assistance* (35,100 jobs), and *Manufacturing* (31,600 jobs). Farm-level employment in the study area averaged 18,100 jobs or 5.5 percent of the study area total.

Table 4.4-1. Employment by industry in the study area, 2007-2011 (annual average).

Industry	Stanislaus County	Merced County	Tuolumne County	Study Area (Total)
Farm	9,594	8,160	362	18,116
Forestry, fishing, and related activities	6,412	4,255	215	10,882
Mining	169	40	158	367
Utilities	(D)	301	107	(D)
Construction	11,357	3,704	1,823	16,884
Manufacturing	21,777	8,800	984	31,561
Wholesale trade	7,240	2,500	321	10,061
Retail trade	25,495	9,801	3,016	38,313
Transportation and warehousing	8,870	3,755	317	12,942
Information	2,010	1,393	319	3,722
Finance and insurance	7,173	2,508	729	10,411
Real estate and rental and leasing	9,297	2,802	1,489	13,588
Professional, scientific, and technical services	8,617	2,827	1,411	12,854
Management of companies and enterprises	2,079	775	158	3,012
Administrative and waste management services	10,596	3,390	886	14,872
Educational services	2,062	333	259	2,654
Health care and social assistance	24,370	7,725	2,976	35,071
Arts, entertainment, and recreation	2,727	1,002	909	4,638

[10] Based on the North American Industry Classification System (NAICS), which is the standard used by Federal statistical agencies to categorize business establishments for use in the collection, analysis, and publication of statistical data on U.S. businesses. NAICS was implemented in 1997 as a replacement for the older Standard Industrial Classification (SIC) system. For more information, see U.S. Department of Commerce, Census Bureau (2013).

Industry	Stanislaus County	Merced County	Tuolumne County	Study Area (Total)
Accommodation and food services	14,661	5,095	1,894	21,650
Other services, except public administration	12,297	4,976	1,758	19,030
Government and government enterprises	28,155	17,249	5,745	51,150
Total Jobs	**214,636**	**91,622**	**25,825**	**332,083**

Source: U.S. Department of Commerce, Bureau of Economic Analysis 2012b.
(D) = Estimate not available to avoid disclosure of confidential information. Values included in county totals.
Column totals may not equal sum of individual entries because of rounding.

At the county level, Stanislaus County provided the greatest number of farm jobs (about 9,600) followed closely by Merced County (8,200); farm-level employment in Tuolumne County was relatively small (nearly 400 jobs). However, on a proportional basis, farming in Merced County was more prominent, accounting for 8.9 percent of the county-wide job total versus 4.5 percent in Stanislaus County. Indirectly, agriculture also provides numerous jobs in those industries that supply inputs to farming operations (e.g., farm machinery and fertilizers) and industries that are reliant on agricultural commodities (e.g., food processing plants), which are reported in categories outside the farm sector; these economic linkages are discussed in greater detail in Section 6.

Table 4.4-2. Percentage of employment by industry in the study area, 2007-2011 (annual average).

Industry	Stanislaus County	Merced County	Tuolumne County	Study Area Total
Farm	4.5%	8.9%	1.4%	5.5%
Forestry, fishing, and related activities	3.0%	4.6%	0.8%	3.3%
Mining	0.1%	0.0%	0.6%	0.1%
Utilities	(D)	0.3%	0.4%	(D)
Construction	5.3%	4.0%	7.1%	5.1%
Manufacturing	10.1%	9.6%	3.8%	9.5%
Wholesale trade	3.4%	2.7%	1.2%	3.0%
Retail trade	11.9%	10.7%	11.7%	11.5%
Transportation and warehousing	4.1%	4.1%	1.2%	3.9%
Information	0.9%	1.5%	1.2%	1.1%
Finance and insurance	3.3%	2.7%	2.8%	3.1%
Real estate and rental and leasing	4.3%	3.1%	5.8%	4.1%
Professional, scientific, and technical services	4.0%	3.1%	5.5%	3.9%
Management of companies and enterprises	1.0%	0.8%	0.6%	0.9%
Administrative and waste management services	4.9%	3.7%	3.4%	4.5%
Educational services	1.0%	0.4%	1.0%	0.8%
Health care and social assistance	11.4%	8.4%	11.5%	10.6%

Industry	Stanislaus County	Merced County	Tuolumne County	Study Area Total
Arts, entertainment, and recreation	1.3%	1.1%	3.5%	1.4%
Accommodation and food services	6.8%	5.6%	7.3%	6.5%
Other services, except public administration	5.7%	5.4%	6.8%	5.7%
Government and government enterprises	13.1%	18.8%	22.2%	15.4%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: U.S. Department of Commerce, Bureau of Economic Analysis 2012b.
(D) = Estimate not available to avoid disclosure of confidential information. Values included in county totals.

4.4.2 Earnings by Industry

Table 4.4-3 shows earnings by industry by county for the period 2007-2011. Aggregated across the three-county study area, farm earnings[11] over the five-year period averaged $1.46 billion and nonfarm earnings $14.78 billion for a total of $16.25 billion across all industries. Among industries, annual earnings in the study area were largest for *Government* ($3.33 billion), *Health Care and Social Assistance* ($2.21 billion), and *Manufacturing* ($2.04 billion). Farm earnings were highest in Merced County at $754.9 million and Stanislaus County at $713.0 million. A range of other industries also support and/or are dependent on the farm sector through backward and forward linkages in the local economy, including, but not limited to manufacturing (e.g., food processing) and transportation (e.g., shipping of raw agricultural commodities).[12] Both of these sectors are large contributors to local economic activity, with the *Manufacturing* and *Transportation and Warehousing* sectors supporting roughly $2.0 billion and $653.9 million in local earnings, respectively, in the study area.

Table 4.4-3. Earnings by industry in the study area, 2007-2011 (annual average) ($millions).[1]

Industry	Stanislaus County	Merced County	Tuolumne County	Study Area Total
Farm earnings	$713.0	$754.9	($3.2)	$1,464.7
Forestry, fishing, and related activities	$259.6	$160.2	$8.1	$427.9
Mining	$2.9	$0.4	$9.7	$12.9
Utilities	(D)	$49.5	$11.7	(D)
Construction	$648.5	$224.0	$80.5	$953.0
Manufacturing	$1,517.0	$476.5	$48.2	$2,041.7
Wholesale trade	$436.9	$125.2	$14.3	$576.4
Retail trade	$842.3	$307.0	$85.3	$1,234.6
Transportation and warehousing	$461.6	$180.5	$11.8	$653.9
Information	$100.8	$63.3	$17.2	$181.4
Finance and insurance	$303.7	$78.9	$23.8	$406.5

[11] Farm earnings are comprised of the net income of sole proprietors, partners and hired laborers arising directly from the current production of agricultural commodities, either livestock or crops. Farm earnings include net farm proprietors' income and the wages and salaries, pay-in-kind, and supplements to wages and salaries of hired farm laborers; but specifically excludes the income of farm corporations. Because net farm income can be negative, farm earnings may also be negative, e.g., for Tuolumne County in 2011.

[12] For more information on the regional economic benefits of local agricultural production, refer to Section 6.3.1.

Industry	Stanislaus County	Merced County	Tuolumne County	Study Area Total
Real estate and rental and leasing	$151.1	$42.5	$14.6	$208.1
Professional, scientific, and technical services	$392.2	$102.1	$53.2	$547.5
Management of companies and enterprises	$144.6	$60.6	$5.0	$210.2
Administrative and waste management services	$322.7	$70.8	$19.7	$413.2
Educational services	$52.7	$3.6	$3.9	$60.2
Health care and social assistance	$1,628.9	$409.9	$170.2	$2,209.0
Arts, entertainment, and recreation	$46.9	$15.7	$18.0	$80.7
Accommodation and food services	$288.5	$96.9	$38.3	$423.6
Other services, except public administration	$444.8	$185.3	$60.3	$690.4
Government and government enterprises	$1,904.7	$1,073.5	$356.5	$3,334.7
Total Earnings	**$10,708.0**	**$4,492.7**	**$1,047.7**	**$16,248.4**

Source: U.S Department of Commerce, Bureau of Economic Analysis 2012c.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
(D) Estimate not available to avoid disclosure of confidential information. Values included in totals..

Table 4.4-4 shows the percentage distribution of earnings by industry. Across the study area, farm earnings were 9.0 percent and nonfarm earnings 91.0 percent of total earnings.

Table 4.4-4. Percentage distribution of earnings by industry, 2007-2011 (annual average).

Employment Type	Stanislaus County	Merced County	Tuolumne County	Study Area Total
Farm earnings	6.7%	16.8%	-0.3%	9.0%
Forestry, fishing, and related activities	2.4%	3.6%	0.8%	2.6%
Mining	0.0%	0.0%	0.9%	0.1%
Utilities	(D)	1.1%	1.1%	(D)
Construction	6.1%	5.0%	7.7%	5.9%
Manufacturing	14.2%	10.6%	4.6%	12.6%
Wholesale trade	4.1%	2.8%	1.4%	3.5%
Retail trade	7.9%	6.8%	8.1%	7.6%
Transportation and warehousing	4.3%	4.0%	1.1%	4.0%
Information	0.9%	1.4%	1.6%	1.1%
Finance and insurance	2.8%	1.8%	2.3%	2.5%
Real estate and rental and leasing	1.4%	0.9%	1.4%	1.3%
Professional, scientific, and technical services	3.7%	2.3%	5.1%	3.4%
Management of companies and enterprises	1.4%	1.3%	0.5%	1.3%
Administrative and waste management services	3.0%	1.6%	1.9%	2.5%

Employment Type	Stanislaus County	Merced County	Tuolumne County	Study Area Total
Educational services	0.5%	0.1%	0.4%	0.4%
Health care and social assistance	15.2%	9.1%	16.2%	13.6%
Arts, entertainment, and recreation	0.4%	0.3%	1.7%	0.5%
Accommodation and food services	2.7%	2.2%	3.7%	2.6%
Other services, except public administration	4.2%	4.1%	5.8%	4.2%
Government and government enterprises	17.8%	23.9%	34.0%	20.5%
Total Earnings	**100.0%**	**100.0%**	**100.0%**	**100.0%**

Source: U.S Department of Commerce, Bureau of Economic Analysis 2012c.
(D) Estimate not available to avoid disclosure of confidential information. Values included in totals.

4.4.3 Major Employers

Table 4.4-5 lists 10 of the largest employers in Stanislaus County. Eight of the 10 are in agricultural production or food processing, and the remaining two are in health-related industries.

Table 4.4-5. Major employers in Stanislaus County.

Employer	Employment Range
Alcott Ridge Vineyards	1,000-4,999
Carlo Rossi Vineyards	1,000-4,999
Con Agra Foods	1,000-4,999
Del Monte Foods	1,000-4,999
Doctors Medical Center	1,000-4,999
E&J Gallo Winery	1,000-4,999
Ecco Domani Winery	1,000-4,999
Emanuel Medical Center	1,000-4,999
Fairbanks Cellars	1,000-4,999
Foster Farms	1,000-4,999

Source: California Employment Development Department 2013a.

Table 4.4-6 lists 10 of the largest employers in Merced County. Four of the 10 are in agricultural production or food processing, four are in health-related industries, and the remaining two are government or educational entities.

Table 4.4-6. Major employers in Merced County.

Employer	Employment Range
Foster Farms	1,000-4,999
Mercy Medical Center Hospital	1,000-4,999
Golden Valley Health Center	500-999
Hilmar Cheese Company	500-999
J. Marchini & Son Farms	500-999
Merced County Human Services	500-999
Mercy Medical Center Surgical Center	500-999
University of California	500-999

Employer	Employment Range
Western Marketing & Sales	500-999
Ansberry Physical Rehab Facility	250-499

Source: California Employment Development Department 2013b.

Table 4.4-7 lists 10 of the largest employers in Tuolumne County. The mix of employers in Tuolumne County includes two health-related businesses, three entertainment and recreation entities, a prison, a college, a utility, a nonprofit, and a big box retail store.

Table 4.4-7. Major employers in Tuolumne County.

Employer	Employment Range
Corrections Department	1,000-4,999
Sonora Regional Convalescent Home	1,000-4,999
Sonora Regional Hospital	1,000-4,999
Black Oak Casino	500-999
Dodge Ridge Ski Resort	500-999
Hetch Hetchy Water & Power	250-499
National Audobon Society	250-499
Walmart	250-499
Chicken Ranch Bingo & Casino	100-249
Columbia College	100-249

Source: California Employment Development Department 2013c.

4.5 Agricultural Economy

This section analyzes the role of the Project on agriculture in the MID and TID service areas and the overall regional economy. The discussion begins with a background on the role of irrigated agriculture in the San Joaquin Valley, and more specifically in Stanislaus and Merced counties. Next is a detailed review of the role of agriculture in the Districts' water service areas, followed by a discussion of the values of crop and dairy outputs in the Districts' service areas. Detailed agricultural statistics are also presented in Attachment C.

The San Joaquin Valley is one of the most productive agricultural regions in the world. It is characterized by a Mediterranean climate and rich and fertile soils which provide farmers with the ability to grow a wide variety of important annual and permanent crops. Several of those crops also provide key inputs for the production of milk as well as cattle, poultry and other meat products in the area. Because of the limited rainfall in the San Joaquin Valley (averaging less than 1-inch precipitation between May 1 and September 30), irrigation is essential to the agricultural sector, which contributed $30.2 billion in farm production value in 2011 (CDFA 2012).

The development of the Central Valley Project (CVP) and State Water Project (SWP) has supported the agricultural sector in several areas of the Valley. However, some parts of the San Joaquin Valley, including most of Stanislaus and Merced counties, are not directly connected to the CVP and SWP. Consequently, farmers in these counties have relied upon and benefited directly from the provision of reliable, high quality irrigation water by MID and TID since late in the 19th century. However, by not being connected to the CVP and SWP, farmers in the

Districts' water service area have no readily-available access to other surface water supplies, which limits farm-level responses to water supply shortages.

The farmland within the Districts' water service area is highly productive. The productivity of the land is borne out by statistics from as early as 1924. In that year, Stanislaus County and Merced County accounted for 5.3 percent of the total farmed acreage in the state, yet contributed 7.6 percent of the total state value of crops (USDA 1925). By 1945, the two counties had 6.2 percent of farmland in the state, yet 7.1 percent of the total state value of farm products. In that year, the value of milk production in the two counties was 16.5 percent of the state total (USDA 1945).

In 2011, Merced and Stanislaus counties were the fifth and sixth largest counties in California as measured by gross value of agricultural production (Table 4.5-1).[13] Together, they contributed $6.5 billion in gross value, 12.3 percent of total gross value for the state, with a significant portion of this production coming from land irrigated with water supplies provided by MID and TID.

The Districts have key roles in the agricultural economies of Stanislaus and Merced counties and the entire San Joaquin Valley. Through the Don Pedro Project, the Districts have provided highly reliable water supplies to their customers, e.g., consistent annual deliveries of high-quality surface water and sufficient groundwater supplies (through recharge by Project surface water) to maintain crops during periods of drought. With these reliable supplies, growers and producers have invested heavily in high-value perennial crops, such as almonds and peaches, as well as dairy production. The consistent, high value of agricultural output has, in turn, resulted in a large complex of agricultural-support industries being developed in the area. As a result, the two counties are regularly among the top 10 most productive agricultural counties in California.

Table 4.5-1. Top 10 California counties by gross value of agricultural production, 2011 ($billions).[1]

Rank	County	Production Value	Percent of State Total
1	Fresno	$7.039	13.4%
2	Tulare	$5.756	10.9%
3	Kern	$5.485	10.4%
4	Monterey	$4.010	7.6%
5	**Merced**	**$3.333**	**6.3%**
6	**Stanislaus**	**$3.139**	**6.0%**
7	San Joaquin	$2.297	4.4%
8	Kings	$2.269	4.3%
9	Imperial	$2.008	3.8%
10	Ventura	$1.883	3.6%
--	All Other Counties	$15.425	29.3%
--	California	$52.643	100.0%

Source: California Department of Food and Agriculture 2012.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

[13] Gross value represents the product of price and quantity for farm products as they leave the farms where they are produced. It does not represent net income, which incorporates farm expenses.

Within the counties the two highest valued commodities produced are milk and almonds. In 2011 the combined value of these two commodities accounted for 46.0 percent and 45.0 percent of the total value of agriculture production for Merced and Stanislaus Counties, respectively.

Table 4.5-2 lists the 2011 value of the top ten commodities for each county. In addition to milk and almonds, both counties produce chickens and cattle and calves, and the silage and hay used to support all livestock. The striking thing about the agricultural production in the two-county area is that nearly all of the top ten commodities are either perennial crops, e.g. nut trees and deciduous fruit or feed crops used to support livestock herds. On both counties' top ten list the only annual crops, that are not supporting livestock herds, are tomatoes (ranked 6th and 7th in Merced County and Stanislaus County, respectively and accounting for 3.0 percent of total agricultural production in both counties) and sweet potatoes (ranked 5th in Merced County at 5.0 percent of total county agricultural production).

With relatively few annual crops, not supporting livestock herds, the flexibility of growers to manage annual fluctuations in surface water irrigation supplies is relatively more limited than in areas where annual crops make up a larger percent of crop value.

Table 4.5-2. Top 10 commodities by county by gross value of agricultural production, 2011 ($thousands).[1]

Stanislaus County			Merced County		
Crop	**Value**	**Percent of Total Value**	**Crop**	**Value**	**Percent of Total Value**
Milk, All	783,452	25%	Milk, All	1,126,089	34%
Almonds	642,479	20%	Almonds	406,078	12%
Chickens, All	225,039	7%	Chickens, All	292,060	9%
Cattle & Calves, All	212,328	7%	Cattle & Calves, All	297,347	9%
Walnuts	179,700	6%	Sweet Potatoes	109,886	5%
Silage, All	159,833	5%	Hay, Alfalfa	91,271	4%
Tomatoes, All	93,065	3%	Silage, All	127,067	3%
Deciduous Fruit & Nut Nursery	73,021	2%	Tomatoes, All	162,663	3%
Hay, Alfalfa	71,649	2%	Eggs	87,107	3%
Turkeys, All	68,755	2%	Milk, All	--	--
Total Agricultural Production	**3,139,000**	**80%**	**Total Agricultural Production**	**3,333,000**	**78%**

Source: Stanislaus County Crop Report, 2011 and Merced County 2011 Report on Agriculture.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

4.5.1 Cropping Patterns

This section provides information first on crop acreage in Stanislaus and Merced counties, then within the Districts' service area. County crop acreage data are important to provide context and comparison for data at the District level, as some of the information for this analysis is available only at the county level. County crop data are taken from the annual crop reports prepared by the Stanislaus County and Merced County Agricultural Commissioners. District crop data are taken from the reports provided by TID and MID. While the categories of reported data differ somewhat between the counties (as reported by their respective Agricultural Commissioners), the crop data for the Districts have been standardized such that the categories in the two are identical.

4.5.1.1 Regional Cropping Patterns (Stanislaus and Merced Counties)

The principal irrigated crops in Stanislaus and Merced counties are a mixture of permanent and annual crops, including alfalfa, almonds, beans, corn, grains, grapes, hay, pasture, silage, tomatoes, and walnuts. Measured by harvested acreage, almonds are the largest crop, followed by corn silage, alfalfa, and hay.

Attachment Table C-1 shows the acreages of Stanislaus County crops by year from 2007 through 2011 and normalized averages[14] for each. Table 4.5-3 aggregates the crops, by category, while Table 4.5-4 shows the percentage distribution of crop acreages among the categories. The normalized average of harvested cropland (excluding dry land pasture and range, but including irrigated pasture) for 2007-2011 was 526,258 acres. The largest acreages were in nuts at 32.4 percent of the total, corn (including corn silage) at 25.8 percent, hay at 14.5 percent, and vegetables at 8.2 percent.

Table 4.5-3. Harvested acreage, Stanislaus County, by crop category and year (2007-2011).

Crop Category	2007	2008	2009	2010	2011	Normalized Average
Corn-Silage	110,640	122,254	139,249	146,600	161,000	136,034
Field and other	18,503	16,144	28,621	42,878	32,712	25,208
Fruit	15,689	16,412	16,097	18,874	17,185	16,911
Grain	33,220	3,609	3,995	4,630	46,550	13,972
Grape	10,700	11,223	10,602	10,700	11,000	10,667
Hay	37,700	77,366	91,615	110,510	59,640	76,395
Irrigated pasture	33,700	33,700	33,700	33,700	33,200	33,700
Nut	146,840	158,568	170,089	182,690	189,120	170,416
Vegetable	32,564	27,443	47,407	63,767	48,707	42,955
Total	**439,556**	**466,719**	**541,375**	**614,349**	**599,114**	**526,258**
Yr/Yr percent change	**--**	**6%**	**16%**	**13%**	**-2%**	**N/A**

Source: Stanislaus County Agricultural Commissioner 2007-2011.

Table 4.5-4. Percentage distribution of harvested acreage, Stanislaus County, by crop category and year (2007-2011).[1]

Crop Category	2007	2008	2009	2010	2011	Normalized Average
Corn-Silage	25.2%	26.2%	25.7%	23.9%	26.9%	25.8%
Field and other	4.2%	3.5%	5.3%	7.0%	5.5%	4.8%
Fruit	3.6%	3.5%	3.0%	3.1%	2.9%	3.2%
Grain	7.6%	0.8%	0.7%	0.8%	7.8%	2.7%
Grape	2.4%	2.4%	2.0%	1.7%	1.8%	2.0%

[14] Normalized figures for a five-year period are found by summing across all years, subtracting the maximum and minimum values, and computing a simple average of the remaining three (3) years' data. Simple average is used if less than five (5) years of data are available.

Crop Category	2007	2008	2009	2010	2011	Normalized Average
Hay	8.6%	16.6%	16.9%	18.0%	10.0%	14.5%
Irrigated pasture	7.7%	7.4%	6.2%	5.5%	5.5%	6.4%
Nut	33.4%	34.0%	31.4%	29.7%	31.6%	32.4%
Vegetable	7.4%	5.9%	8.8%	10.4%	8.1%	8.2%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

[1] Based on data from Table 4.5-3.

Attachment Table C-2 shows the acreages of various Merced County crops by year from 2007 through 2011. Table 4.5-5 herein aggregates the crops, by category, while Table 4.5-6 shows the percentage distribution of crop acreages among the categories for Merced County. Excluding pasture and range, the normalized average of harvested cropland was 593,247 acres for the 2007-2011 period. The largest acreages were in corn silage at 27.7 percent of total normalized average acres, nuts at 17.6 percent, hay at 15.8 percent and vegetables at 9.3 percent of total normalized average acres.

Table 4.5-5. Harvested acreage, Merced County, by crop category and year (2007-2011).

Crop Category	2007	2008	2009	2010	2011	Normalized Average
Corn-Silage	147,417	168,747	176,191	160,700	154,163	161,203
Field and other	57,884	40,459	31,591	46,652	58,796	46,551
Fruit	9,720	9,307	8,787	7,687	7,201	8,561
Grain	56,442	65,977	68,347	66,660	70,050	63,255
Grape	10,459	11,682	11,886	11,751	12,144	11,886
Hay	90,611	93,149	100,655	93,910	86,640	93,685
Irrigated pasture	59,958	49,759	41,570	43,141	54,200	48,205
Nut	97,621	102,617	106,617	110,860	108,810	104,658
Vegetable	47,061	48,058	65,351	63,950	46,363	55,231
Total	**577,173**	**589,755**	**610,995**	**605,311**	**598,367**	**593,247**
Yr/Yr percent change	**--**	**2%**	**4%**	**-1%**	**-1%**	**N/A4.5-11**

Source: Merced County Agricultural Commissioner 2007-2011.

Table 4.5-6. Percentage distribution of harvested acreage, Merced County, by crop category and year (2007-2011).[1]

Crop Category	2007	2008	2009	2010	2011	Normalized Average
Corn-Silage	25.5%	28.6%	28.8%	26.5%	25.8%	27.7%
Field and other	10.0%	6.9%	5.2%	7.7%	9.8%	7.8%
Fruit	1.7%	1.6%	1.4%	1.3%	1.2%	1.4%
Grain	9.8%	11.2%	11.2%	11.7%	11.7%	10.7%
Grape	1.8%	2.0%	1.9%	1.9%	2.0%	2.0%
Hay	15.7%	15.8%	16.5%	15.5%	14.5%	15.8%
Nut	16.9%	17.4%	17.4%	18.3%	18.2%	17.6%
Vegetable	8.2%	8.1%	10.7%	10.6%	7.7%	9.3%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

[1] Based on data from Table 4.5-5.

4.5.1.2 District-Wide Cropping Patterns (MID and TID)

Currently, MID has approximately 3,000 irrigation accounts averaging approximately 20 acres each, indicative of the majority of farms being smaller family farms (MID 2012a). Between 2007 and 2011, parcels in the MID irrigation service area aggregated to an average of 58,821 acres, which included irrigated and other land; irrigated land included 8,689 acres that were double cropped.[15] All parcels capable of being served by MID irrigation water are located in Stanislaus County. The TID irrigation service area is relatively larger. TID has approximately 4,900 irrigation accounts averaging approximately 28 acres each (TID 2013a). Between 2007 and 2011, parcels in the TID irrigation service area aggregated to an average of 135,827 acres, which included irrigated and other land; irrigated land included 44,890 double cropped acres.[16] Parcels capable of being served by TID irrigation water are in both Stanislaus and Merced counties. For TID, 75.6 percent of the parcel acreage is in Stanislaus County and 24.4 percent is in Merced County (Liebersbach 2013). By providing high quality, reliable water supplies, MID and TID have directly supported the development and productivity of crop and livestock agriculture in the two counties and, by extension, have also supported the development of a large complex of industries which support or are supported by production agriculture in the area.[17]

More pertinent to this analysis is the extent of irrigated and harvested acreage in the Districts' water service area. Attachment Table C-3 shows the total acreage of harvested crop land in the MID water service area by year from 2007 to 2011. The largest acreages were in almonds, corn silage, irrigated pasture, walnuts, grain, hay, and alfalfa, which collectively accounted for 85 percent of the total irrigated acreage. Table 4.5-7 shows the acreages of crops irrigated with MID water from Attachment Table C-3, aggregated by category. Table 4.5-8 shows the percentage distribution of crop acreages among the categories shown in Table 4.5-7. The largest acreages among the crop categories were in nuts (42.4%), corn-silage (16.9%) and grain (11.7%) of total normalized average acres

Table 4.5.7. Irrigated acres of crop land, MID, by year (2007-2011).[1]

Crop Category	2007	2008	2009	2010	2011	Normalized Average
Corn-Silage	9,354	9,536	9,536	13,816	13,664	10,912
Field and other	1,181	1,055	1,042	1,015	1,156	1,112
Fruit	3,469	3,418	3,393	2,971	2,807	3,260
Grain	8,707	9,117	9,114	4,736	4,818	7,539
Grape	1,513	1,350	1,347	1,349	1,263	1,349
Hay	3,654	3,649	3,649	3,758	3,280	3,685
Irrigated pasture	8,570	8,528	8,526	7,723	5,849	8,259
Nut	26,722	27,165	27,051	27,898	28,596	27,366

[15] Taken from District data on assessed acres for the period 2007-2011 (MID 2013a). The assessed acreage, averaging 58,821 acres, reflect total acres in property parcels and include cultivated acreage as well as land in buildings, roads, and other non-cultivable uses. Irrigated acres are estimated as 95 percent of assessed acres (Ward 2013).

[16] Taken from District data on assessed acres for the period 2007-2011 (TID 2013b). The assessed acreage, averaging 135,827 acres, reflect total acres in property parcels and include cultivated acreage as well as land in buildings, roads, and other non-cultivable uses. Irrigated acres are estimated as 94 percent of assessed acres (Liebersbach 2013).

[17] See Chapter 6, Regional Economic Analysis.

Crop Category	2007	2008	2009	2010	2011	Normalized Average
Vegetable	969	969	945	1,173	1,274	1,037
Total	**64,139**	**64,787**	**64,603**	**64,439**	**62,707**	**64,519**

Source: MID 2013a.
1 Includes double cropped acres.

Table 4.5-8. Percentage distribution of irrigated acres of crop land, MID, by year (2007-2011).[1]

Crop Category	2007	2008	2009	2010	2011	Normalized Average
Corn-Silage	14.6%	14.7%	14.8%	21.4%	21.8%	16.9%
Field and other	1.8%	1.6%	1.6%	1.6%	1.8%	1.7%
Fruit	5.4%	5.3%	5.3%	4.6%	4.5%	5.1%
Grain	13.6%	14.1%	14.1%	7.3%	7.7%	11.7%
Grape	2.4%	2.1%	2.1%	2.1%	2.0%	2.1%
Irrigated pasture	13.4%	13.2%	13.2%	12.0%	9.3%	12.8%
Hay	5.7%	5.6%	5.6%	5.8%	5.2%	5.7%
Nut	41.7%	41.9%	41.9%	43.3%	45.6%	42.4%
Vegetable	1.5%	1.5%	1.5%	1.8%	2.0%	1.6%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

1 Based on data from Table 4.5-7.

Attachment Table C-4 shows the total acreage of harvested crop land in the TID water service area by year from 2007 to 2011. The largest acreages were in corn, almonds, oats, and alfalfa, which collectively accounted for 76.0 percent of total irrigated acreage.[18] Table 4.5-9 shows the acreages of irrigated crops, based on the respective values from Attachment Table C-4, aggregated by category. Table 4.5-10 shows the percentage distribution of crop acreages among the categories shown in Table 4.5-9. The largest acreages among the aggregated categories were in nuts (29.5%), corn-silage (26.3%), and hay (23.5%).

Table 4.5-9. Irrigated acres of crop land, TID, by year (2007-2011).[1]

Crop Category	2007	2008	2009	2010	2011	Normalized Average
Corn-Silage	45,486	45,756	38,457	42,052	46,287	44,431
Field and other	12,498	15,113	30,270	24,374	18,198	19,159
Fruit	5,585	4,790	5,367	4,237	4,484	4,894
Grain	0	0	0	13	46	4
Grape	1,641	1,840	1,657	1,708	1,570	1,669
Hay	49,145	48,875	35,487	35,636	33,382	39,665
Irrigated pasture	9,047	7,734	7,390	7,308	6,569	7,477
Nut	49,401	49,591	50,117	49,522	50,848	49,774
Vegetable	1,141	1,346	1,803	1,664	1,937	1,607
Total	**173,944**	**175,045**	**170,548**	**166,514**	**163,321**	**168,681**

Source: TID 2013b.
1 Includes double cropped acres

18 Corn and oat acreage include double cropping.

Table 4.5-10. Percentage distribution of irrigated acres of crop land, TID, by year (2007-2011).[1]

Crop Category	2007	2008	2009	2010	2011	Normalized Average
Corn-Silage	26.1%	26.1%	22.5%	25.3%	28.3%	26.3%
Field and other	7.2%	8.6%	17.7%	14.6%	11.1%	11.4%
Fruit	3.2%	2.7%	3.1%	2.5%	2.7%	2.9%
Grain	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Grape	0.9%	1.1%	1.0%	1.0%	1.0%	1.0%
Hay	28.3%	27.9%	20.8%	21.4%	20.4%	23.5%
Irrigated pasture	5.2%	4.4%	4.3%	4.4%	4.0%	4.4%
Nut	28.4%	28.3%	29.4%	29.7%	31.1%	29.5%
Vegetable	0.7%	0.8%	1.1%	1.0%	1.2%	1.0%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**	**100.0%**

1 Based on data from Table 4.5-9.

Based on the data presented in Tables 4.10-7 and 4.10-9, MID and TID water supplies jointly support an average of approximately 233,200 acres of irrigated crop production annually. The largest proportion of crop production is in nuts (33.1%), followed by corn-silage (23.7%), and hay (18.6%). Overall, the amount of irrigated land in the Districts' water service area has remained relatively stable. These consistent figures demonstrate the importance of providing high quality and reliable Project water supplies that are used to produce commodities targeted for both human consumption and livestock feedstuffs.

4.5.2 Crop Production Values

Crop acreages are an important descriptor of agriculture within a region, but do not alone adequately describe a regional agricultural economy. Crop values are a major determinant of regional farm profitability and long-term viability. This section presents a review of crop production values in Stanislaus and Merced counties and in the District's water service areas. Note that the value of agriculture production from livestock, dependent on feed crops, such as milk, meat and eggs is not included in this section on crop production values. The data presented are gross production values and capture the product of average farm-level price and quantity produced of each crop. Gross production value is not synonymous with net farm income, which reflects gross value less farm costs. To show trends in production values over time, they are presented in inflation-adjusted 2012 dollars ($2012). At the regional level, price/value data are based on information presented in the Stanislaus County and Merced County Agricultural Commissioner reports. At the District level, however, crops values are based on values used in the agricultural production model to ensure consistency among data.

4.5.2.1 Regional Crop Production Values (Stanislaus and Merced Counties)

Table 4.5-11 shows the value of crop production, by crop category, in Stanislaus County for the period 2007-2011. Each value shown is calculated using acreages and average per-acre values for each category based on Stanislaus County data. As shown, the estimated normalized average of total gross production value from 2007 to 2011 was over $1.2 billion, with the largest contributions from nuts (49.2%), vegetables (12.4%), field and other (10.9%), and fruit (10%).

Table 4.5-11 Gross annual crop production value, Stanislaus County, by crop category and year (2007-2011) ($millions).[1]

Crop Category	2007	2008	2009	2010	2011	Normalized Average
Corn-Silage	$85.3	$134.8	$79.4	$112.0	$157.8	$104.0
Field and other	$137.3	$130.7	$144.2	$173.8	$141.1	$135.5
Fruit	$118.9	$189.1	$127.0	$144.6	$140.8	$124.0
Grain	$23.6	$3.8	$3.1	$4.0	$29.8	$9.9
Grape	$31.9	$5.0	$45.9	$31.3	$57.7	$34.0
Hay	$46.7	$101.4	$56.1	$63.6	$83.0	$65.2
Irrigated pasture	$5.7	$6.8	$5.9	$5.7	$6.5	$5.8
Nut	$677.6	$615.1	$655.4	$571.1	$925.0	$612.5
Vegetable	$108.6	$110.0	$215.1	$248.6	$166.2	$154.8
Total	**$1,235.6**	**$1,296.7**	**$1,332.1**	**$1,354.8**	**$1,707.8**	**$1,245.7**

Source: Stanislaus County Agricultural Commissioner 2007-2011.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

Table 4.5-12 shows the value of crop production, by crop category, in Merced County for the period 2007-2011. Each value shown is calculated using acreages and average per-acre values for each category based on Merced County data. As shown, the normalized average of total gross production value from 2007 to 2011 was over $1.1 billion, with the largest contributions from nuts (at 30.4%), vegetables (28.2%), corn silage (10.7%) and field and other crops (10.1%).

