Agricultural Water Offset Program
Paso Robles Groundwater Basin
San Luis Obispo County

Abstract: The Ag Water Offset Program (Ag Offset Program) provides a framework for processing 1:1 irrigated water offset projects in areas reliant upon groundwater within the Paso Robles Groundwater Basin (PRGWB) and to satisfy County ordinance #3246. The Ag Offset Program incorporates the best existing, local, public data in an attempt to encompass a myriad of application types and potential future water use demands. Additionally, the program design supports the ability to quantify and track new irrigated agriculture within the PRGWB through the use of Geographic Information Systems (GIS) and an existing database reliant upon groundwater well, parcel, and water use information to provide opportunities for evaluation and verification of the program goals over time.

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Agriculture Water Offset Program
for the
Paso Robles Groundwater Basin

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Acronyms

AC	Acre
AWOP	Agriculture Water Offset Program
AF	Acre-feet
AFY	Acre-feet per year
BMP	Best Management Practice
CIMIS	California Irrigation Management Information System
DWR	Department of Water Resources
ER	Effective rainfall
ETc	Crop evapotranspiration
ETo	Reference evapotranspiration
FAO	Food and Agricultural Organization of the United Nations
FP	Frost Protection
GIS	Geographic Information System
IE	Irrigation Efficiency
LR	Leaching requirement
NOAA	National Oceanic Atmospheric Administration
RCD	Resource Conservation District
PRGWB	Paso Robles Groundwater Basin
Q	Pumping rate
S	Drawdown
SLO	San Luis Obispo
T	Transmissivity
WPA	Water Planning Area
W(u)	Well function

AGRICULTURAL WATER OFFSET PROGRAM

1 PURPOSE

The program framework allows landowners to establish new or expanded agriculture with an understanding that offsetting water use credits strictly satisfy a 1:1 water use ratio. Project proposals must demonstrate the credit consists of physical water[1] and the quantity of the credit must be at least equal to the quantity of the new water use subject to the requirements set forth by the Ag Offset Program.

1.1 Objective

The objective of the Ag Offset Program is to provide a framework for processing 1:1 irrigated water offset projects. As with any program, there are parameters related to the type and scope of projects that will meet program objectives. This section outlines the program parameters and a water credit allotment process.

1.2 Applicability

This program applies to New Irrigated Agricultural Development (see definitions section 1.3) overlying the Paso Robles Groundwater Basin which includes the following:

a. Irrigated agricultural crop conversions;
b. New irrigated agricultural development on previously un-irrigated land;
c. Replanting of existing irrigated crops (of the same crop type) where the replanting results in an increase of crop density or other modification that leads to increased water use (e.g. change in irrigation system or cropping patterns)(see section 4 for more information);
d. Non-Commercial small-scale agriculture for rural residential users.

This program does not apply to new or expanded agricultural reservoirs. Water loss impacts due to evaporative losses from agricultural reservoirs are assessed and approved under a separate County process.

1.3 Definitions

Adjacent / Contiguous property – Properties that share a parcel boundary or are separated by a public right-of-way.

Ag Water Offset Program (AKA. Offset Program)- provides a framework for processing 1:1 irrigated water offset projects in areas reliant upon groundwater within the Paso Robles Groundwater Basin (PRGWB) and to satisfy County ordinance #3246.

Applied Crop Water Demand – The pre-defined amount of applied water expressed in af/ac/yr for a specific crop type.

Area of Severe Decline – The area defined as having a drop in water level of 50-feet or greater since 1997 as shown on the County's annually updated and published basin decline map.

Benefiting/Receiving site – The property(s) where the new or expanded agricultural use is proposed.

[1] Physical water equates to actual water that has been applied for beneficial use within the past five years.

Best Management Practice (BMP) - Voluntary efficiency measures that are intended to save a quantifiable amount of water, either directly or indirectly, and can be implemented within a specified timeframe.

Crediting Site – The property(s) where the Offset Credit will be obtained from.

Crop Type – The categorized grouping of similar crops exhibiting similar water demand characteristics. (Alfalfa, Nursery, Pasture, Small Grains, Citrus, Deciduous, Strawberries, Vegetables, Vineyard).

Current irrigated acres – Agricultural crop acres irrigated in 2008 to date.

Conversion of Dry Farm or Grazing Land to New Irrigated Crop Production - The conversion of a site that had been used for the purposes of farming a crop, orchard, vineyard or other agricultural product without using irrigation, or for the purposes of raising or feeding of beef cattle, sheep, or goats by grazing or pasturing between 2003 - 2013, to new or expanded irrigated crop production. The ten year timeframe includes such time the site was fallow, in rotation but not planted, or covered under a conservation plan prepared as part of the Conservation Reserve Program.

Crop Conversion – The replanting of previously irrigated lands with a different crop type.

Deed Covenant – A legally binding document recorded against a parcel specifying restrictions, limitations, and/or conditions regarding use of the property.

Drawdown Calculator – A calculator created for this program which computes impacts to neighboring wells and the allowable distance that an offset credit be applied.

Ministerial Permit - Any County action, permit, or approval which requires the County, including any Board, Commission, or Department of the County and any official or employee of the County, to determine merely whether there has been compliance with applicable statues, ordinances, regulations or conditions of approval.

Net Agricultural Acreage – The on-site area of planted irrigated crops excluding perimeter roads or buffers and agricultural roads 16-feet wide or greater but including between row spaces.

New or Expanded Irrigated Crop Production - The development, new plantings, or other improvements of a property for the purposes of farming the following, including but not limited to, grains, field crops, vegetables, melons, fruits, tree nuts, flower fields and seed production, ornamental crops, tree and sod farms, other crops, orchards, vineyards or other agricultural products using irrigation. This includes increasing the density of any existing irrigated crop production. This does not include planting of annual or rotational crops where those crops have been planted within the last five years on a site.

Non-Commercial Small-Scale Agriculture- Agricultural rural groundwater uses that are not included in the County's rural domestic offset program (e.g. irrigated domestic livestock pastures, hobby orchards or vineyards). The San Luis Obispo County domestic offset program allows for a maximum permitted irrigated landscape area of 1,000 square feet of immediate exterior to dwelling, assuming 10% turf, and using a total of 170 gallons per dwelling unit per day of irrigation water.

Offset Clearance - A ministerial permit that may be granted by the Director of the Planning and Building pursuant to this Ordinance if the requirements of this Ordinance are met.

Parcel – A legal lot of record.

Paso Robles Groundwater Basin - The groundwater basin encompassing an area of approximately 505,000 acres (790 square miles) that extends from the Garden Farms area south of Atascadero to San Ardo in Monterey County, and from the Highway 101 corridor east to Shandon excluding the Atascadero sub-basin

Safe Yield/Perennial Yield – The amount of usable water of a groundwater basin that can be withdrawn and consumed economically each year for an indefinite period of time. It cannot exceed the sum of the natural recharge, artificial recharge, and incidental recharge, without causing depletion of the basin.

Similar Hydrogeological Strata - Wells completed in the same geological formation (e.g. Paso Robles Formation), that have similar depth ranges (e.g. 400 – 600 feet below ground surface), that have similar water levels and water quality, or that have similar water bearing strata that is likely to be hydraulically connected.

Site – Contiguous acreage under the same ownership.

Subbasin – A portion of a basin that can be subdivided for hydrologic study purposes. Hydraulically, a sub-basin is interdependent on the basin as a whole, but is locally independent of pumping depressions and recharge effects. The Atascadero sub basin is the only sub basin identified in the Paso Robles Groundwater Basin

Neighboring Well– All wells on immediately adjacent properties, and at minimum includes at least one domestic and one agricultural well determined to be in closest proximity to the receiving property.

Water Allotment – The annual maximum amount of water, expressed in acre-feet, permitted to be used on a property approved through the Agricultural Offset Program.

Water Conservation Plan (WCP) – A farm scale conservation plan that assesses a farm's water resource challenges and opportunities and identifies appropriate water conservation practices. Water conservation plans are often a sub-document within a Farm Conservation Plan that holistically and systematically inventories soil, water, habitat and other natural resources and may also include single practice, engineered designs and specifications for operational improvements to achieve over time.

Water level drawdown - The difference between the static water level when the well is not being operated for at least 4 hours and the water level when the impacting well serving the new use is being operated.

2 APPLICATION CONTENT

The application for an offset clearance shall include any information deemed necessary by the County to determine whether or not the specified criteria below can be met. This shall include at minimum the information listed below:

a. Address and APN for crediting and receiving parcels.
b. Owners contact information and signatures.
c. Current and requested acreage and crop identification (written information & graphical map required).
d. Crediting and receiving well data.

e. Requested offset category/type (crop conversion, new irrigation, density increase, etc.).
f. Well location sub area(s).
g. Well Maps for crediting, receiving, and neighboring wells
h. Title reports or other proof of ownership for all parcels included on the application

3 REVIEW FOR COMPLIANCE

Each Offset application will be reviewed for compliance with the Offset Program criteria listed herein. Applications deemed to be compliant with the standards of this program will require that deed covenants be recorded against each participating property detailing the approval criteria for each Offset Clearance. Applications that are deemed to not comply with the provisions of this program will be denied. Denied applications may be resubmitted with modifications to attain compliance.

4 ON-SITE MODIFICATIONS THAT INCREASE WATER USE

This section lists standards for Offset Clearance for on-site modifications that lead to increased water use which include, but are not limited to, the following:

a. Increased density of existing crop type that may lead- to an increase in water use per acre
b. Modifications to irrigation type that may result- in potential increased water use (e.g. Drip to microsprayer or sprinkler)
c. Operational changes that may result in increase applied water use

Applications for the above modifications shall be processed similarly to Category 1 Offset requests with the exception of the Maximum Net Acreage calculation. Maximum Applied Water Allotments shall be used as a qualifying factor instead, as described in section 6. The following criteria shall be applied:

4.1 Offset Approval Criteria

a. Determination of Maximum Applied Water Allotment.
b. Deed Covenants
c. Installation of Flow Meter(s)

4.2 Verification of Proposed Applied Water Rate

In addition to the basic program standards listed in this section, applications for on-site modifications where no expansions to existing crop acreage is proposed shall include verification that the proposed crop, irrigation, and/or management modifications can maintain the calculated maximum applied water amount using the medium value in Table 2. Verification shall be prepared by a qualified professional and shall include:

a. Calculated maximum applied water use value
b. Analysis of irrigation system and verification that the proposed watering schedule and method will comply with the annual water use restrictions.
c. Analysis of property management strategies and/or combined consumptive agricultural uses that may affect overall water use

5 NEW IRRIGATED ACREAGE AND/OR CROP CONVERSIONS

Offset applications for new irrigated agriculture are divided into four (4) categories based on the characteristics of the application and the complexity of review necessary for Offset Clearance approval.

Program requirements for each category are listed below and expanded on in further sections of this document.

5.1 Category I - Same Property, Same Well

Category I applies when the offset credit is derived from the same property and the same well. This typically applies to crop conversions from higher water use crops to lower water use crops.

Offset Approval Criteria:

a. Determination of Maximum Net Acreage
b. Deed Covenants
c. Installation of Flow Meter(s)

5.2 Category II - Credit from Different Well to a Well on the Same Property

Category II applies when the offset credit is derived from a different well on the same property. This could apply to crop conversions that result in allowed expansion or relocation of crops to a different area of the property.

Offset Approval Criteria:

a. Determination of Maximum Net Acreage
b. Hydrogeological Strata Analysis
c. Neighboring Well Impact Analysis
d. Deed Covenants
e. Installation of Flow Meter(s)

5.3 Category III - Credit from a Different Well Located on an Adjacent Property

Category III applies when the credit is derived from a different well located on an adjacent parcel either under the same or different ownership.

Offset Approval Criteria:

a. Determination of Maximum Net Acreage
b. Hydrogeological Strata Analysis
c. Neighboring Well Impact Analysis
d. Landowner Agreements
e. Deed Covenants
f. Installation of Flow Meter(s)

5.4 Category IV - Credit from a Non-Adjacent Property

Category IV applies in cases where the offset credit is coming from a property that is not adjacent to the receiving site either under the same or different ownership.

Offset Approval Criteria:

a. Determination of Maximum Net Acreage
b. Hydrogeological Strata Analysis

c. Neighboring Well Impact Analysis
d. Landowner Agreements
e. Proximity Analysis
f. Deed Covenants
g. Installation of Flow Meter(s)

6 DETERMINATION OF MAXIMUM NET ACREAGE AND APPLIED WATER ALLOTMENT

For the purposes of the Agricultural Offset Program, the crop categories and water use values presented in Tables 1 and 2 are used to determine the potential credit and/or amount of credit needed to satisfy the requirements of this program. Water credits for new agricultural uses are calculated by taking the total net acres of previously irrigated crops and multiplying it by the medium applied water value listed in Table 2 below. The total acres of new irrigated crop(s) is calculated by taking the water credit amount and dividing it by the medium applied water value for the new crop as listed in Table 2. Likewise, this calculation can be done in reverse to determine the amount of water credits needed for a particular proposal for new irrigated crops. Applicants who wish to provide evidence of greater water use for an alternative water credit amount can opt to petition for a special consideration following the standards outlined in Section 11 of this program.

This section also applies to applications where acreage is not increased but modifications to on-site crop patterns or management strategies that increase overall applied water use are proposed. For these types of applications, the maximum applied water allotment rather than acreage becomes the qualifying factor for issuance of an Offset Clearance.

Table 1. *Crop Group and Commodities Used for the Agricultural Demand Analysis*

Crop Group	Primary Commodities
Alfalfa	Alfalfa
Nursery	Christmas trees, miscellaneous nursery plants, flowers
Pasture	Miscellaneous grasses, mixed pastures, sod/turf, sudangrass
Small Grains	Oats, barley, wheat
Citrus	Avocados, grapefruits, lemons, oranges, olives, kiwis, pomegranates (non-deciduous)
Deciduous	Apples, apricots, berries, peaches, nectarines, plums, figs, pistachios, persimmons, pears, quinces, strawberries
Strawberries	Strawberries
Vegetables	Artichokes, beans, miscellaneous vegetables, mushrooms, onions, peas, peppers, tomatoes

Vineyard	Wine grapes, table grapes

If a proposed crop is not specifically named within the above categories, evidence of crop water use specific to the North County region must be submitted and reviewed by the County to determine the most appropriate crop category to use for the application.

Table 2. *Crop-Specific Applied Water (af/ac/yr) by Crop and Water Planning Area*

Crop	Ranges	Applied Water
		Salinas/ Estrella WPA
Alfalfa	Low	3.8
	Medium	4.5
	High	5.2
Citrus	Low	1.9
	Medium	2.3
	High	2.7
Deciduous [2]	Low	3.0
	Medium	3.5
	High	4.1
Strawberries[3]	Low	2.0
	Medium	2.3
	High	2.6
Small Grains[3]	Low	1.0
	Medium	1.2
	High	1.4
Nursery	Low	2.0
	Medium	2.5
	High	2.9
Pasture [2]	Low	4.2
	Medium	4.8
	High	5.5
Vegetables[1]	Low	1.6
	Medium	1.9
	High	2.2
Vineyard	Low	1.4
	Medium	1.7
	High	2.1

[1] Assumes two vegetable crops planted per acre per year.

[2] Values for Deciduous crops and Pasture are modified from the values presented in the MWR and are calculated based on original data used to prepare the MWR.

[3]Information obtained from Current Cost and Return Studies, UCCE, UC Davis (Small grains 2013 data, Strawberries 2011 data) (see Appendix A for more information)

6.1 Applicability of Applied Water Values for Determining Offset Approval

All offset applications will be evaluated using the medium applied water value for crediting site and receiving site crops except where special considerations are requested per section 11 of this program.

6.2 Calculating Water Credit Amount / Water Allotment

To determine the amount of water available for use in the Ag Offset Program, the number of current irrigated crop acres is multiplied by the applied water use value for the specific crop using the values in Table 2 above. This will provide the maximum amount of available water from the crediting site expressed as acre-feet per year (af/yr).

Example: Maximum amount of water available from 100 acres of Alfalfa

(100 acres of Alfalfa) x 4.5 af/ac/yr (from table 2) = 450 af/yr

This number will provide the qualifying criteria for projects where acreage remains constant but crop density and/or operational modifications are made that may affect overall water consumption.

6.3 Calculating Maximum New Irrigated Crop Acreage

To determine the acreage of new irrigated crop permitted through the Ag Offset Program, the maximum amount of available water from the crediting site is divided by the applied water use value for the new crop type to be established at the receiving site. This will determine the number of acres available to plant from the crediting agricultural development.

Example: Conversion of 100 acres of Alfalfa to Vineyard

450 af/yr (from above equation) / 1.7 af/ac/yr (from table 2) = 264.7 acres of potential new irrigated vineyard

7 HYDROLOGIC STRATA ANALYSIS

The proposed offset credit source shall be derived from a well that is open to similar hydrogeological strata as the receiving well. Similar hydrogeological strata means that both wells are completed in the same geological formation (e.g. Paso Robles Formation), have similar depth ranges (e.g. 400 – 600 feet below ground surface), have similar water levels and water quality, or similar water bearing strata that is likely to be hydraulically connected. Either of the below listed methods may be used to determine compliance with this requirement.

7.1 Standard Assumptions

If well is less than 200 feet deep, assume the well is completed in alluvium. If the well is greater than 200 feet deep, assume it is completed in the Paso Robles Formation.

7.2 Optional Detailed Analysis

If detailed strata data is available for both the receiving and crediting site, the following information can be provided as proof that the receiving and crediting wells are completed in the same strata. Supplemental information shall require peer review by a County agent at the cost of the applicant.

a. Well log/report indicating strata type, or
b. Report prepared by a licensed hydrogeological or geological professional

8 NEIGHBORING WELL IMPACT ANALYSIS

The applicant shall demonstrate that active wells (irrigation and domestic) located near the receiving well will not be significantly impacted by the additional water level drawdown caused by the receiving well based on the following (See Appendix C for additional detail):

8.1 Submittal Content

a. Well location sub area(s)
b. Map of Wells
c. Distances to Neighboring Wells
d. Neighborhood Notification
e. Flow Rate and Hours of Operation Per Day

8.2 Extent of Analysis Required

As impacts are assumed to lessen as the distance from the receiving well increases, the analysis shall include wells that are located on properties adjacent to the receiving site and shall include at minimum one agricultural well and one domestic well located in closest proximity to the receiving well regardless of whether the well(s) is located on an adjacent property.

8.3 Impact on Neighboring Well Calculation

The calculation method described in Appendix C shall be used to compute the amount of drawdown that may occur in each neighboring domestic and irrigation well as summarized below.

8.3.1 Calculation Method – Well Data Available

If detailed well and pump information is submitted from a neighboring property owner(s), a well specific analysis shall be completed by a qualified professional to determine the impact based on the criteria listed in Section 8.4 consistent with the methodology established in Appendix C. A peer review may be required. Any peer review shall be at the cost of the applicant.

8.3.2 Calculation Method – No Well Data Available

If more detailed information is not supplied from the owners/operators of the wells within the identified properties of impact within the prescribed time frame, the applicant shall use the standard drawdown calculator as described in Appendix C and as provided on the County website at sloplanning.org.

8.4 Determination of Drawdown Significance

Once the level of drawdown in the neighboring well has been calculated, the next step in the process is to evaluate the significance of the water level drawdown impact on neighboring wells.

8.4.1 Eligibility Criteria- Well Data Available

Where detailed well data is available, the analysis of potential impact shall be performed by a hydrogeologist or other qualified professional. A peer review of submitted information may be required. Any peer review shall be at the cost of the applicant. The following eligibility criteria apply:

a. New pumping at the benefiting/receiving well shall not increase the drawdown of neighboring wells by 20%, or

b. Water level drawdown in the impacted well shall not drop below the pump intake or well screen.

8.4.2 Eligibility Criteria- No Well Data Available

Where no neighboring well specific data is received within the listed comment period, the standard drawdown calculator method shall be used and the following criteria shall apply:

a. For domestic wells, the calculated water level drawdown at the impacted well is greater than 15 feet, or

b. For irrigation wells, the calculated water level drawdown at the impacted well is greater than 30 feet.

8.5 Impact of Multiple Well Use

The use of multiple wells to serve the proposed new agricultural use can have an additive effect on the drawdown at a neighboring well and therefore must be considered in the impact evaluation. To evaluate this impact, the amount of water level drawdown at the neighboring well produced by each new well is added together. For example, analysis using data supplied by neighboring well owners/operators is first used to estimate the drawdown at neighboring wells caused by each receiving site well. All resulting drawdown estimates are added together to determine the total drawdown impact caused by all receiving site wells. Likewise, if using the Drawdown Calculator, the sum of the values generated for each of the receiving wells is added together to determine the total impact.

8.6 Failure to Meet Neighboring Well Impact Analysis Criteria:

If the calculated water level drawdown exceeds the drawdown criteria, the offset clearance will be denied unless the application can be modified to lessen the impact of the proposed well(s) serving the new use. The County will hold the application open for 60 days. If at the end of the 60-day period the applicant cannot provide a passing impact analysis using the new data, the application will be denied and closed. Options may include:

a. Contacting the neighboring well owners for more specific information to determine if the impact is valid.
b. Revising the application to reduce the impact below the level of significance by modifying the pumping rate and/or duration to reduce impacts to neighboring wells. This will be peer reviewed by the County and/or their designated agent to ensure feasible operational values are represented.
c. A request for Special Consideration pursuant to Section 11

8.7 Pumping Rate and Duration Established

The ability to meet criteria related to neighboring well impacts is based on specification of well pumping rates and durations. A copy of proposed well operation criteria used to meet this requirement will be kept on file with the County and shall be reviewed annually through the 3rd party verification process to determine compliance with the program.

9 OFFSET DISTANCE ANALYSIS

The proposed offset well location(s) must be within the cone of depression formed by the well serving the new use based on the parameters defined below. If the resulting water level recovery at the credit well

location falls within the cone of depression of the pumping well serving the new use, the proposed offset credit is assumed to benefit the aquifer and offset the new use. Following are the criteria for applying the offset distance analysis.

9.1 Offset Distance Calculation

The allowable distance that the offset credit may be applied is calculated using the method described in Appendix D for all applications where the receiving and benefiting site are not adjacent. A calculator to determine this value can be found on the County website at sloplanning.org.

9.2 Approval Criteria

The following criteria shall be met by all applications where the receiving and benefiting site are not adjacent.

a. The crediting well(s) must be within the radius formed by the calculated cone of depression for the benefiting well as defined using a 2-foot drawdown value to determine the extent of the acceptable radius.
b. The proposed offset application must comply with section 10 (Areas of Severe Decline).

9.3 Exemptions to Offset Distance Requirements

Transfers of credits from an area of severe decline to an area not listed as such shall be exempt from all of the Offset Distance requirements.

9.4 Impact of Multiple Well Use

Multiple wells pumping to serve the new use may expand the radius of the allowable offset distance. This analysis requires additional groundwater expertise and qualifying criteria. Applicants wishing to expand the radius based on multiple well use at the receiving site must adhere to the requirements listed in Section 11 (Special Considerations).

10 Areas of Severe Decline

No offset credits shall be permitted to be transferred from non-severe decline areas to areas of severe decline. Areas of severe decline shall be defined as noted above in section 1.3 (Definitions). A map of this area shall be published annually by the County of San Luis Obispo based on analysis of basin decline using the most current monitoring well data available.