Table 4.5-12 Gross annual crop production value, Merced County, by crop category and year (2007-2011) ($millions).[1]

Crop Category	2007	2008	2009	2010	2011	Normalized Average
Corn-Silage	$108.6	$165.1	$101.0	$110.4	$149.9	$118.0
Field and other	$132.7	$70.8	$87.0	$138.9	$157.6	$111.4
Fruit	$39.3	$39.8	$37.0	$40.2	$34.4	$35.3
Grain	$40.4	$61.4	$40.1	$34.8	$58.0	$42.0
Grape	$21.1	$37.3	$45.9	$36.8	$53.1	$37.8
Hay	$124.5	$143.2	$81.0	$87.9	$130.1	$108.0
Irrigated pasture	$8.2	$7.1	$5.4	$5.5	$5.3	$5.7
Nut	$392.8	$330.0	$329.7	$413.2	$473.3	$336.8
Vegetable	$324.4	$312.1	$422.7	$336.8	$286.5	$312.0
Total	**$1,192.1**	**$1,166.8**	**$1,150.0**	**$1,204.4**	**$1,348.1**	**$1,107.1**

Source: Merced County Agricultural Commissioner 2007-2011.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

4.5.2.2 District-Wide Crop Production Values (MID and TID)

The average per-acre values (i.e., farmgate value[19]) for the crops grown within the Districts' service area are presented in Table 4.5-13. The data shown in Table 4.5-13 are those used in the agricultural production model, discussed in Section 5 of this report. The model uses

[19] Refers to the price (or value) of the commodity when sold by the farm.

aggregations of crops into different categories, used elsewhere in this chapter. For each category in the model, a "proxy" crop is used, one assumed to be representative of all crops in that category (e.g. almonds for all nuts including almonds, pistachios, and walnuts). As expected, permanent crops (i.e., fruits, nuts, and grapes) are generally higher value than annual crops, with the exception of vegetables.

Table 4.5-13. Average per-acre gross production value, by crop category, Stanislaus County.[1]

Crop Category	Average Per-Acre Value
Corn-Silage	$1,253
Field and other	$1,634
Fruit	$7,228
Grain	$822
Grape	$3,705
Hay	$559
Irrigated pasture	$525
Nut	$3,716
Vegetable	$7,821

Source: Stanislaus County Agricultural Commissioner 2007-2011, Merced County Agricultural Commissioner 2007-2011.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

MID and TID irrigation water is critical to the production of all agricultural commodities produced in the Districts' water service area in Stanislaus and Merced counties, including many high-value permanent crops and crops that support livestock herds. Tables 4.5-14 and 4.5-15 present the value of crop production in the TID and MID water service areas, respectively. The gross value of crop production in the MID service area is estimated to average approximately $167.2 million annually, with more than 60.0 percent of that value from nut production. The value of crops produced in the TID service area is substantially higher, at roughly $359.3 million annually. Similar to MID, nut production is the leading commodity in terms of production value (51.5%). The average annual value of crops grown in the two districts aggregated to $526.5 million, which has been fairly stable over the period 2007 to 2011. It should be noted that water years 2007, 2008, and 2009 were relatively dry water years, thus indicating the importance of water storage in Don Pedro Reservoir to maintain water supplies and related crop production values and employment levels over a series of sequential dry years.

Table 4.5-14. Gross annual crop production value, MID, by crop category and year (2007-2011) ($millions).[1]

Crop Category	2007	2008	2009	2010	2011	Normalized Average
Corn-Silage	$11.7	$12.0	$12.0	$17.3	$17.1	$13.7
Field and other	$2.3	$2.0	$2.0	$1.9	$2.2	$2.1
Fruit	$25.9	$25.5	$25.4	$22.2	$21.0	$24.4
Grain	$6.2	$6.5	$6.5	$3.4	$3.4	$5.3
Grape	$6.1	$5.5	$5.5	$5.5	$5.1	$5.5
Hay	$2.0	$2.0	$2.0	$2.1	$1.8	$2.1
Irrigated pasture	$4.5	$4.5	$4.5	$4.1	$3.1	$4.3
Nut	$99.3	$100.9	$100.5	$103.7	$106.3	$101.7

Crop Category	2007	2008	2009	2010	2011	Normalized Average
Vegetable	$7.6	$7.6	$7.4	$9.2	$10.0	$8.1
Total	**$165.6**	**$166.5**	**$165.7**	**$169.3**	**$170.0**	**$167.2**

Source: Internal calculations based on MID 2013a, Stanislaus County Agricultural Commissioner 2007-2011, and Merced County Agricultural Commissioner 2007-2011.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

Table 4.5-15. Gross crop production value, TID, by crop category and year (2007-2011) ($millions).[1]

Crop Category	2007	2008	2009	2010	2011	Normalized Average
Corn-Silage	$0.1	$57.3	$48.2	$52.7	$58.0	$55.7
Field and other	$23.9	$28.9	$57.9	$46.7	$34.8	$36.7
Fruit	$41.7	$35.8	$40.1	$31.7	$33.5	$36.6
Grain	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Grape	$6.6	$7.5	$6.7	$6.9	$6.4	$6.8
Hay	$27.5	$27.3	$19.8	$19.9	$18.7	$22.2
Irrigated pasture	$4.7	$4.1	$3.9	$3.8	$3.4	$3.9
Nut	$183.6	$184.3	$186.2	$184.0	$189.0	$185.0
Vegetable	$8.9	$10.5	$14.1	$13.0	$15.1	$12.6
Total	**$297.1**	**$355.7**	**$377.0**	**$358.8**	**$359.0**	**$359.3**

Source: Internal calculations based on TID 2013b, Stanislaus County Agricultural Commissioner 2007-2011, and Merced County Agricultural Commissioner 2007-2011.
1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

4.5.3 Livestock Production

Livestock production is a critical component of the agricultural economy of Stanislaus and Merced counties and the MID and TID service areas. Data on the inventory of livestock, number and type of livestock operations and the value of livestock and their products are critical for understanding the full scope and structure of agricultural production within the region. In 2012, milk ranked first among agricultural commodities by gross production value in both Stanislaus and Merced counties. Chickens ranked third in Stanislaus County, while cattle and calves ranked third in Merced County. It is important to understand that embedded in the gross value of livestock production is the gross value of crops produced and consumed as animal feed including silage, hay, pasture, grains, and even almond hulls and shells. It follows that the Don Pedro Project supports livestock production indirectly when crops produced with Project water are consumed as feed at livestock operations in the region, regardless if they are located within or outside the Districts' service area boundaries. In light of that fact, this section focuses on the value of the two-county livestock production supported by crops grown with the Districts' water (as opposed to the degree to which livestock operations are located within the MID and TID service areas).

4.5.3.1 Livestock Inventories

By census, poultry are the dominant livestock population in Stanislaus and Merced counties. Table 4.5-16 reports the livestock inventories of Stanislaus and Merced counties during 2012. At nearly 260 million head, chickens surpass the inventory of all other livestock combined. Turkeys are a distant second, with nearly 15 million head. Cattle and calves total 1.1 million head, with dairy cattle (milk cows and replacement heifers) accounting for over half of all cattle and calves. In terms of population, poultry are the dominant livestock within the area.

Table 4.5-16. Livestock inventory, number of head (thousands), 2012

Livestock	Stanislaus	Merced	Total
Cattle and Calves[1]	514	577	1,091
Milk cows	187	268	455
Replacement Dairy Heifers	70	66	136
Dairy Cattle Slaughter	75	71	146
Beef Cattle, Feeders	136	129	265
Beef Cattle, Slaughter	46	43	89
Chickens	184,097	74,730	258,827
Turkeys	12,268	2,630	14,898
Hogs and pigs	31	0	31
Goats, all	14	47	61
Sheep & lambs	2	37	39
Other poultry[2]	520	66	586
Total	**197,446**	**78,087**	**275,533**

Source: Stanislaus County Agricultural Commissioner 2012, Merced County Agricultural Commissioner 2012, and CDFA 2012
[1] Individual components other than milk cows are not reported for Merced County and were estimated based on the Stanislaus County report.
[2] Squab, chukar, and other game birds.

While poultry outnumber the other livestock, drastic differences in live weight and the nature of production practices result in a different picture in terms of the number of operations.[20] As Table 4.5-17 illustrates, beef cattle ranches and farms are the most numerous livestock production operations in Stanislaus and Merced counties, outnumbering dairy operations by nearly 2 to 1, and poultry operations by 6 to 1. As of 2007, beef cattle ranches and cattle feed lots accounted for nearly one-half of the farms in Stanislaus County classified as livestock operations. That figure was closer to one-third in Merced County, where a greater percentage of livestock operations are dairies. Poultry and egg producing operations (which includes both chickens and turkeys) accounted for approximately six percent of all livestock operations in the region.

Table 4.5-17. Number of farms by type of operation, 2007

Type of Operation by Primary Activity (NAICS)	Stanislaus	Merced	Total
Livestock production, any	**1,573**	**861**	**2,434**
Beef cattle ranching and farming (112111)	694	319	1,013
Cattle feedlots (112112)	23	3	26
Dairy cattle and milk production (11212)	257	277	534
Hog and pig farming (1122)	19	3	22
Poultry and egg production (1123)	115	38	153
Sheep and goat farming (1124)	98	61	159
Animal aquaculture and other animal production (1125, 1129)	367	160	527
Crop production, any	**2,541**	**1,746**	**4,287**
Total	**4,114**	**2,607**	**6,721**

[20] Livestock inventory figures can be somewhat misleading, as the live weight of the various animals can differ considerably. For example, the average chicken in Stanislaus County weighs approximately 5.7 pounds, meaning that a single, 1,100 pound beef cattle is equivalent to nearly 200 chickens on a live weight basis.

Source: USDA NASS 2007 Census of Agriculture, Volume 1, Chapter 2, Table 45. Farms by North American Industry Classification System: 2007.

4.5.3.2 Livestock Production Value

Comprised of expenditures on productive inputs and proprietor income (profit), gross production value is a more relevant measure of the economic importance of livestock and their products within the regional agricultural economy than censuses of animals or farm operations. As with crop production values, livestock production values reported here reflect gross production values, capturing the product of average farm-level price and the quantity of animals or animal products produced. Of particular importance for comparison with crop production values is that a substantial component of livestock production value is comprised by the production value of crops consumed as feed with the percent depending on the type of livestock and variation in the price of livestock and feed crops. This section presents livestock production values in Stanislaus and Merced counties and estimates the portion that is supported by feed crop production in the Districts' water service areas. The estimates developed in this section are used to support economic impact estimates, presented in Section 6, of the total regional contribution of the Districts' water to livestock production and related processing industries.

Table 4.5-18 reports average annual gross production values of livestock and livestock products in Stanislaus and Merced counties over the period 2007-2011. At three times the value of chickens, milk is the leading livestock product by value in both Stanislaus and Merced counties, accounting alone for over half the value of livestock production in the region. Milk, chickens and their eggs, and cattle and calves (including significant production of replacement heifers for the regional dairy herd) account for 93 percent of total annual livestock production value in the two-county area. While other livestock and their products may be supported to some degree by crops grown in the Districts' service areas, this study focuses on the value of milk, chicken and egg, and cattle and calf production supported.

Table 4.5-18. Gross annual production value of livestock and their products, annual average (2007-2011) ($millions).[1]

Livestock or Product	Stanislaus	Merced	Total	% of Value
Milk, Cows	$712.8	$1,028.2	$1,741.0	56%
Chickens, All	$262.4	$319.5	$581.9	19%
Cattle and Calves[2]	$165.2	$252.8	$418.0	13%
Replacement Dairy Heifers	$77.8	$118.8	$196.6	--
Dairy Cattle Slaughter	$37.4	$54.6	$91.9	--
Beef Cattle, Feeders	$43.7	$69.9	$113.6	--
Beef Cattle, Slaughter	$6.4	$9.5	$15.9	--
Eggs, All[3]	$44.1	$108.5	$152.6	5%
Turkeys, All	$61.8	$66.3	$128.1	4%
Apiary Products, All	$49.1	$25.6	$74.7	2%
Other[4]	$13.1	$21.5	$34.5	1%
Total	**$1,309**	**$1,822**	**$3,131**	**100%**

Source: Stanislaus County Agricultural Commissioner 2007-2011, and Merced County Agricultural Commissioner 2007-2011.

1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

2 Individual components are not reported for Merced County and were estimated based on Stanislaus County reports.

3 Over 94 percent of the value is associated with chicken eggs marketed for human consumption.

4 Includes hogs and pigs; sheep, lambs and wool; fish; other poultry (e.g., squab, other game birds); goats and goat milk; fish (aquaculture); and manure.

4.5.3.3 Dairy Industry

Milk is the leading agricultural commodity, by production value, in both Merced and Stanislaus counties. In 2011, milk represented approximately 29 percent of the total gross agricultural production value in the two counties and 4 percent of that for the state overall. California is the leading U.S. state in dairy production, and the two counties rank among the top five in the state in milk production. Of the 439,803 milk cows at 483 dairies in Stanislaus and Merced counties in 2011, it is estimated that 200,164, or 45.5 percent, are at the 269 dairies located within the MID and TID service area (Davis 2013, CDFA 2011).[21]

The region's dairy farms provide a consistent flow of high quality milk that is processed almost entirely in the local area. Additionally, the dairies represent important sources of demand for locally-produced corn-silage, alfalfa hay and other forages and feeds on which they rely heavily, and to which MID and TID irrigation water is a critical productive input.

Industry Trends

The U.S. dairy industry has undergone significant structural change in recent decades. As a result of the risks inherent in the dairy business there has been a trend towards larger, more specialized operations, which has been the source of expanded milk production in the face of substantial consolidation of operations.[22] Nationwide, the number of operations with at least 2,000 head increased 104 percent between 2000 and 2006 while the smallest class of dairy operations (<30 head), which tend to combine other commodities with the dairy enterprise, contracted by 31 percent (MacDonald et al., 2007). The trend towards larger operations has continued in Stanislaus County during recent years. Between 2006 and 2012 average herd size increased 37 percent, from 631 to 866 cows per operation (CDFA 2006, 2012). This is compared to a 29 percent increase statewide, from 902 to 1,164 cows per operation.[23]

Coupled with the risks of obtaining feed at consistent prices, the challenge of tending to live animals, large swings in prices received for milk (farmgate values), and recently established environmental regulation on waste management, dairy farming is one of the more demanding and risk-prone means of agricultural production. Gains experienced in one year can be followed 3by a string of years with losses or relatively small profit margins (Smith 2012). California producers in particular have experienced difficult market conditions beginning in 2009 that have led to industry consolidation. In 2009, the prices received by California dairy farmers (mailbox prices) fell substantially, by nearly 50 percent from a recent peak in 2009 when prices reached

[21] Information on dairy operations in Merced and Stanislaus counties, which includes the Districts' water service areas, was provided by the Central Valley Regional Water Quality Control Board (CVRWQCB). There are 41 dairy farms in the MID service area; and 228 in the TID service area, including 156 in Stanislaus County and 72 in Merced County (Davis 2013). Within the MID and TID service areas, there were an estimated 28,563 and 171,601 dairy cows, respectively, in 2011. The California Department of Food and Agriculture (CDFA) estimated 442,547 dairy cows in the two-county region during 2011, corroborating closely with the CVRWQCB estimates.

[22] Some studies find cost advantages accrue to efficiency of input use realized in larger operations, that is cost advantages are driven less by scale itself and more by the fact that larger operations use inputs more efficiently, while other studies find scale rather than efficiency is the main driver of observed cost advantages (Tauer and Mishra 2006; Mosheim and Lovell 2006).

[23] While the largest operations are driving expansion, the phenomenon is not limited to large corporate operations. One family farm operation in the San Joaquin Valley increased their herd from 160 cows in 1992 to 900 cows by 2012, the article citing the increase has been part of "grow[ing]with the times." (Smith 2012)

over $20 per hundred weight (CWT) (CDFA 2012). While milk prices recovered to near record highs in the late fall of 2011, feed prices were also at record highs. Alfalfa prices nearly doubled between 2009 and 2011, going from $146 to $281 per ton (CDFA 2012). As a result, profit margins were limited even at record milk prices.

Role of District Crop Production in Milk Production

Feed is the major source of milk production costs, accounting for approximately 65 percent of total production costs in the region and throughout California during 2012 and averaging 61 percent of costs over the period 2011 to 2012 (CDFA 2007-2012). In the diet of California Holstein herds (the major breed in the region), roughage accounts for approximately 40 percent of feed costs, while concentrates and by-products account for 50 percent (CDFA 2012, Heguy 2013). While concentrates and by-products are largely, if not exclusively sourced from the Midwest, Great Plains and even Canada, much of the roughage is grown locally.[24] Major components of roughage in the dairy feed ration include corn-silage and alfalfa hay, each of which is grown within the Districts' service areas. The relationship between local dairies and silage and alfalfa hay underscores the importance of these crops, which are dependent on District water supplies, to livestock production and related production of agricultural commodities (e.g., milk).

Corn-silage is the major component of wet roughage in the milk cow feed ration. Milking cows consume upwards of 28 pounds daily, making corn-silage the single largest component of the entire feed ration, 30 percent of daily intake on as-fed weight basis.[25] Locally sourced and in plentiful supply relative to other feed stuffs, corn-silage accounts for approximately 11 percent of feed costs. Corn-silage is extremely heavy and therefore costly to transport. Location to nearby supplies of quality corn-silage is critical for the competitiveness of the highly specialized California dairy operations (Saitone 2014). For this reason, dairies source corn-silage from no greater than a 20 to 30 miles radius around the operation, consequently, the availability of corn silage from the Districts' service area is of critical importance to the local dairy industry.

MID and TID farmers irrigated approximately 55,000 acres of corn-silage annually during 2007-2011, 32 percent of the acreage in the two-county area. Given the typical yield, required ration feed per cow and typical corn-silage shrinkage from field to dairy, corn-silage grown within the Districts can support approximately 267,000 milk cows annually (4.8 head to 1 acre).[26]

High-quality alfalfa hay is the major component of dry roughage and a critical component of milk production. Milk cows rely heavily on alfalfa hay, and very little on pasture and other hay that is a staple in cattle production.[27] Alfalfa hay accounts for approximately 11 percent of the total feed ration by weight, but nearly 18 percent of feed costs. While alfalfa hay grown within the region helps to insulate the Counties' dairy operations from this market risk and higher cost

[24] At just over 8 pounds per cow per day rolled corn is the major component of concentrates and by-products, followed by canola (CDFA 2012).
[25] By contrast other silage accounts for approximately 10 percent of the daily ration on an as-fed weight basis.
[26] While cattle feed lots use corn and corn-silage for fattening, most all of the corn-silage grown in the two-county region is utilized in the dairy industry (Pelican 2014).
[27] Other, non-alfalfa, hay accounts for less than one percent of milk cow feed on both an as-fed weight and cost basis (CDFA 2012).

imports, California is an alfalfa hay-deficit region and the insulating effect of its internal supply of alfalfa is limited.[28] MID and TID farmers irrigated approximately 13,000 acres of alfalfa hay annually during 2007-2011, approximately 11 percent of the acreage in the two-county area. Given the typical yield, required ration per cow and typical utilization in milk and dairy cattle production relative to other end uses, alfalfa grown within the Districts can support approximately 44,000 milk cows annually (3.4 head to 1 acre).[29]

Although less well-recognized, almond hulls and shells are another component of dry roughage in the milk cow diet. Almond hulls and shells account for approximately 4 percent of the milk cow feed ration on both an as-fed weight and cost basis. California leads the nation in almond production and Stanislaus County is a major almond producing region. MID and TID farmers irrigate 64,000 acres of almonds, approximately 27 percent of the acreage in the two-county area. Given the typical almond meat (kernel) yield, the ratio of hulls and shells to kernel weight and required ration per cow, almond hulls and shells grown within the Districts can support approximately 240,000 milk cows annually (3.8 head to 1 acre).[30]

Role of District Crop Production in Manure Management

In addition to market risk, California dairy farmers have also had to adapt to regulations implemented by the Central Valley Regional Water Quality Control Board (CVRWQB) aimed at protecting water quality by managing impacts from waste generated at dairies. Many Central Valley dairies have systems to store and distribute manure, and research has shown that more than 50 percent of excreted nutrients collected in these systems are applied to crops (Pettygrove, et al. 2003).[31] To do so, a dairy is required to develop a nutrient management plan (NMP) and waste management plan (WMP), and to follow a monitoring and reporting program (MRP), which includes annual reporting. The NMP requires that any land to which dairy waste is applied must be planted to crops. Consequently, continuous disposal of dairy waste from a herd of given size requires cultivation of a minimum number of acres of proximate crops and, therefore, supplies of fresh water adequate to dilute dairy waste for application to those crops. If supplies of irrigation water are reduced, dairy farmers must change their operations, e.g., by transporting waste to other locations for ground application or reducing the size of their herds.

Quantifying the degree to which District crops absorb manure from local dairy operations requires farm specific detail that was not obtained for this study.

Estimated Value of Milk Production Supported by Project Water

Estimating the value of milk supported by the Project is grounded in the fact that Project water supports the region's dairy herd indirectly through production of high-quality feed crops, which

[28] Oregon and Nevada are recognized as major supply regions of alfalfa hay to the California dairy industry (Mooney 2011).

[29] Statewide between 75 and 85 percent of alfalfa hay is utilized in milk production and herd replacement. The balance is utilized for equine (10 to 15%), beef (5 to 10%) and even a small export market (1 to 2%) (Klonsky et al., 2007).

[30] The figure stated assumes hulls and shells are used in equal parts, as the data source for the daily feed requirement (CDFA 2012) is not specific about the mix.

[31] To do so, a dairy is required to develop a nutrient management plan (NMP) and waste management plan (WMP), and to follow a monitoring and reporting program (MRP), which includes annual reporting. The NMP includes data on the number of dairy cows, acres of forage and other support crops, crop yields, and other information. The NMP requires that any land to which dairy waste is applied must be planted to crops.

virtually allow the local industry to exist. This is particularly true with respect to corn-silage. While other feed component can be imported to some degree, corn-silage is too heavy to transport and importing is cost-prohibitive. Further, District crops whether feed crops or otherwise, utilize Project water to provide some degree of nutrient management services to the local dairy herd.

A number of data points suggest the Project supports between 20 to 35 percent of milk production in the two-county region. These include the Districts' share of two-county corn-silage production; the share of corn-silage in the milk cow diet on as-fed basis; the implied gross revenue-cost multiplier on the value of corn-silage, alfalfa hay and almond hulls and shells grown in the District; and the component value of milk supported by District crops. Other approaches yield extremes of 10 and 60 percent of two-county milk production supported by District crops.[32] For this study, a point estimate of 31 percent is applied to the gross value of milk produced in the two-county region.

The gross production value from dairy farms is the sum of values for fresh milk and manufacturing milk. The value of replacement dairy heifer production and dairy slaughter is addressed with cattle production.[33] The figures are shown in Table 4.5-19. In 2011, the value of milk production in Stanislaus and Merced counties was $1.9 billion, averaging $1.7 billion for the five years from 2007 to 2011. As described above, it is estimated that 31 percent of milk produced in the two-county region is supported by crops grown in the MID and TID service areas, or $537.4 million.

Table 4.5-19. Gross value of milk produced in Stanislaus and Merced Counties supported by crops grown within the Districts' service areas, 2007-2011 ($millions).[1]

County	2007	2008	2009	2010	2011	Normalized Average
Stanislaus	$816.5	$728.9	$490.2	$627.3	$782.3	$712.8
Merced	$1,149.1	$1,053.4	$702.5	$905.5	$1,125.6	$1,028.2
Total	**$1,965.6**	**$1,782.3**	**$1,192.7**	**$1,532.8**	**$1,907.9**	**$1,741.0**
Estimated Portion of Gross Value Supported						**31%**
Estimated Gross Value Supported						**537.4**

Sources: Stanislaus County Agricultural Commissioner 2007-2011, Merced County Agricultural Commissioner 2007-2011.
1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

In addition to the estimated $537.4 million value of annual milk production in Stanislaus and Merced Counties supported by District-grown feed crops, Stanislaus and Merced counties are home to 17 of the 127 total dairy plants in California. Stanislaus County has 11 of the plants (9%), while Merced County has six plants (5%) (see Table 4.5-20).

32 The value of milk produced by the 44,000 cows supported entirely by District alfalfa hay (dedicated to milk production), corn-silage and almond hulls and shells is 10 percent of the annual average value of milk produced in the two-county region, while the value of milk produced by the 267,000 cows supported entirely by District corn-silage equates to 60 percent.

33 This is appropriate, as *Beef cattle ranching and farming (NAICS 112111*) comprises establishments primarily engaged in raising cattle (including cattle for dairy herd replacements), while *Dairy cattle and milk production (NAICS 112120)* comprises establishments primarily engaged in milking dairy cattle. As explained in subsequent sections this distinction becomes important in the regional economic analysis linking direct gross production value to indirect and induced gross value and income.

Table 4.5-20. California dairy plants, by county.

County	Number of Dairy Plants	Percent of State	County	Number of Dairy Plants	Percent of State
Los Angeles	23	18%	Humboldt	2	2%
Tulare	12	9%	San Joaquin	2	2%
Sonoma	11	9%	Santa Clara	2	2%
Stanislaus	**11**	**9%**	Del Norte	1	1%
Alameda	9	7%	Imperial	1	1%
Kings	6	5%	Kern	1	1%
Merced	**6**	**5%**	Napa	1	1%
Orange	6	5%	Sacramento	1	1%
Fresno	5	4%	San Benito	1	1%
Marin	5	4%	San Diego	1	1%
Riverside	5	4%	San Luis Obispo	1	1%
San Bernardino	4	3%	San Mateo	1	1%
Mendocino	3	2%	Santa Barbara	1	1%
Contra Costa	2	2%	Solano	1	1%
Glenn	2	2%	**California**	**127**	**100%**

Source: California Department of Food and Agriculture 2012.

4.5.3.4 Poultry

Chickens and eggs are major livestock and livestock products in Stanislaus and Merced counties. For the five years 2007-2011, annual production value of chickens and eggs averaged $734 million, accounting for 24 percent of livestock and livestock product value in the two-county region. While this is clearly substantial value in the context of livestock production within the region, the degree to which any measureable portion of this value is supported by District crop production is less certain.

Consistent with the U.S. poultry industry as a whole, chickens in the region are fed mainly high protein diets (USDA ERS 2014a). Protein sources in these diets can consist of soybean meal, fishmeal, corn gluten meal, alfalfa meal, minerals; while energy requirements are satisfied mainly by corn-grains (Chiba 2009). Much, if not virtually all of these feed stuffs are imported from other regions of the United States (Pelican 2014, Barry 2014). Soybeans are not grown in the region. Although fish are produced in the region ($3 million annual value), Project surface water is not likely utilized in production. Alfalfa is largely directed toward the substantial dairy and cattle industries in the region. While corn is a significant crop grown in the Districts, most is harvested as silage for dairy feed. MID reports just 600 acres of corn for grain, while TID does not report any corn grain acreage (Attachment C, Tables C-3 and C-4). Corn grain grown in the region is utilized in processed food products (e.g., chips, tortillas), ethanol production, and as grain feed for livestock (Merced County Agricultural Commissioner, 2012). Nationwide the percentage of corn used domestically in food, alcohol and industrial use increased from 43 to 58 percent from 2007 to 2013 (USDA ERS, 2014b).

For these reasons, it is unlikely that District crop production supports a measurable percentage of the gross value of chicken or egg production in the region.

4.5.3.5 Cattle Industry

The value of cattle production (cattle and calves) in Stanislaus and Merced County averaged $418 million annually over 2007-2011, comprising 13 percent of the gross value of livestock and livestock products in the counties. Nearly half of the value is from production of replacement dairy cattle ($197 million). Another 30 percent of the value ($114 million) is from production of beef cattle; calving, weaning calves, feeding of steers and heifers, and fattening/finishing of beef cattle on grass or in feed lots.

Beef cattle production in California is divided into three phases: cow-calf, where calves are birthed and weaned to approximately 600 pounds; yearling/stocker, where weaned calves are grown to 900 pounds mainly on grazed feed with supplemental hay; and finishing, where cows are fattened to market weight either on grass or in feed lots, generally over a 90 to 120 day period (UCCE 2010b, 2012c). A single operation may combine one or more of these phases. The available data suggest most of the value of cattle production captured in the region is generated in the cow-calf and yearling/stocker phases. As of 2007, there were 40 beef cattle ranching and farming operations for every feed lot in the two-county area. While feed lots operate in the area, the large feed lots finishing cattle on grains, corn-silage and alfalfa hay are located south of the region in the central San Joaquin Valley and in California's Imperial Valley (Barry 2014).

Cattle and calf operations in the region reside on rangeland and irrigated pasture. Cattle generally consume the hay and grass harvested from the land, supplemented by purchased hay, though not generally of the alfalfa variety. In the Sacramento Valley region, a steer or heifer consumes 0.4 tons of hay in addition to yield from the pasture (UCCE 2010b). MID and TID farmers irrigated 15,700 acres of pasture annually during 2007-2011, comprising 24 percent of the acreage in the two-county area. District acreage of oat, Sudan and grain hay averaged 37,000 acres annually over the 2007-2011 period, accounting for 38 percent of non-alfalfa hay grown in the two-county region.

Based on these figures, it is estimated that crops produced with Project water support approximately 31 percent of the value of cattle and calves production. This equates to $128.1 million based on the gross value of cattle and calves in the two-county region (Table 4.5-18). The estimated portion of dairy heifer and beef cattle production that is supported by District crop production is based the Districts' share of irrigated pasture and hay acreage. Dairy slaughter value is generated when cull dairy cattle are sent to slaughter for beef, thus the estimated portion of value supported is based on the estimates of milk value supported.

4.5.4 Total Gross Value of Agricultural Production in the Districts' Service Areas

Tables 4.5-14 and 4.5-15 shows the estimated average annual gross crop production value for the period 2007-2011 is $167.2 million for MID and $359.3 million for TID, a total of $526.5 million. The estimated annual value of livestock production, supported by crops grown within the Districts' service area, for the same period is $665.5 million (see Table 4.5-18 and Section 4.5.3.5). Thus, the gross value of agricultural production (both crops and livestock) for the period

2007-2011 was approximately $1.2 billion, or 22.0 percent of the total value of agriculture production for the two-county area (see Table 4.5-21).

Table 4.5-21. Comparison of the estimated annual value of agriculture output; two-counties to two-districts.

Category	Total Two-Counties	Total Two-Districts	Two-District percent of two-county total
Crop Production			
Corn-Silage	$203.4	$68.4	34.1%
Field and other	$248.7	$40.6	15.6%
Fruit	$154.3	$61.0	39.5%
Grain	$65.6	$5.4	8.2%
Grape	$69.7	$12.2	17.5%
Hay	$154.6	$24.3	15.7%
Irrigated pasture	$11.5	$8.3	72.1%
Nut	$1,014.4	$286.7	28.3%
Vegetable	$420.7	$20.7	4.9%
Crop sub-total	*$2,342.7*	*$527.9*	*22.5%*
Livestock			
Milk production	$1,741.0	$537.4	30.9%
Cattle and calves	$418.0	$128.1	30.6%
Poultry	$862.6	$0	0.0%
Other	$109.2	$0	0.0%
Livestock sub-total	*$3,130.7*	*$665.5*	*21.3%*
Total	**$5,473.5**	**$1,192.0**	**22.0%**

5.0 ECONOMIC VALUE OF EXISTING PROJECT WATER SUPPLIES

5.1 Agricultural Water Use

Changes in the volume and reliability of surface water diversions for irrigation affect agricultural productivity and viability, and consequently, the economic value of the water supplies. Surface water supplies from MID and TID are critical components to the agricultural sector in Stanislaus and Merced counties. Estimates of annual canal diversions for the 42 years from 1971 to 2012 show a relatively high degree of supply reliability by the Districts to farms in their service areas due to the water storage provided by the Don Pedro Project. Reliability is an important factor in the value of Project water supplies. The average annual volume of canal diversions from 1971 to 2012 was 848.1 TAF, with a maximum of 966.9 TAF (113.9% of average) in 1972 and a minimum of 639.7 TAF (76.3% of average) in 1992 (TID/MID 2013b).[34] The high degree of surface water supply reliability has encouraged and supported irrigators' investments in high value perennial crops (nuts, fruits, and vines) and crops that support dairy operations; and reduced acreage in other annual crops. As such, the value of water supplied by TID and MID has increased over time by reducing the substantial risk otherwise associated with the long-term investments needed for nut and fruit trees.

This section provides information on the methodological approach utilized to estimate the dollar value of Project water to agriculture in the MID and TID service areas. The section begins with a background on agricultural economic modeling and then discusses the conceptual framework and inputs for the model used for this analysis. The final part of this section is a review of the economic value of agricultural water supplies provided by MID and TID, based on the outputs of the model.

5.1.1 Background on Agricultural Economic Modeling

Many agricultural economic models have been developed to simulate farm-level decision making under various resource constraints, government policies, administered prices, and other factors such as the prices and availability of farm inputs. Some of the pioneering work in this area was completed during World War II in planning and coordinating the massive amounts of food and feed required to support the military. Other work was done at Iowa State University in the 1940s and 1950s, reported by Heady (1952); and at the University of California campuses at Davis and Berkeley, which also provided important applications to the literature, summarized in Johnston and McCalla (2009).

The methodology used in this study is traceable in large part to the agricultural economics framework developed and applied during the 1940s and since. Some of the more recent work has been focused on analyzing the impacts on agriculture and regional economies of limitations on water and other resources. The limitations have arisen from such factors as changes in federal regulations (e.g., the Central Valley Project Improvement Act) and restrictions on water

[34] Canal diversions include both agricultural deliveries and water delivered to the City of Modesto for M&I purposes. Canal diversion volumes are provided in Don Pedro Project Updated Study Report W&AR-02, Tuolumne River Daily Operations Model Base Case Description.

exports from the Sacramento-San Joaquin River Delta because of ESA restrictions; see, for example, McKusick (2005), ENTRIX (2007), and ICF International (2012).