11 Special Considerations

If an applicant wishes to apply alternative criteria to their offset application, they may elect to request a review for special considerations subject to the following standards and processes. Any technical documentation submitted will required a peer review by the County's agent. Peer review shall be completed at the cost of the applicant.

11.1 Review Authority

Requests for special considerations shall be reviewed and approved by the County. Special consideration requests requiring a high level of specialized technical review will be analyzed by an approved county contractor (e.g. agricultural engineer, hydrogeologist) at the cost of the applicant.

11.2 Applied Water Rate Adjustment

Water rates may be adjusted to a maximum of the high applied water value as listed in Table 2 for crediting well locations allowing for increased irrigated acreage for new agriculture.

11.2.1 Approval Criteria

Approval of requests shall be subject to providing all of the following as proof of historic higher water use amounts:

a. Aerial Photo Documentation

Aerial photo documentation 5-years from the date of Urgency Ordinance adoption (2008 to 2013) showing the area where the crop was grown.

b. Flow Meter Data

Flow meter data at the crediting well location(s) documenting water use 5-years from the date of Urgency Ordinance adoption (2008 and 2013).

c. Pump Efficiency/ Power Usage

A pump efficiency/power usage report will be required to verify expressed previous water use (AF/KWH). Report must be prepared by an Agricultural Engineer or other qualified professional and shall include the following components:

i. An analysis of water usage for the period between 2008 and 2013 utilizing calculated values obtained through confirmed well pump electrical data and a water to wire efficiency analysis that relates KW usage and pumping rate.
ii. Documentation that the water was applied efficiently using best available water management practices for that particular crop. Documentation shall include, but is not limited to, details of how water is applied (including type of irrigation system), how water application is controlled, and irrigation scheduling.

11.2.2 Properties Containing Ag Ponds/ Reservoirs

Sites with ponds are ineligible from this special consideration category due to evaporative water losses, which cannot count toward actual crop application.

11.3 Alternative Neighboring Well Impact Analysis Consideration

If compliance with the neighboring well impact criteria cannot be met, the applicant may enter into agreements with landowners of properties where the impact occurs. Such agreements shall include the following:

a. Acknowledgement from the neighboring landowner that impacts may occur from the establishment of the new use, and
b. Statement that the neighboring landowner accepts the possibility of potential future impacts, and
c. The agreements shall be recorded against the Offset project parcel(s) and the potentially impacted neighboring property(s).

11.4 Alternative Offset Distance Analysis

Because the proximity distance radius for determining eligibility for the program for Category IV applications is calculated using the County's offset distance calculator, detailed analysis using greater technical methods or data shall comply with the following.

11.4.1 Refinement of Aquifer Parameters

Substitution of standardized aquifer parameters using more specific basin data will require that the applicant request a special consideration for the application. Such application requests shall be reviewed based on the following:

a. Aquifer Parameters
Updated estimate of aquifer parameters including transmissivity and storativity shall be used to provide alternative analysis to the standard calculator. These updated values must be based on site specific aquifer tests performed by a qualified groundwater professional.

b. Technical Analysis
Analysis shall be completed by a technical professional with special technical expertise in the Paso Robles Groundwater Basin. The applicant will fund the County's peer review and approval of the technical report.

c. Proximity Radius Calculations
Calculations of proximity radius shall be consistent with the calculation methodology used in the County's standardized calculator.

11.4.2 Expansion of Distance Radius Due to Multiple Well Locations at the Receiving Site

Multiple wells pumping to serve the new use may expand the radius of the allowable offset distance. This analysis requires additional groundwater expertise and qualifying criteria. Applicants wishing to expand the radius based on multiple well use at the receiving site shall comply with the following.

a. Technical Analysis
Documentation and analysis analyzing aquifer characteristics and the effective additive value of multiple well locations at the receiving site shall be prepared by a qualified professional. Distance analysis must use the same methodologies as described in Appendix D as applicable.

b. Peer Review Required
Documentation submitted shall require peer review by the County's contractor to determine if the above conditions meet the requirements of this section at the expense of the applicant.

11.5 Unique Case Study Projects

The County may elect to accept case study applications under the Agricultural Offset Program that allow for exceptions to the Maximum Acreage determinations set forth in section 6 where landowners/operators agree to provide real-time site information to facilitate expanded research and data collection goals that will also improve the program efficiency subject to the following:

a. Water Use Allotment Enforced
The calculated water use offset allotment shall be enforced and adhered to for all case study applications.

b. Data Collection Required

All participating properties must install real time automated data measurements systems and data must be uplinked to the County and/or their agent to allow for enhanced research and data collection. At a minimum, the following shall be included for case study projects:

i. Published flow meter data (to public) that is overseen by 3rd party
ii. Utilizes conservation technology and demonstrates results
iii. A Water Conservation Plan prepared for the irrigated acreage within the scope of the Special Consideration project boundary
iv. Significant additional data collection may be required based upon proposal

Additional data measurements may be included at the discretion of the County and shall be provided as specified to provide benefit to the larger agricultural industry.

c. Signed Agreement

A signed agreement with the County shall be recorded against the property deed outlining the specifics of the data sharing and case study status requirements.

d. Failure to Comply

Failure to comply with the maximum water allotment may result in required reduction of planted crop acreage or other enforcement action.

12 ISSUANCE OF OFFSET CLEARANCE

If all criteria listed in the program can be met, an offset clearance shall be issued by the County. The offset clearance shall be subject to the below criteria. Annual renewal of an issued Offset Clearance shall be required as described in section 15.

a. Landowner Agreements and Deed Covenants

Agreements and Deed Covenants shall be submitted per the requirements of section 13 for all legal lots of record participating in the Ag Offset Program.

b. Flow Meter Installation

A flow meter shall be installed for each well included on an offset application per the requirements of section 14.

c. Annual Monitoring and Verification

All benefiting and receiving well locations shall be monitored and water use shall be verified per section 15 of this program.

13 LANDOWNER AGREEMENTS AND DEED COVENANTS REQUIRED

13.1 Deed Covenants

All properties included in an offset clearance application for either crediting wells or receiving wells shall include a deed covenant recorded against the property, regardless of whether or not the properties are owned by the same entity or person. Deed covenants shall be in a form approved by the County and the County shall be a party to the agreement by reference. Amendments to the agreements shall be prohibited without written County approval. Each covenant shall include at minimum the following information:

a. Approved Total Maximum Water Allotment

b. Approved Maximum Acreage
c. Approved Crop Type(s)with acreages for each listed if more than one crop type is approved
d. Identification of properties participating in the Offset Clearance (crediting and/or receiving sites)
e. Acknowledgement of Annual Verification Requirements and Renewal of Offset Clearance (annual application fees required)
f. Annual Verification Schedule and Annual Reporting due date
g. Acknowledgement of consequences for failing to meet reporting deadlines and/or approved Offset criteria
h. Statement of County control over document content and acknowledgement that amendments cannot be made without written county approval.
i. Nullification Language (see section 13.3)

13.2 Property Owner Agreements

A notarized signed copy of the agreement for transfer of offset credits between participating private landowners shall be submitted to the County for maintenance in the application file. The County will ensure that participating landowners list the credit amount and agree to supply the credits in perpetuity, or until the basin reaches a level 1 or better severity ranking (also see section 12.3.2). Agreements shall also acknowledge annual reporting requirements and grant access to well locations as applicable.

13.3 Release of Deed Covenant

Deed Covenants related to approval of an Offset Clearance may be released subject to the following:

a. Nullification Language for Deed Covenants

Language shall be included in each deed covenant releasing all participating properties from the requirements and restrictions of the Ag Offset Program if the basin reaches a level 1 severity rating or better as declared by the County Board of Supervisors.

b. County Authority to Release Covenants

The County shall have the ability to release recorded agreements and covenants if a crop or crops are removed from a receiving site, or water use is returned to what it was prior to offset being applied, based on a written request from the receiving site landowner.

c. Superseding Documents

Superseding documents shall be recorded for all modifications to the property requirements with the exception of the level of severity 1 declaration. Modifications to recorded documents shall require County approval.

14 Flow Meter Installation Required

All approved Offset Clearance applications will require that a flow meter be installed on all crediting and benefiting wells with the following exceptions:

14.1 Wells Removed from Service or Reduced in Service at Crediting Sites

Wells to be removed from or reduced in service at crediting locations where land will be fallowed in order to generate a credit shall employ one of the following methods:

d. Well Destroyed/ Decommissioned

Destruct well as per County Health Department protocol, if not offering as monitoring well as per 8.40 of the County Code.

e. Inoperative Well

A well is considered inoperative when the pump has been removed, the crop irrigation system is disconnected, or the power source is removed. Documented proof of these actions must be provided in the annual verification report submitted by the 3rd party.

f. Flow Meter Installed

A flow meter may be installed on the crediting well location as proof of water savings. Documented proof of these actions must be provided in the annual verification report submitted by the 3rd party. This option is required where a crediting well will remain in partial service.

d. Monitoring Well Location

The well may be offered for use as a County groundwater level monitoring well by following County process for such.

15 ANNUAL REPORTING AND WATER USE VERIFICATION

15.1 Annual Renewal of Offset Clearance

An Offset Clearance shall be renewed annually concurrent with the annual reporting process. An application for Offset Clearance Renewal shall be submitted with the annual verification report and shall include an application fee. Failure to submit the annual clearance renewal application, application fee, and or annual verification report shall be subject to the provisions listed in section 16.

15.2 Annual Reporting Schedule

All flow meters for participating properties shall be read during the months of Oct 1- Dec 1 for each year. Verification reports shall be submitted to the County no later than December 1. Participant reports that have been enrolled in the program less than 6 months shall be submitted for the following year. If any of the participating properties are found to be in non-compliance with the requirements of the program, reporting shall be made in accordance with section 16.

15.3 Annual Reporting Criteria

The following standards shall apply to all required Ag Offset Program reporting:

15.3.1 Report Preparation

All reports shall be prepared by a qualified 3rd party to assess the below listed items. The County may assess fees or take enforcement actions against those who fail to report according to these standards.

15.3.2 Required Information

The following required information shall be included in all Offset verification reports:

a. Amount of water approved with the offset clearance, and
b. Current and past meter reading, and
c. A map showing where water was applied and which crop was grown (verification of acreage), and
d. Verification of wells not in service or in partial service at crediting location(s), and
e. Statement of compliance with the approved offset clearance

16 PROPERTIES IN NON-COMPLIANCE

Properties found to be out of compliance with the approved offset clearance are subject to enforcement action, including administrative fines, and may be subject to a probationary period as determined by the County. If it is determined that the owner is not taking steps to reduce irrigation water use and/or target water use values are not achieved, additional actions may be enforced per section 22.74.010 et seq.

16.1 Probation Period

Participants in the program found to be out of compliance with the approved offset clearance may be given up to 12-months to bring the subject well locations into compliance subject to the below standards. The County shall have the authority to forgo the probationary period or end the probationary period at any time and take any enforcement action deemed necessary to bring about compliance.

16.2 Reporting Standards for Non-Complying Properties

The following standards shall be met for all non-compliant properties during the probation period:

16.2.1 Water Conservation Plan Required

Participants will be required to develop and implement a water conservation plan (WCP) to meet their water requirement goals (See definitions, Section 1.3). At a minimum, the WCP shall include the following:

a. Analysis of operational practices resulting in excess water consumption, and
b. Analysis of projected target water use values, and
c. A discussion of operational and/or irrigation modifications needed to achieve the reduced water use goals (BMPs), and
d. Schedule for implementation of infrastructure and/or operational improvements.

16.2.2 Timing

A WCP shall be submitted within 30 days of County notification of non-compliance.