5.1.2 Conceptual Framework

The valuation of water in agricultural production traces ultimately to farm-level decision making. These decisions can be characterized as both short term and long term. The short term is a period in which key decisions involve crop selection and how much water, labor, chemicals, and other inputs to apply to those crops. However, in the short term, adjustments to fixed assets such as land and machinery are not possible. The long term is a period over which decisions are made on all production inputs. These include not only those made for the short term, but also such long term issues as buying or selling of land, machinery, and other fixed assets.

The key elements of agricultural economics underlying this analysis include those described above combined with several others, including:

(1) "The goal" of growers is to maximize profits, subject to cultural and management practices.

(2) Growers are efficient, that is, they do not use more water, labor, machinery, or other inputs than necessary to produce their crops over the short and long term (Heady 1952).

(3) Growers producing several crops allocate inputs (e.g., fertilizer, borrowed funds, or chemicals) between the crops such that the marginal profit of the input is equal across crops, taking into account cultural practices like crop rotation. So long as the profit of an input is higher for one crop than for another, profits could be increased by shifting some of the input from the crop in which profit yield is lower to another where the profit yield is higher (Baumol 1965).

(4) Only variable costs are relevant in short-run decision making. In the long run, all costs must be covered.

5.1.3 Statewide Agricultural Production Model Approach and Model Inputs

The Statewide Agricultural Production (SWAP) model was selected for this study to estimate:

(1) the economic value of the Districts' irrigation water in current uses; and

(2) the potential changes in agricultural production which may result from changes in surface water supplies from Project operations.

The SWAP model was first used in the development of the California Value Integrated Network (CALVIN) model (Howitt et al. 2010). SWAP outputs of the estimated economic values of water shortages were input to the CALVIN model to estimate an efficient water allocation throughout the state (Draper et al. 2003). Subsequently, SWAP has been used in the development of varied planning scenarios and studies, such as those supporting the California Department of Water Resources preparation of the 2009 Water Plan Update (DWR 2009), referenced in (Howitt, et al. 2008).

The mathematical basis for SWAP is Positive Mathematical Programming (PMP), which is a self-calibrating modeling approach applied to agricultural production modeling. PMP is a widely-accepted method for analyzing water demand and analyzing changes in resource policies (Medellin-Azuara et al. 2008; Howitt 1995; and Lund et al. 2007). The calibration method ensures that the initial predicted crop production results from the model match the actual historical data (Howitt 1995).

The SWAP model is an annual model and is structured on the assumption that farmers choose cropping patterns that will maximize their profits, subject to constraints on available land and irrigation water supplies. The specific constraints that will be used when the model is run to estimate on-farm cropping patterns on lands in TID and MID under various water-supply scenarios are listed in Table 5.1-1.

Because SWAP is an annual model, the total predicted crop acreage in any year is constrained to be no greater than the amount of irrigated land at that time. Once calibrated, the model is used to estimate annual changes to cropping patterns, total irrigated acres, crop yield, and/or changes in water use per acre that result from changes in water supply for irrigation.

Table 5.1-1. Constraints on land, water and perennial crops.

Constraint	TID	MID
Total acres available for farming	117,424	59,341
Total acres double cropped	49,226	5,186
Total acres harvested	166,650	64,527
Total irrigation water supply	Estimates obtained from the Operations Model	

5.1.3.1 Model Input Data

Since the SWAP model is based on an assumption that growers maximize profits from their farms, it includes revenue and cost as the basis for calculating profit for each crop. Revenue is calculated using crop prices and crop yields, both taken from the annual crop reports prepared by the Stanislaus and Merced County Agricultural Commissioners. Crop costs include three main categories: production supplies (e.g., seed, chemicals, fertilizer), land, and labor. Crop costs are obtained from cost and return studies published by the University of California Cooperative Extension Service. Also obtained from these studies are estimated applied water demands per acre for each crop.

Acreage reports for MID and TID include many individual crops. The crops selected to model cropping patterns in the Districts were aggregated from those into eight crop categories. This aggregation was done because UCCE studies are not available for all of the crops grown in the two districts and also in order to increase the usefulness of the model results. Table 5.1-2 shows the crops reported by the Districts and the crop categories, crop type (annual, perennial, and those that support dairy) and the UCCE studies used for the representative crops in the model.

The crop aggregation for the group of ‘Field and Other’ was created to include several crops which individually comprise a small percentage of total acreage in the two Districts’ service areas. The crops were aggregated to simplify the structure of the model and without loss of accuracy since the number of acres in the overall aggregation is relatively small compared to the total and will have little impact on the model output. Table 5.1-3 lists the average price, yield, per acre value, and applied water for each of the crop categories.

Table 5.1-2. District-level crop categorization used for SWAP calibration.

District-Reported Crop Categories	Planning Model Assumptions			
	Crop Category	Crop Type	Proxy Crop	Cost and Return Studies
Beans, beans-canning, beans- dry, Christmas, garden, garden- other, lawn -garden, nursery stock, open land, other crops, sunflowers, trees-Christmas	Field and Other	Annual	Lima beans	Beans- Large Lima, 2010 San Joaquin Valley North
Eggplant, melons, melons - other, melons -watermelons, miscellaneous, onions, peas, pumpkins, seed -melons, seed - other, seed - squash, sugar beets, sweet potatoes, tomatoes - canning, tomatoes - shipping, vegetable crops, strawberries	Vegetable	Annual	Sweet potatoes	Sweet Potatoes, 2006 San Joaquin Valley, Merced County
Corn silage, corn	Corn-Silage	Livestock Support	Silage	Silage Double Cropped, 2012 San Joaquin Valley North
Grain, grain-barley, grain-milo, grain-oats, grain-rye, grain-wheat, rice	Grain	Livestock Support	Wheat (grain)	Wheat for Grain, 2008 San Joaquin Valley South
Alfalfa, clover, grain-hay, oats, sudan hay	Hay	Livestock Support	Oat Hay	Double Cropped Oat Hay in the San Joaquin Valley, 1990.
Pasture -irrigated	Irrigated Pasture	Livestock Support	NA	Pasture, Establish and Produce 2002, Sacramento Valley..
Apples, apricots, berries, cherries, peaches, peaches - cling, peaches - free, pears, plums	Fruit	Perennial	Peaches	Peaches, Processing (Cling and Freestone), 2011 Sacramento and San Joaquin Valley
Grapes - raisin, grapes-table, grapes-wine, vineyard	Grape	Perennial	Grapes (wine)	Grapes/Wine Crush, District 11 Cabernet Sauvignon, 2012
Almonds, other nut trees, walnuts	Nut	Perennial	Almonds	Almonds, 2011 San Joaquin Valley North

Sources: University of California Cooperative Extension 2006, 2008a, 2008b, 2010a, 2011a, 2011b, 2012a, and 2012b.

The SWAP model incorporates the cost of both surface water and groundwater supplies as separate inputs. Surface water costs are based on publicly-available rate schedules, e.g., those published by MID and TID (Table 5.1-4). Variable cost to pump groundwater is estimated to be $36.22 per AF.[35]

The modeling unit used in the SWAP model is based on the type of crop grown. Frequently, the SWAP modeling units are defined as a geographic region, such as an irrigation district, and the model allocates water, in large part, to the highest valued crops grown within the district. To accurately represent both the highly specialized nature of agriculture by the growers within the

[35] Assuming pump lift of 100 feet, pump efficiency of 60.0 percent, and a blended price for electricity of $0.1061/KWh.

Districts' service area and how water is delivered to those growers the appropriate modeling unit is the crop type. The implications of those assumptions are:

- Specialized Agriculture – The growers in TID and MID tend to specialize in one crop, e.g., almond growers generally are not growing vegetables or other field crops. Therefore, the modeling assumption that a grower would transfer water from a lower valued crop to a higher valued crop if faced with a reduction in irrigation supplies is not valid in TID and MID.
- Water Delivery Policy – MID and TID do not currently have policies that allow for a one-year short team transfer of water from one grower to another grower. Therefore water could not be transferred from growers of annual crops to growers of permanent crops.

These two assumptions result in estimates of the percent change in crop output that closely approximate the percent change in surface water irrigation supplies. For example, a ten percent reduction in water supplies would result in nearly the same percent reduction in crop acreage, yield and gross revenue, except for perennial crops. For perennial crops the SWAP model was revised to reflect a reduction in yield if irrigation supplies were reduced (Goldhamer et al. 2006). Acreage would remain the same as the baseline; however, yield would fall as a result of deficit irrigation.

The average price, yield and applied water for each crop group are critical inputs to the SWAP model. As shown in Table 5.1-3, these parameters vary considerably by the type of crop being grown.

Table 5.1-3. Average price, yield and applied water by crop.[1]

Crop Group	Average Price ($/ton)	Yield (Tons/Acre)	Value ($/Acre)	Applied Water (AF)
Corn-Silage	$45	27.84	$1,253	3.3
Field and other	$1,412	1.35	$1,916	2.5
Fruit	$318	22.72	$7,228	3.5
Grain	$227	3.13	$709	1.7
Grape	$395	10.26	$4,053	1.5
Hay	$160	3.5	$560	1.7
Irrigated Pasture	$100	5.25	$525	4.5
Nut	$3,516	1.028	$3,614	3.5
Vegetable	$353	22.1	$7,801	3.5

Sources: Stanislaus County Agricultural Commissioner 2007-2011; Merced County Agricultural Commissioner 2007-2011; and UCCE 2006, 2008a, 2008b, 2010a, 2011a, 2011b, 2012a, and 2012b.

[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

Table 5.1-4 shows the 2012 water prices used to calibrate SWAP. The SWAP model can be run to simulate the agricultural impacts of any water rates.

Table 5.1-4. 2012 irrigation rates and allotments for MID and TID.

Measure	MID			TID		
	Base	Tier 1	Tier 2	Base	Tier 1	Tier 2
$/Acre	$29.50	N/A	N/A	$26.00	N/A	N/A
Volume (AF)	3.0	0.5	1.0	3.0	1.0	1.0
$/AF	$9.80	$14.80	$30.00	$8.70	$15.00	$20.00
Blended rate ($/AF)[1]	$9.80	$10.50	$14.90	$8.70	$10.30	$12.20

Sources: MID 2013b and TID 2013c.
[1] The blended rates are calculated.
N/A: Not applicable.

The normalized average of crop-year acreages from 2007 through 2011 provided by the Districts were used as the cropping pattern input for the SWAP model. Table 5.1-5 shows the input for the number of acres planted by crop within each District's service area. Most of the land in the MID and TID service areas is planted in either perennial crops or crops that support dairy operations. Only 3.9 percent of MID's land and 3.1 percent of TID's land is planted in annual crops which are not directly in support of dairy operations.

The data in Table 5.1-5 are the SWAP model estimates of the normalized average number of acres actually irrigated between 2007 and 2011. The data include double cropped acres, and thus, do not reflect the "physical" or "assessed" acres in the parcels served by the Districts. The acreages also exclude the non-irrigable portions of parcels, estimated to be five percent for MID (Ward 2013) and six percent by TID (Liebersbach 2013).

Table 5.1-5 Cropping patterns for SWAP input, 2007-2011 (normalized acres).

Crop Category	Total
MID	
Corn-Silage	10,912
Field and other	1,112
Fruit	3,260
Grain	7,539
Grape	1,349
Hay	3,685
Irrigated pasture	8,259
Nut	27,366
Vegetable	1,037
Sub-Total Acres	*64,519*
TID	
Corn-Silage	44,431
Field and other	19,159
Fruit	4,894
Grain	4
Grape	1,669
Hay	39,665
Irrigated pasture	7,474
Nut	49,774
Vegetable	1,607
Sub-Total Acres	*168,681*
Districts (Combined)	
Corn-Silage	55,343
Field and other	20,271

Crop Category	Total
Fruit	8,154
Grain	7,543
Grape	3,017
Hay	43,350
Nut	77,140
Vegetable	2,644
Total Acres	**233,200**

Sources: MID 2013a and TID 2013b.

5.1.3.2 Model Calibration

As described in Howitt (1995), the SWAP model calibrates to the baseline input data by construction such that calibrated acreages are equal to actual historical figures. The profit maximization goal of growers is incorporated into the model's objective function. For the model calibration, a constraint specifies that the amount of all resources across all crops equates to the input data. For example, the calibration water constraint assumes that the amount of applied irrigation water available for the production of all crops is equal to the crop demand. The baseline water constraint states that surface water comprises approximately 81.0 percent of the water needed to meet the baseline crop demand, the remaining 19.0 percent of total crop demand is met from ground water pumping (TID/MID 2013b) (Table 5.1-6).

The model is programmed in GAMS (General Algebraic Modeling System), utilized for mathematical programming and optimization. The model includes a language compiler and solvers (GAMS Development Corporation). Once the constraints and objective function are specified, the model is run and can be used to estimate how agriculture will respond to such scenarios as reduced water supplies, changes in crop prices, or various policies affecting agriculture.

Table 5.1-6. Estimates of baseline irrigation water volume by source.

Water Source	MID		TID		Districts - Total	
	TAF	% of Total	TAF	% of Total	TAF	% of Total
District surface [1]	198.6	84%	421.6	80%	620.0	81%
District pumping [2]	17.3	7%	77.1	15%	94.4	12%
Private pumping [2]	21.0	9%	31.3	5%	52.3	7%
Total [3]	**236.9**	**100%**	**529.9**	**100%**	**766.7**	**100%**

[1] Calculated value.
[2] Average annual pumping volume of 42-year hydrologic trace, model output provided by Dan Steiner, to Susan Burke, Cardno ENTRIX via e-mail on December 3, 2013.
[3] SWAP model calculation of applied water for irrigation based on the normalized 2007-2011 estimated cropping pattern, calculated by multiplying the per-acre crop-specific applied water estimate by number of acres of crops.

Table 5.1-7 shows the results of the calibration run compared to the baseline cropping pattern (2007-2011 normalized average). The differences between the SWAP calibration acreage estimates are 1.0 percent or less for all crops.

Table 5.1-7. Calibration run estimate of acres in production by modeling enterprise and crop.

District	Crop	Calibration[1]	Normalized Average Acres (2007-2011)[2]	Difference	
				Acres	Percent
MID					
	Corn-Silage	10,923	10,912	-11	0%
	Field and Other	1,113	1,112	-1	0%
	Fruit	3,263	3,260	-3	0%
	Grain	7,546	7,539	-7	0%
	Grape	1,350	1,349	-1	0%
	Hay	3,689	3,685	-4	0%
	Irrigated pasture	8,267	8,259	-8	0%
	Nuts	27,393	27,366	-27	0%
	Vegetable	1,038	1,037	-1	0%
	Total	**64,582**	**64,519**	**-63**	**0%**
TID					
	Corn-Silage	43,651	44,431	780	2%
	Field and other	20,111	19,160	-951	-5%
	Fruit	4,899	4,894	-5	0%
	Grain	4	4	0	0%
	Grape	1,670	1,669	-1	0%
	Hay	39705	39,665	-40	0%
	Irrigated pasture	7,484	7,477	-7	0%
	Nuts	49,824	49,774	-50	0%
	Vegetable	1,601	1,607	6	0%
	Total	**168,949**	**168,681**	**-268**	**0%**
MID & TID (Combined)					
	Corn-Silage	54,574	55,943	1,369	2%
	Field and other	21,224	20,271	-953	-5%
	Fruit	8,162	8,154	-8	0%
	Grain	7,550	7,543	-7	0%
	Grape	3,020	3,018	-2	0%
	Hay	43,394	43,350	-44	0%
	Irrigated pasture	15,751	15,736	-15	0%
	Nuts	77,217	77,140	-77	0%
	Vegetable	2,639	2,644	5	0%
	Total	**233,531**	**233,799**	**268**	**0%**

1 Calibration run taken from the SWAP output.
2 2007-2011 actual cropping patterns obtained from TID and MID.

5.1.4 Economic Value of Agricultural Water Supplies

The estimated annual gross revenues (gross farm production value) and profits from irrigated crops from the SWAP calibration run are presented in Table 5.1-8. Gross annual revenue for all crops produced in the Districts' water service area is estimated at $527.9 million annually.[36] Nut

[36] Excludes the value of milk and cattle production dependent on grain and forage crops used for feed. The SWAP model does not estimate gross revenue of livestock products, e.g., milk for manufacturing, fluid milk, and cattle (such as dairy heifers, culled cows). However, as presented in Section 4.5.3.3, the value of milk production supported by crops produced in the

crops make up the highest percentage (54.4%) of gross revenue followed by corn-silage (13.0%) and fruit crops (11.6%).

Table 5.1-8. Estimated MID and TID SWAP model estimates of gross revenue by crop ($millions).[1]

Crop	Gross Revenue	
	Value ($)	**Percent**
Corn-Silage	$68.4	13.0%
Field and other	$40.6	7.7%
Fruit	$61.0	11.6%
Grain	$5.4	1.0%
Grape	$12.2	2.3%
Hay	$24.3	4.6%
Irrigated pasture	$8.3	1.6%
Nut	$287.0	54.4%
Vegetable	$20.7	3.9%
Total	**$527.9**	100.0%

5.1.5 Model Limitations

Not unlike all models, there are limitations to the model. First, SWAP is a short-run model, estimating annual changes in cropping patterns from an estimated annual change in irrigation water supplies. For this study, the hydrologic model may estimate that changes in Project operations due to relicensing causes reductions in estimated canal deliveries in one year, to an extent that the SWAP model may then estimate a reduction in perennial crop acres. If in the following year the estimated canal deliveries return to pre-relicensing levels, the SWAP model would estimate that the acres of perennial acres would also return. Clearly perennial crops do not offer this type of annual flexibility, and the constraint on yearly changes in perennial crop acreage mitigates this effect. Also, the estimates of potential annual changes in cropping patterns will be used as building blocks for an estimate of the potential long-run impacts of the potential future operating scenarios of Don Pedro Project.

The second shortcoming relates to the estimate of a change in water delivery patterns on dairy operations. Livestock and/or their products are not modeled with SWAP. The model estimates the acreage of feed crop acreage under changes in water supply, assuming feed crops are sold as an end product. While feed crop acreage under changes in water supply is determined internally within the optimization model, changes in livestock production will be estimated in a post-processing environment. The challenge of estimating the dairy response to a change in irrigation supplies is the diversity of dairy operations and the associated diversity of solutions available to respond to impacts of water shortages. As rational economic agents with the objective of maximizing profit, dairy farmers will respond with the least cost (i.e., reduction in profit) solution. Solutions may increase cost, reduce revenue, or both. However, dairy operations and their initial financial conditions are highly diverse and therefore so will be the particular response chosen by each operation. An operation's ability to respond can depend on several individual characteristics of the operation including the degree to which land and other capital is leveraged,

District's water service area is $537.4 million annually. As presented in section 4.5.3.5, the value of cattle and calves production supported by crops produced in the Districts' water service area is $128.1 million annually.

reliance on purchased feed, land base, current scale relative to the minimum efficient scale, and marketing and contractual commitments. (See Section 8.1.3 for a discussion of the value of reliable water supplies to dairy operations.)

5.2 Municipal and Industrial Use

In addition to agriculture, water from the Project is also used consumptively by local M&I (urban) customers. Since 1995, MID has provided treated M&I water to the City of Modesto. Municipal water is also provided to the community of La Grange (jointly served by TID and MID).[37] This section provides background information on local users of M&I water supplies; presents different approaches for valuing urban water supplies; and presents a range of estimates of the value of M&I water supplies from the Don Pedro Project. Also, the Don Pedro Reservoir provides a ‘water bank” for the CCSF which serves to substantially improve the reliability of its Hetch Hetchy water supply system.

5.2.1 Background and Overview

M&I supplies from the Don Pedro Project are critical in enabling local water purveyors, namely the City of Modesto, to manage its groundwater resource conjunctively with surface water supplies, meet local health and safety requirements, and support both current and future economic development and job growth. In addition, there are municipalities within Stanislaus County that are seeking Project water supplies to substitute for groundwater supplies that are currently being used to meet M&I demands.[38]

The Don Pedro Project also provides up to 570,000 AF of “water bank” credits to CCSF that can be used in its management of the Hetch Hetchy water system. Although water stored in the Don Pedro Reservoir is not delivered to CCSF water customers, the water bank privilege enables CCSF to ensure the reliability of its Tuolumne River water supply delivered from the Hetch Hetchy System to approximately 2.6 million urban customers in the San Francisco Bay Area. Those M&I customers are served by CCSF directly or by the 26 member agencies of the Bay Area Water Supply and Conservation Agency (BAWSCA) which depends on wholesale purchases of water from CCSF.

Prior to 1995, all M&I water use in the MID service area came from groundwater pumping (MID 2012a). Until that time, the City of Modesto, other local communities, rural residences, and businesses pumped groundwater from the Modesto Groundwater Sub-basin for domestic and commercial uses. Due in part to groundwater overdraft and concerns over groundwater quality, the City of Modesto entered into an agreement to purchase wholesale surface water supplies from MID, which are diverted from the Tuolumne River, treated at the Modesto Regional Water

[37] TID, under an agreement dating back to 1921, provides water for domestic use in the unincorporated community of La Grange, which is located outside its water service area boundary. The La Grange domestic water system is co-owned by TID and MID, and serves approximately 68 connections. TID operates and maintains the water system. Based on the relatively small quantity of water deliveries and limited number of hookups in La Grange, the M&I analysis presented in this study focuses exclusively on urban water supplies utilized by the City of Modesto.

[38] TID prepared an Environmental Impact Report (EIR) to the SWRCB to construct a new water treatment plant in Stanislaus County to facilitate the provision of surface water supplies from the Project for M&I purposes.

Treatment Plan (MRWTP),[39] and delivered to the City. The original agreement obligates MID to deliver 33,600 AFY (30 MGD) during normal years. In 2005, MID and the City of Modesto signed a new agreement that provides for the expansion (Phase Two) of the MRWTP, which would provide up to 67,200 AFY of surface water from the Tuolumne River to the City of Modesto (City of Modesto and MID 2005). The Phase Two expansion of the MRWTP has not yet been completed.

Municipal demand for water in the City of Modesto fell from 79,400 AF (in 2007) to 64,100 AF (in 2011) annually, averaging 71,200 AFY (West Yost Associates 2011). The steady decline in M&I water use over this time frame has been due to drought conditions that have resulted in water conservation and water use awareness, and a downward turn in the local economy that left homes unoccupied and businesses closed. During this period, MID delivered an annual average of 31,300 AF of treated M&I water to the City of Modesto, which represents approximately 44 percent of its total demand. The remaining demand was met by groundwater pumping. On average, the City of Modesto has pumped about 39,900 AF of groundwater annually. Groundwater use had been declining since 2007 due in part to the closure of some wells to comply with public health regulations, as well as reduced demand. This trend reversed in 2011, when groundwater pumping increased to 36,500 AF, up from 33,800 AF in 2010. Although municipal water use has declined in the City of Modesto service area between 2007 and 2011, population growth and development are projected to increase the demand for M&I water supplies. That annual demand is expected to increase to 82,900 AF by 2015 and 104,800 AF by 2035 (West Yost Associates 2011).

5.2.2 Literature Review

The economic value of M&I (urban) water supplies in California has been the subject of substantial research due to the competing demands and declining supplies that have characterized surface water in the State. Much of the research has focused on the economic cost (or impact) attributed to potential reductions in urban water supplies. Generally, it is difficult to quantify the economic costs of urban water supply reductions due to the vast array of response options for urban water managers, businesses and households. However, the concept of assigning economic values to urban water supplies has been the subject of numerous studies, particularly relative to the 1987-1992 drought in California, and more recently as part of the Delta Vision process. The results and conclusions from these studies, although not necessarily directly applicable to urban water supplies supported by the Don Pedro Project, provide valuable information on the value of urban water supplies elsewhere in California. [40]

In Jenkins et al. (2003), the authors developed economic loss functions for major urban water users throughout California. These economic loss functions are based on residential water demand elasticities and residential willingness-to-pay (WTP) for water, industrial WTP for water and assumed fixed commercial sector water use for 2020 population levels. These have been integrated into the California Value Integrated Network (CALVIN) economic-engineering

[39] The Modesto Regional Water Treatment Plant is owned and operated by MID.

[40] These studies referenced here focus on urban water scarcity costs, which account for economic losses associated with inadequate water supplies. For the baseline analysis, there are no urban water shortages associated with the Don Pedro Project; therefore, as presented in Section 5.3, the range of economic values attributed to the urban water supplies provided by the Project are based on the marginal cost of replacement supplies and market data.

optimization model of California's water supply system. The study estimated that the average annual cost to end users of urban water scarcity (906,000 AF/yr) in California in 2020 under current operations, allocations, and infrastructure would be $1.6 billion per year,[41] or $1,766 per AF. This study represents the precursor to the economic assessment of reduced water supplies as part of the Delta Vision program discussed below.

Lund et al. (2007) present an analysis of ways in which California water users might adapt to major changes in Delta management and water supplies. They argue that in the long-term, many water agencies have a number of options to respond to changes in water supplies, such as development of interties (i.e., connectors between aqueducts); underground storage (i.e., groundwater banking); water use efficiency and conservation; water markets, transfers, and exchanges; wastewater reuse; desalination, and changes in water pricing. With these options in place, it is argued that the economic effects of reduced Delta water supplies would be minimized if properly planned for, particularly when compared to sudden changes in water supplies (with estimated costs of up to $10 billion). The CALVIN model was used to analyze long-term statewide adaptations to changes in Delta water availability and related economic costs. The analysis assumes a projected 2050 level of demand, implementation of planned infrastructure improvements, and the case where no water is exported from the Delta. Under this scenario, there is a net decrease in annual urban water deliveries of 287 thousand acre-feet (TAF) relative to with-export conditions, which has an associated scarcity cost of $277 million, or $965 per AF. In the San Joaquin Valley, the urban scarcity cost was $1,172 per AF/yr (2006 dollars).[42]

A more historical context can be gained from economic studies prepared in response to the 1987-1992 drought in California. Urban water supply studies focused on both residential and industrial water users. Wade et al. (1991) collected survey data from major manufacturing sectors within areas served by California Urban Water Agency (CUWA) member agencies. The study excluded commercial activities, institutional sectors, and service industries. The study focused on potential plant production/output and employment losses associated with hypothetical 15 percent summer-seasonal and 30 percent year-long reductions in water supplies. The survey found that industry responses to reductions in urban water supplies include increasing water use efficiency; implementing high-cost conservation measures; and re-evaluating California's desirability as a location for new and expanded business operations. The study also found that even small industrial water shortages would cause large economic impacts on industrial production and jobs. It concluded that one acre-foot of water supports nearly $400,000 for plant shipments and 2.6 jobs on average for all of the surveyed industry groups. As a result, it was concluded that unreliable water supplies have the potential to adversely and significantly affect California's economy and business climate.

A series of economic studies and reports were prepared by the RAND Corporation related to the 1987-1992 drought. A compilation of the results of these studies is presented in *Drought Management Policies and Economic Effects in Urban Areas of California*, 1987-1992. Dixon et al. (1996) concluded that although average water costs increased during the drought, the majority

[41] The costs of water scarcity represent the economic value or benefits that users would gain from additional water deliveries up to the maximum quantity demanded. In other words, economic losses reflect the value (or utility) of foregone water use unadjusted for other benefits of delivering less than maximum water demands.

[42] In this study, the only regions with urban water scarcity costs are the San Joaquin Valley and Southern California.

of economic impacts were in the municipal sector, while industries were shielded from substantial economic losses (except for specific industries, such as landscaping). Further sizable potential losses were reduced by the state's Drought Water Bank, which provided approximately 10 percent of all urban supplies in 1991. From the perspective of municipalities and household users, the study found that the average welfare losses (from July 1991 to December 1992) associated with implementation of drought management strategies ranged between $14 and $23 per household. However, the study also concluded that it was difficult to distinguish effects associated with the drought from other forces (e.g., recession in the early 1990s), particularly for industries.

Finally, additional insight on residential values of urban water supplies is provided in Barakat & Chamberlain (1994). That study was based on contingent valuation (CV) methodology applied to an extensive survey of residential water users in the service areas of 10 CUWA agencies. The hypothetical extent of water shortages used in the study ranged from 10 percent to 50 percent in residential water supplies, and the frequency of such shortages ranged from one in three years to one in 30 years. The study found that California residents were willing to pay between $12 and $17 more per month per household to avoid the types of water shortages which they or their regional neighbors experienced in recent memory. As expected, residential water users were willing to pay more to avoid larger shortages and shortages with higher frequencies. Further, the impacts of frequency variations was found to be smaller than impacts of shortage magnitudes; residential customers believed that infrequent large shortages impose higher costs than more frequent small shortages, although they responded that they are still willing to pay substantial amounts to avoid even minor shortage scenarios. Several other conclusions were drawn from this study. First, people with larger landscape areas have a higher WTP than those people with less landscaping. Also, individuals who desire their communities to grow have a higher WTP than those who do not. Lastly, people with the perception that limited water supplies are a long-term problem have higher WTP than people who do not. The study also found that the WTP estimates were consistent across CUWA service areas and that there were no significant differences in WTP across northern and southern regions of the state.

5.2.3 Conceptual Framework

The economic value of M&I water supplies is typically considered in terms of average and marginal values. The average value of M&I supplies represents the value of water to local businesses and industries as an input to production (measured by the relationship between water supplies and production process), and the value of water supplies for domestic uses, such as drinking water. Alternatively, the economic value of M&I water supplies can be evaluated based on marginal values, i.e., the value of the last increment of water used. Conceptually, the marginal value of M&I supplies can be measured as the avoided costs of water supply reductions, which can be analyzed based on changes in consumption patterns (e.g., restrictions on water use for landscaping at the household level or declines in industrial production) assuming no alternative supplies are available. However, in most cases, the marginal value of urban water may be evaluated as the avoided cost of replacement supplies, where available, because domestic water use, including drinking water, is considered a fundamental need.

5.2.3.1 Water Valuation Approaches

Several appraisal techniques have been developed to estimate the value of M&I water supplies. The approaches commonly used include: (1) comparable sales; (2) avoided cost or least-cost alternative; (3) income capitalization; and (4) land value differentials (Bush 1987). Brief descriptions of these techniques are presented below. Section 5.2.4 presents estimated values of M&I water supplies from the Don Pedro Project using these approaches where applicable.

Comparable Sales (Market Value)

One of the most commonly-used approaches for valuing water when sufficient transaction data are available is the use of comparable sales, which provides a measure of the market value for water. The comparable sales method involves comparing the water being valued with similar water supplies that have been leased (e.g., annual water transfers) or permanently sold (e.g., transfer of water rights). The identification of comparable sales to use in the valuation process is based on the characteristics of the water being valued, such as location, use, and applicable local/regional water laws and policies.

Least Cost Alternative (Avoided Cost)

The least-cost alternative (or avoided cost) approach involves estimating the cost of alternative water supplies that are similar in legal and hydrologic terms to the water being valued, and identifying the least cost option. The cost of alternative supplies can be based on the development of a new water source, which increases the production of an existing water supply through infrastructure improvements so that the new/expanded water supply is similar in quantity and quality to the water being valued.

Income Capitalization

This approach, which primarily estimates the current use value of the water, is based on the premise that the market price of water is determined by the annual net returns attributable to it. The owner of the water foregoes future income by selling it. As such, the income capitalization technique involves estimating the contribution of that water to the net revenue in its current use. The approach is useful if it is possible to identify and quantify the annual net returns attributable to water.

Land Value Differential

Typically used for valuing agricultural water rights, this approach entails a comparative analysis of the selling prices of recent and relevant land sales with and without water rights. The difference between these two prices provides an estimate of the value of the water right. This approach is only useful in areas where land is routinely sold both with and without water rights, so that sufficient transaction data are available.

5.2.3.2 Data Sources and Coordination

In order to estimate the value of M&I water supplies from the Project, a range of information was obtained from the City of Modesto, the lone municipal water purveyor evaluated in this study. To facilitate the exchange of information, a meeting was held between the Districts and City of Modesto (Jack Bond, Senior Civil Engineer) on October 19, 2012. The City of Modesto provided information on the quantity of M&I water deliveries from the Don Pedro Project; alternative sources of water supplies; average costs of water supplies, including treatment costs; groundwater availability; type of water supply accounts; and water rates. Key documents that were reviewed and integrated into the analysis include:

- *Joint 2010 Urban Water Management Plan*, prepared for the City of Modesto and Modesto Irrigation District, by West Yost Associates, May 2011 (West Yost Associates 2011).
- Technical Memorandum, *Cost Impacts for City of Modesto due to Delays in the Phase Two Expansion of the Modesto Regional Water Treatment Plan*, prepared by Peterson-Brustad, Inc., August 29, 2012 (Peterson-Brustad 2012).
- [Proposed] *Agreement Between Modesto Irrigation District and San Francisco Public Utilities Commission for a Firm Long Term Transfer of 2 MGD of Water Supply* (MID 2012b).

In the future, the Project may provide surface water supplies to municipalities that are currently served only by groundwater. A shift from groundwater to surface water may generate economic benefits to these municipalities in the forms of more reliable and higher quality supplies, which may promote business recruitment and retention within the region. The economic benefits of such shifts include the cost savings between surface water diversions and groundwater pumping and treatment costs. However, because this study focuses on baseline conditions, the quantitative analysis excludes these municipalities. Nevertheless, the study team contacted other municipalities that may seek surface water supplies from the Don Pedro Project. The information requested included existing and future sources of water supplies, quantity of water use, historical changes in demand, projected water demands, and water prices. The following municipalities were contacted: City of Turlock; City of Hughson; City of Ceres; Denair Community Services District; Keyes Community Services District; Hilmar County Water District; and Delhi County Water District.

5.2.4 Economic Value of Municipal and Industrial Water Supplies

This section presents a range of estimated values for the M&I water supplies provided by the Don Pedro Project utilizing the approaches outlined above (where applicable).

5.2.4.1 Comparable Sales (Market Value)

The market value of M&I water supplies from the Project can be estimated using the comparable sales approach. A proposed water transfer agreement between MID and San Francisco Public Utilities Commission (SFPUC) in August 2012 would have provided for the transfer of 2 MGD of water, or approximately 2,240 AFY, over a 50-year period. The negotiated rate was $700 per

AF. However, the agreement was not finalized between the two parties and the proposed transfer of the water was terminated in September 2012 when MID voted to cease negotiations with the SFPUC. Although this agreement was not executed, SFPUC's WTP, $700 per AFY (2012 dollars), for a long-term lease of Project water for M&I purposes serves as a reasonable proxy of the value of M&I water supplies currently being delivered to the City of Modesto. The WTP value, $700 per AFY, when capitalized over 30 years using a six percent discount rate, provides an estimated price of $9,635 per AF for a permanent right to this water.

5.2.4.2 Least-Cost Alternative (Avoided Cost)

This technique utilizes the estimated cost of using alternative water supplies as a proxy for the value of M&I water supplies from the Don Pedro Project. Alternative water supplies can include existing sources, e.g., groundwater pumping, or the development of new supplies by the City of Modesto, with characteristics similar to M&I water from the Project. For this study, the alternative water sources evaluated are: (1) construction of a water desalination plant; (2) recycled water; and (3) groundwater pumping. Based on a preliminary review of these sources, groundwater resources are the least-cost alternative to existing M&I water supplies from the Project.

Desalination

The City of Modesto considers the desalination of water as a source of water in the City of Modesto/MID 2010 Urban Water Management Plan. However, it is considered an unlikely option given the lack of need for securing additional water supplies, significant infrastructure requirements, lack of proximity to brackish supply sources, and the depth to saline groundwater. As a result, the related costs for desalination have not been quantified.

Recycled Water

The City of Modesto could use recycled water as an alternative source to meet some of its municipal demand (West Yost 2011). Use of recycled water can displace an equivalent amount of non-potable municipal water (e.g., landscape irrigation, industrial reuse, and other non-potable uses). The cost of developing recycled water as an alternative water supply source is analyzed below.

Multiple recycled water treatment facility options were evaluated in the Northern San Joaquin Valley Water Reclamation Project (City of Modesto 2005). Four separate water recycling alternatives were evaluated by the City of Modesto, including recycling water at the primary treatment plant and three other scenarios evaluating recycling water at satellite treatment facilities. Based upon the location and the size of these water recycling facilities, it was estimated that the construction, treatment, and O&M costs for water recycling in the City of Modesto would be between $1,330 and $5,490 per AFY (2012 dollars).[43]

[43] Infrastructure costs related to recycled water distribution have been excluded from these cost estimates in order to be comparable with M&I supplies provided by the MRWTP.

Groundwater Pumping

The use of groundwater by the City of Modesto to meet local M&I demand was found to be the least cost alternative relative to M&I water supplies from MID via the MRWTP. As shown in Table 5.2-1, groundwater extraction costs[44] incurred by the City of Modesto are estimated to be $82.99/AF (excluding capital costs), or approximately $30/AF higher than operating costs for M&I Project water from the MRWTP. Operating costs for groundwater wells in the City of Modesto include the cost of electricity ($70.21/AF) and chemical treatment costs, namely carbon and chlorine ($12.78/AF).

Table 5.2-1. Groundwater operating costs, City of Modesto.[1]

Year	Electricity	Chemical Treatment		Total Operating Costs	Total Operating Costs ($2012)	Pumping Volume (AF)	Variable Costs/AF
		Carbon	Chlorine				
2010	$1,996,101	$315,337	$94,394	$2,405,832	$2,524,958	29,342	$86.05
2011	$2,187,573	$243,086	$107,741	$2,538,400	$2,595,340	32,356	$80.21
Average	$2,091,837	$279,212	$101,068	$2,472,116	$2,560,149	30,849	$82.99

Source: Peterson-Brustad, Inc. 2012.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

To understand the full costs associated with groundwater pumping, the capital costs associated with well construction must also be considered. The cost of a typical municipal groundwater well in the City of Modesto, with a yield of 1,500 GPM (or 2,420 AF/yr) is estimated at approximately $2 million (Bond 2013). The annualized value over 30 years and a six percent interest rate is $143,300. Based on these figures, the capital costs for groundwater wells is about $60.05 per AF/yr. Accounting for both capital and operating costs, groundwater costs in the City of Modesto are an estimated $143 per AF.

5.2.4.3 Other Methods Not Utilized

The income capitalization approach requires information on M&I water deliveries to each type of municipal customer and the net returns earned by the business and industrial enterprises that utilize municipal water as an input to production. The required data are not available and therefore the income capitalization approach is not used in this study.

As described above, the land value differential approach is more relevant for valuing water rights associated with agricultural land and is typically not employed for valuing M&I water supplies. Therefore, this approach is not used for this study.

5.2.4.4 M&I Water Valuation Summary

As described above, the value of M&I water supplies can be measured utilizing various approaches, including comparable sales and avoided cost approaches. In this context, the most relevant measure for valuing M&I water supplies provided by the Don Pedro Project is the avoided costs of groundwater pumping by the City of Modesto, which is estimated at about $143

[44] Based on operating costs for groundwater wells, including power and treatment costs; excludes capital costs.

per AF. Applying this value to the total quantity of Project water currently used for M&I purposes (31,308 AF/yr), the total value of Project M&I water is an estimated $4.5 million annually (2012 dollars).

5.3 Recreational Use

5.3.1 Background and Overview

The Don Pedro Project provides water storage for multiple uses, including recreation. Recreation activity occurs throughout the Project area, but tends to be concentrated in three designated recreation areas: Blue Oaks, Fleming Meadow and Moccasin Point, which are managed by the Don Pedro Recreation Agency (DPRA).[45] Visitors undertake a wide range of recreation activities in the Project area, many of which are water dependent, such as fishing and boating. Overall, the Don Pedro Project attracts hundreds of thousands of visitors annually, who realize an economic benefit associated with their recreation experience. This purpose of this section is to quantify the economic values associated with recreation at the Don Pedro Project. These benefits are distinct from the economic contribution to the local economy from recreation-related spending and the recirculation of those dollars across industries and households; the regional economic benefits attributed to recreation are covered in Section 6.0.

5.3.2 Conceptual Framework

The economic benefit (or value) of recreation captures how much people value their participation in recreation activities. This concept is analogous to “consumer surplus” value, which reflects the amount that an individual would be willing to pay to be able to participate in particular recreation activities over and above their actual expenditures. For example, if visitors to Don Pedro Reservoir are willing to pay $50 to fish for a day, but the actual cost of their fishing trip is only $20, they receive a net economic benefit of $30 per day from their fishing experience. Estimating the economic benefits of recreation requires two types of information: 1) the value that participants receive from each day of participation in a particular recreation activity; and 2) estimates of the annual recreation participation by type of activity. Each is addressed below.

Unlike typical goods and services, the value of recreation is not directly measured in markets. Consequently, measurement of the values provided by recreation relies on “non-market” techniques, such as CV or travel cost (TC). The cost and time requirements for utilizing these techniques, particularly associated with collecting data and conducting statistical analysis, are beyond the scope of this analysis. In lieu of these primary research methods, this study utilizes the “benefit transfer” approach to estimate recreation-based economic values at Don Pedro Reservoir. The benefit transfer method uses available information on economic values for recreation from studies already completed in another similar location and/or context and applies them to the project being analyzed. The goal of the benefit transfer method is to estimate benefits for a targeted location (typically referred to as the “policy” site) by adapting an estimate of benefits from some other location (referred to as the “study” site). This approach yields representative values as long as the policy and study scenarios (the characteristics of the sites;

[45] This study focuses on flat-water recreation at Don Pedro Reservoir. It does not cover recreation on the Tuolumne River because river-based recreation is not expected to change under the Relicensing alternatives.

relevant aspects of the market such as access fees, distance to the site, and availability of substitutes; aspects of the recreation experience such as intensity and duration; and the characteristics of the population) are relatively comparable, and if the level of potential uncertainty is deemed acceptable for a particular application.[46]

For this study, economic values attributed to recreation have been obtained from a meta-analysis of recreation use valuation studies developed for the USFS (Loomis 2005). As part of that study, Loomis developed composite estimates of recreation use values by recreation activity and by region in the U.S. For this analysis, value estimates for both the Pacific region and all U.S. regions were applied to estimates of recreation use and activity participation at the Don Pedro Project as described below.

There are some caveats associated with the use of the recreation values reported by the USFS. First, the benefits estimates in the USFS study are based on over 1,200 prior studies that predominantly cover recreation at federally-managed lands (e.g., National Forests and National Parks), and there may be differences in the types and quality of recreation opportunities on these lands compared to the Don Pedro Project. Second, there are several primary activities reported by Don Pedro visitors that are not included in the USFS benefits estimates, which required assigning these activities to the most applicable USFS category, including “general recreation” in many cases. Third, some of the values in the USFS study are based on a small number of previous studies or estimates, particular for the Pacific Region, which could limit the accuracy of the estimate(s). In cases where no estimates for a particular activity are reported for the Pacific Region dataset, national values were used as a proxy. Notwithstanding these concerns, the benefit estimates from the USFS study provide a reasonable estimate of the recreation values supported by the Don Pedro Project given the purpose and scope of this analysis.[47]

Recreation use levels at the Don Pedro Project have been collected from the DPRA, which estimates the number of recreation days annually as part of the Davis-Grunsky Act reporting requirements. DPRA provided recreation use data for the period 2010 to 2012, which represents the baseline period for this analysis. DPRA does not collect information on recreation use levels by type of activity; however, this information has been collected as part of other relicensing studies, namely *RR-1: Recreation Facility and Public Accessibility Assessment* (TID/MID 2013a). Together, these data were used to quantify recreation use and activity levels at the Project under baseline conditions.

Using the data sources outlined above, it is relatively straightforward to estimate the economic value of recreation activity at the Don Pedro Project. Total economic benefits attributed to recreation are calculated by multiplying the estimated number of recreation days for which visitors to the Don Pedro Project participate in specific activities by the corresponding value per “activity day” for each activity and type of facility.

[46] See Rosenberger and Loomis (2001) and references therein (particularly Desvousges and Johnson 1998) for additional discussion regarding the conditions under which benefits transfers are appropriate for different purposes.

[47] See references in Rosenberger and Loomis (2001) for additional discussion regarding factors that lead to uncertainty in benefits transfer. One type of potential bias results when the policy site is not unique but the literature focus on unique sites or resources. This is of particular concern when there are relatively few studies available for a particular activity or region because one high value associated with a unique site may skew the mean upward.

5.3.3 Economic Value of Recreation Activity

The economic analysis of recreation focuses on the value of flat-water recreation at Don Pedro reservoir as measured by the value to the recreation user, measured as consumer surplus. This section presents estimates of recreation use at the Don Pedro Project under baseline conditions, representative consumer surplus values for recreation from existing studies, and applies these values to the Don Pedro Project to estimate the total economic value of recreation activity.

5.3.3.1 Recreation Visitation

Visitation level data by type of recreation activity are needed to estimate the economic value of recreation. Estimates of recreation visitation at the Don Pedro Project between 2010 and 2012 are presented in Table 5.3-1. Recreation use levels at Don Pedro have been declining over the past several years, falling from approximately 397,700 visitor days in 2010 to 344,000 visitor days in 2012. Approximately 55 percent of the visitors are day-use recreationists, while the remaining 45 percent are overnight campers.

Table 5.3-1. Recreation visitation at the Don Pedro Project, 2010-2012.

Visitor Type	Visitor Days			
	2010	2011	2012	Average
Day Use	218,724	212,399	189,569	206,897
Overnight (Camping)	178,956	180,206	154,476	171,213
Total	**397,680**	**392,605**	**344,045**	**378,110**

Source: Don Pedro Recreation Agency 2010, 2011, and 2012.

Table 5.3-2 shows the distribution of recreation use across primary activities at the Don Pedro Project. The two prominent recreation activities are fishing and camping, which account for approximately 32 percent and 27 percent of total recreation use, respectively. Recreational boating and houseboating are also popular, jointly accounting for 22 percent of recreation use at the Project.

Table 5.3-2. Primary recreation activity at the Don Pedro Project.

Recreation Activity	Survey Respondents	Percentage
Fishing	177	32.4%
Camping	146	26.7%
Boating	67	12.3%
Houseboating	53	9.7%
Relaxing	31	5.7%
Swimming	20	3.7%
Water Sports	15	2.7%
Picnicking	11	2.0%
Personal Watercraft (PWC)	7	1.3%
Fireworks	4	0.7%
Family Reunion	3	0.5%
Party	2	0.4%
Youth Group	2	0.4%
Bachelor Party	1	0.2%
Boat Camping	1	0.2%
Church Group	1	0.2%

Recreation Activity	Survey Respondents	Percentage
More than 3 activities	1	0.2%
Outdoor Fun	1	0.2%
Pleasure Driving	1	0.2%
Visit Family	1	0.2%
Visit Yosemite	1	0.2%
Total	**546**	**100.0%**

Source: TID/MID 2013a.

5.3.3.2 Recreation Values (Unit Values)

Representative economic (consumer surplus) values associated with different types of recreation activities are presented in Table 5.3-3. For the Pacific Region, there are a total of 186 estimates with a weighted mean value of $51.13 per recreation day (2012 dollars) across all types of recreation. There are substantially more observations across all regions (1,239 estimates), where the weighted mean value was $58.07 per recreation day. There is one key difference between the two datasets that is relevant for this analysis. The mean value for camping activity in the Pacific Region is estimated at $127.18 per recreation day, which is substantially higher than the national estimate of $45.33 per recreation day. Although there may exist some differences between the type and quality of camping activity in the Pacific Region relative to other parts of the country, this difference is noteworthy and is likely due to the limited number of estimates for the Pacific Region. Because much of the recreation activity at the Don Pedro Project is camping, estimates of economic value using the Pacific Region dataset provide an upper bound on the value of recreation at the Don Pedro Project.

Table 5.3-3. Average consumer surplus values (per person per day) by activity and region.[1]

Activity	Pacific Region [2]			All Regions		
	# Estimates	Mean	Std. Error	# Estimates	Mean	Std. Error
Backpacking	6	$63.50	$11.32	6	$63.50	$11.32
Birdwatching	--	--	--	8	$36.08	$10.18
Camping	4	$127.18	$55.31	48	$45.33	$7.03
Cross-country skiing	1	$58.97	$0.00	12	$38.25	$4.16
Downhill skiing	1	$30.57	$0.00	5	$40.82	$10.34
Fishing	15	$54.07	$10.58	177	$57.48	$5.86
Floatboating / rafting / canoeing	4	$33.93	$1.23	81	$122.99	$11.65
General recreation	9	$39.43	$17.53	39	$42.78	$10.59
Going to the beach	--	--	--	33	$48.06	$6.17
Hiking	49	$28.33	$3.23	68	$37.59	$5.28
Horseback riding	--	--	--	1	$22.08	N/A
Hunting	18	$55.44	$9.42	277	$57.19	$2.68
Motorboating	8	$32.83	$7.19	32	$56.39	$9.06
Mountain biking	16	$60.55	$3.34	32	$89.92	$14.76
Off-road vehicle driving	1	$49.20	$0.00	10	$27.94	$4.81
Other recreation	1	$90.76	$0.00	16	$59.36	$14.10
Picnicking	3	$78.27	$48.34	13	$50.53	$13.03
Pleasure driving	--	--	--	11	$72.19	$22.96
Rock climbing	--	--	--	27	$68.57	$8.36
Scuba diving	10	$64.11	$31.52	24	$39.44	$13.66

Activity	Pacific Region [2]			All Regions		
	# Estimates	Mean	Std. Error	# Estimates	Mean	Std. Error
Sightseeing	4	$24.71	$16.47	28	$44.90	$10.73
Snorkeling	9	$36.94	$18.72	9	$36.94	$18.72
Snowmobiling	--	--	--	8	$44.23	$16.14
Swimming	4	$33.26	$13.83	26	$52.02	$7.48
Visiting environmental education centers	--	--	--	1	$7.33	N/A
Visiting arboretums	--	--	--	1	$16.50	N/A
Visiting aquariums	--	--	--	1	$34.50	N/A
Waterskiing	--	--	--	4	$59.75	$15.50
Wildlife viewing	23	$88.34	$20.60	240	$51.63	$3.22
Windsurfing	--	--	--	1	$482.00	N/A
Average (Weighted) [3]	**186**	**$51.13**	**N/A**	**1,239**	**$58.07**	**N/A**

Source: Loomis 2005.
1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
2 Pacific Region includes Washington, Oregon, California, and Hawaii.
3 Weighted average for all recreation activities (weighted by number of estimates).
N/A: Not Applicable

5.3.4 Recreation Values from the Don Pedro Project

Estimates of the economic value attributed to recreation at the Don Pedro Project are presented in Table 5.3-4. The values are based on estimates of recreation use by recreation activity (see Section 5.3.3.1) and representative unit values by recreation activity (Section 5.3.3.2). Two sets of values are used in the analysis, one based on values of recreation in the Pacific Region and the other for all regions combined. The two sets offer a reasonable range of values. In total, the Don Pedro Project attracts approximately 378,100 visitor days annually under baseline conditions, with visitors primarily engaging in fishing, camping, and boating activity. This level of recreation has a corresponding economic value to recreation participants of $19.8 million to $25.4 million per year (2012 dollars). The average consumer surplus value across all activities at the Don Pedro Project is about $67 per person per day using Pacific Region data and $52 per person per day using national estimates.

Table 5.3-4. Economic values attributed to recreation at the Don Pedro Project.[1]

Activity	Percent of Total Visitation	Number Visitor Days (Estimated)	Proxy Activity	Consumer Surplus Value ($/Visitor Day)		Total Economic Value ($)	
				Pacific Region [2]	All Regions	Pacific Region	All Regions
Fishing	32.4%	122,570	Fishing	$54.07	$57.48	$6,627,100	$7,045,400
Camping	26.7%	101,110	Camping	$127.18	$45.33	$12,859,000	$4,582,900
Boating	12.3%	46,400	Motorboating	$32.83	$56.39	$1,523,500	$2,616,600
Houseboating	9.7%	36,700	Motorboating	$32.83	$56.39	$1,205,100	$2,069,800
Relaxing	5.7%	21,470	General recreation	$39.43	$42.78	$846,400	$918,400
Swimming	3.7%	13,850	Swimming	$33.26	$52.02	$460,700	$720,500
Water Sports	2.7%	10,390	Swimming	$33.26	$52.02	$345,500	$540,400

Activity	Percent of Total Visitation	Number Visitor Days (Estimated)	Proxy Activity	Consumer Surplus Value ($/Visitor Day)		Total Economic Value ($)	
				Pacific Region [2]	All Regions	Pacific Region	All Regions
Picnicking	2.0%	7,620	Picnicking	$78.27	$50.53	$596,200	$384,900
Personal Watercraft (PWC)	1.3%	4,850	Waterskiing	$59.75	$59.75	$289,600	$289,600
Fireworks	0.7%	2,770	General recreation	$39.43	$42.78	$109,200	$118,500
Family Reunion	0.5%	2,080	General recreation	$39.43	$42.78	$81,900	$88,900
Party	0.4%	1,390	General recreation	$39.43	$42.78	$54,600	$59,300
Youth Group	0.4%	1,390	General recreation	$39.43	$42.78	$54,600	$59,300
Bachelor Party	0.2%	690	General recreation	$39.43	$42.78	$27,300	$29,600
Boat Camping	0.2%	690	Camping	$127.18	$45.33	$88,100	$31,400
Church Group	0.2%	690	General recreation	$39.43	$42.78	$27,300	$29,600
More than 3 activities	0.2%	690	General recreation	$39.43	$42.78	$27,300	$29,600
Outdoor Fun	0.2%	690	General recreation	$39.43	$42.78	$27,300	$29,600
Pleasure Driving	0.2%	690	Pleasure Driving	$72.19	$72.19	$50,000	$50,000
Visit Family	0.2%	690	General recreation	$39.43	$42.78	$27,300	$29,600
Visit Yosemite	0.2%	690	General recreation	$39.43	$42.78	$27,300	$29,600
Total [3]	**100.0%**	**378,110**	**--**	**$67.06**	**$52.24**	**$25,355,400**	**$19,753,500**

Source: TID/MID 2013a; Loomis 2005.

1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

2 Where consumer surplus values for the Pacific region were not available for a particular recreation activity, the analysis is based on national estimates.

3 Total may not reflect sum of columns due to rounding.

5.4 Hydropower Generation

5.4.1 Background and Overview

Hydropower plants are critical to the electricity grid for many reasons, including their ability to meet rapid or unexpected changes in power demands. The energy produced is also clean and renewable, creating no air, land, or water pollution; and the water which fuels the plants is not consumed and instead is reused. One of the most important benefits of hydropower to utility customers is its cost. Aside from certain types of natural gas-fired plants, the total system levelized costs of hydroelectric generation facilities are lower than those of any other plant type.

The Don Pedro Project hydroelectric facility provides a highly-reliable source of renewable energy to residential, commercial, and industrial customers in the MID and TID service areas. The FERC-authorized capacity of the Project is 168 MW, representing 1.5 percent of the total hydroelectric nameplate capacity for California. Hydropower is generated at the facility by water flows released for agricultural and municipal and industrial uses, and other downstream purposes. Hydropower is a valuable, but secondary, purpose of the Project. The Don Pedro Project would operate in essentially the same manner if there were no hydropower associated with the Project.

MID provides electrical service to seven communities in Stanislaus and San Joaquin counties, comprising about 114,000 accounts in a service territory of 560 square miles. The composition of those accounts is shown in Table 5.4-1.

Table 5.4-1. MID customer accounts, by type of account.

Type of Account	Number of Accounts	Percent of Accounts
Residential	94,119	82.6%
Commercial	12,265	10.8%
Industrial	157	0.1%
Agricultural	1,819	1.6%
Other	5,571	4.9%
Total	**113,931**	**100.0%**

Source: Modesto Irrigation District 2013c.

TID serves 100,345 accounts across 14 communities in a service area of 662 square miles in Stanislaus, Merced, Tuolumne, and Mariposa counties. The communities served include Ballico, Ceres, Crows Landing, Delhi, Denair, Diablo Grande, Hickman, Hilmar, Hughson, Keyes, La Grange, Patterson, South Modesto, and Turlock. The composition of those accounts is shown in Table 5.4-2.

Table 5.4-2. TID customer accounts, by type of account.

Type of Account	Number of Accounts	Percent of Accounts
Residential	72,033	72%
Municipal/street lighting	16,367	16%
Commercial	6,983	7%
Agricultural	2,508	2%
Other	1,656	2%
Industrial	798	1%
Total	**100,345**	**100%**

Source: Turlock Irrigation District 2013d.

5.4.2 Conceptual Framework

Unlike fossil fuel plants, the fuel for hydropower plants is not consumed. Power is generated when water passes through the turbines in the facility. Generation at the Don Pedro Project hydroelectric facility is directly associated with the demands for water for other purposes, namely irrigation, flows for protection of aquatic resources in the lower Tuolumne River, and M&I use. Because of this relationship, the Project has many linkages to the regional economy. Agriculture in the San Joaquin Valley requires water for irrigation of the many crops grown in the region. Municipal and industrial users require water for home, business, and other commercial and industrial purposes. In addition, the Project benefits electric customers by providing them with power at a lower delivered cost than many other sources of power.

Hydropower generation also has direct linkages with the regional economy through employment at the plant and outlays for O&M activities. The plant employs a number of full-time and part-time workers, which supports regional employment and contributes to regional income, which in turn supports consumer purchases of goods and services in the regional economy. In addition, O&M outlays by MID and TID on the Project facilities contribute to the regional economy. Each of these factors is analyzed in the regional economic analysis presented in Section 6.

The focus here is on the value of hydropower generation by the Don Pedro Project.[48] Don Pedro hydropower output is valued based on representative market values for alternative sources of power, which could serve as a replacement energy source for the Don Pedro Project; for this analysis, the replacement energy source is the California power grid operated by the California Independent System Operator Corporation (CAISO). Power generation data are based on historical data for the Don Pedro powerhouse. For hydropower values, market price data for the CAISO are taken from the FERC Market Oversight reports.[49]

5.4.3 Economic Value of Power Production

The output and price data used to estimate hydropower output values are shown in Table 5.4-3. As shown, output varied considerably over the five years from 2008-2012, with peak production in 2011 at more than 1.0 billion kWh; and the minimum in 2008, at about 340 million kWh. Over the same period, electricity prices varied from a peak of $0.085 per kWh in 2008 to a minimum of $0.032 per kWh in 2012, with an average price of $0.047 per kWh (in $2012 dollars). As shown, the average value of hydropower generation supported by the Don Pedro Project is approximately $24.8 million annually, with a normalized annual value of $24.7 million.

Table 5.4-3. Value of hydropower generation, Don Pedro Hydroelectric Plant, 2008-2012.[1]

Year	Output (kWh)	Price/Value ($/kWh)[2]	Total Value ($s million)
2008	339,501,259	$0.085	$28.8
2009	364,964,701	$0.042	$15.2
2010	715,749,872	$0.042	$30.1
2011	1,013,360,425	$0.037	$37.1
2012	397,234,660	$0.032	$12.7
Average (5-Year)	**566,162,183**	**$0.047**	**$24.8**
Average (Normalized)	**492,649,744**	**--**	**$24.7**

Sources: TID/MID 2013b, FERC 2013.
1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
2 Prices are annual average day ahead on-peak prices

48 The analysis excludes hydropower generation at the La Grange hydroelectric facility.
49 The specific series is the California Independent System Operator NP 15 EZ Gen Hub 5 MW Peak Calendar-Day Real-time LMP Futures. The prices are the annual average day ahead on peak quantities in dollars per megawatt-hour. The price has been converted to dollars per kilowatt-hour by dividing the first series by 1,000.

5.5 Land Values

The availability of reliable, high-quality, and affordable water supplies and electricity from the Don Pedro Project has a positive influence on regional land values, which represent a major source of value and wealth in the farming community served by the Project. This section analyzes the role of the Project on land values based primarily on a comparative analysis between land values in the Districts' service areas and other nearby regions.

5.5.1 Background and Overview

Land holdings are a significant source of wealth particularly for agricultural landowners. According to an analysis prepared for Giannini Foundation of Agricultural Economics, it has been estimated that off-farm income, including capital gains on assets, represents over 90 percent of average farm-household income (Blank et al. 2006). Farmland has historically represented about 75 percent of assets held by farm households (Blank et al. 2006). That study also makes several noteworthy conclusions with respect to farm-household wealth and land values: (1) wealth comes from capital gains, rather than income, in the agricultural industry; and (2) holding farmland is a more profitable investment than non-farm investment alternatives, on average. The study also found that non-farm demand for land, due primarily to urbanization, is increasingly affecting farmland values. This speculative value must be considered along with traditional economic theory, which posits that the value of farmland is determined primarily by its ability to generate agricultural income. Based on these factors, the potential effect on agricultural operations and related land values from the relicensing of the Don Pedro Project is an important consideration for local agricultural landowners served by the Project.

5.5.2 Conceptual Framework

This section highlights the fundamental principles of farmland valuation and describes the methods and data sources used to evaluate farmland relative to the Don Pedro Project.

5.5.2.1 Principles of Farmland Valuation

Supply and demand factors are important determinants of farmland prices, namely the amount of farmland offered to and sought from the market. However, the market for farmland is unique in several respects. First, farmland itself is not mobile, and therefore farmland markets are necessarily local markets. Farmland also differs in that it cannot be readily produced or manufactured, particularly in the absence of key resources, such as water. This is evidenced by the fact that while the amount of land in farming in the U.S. has been declining over time, agricultural innovations and improved efficiency have increased yields and reduced the need for the amount of farmland cultivated historically. Also, the farmland market is illiquid because of limited transactions, reflecting the large capital investment involved and lack of complete information on agricultural costs and returns. Illiquidity also results from uncertainties related to the regulatory environment, resource availability and climate conditions, which are constantly changing over time. Consequently, the fair market value (FMV) for farmland can be difficult to quantify in the marketplace.

Relative to demand, the typical approach to farmland valuation by prospective purchasers is based on income capitalization. In its simplest form, this approach reflects that farmland values are positively influenced by higher net returns on commodities produced and negatively influenced by the expected capitalization rate, which is driven by interest rates, risk premiums, or anticipated rates of income growth. In some cases, particularly near urban settings, the development potential of land can also be important, with speculative value based on the potential for farmland conversion to relatively-higher valued nonagricultural uses.

Relative to supply, the turnover on farmland is usually very low, thereby limiting the availability of farmland for purchase. Some of the key factors that influence farmland supply include the demographic characteristics and investment strategy of agricultural landowners and their beneficiaries; expected returns on investment; macroeconomic conditions that can lead to distressed sales of farmland; and tax considerations.

5.5.2.2 Methodology

For this study, the effect of Project water supplies on agricultural land values is based on market data for areas within and outside the Districts' service areas. Market data on agricultural land values between 2007 and 2011 were compiled from the California Chapter of the American Society of Farm Managers and Rural Appraisers (CASFMRA).[50] A comparative analysis was performed that estimates the land value differential between the Districts' service areas and other nearby areas served by different water sources or that are in dryland agricultural production and/or grazing uses. Conceptually, the difference in land values can be attributed, at least in part, to the availability and reliability of water and electrical supplies provided by the Don Pedro Project. In addition, local real estate, appraising, and lending professionals have provided both data and anecdotal information on the role of Project water supplies on local land values.

5.5.3 Role of Project on Regional Land Values

This section commences with a comparative analysis of regional land values based on data compiled by CASFMRA. This is followed by a summary of information collected from professionals with first-hand knowledge of the local agricultural land market.

5.5.3.1 Statewide Perspective on Agricultural Land Values

California supports a highly-productive agricultural industry, which is reflected in farmland values across the State. Table 5.5-1 presents trends in agricultural land values between 2002 and 2011 (in 2012 dollars). The value of all cropland, both irrigated and non-irrigated, was approximately $9,440 per acre in 2011. In real terms, cropland values have increased by about 29 percent since 2002; however, values have been steadily declining since peaking around 2007. (Note: there was a slight increase in nominal cropland values between 2010 and 2011.) As expected, irrigated cropland is valued higher than non-irrigated cropland, with irrigated land valued over three times higher than non-irrigated land; this differential is even higher when compared to pastureland typically for livestock grazing uses.

[50] See 2012 Trends in Agricultural Land & Lease Values, Region 3, Northern San Joaquin Valley (CASFMRA 2012).

Table 5.5-1. Agricultural land values in California, 2002-2011.[1]

Year	Land Value ($/acre)				
	All Cropland [2]	Irrigated Cropland	Non-Irrigated Cropland	Farm Real Estate [3]	Pastureland
2002	$7,330	$7,810	$2,500	$4,350	$1,790
2003	$7,400	$7,880	$2,500	$4,500	$1,880
2004	$6,700	$8,030	$2,600	$4,630	$1,950
2005	$9,090	$10,990	$3,160	$5,940	$2,230
2006	$9,380	$11,310	$3,370	$6,060	$2,430
2007	$10,620	$12,820	$3,810	$6,530	$3,070
2008	$10,470	$13,030	$3,780	$6,820	$3,200
2009	$10,070	$12,330	$3,610	$7,010	$3,080
2010	$9,580	$11,650	$3,670	$7,030	$2,990
2011	$9,440	$11,450	$3,680	$6,750	$2,860

Source: U.S. Department of Agriculture 2011.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
[2] The value of land used to grow field crops, vegetables or land harvested for hay.
[3] The value at which all land and buildings used for agriculture production including dwellings, could be sold under current market conditions, if allowed to remain on the market for a reasonable amount of time.

Table 5.5-2 presents cash rents[51] for agricultural land across regions in California in 2011. Annual cash rents ranged from about $195 per acre (Northeast region) to $1,083 per acre (Central Coast region) in 2012 dollars. In the San Joaquin Valley, where the Don Pedro Project is located, cash rents were estimated at $244 per acre per year for irrigated cropland, $56 per acre per year for non-irrigated cropland and $14 per acre per year for pastureland. As expected, cash rents for irrigated cropland are higher than non-irrigated cropland and pastureland.

Table 5.5-2. Cash rents across regions in California, 2011.[1]

Region	Cash Rent ($/acre/year)		
	Irrigated Cropland	Non-Irrigated Cropland	Pasture Land
Northern Coast	$322.10	$52.70	$22.00
Siskiyou-Shasta	$244.40	$37.80	$14.30
Northeast	$195.30	(D)	$13.80
Central Coast	$1,083.80	$42.90	$9.20
Sacramento Valley	$255.60	$36.80	$16.40
San Joaquin Valley	**$244.40**	**$55.70**	**$13.80**
Sierra Mountains	$202.40	$33.70	$15.30
Southern California	$393.60	(D)	$6.00
Other Districts	N/A	$76.20	N/A
State	$342.50	$51.10	$12.80

Source: U.S. Department of Agriculture 2011.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
N/A: Not Applicable
(D) Districts were suppressed to avoid disclosure of individual operations.

5.5.3.2 Agricultural Land Values in the Project Area

As shown in Table 5.5-3, cropland values in the TID service area have averaged approximately $19,100 per acre in Merced County and $21,300 per acre in Stanislaus County between 2007 and

[51] Cash rents refer to annual lease rates for agricultural land.

2011 (2012 dollars) (CASFMRA 2012). The value of agricultural land in the Project area has remained relatively stable over the past several years despite the economic recession that has affected the Central Valley and state as a whole. The main factors contributing to stability of land values in MID and TID are high commodity prices, low interest rates, limited supply of available agricultural land, and access to high-quality and low-cost surface water supplies.

Agricultural land in the Districts' service areas is characterized by higher values compared to other regions in Stanislaus and Merced counties. Cropland values in the TID service area in Merced County are roughly 30 percent higher than land served by nearby Merced Irrigation District and more than double the value of agricultural land served by the San Joaquin River Exchange Contractors Water Authority and other westside properties. TID land values are also higher than areas that rely mainly on groundwater for irrigation, namely some of the lands within the El Nido Irrigation District (ENID) and Chowchilla Water District (CWD).

Similar patterns of land values are found in Stanislaus County. Cropland in the Districts' service areas is over 50 percent higher than Oakdale Irrigation District (OID), and even greater differentials exist relative to agricultural operators located in the west side of the valley. District land supporting almond production is valued even higher, approximately $23,000 per acre, compared to $17,800 per acre for land served by minor irrigation districts and wells, a 29 percent premium on land producing the same commodity.