16.2.3 Quarterly Reporting Required

Quarterly reports shall be submitted by a 3rd party verifier throughout the probation period to determine if water use reduction strategies and operational changes are being implemented in order to comply with the Ag Offset Program and that progressive actions toward the participants Water Conservation Plan are being met.

16.3 Extension of Probationary Period

If at the end of the prescribed probationary period the property remains out of compliance but all efforts have been made to reduce water use and a qualified professional determines that compliance can be achieved by the next reporting cycle, the County may grant an extension to the probationary period. All reporting requirements shall be consistent with those listed above in section 16.2.

16.4 Assessment of Fines

If at the end of the prescribed probationary period, or at any point in time during the probationary period, it is determined that the owner is not taking steps to reduce irrigation water use and/or target water use values are not achieved, fines shall be assessed consistent with section 22.74.010 of the County Code.

16.5 Reduction of Approved Acreage

If compliance cannot be achieved at any point in time, the County shall have the authority to reduce the number of acres approved through the Offset Clearance.

a. Acreage shall be determined based on current water use levels to achieve the approved water allotment amount, and
b. Superseding deed covenants shall be recorded against the property(s) listing the revised acreage, and
c. All crops shall be removed from the excess acreage within 60 days of the recordation of the superseding document.

17 NULLIFICATION OF PROGRAM

If at any point in time beyond the approval date of the Ag Offset Program the basin is certified at a level I severity or better, this program shall become null and void and all restrictions on applied irrigation for participating properties shall be negated. This language will be reinforced for offset credit transactions recorded in property deeds. It is important to note that the process for basin severity ranking follows a scientifically based, data intense process and must be ratified by the County Board of Supervisors.

18 CONSISTENCY WITH COUNTY DOCUMENTS, RULES, AND PROCEDURES

All applications for an Agricultural Offset Clearance must be consistent with the Land Conservation Act and the County's Rules and Procedures. No application shall be approved which conflicts with any applicable Federal, State, or County regulation.

19 SEVERABILITY

If any provision of this program or its application to any person or circumstance is held invalid, the remainder of the program or the application of the provision to other persons or circumstances is not affected.

APPENDIX A. APPLIED CROP WATER DEMAND

1. Localized Crop Water Data

This section presents the equations and values used to calculate the Applied Crop Water values used to establish offset credits in the program. Portions of this work are also presented in the SLO Master Water Report (2012). Only data for the Santa Margarita, Atascadero/Templeton, and Salinas/Estrella Water Planning Areas (WPA) presented in the Master Water Report apply to the Paso Basin and the program focuses on data that is most specific to the Salinas/Estrella area.

2. Crop Water Requirements

In order to determine the quantity of water potentially saved by switching from one crop to another, the amount of water required to grow particular crops must be determined. Several variables are required for this calculation of annual crop-specific applied water, calculated as acre-feet water per acre per year. These include factors related to the crop, the location in which it is grown, irrigation water quality, and irrigation system efficiency. It is important to note crop water use is influenced by the variability in weather parameters, crop characteristics, management practices, and other environmental factors (Allen et al. 1998). As a result, a precise number for Crop Water Requirement is difficult to determine. The SLO Master Water Report includes a range of crop water requirements presented as low, medium, and high values to account for this variability. We recommend that a medium value be used in the Ag Offset Program for each crop category because this represents an average condition. Using the low value could result in insufficient water being allocated for the crop and a high value could result in too much water use in some years. Equations and values used to calculate the Crop Water Requirements are derived from Appendix I of the SLO Master Water Report (2012).

The annual crop-specific applied water expressed in acre-feet per acre per year (AF/Ac/Yr) is calculated in the SLO Waster Water Report using the following equation:

$$\text{Annual Crop-Specific Applied Water(AF/Ac/Yr)} = \frac{\text{ETc - ER}}{(1 - \text{LR})x\ \text{IE}} + \text{FP}$$

where:

ETc = crop evapotranspiration = ETo x Kc
ETo = reference evapotranspiration
Kc = crop coefficient
ER = effective rainfall
FP = frost protection
LR = leaching requirement
IE = irrigation efficiency

Each variable used in the equation is discussed in the following sections.

2.2 Evapotranspiration and Crop Groups

Evapotranspiration is the combination of the water lost from a cropped area by evaporation from wet soil and plant surfaces, and loss of water from plant transpiration. The Food and Agriculture Organization of the United Nations (FAO) presents a procedure for estimating crop evapotranspiration in Irrigation and Drainage Paper No. 56 (Allen et al. 1998). The California Department of Water Resources, University of California Cooperative Extension, and the Cal Poly Irrigation Training and Research Center use this procedure, and it is the same procedure used in the preparation of the San Luis Obispo (SLO) Master Water Report (2012). Crop evapotranspiration (ETc) is calculated as the product of reference evapotranspiration (ETo) and a crop specific coefficient (Kc). Crops are assigned to Crop Groups on the basis of water demand for evapotranspiration.

a. Reference Evapotranspiration (ETo)

Reference evapotranspiration (ETo) represents the approximate theoretical water use of a well watered, cool-seasoned grass, 4 – 6 inches tall, under full cover. The principal weather parameters affecting evapotranspiration are radiation, air temperature, humidity, and wind speed. The California Irrigation Management Information System (CIMIS) is a program of the Office of Water Use Efficiency, California Department of Water Resources (DWR) that manages a network of over 120 automated weather stations in the state of California. Hourly average weather data is used to calculate hourly ETo. The 24 hourly ETo values for the day (midnight-to-midnight) are then summed to produce estimates of daily ETo. Water Planning Areas were assigned to specific Paso Robles Climate Groups (Table 1a) and Monthly reference crop ETo values from for the Paso Robles Climate Group are given in Table 1c. Appropriate CIMIS were selected for the assigned climate groups (Table 1b). Reference evapotranspiration can be quite variable (Figure 1). It is higher during the summer months and varies between years depending on whether the year was wet, normal, or dry.

Table 1a. Assigned Climate Groups

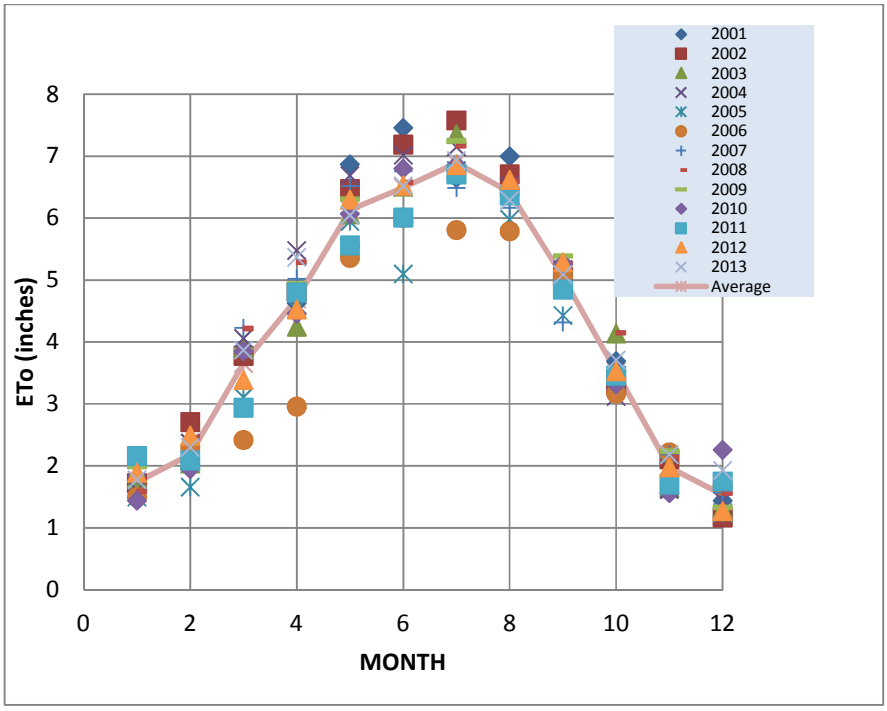
Water Planning Area	Assigned Climate Group
Santa Margarita	Atascadero
Atascadero/Templeton	Atascadero
Salinas/Estrella	Paso Robles

Table 1b. Rainfall Stations and Average Precipitation (Inches/Yr) by WPA

Water Planning Area	Assigned Rainfall Station	County Gage #	Average Precipitation (AF/Ac/Yr)	Record
Santa Margarita	Santa Margarita	9a	2.03	1887-2003
Atascadero/Templeton	Atascadero Mutual Water Company	34	1.45	1916-2003
Salinas/Estrella	Paso Robles	10	1.27	1972-2003

Table 1c. Monthly Reference Crop ETo (Inches/Month) by Climate Group		
Month	ETo (inches/month)	
	Atascadero	Paso Robles
January	1.2	1.6
February	1.5	2.0
March	2.8	3.2
April	3.9	4.3
May	4.5	5.5
June	6.0	6.3
July	6.7	7.3
August	6.2	6.7
September	5.0	5.1
October	3.2	3.7
November	1.7	2.1
December	1.0	1.4
Total (Inches/Yr)	43.7	49.2

Figure 1. Monthly variation in the Reference Evapotranspiration (ETo) at CIMIS Station 163 in Atascadero (2001-2010)



b. Crop Coefficient (Kc)

The crop coefficient integrates the effects of characteristics that distinguish a field crop from the grass reference described above. Different crops will have different Kc coefficients. The changing characteristics of the crop over the growing season also affect the Kc coefficient. In general, the Kc value increases as the plants grow in size. These Kc values were adapted from a Department of Water Resources Bulletin (DWR 1974) and two UC Cooperative Extension documents (Snyder et al. 1989a, b).

A specific crop in SLO County is assigned the Kc value used for the Crop Group in which it categorized (Table 2). Small grains and strawberries were added to the crop group list presented in the SLO Master Water Report. Assignment of Crop Groups is discussed below.

Table 2. Crop Coefficient for Each Crop Group by Month

Month	Crop Coefficient						
	Alfalfa	Citrus	Deciduous	Nursery	Pasture	Vegetables	Vineyard
January	0.0	0.56	0.0	0.5	0.0	0.0	0.0
February	0.0	0.56	0.0	0.5	0.0	0.0	0.0
March	0.9	0.56	0.6	0.5	1.0	0.0	0.0
April	0.9	0.56	0.7	0.5	1.0	0.0	0.0
May	0.9	0.56	0.8	0.5	1.0	0.0	0.6
June	0.9	0.56	0.9	0.5	1.0	0.0	0.7
July	1.0	0.56	1.0	0.5	1.0	0.0	0.6
August	1.0	0.56	1.0	0.5	1.0	1.0	0.5
September	1.1	0.56	0.9	0.5	1.0	1.0	0.3
October	1.0	0.56	0.8	0.5	1.0	1.0	0.1
November	0.0	0.56	0.0	0.5	0.0	1.0	0.0
December	0.0	0.56	0.0	0.5	0.0	1.0	0.0

c. Crop Evapotranspiration (ETc)

Crop evapotranspiration (ETc) is calculated by multiplying the reference evapotranspiration (ETo) (Table 1c) by the crop coefficient (Kc) (Table 2). The results are summarized in Table 3. Vineyard and vegetable crops have the lowest ETc values. Pasture and alfalfa have the highest ETc values, twice the ETc of vineyards.

Table 3. Annual Crop Evapotranspiration (AF/Ac/Yr) for each Crop Group and WPA

Crop	Annual Crop Evapotranspiration (AF/Ac/Yr)		
	Santa Margarita WPA	Atascadero/Templeton WPA	Salinas/Estrella WPA
Alfalfa	3.1	3.1	3.4
Citrus	2.0	2.0	2.3
Deciduous	2.8	2.8	3.0
Nursery	1.8	1.8	2.1

Pasture	3.2	3.2	3.5
Vegetables	1.4	1.4	1.6
Vineyard	1.3	1.3	1.4

2.3 Crop Groups

Crops with similar calculated ETo values are assigned to Crop Groups by California DWR. Although the groups are based on commodities that may have similar water requirements, the actual water usage will vary based on individual commodity, stage of maturity, presence of cover crop, soil type, and management factors. A significant discrepancy in the grouping is that water use by strawberries is more similar to water use by vegetables than by deciduous trees.