Table 5.5.3. Regional land values, 2007-2011.[1]

Region / Land Use	Land Value ($/acre)		
	Low	High	Average
Merced County			
Cropland: TID	**$15,870**	**$22,410**	**$19,140**
Cropland: Well Water (ENID & CWD)	$5,290	$10,580	$7,930
Cropland: Merced ID	$10,170	$19,290	$14,730
Cropland: Westside, Exchange Contractors	$5,700	$10,300	$8,000
Cropland: Westside, Federal and Other	$3,700	$5,820	$4,760
Permanent Cropland: Almonds	$12,690	$22,430	$17,560
Permanent Cropland: Walnuts	$12,450	$21,320	$16,880
Rangeland: West County	$530	$1,270	$900
Rangeland: East County and Mariposa County	$740	$1,670	$1,210
Stanislaus County			
Cropland: MID and TID	**$16,500**	**$26,040**	**$21,270**
Cropland: Non-Federal Water (Westside, incl. Gustine)	$10,000	$15,000	$12,500
Cropland: Well Water and Federal (Westside)	$8,170	$12,910	$10,540
Cropland: Well and OID (Eastside)	$10,370	$17,350	$13,860
Permanent Cropland: Almonds (MID and TID)	**$17,760**	**$28,160**	**$22,960**
Permanent Cropland: Almonds (Minor Irrig. Districts and Wells)	$15,020	$20,500	$17,760
Permanent Cropland: Walnuts	$14,560	$24,530	$19,540
Permanent Cropland: Cling Peaches	$15,230	$23,080	$19,160
Permanent Cropland: Wine Grapes (District 12)	$13,990	$20,980	$17,480

Region / Land Use	Land Value ($/acre)		
	Low	High	Average
Rangeland: Westside	$1,060	$1,900	$1,480
Rangeland: Eastside and Tuolumne County	$1,940	$4,570	$3,250

Source: American Society of Farm Managers and Rural Appraisers, California Chapter 2012.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
ENID = El Nido Irrigation District
CWD = Chowchilla Water District
OID = Oakdale Irrigation District

Overall, there appears to be a clear premium on land values in the Districts' service areas compared to other nearby regions with access to surface or groundwater supplies. The land value differential is more dramatic when compared to rangeland without water supplies. Irrigated land values in the Districts' service areas are five to 15 times greater than rangeland values, demonstrating the value added by reliable water supplies for agricultural production. However, there are likely a number of factors other than water supplies that also drive land values in the region, such as soil quality and proximity to urban centers and infrastructure. Therefore, it is not reasonable to attribute the land value premium solely to water supplies. However, it is clear that high-quality, reliable surface water supplies provided by the Don Pedro Project have a positive influence on land values.

5.5.3.3 Information from Local Land Value Professionals

In order to validate published data on regional land values, information was also collected from local land value professionals, including local appraisers, real estate agents, and agricultural lenders. For each entity contacted, a brief questionnaire was provided to obtain relevant information on land values, including the role that water supply availability has on land values. A summary of the information obtained is provided below.[52]

- Primary factors that affect agricultural land values in the northern San Joaquin Valley include available water sources, particularly cost, availability, reliability, and quality. Other factors include land profile (e.g., soil characteristics, topography, and crop suitability), parcel size, and commodity prices.
- Agricultural land values in the Districts' service areas are from approximately $20,000 to $30,000 per acre, which is generally consistent with (albeit slightly higher) than data presented in the *2012 Trends in Agricultural Land & Lease Values* (CASFMRA 2012). Agricultural land values have been increasing in recent years, and there has been extensive activity in the land market over the past year, which has driven prices higher in 2012 compared to 2011.
- Agricultural properties served by MID and TID water service generally have higher values compared to properties outside district boundaries, with the land value premium estimated at 10 to 20 percent on average. Generally, undeveloped land properties with district water sell for more than bare land properties with no district water service. Districts with lower cost and more reliable water sources have higher land values than districts with higher cost and less reliable water supplies.

[52] The names of respondents have been withheld for confidentiality purposes. Some responses have been paraphrased for clarity.

- Residential and agricultural properties served by District electrical service also tend to have higher values compared to properties outside district boundaries. The price differential typically depends on the types of structures involved. For agricultural properties, there appears to be a land value differential based on the electrical service provider. This is particularly true for crops with smaller profit margins where cultural expenses, such as groundwater pumping costs, are important. This also applies to dairies, which are another major user of electricity.
- Water service within the TID/MID service area has a relatively greater influence on land values relative to other irrigation/water districts in the region. This is particularly true when compared to water districts with higher cost and lower reliability (mainly on the west side). There is little or no difference when compared to districts with comparable cost and reliability (mainly on the east side, but including some west side districts as well).
- Generally, properties with affordable and reliable water supplies are in high demand due to increasing demands for commodities, which in turn drives up land values. The role of affordable, reliable, good quality water at quantity sufficient for permanent planting or dairy facility/feed crop needs has been a main component of land value in the Northern San Joaquin Valley for decades. The value difference is magnified when specific crop profit margins are small or moderate, but plays a part in marketability and value even when profit margins are large.
- Water supplies are an important factor in the context of agricultural lending decisions. In fact, the water source, cost, reliability, and supply available on a yearly basis are researched for every agricultural loan. They are also primary components of value when land is being evaluated for mortgage purposes or being considered as collateral for development, construction or production loans.

Overall, the information provided by local land value professionals supports the land value estimates reported above, which are based on published sources. It is clear that water supply from the Don Pedro Project has a positive influence on land values based on its relatively low cost and high reliability compared to other water districts in the region as shown in Table 5.5-3.

6.0 REGIONAL ECONOMIC BENEFITS OF EXISTING PROJECT WATER SUPPLIES

6.1 Background and Overview

Project water supplies are critical to the productivity and viability of the local agricultural sector and the regional economy. The regional economic analysis focuses on the manner in which activities supported by the Don Pedro Project drive economic activity throughout the economy. The key drivers of economic activity supported by the Project are agricultural production and agricultural-dependent industries; non-residential urban uses (e.g., manufacturing) that rely on Project water supplies; recreation spending by visitors to Don Pedro Reservoir; and hydropower production at the Don Pedro powerhouse. This section also qualitatively assesses the fiscal effects on local governments associated with the economic activity supported by the Project.

6.2 Conceptual Framework

Regional economic analysis measures the economic activity based on linkages among industries, institutions (e.g., government), and households with a region. Linkages may be expressed as both “backward” and “forward.” Backward linkages account for the purchases by industries from input suppliers in order to produce its output. Examples include connections between production agriculture and the many industries which supply that industry, such as farm machinery and chemical and seed dealers and lenders. Forward linkages account for the interconnection of an industry that sells its output to other industries for use as inputs in their production process. Examples include shipment of such farm commodities to food processing plants. This analysis captures both the backward and forward linkages between industries that are dependent on the Don Pedro Project. The analysis is founded on the principles of input-output analysis, implemented through the use of the IMPLAN regional economic model as described below.

6.2.1 Input-Output Analysis

Input-output (I-O) analysis provides the framework to measure the regional economic benefits associated with activities supported by the Don Pedro Project. This framework measures the flow of commodities and services among industries, institutions, and final consumers within the economy being evaluated. I-O models capture all market transactions related to the demands for goods and services, accounting for inter-industry linkages and availability of regionally produced goods and services. For example, each sector not only produces its own goods and services, but also purchases goods and services for use as inputs to its production process. To the extent that these inputs to production are purchased locally, economic benefits are generated. Regional I-O analysis is based on a standardized accounting framework that is modified to reflect regional characteristics defining industry production processes and household spending patterns. A set of I-O accounts represents a snapshot of the economic structure of a region at one point in time.

Using this framework, I-O models estimate the total economic effects within an economy based on the concept of economic multipliers, which measure the total economic effect across all industries within an economy relative to the direct effect (final demand[53]) in any one industry. Multipliers are calculated based on the ratio of the total economic activity relative to direct effects. For example, an output multiplier of 2.5 for the vegetable industry indicates that $1,000,000 in vegetable production supports a total of $2,500,000 in output throughout the regional economy, including the initial $1,000,000 in the farm production sector. Multipliers are unique to each local industry and can be constructed for all measures of regional economic activity: including output (production),[54] labor income, value added, and employment.

The *total* economic impact, or economic contribution, of an industry represents the sum of direct, indirect, and induced effects as defined below. The measurement of total economic effects captures the multiplier (or "ripple") effect associated with direct effects.

- **Direct effects.** Represent the impacts for the expenditures and/or production values specified as direct final demand changes
- **Indirect effects.** Represent changes in output, income, and employment resulting from the iterations of industries purchasing from other industries caused by the direct economic effects.
- **Induced effects.** Represent changes in output, income, and employment caused by the expenditures associated with new household income generated by direct and indirect economic effects.

6.2.2 IMPLAN Model

The I-O model for the Don Pedro Project was developed using IMPLAN software and data. IMPLAN (IMpact Analysis for PLANning) is a widely-used and accepted regional economic modeling system that can measure the effect of projects, programs, and/or policies on local economic conditions. It was originally developed by the U.S. Department of Agriculture, Forest Service in the late 1970s to assist in land and resource management planning, but its role has expanded to serve clients in federal, state, and local governments, universities, and the private sector.

IMPLAN consists of two components – the software and the database. IMPLAN data are developed annually using information collected at the national, state, county and zip-code levels, and provide the base economic information needed to create regional models. The software performs the necessary calculations with IMPLAN data to measure regional economic activity within the defined study area. The primary advantages of IMPLAN include a comprehensive underlying dataset, opportunities for customization, robust multipliers based on a complete set of social accounts, and detailed trade-flow data that allows for multi-regional analysis. Further, although the IMPLAN model is designed to measure effects associated with backward linkages, the base data can be used to estimate effects on forward-linked sectors in the economy. This study is based on the 2010 IMPLAN dataset for California (and all counties).

[53] Final demand refers to the value of goods and services produced and sold to final users.
[54] Economic output refers to the value of goods and services produced in a region.

6.2.3 Model Geography

An important initial step in conducting regional economic studies is to define the geographic area of analysis. The selection of an appropriate study area is an important consideration for regional economic analyses because it affects the magnitude and extent of impacts being evaluated. The study area should be defined to generate the information most meaningful to a project's stakeholders and decision makers. From an analytical perspective, the study area should be large enough to capture not only the direct effects of the project, but also the key economic linkages associated with an action or activity without masking project impacts with extraneous economic activity. The concept of a "functional economic area" can serve as a guide in identifying the appropriate study area, and is defined as a semi-sufficient economic unit that can be based on the location of affected people (e.g., where people live, work, and spend money), as well as affected industries and services.

For this study, the study area has been defined as a multi-county region covering Stanislaus, Merced, and Tuolumne counties. The Districts' service water service areas are located in Stanislaus and Merced counties, and most of the agricultural-support industries are located in these two counties. For example, farmers in the Districts' service areas routinely purchase inputs, such as machinery, chemicals, and seed, from suppliers throughout Stanislaus and Merced counties. Further, farm laborers working on local farms often reside locally and agricultural products are commonly shipped, brokered, and processed within the local area. Inclusion of Tuolumne County was based on the physical location of the Don Pedro Reservoir and the associated recreation use and spending and hydropower generation that occurs at or near the reservoir.

In addition, the regional economic analysis was also conducted at the State level using the same methodology as described here. This information demonstrates how activities supported by the Don Pedro Project affect the larger statewide economy, including effects in the regional study area. The results of the statewide analysis are presented in Attachment D.

6.2.4 Temporal Considerations

IMPLAN is an annual model, and inputs and outputs of the model are defined in annual terms. For this baseline study, the results represent average annual values over the baseline period, which varies by the resource being evaluated.

6.2.5 Limitations of I-O Modeling and the IMPLAN Model

IMPLAN analysis has some limitations, which are attributable to the I-O methodology. Below is a summary of the key limitations:

- **Fixed Proportions.** For any good or service, all productive inputs are combined in fixed proportions that are constant regardless of the level of output. Hence, there is no substitution among production inputs and no economies of scale are possible.[55]

[55] This is also referred to as a Leontief production function.

- **Fixed Technology.** Each production function incorporates fixed technology; thus, for example, the same proportions of labor and capital are used. If an industry is undergoing rapid technological change, this rigidity may under or overestimate impacts for any industry. This concern is offset in part by the slow, gradual technological changes that are typical in many sectors of the economy.
- **Constant Prices.** Regardless of the level of production, it is assumed that price and returns per unit of production are constant. An investigator wishing to analyze price impacts must do so outside of the I-O framework.
- **Fixed Employment of Resources.** I-O assumes that resources that become unemployed or employed due to a change in final demand have no alternative employment.
- **Aggregation of Economic Activities.** I-O models are organized by industry sector. The IMPLAN database contains 440 economic sectors nationwide. While this is a large number of sectors, some sectors contain a wide range of products or services and the production functions reflect the average or aggregate production technology for the goods or services produced. There are 10 crop production sectors in IMPLAN. Each sector includes an average production function for the crops included in that sector.
- **Issues of Geographic Scale.** The IMPLAN database is developed from national, state, and county level data sets, with the national level used as a control. A proven, reliable disaggregation procedure is used to ensure that the state data sets add up to the national totals, and that the county data sets add up to their respective state totals. There are occasional instances where apparent anomalies occur, particularly in counties with very small economies and particularly with very small sectors within these counties.
- **No Direct Accounting of Forward-Linkages.** IMPLAN software is designed to measure the total multiplier effects of a change in output (final demand) in the industry under study from changes in demand for labor and goods and services it utilizes as inputs (i.e., backward linkages). IMPLAN software is not designed to measure multiplier effects of the same change in output on industries purchasing the targeted industry's output, such as food processing in the case of crop production. Resulting changes in final demand in the forward linked industries must be computed outside of IMPLAN and then re-input as a direct change in output (final demand) of the forward-linked industry.

6.2.6 Economic Drivers Associated With the Don Pedro Project

In order to estimate regional economic effects, the direct effects on target industries, commonly referred to changes in "final demand," must be quantified for use in the modeling process. For this study, the following key drivers of economic activity supported by the Don Pedro Project are evaluated as part of the regional economic analysis:

- Agricultural production and agricultural-dependent processing industries;
- Urban uses (e.g., manufacturing) that rely on Project water supplies;
- Recreation spending by visitors to Don Pedro Reservoir; and
- Hydropower generation.

6.2.6.1 Agricultural Production

For the regional economic analysis, the direct value of crop production in the Districts' service areas is defined as gross revenues (i.e., farmgate value) of commodities produced, which are based on results of the SWAP model (refer to Section 5.1 for additional details). The SWAP model estimates annual gross revenues across crop categories under existing conditions. The estimated gross revenues by SWAP model category and applicable IMPLAN sector are presented in Table 6.2-1. In total, SWAP estimates the annual gross value of irrigated crop production in the Districts' service areas totaling $527.9 million. Note, this total is slightly different from the estimated $525.5 million of gross revenue presented as the existing condition in Tables 4.5-14 and 4.5-15 due to the calibration of the SWAP model (see Table 5.1-7). The largest commodity in terms of acreage and revenues ($287.0 million) is nut farming, accounting for 54.4 percent of total crop revenues in the Districts' water service area.

Table 6.2-1. Agricultural gross revenues, Districts' water service areas ($millions).[1,2]

SWAP Crop Group	Gross Revenues	IMPLAN Sector
Corn-Silage	$68.4	2-Grain farming
Field and other	$40.6	2-Grain farming
Fruit	$61.0	4-Fruit farming
Grain	$5.4	2-Grain farming
Grape	$12.2	4-Fruit farming
Hay	$24.3	10-All other crop farming
Irrigated pasture	$8.3	10-All other crop farming
Nut	$287.0	5-Tree nut farming
Vegetable	$20.7	3-Vegetable and melon farming
Total	**$527.9**	**N/A**

Source: Cardno ENTRIX (based on SWAP modeling).
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
[2] Average annual values between 2007 and 2011.
N/A: Not applicable

6.2.6.2 Agricultural-Dependent Industries

If all of the crops produced locally were exported or consumed as fresh produce, the value of crop production and its associated backward linkages would be the main drivers of economic activity attributed to the local agricultural industry. However, in addition to direct impacts in the agricultural sector, the production of crops in the Districts' service area also supports forward-linked industries, including dairy production and cattle ranching (based on dependence on feed supplies) and processing industries that use raw inputs (both crops as well as dairy and cattle products) to manufacture a range of food and beverage products. Without local agricultural production, many local dairy and cattle operations and food processing industries would not exist because transportation costs to import the required commodities would be prohibitively expensive. As a result, it is important to evaluate these forward-linked industries dependent on locally-produced commodities in order to measure the full economic contribution of agriculture supported by the Project. To do so, the direct output (final demand) in these forward-linked industries was estimated, as outlined below.

Note that because the production functions for these forward-linked industries account for the purchase of local inputs (i.e., crops, cattle and dairy products), it is necessary to modify the

IMPLAN model prior to analyzing the final demand for these forward-linked sectors. These changes are to avoid calculating twice the economic benefits of crop, cattle and dairy production that are used as inputs to forward-linked sectors, which would result in double counting of benefits. To accomplish this, the IMPLAN model was modified so that the forward-linked sectors dependent on crop (cattle and dairy) are assumed to make no purchases of local crops (cattle and dairy).[56]

Through this process, we avoid counting the same production as both a direct and indirect impact. With this adjustment, we obtain the correct indirect and induced values. However, the direct output value of the raw crop, cattle, and dairy used as inputs in forward-linked sectors is still counted twice: once in the original crop, cattle, or dairy output value, and again in the forward-linked sector output value (output value includes the value of all intermediate inputs – such as crops, dairy, or cattle - required to produce the processing sector output). To eliminate the double counting of direct output, in the final table of this section (Table 6.3-11), direct output values in forward-linked sectors are adjusted downwards by the value of the crop, cattle, and dairy production inputs that are included in the processing sector output value.

Dairy (Milk) Production

There is a strong relationship between crop production and milk production in the study area. In fact, some dairy farmers also produce feed and forage crops, such as alfalfa and corn silage, to support their internal operations and aid in waste management. Feed crops grown in the Districts' service areas with Project irrigation water may be consumed by dairy cows located both within and outside of the service area boundary. The location of these crop operations proximate to the region's highly specialized dairy operations is a major support to the dairy industry. For the dairy sector, specifically milk production, direct output value supported by crops grown with the Districts' water was estimated at 31.0 percent of average annual gross production value in Stanislaus and Merced Counties over the period 2007-2011. As described in Section 4.5.3.3, this estimate is based on several alternative methods of estimating the industry's dependence on District crops. These methods include the Districts' share of two-county corn-silage production, the share of corn-silage in the dairy cow diet on an as-fed basis, and the implied gross revenue of milk based on the dollar value of dairy feed crops grown in the Districts. Applying the 31 percent point estimate to the $1.741 billion average annual milk production value in the two-county area yields an estimated milk production value supported by the Project of $537.4 million. This represents the final demand in IMPLAN Sector 12, *Dairy cattle and milk production*.

Cattle Production

Similar to milk production, cattle and calves production is also dependent on crops grown in the Districts' service areas using Project irrigation water. Instead of alfalfa hay and corn-silage, the majority of cattle and calves production in the region relies mainly on yields from irrigated pasture in the as well as hay (other than alfalfa).

[56] This is done by changing the model parameters measuring the purchases of local products to zero.

For the cattle and calves sector, direct output value was estimated at 31 percent of average annual gross production value in Stanislaus and Merced Counties over the period 2007-2011. As described in Section 4.5.3.5, this estimate is based on several alternative methods of estimating the industry's dependence on District crops. For this study, the portion of Stanislaus and Merced counties' irrigated pasture and hay acreage irrigated with Project water was developed to estimate the proportion of Project supported cattle and calves production in the two-county area. Applying the 31 percent point estimate to the $417.9 million average annual cattle and calves production value in the two-county area yields an estimated $128.1 million of cattle and calves production value supported by the Project. This represents the final demand in IMPLAN Sector 11, *Cattle ranching and farming*.

Food and Beverage Processing (Crop Production)

There is a wide range of food and beverage processing industries in the study area which are dependent on local agricultural and dairy production. These are captured in 34 separate food and beverage processing sectors in IMPLAN. This analysis focuses only on the top five processing sectors that are reliant on *local* crop and dairy production.

The top five IMPLAN sectors, in terms of reliance on local crop inputs, are listed below, including the 2010 output value used in IMPLAN (reported in 2012 dollars).

- *Wineries* (Sector 72), $1.4 billion,
- *Fruit and vegetable canning, pickling, and drying* (Sector 54), $2.3 billion,
- *Frozen food manufacturing* (Sector 53), $537.9 million,
- *Other animal food manufacturing* (Sector 42), $954.4 million, and
- *Snack food manufacturing* (Sector 65), $1.2 billion.

In total, these crop processing sectors in the three-county study area produced a total of nearly $6.5 billion in output annually, most of which was in Stanislaus and Merced counties. The following discussion summarizes the methods used to convert the estimated value of local crop production into changes in final demands in the forward-linked processing sector.

Overall, an estimated 11.2 percent of local agricultural output, or $56.5 million, is used in these five crop processing sectors. The remaining agricultural output of $471.4 million is exported, consumed locally, or used in other industries. The next step is to estimate the total value of crop processing output for every dollar of agricultural commodities that is purchased by the processing industry. Even though agricultural products are a primary ingredient in the processing sector, on average, these inputs only account for 9.9 percent of total production value. Accordingly, for every dollar of agricultural products used in processing, approximately $10.08 in value of crop processing output is supported. Therefore, the $56.5 million dollars of agricultural commodities purchased by the food and beverage processing sector is utilized in the production of manufactured products valued at approximately $569.1 million, which is the final demand value used in IMPLAN.

The estimated crop input value and associated processing output value (final demand value) for each of the five sectors is as follows:

- *Wineries* (Sector 72), $23.9 million of crop is used to produce $226.7 million of processing output.
- *Fruit and vegetable canning, pickling, and drying* (Sector 54), $17.5 million of crop is used to produce $205.4 million of processing output.
- *Snack food manufacturing* (Sector 65), $4.5 million of crop is used to produce $70.0 million of processing output.
- *Frozen food manufacturing* (Sector 53), $5.3 million of crop is used to produce $34.7 million of processing output.
- *Other animal food manufacturing* (Sector 42), $5.3 million of crop output is used to produce $32.3 million of processing output.

Food and Beverage Processing (Milk Production)

This process is repeated for dairy production used as inputs to the primary dairy processing sectors in the three-county area, consisting of the following three IMPLAN sectors listed below, including the 2010 output value used in IMPLAN (reported in 2012 dollars).

- Fluid milk and butter manufacturing (Sector 55), $943.1 million,
- Cheese manufacturing (Sector 56), $1.3 billion,
- Dry, condensed, and evaporated dairy product manufacturing (Sector 57), $66.1 million, and
- Ice cream and frozen dessert manufacturing (Sector 58), $1.0 million.

In this case, of the estimated total value of milk production supported by crops grown in the Districts' service areas ($537.4 million), about $295.4 million is used in the dairy processing industry, and every dollar of dairy production supports about $2.67 in dairy processing output. In total, the food and beverage processing sector produces about $787.6 million in manufactured products from the milk sourced from dairy cows supported by crops grown with the Districts' water.

The estimated dairy input value and associated processing output value (final demand value) for each of the three sectors is as follows: Sector 55, *Fluid milk and butter manufacturing* ($118.0 million of milk is used to produce $317.2 million of processing output); Sector 56, *Cheese manufacturing* ($171.1 million of milk is used to produce $448.2 million of processing output); and Sector 57, *Dry, condensed, and evaporated dairy product manufacturing* ($6.3 million of milk is used to produce $22.2 million of processing output).

Food and Beverage Processing (Cattle Production)

This process is also repeated for cattle production used as inputs to the animal processing sector in the three-county area, consisting of the following IMPLAN sector listed below, including the 2010 output value used in IMPLAN (reported in 2012 dollars):

- Animal (except poultry) slaughtering, rendering, and processing (Sector 59), $348.6 million.

In this case, of the estimated total value of cattle production supported by crops grown in the Districts' service areas ($128.1 million), an estimated $49.4 million is used in the animal processing industry, and every dollar of cattle supports about $3.14 in animal processing output. In total, the animal processing sector produces about $119.8 million in manufactured products from the cattle supported by crops grown with the Districts' water.

6.2.6.3 M&I (Urban) Land Uses

The City of Modesto receives part of its M&I water supply from MID via the MRWTP. In turn, the city provides water supplies to local households and businesses. Although households derive value from these water supplies, household water consumption does not generate regional economic benefits. However, provision of M&I water supplies by the City of Modesto to local businesses and industries facilitates economic production and supports jobs throughout the city's service area. Although local production by commercial businesses and industrial operations cannot be entirely attributed to high quality, low-cost water supplies, it is a major contributing factor that is recognized as a factor promoting economic development in the region.

For this analysis, the regional economic benefits provided by M&I water supplies are focused on the manufacturing sector in the City of Modesto service area. Several steps were taken to estimate the direct output of the manufacturing sector served by the City of Modesto. First, a separate IMPLAN model was created corresponding to only Stanislaus County, which captures the City of Modesto service area, and the existing output of all manufacturing sectors was tallied; in total, the manufacturing sectors in Stanislaus County jointly produced approximately $9.9 billion of output in 2010 (corresponding to the model timeframe). Next, to estimate the extent of manufacturing production in the City of Modesto service area, the population levels within the two regions were compared. In 2010, population in the city's service area is roughly 264,000 people compared to about 514,500 people countywide; this equates to a ratio of 51.3 percent. Last, this ratio was applied to the countywide output value to estimate production in the city's service area, which implicitly assumes that manufacturing production occurs in proximity to the region's population base; the resultant value is over $5.3 billion, which is the final demand value input into an aggregated manufacturing sector in the three-county IMPLAN model.

6.2.6.4 Recreation Spending

The Don Pedro Reservoir attracts visitors to the region for recreation purposes and induces recreation-related spending at local businesses. Typical types of recreation-related expenditures include food, lodging, fuel, recreation equipment and services, and other miscellaneous retail goods. To the extent that recreation spending occurs within the three-county region, it generates benefits to the local economy, including jobs and incomes for local residents. These benefits are distinct from the economic value associated with participating in recreation activities presented in Section 5.3, which measures value to the recreationist rather than the local economy.

The focus of this component of the study is to quantify the economic *contribution* of recreation occurring at Don Pedro Reservoir. It is important to distinguish the concept of economic *contribution* from the related concept of economic *impact*. An economic contribution study captures the total economic activity that currently depends on an industry or event, such as recreation activity, which includes spending by both local and non-local visitors. However, it is plausible that if visitors could no longer recreate at Don Pedro Reservoir, they would potentially engage in other forms of recreation in the local area. Thus, a portion of the money spent by local residents recreating at Don Pedro Reservoir would continue to be spent in the three-county region, thereby continuing to support the local economy. Therefore, an alternative way to evaluate the recreation benefits to the region is to focus solely on activities that bring new money into the region, namely the expenditures of non-local visitors to Don Pedro Reservoir. This analysis estimates the economic contribution of visitation to Don Pedro Reservoir under baseline conditions, which considers spending by both local and non-local recreation users.

In order to estimate the economic contribution of recreation at the Don Pedro Project to the local economy, it is necessary to document existing visitation levels and estimate typical spending patterns. Based on recreation use data compiled by the DPRA, approximately 378,100 visitor days are supported by the reservoir on an annual basis, of which 206,900 (54.7%) are attributed to day users and 171,200 (45.3%) to overnight campers (refer to Section 5.3 for additional details). Expenditure patterns for visitors are based on recent research on recreation spending at the California State Park system (BBC Research & Consulting 2011). That study provides statewide estimates of recreation spending within (< 25 miles) and outside (> 25 miles) communities near all types of state park units. Separate spending profiles were developed for day-use visitors and overnight campers, and spending is categorized by types of expenditures, namely overnight lodging, food, supplies, gasoline, and recreation purchases. Table 6.2-2 presents the recreation spending profiles used in this study. In total, day use visitors spent on average $45.29 per visitor day, while overnight campers spent about $31.25 per visitor day.

Table 6.2-2. Recreation spending profiles (expenditure per visitor day).[1]

Expenditure Type	Day User		Overnight Camper	
	< 25 Miles	> 25 Miles	< 25 Miles	> 25 Miles
Overnight Lodging	$6.61	$6.16	$2.83	$1.29
Food	$5.17	$4.19	$2.19	$1.29
Supplies	$3.93	$3.69	$3.87	$6.80
Gasoline	$3.72	$8.62	$3.09	$7.71
Recreation Purchases	$1.24	$1.97	$0.90	$1.29
Sub-Total	*$20.66*	*$24.63*	*$12.88*	*$18.37*
Total	**$45.29**		**$31.25**	

Source: BBC Research & Consulting 2011.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

The spending estimates reported in Table 6.2-2 were applied to the total number of recreation days at the Don Pedro Project under existing conditions, and estimates of these expenditures within the three-county region were evaluated as part of the regional economic analysis. In total, it is estimated that recreation visitors to the Don Pedro Project spent about $14.7 million annually during their visit – nearly $9.4 million by day users and $5.4 million by overnight campers. It was assumed that 90 percent of all expenditures occurring within 25 miles of the facility and 50 percent of expenditures greater than 25 miles occurred within the three-county area. Based on these assumptions, visitors to Don Pedro Reservoir spend an estimated $10.0 million annually in recreation-related purchases in the three-county region covering Stanislaus, Merced, and Tuolumne counties. These expenditures serve as inputs to IMPLAN. Expenditures by category (from the spending profile) were assigned to applicable IMPLAN sectors as shown in Table 6.2-3.

Table 6.2-3. Recreation spending allocation to IMPLAN sectors.

Type of Expenditure	IMPLAN Sector [1]
Overnight Lodging	• Sector 411, Hotels and motels
Food	• Sector 413, Food services and drinking places
Supplies	• Sector 324, Retail stores–food and beverage • Sector 327, Retail-clothing • Sector 328, Retail-sporting goods • Sector 329, Retail-general merchandise • Sector 330, Retail-miscellaneous
Gasoline	• Sector 326, Retail stores–gasoline stations
Recreation Purchases	• Sector 363, General consumer goods • Sector 410, Other amusement and recreation

[1] Expenditures were allocated equally for categories with more than one IMPLAN sector.

6.2.6.5 Hydropower Generation

Estimates of the direct output value for hydropower production at the Don Pedro Powerhouse are based on historic generation levels and representative unit values for electricity in the region. Between 2008 and 2012, the Don Pedro Project generated approximately 493,000 MWH of electricity annually, on average,[57] with a corresponding wholesale value of $24.7 million per year (refer to Section 5.4 for additional details). This final demand value was input into Sector 31, *Electric Power Generation, Transmission and Distribution* in the IMPLAN model.

6.3 Estimates of Regional Economic Benefits

Using the methodology outlined above, the regional economic benefits supported by the Don Pedro Project are presented in this section. These benefits are based on the results from a regional IMPLAN model covering Stanislaus, Merced, and Tuolumne counties. The regional benefits captured are attributed to agricultural production (including both backward and forward linkages), M&I water use, recreation spending, and hydropower generation.

[57] Reflects normalized average value between 2007 and 2011.

6.3.1 Agriculture

6.3.1.1 Crop Production

Agriculture is a key industry in the regional economy directly supporting a large number of jobs and income at the farm level and generating secondary economic benefits based a wide range of inter-industry linkages with the agricultural sector. Farmers in the Districts' service area purchase large amounts of seed, feed, fertilizer, chemicals, farm machinery, and other inputs for their operations, and utilize a range of specialized services, such as soil testing, planting, harvesting, and farm management; many of these inputs come from within the three-county study area. All of these factors of production are attributable to and a reflection of the size and importance of the economy that has built up around agricultural production supported by the Don Pedro Project. As a result, the regional economic effects attributable to crop production in the District's service area are substantial.

Table 6.3-1 presents the regional economic benefits associated with current crop production supported by the Don Pedro Project. The direct effects represent impacts in agricultural sector, while total effects account for changes across all industries with economic linkages to agricultural production. As explained in Section 5.1, the primary agricultural activity within the Project area is permanent crop production, namely tree nut farming, which is characterized by relatively high commodity values. Overall, the total annual value of crops grown in the Districts' service area under existing conditions is $527.9 million; this is the direct output value of agricultural production.

To support local crop production, a comprehensive infrastructure of agricultural-support businesses and service providers has developed in the region. Consequently, changes in agricultural production have widespread ripple effects throughout the regional economy. Based on baseline levels of crop production (between 2007 and 2011), agricultural activity supported by the Don Pedro Project *directly* supported $527.9 million in output (i.e., value of commodity production), $171.7 million in annual labor income, and nearly 4,400 jobs (full and part-time) at the farm level. Accounting for the indirect and induced effects as money "ripples" through the regional economy, the total effects include $854.2 million in annual output, $278.1 million in annual labor income, and roughly 7,300 jobs (full and part-time) in the three-county region.

Table 6.3-1. Annual regional economic benefits – crop production, Districts' water service area.[1,2]

Metric	Direct	Indirect	Induced	Total
Output ($millions)	$527.9	$164.0	$162.3	**$854.2**
Labor Income ($millions)	$171.7	$57.3	$50.7	**$278.1**
Employment (full and part-time jobs)	4,340	1,590	1,330	**7,270**

Source: Cardno ENTRIX (based on IMPLAN modeling).
1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
2 Results represent annual effects in three-county study area (Stanislaus, Merced, and Tuolumne counties).

Total effects of existing agricultural production in the Districts' service area at the industry level are presented in Table 6.3-2. As expected, the greatest benefits accrue to the agricultural sector, accounting for $571.2 million in total annual economic output, $202.0 million in annual labor income, and nearly 5,300 jobs (full and part-time) in the region. The services sector also benefits substantially from local agricultural production, supporting approximately 1,400 jobs (full and part-time) with $47.9 million in corresponding annual labor income.

Table 6.3-2 Annual regional economic benefits by industry – crop production, Districts' water service area.[1,2]

Industry	Total Output ($millions)	Total Labor Income ($millions)	Total Employment (full and part-time jobs)
Agriculture	$571.2	$202.0	5,260
Mining	$0.1	$0.0	0
Construction	$6.2	$2.4	40
Manufacturing	$13.4	$1.9	40
TIPU	$20.9	$6.9	140
Trade	$29.8	$12.7	350
Services	$200.0	$47.9	1,400
Government	$13.0	$4.4	50
Total	**$854.6**	**$278.2**	**7,280**

Source: Cardno ENTRIX (based on IMPLAN modeling).
1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
2 Results represent annual effects in three-county study area (Stanislaus, Merced, and Tuolumne counties).
TIPU = Transportation, Information, and Public Utilities.

6.3.1.2 Agriculture-Dependent Industries (Forward Linkages)

Three industries particularly dependent on local agricultural production are dairy, beef cattle ranching and food and beverage processing. The results of the forward-linkage analysis for the dairy industry are presented in Table 6.3-3, while the results of the forward-linkage analysis for the cattle ranching industry are presented in Table 6.3-4. Different sectors of the food and beverage processing industry are dependent on agricultural (crop), dairy production and cattle ranching. The forward linkage results of these three analyses are presented in Tables 6.3-5, 6.3-6 and 6.3-7, respectively.