Table 3. Crop Group and Commodities Used for the Agricultural Demand Analysis

Crop Group	Primary Commodities
Alfalfa	Alfalfa
Nursery	Christmas trees, miscellaneous nursery plants, flowers
Pasture	Miscellaneous grasses, mixed pastures, sod/turf, sudangrass
Small Grains	Oats, barley, wheat
Citrus	Avocados, grapefruits, lemons, oranges, olives, kiwis, pomegranates (non-deciduous)
Deciduous	Apples, apricots, berries, peaches, nectarines, plums, figs, pistachios, persimmons, pears, quinces, strawberries
Strawberries	Strawberries
Vegetables	Artichokes, beans, miscellaneous vegetables, mushrooms, onions, peas, peppers, tomatoes
Vineyard	Wine grapes, table grapes

2.4 Effective Rainfall

Effective rainfall is defined as the part of the rainfall that is used to meet the evapotranspiration needs of growing crops, and does not include runoff and percolation below the root zone (NEH, 1993). The primary factors that influence effective rainfall are precipitation characteristics, soil properties, crop ETc, and irrigation management.

The amount of effective rainfall was calculated by multiplying the average precipitation measured at the rainfall Paso Robles station assigned to the WPA in which a crop is grown (Table 1b) by the effective rainfall percentage, that is, the portion of rainfall that infiltrates into the soil (Table 4).

Table 4. Effective Rainfall Percentage for Each Crop Group		
Crop	Low Range	High Range
Alfalfa	40%	60%
Citrus	40%	60%
Deciduous	40%	60%
Nursery	30%	50%
Pasture	40%	60%
Vegetables	15%	25%
Vineyard	30%	50%

Recharge of soil water by rainfall during winter can reduce the crop irrigation requirement (NEH 1993). However, the contribution of winter rain events is difficult to estimate. In semi-arid regions, the winter precipitation may be inadequate to recharge the crop root zone before the start of irrigation. However, a Paso Robles vineyard irrigation study showed a reduction in irrigation application with greater rainfall during the preceding winter (Battany 2013).

2.5 Frost Protection

Only grapes and berries are protected from frost during the winter months (Table 5). Sprinkler frost protection is used for grapes throughout SLO County from March to April, and for strawberries and blueberries in Salinas/Estrella WPA from January to March. The amounts of water used for frost protection included in the calculation of the Annual Crop-Specific Applied Water for vineyards and berries were 0.25 AF/Ac/Yr and 0.4 AF/Ac/Yr (SLO 2012). It should be noted that the amount of water used for frost protection varied between farms and years. The SLO Master Water Report describes the assumptions made to calculate the amount of frost protection water used for grapes and berries.

Table 5. Estimated Frost Protection Requirements in AF/Ac/Yr	
Crop Type	Estimated AF/Ac/Yr for frost protection
Berries	0.40
Grapes	0.25

2.6 Leaching Requirement

Leaching requirement is the fraction of the applied water required to maintain a desired salinity level in the soil. Leaching requirements in Table 6 are adapted from the Final Report Paso Robles Groundwater Basin Study (2002).

Table 6. Leaching Requirements for the WPAs in Analysis	
Crop	Leaching Requirement Units
Alfalfa	0.08
Citrus	0.05
Deciduous	0.08
Nursery	0.05
Pasture	0.11
Vegetables	0.08
Vineyard	0.16

2.7 Irrigation Efficiency

The SLO Master Water Report relies on information from local farm advisors to identify common types of irrigation used for the various crops (Table 7a). The most common irrigation systems used in this area are sprinkler and micro-irrigation (aka drip). Alfalfa and pastures are irrigated using sprinklers only, and vineyards use only drip irrigation.

Table 7a. Estimates of Current Irrigation System Types by Crop Group			
Crop	Percentage of Acreage with Irrigation System Type (%)		
	Surface	Sprinkler	Micro
Alfalfa	0	100	0
Citrus (permanent)	0	20	80
Deciduous	0	20	80
Nursery	0	50	50
Pasture	0	100	0
Permanent	0	20	80
Vegetables	0	40	60
Vineyard	0	0	100

Irrigation Efficiency was estimated using the following equation:

$$\text{IE (\%)} = \text{Distribution Uniformity} \times (1\text{- Losses}) \times 100$$

Distribution uniformity (DU) is defined as a measure of how uniformly water is applied to different areas in a field, expressed as a percentage. Average Distribution Uniformity values for sprinklers and micro irrigation systems of 75 and 85 percent were used to calculate the irrigation efficiency (IE).Water loss from the system occurs through over-watering, evaporation from the wet soil surface, runoff, and seepage from water distribution ditches, and leaks. Data on irrigation uniformity and losses was obtained from local Resource Conservation Districts, vineyard owners, and recent studies reviewed by ESA during the preparation of the Master Water Report (SLO 2012). Irrigation

Efficiencies were assigned to crop groups according to the primary irrigation system (Table 7b). A considerable range in IEs can be expected between individual system DUs and water loss control.

Table 7b. Existing Irrigation Efficiencies for Each Crop Group		
Crop	Existing Irrigation Efficiency Ranges (%)	
	Low	High
Alfalfa	60%	75%
Nursery	60%	75%
Pasture	60%	75%
Citrus and Deciduous	70%	85%
Vegetables	70%	85%
Vineyard	70%	85%

2.8 Crop Water Requirement Results

The low values for crop water requirement were calculated by using the high values for effective rainfall and irrigation efficiency in equation 1. The high values for crop water requirement were calculated by using the low values for effective rainfall and irrigation efficiency in equation 1. The medium values were calculated by adding the low and high values, and dividing by two. All values are presented in Table 8. Based on the range between high and low crop applied water values for the crops in Table 8, we can estimate similar ranges for small grains and strawberries to be the medium value ± 20 %. The high values for small grains and strawberries are 2.0 and 2.8 AF/Ac/Yr.

Table 8. Crop Specific Applied Water (AF/Ac/Yr) by Crop and WPA		
Crop	Ranges	Applied Water (AF/Ac/Yr)
		Salinas/ Estrella WPA
Alfalfa	Low	3.8
	Medium	4.5
	High	5.2
Citrus	Low	1.9
	Medium	2.3
	High	2.7
Deciduous [2]	Low	3.0
	Medium	3.5
	High	4.1
Strawberries[3]	Low	2.0
	Medium	2.3
	High	2.6
Small Grains[3]	Low	1.0
	Medium	1.2
	High	1.4
Nursery	Low	2.0
	Medium	2.5
	High	2.9
Pasture [2]	Low	4.2
	Medium	4.8
	High	5.5
Vegetables[1]	Low	1.6
	Medium	1.9
	High	2.2
Vineyard	Low	1.4
	Medium	1.7
	High	2.1

1 Assumes two vegetable crops planted per acre per year.
2 Values for Deciduous crops and Pasture are calculated based on original data used to prepare the Master Water Report.
3Information obtained from Current Cost and Return Studies, UCCE, UC Davis (Small grains 2013 data, Strawberries 2011 data)

3. Possible Sources of Offset Credits

Credits for the Ag Water Offset Program, within the PRGWB, may come from a combination of sources. As technology, information, practices, and irrigation efficiencies evolve and improve, other forms and sources of credits may become available to offset new water use in the PRGWB. Below is a list of potential sources of credits available from current documented practices.

- Fallowing of irrigated land resulting in less pumping;
- Crop conversion(s) to less water intensive crops as designated by the adopted program water use charts (e.g. alfalfa to olives, irrigated pasture to dryland range, water intense deciduous crops to less intensive deciduous, grain or vegetable crops, etc).

3.1 Water available from crop conversion

Calculating the amount of water that is made available by switching from a specific crop to one requiring less water can be done by using the annual crop-specific applied water calculated for each Crop Group within each WPA (SLO 2012). However, as noted above, the methodology used to derive the listed numbers is a standardized accepted approach. This information for the Salinas/Estrella WPA, using the medium value, is shown in Table 9.

Table 9. Existing Crop-Specific Applied Water by Crop Group

Crop Group	Applied Water (AF/Ac/Yr)
Alfalfa	4.5
Citrus	2.3
Deciduous	3.5
Strawberries	2.3[1]
Nursery	2.5
Pasture	4.8
Small Grain	1.2[1]
Vegetables	1.9
Vineyard	1.7

1. Information obtained from Current Cost and Return Studies, UCCE, UC Davis (Small grains 2013 data, Strawberries 2011 data), see section "Strawberries" and "Small Grains" in this report to understand how these crop requirement numbers were derived using the methodology of the Master Water Report

To determine how many acres of a "new" crop can be grown using the same amount of water as an "existing" crop, an area conversion factor can be calculated by dividing the "existing" crop applied water by the "new" crop applied water. Converting from a high water usage crop to one requiring less water will result in a larger (*i.e.* more than 1) acreage conversion factor. An example of the results of this calculation crops in the Salinas/Estrella WPA is shown in Table 10.

In this WPA, because alfalfa and pasture use more water than vineyards or vegetables, the area conversion factor ranges between 2.4 to 3.5. Likewise, if 100 acres of irrigated alfalfa in this WPA was fallowed, the water could be used for 265 acres of "new" vineyards. It is clear that there is water available for crop conversion within the Salinas/Estrella WPA.

Table 10. Crop Area Conversion per Crop for Salinas/Estrella WPA

Convert from 1 Ac	Applied Water (AF/Ac/Yr)	**To Acreage**								
		Alfalfa	Citrus	Deciduous	Strawberries	Nursery	Pasture	Small Grains	Vegetables	Vineyard
Alfalfa	4.5		1.96	1.13	1.96	1.80	0.75	2.65	2.37	2.65
Citrus	2.3	0.51		0.58	1.00	0.92	0.38	1.35	1.21	1.35
Deciduous	4	0.89	1.74		1.74	1.60	0.67	2.35	2.11	2.35
Strawberries	2.3	0.51	1.00	0.58		0.92	0.38	1.35	1.21	1.35
Nursery	2.5	0.56	1.09	0.63	1.09		0.42	1.47	1.32	1.47
Pasture	6	1.33	2.61	1.50	2.61	2.40		3.53	3.16	3.53
Small Grains	1.7	0.38	0.74	0.43	0.74	0.68	0.28		0.89	1.00
Vegetables	1.9	0.42	0.83	0.48	0.83	0.76	0.32	1.12		1.12
Vineyard	1.7	0.38	0.74	0.43	0.74	0.68	0.28	1.00	0.89	

Strawberries:

The calculated medium crop applied water for strawberries is 2.3 AF/Ac/Yr (November through August). The Paso Robles (Salinas/Estrella)ETo values used for the calculation are presented in Table A6 of the SLO Master Water Report(2012). The crop coefficients(Table 11a) are based on UC strawberry variety Albion planted in the Salinas Valley on 48-in beds (Cahn, 2012). We used the same low and high effective rainfall (ER = 0.4 and 0.6 AF/Ac), leaching ratio (0.16), and low and high irrigation efficiency (IE =70 and 85 %) as used for vineyards to calculate the crop water use value. The value for frost protection (FP) used in the calculation is 0.4 AF/Ac/Yr (SLO Master Water Report, 2012). The low and high crop applied water values for strawberries are 2.0 and 2.6 AF/Ac/Yr.