The direct output value of milk production in the two-county area that is estimated to be supported by the Districts' crop production is estimated at $537.4 million annually. In addition to crops, local dairy operators purchase large amounts of inputs for their operations – supplies, veterinary services, equipment purchases and rentals, trucking, and other. Considering the secondary economic benefits in the local economy, the total output value attributed to dairy production is over $816 million in the three-county study area, excluding indirect impacts in the local agricultural industry that provides animal feed (modeled separately). In addition, dairy production supported by the Districts' water is estimated to directly employ nearly over 2,300 full and part-time workers with and $23.6 million in labor income annually. Total employment and annual income benefits to the regional economy are estimated at 3,630 full and part-time jobs and $75.3 million, respectively.

Table 6.3-3. Annual regional economic benefits – dairy cattle production, Districts' water service area.[1,2,3]

Metric	Direct	Indirect	Induced	Total
Output ($millions)	$537.4	$235.24	$44.10	**$816.7**
Labor Income ($millions)	$23.6	$38.0	$13.7	**$75.3**

Metric	Direct	Indirect	Induced	Total
Employment (full and part-time jobs)	2,270	990	370	**3,630**

Source: Cardno ENTRIX (based on IMPLAN modeling).
1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
2 Results represent annual effects in three-county study area (Stanislaus, Merced, and Tuolumne counties).
3 Analysis represents forward-linkage with the agricultural; therefore, results exclude effects in these sectors to avoid double counting.

The direct output value of cattle ranching in the two-county area that is estimated to be supported by the Districts' crop production is estimated at $128.1 million annually (approximately 30 percent of the two-county cattle ranching production value). Similar to dairy operations, local cattle ranch operators purchase other, non-crop inputs for their operations –supplies, veterinary services, equipment purchases and rentals, trucking, and other. Cattle ranching production supported by District water is estimated to directly support 620 full and part-time jobs and $7.2 million in labor income annually. Considering the secondary economic benefits in the local economy, total employment and annual income benefits to the regional economy are estimated at approximately 1,200 full and part-time jobs and $22.7 million, respectively.

Table 6.3-4. Annual regional economic benefits –cattle ranching production supported by crops from Districts' water service area.[1,2,3]

Metric	Direct	Indirect	Induced	Total
Output (millions, 2012$)	$128.1	$91.5	$13.34	**$233.0**
Labor Income (millions, 2012$)	$7.2	$11.4	$4.1	**$22.7**
Employment (full and part-time jobs)	620	490	110	**1,220**

Source: Cardno ENTRIX (based on IMPLAN modeling).
1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
2 Results represent annual effects in three-county study area (Stanislaus, Merced, and Tuolumne counties).
3 Analysis represents additional forward-linkage impacts of agricultural crop production; therefore, results exclude effects in crop production sectors (already estimated above in Table 6.3-1) to avoid double counting.

The local food and beverage processing industry also contributes substantially to the regional economy. This industry is supported by local crop and animal production within the Districts' service area, as well as production elsewhere in the three-county region and other parts of the state. For this analysis, estimates of the food and beverage processing output within the three-county area attributed specifically to the Don Pedro Project have been quantified. The direct value of processing output supported by the Districts' crop production is estimated at $569.1 million annually (Table 6.3-5). The appurtenant economic benefits on local employment and labor income are significant as well. The direct employment and income benefits attributed to processing of local crops include an estimated 1,050 full and part-time jobs and $87.0 million in annual labor income, respectively. Taking into account the multiplier effect across all industries (excluding the indirect effect on crop production sectors to prevent double counting of impact), food and beverage processing attributed to crop production supported by the Don Pedro Project supports nearly 2,900 full and part-time jobs with $165.8 million in annual labor income. Approximately 80 percent of these estimated benefits are from two processing sectors: wineries and fruit and vegetable canning, pickling, and drying.

Table 6.3-5. Annual regional economic benefits –food & beverage processing dependent on crop production in the Districts' water service area.[1,2,3]

Metric	Direct	Indirect	Induced	Total
By Food and Beverage Processing Sector				
Wineries				
Output (millions, 2012$)	$226.7	$70.6	$52.8	$350.1
Labor Income (millions, 2012$)	$53.3	$20.4	$16.3	$90.0
Employment (full and part-time jobs)	430	390	450	1,270
Fruit and vegetable canning, pickling, and drying				
Output (millions, 2012$)	$205.4	$73.7	$28.5	$307.6
Labor Income (millions, 2012$)	$22.2	$17.6	$8.8	$48.6
Employment (full and part-time jobs)	390	370	250	1,010
Snack food				
Output (millions, 2012$)	$70.0	$19.0	$7.4	$96.4
Labor Income (millions, 2012$)	$5.0	$5.3	$2.3	$12.6
Employment (full and part-time jobs)	100	110	60	270
Frozen Food				
Output (millions, 2012$)	$34.7	$13.8	$5.8	$54.3
Labor Income (millions, 2012$)	$4.7	$3.4	$1.8	$9.9
Employment (full and part-time jobs)	100	70	50	220
Other animal food				
Output (millions, 2012$)	$32.3	$11.5	$2.7	$46.5
Labor Income (millions, 2012$)	$1.8	$2.0	$0.8	$4.7
Employment (full and part-time jobs)	30	40	20	90
Total				
Total, Food and Beverage Processing				
Output (millions, 2012$)	**$569.1**	**$188.6**	**$97.3**	**$854.9**
Labor Income (millions, 2012$)	**$87.0**	**$48.7**	**$30.1**	**$165.8**
Employment (full and part-time jobs)	**1,050**	**980**	**830**	**2,870**

Source: Cardno ENTRIX (based on IMPLAN modeling).

1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

2 Results represent annual effects in three-county study area (Stanislaus, Merced, and Tuolumne counties).

3 Analysis represents forward-linkage with the key crop production sectors; therefore, results exclude effects in these sectors to avoid double counting.

The regional economic benefits associated with processing of local dairy products (supported by crops grown in the Districts' service) area are also substantial (see Table 6.3-6). The direct effects of dairy processing include $71.8 million in labor income annually and approximately 1,060 full and part-time jobs. In total, the dairy processing sector supports $156.3 million in annual labor income, and roughly 3,000 full and part-time jobs (excluding labor and income effects in the dairy production sector, estimated above in Table 6.3-3).

Table 6.3-6. Annual regional economic benefits –food & beverage processing dependent on milk production supported by crops grown in the Districts' water service area.[1,2,3]

Metric	Direct	Indirect	Induced	Total
By Dairy Processing Sector				
Milk and butter				
Output (millions, 2012$)	$317.2	$92.4	$40.5	$450.1
Labor Income (millions, 2012$)	$35.0	$21.7	$12.5	$69.2
Employment (full and part-time jobs)	480	470	340	1,290
Cheese				

Metric	Direct	Indirect	Induced	Total
By Dairy Processing Sector				
Output (millions, 2012$)	$448.2	$163.9	$48.6	$660.7
Labor Income (millions, 2012$)	$35.2	$32.8	$15.1	$83.1
Employment (full and part-time jobs)	560	700	410	1,670
Dry, condensed, evaporated milk				
Output (millions, 2012$)	$22.2	$7.7	$2.3	$32.3
Labor Income (millions, 2012$)	$1.6	$1.7	$0.7	$4.0
Employment (full and part-time jobs)	20	40	20	80
Total				
Total, Dairy Processing				
Output (millions, 2012$)	**$787.6**	**$264.0**	**$91.4**	**$1,143.1**
Labor Income (millions, 2012$)	**$71.8**	**$56.1**	**$28.3**	**$156.3**
Employment (full and part-time jobs)	**1,060**	**1,210**	**770**	**3,040**

Source: Cardno ENTRIX (based on IMPLAN modeling).
1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
2 Results represent annual effects in three-county study area (Stanislaus, Merced, and Tuolumne counties).
3 Analysis represents forward-linkage with the dairy production sector; therefore, results exclude effects in this sector to avoid double counting.

Cattle ranching supported by crops irrigated by the Districts' water is, in turn, estimated to support approximately $119.8 million of animal processing output. The direct economic benefits of this processing (Table 6.3-7) are approximately $11.8 million in labor income annually and approximately 270 full and part-time jobs. In total, animal processing associated with the Don Pedro water supply supports an estimated $24.2 million in labor income, and over 600 full and part-time jobs (excluding effects in the dairy production sector, estimated above in Table 6.3-4).

Table 6.3-7. Annual regional economic benefits – regional food processing dependent on cattle production supported by crops from the Districts' water service area.[1,2,3]

Metric	Direct	Indirect	Induced	Total
Animal (except poultry) slaughtering, rendering, processing				
Output (millions, 2012$)	$119.8	$32.1	$14.18	**$166.0**
Labor Income (millions, 2012$)	$11.8	$8.0	$4.4	**$24.2**
Employment (full and part-time jobs)	270	240	120	**630**

Source: Cardno ENTRIX (based on IMPLAN modeling).
1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
2 Results represent annual effects in three-county study area (Stanislaus, Merced, and Tuolumne counties).
3 Analysis represents forward-linkage with the cattle ranching sector; therefore, results exclude effects in this sector to avoid double counting.

6.3.2 Urban Land Uses Dependent on M&I Water Supplies

As discussed previously, it is difficult to estimate the direct value of production across businesses and industries utilizing M&I water supplies from the Don Pedro Project. However, it is useful to review the regional economic benefits attributed to all manufacturing in the City of Modesto service area, which are dependent in part on Don Pedro water supplies. Overall, it is estimated direct manufacturing output in the City of Modesto is approximately $5.3 billion annually, which supports over 11,000 full and part-time jobs and $715.3 million in associated labor income (see Table 6.3-8). The total annual regional economic benefits of local manufacturing include $7.6 billion in total output, $1.3 billion in labor income, and 25,700 full and part-time jobs. (It was not possible to disaggregate these effects from the regional food processing sector that is reliant on Don Pedro water supplies; therefore, the effects presented in Table 6.3-8 include the food processing sector and backward linkages to the agricultural and animal production sectors and cannot be combined with those analyses presented above.)

Table 6.3-8. Annual regional economic benefits – manufacturing sector in City of Modesto water service area.[1,2,3,4]

Metric	Direct	Indirect	Induced	Total
Output ($millions)	$5,319.9	$1,468.3	$784.7	$7,572.9
Labor Income ($millions)	$715.3	$371.0	$243.1	$1,329.4
Employment (full and part-time jobs)	11,220	8,180	6,300	25,700

Source: Cardno ENTRIX (based on IMPLAN modeling).
1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
2 Results represent annual effects in three-county study area (Stanislaus, Merced, and Tuolumne counties).
3 Manufacturing sector includes food processing; therefore, results cannot be combined with those presented in Tables 6.3-5 to 6.3-7.
4 Analysis includes backward-linkages to agricultural and dairy production sectors; therefore, results cannot be combined with Tables 6.3-1 through 6.3-4.

6.3.3 Recreation

Recreation activity supported by the Don Pedro Project generates spending in the regional economy. Based on estimates of total visitation to Don Pedro Reservoir (approximately 378,000 visitor days annually) and applicable spending profiles for day and overnight visitors, it is estimated that recreation at Don Pedro Reservoir generates approximately $14.7 million in total spending annually, of which $10.0 million occurs in the three-county study area. This spending occurs across a range of recreation-support businesses in the region, predominantly at the retail level.

Table 6.3-9 presents the regional economic benefits generated by recreation spending by visitors to Don Pedro Reservoir. The approximate $10 million in recreation spending is estimated to generate about $6.2 million in direct output at local businesses and $9.7 million in total output across all industries on an annual basis. In addition, total labor income and jobs supported by recreation spending totals about $2.9 million per year and 100 total full and part-time jobs, respectively.

Table 6.3-9. Annual regional economic benefits – recreation visitation at DPRA.[1,2]

Metric	Direct	Indirect	Induced	Total
Output ($millions)	$6.2	$1.8	$1.7	$9.7
Labor Income ($millions)	$1.9	$0.5	$0.5	$2.9
Employment (full and part-time jobs)	80	10	10	100

Source: Cardno ENTRIX (based on IMPLAN modeling).
1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
2 Results represent annual effects in three-county study area (Stanislaus, Merced, and Tuolumne counties).

6.3.4 Hydropower

Hydropower generation at the Project generates long-term benefits to the regional economy based on the value of power produced and the ancillary expenditures and labor force required to operate the facility. The direct economic benefits of power plant operations consist of the value of power generated by the plant (i.e., direct output) and operations-related workforce requirements and related payroll (i.e., direct employment and labor income, respectively). These direct effects, in turn, generate additional economic activity based on local expenditures that are required for the plant to operate and local spending of income earned by the operations work force and other local workers.

The direct output value of hydropower generation is $24.7 million annually (Table 6.3-10). This value is based on representative wholesale market values for electricity in northern California, assumed to be a proxy for the value of power that is generated at the Don Pedro Powerhouse. Based on this figure, the IMPLAN model estimates the direct labor force at 28 employees earning $7.5 million in annual labor income. To the extent that hydropower generation generates demand for local goods and services and local workers spent their earnings locally, additional benefits accrue to the regional economy. In total, hydropower generation at the Don Pedro Project supports an estimated $31.2 million in total economic output, $9.5 million in total annual labor income, and about 90 total full and part-time jobs.

Table 6.3-10. Annual regional economic benefits – hydropower generation at the Don Pedro Project [1,2]

Metric	Direct	Indirect	Induced	Total
Output ($millions).	$24.7	$1.0	$5.5	$31.2
Labor Income ($millions).	$7.5	$0.3	$1.7	$9.5
Employment (full and part-time jobs)	30	10	50	90

Source: Cardno ENTRIX (based on IMPLAN modeling).
1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
2 Results represent annual effects in three-county study area (Stanislaus, Merced, and Tuolumne counties).

6.3.5 Summary of Regional Economic Effects

Table 6.3-11 presents a summary of the regional economic effects presented in this section. Accounting for both directly-supported activities and other forward-linked sectors, it is estimated that the Don Pedro Project supports approximately 18,900 total jobs and $734.8 million in total labor income annually.

Table 6.3-11. Annual regional economic benefits – summary ($millions).[1,2]

Activity	Output ($millions)		Labor Income ($millions)		Employment (Full and Part-Time Jobs)	
	Direct	Total	Direct	Total	Direct	Total
Directly-Supported Activities						
Crop Production	$527.9	$854.2	$171.7	$278.1	4,340	7,270
Recreation Spending	$6.2	$9.7	$1.9	$2.9	80	100
Hydropower	$24.7	$31.2	$7.5	$9.5	30	90
Directly-Supported Sub-total	*$558.9*	*$859.1*	*$181.1*	*$290.5*	*4,400*	*7,500*
Forward Linkages						
Crop Processing	$569.1	$854.9	$87.0	$165.8	1,050	3,020
Crop Processing Subtotal[3]	*$512.6*	*$854.9*	*$87.0*	*$173.4*	*1,050*	*2,870*
Dairy Production	$537.4	$816.7	$23.6	75	2,270	3,630
Dairy Processing	$787.6	$1,143.1	$71.8	156	1,060	3,040
Dairy Subtotal[3]	*$922.1*	*$1,959.8*	*$95.4*	*$231.6*	*3,330*	*6,670*
Cattle Production	$128.1	$233.0	$7.2	23	620	1,220

Activity	Output ($millions)		Labor Income ($millions)		Employment (Full and Part-Time Jobs)	
	Direct	Total	Direct	Total	Direct	Total
Cattle Processing	$119.8	$166.0	$11.8	24	270	630
Cattle Subtotal[3]	*$172.9*	*$399.0*	*$19.0*	*$46.9*	*890*	*1,850*
Forward-Linkage Sub-Total	*$1,607.6*	*$3,213.7*	*$201.4*	*$444.3*	*5,300*	*11,400*
Total Economic Benefits						
Total	**$2,166.4**	**$4,108.8**	**$382.5**	**$734.8**	**9,700**	**18,900**

Source: Cardno ENTRIX (based on IMPLAN modeling).
1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
2 Results represent annual effects in three-county study area (Stanislaus, Merced, and Tuolumne counties).
3 Forward linkage direct output values are adjusted to avoid double counting of crop, dairy, and cattle output that become inputs into a processing sectors (where their value is included in the processing sector output value). For example, $56.5 million of crop output is estimated to be processed in the food and beverage processing sectors, and is included in the $569.1 direct processing output value. The direct additional output due to crop processing is thus $512.6 million ($569.1 million less the $56.5 million of crop input).

6.4 Fiscal Benefits

The results of the regional economic analysis presented in Section 6.3 can provide insight on the potential tax revenues generated by the drivers of economic activity supported by the Don Pedro Project. Taxes are levied at the local, state, and federal levels, and include sales tax on goods and services, income taxes, and property taxes. It is important to note that these fiscal impacts are not in addition to the economic impacts in the previous section; rather, they represent the portion of income that is distributed to the government.

Sales and use tax receipts provide income to both local municipalities and the state. Sales taxes are generated when there are retail purchases on taxable goods and services. Such transactions are made local farmers when purchasing many types of agricultural inputs, which may include certain types of farm equipment and machinery. (It is noted that there is an agricultural sales tax exemption on qualifying transactions in California.) Recreation-related spending by local visitors also generates sales tax revenues. In addition, all of the economic activities supported by the Project provide labor income benefits as described above. As households spend their income on taxable retail goods and services, sales tax receipts accrue to local and state governments. Similarly, the household income generated by Project-supported economic activities generates both state and federal income tax revenues.

In addition, lands utilizing Project water supplies are subject to local property taxes collected by local governments. Agricultural lands are generally taxed based on full market value, but tax assessments may be lower for agricultural properties enrolled in Williamson Act contracts.[58] As shown in Section 5.5, land values in the Districts' service areas are generally higher than surrounding regions, which is due in part to reliable water supplies from the Project. To the extent that these land value premiums are represented in the assessed value of these properties located within the Districts' service area (and not under Williamson Act contracts), the Project is providing incremental tax benefits to local governments.

[58] The California Land Conservation Act of 1965, commonly known as the Williamson Act, enables local governments to enter into contracts with private landowners to promote the continued use of land in agricultural or related open space use. In return, landowners receive property tax assessments that are based on farming and open space uses instead of full market value.

7.0 SOCIAL CONSIDERATIONS AND ENVIRONMENTAL JUSTICE

7.1 Role of Project Operations on Affected Social Groups

As explained throughout this study, water supplies from the Don Pedro Project generate a range of economic benefits to the local community and larger region. These benefits relate to existing uses of Project water supplies, including agriculture, M&I (urban) uses, recreation, and hydropower generation, as well as related effects on land values in the region. However, these economic benefits that have been quantified and presented in Sections 5 and 6 above do not tell the entire story of the role that the Project has on the local community. Specifically, there are a number of social groups that have developed around the activities supported by the Don Pedro Project. This section covers the relationship between these social groups and the Project.

The importance of the Don Pedro Project on local farms cannot be underestimated. Project water supplies allow local farmers to grow a range of permanent and annual crops that help feed people all over the world. These farming operations include mostly family farms, which in many cases have been held in the same family for generations. These families have come to rely on readily-available and affordable water supplies from the Project for their livelihood and ability to support their families and communities. Further, Project water supplies have a positive influence on local property values, which in turn provides a source of wealth and financial stability for these families.

Local recreationists also benefit from the presence of the Don Pedro Project. Individuals and families come to Don Pedro Reservoir to experience high-quality recreation opportunities that the Project provides. With its abundant opportunities for fishing and developed campground facilities, the reservoir is particularly suited to anglers and campers from both within the local community and from outside the region. For locals, it serves as a high-quality and convenient recreation option.

Similarly, a large number of local business owners in the surrounding community rely on agricultural production and recreation visitation supported by the Project to sustain business activity that allows them to continue operating. In the context of farming, these agriculture-support businesses are diverse, such as heavy equipment dealerships, seed and fertilizer wholesalers/retailers and farm labor contractors. Recreation-serving businesses include local restaurants, hotels, and convenience and sporting goods stores. Similar to local farmers, these business owners that indirectly benefit from Project operations have come to depend on the Project for their economic well-being and have made financial investments and plans based on the existing structure of Project operations that provide reliable water supplies to farms and foster recreation opportunities the region.

Lastly, Project operations also affect local water and electrical ratepayers throughout the region. Agricultural water users and electrical ratepayers are served directly by TID and MID, while urban water users in the Modesto area are served by the City of Modesto which receives a portion of their water supplies from the Don Pedro Project. These ratepayers not only include local residents, including farmers, but also businesses, such as food processing facilities, that use the power and water from the Project to sustain their operations. Local residents use local water supplies as a source of drinking water, landscaping, and other domestic uses. Similarly, low-cost electrical supplies are an essential component of day-to-day living by local residents.

7.2 Environmental Justice

Environmental Justice is defined as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies" (EPA 2013). Executive Order (EO) 12898 requires each federal agency to achieve environmental justice as part of its mission by identifying and addressing disproportionately high and adverse human health or environmental effects, including social or economic effects, of programs, policies, and activities on minority populations and low-income populations of the United States.

The purpose of an environmental justice analysis is to determine whether the implementation of projects, programs, or policies would cause disproportionately high and adverse environmental and economic effects to minority and/or low-income populations. For this study, the focus is on changes in Project operation under the Relicensing alternatives. While the impacts of changes in water supplies will be addressed in the future impacts analysis, this section provides a baseline description of the minority and low-income populations in the area and evaluates how these groups are affected by existing Project operations.

For this baseline description, information on the demographic and social characteristics of the study area has been collected and is used to determine the extent to which minority and/or low-income populations exist in the Project area (refer to Section 4). Because environmental justice focuses on minority and low-income populations, relevant topics include race and ethnicity and relevant economic indicators of social well-being, including income, poverty, and unemployment. For this analysis, data are based on the 2010 Census of Population and Housing.

In order to determine whether environmental justice is an issue with respect to Project operations, the social and demographic characteristics of the study area are evaluated to determine if there are any environmental justice communities present. This determination is based on the comparison of select social and demographic parameters for the Districts' water service areas relative to the state of California, which serves as the reference population. If the minority or low-income populations are meaningfully greater in the region relative to this reference population, then an environmental justice community of concern is assumed to be present.

7.2.1 Race and Ethnicity

Information on race and ethnicity information is utilized to discern any minority populations that are or could be disproportionately affected by Project operations. Minority populations include the following categories:

- African American/Black,
- American Indian/Alaskan Native,

- Asian,
- Hawaiian/Pacific Islander,
- Other Race,
- Multi-Race, and
- Hispanic ethnicity (of any race).

In Section 4, Tables 4.1-6 and 4.1-7 show the racial and ethnic composition of the three-county study area and the Districts' water service areas, respectively. Table 7.2-1 compares those with statewide data. As shown, the largest minority group is Hispanic/Latino, which represents 41.9 percent of the water service area and 43.9 percent of the study area population. These areas have a slightly higher Hispanic population relative to statewide levels (37.6% in California). The large Hispanic population is representative of the large farm labor force that helps supports California's agricultural industry and larger economy. In fact, Hispanics made up more than two-thirds (67.9 %) of the agricultural labor force in California, but only about one-third (33.5%) of the state's nonagricultural labor force in 2008 (California Employment Development Department 2008). In terms of other minority populations, the racial makeup of the water service area and study area populations is generally comparable to statewide patterns.

Table 7.2-1. Race and ethnicity of affected populations compared to California, 2010.

Race/Ethnicity	Districts' Water Service Area [1]	Three-County Study Area	California
White	65.2%	64.7%	57.6%
Black/African American	2.8%	3.1%	6.2%
American Indian/Alaska Native	1.2%	1.3%	1.0%
Asian	5.3%	5.5%	13.0%
Hawaiian/Pacific Islander	0.6%	0.5%	0.4%
Other Race	19.4%	19.9%	17.0%
Multi-Race	5.4%	5.1%	4.9%
Hispanic of any race	41.9%	43.9%	37.6%

Source: U.S. Department of Commerce, U.S. Census Bureau 2010.
[1] Based on census tracts that fall within or are transected by the Districts' Water Service Area boundaries.

7.2.2 Income and Poverty

Low-income populations in the study area can be identified by several socioeconomic parameters, including median household income, per-capita income, and poverty status, which are presented in Table 7.2-2. As shown, the weighted median household income levels in the water service area ($51,500) and study area ($48,604) are lower than in California as a whole ($60,883). Similarly, per-capita income levels in the region are also lower than statewide levels.

Based on these data, as expected, local poverty rates are higher in the Districts' Water Service Area than in California overall. The poverty rate for all people is 16.3 percent in the Districts' service areas and 17.8 percent in the three-county study area, both of which are higher than the statewide average of 13.7 percent. Generally, the income levels are lower and poverty rates higher for the agricultural workforce, which represents an important part of the local population that rely on Project water supplies. In 2008, 48.6 percent of California's agricultural workers reported annual family income of less than $35,000 versus 21.0 percent for non-agricultural workers (California Employment Development Department 2008).

Table 7.2-2. Income measures of affected populations compared to California, 2006-2010.

Income Measure	Districts' Water Service Area [1]	Three-County Study Area	California
Median Household Income	$51,500	$48,604	$60,883
Per Capita Income	$21,697	$21,047	$29,188
Poverty Rate (Families)	13.4%	14.3%	10.2%
Poverty Rate (All People)	16.3%	17.8%	13.7%

Source: U.S. Department of Commerce, Census Bureau (American Community Survey) 2011.
[1] Based on census tracts that fall within or are transected by the Districts' Water Service Area boundaries.

7.2.3 Unemployment

Another socioeconomic indicator providing insight on the economic well-being of the population is unemployment. Average unemployment rates for affected populations between 2006 and 2010 are presented in Table 7.2-3. The unemployment rate averaged 12.7 percent in the Districts' service areas and 12.8 percent in the three-county study area, both of which are substantially higher than the statewide unemployment rate of 9.0 percent.

Table 7.2-3. Unemployment of affected populations compared to California, 2006-2010.

Measure	Districts' Water Service Area [1]	Three-County Study Area	California
Unemployment Rate	12.7%	12.8%	9.0%

Source: U.S. Department of Commerce, Census Bureau (American Community Survey) 2011.
[1] Based on census tracts that fall within or are transected by the Districts' Water Service Area boundaries.

7.2.4 Role of Project Operations on Environmental Justice Communities

Taking into consideration the racial and ethnic composition of the region, including its large agricultural workforce characterized by a relatively large Hispanic/Latino population, as well as other indicators that demonstrate the region's economic disparity relative to the remainder of the State of California, it is important to evaluate the role that Project operations has on these environmental justice groups. This is particularly true based on the strong link between minority farm workers and the agricultural industry, which are affected by Project operations.

As described in Section 5.1, water supplies provided by the Don Pedro Project supports an expansive agricultural industry, which generates substantial economic benefits to local farmers and supports a large agricultural workforce. It also represents a primary driver of economic activity in the local and regional economies based on large network of agricultural-support industries and spending by agriculturally-dependent households. At the farm-level, many of the economic benefits accrue to agricultural workers, including jobs and related wage income. Because the agricultural labor force predominantly consists of farm workers of Hispanic origin (67.9 % of the agricultural workforce) and are generally part of the low-income population in the region, existing agricultural production provides economic benefits for minority and low-income populations in the region that are the focal point of environmental justice.

At the regional level, the existing Project operations support thousands of jobs and an associated labor income across the three-county study area. As demonstrated above, this region has a relatively high proportion of minorities, including Hispanics which account for 43.9 percent of the population, and low-income residents, which are reflected in the poverty rate of 17.8 percent. Because the Don Pedro Project generates benefits not only at the farm level, but also throughout a wide range of industries that comprise the regional economy, the environmental justice communities living in the three-county region realize some of the employment opportunities and income benefits supported by the Project.

8.0 POTENTIAL ECONOMIC IMPACTS OF REDUCED PROJECT WATER SUPPLIES

The FERC relicensing process could potentially include consideration of long-term changes in water use from the Don Pedro Project. Potential scenarios may involve reductions in water availability for agricultural, M&I, and other existing uses of Project water supplies. This section presents the potential economic impacts of reduced water supplies from the Don Pedro Project focusing on agricultural water use in the Districts' water service area and M&I water use by the City of Modesto.[59] CCSF is conducting an independent evaluation of potential effects on its Bay Area customers. The analysis herein considers both changes in economic values attributed to changes in water use (i.e., social welfare changes), as well as potential "ripple" effects in the regional economy, including employment and income impacts that would be incurred by people and businesses dependent on the economic activity supported by Project operations. The analysis is based on hypothetical incremental water supply reductions from 10 to 50 percent of full water supplies in 10 percent increments.

8.1 Agricultural Water Supply Impacts

Table 8.1-1 shows the gross revenue by crop for a range of irrigation water supplies. As analyzed, agricultural water use ranges in volume from 100 percent of full water supply (equivalent to crop water demand) to 50.0 percent of full supply. The estimated reduction in gross revenue ranges from $48.7 million at 90 percent of full agricultural water supply to $251.8 million at 50 percent of full water supply. The estimates assume that:

(1) groundwater pumping does not increase to make up for the reduction in surface water deliveries (e.g., groundwater pumping volumes remain at baseline levels for the entire range of surface irrigation water deliveries; and

(2) specialization is high, e.g., growers only grow one crop, and irrigation supplies cannot be 'transferred' to relatively higher valued crops (Bernaciak 2013).

Below is a summary of the yield and price assumptions used to estimate the gross revenue for each crop type; perennials (nuts, fruits and vines), annuals (field and vegetable crops) and dairy-support crops. A discussion of the potential impact on dairy production is presented at the end of this section.

Table 8.1-1. Estimated annual gross revenue by crop for a range of agricultural water supply shortages ($millions).

Crop Type	Water Supply (Percentage of Full Supply)					
	100% (baseline)	90%	80%	70%	60%	50%
Corn-Silage	$68.4	$62.0	$55.6	$49.1	$42.5	$35.7
Field and other	$40.6	$37.0	$33.3	$29.5	$25.5	$21.5
Fruit	$61.0	$55.5	$49.9	$44.1	$38.2	$32.2

[59] This analysis does not consider potential impacts on other water supply benefits supported by the Project, including recreation, hydropower generation, and land values.

Crop Type	Water Supply (Percentage of Full Supply)					
	100% (baseline)	**90%**	**80%**	**70%**	**60%**	**50%**
Grain	$5.4	$4.8	$4.3	$3.8	$3.2	$2.7
Grape	$12.2	$11.1	$9.9	$8.8	$7.6	$6.4
Hay	$24.3	$22.1	$19.9	$17.6	$15.2	$12.8
Irrigated pasture	$8.3	$7.5	$6.7	$5.9	$5.1	$4.3
Nut	$287.0	$260.3	$233.8	$206.0	$178.1	$149.5
Vegetable	$20.7	$18.8	$16.9	$15.0	$13.0	$10.9
Total	$527.9	$479.1	$430.3	$379.7	$328.5	$276.1
Change in Gross Revenue		-$48.7	-$97.6	-$148.2	-$199.4	-$251.8
Percent change from baseline		-9%	-18%	-28%	-38%	-48%

Source: Cardno ENTRIX, based on SWAP modeling.
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

8.1.1 Perennials

There are three perennial crops in the model; (1) nuts, represented by almonds, (2) fruit, represented by peaches and (3) vines, represented by wine grapes. The assumptions about the crop response to deficit irrigation for each representative crop are described below.

Almond trees are drought tolerant (Fereres and Goldhamer 1990; Hutmacher et al. 1994; and Torrecillas et al. 1996); however, irrigation is critical in producing high yields of top quality nuts (Castel and Fereres 1982; Prichard et al. 1993; and Nanos et al. 2002). Water stress can negatively affect both the primary yield components in almond, kernel size (Girona et al. 1993) and fruit load (Goldhamer and Smith 1995; Goldhamer and Viveros 2000; and Esparza et al. 2001). Goldhamer et al (2006) found reductions in yield ranged between 4.0 percent of maximum and 29.0 percent of maximum when evapotranspiration (ET) ranged between 85.0 percent of full ET (under a uniform stress delivery pattern) to 55.0 percent of full ET (under a post-harvest delivery pattern). Currently the impact model assumes an annual yield reduction between 5.0 percent and 45.0 percent of baseline yield when surface irrigation deliveries range between 10.0 percent of baseline and 50.0 percent of baseline, respectively.

Almond prices paid to growers also impact on-farm revenue. If almond yield falls due to a regional water shortage the price of almonds may increase. Conversely, the factors mentioned above that impact almond yield, such as kernel size, could drive the price paid to growers down. Due to the uncertainty of the impact of water availability on almond price the model assumes almond prices are static over the range of water deliveries.

Peach trees have been shown to survive and remain productive for four consecutive years with no irrigation between June and October in a deep soil under flood irrigation (Johnson et al. 2008). However, water stress does decrease yields. Estimates of a yield reduction range between 6.0 percent, when irrigation supplies are reduced by approximately 25.0 percent, to 34.0 percent, when irrigation supplies are reduced by 50.0 percent (Razouk, et al. 2013; and Johnson et al. 1994). Additionally, water stress in late summer also interferes with flower bud development and can cause fruit defects the following year. Deep sutures and fruit doubles and smaller fruit size can all result from previous years' water stress (Handley & Johnson 2000; and

Johnson & Phene 2008). Therefore, stress irrigation affects not only the current years' yield but also has a lag effect on the subsequent years yield. Johnson et al. (2008) estimate the total fruit defects the year following stress irrigation range from 3.6 percent at harvest to 39.9 percent at harvest, over a range of seven different irrigation treatments.

The estimates of reduction in yield from these two effects: (1) the reduction in crop yield due to a reduction in surface water supplies in the current year, and (2) the reduction in current year yield (defective fruit) caused by the previous year's stress irrigation, suggest that yield reductions in any one year might range from 9.6 percent to 73.9 percent. The studies that produced these estimates in yield reduction utilized a wide range of irrigation treatment options that are not easily reproduced in an impact model and are subject to speculation about how individual growers would choose to apply water. For ease of exposition and based on the ranges of irrigation treatment options from the literature it is reasonable to assume that for this agricultural impact model the yield reduction in any one year equal the reduction in surface water supplies for that year, ranging from 10.0 percent to 50.0 percent.

Like almonds and peaches, grapes are also drought tolerant (Blum 2009). In the late 1990s, grape growers began adopting a practice called *Regulated Deficit Irrigation* (RDI). Under the RDI practice growers intentionally apply less than the full water requirement on vines with a drip irrigation system to achieve properly timed mild water stress. The results are improved wine quality and conservation of water and energy. For the baseline we assume growers in TID and MID are practicing RDI and reductions in irrigation supplies that could result from the relicensing go beyond the desired RDI levels.

The effect of water deficit on grapevine production differs depending on the stage of canopy growth and berry development when the water deficit is applied (Chalmers 2012). When a water deficit is applied between fruit set and veraison, there is potential to reduce yield by affecting berry size (Hardie & Considine 1976; Matthews et al. 1987; and McCarthy 2000). Hardie & Considine (1976) noted that the most sensitive stage for affecting berry development was during the flowering to fruit set stage, whereas a water deficit applied post-veraison tended to cause a reduction in berry weight. Early and late season water deficits can affect the development of the current season's berries as well as the primordia for the subsequent season's berries (Matthews & Anderson 1989).

As a consequence of the sensitivity of grape yield to the timing of irrigation application, field trials that estimate these impacts generally test multiple irrigation treatments, e.g., applying less water early in the season and full water late in the season (Wample 2002). Making generalization to an impact model difficult, however, Wample (2002) tested a uniform application of a 45.0 percent reduction in irrigation water over a six year field trial and found the yield impacts ranged from a 9.0 percent reduction in tons/hectare to a 55.0 percent reduction in tons/hectare.

In addition to grape yield, grape price also impacts the growers' gross revenue. Prices for wine grapes are particularly volatile, ranging from $266.17 per ton in 2007 to $392.72 per ton in 2009 in Stanislaus County (Stanislaus County Agriculture Commissioner 2008 and 2010). Some of the factors that impact price relate to the qualities of the fruit, which are impacted by the timing of irrigation. For example, sugar content of a berry varies under various irrigation timing treatments (Chaves et al. 2010).

Given the wide range of yield impacts, and the uncertainty involved in estimating the price of wine grapes it is reasonable to assume that for this agricultural impact model, the gross revenue reduction in any one year equal the reduction in surface water supplies for that year, ranging from 10.0 percent to 50.0 percent. This is within the range of both yield impacts seen in the literature and reported changes in grape prices.

8.1.2 Annuals

There are two annual crops in the model that are not directly related to supporting dairy: (1) field crops, represented by wheat; and (2) vegetables, represented by sweet potatoes. The impact model assumes that these crops are not deficit irrigated; rather the acreage is reduced to a level that can be fully irrigated based on the availability of surface water supplies.

The grower must make decisions about the number of acres as early as January or February, prior to knowing what spring run-off for the year will be and therefore before knowing what surface water supplies will be available. The impact of this may be felt not in the estimate of gross revenue, but in the estimate of grower profit.

8.1.3 Dairy-Support Crops

There are three crops in the model that support dairy: (1) corn silage; (2) hay; and (3) grain. The impact model assumes that these crops are not deficit irrigated; rather the acreage is reduced to a level that can be fully irrigated based on the availability of surface water supplies. A reduction in these crops has the potential to impact a dairy in two ways: (1) reduced supply of internally produced feed grains for dairy operations, and (2) reductions in acreage of annual crops, whether feed grains or other crops, or whether on or off dairy operations, may require altering existing Waste Management Plans (WMPs) or Nutrient Management Plans (NMPs).

Modeling the potential impact of a regional change in dairy production as a result of surface water availability requires generalizing the diversity of individual dairy operations in TID and MID; and the dairy operations in TID and MID are very diverse in their scale, enterprise model, resource availability, production practices, waste/nutrient management practices, and financial structure (Heguy 2013, MacDonald et al. 2007). At a regional scale, the impact model assumes that costs will likely increase, adversely affecting profits, and consolidations may increase, changing the structure and characteristics of dairy production in the Districts’ water service area; however, the total regional gross revenue of milk products produced may remain relatively unchanged. Below is a discussion of farm-level management options for dealing with the effects of water shortages.

Impacts of reduced feed grain acreage depend on several factors, some external to the region and others determined by the situation of individual operations. A common thread is that feed is the major component of milk production costs, accounting for 65 percent of total costs per hundredweight of milk. Alfalfa hay and corn silage alone combine to account for nearly 20 percent of total production costs. Reductions in feed grain acreage may not impact production on all operations to the same degree and may not impact some operations at all. Potential impacts on dairy production include:

- Assuming feed is available from other regions, dairy operations within the service areas can import more feed in place of internal supplies. Importing a greater percentage of feed grain requirements translates into higher cost to produce a hundredweight of milk, thus at the same level of milk production dairy operations face higher total cost and reduced profit.
- If feed from other regions is available, but at reduced quality relative to the current mix of internal and imported feed, then impacts are less certain. Lower quality feed may be cheaper than existing feed. However, any cost savings may be offset by lower revenue due to decreased productivity and quality, leading to both volume and price impacts to revenue.
- If feed grains are unavailable from other regions, producers could alter the feed ratio depending on the degree of the internal supply shortage. While feed costs may actually decline, altering the feed ratio may have volume and quality impacts the decrease revenue, similar to maintaining feed ratios but with lower quality inputs.
- Assuming imports are unavailable and depending on the degree of the internal shortage, producers could chose to send less productive cows to slaughter to ensure remaining cows are fed in the volume and ratio prescribed for maximum productivity and quality. High beef prices will make this option more attractive. However, this option may not be viable for operations that continue to leverage the cows, as banks hold collateral over the herd and selling off individual cows may not be feasible. Further, WMPs/NMPs are certified for a baseline herd size that may not increase or decrease by more than 15 percent without a new permit. Finally, reducing herd size is not a sustainable long run practice given the structural change that has occurred in the dairy industry and the demonstrated profit-generating incentives of larger herds.
- Producers securing supplies of feed grains with futures or other forward price supply contracts will have secured feed supplies and may not face any impact at all.
- If the internal feed shortage is severe enough and prices of imported feed are high enough, a last resort is to shut down operations. This isn't likely to happen for a single water-short year, but in the long-run smaller operations may choose to sell out.

Reductions in the acreage of annual crops in the service area can have implications for existing WMPs/NMPs of dairy operations. Many operations utilize annual crop acreage in one way or another to spread and absorb manure. Additionally, reduced surface water supply may impact the ability of dairy operations to spread manure on remaining acreage, as water is required to dilute and treat the manure prior to spreading. Impacts are not limited to reductions in crop acreage at dairy operations. Other potential implications include:

- Reducing herd size. Sending less productive cows to slaughter or raising heifers off-farm should reduce manure output. In turn, milk production will decline and average costs per hundredweight will likely increase. Also, data show that many of larger operations are already paying to have heifers raised offsite. This is an unlikely management plan for an individual dairy to adopt because economies of scale suggest reducing herd size would idle valuable capital and further, the California Regional Water Quality Control Board's Waste Discharge Requirement General Order for Existing Milk Cow Dairies (Order No. R5-2007-0035) puts a cap on changes in the herd size.

- Expand land base. While the USDA report referenced this as a strategy for manure management, it is not likely to be feasible in California where land is expensive (MacDonald et al. 2007).
- Removing manure from the dairy operation. Paying to have manure removed is expensive since it is heavy and costly to transport. Transporting manure decreases profits, as the USDA reports about half of western states dairies that are removing manure from the operation are simply giving it away. Further, if other growers in the service area have reduced the acres they are farming due to limited water supplies, the manure may have to travel further for disposition, increasing costs even more.

While impacts to individual dairy enterprises can be substantial, as described above, the impact on the regional economy in terms of the total output of dairy products may be minimal. Assuming dairy operations respond to securing alternative feed grains at higher costs, production value will remain unchanged. Even if water shortages caused further consolidation, opportunistic behavior by remaining dairy operations may be sufficient to maintain baseline milk production levels.

8.2 M&I Water Supply Impacts

Potential water supply shortages would also affect municipal uses in the City of Modesto. Any reductions in water supplies from the Don Pedro Project would affect all deliveries proportionally irrespective of use; therefore, M&I deliveries to the City of Modesto would be reduced by the same proportion as agricultural deliveries. Under existing conditions, total M&I water demand in the City of Modesto has averaged approximately 71,200 AFY between 2007 and 2011. Of this total, roughly 31,300 AFY (44.0%) is provided by surface water supplies from the Don Pedro Project (via the MRWTP), while the remaining 39,900 AFY (56.0%) comes from groundwater pumping. For this analysis, it is assumed the any potential surface water supply shortages from the Project would be made up by groundwater pumping due to the essential nature of M&I water uses (e.g., drinking water supplies).

Table 8.2-1 shows the volume of potential M&I water supply impacts. Generally, as surface water supplies are reduced, groundwater pumping volumes are expected to increase. For every 10 percent decline in surface water supplies (approximately 3,310 AFY), groundwater pumping would increase by that same amount. For example, a 50 percent reduction in surface water supplies totaling almost 15,700 AFY would result in groundwater pumping levels exceeding 55,500 AFY. The long-term viability of sustained groundwater pumping at these levels is unknown.

Table 8.2-1. Estimated annual cost of potential M&I water supply shortages (AF/yr).

Impact	Water Supply (Percentage of Full Supply)					
	100%	**90%**	**80%**	**70%**	**60%**	**50%**
Surface Water Supplies (MID)	31,308	28,177	25,047	21,916	18,785	15,654
Groundwater Pumping	39,879	43,010	46,140	49,271	52,402	55,533
Total M&I Water Demand	**71,187**	**71,187**	**71,187**	**71,187**	**71,187**	**71,187**

As described in Section 5.2, the economic value of surface water supply reductions for M&I uses can be measured in several ways. In the context of the Don Pedro Project, the most pertinent measure of the value of M&I water supplies is based on the least-cost alternative supply, which in this case is groundwater. The value of M&I water supplies provided by the Don Pedro Project to the City of Modesto is estimated to be about $143 per AF, which reflects the avoided capital and operating costs of groundwater pumping. Based on this value, the economic losses associated with a 10 percent reduction in surface water supplies is approximately $448,000 per year, which increases to over $2.2 million annually under a 50 percent water supply shortage (Table 8.2-2).

Table 8.2-2. Estimated economic losses due to potential M&I water supply shortages.[1]

Impact	Water Supply (Percentage of Full Supply)					
	100%	**90%**	**80%**	**70%**	**60%**	**50%**
Reductions in Surface Water Supplies (MID)	--	-3,131	-6,262	-9,392	-12,523	-15,654
Loss in Economic Value	--	-$447,842	-$895,684	-$1,343,526	-$1,791,368	-$2,239,210

[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

The impacts presented above reflect social welfare losses. However, it is also important to consider the economic impacts that would be incurred directly by water users, which would fall to the City of Modesto (and potentially its ratepayers).[60] In this context, one must also recognize the cost differential between groundwater supplies relative to the cost of surface water supplies from the MRWTP. It has been estimated that the net increase in water supply costs between groundwater supplies and surface water is approximately $30/AF (based on variable costs only). Therefore, for the City of Modesto, increased water supply costs attributed to water supply shortages ranges from $95,500 to $472,400 per year if groundwater pumping is used to replace lost surface water supplies. These costs would potentially be passed on to local ratepayers in the form of higher water rates; however, potential impacts to water rates have not been quantified.

8.3 Regional Economic Impacts

Water supply reductions from the Don Pedro Project would also have implications for the regional economy, namely impacts on production, income and employment across a wide range of industries in the three-county study area (Stanislaus, Merced, and Tuolumne counties). This analysis focuses on changes in agricultural production as estimated by the SWAP model, in conjunction with the appurtenant changes in agricultural processing sectors that rely on the production of local crops.

[60] The concept of economic impacts is different than the economic value of water supplies. The economic impact of water supply shortages measure the net effect on affected interests, which is measured by the cost differential between water supply options.

Table 8.3-1 presents the regional economic impact associated with reductions in crop production in the Districts' water service area due to water supply shortages from the Project.[61] These impacts capture not only the direct effects at the farm level, but also across the broader economy based on linkages between industries and households with the agricultural sector. Reductions in local crop production would result in declines the production of a wide range of goods and services in the regional economy that support the agricultural sector, which in turn would adversely affect employment and income levels of local residents. For every 10 percent reduction in agricultural water supplies, total employment in the three-county economy is expected to fall by about 600 to 800 jobs, with the magnitude of impacts increasing with greater water supply shortages. Under the 50 percent water supply scenario, total employment attributed to local crop production is expected to decline from 7,655 jobs to 4,034 jobs, a loss of over 3,600 jobs. Similarly, income levels would fall from $294.4 million to $156.6 million, a loss of roughly $138.0 million annually.

Table 8.3-1. Annual regional economic impacts from water supply shortages – crop production.[1,2]

Impact Metric	Water Supply (Percentage of Full Supply)					
	100%	90%	80%	70%	60%	50%
Total Output ($millions)	$840.7	$775.61	$706.40	$621.26	$532.91	$443.19
Total Labor Income ($millions)	$274.6	$254.27	$232.45	$204.57	$175.48	$145.92
Total Employment (full and part-time jobs)	7,200	6,642	6,049	5,320	4,563	3,794

Source: Cardno ENTRIX (based on IMPLAN modeling).
1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
2 Results represent regional effects in three-county study area (Stanislaus, Merced, and Tuolumne counties).

The agricultural industry also has forward economic linkages with local food processing industries, which rely heavily on locally-grown crops. As a result, the regional economy would realize additional economic impacts based on lost production in the food processing sectors that rely on crops produced in the Districts' water service area.[62] Building off the potential impacts at the farm level as estimated by the SWAP model, it is estimated that for every 10 percent reduction in surface water supplies, the regional economy would lose between 140 and 200 jobs along with income losses associated with these jobs. With a 50 percent reduction in water supplies from the Project, approximately 880 jobs and $49.3 million in labor income would be lost within the regional economy based on the slowdown in the food processing sectors (Table 8.3-2).

Table 8.3-2. Annual regional economic impacts from water supply shortages – regional food & beverage processing dependent on crop production in the Districts' water service area ($millions).[1,2,3]

Impact Metric	Water Supply (Percentage of Full Supply)					
	100%	90%	80%	70%	60%	50%
Total Output	$904.50	$834.69	$760.36	$668.84	$573.70	$477.05
Total Labor Income	$173.40	$160.11	$145.83	$128.22	$109.95	$91.52

[61] The analysis assumes no additional groundwater pumping or water transfers to address agricultural water shortages.
[62] The analysis assumes that replacement crops are not available from outside the region to compensate for lost local production. If replacement supplies are available, the potential impacts to the local food processing industry would be attributed to higher costs of raw inputs, primarily due to transportation costs.

Impact Metric	Water Supply (Percentage of Full Supply)					
	100%	90%	80%	70%	60%	50%
Total Employment	3,020	2,787	2,540	2,234	1,915	1,593

Source: Cardno ENTRIX (based on IMPLAN modeling).

1 Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

2 Results represent regional effects in three-county study area (Stanislaus, Merced, and Tuolumne counties).

3 Analysis represents forward-linkage with the key crop production sectors; therefore, results exclude effects in these sectors to avoid double counting.

9.0 SUMMARY & CONCLUSIONS

The Don Pedro Project is essential to the central San Joaquin Valley. The Project's primary purpose is to provide irrigation water to more than 200,000 acres of highly-productive farmland, drinking water to residential and business customers, storage for flood management, recreation, and protection of aquatic resources.[63] In addition, the Project provides important benefits to the Bay Area by allowing operational flexibility in CCSF's water supply system. Any changes in the Project operations which reduce historical water supplies will have important effects on the many uses of Project water. Those changes in turn may have important socioeconomic impacts on many key industries throughout Stanislaus, Merced, and Tuolumne counties, along with the San Francisco Bay Area.

This report provides a baseline against which those impacts can be measured. It demonstrates the economic strength of the area, including the many people and industries which are directly and indirectly affected by the Project. The Project is shown to be a major force by supporting agriculture and many other industries which provide thousands of jobs and millions of dollars of output and income in the central San Joaquin Valley. Many parts of the area are environmental justice communities, and changes in Project operations which result in reduced water supplies for agriculture and other industries can be expected to have adverse effects on those communities and the businesses which serve and are served by them.

9.1 Agriculture

Agriculture has been, and remains, a very important industry, particularly in Merced and Stanislaus counties. Agriculture has been a foundation industry of the San Joaquin Valley for more than 150 years. Agriculture in the area began as land-extensive livestock and grain centric, but with development of groundwater supplies agriculture became increasingly land intensive, however groundwater overdraft was an increasing issue. Development of surface water supplies encouraged additional land cultivation and helped offset the groundwater overdraft problems that resulted from widespread pumping in many parts of the Valley.

Water supply reliability has been a critical issue for agriculture in the San Joaquin Valley. In this respect, the Don Pedro Project has been crucial to the development, directly, of crop and dairy production in the MID and TID service areas. Water supply reliability has been one of the most important factors supporting the large investments made by farmers in such permanent crops as almonds, peaches, and grapes; and in the livestock operations which rely on the associated production of corn silage, alfalfa, and other forage crops.

Agricultural operations in the Districts' service areas represent a cornerstone in the regional economy of Stanislaus and Merced counties. In revenue alone, farmers in the Districts' service areas contribute an estimated $1.2 billion annually directly into the local economy; $527.9 million from crop production and $665.5 million from livestock operations. In addition to supporting about 7,500 on-farm (direct) jobs generating $293.7 million in labor income

[63] Flood control and fishery-related benefits are not included as part of this economic evaluation.

With the development of agriculture has gone the concurrent development of a plethora of industries which both support and are supported by agriculture. Consequently, the estimated $859.1 million in annual gross agricultural production within the Districts' service areas supports an additional $3.2 billion in annual output, taking into account both the industries which support and which are supported by production agriculture. These industries create another 11,400 jobs generating $444.3 million in labor income. Among major employers in Stanislaus and Merced counties, half are directly related to agriculture.

Neither Stanislaus County nor Merced County would have the agricultural strength they have absent the irrigation water provided by the Don Pedro Project. Neither county is capable of being served by the SWP or CVP, and groundwater availability and quality are not sufficient to independently support the large, highly-productive agricultural land base in the area. Thus, Tuolumne River water provided through the Project has been critical to the success of agriculture.

9.2 Municipal and Industrial Use

In addition to agriculture, the Project supplies water to M&I users in both Districts. M&I water demands trace directly to the economic development and job creation characterizing the area. In addition to those presently served, several municipalities within Stanislaus County are seeking Project water as a substitute for ground water supplies. And the CCSF, with water bank credits in the Don Pedro Reservoir, is able to reliably deliver Hetch Hetchy water supplies to 26 water agencies in the Bay Area.

Project water is also integral to conjunctive use programs in the region. Until 1995, all M&I water supplies were taken from groundwater pumping. Concerns over both overdraft and water quality lead to the development of an agreement between MID, whereby the City of Modesto purchases surface water supplies from MID. M&I water demands are likely to increase with further population growth and economic development in the region.

The value of M&I water supplies is less easily estimated than that for agriculture. As noted, farm profit is the difference between gross production value and costs, aggregated over all crops. The value of M&I supplies is not directly measurable and such measurement instead requires estimates of the costs of alternative supplies. Those alternatives may include groundwater, desalination, recycling, or transfers from other areas. Based on those alternatives, Don Pedro M&I water values range from $143 per AF (for groundwater pumping[64]) to $700 per AF, reflecting the estimated WTP by the SFPUC for municipal water supplies.

9.3 Recreation

In addition to consumptive agricultural and M&I water uses, the Project provides unique recreational opportunities in designated recreation areas managed by DPRA. Annual visitation to the Reservoir is in the hundreds of thousands, whose expenditures benefit the entire regional economy. At current estimates of 378,000 visitor days per year, the economic value of recreation to participants is between $19.8 million and $25.4 million per year.

[64] Includes both fixed (capital) and variable (operating) costs associated with groundwater pumping.

9.4 Hydropower Generation

Another of the many important benefits which the Project provides is hydroelectric generation. The facility provides an average of 493,525 MWh of clean, low-cost energy per year. The value of the hydropower produced by the Don Pedro Project is estimated to be $24.7 million annually. It is used by MID and TID to serve 21 communities in their combined service areas. About 80 percent of the electrical accounts are residential or commercial and industrial, with agriculture, municipal and street lighting, and other types making up the remainder. The hydroelectric facility is particularly important in helping to meet peak power needs, especially during high-demand summer days.

9.5 Land Values

Land values, particularly agricultural land values, are affected by the availability of affordable water and electricity from the Project. Irrigators who have access to low-cost and reliable water supplies, other factors equal, will be more profitable than those who do not have such access. The availability of low-cost, reliable water supplies is capitalized into land values because those values frequently reflect the stream of net income available from the land; and because net income is higher, other factors equal, with lower than with higher water prices.

Land values in the Districts' service areas have been relatively stable despite the economic recession, the effects of which have been offset by high crop prices, low interest rates, and available water supplies. Currently, cropland in the Districts' service areas is valued from 30 to 50 percent higher than similar cropland in other districts served by both surface water and groundwater. The land valuation is important in supporting the decisions by irrigators to invest in permanent and other high-value crops that account for such a large part of overall agricultural value in the area.

9.6 Regional Economics

The Don Pedro Project has many positive direct and indirect economic effects on the entire regional economy within Stanislaus, Merced, and Tuolumne counties. With low-cost, reliable irrigation water supplies, it directly supports the vibrant agricultural sector which has evolved in the Districts' service areas. And by extension, it indirectly supports the large agribusiness complex that has developed around crop and dairy farm production, including input suppliers, dairy plants, food processing businesses, and many others. The Don Pedro Project also provides reasonable M&I water supplies that are essential to meet population and business growth in the area. Surface water from the Don Pedro Project in both types of use helps reduce the use of groundwater supplies which have been over-drafted historically.

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STUDY REPORT W&AR-15
SOCIOECONOMICS

ATTACHMENT A

STUDY PLAN VARIANCES

The following is a summary of variances to the Socioeconomics study plan. Some of the data concepts included in the Initial Study Plan have been researched and have been found either to be unavailable at the geographic level of the study, or not essential to the analysis.

Agricultural Water Use

- The study plan stated that surveys of representative growers of principal crops would be administered. At this time, the study team is relying on University of California Cooperative Extension Service (UCCE) crop budgets.
  - Initial concepts included disaggregating each District into several parts, considering differences in soil types, cropping patterns, water supplies, and other factors; and interviewing representative growers of key crops within each disaggregated sector. The study was also to consider the potential for differential impacts on prime farmland, farmland of statewide importance, and similar characteristics.
  - The decision was made to limit the geographical scope to the total District areas. The key financial information required in order to develop and use an agricultural model is farm profitability, based on crop revenues and costs. The main source for production costs are the enterprise budgets prepared by UCCE. Those budgets are typically prepared for multi-county areas and provide no resolution at the sub-county level. Ascribing differences in production costs to differences in soil types, water supplies, and other pertinent factors would have been purely speculative. Consequently, it was decided to use the UCCE budgets, without attempting to modify those studies for smaller geographical areas.
- As a result, the baseline study addresses only total crop acreages at the District level. The impacts analysis, based on changes in water supplies attributable to changes in Project operations, will similarly address only changes in total crop acreages at the District level and will not analyze impacts below that level.

Municipal and Industrial Water Use

- The study plan indicated that all water agencies utilizing District water will be surveyed for information on their water supply portfolios, including the extent of their reliance on Project supplies. It is understood that both the City of Modesto and community of La Grange are served directly by M&I water supplies from the Project. However, because the City of Modesto accounts for over 95 percent of the total M&I use, the M&I analysis is focusing primarily on urban water supplies utilized by the City of Modesto. In addition, the community of La Grange would continue to be served by MID and TID regardless of any changes in operations due to relicensing.

Recreation

- The study plan indicated that data from the Don Pedro Recreation Agency (DPRA) will be used to characterize the extent and types of recreation activity at Don Pedro Reservoir. DPRA does not collect information on individual recreation activities. Instead, information on recreation activities will be based on the results of Study Plan RR-01: Recreation Facility Condition, Public Accessibility, and Recreation Use Assessment.

- The study plan stated that the economic valuation of recreation benefits will utilize “benefit transfer” methodology based on Rosenberger, R. S., and J. B. Loomis (2001), instead more recent data will be used from Loomis (2005).

Environmental Justice

- The study plan noted that data would be collected on local crime rates and health statistics from various sources to ascertain whether environmental justice communities would be disproportionately affected by changes in Project operations. To this point, the data does not appear to exist which would allow correlating either the health statistics or crime rate data to reduced economic health due to reduced water supplies from the Don Pedro Project. Therefore, the study does not attempt to ascertain whether environmental justice communities would be disproportionately affected by changes in Project operations based upon health statistics or crime data.

Other Variances: Schedule

- The study plan indicated that a progress meeting would be held in September 2012, the draft study report would be prepared in October 2012, and the final study report would be complete in December 2012. A progress meeting was held on November 9, 2012. Additional data and reports from external sources were continually received. Both Districts filed 5-year updates to their Agricultural Water Management Plans with the State of California in December 2012. These plans contain a significant amount of up-to-date information on agricultural water use in the two districts. With these reports in hand, along with the data from RR-01, data collection activities are considered complete. Therefore, the draft study report will be filed in the Updated Study Report.

STUDY REPORT W&AR-15
SOCIOECONOMICS

ATTACHMENT B

URBANIZATION OF THE MODESTO IRRIGATION DISTRICT

Urbanization of the Modesto Irrigation District
Modesto, California, USA

Walter P. Ward[1] and William R. Johnston, F, ASCE[2]

Introduction

Irrigation districts in California are local government agencies formed under the California Irrigation District Law of 1887 to provide irrigation and drainage service to land within the boundaries of the districts (CA Water Code, Section 20500). Urbanization of these irrigated agricultural areas creates numerous problems for the districts. In many instances, the district facilities were constructed more than one hundred years ago with no thought of operation within a heavily populated area. This paper describes the type of problems created, the methods used to deal with the problems, and the evolution of the demands for services related to the growth of a large urban community within a well organized and operated irrigation district in central California.

Historical Development

The Modesto Irrigation District (MID) was formed in July 1887 to serve irrigation water to fertile San Joaquin Valley land lying east of the San Joaquin River between the Tuolumne and Stanislaus Rivers (Barnes, 1987; Paterson, 1987). The climate of this part of the valley is characterized by long, hot, dry summers followed by a mild winter during which time the majority of the average annual rainfall of a little more than 30.5 cm (12 in.) occurs. Therefore irrigation is required for the production of crops during the 240 day spring and summer growing season. MID obtains its water from the 4,870 km^2 (1,880 mi^2) Tuolumne River watershed on the western slope of the Sierra Nevada mountain range. At the time of its organization, MID and its partner district Turlock Irrigation District (TID) agreed to divide the Tuolumne River water supply proportioned in accordance with each district's land area at that time. These percentages hold today for MID's irrigation service area of 42.3 ha (105,000 ac.) or 31.54 percent, compared to TID's 68.46 percent, of the total land area within both districts.

<u>Water Rights</u>

The districts have obtained Tuolumne River water rights that were first recorded for mining purposes on January 23, 1855 (Tuolumne County, 1855). Since 1855, the districts have acquired substantial water rights from filings they have purchased from others and from rights obtained from filings with the State of California. The natural runoff pattern of the Tuolumne River is characteristic of the Sierra Nevada watershed, with 60 percent of the average 2,220 x 10^6 m^3 (1.8 x 10^6 ac. ft.) annual flow of the river resulting from snow melt between April and June. Flows greatly diminish during the summer months.

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Physical Facilities

MID, in conjunction with TID, owns and operates La Grange Dam, which was completed in 1893 and still serves as the diversion dam for the districts' two canal systems. The dam is a "Cyclopean rubble masonry" dam standing approximately 39 m (128 ft.) high. The initial construction of the MID canal system began in 1900. The canal system carries water diverted from the Tuolumne River at La Grange Dam under gravity flow into the distribution system.

It soon became clear that water storage would be necessary in order for the district to deliver water throughout a longer growing season so that crops other than wheat could be grown. Consequently, MID constructed Modesto Reservoir, an off-stream storage facility, in 1910. The reservoir increased MID's storage capacity by 34.5 x 10^6 m^3 (28,000 ac. ft.) and allowed the irrigation season to extend further into the summer months.

In 1921, after more than 10 years of planning, MID and TID expanded their water storage with the construction of Don Pedro Dam, located about 5 km (3 mi.) upstream from La Grange Dam. The dam, an 86.6 m (264 ft.) high reinforced concrete gravity dam (the highest concrete gravity dam in the world at that time) with a 15 MW power plant, was officially dedicated on June 25, 1923. The new reservoir was capable of storing 358.2 x 10^6 m^3 (290,400 ac. ft.) of water that allowed the districts to extend the irrigation season into September or early October. However, the occurrence of the six-year drought, 1928-1934, demonstrated that Don Pedro Reservoir did not store sufficient water to meet the needs of the district crops when multiple dry years occurred sequentially.

Consequently, the districts started planning for an even larger storage reservoir. On February 29, 1940, the districts and the City and County of San Francisco (CCSF) agreed to cooperate on any further development of the Tuolumne River. Prior to the time of this agreement, the CCSF had constructed O'Shaughnessy Dam, which created the Hetch Hetchy Reservoir in the Tuolumne River Canyon. New Don Pedro Reservoir was planned as a joint facility to include storage space for the districts and the CCSF, as well as flood control space for the Tuolumne River watershed to be controlled by the U.S. Army Corps of Engineers. Construction on the dam and reservoir, with a capacity 2,504 x 10^6 m^3 (2.03 x 10^6 ac. ft.), was started on September 1, 1967. The dedication was held on May 22, 1971. In addition, a New Don Pedro Powerhouse initially capable of generating 165 MW of power was included in the project. Since the time of the original construction, a fourth turbine unit has been added which results in a total powerhouse capacity of just less than 200 MW.

MID owns, operates, and maintains an irrigation water distribution system consisting of 230 km (140 mi.) of concrete-lined open-channel canals and 65 km (40 mi.) of buried pipeline. Approximately 10% of the 330 km (205 mi.) system remains as unlined earthen channel. In addition, MID has constructed and operates more than 100 ground water wells that are used for water table control purposes and for supplementing surface water supplies in the distribution system.

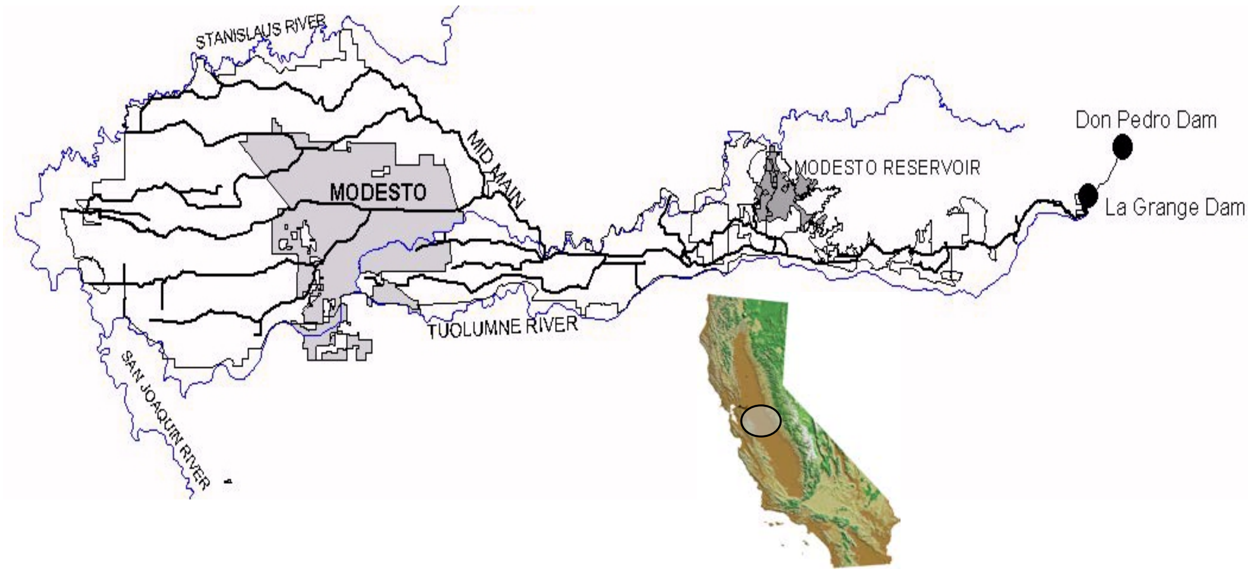

Figure 1. The location of the Tuolumne River, MID storage facilities, the primary components of the canal distribution system, and the irrigation service area.

Population Growth

The MID service area has changed over time from a primarily agricultural, rural setting in 1900 to one that in 1999 encompasses a large urban area, the city of Modesto. The urbanized area is intimately linked to the local agribusiness-based economy. The city of Modesto, with the motto "Water, Wealth, Contentment, Health," has grown from a small 7.3 km^2 (2.8 mi^2) community in 1900 to a large 92.5 km^2 (35.7 mi^2) city in 1999. The population of the city of Modesto has increased from approximately 2,000 people in 1900 to more than 180,000 people in 1999.

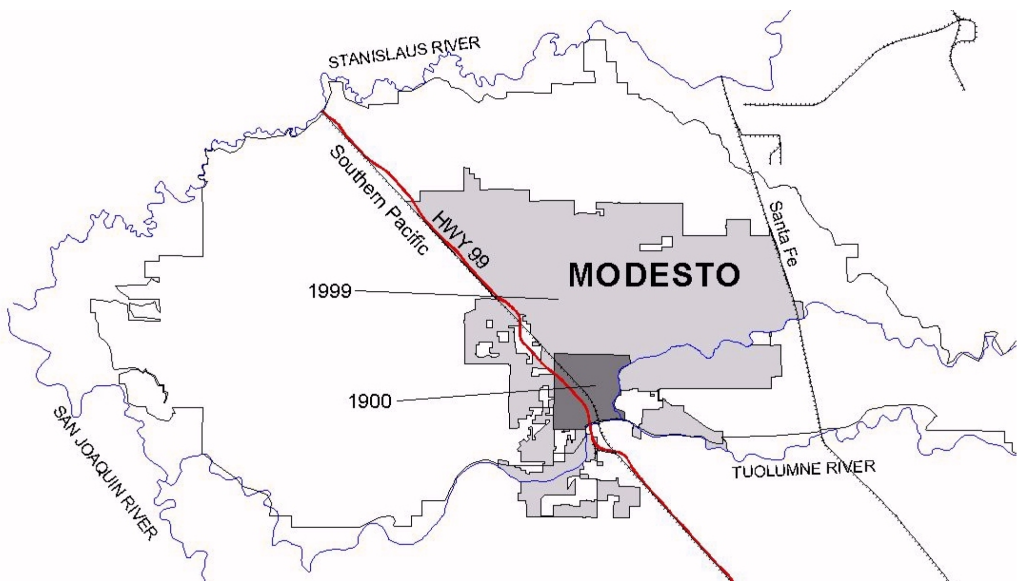

Figure 2. The size of the urban area within the Modesto Irrigation District, 1900 and 1999.