Table 11a. Strawberry Crop Coefficients and Calculated Crop Evapotranspiration

Month	ETo (inches)	Kc	ETc (foot)
January	1.6	0.06	0.01
February	2.0	0.14	0.02
March	3.2	0.23	0.06
April	4.3	0.37	0.13
May	5.5	0.52	0.24

June	6.3	0.66	0.35
July	7.3	0.74	0.45
August	6.7	0.79	0.44
September	5.1	0	0
October	3.7	0	0
November	2.1	0.02	0
December	1.4	0.04	0
Total			**1.71**

The following equation was used to calculate the crop applied water (AF/AC/YR):

$$Crop\ Applied\ Water\ = \frac{ETc - ER}{(1 - LR)\ x\ IE} + FP$$

The calculated low value of crop applied water is:

$$Strawberry\ Low\ Crop\ Applied\ Water\ (AF/AC/YR)\ = \frac{1.71 - 0.6}{(1 - 0.16)\ x\ 0.85} + 0.4\ = 2.0$$

The calculated high value of crop applied water is:

$$Strawberry\ High\ Crop\ Applied\ Water\ (AF/AC/YR)\ = \frac{1.71 - 0.4}{(1 - 0.16)\ x\ 0.70} + 0.4\ = 2.6$$

The calculated average value of crop applied water is:

$$Strawberry\ Average\ Crop\ Applied\ Water\ (AF/AC/YR) = \frac{High + Low}{2} = \frac{4.6}{2} = 2.3$$

Similar crop applied water values were published by Dara et al. (UCCE Report, 2011) who reported that the total water applied to strawberries in Santa Barbara and San Luis Obispo Counties is 2.3 AF/Ac/year. Strawberries are irrigated using sprinklers after planting. From December through February, the plants are drip irrigated as necessary. From February through July the plants are drip irrigated every three to four days. Effective rainfall is not taken into account.

Cahn, M.D. 2012. Estimated Crop Coefficient of Strawberry. Salinas Valley Agriculture – ANR Blogs. http://ucanr.edu/blogs/blogcore/postdetail.cfm?postnum=6934.

Dara, S., K.M. Klonsky, and R.L. De Moura. 2011. Sample Cost to Produce Strawberries. South Coast Region: Santa Barbara and San Luis Obispo Counties. ST-CC-11-1. University of California Cooperative Extension. Davis, California.

Small Grains (winter forage):

Small grains, or winter forage, include oats, wheat and barley. In San Luis Obispo approximately half of the small grain acreage is planted with oats, the rest is mainly barley and a little wheat. Planting occurs between October and December, and harvest is in early spring. The Paso Robles (Salinas/Estrella) ETo

values used for the calculation are presented in Table A6 of the SLO Master Water Report (2012). We use the Kc values of 1.0 to calculate ETc (Table 11b). The calculated medium crop applied water for small grains is 1.2 AF/Ac/Yr. We used the same low and high effective rainfall (ER =0.4 and 0.5 AF/Ac), leaching ratio (LR = 0.05), and low and high irrigation efficiency (IE =60 and 75 %) as used for pastures to calculate the crop water use value. The low and high crop applied water values for small grains are 1.0 and 1.4 AF/Ac/Yr.

Table 11b. Small Grain Crop Coefficients and Calculated Crop Evapotranspiration

Month	ETo (inches)	Kc	ETc (foot)
January	1.6	1.00	0.13
February	2.0	1.00	0.17
March	3.2	1.00	0.27
April	4.3	1.00	0.36
May	5.5	0	0.00
June	6.3	0	0.00
July	7.3	0	0.00
August	6.7	0	0.00
September	5.1	0	0.00
October	3.7	0	0.00
November	2.1	1.00	0.18
December	1.4	1.00	0.12
Total			**1.22**

The following equation was used to calculate the crop applied water (AF/AC/YR):

$$Crop\ Applied\ Water\ = \frac{ETc - ER}{(1 - LR)\ x\ IE} + FP$$

The calculated low value of crop applied water is:

$$Small\ Grain\ Low\ Crop\ Applied\ Water\ (AF/AC/YR)\ = \frac{1.22 - 0.5}{(1 - 0.05)\ x\ 0.75} + 0\ = 1.0$$

The calculated high value of crop applied water is:

$$Small\ Grain\ High\ Crop\ Applied\ Water\ (AF/AC/YR)\ = \frac{1.22 - 0.4}{(1 - 0.05)\ x\ 0.60} + 0\ = 1.4$$

The calculated average value of crop applied water is:

$$Small\ Grain\ Average\ Crop\ Applied\ Water\ (AF/AC/YR) = \frac{High + Low}{2} = \frac{2.4}{2} = 1.2$$

The crop water use will vary due to planting date, type of crop, weather/location, and maturity range of the variety. The calculated values of crop water use presented in this report are within the ranges

observed in CA. The moisture required to produce a crop of oat hay ranges from 0.8 to 1.6 AF/Ac(UC, 1982). Water consumption by wheat in the Central Valley can range from 0.75 AF/Ac if the crop is harvested at the boot stage for forage, to 1.8 AF/Ac if harvested for grain (UC, 2006). Barley consumes less water than wheat because it has a shorter growing season (1.4 AF/Ac).

University of California (UC). 1982. Oat Hay and Silage Production. Leaflet 21265. University of California, Division of Agricultural Sciences. Davis, California.

University of California (UC).) 2006. Small Grain Production Manual, Part 5: Irrigation and Water Relationship. Publication 8168. University of California, Division of Agriculture and Natural Resources. Oakland, California.

Pasture:

The pasture crop applied water was recalculated using the Salinas/Estrella ETc value (Table 3) presented in the San Luis Obispo Master Water Report (2012). We used the low and high effective rainfall (ER =0.4 and 0.5 AF/Ac), leaching ratio (LR = 0.05), and low and high irrigation efficiency (IE =60 and 75 %) as presented in the SLO Master Water Report. The low and high crop applied water values for pasture are 4.2 and 5.5 AF/Ac/Yr. The calculated medium crop applied water for pasture is 4.8 AF/Ac/Yr. These numbers are different than those presented in the SLO Master Water Report Table A1.

The calculated low value of Crop Applied Water is:

$$Pasture\ Low\ Crop\ Applied\ Water\ (AF/AC/YR) = \frac{3.51 - 0.5}{(1 - 0.05)\ x\ 0.75} + 0 = 4.2$$

The calculated high value of Crop Applied Water is:

$$Pasture\ High\ Crop\ Applied\ Water\ (AF/AC/YR) = \frac{3.51 - 0.4}{(1 - 0.05)\ x\ 0.60} + 0 = 5.5$$

The calculated average value of Crop Applied Water is:

$$Pasture\ Average\ Crop\ Applied\ Water\ (AF/AC/YR) = \frac{High + Low}{2} = \frac{2.4}{2} = 4.8$$

Deciduous Crops:

The deciduous crop applied water was recalculated using the Salinas/Estrella ETc value (Table 3) presented in the San Luis Obispo Master Water Report (2012). We used the low and high effective rainfall (ER =0.5 and 0.8 AF/Ac), leaching ratio (LR = 0.11), and low and high irrigation efficiency (IE =70 and 85 %) as presented in the SLO Master Water Report. The low and high crop applied water values for deciduous are 3.0 and 4.1 AF/Ac/Yr. The calculated medium crop applied water for deciduous is 3.5 AF/Ac/Yr. These numbers are different than those presented in the SLO Master Water Report Table A1.

The calculated low value of crop applied water is:

$$Deciduous\ Low\ Crop\ Applied\ Water\ (AF/AC/YR)\ =\ \frac{3.05-0.8}{(1-0.11)\ x\ 0.85}\ +0\ =3.0$$

The calculated high value of crop applied water is:

$$Deciduous\ High\ Crop\ Applied\ Water\ (AF/AC/YR)\ =\ \frac{3.05-0.5}{(1-0.11)\ x\ 0.7}\ +0\ =4.1$$

The calculated average value of crop applied water is:

$$Deciduous\ Average\ Crop\ Applied\ Water\ (AF/AC/YR) = \frac{High+Low}{2}\ = \frac{7.1}{2} = 3.5$$

3.3 Existing water usage by crop type in the PRGWB

The SLO Water Master Report presents the 2008 estimated acreage of irrigated crops as reported by the growers utilizing the County Crops ArcGIS® (2008) layer. Estimates for the 2013 acreage of irrigated crops were determined utilizing the County Crops ArcGIS® (2013) as shown in Table 12. For the purposes of this analysis, the irrigated commodities were categorized into seven groups, excluding strawberries and small grains, and overlayed with Paso Robles Ground Water Basin Sub Area delineation data from SLO County.

Table 12. Existing Estimated Irrigated Crop Acreage by Sub-Area[(1)]

	Crop Group 2013						
Sub Area	**Alfalfa (ac)**	**Citrus (ac)**	**Deciduous (ac)**	**Nursery (ac)**	**Pasture (ac)**	**Vegetables (ac)**	**Vineyard (ac)**
Estrella	635	132	570	9	740	3,608	17,032
Creston	462	247	82	12	169	2,039	6,984
Shandon	294	18	0	44	9	1,227	3,728
Atascadero	57	7	13	12	236	1,777	397
San Juan	389	0	0	0	201	710	2,672
South Gabilan	0	1	0	0	0	91	465
North Gabilan[(2)]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Bradley[(2)]	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Total[(3)(4)]	**1,837**	**405**	**665**	**77**	**1,355**	**9,453**	**31,277**

Notes:
1. Acreages were determined by utilizing County Crops ArcGIS® (2013) data, which is based on the pesticide use records.
2. South and North Gabilan sub-areas were excluded from analysis and not within San Luis Obispo County limits.
3. 99.9 percent of strawberries in the County are located outside of the sub-areas analyzed.
4. Small grains is not a classified commodity in the County Crops ArcGIS® (2013) layer.

The estimated total volume of water use by each crop type in all the sub-basins was calculated by multiplying the total irrigated crop area (Table 12) by the medium range Crop Applied Water values for crops in the Salinas/Estrella WPA (Table 9).

Information on how much water can be conveyed from one crop to another within the PRGWB is shown in Table 13. This table indicates that a maximum potential of 16,394 AF/Yr will be available for the conversion of current alfalfa and pasture cropland to vineyard, or a maximum potential for 9,644 Ac of new irrigated vineyards.

Table 13. Estimated Total Irrigation Water Use per Year (AF/Yr) by Crop within all the PRGWB Sub-Areas

Crop Group	Applied Water (AF/Ac/Yr)	Total Acres	Total Irrigation Water Use per Year (AF/Yr)
Alfalfa	4.5	1,837	8,266
Citrus	2.3	405	932
Deciduous	3.5	665	2,328
Nursery	2.5	77	192
Pasture	4.8	1,355	6,503
Vegetables	1.9	9,453	17,960
Vineyard	1.7	31,277	53,171
Total			**89,352**

5. DISCUSSION

Reviewing the available information and applying standards to evaluate water use by crop categories within WPAs, it is clear there exists the potential to develop a practical Agriculture Water Offset Program for the Paso Robles Groundwater Basin in SLO County.

It is recommended that, when evaluating applications for new irrigated agriculture, the medium value of the crop specific applied be used when estimating the amount of credit available from crop conversions. The rationale is there is a significant amount of variability in crop water use because of factors such as soil, micro-climates, evapotranspiration rates, crop management, etc. that will affect the true amount of water applied. Also, for the purpose of the program, it is the ratio of the water use between the crops and not the specific number that determines the offset potential.