The MID encompasses a 42.3 x 10^3 ha (105,000 ac.) service area with 25 x 10^3 ha (62,000 ac.) of land under active irrigation. The increase in the size of the urban area, from less than three percent of the irrigated area to over 35% in the last 100 years, has caused numerous challenges for the MID. The urban growth challenges involve, but are not limited to, the following:

- Public Safety and Rights-of-Way
- Roadways, Railroad and Urban Expansion
- Water Scheduling and Delivery
- Municipal and Industrial Water Supply
- Groundwater Management
- Storm Water Conveyance
- Protection of Fish and Wildlife
- Recreation

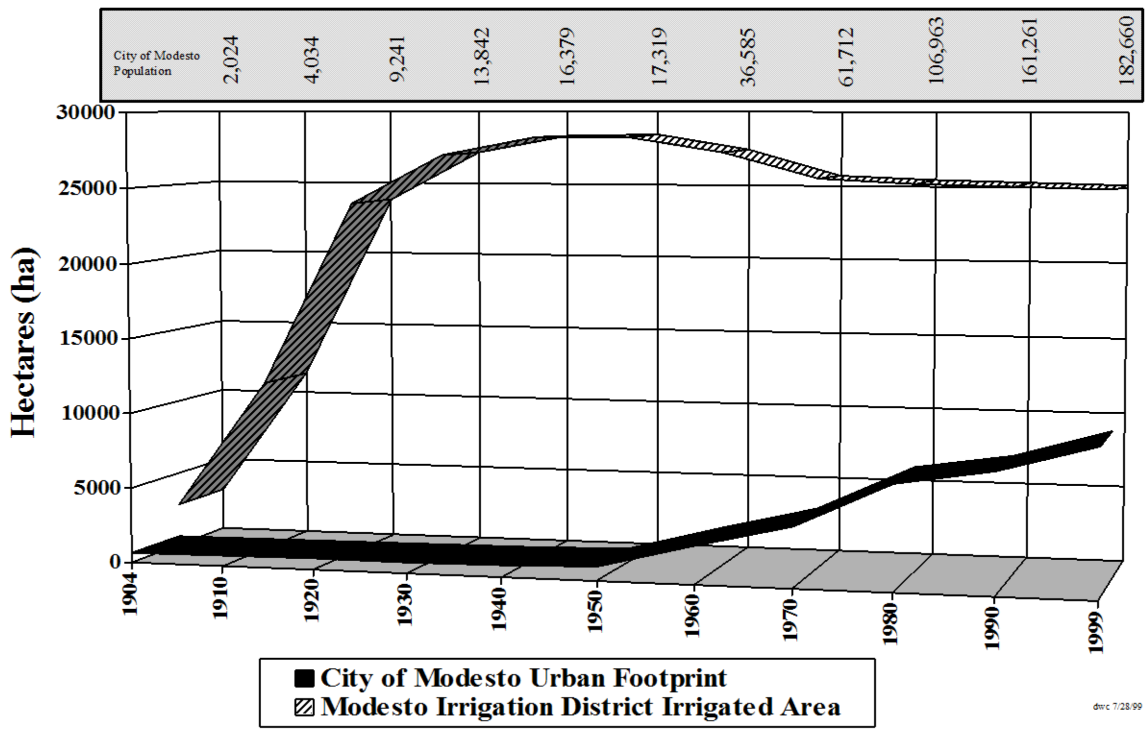

Figure 3. Change in the size of the city of Modesto urban area compared to the irrigated area within the MID over the last 100 years.

Urban Growth Issues

Public Safety and Rights-of-Way

The MID canal system is perceived by the public to be public land. This leads to an expectation of free and unobstructed access to these properties for recreational purposes such as jogging, bike riding and swimming, none of which are authorized by MID. Public access to these properties poses problems for MID from an operations and maintenance perspective as well as public safety aspect. Over the last ten years, the MID has installed hundreds of roadway gates to prevent vehicular access, grates to block siphons under roadways and crossing railings to help protect the public. There are signs posted at every MID facility warning the public to not trespass. Over the years there have been numerous drownings and personal injuries due to the public encroachment and public use of MID facilities.

In addition, the public has used MID rights-of-way to illegally dump materials such as garbage, abandoned or stolen vehicles, bicycles, household appliances and hazardous materials. In response to public comments and complaints, MID has increased its field activities of wintertime canal cleaning, roadway grading and nuisance weed abatement programs over the years to a higher level of maintenance than would otherwise be required for solely operational purposes. All of these activities significantly affect MID's cost of operations, maintenance and insurance.

Roadways, Railroad and Urban Expansion

Two major railroad lines, the Southern Pacific and Santa Fe, cut across the MID service area from north to south. These two railroads effectively split the MID service area into a western agricultural area, a central urban area, and an eastern agricultural area. A major state roadway, Highway 99, splits the district in half, roughly along the urban corridor. All of the surface water must move from east to west, across and through the central urban area. In addition, many city and county roadway expansions have caused the re-alignment of the water distribution system and forced many miles of canal underground. The development of housing and commercial areas has caused the removal of some parts of the distribution system and major re-alignments in other areas where irrigated parcels remain within an area that is undergoing urban transition.

Water Scheduling and Delivery

Historically, water has been delivered to crops within MID by gravity under flow conditions of about 425 L/s (15 cfs). The delivery of water to the irrigation accounts has changed over time due to a number of factors relating to urban growth in the Modesto area. Most notable has been the increase in travel time for the field staff (ditchtenders) to move from one area of the district to another. The time it takes to switch a head of water from one irrigator to another irrigator can be delayed due to the time it takes for the water to move through the urban area. Historically, the water would have been handed off to the next farmer in rotation. Operational improvements to the canal system, in the form of automated operation of major diversion heads and telemetered pump operation through a centralized Supervisory Control and Data Acquisition system, have improved delivery efficiency and response time. The increase in travel time has also resulted in the need to re-align the ditchtender areas to take into account the heavily traveled and congested urban area.

Over time the average size of an irrigated parcel has declined because of the urbanization of farm land. This has also caused problems related to ordering and scheduling water delivered under high flow conditions, especially with smaller and mixed-sized parcels. The smaller irrigated parcels, less than five acres, are called "garden heads." The scheduling and delivery of water to these parcels is every other weekend. Garden heads are not part of the normal irrigation rotation or call on demand. Because of the general inexperience of the "weekenders," many parts of the delivery system are subject to losses due to breaks and leaks caused by inappropriate operation of the system, such as air hammer from opening or closing gates too quickly. These breaks in the system require a high level of maintenance that can result in delays of water deliveries at important times of the growing season.

Municipal and Industrial Water Supply

The municipal and industrial water demand in MID is continuing to increase as the city of Modesto and other small cities within the district grow. The cities have historically relied on groundwater as their sole source of drinking water supply. As agricultural lands have converted to urban use over the last half-century, MID decided that it would be resource-efficient to serve the growing demand for potable water with water that was previously delivered for agricultural purposes and on land that was previously farmed (URS Consultants, 1990). Additionally, certain instances of groundwater contamination and changes in federal and state drinking water standards have led to a desire to provide municipal users an alternative drinking water supply. In response to these concerns and to secure a long-term, sustainable supply of high quality drinking water for the city and surrounding environs, MID began treating and delivering municipal and industrial water to the city of Modesto in late 1994. The Tuolumne River source water, of superior quality, is treated in MID's 114 x 10^6 L/day (30 x 10^6 gal/day) ozone disinfection treatment plant and delivered to the city of Modesto through a 29 km (18 mi.), 152 cm (60 in.) diameter pipeline. The treated surface water, which has a total dissolved solids concentration of less than 30 ppm, is mixed with ground water pumped from the City's wellfield after entering the distribution system operated by the City. MID is currently investigating the expansion of its municipal water treatment facilities to provide additional treated surface water to Modesto and other municipal water users in its service area to meet the continued growth of the urban area.

Groundwater Management

Throughout most of the history of the city of Modesto, drinking water has been provided through the operation of a City-owned and operated wellfield. More than 100 domestic water production wells are in existence today, distributed throughout the City area. Over time, the wellfield operations have caused a significant cone of depression in the water table. This decline in water level has resulted in increased operational costs and has caused the migration of poor quality water and contamination into the city's drinking water supply.

MID relies upon groundwater as a back-up irrigation supply source during periods of drought and as a supplemental source of water to augment surface water supplies under routine operations. It can be shown, from both a water quality and volumetric perspective, that the majority of the water stored in the aquifer system in the Modesto Basin is MID delivered surface water that has been incidentally recharged through deep percolation of applied irrigation water and seepage from Modesto Reservoir over the last 100 years.

Because of the increasing demand for domestic water due to urban growth in the area and the need to ensure that the groundwater resources of the Modesto Basin are properly managed for current and future uses, MID led the formation of the Stanislaus and Tuolumne Rivers Groundwater Association. MID developed and adopted a groundwater management plan for the Modesto Basin under the guidelines of California Assembly Bill 3030 (CA Water Code, Section 10750). The initial phase of the groundwater management plan, which has been completed and formally adopted by MID, summarized existing groundwater management practices and hydrogeologic characteristics of the basin (MID, 1996). The next phase of the plan includes the development of an ambient groundwater monitoring network to measure spring and fall water levels and the development of a three-dimensional, calibrated groundwater model for the basin. This model is one tool among others to be used to actively pursue a conjunctive use program that may involve artificial recharge to supplement the recharge that has historically occurred through deep percolation of applied irrigation water.

Storm Water Conveyance

The rainy season in Modesto occurs generally from November to March. The active irrigation season runs generally from mid-March to mid-October. Therefore, during the late fall and winter, the canal distribution system is not carrying irrigation water. Most of the canal maintenance work is performed during this outage period. Also, because this same time period corresponds with the rainy season, the canal distribution system has increasingly been relied upon by the City as a means of conveying storm water runoff. However, the movement of storm water through the system is problematic from an operations and maintenance perspective due to reduced downstream canal conveyance capacity.

The irrigated area of the MID reduces the further one travels downstream in the system. Therefore, the size of the irrigation canals and laterals decrease because there is less and less land to irrigate. Therefore, the conveyance capacity decreases downstream in the canal distribution system. Ideally, a storm water collection system should be designed with an increasing downstream flow capacity. For example, during the 1998 El Niño water year, when more than 66 cm (26 in.) of rain fell in the Modesto area, the conveyance capacity of the canal and underground piping system was exceeded. Significant street and open property flooding occurred on the east side of Modesto due to the lack of a comprehensive storm water collection and conveyance system.

In addition, there is concern over the quality of the water entering the MID canal system from City pavements and adjacent urban areas. To address this concern, the City is required to provide pre-treatment detention and to monitor the water quality before discharging into the canal system.

Protection of Fish and Wildlife

The competition for Tuolumne River water for irrigation and domestic water supplies, for the production of electrical energy and for instream fish flows, evolved early in the districts' efforts to secure a license to operate the Don Pedro Project as a hydroelectric facility. To date, competition for the use of Tuolumne River water has primarily been among basin users and uses. However, a fisheries turmoil throughout the State of California has led to an identification of various proposed means to reverse recent declines of certain species of fish. Those measures include looking towards the Tuolumne River, and other rivers, for additional flow for environmental purposes beyond the geographical confines of the lower Tuolumne River. Noteworthy among the forums potentially affecting the Tuolumne River is current regulatory action by the State Water Resources Control Board concerning implementation of the 1995 Water Quality Control Plan for the Bay-Delta Estuary and ongoing Endangered Species Act considerations. These processes could potentially call for additional water flows from the Tuolumne River which would only increase the keen competition that already exists for its limited resource.

Recreation

MID and TID, in partnership with the City and County of San Francisco, govern the Don Pedro Recreation Agency at Don Pedro Reservoir. Recreational activities at Don Pedro Reservoir include boating (ranging from personal watercraft to houseboats), water skiing, camping (tent and RV), fishing and hiking. Recreation opportunities exist above and below Don Pedro Reservoir. The recreation activities available in the Tuolumne River basin include white water rafting, boating, hiking, swimming and fishing. The varied uses can conflict with each other in terms of optimal flow conditions supporting each use, as well as water quality concerns, such as the presence of coliform bacteria and the gasoline additive MTBE. Fundamentally, there is an inherent conflict between reservoir recreation and lower Tuolumne River releases. The more water is released for lower river purposes, including incidental recreation, the greater the potential impact to reservoir recreation. There has been an increasing demand for the use of the facilities and services at Don Pedro Reservoir as the population in the Central Valley and Bay Area has continued to grow.

Conclusion

MID's first 100 years have been full of many challenges due to urban growth. These challenges brought changes to MID water operations that have enabled us to successfully survive as an irrigation district into the 21st Century. Success has also meant increased customer expectations for broader and expanded services, to which challenge MID has delivered. MID has and will continue to contribute significantly to the economic stability and prosperity in the region through the delivery of high quality water and expanded water operations services. The MID water operations mission is to responsibly manage the water resources of the district to provide a safe, reliable and sustainable water supply for the agricultural and urban community for future generations.

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ATTACHMENT C

DETAILED AGRICULTURAL STATISTICS

Table C-1 Harvested acreage in Stanislaus County, by crop and year (2007-2011).

Crop	2007	2008	2009	2010	2011	Normalized Average [1]
Almonds, all	118,000	128,598	134,003	145,000	150,000	135,867
Apples, all	919	824	807	1,140	772	850
Apricots, all	4,600	824	4,429	5,621	4,680	4,570
Beans, blackeye (peas)	560	870	1,684	2,620	4,950	1,725
Beans, dry, edible unspecified	440	580	1,122	1,760	205	714
Beans, fresh, unspecified	2,450	1,759	5,486	8,750	4,110	4,015
Beans, lima, baby dry	2,400	1,550	2,995	4,660	6,830	3,352
Beans, lima, large dry	8,000	6,700	12,912	20,100	11,500	10,804
Broccoli, unspecified	2,490	2,817	4,974	7,670	5,810	4,534
Cauliflower, unspecified	678	315	686	756	674	679
Cherries, sweet	1,890	4,498	2,554	3,630	3,160	3,115
Citrus, unspecified	341	2,348	430	428	487	448
Corn silage	63,200	71,764	80,505	88,700	91,500	80,323
Field crops, seed, miscellaneous	529	520	767	560	889	619
Field crops, unspecified	1,088	1,676	2,200	2,890	3,390	2,255
Fruits and nuts, unspecified	1,040	1,694	6,458	5,690	7,220	4,614
Grapes, unspecified	10,700	11,223	10,602	10,700	11,000	10,667
Hay, alfalfa	33,400	35,330	41,810	45,800	40,400	39,180
Hay, grain	30,100	0	0	0	41,500	10,033
Hay, other unspecified	0	38,530	45,345	59,200	13,500	32,458
Hay, sudan	4,300	3,506	4,460	5,510	5,740	4,757
Melons, cantaloupe	1,250	1,402	1,400	1,520	1,810	1,441
Melons, honeydew	0	200	200	150	387	183
Melons, unspecified	142	139	268	100	182	154
Melons, watermelon	79	0	0	0	0	0
Nectarines	199	0	0	0	0	0
Nursery products, miscellaneous	370	458	763	594	477	510
Nursery, fruit/vine, nut non-bearing	2,302	2,048	975	1,050	762	1,358

Crop	2007	2008	2009	2010	2011	Normalized Average [1]
Nursery, woody ornamentals	402	503	484	454	488	475
Pasture, irrigated	33,700	33,700	33,700	33,700	33,200	33,700
Pasture, range	441,000	441,000	441,000	441,000	436,000	441,000
Peaches, clingstone	6,905	7,018	6,998	7,320	7,350	7,112
Peaches, freestone	835	900	879	735	736	817
Potatoes, sweet	682	949	1,225	1,430	1,480	1,201
Pumpkins	110	78	153	181	150	138
Rice, milling	1,520	2,065	1,600	1,600	1,590	1,597
Silage	47,440	50,490	58,744	57,900	69,500	55,711
Spices and herbs	491	0	0	0	0	0
Spinach, unspecified	3,700	1,352	5,257	6,790	3,320	4,092
Squash	347	342	1,547	2,190	600	831
Tomatoes, fresh	2,020	1,241	4,434	6,520	2,620	3,025
Tomatoes, processing	17,000	15,238	24,237	32,600	27,400	22,879
Vegetables, unspecified	3,537	2,850	2,259	3,300	3,385	3,178
Walnuts, English	27,800	28,276	29,628	32,000	31,900	29,935
Wheat, all	1,600	1,544	2,395	3,030	3,460	2,342
Total, including non-irrigated pasture and range	**880,556**	**918,942**	**982,375**	**1,055,349**	**1,035,114**	**967,258**
Total, excluding non-irrigated pasture and range	**439,556**	**477,942**	**541,375**	**614,349**	**599,114**	**526,258**

Source: Stanislaus County Agricultural Commissioner 2007-2011.

[1] Normalized figures are found by summing across all years, subtracting the maximum and minimum values, and computing a simple average of the remaining 3 years' data. Simple average is used if less than 5 years of data available.

Table C-2 Harvested acreage in Merced County, by crop and year (2007-2011).

Crop	2007	2008	2009	2010	2011	Normalized Average [1]
Almonds, all	87,881	92,662	94,635	98,900	98,500	95,266
Apricots, all	1,123	1,019	807	413	349	746
Barley, feed	3,514	2,380	0	0	0	1,179
Barley, unspecified	0	0	3,185	4,060	2,290	3,178
Beans, dry, edible unspecified	505	0	0	0	0	101
Beans, lima green	2,308	1,659	1,479	992	524	1,377
Beans, lima, large dry	2,670	0	2,259	1,820	1,280	1,606

Crop	2007	2008	2009	2010	2011	Normalized Average [1]
Berries, strawberries, unspecified	97	93	70	74	82	83
Corn silage	85,160	94,423	97,880	90,100	87,963	90,829
Corn, grain	10,674	12,294	10,826	12,100	16,000	11,740
Cotton lint, unspecified	49,190	35,010	23,385	39,300	55,600	41,167
Field crops, seed, miscellaneous	2,920	3,323	5,626	5,070	3,613	4,002
Field crops, unspecified	0	0	3,040	3,220	0	1,252
Figs, dried	1,729	1,542	1,572	980	950	1,365
Fruits & nuts, unspecified	0	0	1,959	2,180	0	828
Grapes, raisin	640	607	569	551	544	576
Grapes, wine	9,819	11,075	11,317	11,200	11,600	11,197
Hay, alfalfa	84,056	84,523	90,551	84,200	76,700	84,260
Hay, grain	33,302	38,820	40,461	36,100	32,800	36,074
Hay, sudan	6,555	8,626	10,104	9,710	9,940	9,425
Melons, cantaloupe	3,997	4,633	5,678	6,350	4,530	4,947
Melons, unspecified	0	0	2,084	3,400	2,000	1,497
Nursery products, miscellaneous	911	89	1,428	1,320	1,392	1,208
Pasture, forage, miscellaneous	20,997	11,895	10,851	12,441	27,600	15,111
Pasture, irrigated	38,961	37,864	30,719	30,700	26,600	33,094
Pasture, range	569,615	569,615	569,828	567,000	562,000	568,743
Peaches, clingstone	3,248	3,036	2,749	2,630	2,410	2,805
Peaches, freestone	1,786	1,864	1,836	1,880	1,760	1,829
Pistachios	3,967	4,256	4,411	4,450	5,160	4,372
Plums, dried	1,737	1,753	1,753	1,710	1,650	1,733
Potatoes, sweet	12,183	13,711	16,361	16,500	16,700	15,524
Rice, milling	2,858	2,529	2,455	2,500	2,260	2,495
Silage	62,257	74,324	78,311	70,600	66,200	70,375
Sugar beets	2,300	3,701	0	0	0	1,200
Tomatoes, fresh	9,761	10,177	10,987	8,610	6,520	9,516
Tomatoes, processing	18,200	16,214	21,000	20,600	13,000	18,338
Vegetables, unspecified	0	0	3,615	3,420	0	1,407
Walnuts, English	5,773	5,699	5,612	5,330	5,150	5,547
Wheat, all	6,094	9,954	11,420	11,900	16,700	11,091
Total, including non-irrigated pasture and range	**1,146,788**	**1,159,370**	**1,180,823**	**1,172,311**	**1,160,367**	**1,167,082**
Total, excluding non-irrigated pasture and range	**577,173**	**589,755**	**610,995**	**605,311**	**598,367**	**598,338**

Source: Merced County Agricultural Commissioner 2007-2011.
[1]Normalized figures are found by summing across all years, subtracting the maximum and minimum values, and computing a simple average of the remaining 3 years' data. Simple average is used if less than 5 years of data available.

Table C-3 Total acres of crop land, MID, by crop and year (2007-2011).[1]

Crop	2007	2008	2009	2010	2011	Normalized Average
Alfalfa	3,541	3,328	3,328	3,002	2,501	3,219
Almonds	18,791	19,206	19,122	19,900	20,304	19,409
Apples	49	49	49	49	47	49
Apricots	32	32	32	25	25	30
Beans, dry	135	12	12	156	231	101
Berries	33	42	42	8	8	28

Crop	2007	2008	2009	2010	2011	Normalized Average
Cherries	345	387	387	390	496	388
Garden, other	32	38	36	28	31	33
Grain, barley	55	55	55	0	0	37
Grain, corn	490	431	431	880	1,072	600
Hay, grain	6,707	6,936	6,933	2,825	2,710	5,489
Grain, oats	1,124	1,218	1,218	519	517	954
Grain, other	5	11	11	0	0	5
Grain, wheat	5	118	118	36	38	64
Grapes, table	32	32	32	1	1	22
Grapes, wine	1,481	1,318	1,315	1,348	1,262	1,327
Lawn, garden	344	352	351	290	153	328
Melons, watermelons	3	3	3	3	0	3
Miscellaneous	46	46	22	118	221	70
Nursery stock	102	83	83	111	113	98
Open land	523	525	515	430	628	521
Other fruit and nut trees	183	194	194	286	621	225
Pasture, dry	6	6	6	9	8	6
Pasture, irrigated	8,570	8,528	8,526	7,723	5,849	8,259
Peaches, clingstone	2,962	2,867	2,842	2,456	2,176	2,722
Peaches, freestone	27	20	20	27	39	25
Pumpkins	0	0	0	6	6	2
Rice	321	348	348	476	481	391
Seed, other	1	1	1	1	1	1
Silage, corn	9,354	9,536	9,536	13,816	13,664	10,912
Strawberries	21	21	21	16	16	19
Hay, sudan	113	321	321	756	779	466
Trees, Christmas	45	45	45	0	0	30
Vegetables	919	919	919	1,045	1,046	961
Walnuts	7,748	7,765	7,735	7,712	7,671	7,732
Total-Irrigated	***64,137***	***64,786***	***64,602***	***64,441***	***62,707***	***64,518***
Total-Non-Irrigated	***6***	***6***	***6***	***9***	***8***	***6***
Total	**64,143**	**64,792**	**64,608**	**64,449**	**62,715**	**64,525**

Source: MID 2013a.
[1] Includes double cropping.

Table C-4 Total acres of crop land, TID, by crop and year (2007-2011).[1]

Crop	2007	2008	2009	2010	2011	Normalized Average
Alfalfa	9,735	10,472	10,236	9,274	8,971	9,748
Almonds	44,238	44,324	44,967	44,399	45,163	44,563
Apples	648	561	612	485	496	556
Apricots	2	2	2	2	2	2
Beans, dry	188	119	106	375	212	173
Berries	0	4	0	0	0	0
Cherries	525	477	431	497	410	469
Citrus	8	0	8	8	8	8
Clover	333	302	321	122	135	253
Corn (incl. double crop and irrigated silage)	45,486	45,756	38,457	42,052	46,287	44,431

Crop	2007	2008	2009	2010	2011	Normalized Average
Grain	0	0	0	13	46	4
Grapes	1,641	1,840	1,657	1,708	1,570	1,669
Hay, sudan	436	715	612	639	364	562
Irrigated pasture	9,047	7,734	7,390	7,308	6,569	7,477
Kiwi	14	9	14	14	22	14
Lawn & garden	1,293	1,213	1,332	1,434	1,396	1,340
Melons	103	39	121	25	80	74
Oats (including double crop)	38,641	37,386	24,318	25,601	23,912	29,102
Olives	0	5	72	72	125	50
Onions	0	0	0	20	0	0
Other crops (including double crop)	11,017	13,781	28,832	22,565	16,582	17,642
Other fruit and nut trees	392	464	411	444	467	439
Peaches	4,363	3,722	4,218	3,149	3,418	3,786
Pears	7	7	7	7	0	7
Peas	0	10	0	0	0	0
Plums	18	3	3	3	3	3
Pumpkins	43	83	63	58	127	68
Sunflowers	0	0	0	0	8	0
Sweet potatoes	995	1,214	1,619	1,561	1,723	1,465
Tomatoes	0	0	0	0	7	0
Unirrigated forage	1,166	1,918	8,454	9,935	13,486	6,769
Walnuts	4,771	4,803	4,739	4,679	5,218	4,771
Total - Irrigated	***173,944***	***175,045***	***170,547***	***166,514***	***163,320***	***168,677***
Total - Non-Irrigated	***1,166***	***1,918***	***8,454***	***9,935***	***13,486***	***6,769***
Total	**175,110**	**176,963**	**179,001**	**176,449**	**176,806**	**175,446**

Source: TID 2013b.
[1] Includes double cropping.

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STATEWIDE ECONOMIC ANALYSIS (IMPLAN) – RESULT TABLES

1.0 Introduction

This section presents the results of the statewide economic analysis using IMPLAN. It builds off of the information presented in Section 6, *Regional Economic Analysis*, but captures the economic effects generated at the state level (inclusive of the three-county study area) from activities supported by the Don Pedro Project.

The direct impacts of the statewide analysis are the same as the three-county direct impacts, as the analysis conservatively does not consider animal production or food and beverage processing located outside of the three-county region that may depend on crops produced with the Districts' water (i.e., no forward-linkages for industries located outside the three-county area are estimated). As processing sectors outside the three-county area likely depend on crop production from the Districts service area, this statewide analysis is expected to underestimate the statewide economic contribution of the Don Pedro Project. Despite this, compared to the local impacts, the state-wide indirect and induced impacts are larger due to the increased number and size of economic linkages between all sectors in the state economy compared to the local economy (i.e., the larger the economic area, the larger the economic multiplier effect).

Similar to the model of the three-county area, to avoid double counting, the purchase of crops, dairy, and cattle products is adjusted to ensure that production of these commodities is counted only as a direct impact and not again as an indirect impact.

2.0 Result Tables

Table D-1. Annual statewide economic benefits – crop production, Districts' water service area.1

Metric	Direct	Indirect	Induced	Total
Output ($Millions)[2]	$527.9	$317.9	$341.5	**$1,187.2**
Labor Income ($Millions)[2]	$171.7	$123.7	$115.1	**$410.5**
Employment	4,380	3,050	2,300	**9,730**

Source: Cardno ENTRIX and Highland Economics (based on IMPLAN modeling).
Results represent annual effects statewide, including the three-county study area (Stanislaus, Merced, and Tuolumne counties).
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).

Table D-2 Annual statewide economic benefits by industry – crop production, Districts' water service area.[1]

Industry	Total Output (millions, 2012$)[2]	Total Labor Income (millions 2012$)[2]	Total Employment (full and part-time jobs)
Agriculture	$616.4	$237.7	6,470
Mining	$3.3	$1.2	10
Construction	$8.4	$3.6	50
Manufacturing	$93.8	$10.5	140
TIPU	$39.2	$13.0	190
Trade	$58.7	$28.0	560
Services	$351.5	$110.1	2,250

Industry	Total Output (millions, 2012$)[2]	Total Labor Income (millions 2012$)[2]	Total Employment (full and part-time jobs)
Government	$15.9	$6.4	60
Total	**$1,187.2**	**$410.5**	**9,730**

Source: Cardno ENTRIX and Highland Economics (based on IMPLAN modeling).
[1] Results represent annual effects statewide, including the three-county study area (Stanislaus, Merced, and Tuolumne counties).
[2] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
TIPU = Transportation, Information, and Public Utilities

Table D-3. Annual statewide economic benefits – dairy cattle production, Districts' water service area.[1,2,3]

Metric	Direct	Indirect	Induced	Total
Output (millions, 2012$)	$537.4	$364.4	$119.5	**$1,021.3**
Labor Income (millions, 2012$)	$23.6	$78.8	39.8	**$142.2**
Employment (full and part-time jobs)	2,270	1,620	830	**4,720**

Source: Cardno ENTRIX and Highland Economics (based on IMPLAN modeling).
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
[2] Results represent annual effects statewide, including the three-county study area (Stanislaus, Merced, and Tuolumne counties).
[3] Analysis represents additional forward-linkage impacts of agricultural crop production; therefore, results exclude effects in crop production sectors (already estimated above in Table 6.3-1) to avoid double counting.

Table D-4. Annual statewide economic benefits –cattle ranching production supported by crops from Districts' water service area.[1,2,3]

Metric	Direct	Indirect	Induced	Total
Output (millions, 2012$)	$128.1	$107.7	$31.5	**$267.4**
Labor Income (millions, 2012$)	$7.2	$20.0	$10.5	**$37.7**
Employment (full and part-time jobs)	620	550	220	**1,390**

Source: Cardno ENTRIX and Highland Economics (based on IMPLAN modeling).
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
[2] Results represent annual effects statewide, including the three-county study area (Stanislaus, Merced, and Tuolumne counties).
[3] Analysis represents forward-linkage with cattle production; therefore, results exclude effects in the cattle sector to avoid double counting.

Table D-5. Annual statewide economic benefits – regional food & beverage processing dependent on crop production in the Districts' water service area.[1,2,3]

Metric	Direct	Indirect	Induced	Total
Output (millions, 2012$)	$569.1	$380.2	$219.5	**$1,168.8**
Labor Income (millions, 2012$)	$87.0	$112.3	$72.9	**$272.2**
Employment (full and part-time jobs)	1,050	1,650	1,510	**4,210**

Source: Cardno ENTRIX and Highland Economics (based on IMPLAN modeling).
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
[2] Results represent annual effects statewide, including the three-county study area (Stanislaus, Merced, and Tuolumne counties).
[3] Analysis represents forward-linkage with key crop production sectors; therefore, results exclude effects in those sectors to avoid double counting.

Table D-6. Statewide economic benefits – regional food & beverage processing dependent on dairy cattle production in the Districts' water service area ($millions).[1,2,3]

Metric	Direct	Indirect	Induced	Total
Output (millions, 2012$)	$787.6	$427.0	$234.3	**$1,449.0**

Metric	Direct	Indirect	Induced	Total
Labor Income (millions, 2012$)	$71.8	$113.0	$78.0	**$272.2**
Employment (full and part-time jobs)	1,060	1,690	1,620	**4,370**

Source: Cardno ENTRIX (based on IMPLAN modeling).
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
[2] Results represent annual effects statewide, including the three-county study area (Stanislaus, Merced, and Tuolumne counties).
[3] Analysis represents forward-linkage with the dairy production sector; therefore, results exclude effects in the dairy production sector to avoid double counting.

Table D-7. Annual statewide economic benefits – regional food & beverage processing dependent on cattle production in the Districts' water service area.[1,2,3]

Metric	*Direct*	*Indirect*	*Induced*	*Total*
Output (millions, 2012$)	$119.8	$110.3	$41.8	**$271.8**
Labor Income (millions, 2012$)	$11.8	$22.0	$13.9	**$47.7**
Employment (full and part-time jobs)	270	580	290	**1,140**

Source: Cardno ENTRIX and Highland Economics (based on IMPLAN modeling).
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
[2] Results represent annual effects statewide, including the statewide study area (Stanislaus, Merced, and Tuolumne counties).
[3] Analysis represents forward-linkage with cattle ranching; therefore, results exclude effects in the cattle ranching sector to avoid double counting.

Table D-8. Statewide economic benefits – manufacturing sector in City of Modesto water service area.[1,2,3,4]

Metric	Direct	Indirect	Induced	Total
Output (millions, 2012$)	$5,319.9	$2,945.1	$2,215.3	**$10,480.4**
Labor Income (millions, 2012$)	$715.3	$942.3	$763.8	**$2,421.4**
Employment (full and part-time jobs)	11,220	12,790	15,070	**39,080**

Source: Cardno ENTRIX (based on IMPLAN modeling using 2010 data).
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
[2] Results represent annual effects statewide, including the three-county study area (Stanislaus, Merced, and Tuolumne counties).
[3] Manufacturing sector includes food processing; therefore, results cannot be combined with those presented in Tables D-4 and D-5.
[4] Analysis includes backward-linkages to agricultural and livestock production sectors; therefore, cannot combine results with Tables D-1 and D-3.

Table D-9. Statewide economic benefits – recreation visitation at DPRA.[1,2]

Metric	Direct	Indirect	Induced	Total
Output (millions, 2012$)	$8.8	$4.0	$5.3	**$18.1**
Labor Income (millions, 2012$)	$3.1	$1.4	$1.8	**$6.3**
Employment (full and part-time jobs)	110	20	40	**170**

Source: Cardno ENTRIX (based on IMPLAN modeling).
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
[2] Results represent annual effects statewide, including the three-county study area (Stanislaus, Merced, and Tuolumne counties).

Table D-10. Statewide economic benefits – hydropower generation at the Don Pedro Project ($millions).[1,2]

Metric	Direct	Indirect	Induced	Total
Output	$24.7	$2.3	$7.5	$34.5
Labor Income	$7.5	$0.8	$2.5	$45.3
Employment	30	10	50	90

Source: Cardno ENTRIX (based on IMPLAN modeling).
[1] Monetary values reported in constant 2012 dollars adjusted using the California Consumer Price Index (CPI).
[2] Results represent annual effects statewide, including the three-county study area (Stanislaus, Merced, and Tuolumne counties).