APPENDIX B. IMPACT ANALYSIS FOR WELL PROXIMITY

1. PROXIMITY INTRODUCTION

Following determination of water use by crop type, proximity criteria was developed for acceptable offset credits to ensure that the credit does not cause unintended impacts to neighboring wells and the groundwater basin from applying offsets. A categorical (category 1-4) process was established to develop the proximity criteria. Each category is progressively more complex and the proximity criteria more stringent depending upon the location of the credit. Because credits and offsets will not always be on the same property or by the same landowner, a mechanism to calculate impacts within the PRGWB was developed. This mechanism uses standard drawdown calculations to assess the sphere of influence from well operations. This is an important step to be able to verify and ensure offset credits actually mitigate increased groundwater use within the PRGWB.

2. PROXIMITY CRITERIA

Increased pumping to serve a new or expanded use has the potential to exacerbate the groundwater level decline in the basin and to negatively impact neighboring wells as a result of increased water level drawdown. For these reasons, proximity criteria were developed to make sure the offset credit actually benefits the aquifer in the vicinity of the impact (increased pumping) and to reduce the potential to impact neighboring wells. To encompass the various possibilities of offsets, a series of categories or types of credits were established; the first category will be the simplest condition and subsequent categories will be more involved. Proximity criteria that must be met for each Category of offset are described below. Terminology used throughout this section is presented in Figure 1.

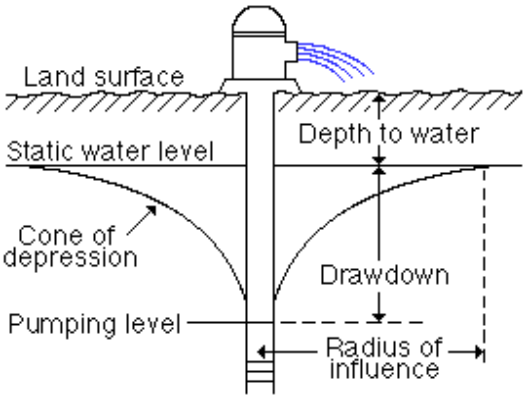


Figure 1. Illustrates terminology used throughout this section

Category 1 **Offset Credit and Increased Water Use on Same Property from Same Well**

This applies when the offset credit is derived from the same property, same well, and same ownership. If the proposed new water use (well) is within the areas determined by San Luis Obispo County as being severely depleted, no offset credits will be allowed that will permit additional pumping in that area unless the offset credit is derived from the same depleted area. Figure 2 is a map prepared by GEI Consultants (August 2013) that shows the most recent Paso Robles Basin groundwater depletion map for the period 1997 - 2013. On this map, the areas with severe depletion are shown in deep red. For the purposes of this analysis, the RCD is recommending that the severe depletion area be defined as the area where there has been greater than 50 feet of groundwater level decline. No additional pumping will be permitted in this area if the offset credit is derived from an area outside of the severe depletion area. Credits that are derived from within the severe depletion area can be applied to new uses within the severe depletion area. It is recommended that the severe depletion map be updated annually using updated water level data and that the map be prepared using consistent data interpolation protocols. Category 1 offset credit proposals located outside of the severely depleted area have no further proximity related criteria that must be met.

Category 2 **Offset Credit Coming from Different Well on the Same Property**

This applies when the offset credit is derived from a different well on the same property with the same ownership. The applicant must meet the Category 1 criteria and the offset credit source must be derived from a well that is open to the same hydrogeological strata as the well providing the new water source (must provide well log/report indicating strata type and other geologic information).

The applicant must demonstrate that neighboring wells (irrigation and domestic) located near the well serving the new water use will not be significantly impacted by the additional water level drawdown, or all property owners within that radius provide written approval of the new water use. The method for determining the amount of drawdown impact at neighboring wells is presented in Appendix B. Once the level of drawdown in the neighboring well has been calculated, the next step in the process is to evaluate the significance of the water level drawdown impact on neighboring wells. For the purposes of this analysis, water level drawdown in the neighboring well means the difference between the static water level when the well is not being operated for at least 4 hours and the water level in the neighboring well when the well serving the new use is being operated. In order to evaluate the level of impact, criteria were established. For this analysis, a significant impact on a neighboring well is defined as follows:

a) For domestic wells, the calculated water level drawdown at the impacted well is greater than 15 feet or more than 20 percent of the available drawdown in the well (available drawdown is defined as the amount of standing water above the pump intake or well screen), or

b) For irrigation wells, the calculated water level drawdown at the impacted well is greater than 30 feet or more than 20 percent of the available drawdown in the well, or

c) The drawdown would result in the water level in the impacted well to drop below the pump intake or well screen.

Data needed for application process (related to proximity):

Following is a list of key information we need from the applicant relating to the proximity analysis:

- Subarea: Identify the subarea where the well serving the new use is located. The Drawdown and Offset Distance Calculators will select the appropriate aquifer properties to use in the drawdown equation based on published information.
- MAP: Provide a map with scale showing where the well serving the new use is located and the location of neighboring irrigation and domestic wells within one mile. Also show the location of the well that is the source of the offset credit.
- Distances to Neighboring Wells: From the map, measure the distances from the new well to the nearest neighboring wells and entered into the Drawdown Calculator.
- Flow Rate and Hours of Operation Per Day: For new wells, the applicant will provide the anticipated pumping rate of the new well and hours of operation per day. The Drawdown Calculator automatically computes an average daily pumping rate. The Calculator will also compare this to the average amount of water required to grow the crop so that the requested rate reflects the appropriate amount of water that is needed to grow the crop. For existing wells that are serving both existing and new uses, the Applicant will provide the pumping rate and hours of operation of the original use and the anticipated pumping rate and hours for the new use. The Calculator will compute an average increase in daily pumping. The Calculator will compare this to the average amount of water required to grow the crop so that the requested rate reflects the appropriate amount of water that is needed to grow the crop.

The Drawdown Calculator, will compute the amount of additional drawdown that may occur at a neighboring well. Additional drawdown that exceeds 15 feet for domestic wells and 30 feet for irrigation wells is considered an unacceptable impact.

If the calculated water level drawdown exceeds the drawdown criteria, the applicant will be required to notify the affected neighboring well owner(s) in order to determine where the top of screen and pump intake is set in the neighboring well(s). If the neighboring well owners do not respond and provide the requested information within 30 business days of being contacted, the applicant may not be required to address the drawdown impact. Alternatively, the applicant may revise the application to reduce the impact below the level of significance or provide evidence that there is a written agreement with the neighboring well owner to mitigate the impact.

Category 3 **Offset Credit Derived from a Different Well Located on an Adjacent Property**

This applies when the credit is derived from a different well located on adjacent properties, whether involving another property owner or not. The applicant must meet the proximity criteria for Category 1 and Category 2 offsets and must have a written agreement with the neighboring landowner (as applicable) providing the credit that will remain in effect for the duration of the new water use. Depending on the

circumstance and permanency of the new use, the County may require a covenant be recorded on the deeds for the land being used to supply the offset credit and the land that is using the offset credit for the expanded groundwater use.

Category 4 **Offset Credit from a Non-Adjacent Property (may or may not be the same land owner)**

This applies in cases where the offset credit is coming from a property that is not adjacent (may or may not be the same land owner). The applicant must meet the criteria for Category 1, 2, and 3 offsets and the proposed offset location (e.g., well) must be within the cone of depression formed by the well serving the new use. This approach was developed based on established hydrogeologic principals with an assumption that an offset credit can be a created by reduced pumping. If the resulting water level recovery at the credit well location falls within the cone of depression of the pumping well serving the new use, the proposed offset credit is assumed to benefit the aquifer and offset the new use. Because the cone of depression caused by pumping in a confined aquifer (such as the Paso Robles Formation) can theoretically extend outward in a radial pattern for miles, it is necessary to pick a threshold value for water level drawdown, at some distance away from the well serving the new use, that is assumed to be significant and measureable. In this case, a water level drawdown value of 2 feet is assumed as a threshold.

An Offset Distance Calculator was created to assist applicants in demining the applicable cone of depression radius. The Offset Distance Calculator will compute the maximum radial distance away from the well serving the new use that an offset credit may be applied.

Applicants must provide the following data for credit processing:

- Map research – confirm well locations and look for others
- Notice to Neighboring Well Owners – identify parcels, names, addresses; process information that is returned
- If the County chooses to use the additional drawdown criteria of 20% of available drawdown – refer to a Hydrogeologist who will evaluate data provided by neighboring well owners to evaluate on a per well basis
- All Line #2 requests – applicant does not agree with drawdown analysis or offset distance findings and has site specific data that may improve the evaluation (I believe I provided this in a previous email).

The area that falls within this radial distance from the pumping well is assumed to be in hydraulic connection with the pumping well as long as the water bearing strata are connected and a groundwater flow boundary such as a fault or fold does not interrupt this connection. For the purposes of this analysis, we have assumed that the aquifer is homogeneous and laterally extensive (which we know is not always the case). Other drawdown values could be selected as a threshold; however, this assumed value is believed to be protective of the aquifer, while providing for reasonable opportunities to apply an offset. This approach improves the likelihood that the proposed offset credit benefits the aquifer within the radius of impact from the well serving the new use.

Figure 3 presents a conceptual cross section illustrating the concepts discussed in this section. The methodology used for computing the radial distance away from the well serving the new use where a

Category 4 offset may be applied is presented in Appendix C. It is based on the same Theis non-equilibrium equation described previously for the evaluation of drawdown impacts on neighboring wells and the estimated aquifer parameters for each sub area presented in Table B-1 in Appendix B.

Areas of Severe Decline (see decline map on page 30)

It is recommended that no offset credits be permitted to be transferred from non-severe decline areas to areas of severe decline in order to avoid exacerbations of additional water drawdown in areas where significant water level drops have been noted.

It is further recommended that transfers of credits from an area of severe decline to an area not listed as such should be exempt from the offset distance requirements to encourage water savings in areas where significant declining water levels have been noted.

Figure 2: Generalized Difference in Spring Groundwater Elevations between 1997 and 2013

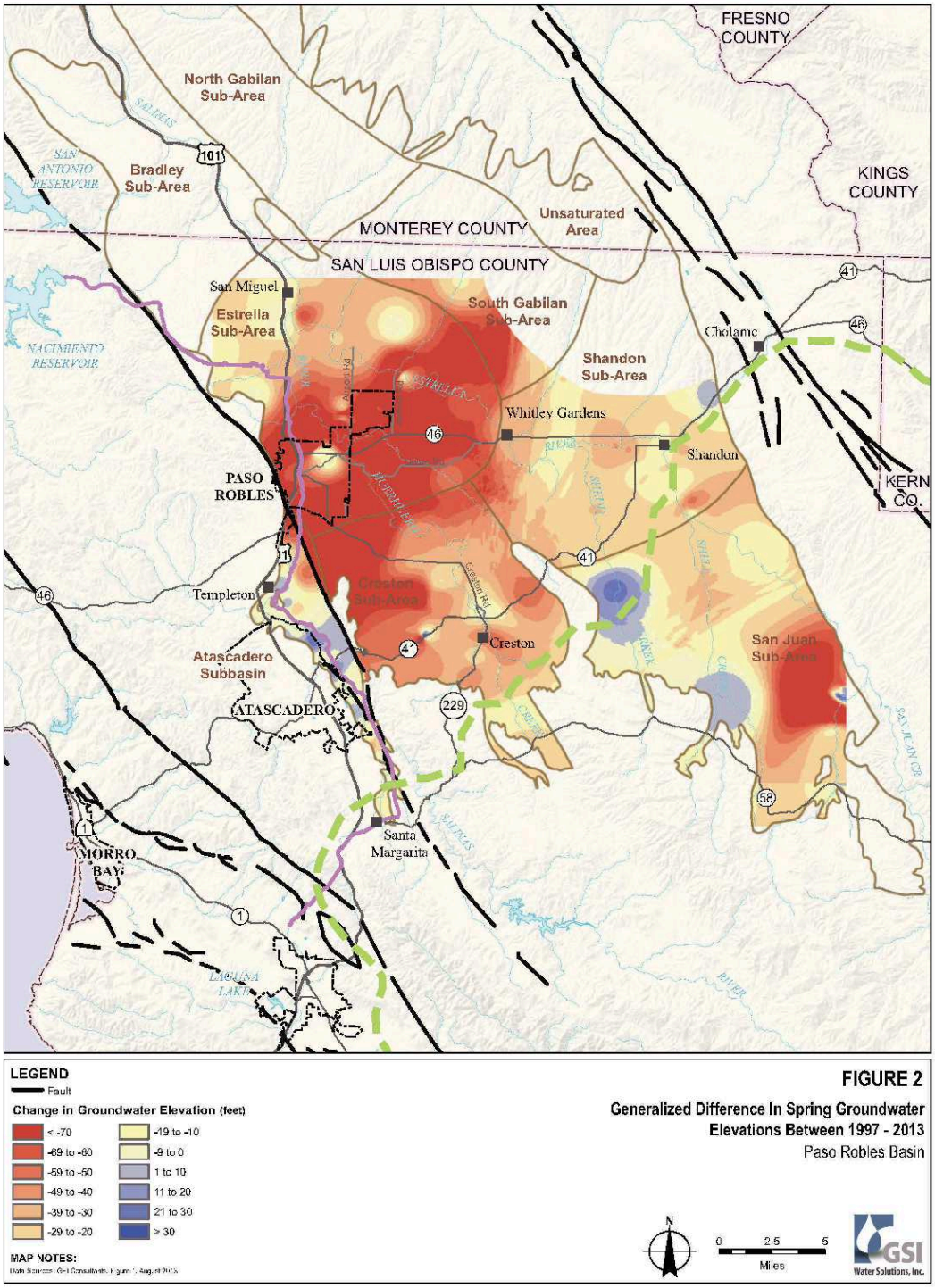
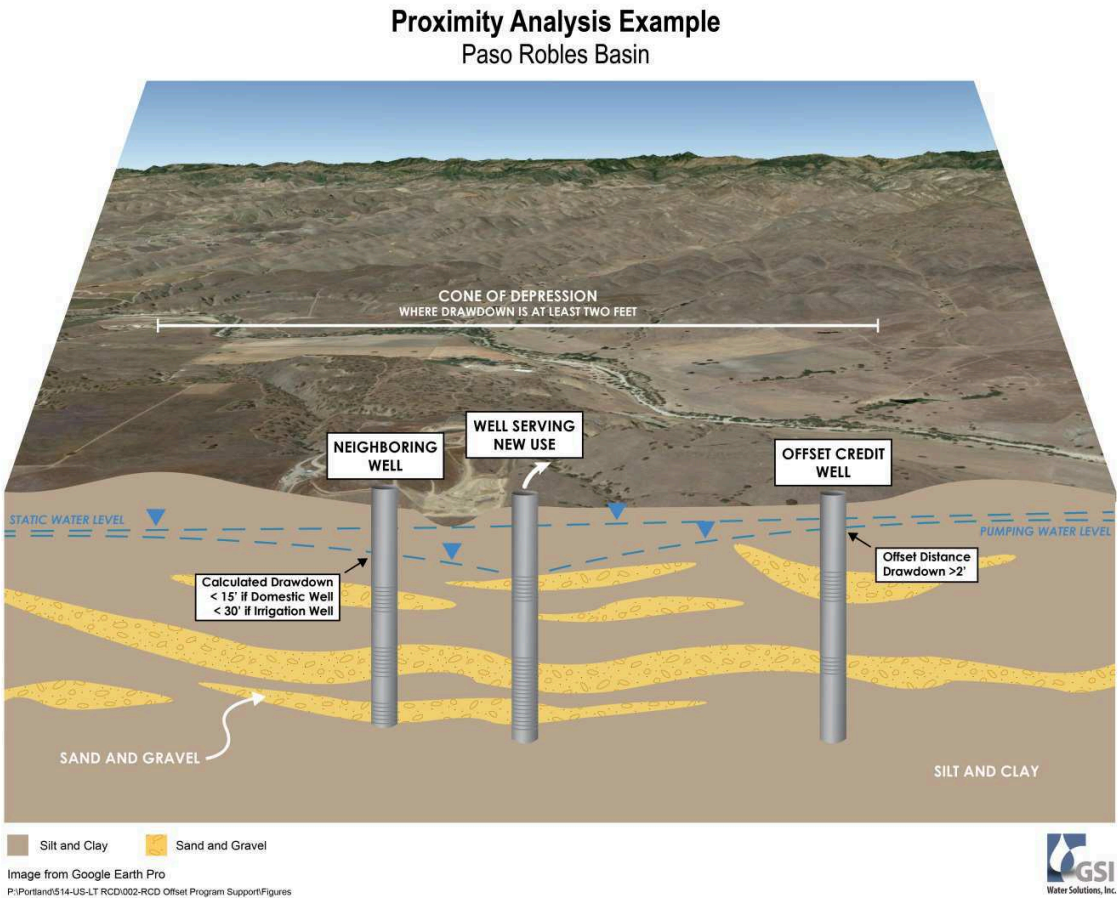


Figure 3: Proximity Analysis Example Showing Drawdown at Neighboring Well and Offset Distance based on Cone of Depression.



APPENDIX C. DRAWDOWN CALCULATOR & METHODOLOGY

The method for determining the amount of drawdown impact at neighboring wells is presented below.

1. Identify the distance to the nearest domestic and irrigation wells within one mile of the well serving the new water use. Well locations may be identified from published maps or from Google Earth images. Location related items include:

    a. Developing landowner confirms and maps neighboring well locations and submits to agency (via rough map, Google earth image, parcel numbers, etc);

    b. Agency Notices Neighboring Well Owners – identify parcels, names, addresses; process information that is returned;

2. Use the Drawdown Calculator that will be placed on a SLO County webpage (at such time the program is adopted). This drawdown calculator estimates the amount of water level drawdown that is predicted to occur in each neighboring well using the Theis non-equilibrium equation (Theis, 1935) and estimated aquifer parameters for the area underlying the new use. The calculator is intended to make it easy to estimate water level drawdown at various distances with little previous hydrogeologic knowledge. The Theis equation used in the calculator is as follows:

$$s = \frac{114.6QW(u)}{T}$$

s = drawdown, in feet
Q = pumping rate, in gpm
T = Transmissivity, in gpd/ft
W(u) = well function of u

$$u = \frac{1.87r^2S}{Tt}$$

r = distance from pumped well to where s measured, in feet
S = storativity, dimensionless
t = time since pumping started, in days

Values for Theis W(u) can be found in Driscoll, 1986

Aquifer parameter values used in the equation, including transmissivity (T) and storativity (S), are presented in Table B-1 below. These values are automatically used in the Calculator when the user selects the subarea and the geologic unit tapped by the well where the new water use is located. The aquifer parameters used in the calculations were derived from Table 2 in the Paso Robles Groundwater Basin Report prepared by Fugro, 2005. Updated aquifer parameter values may be used whenever they become available.

TABLE B-1 AQUIFER PARAMETER SUMMARY (FUGRO, 2005)

Subarea	**Geologic Unit**	**Average Transmissivity**[(1)] (gpd/ft)	**Storativity**[(1)] (dimensionless)
Bradley	Alluvium and Paso Robles FM	52,800	na
	Paso Robles FM	8,000	na
Creston	Alluvium (Huer Huero Creek)	104,000	na
	Paso Robles FM	7,800	0.003
Estrella	Alluvium and Paso Robles FM	22,400	0.0004
	Paso Robles FM	4,600	0.003
Shandon	Paso Robles FM	11,000	0.003
San Juan	Paso Robles FM	35,000	0.003
North and South Gabilan	Paso Robles FM	5,600	0.003

NOTES: (1) from Fugro (2005), except Bradley from Fugro (2002); (2) geometric mean of range reported by Fugro (2005)

Because the impact of water level drawdown on neighboring wells caused by an increase in pumping rate or volume is of interest, the value for the average pumping rate (Q) used in the equation is the difference between the historical pumping rate and the new pumping rate. If the new water use is from a new well that has had no historical pumping, then the average pumping rate equals the total new rate. The average pumping rate (Q) at the well serving the new use is calculated by multiplying the instantaneous maximum pumping rate (gpm) by the number of hours the well will be operated per day and dividing by 24 hours.

The calculator will include an appropriate range of pumping rate and operation hours that are typically needed to serve the new use (e.g., irrigation of grapes in the summer).

As illustrated below in the Drawdown Calculator, the process involves the following steps:

1) Identify the subarea the well serving the new water use is located (e.g., Shandon);
2) Select the geologic unit the well is completed in (e.g., if well is less than 200 feet deep, assume the well is completed in alluvium. If the well is greater than 200 feet deep, assume it is completed in the Paso Robles Formation);
3) Map of Wells: The applicant shall determine the location of all agricultural and domestic use wells located on all adjoining parcels as well as locate the well(s) receiving the credit(s). The closest domestic and agricultural well not owned by the applicant must be identified, regardless of whether it is on an adjoining property. This shall be accomplished by examination of aerial photographs and ground surveys to determine the approximate location of active wells.

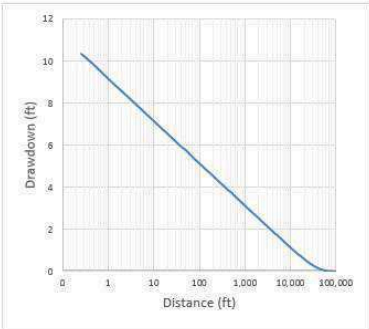
4) Distances to Neighboring Wells: Using the map, measure the distances from the new well to the nearest neighboring wells.

5) Enter the new instantaneous pumping rate and the historical instantaneous pumping rate of the well serving the new use;
6) Enter the average number of hours per day the well is pumped; and,
7) Enter the distance the neighboring wells are away (in feet [ft]). Repeat for each well located within 1 mile.

The Calculator then computes the water level drawdown that can be expected at the neighboring well. A screen shot of the water level Drawdown Calculator is shown below.

USER-DEFINED INPUT VALUES

DRAWDOWN CALCULATION AT NEAREST WELL		
Subarea	San Juan	
Geologic Unit	Paso Robles FM	
Transmissivity	35,000	gallons per day per foot (gpd/ft)
Storativity	0.003	dimensionless
Original Pumping:		
Instantaneous Puming Rate	400	gallons per minute (gpm)
Average Hours Pumping Per Day	8	hours
Average Pumping Rate Per Day	133	gpm
New Pumping:		
Instantaneous Puming Rate	800	gpm
Average Hours Pumping Per Day	8	hours
Average Pumping Rate Per Day	267	gpm
Distance from Well with Increased Pumping to Nearest Well	1,000	feet
Drawdown at Nearest Well =	3.1	Feet



APPENDIX D. OFFSET DISTANCE CALCULATOR & METHODOLOGY

The methodology used for computing the radial distance away from the well serving the new use where a Category 4 offset may be applied is presented below. It is based on the same Theis non-equilibrium equation described previously for the neighboring well impact evaluation and the estimated aquifer parameters for each sub area presented in Table B-1. The steps are listed below:

1. Use the Offset Distance Calculator that will be placed on a SLO County webpage (at such time the program is adopted). This Offset Distance Calculator estimates the maximum distance the offset location (e.g., well) must be in order to be within the cone of depression formed by the well serving the new use where there is at least 2 feet of drawdown in the aquifer. The calculator is intended to make it easy to estimate the acceptable maximum distance that the offset credit can be from the well serving the new use, with little previous hydrogeologic knowledge.
2. As shown below, the user will select the subarea that the well serving the new water use is located (e.g., Shandon) and the geologic unit the well is completed in (e.g., Paso Robles Formation if the well is greater than 200 feet deep and alluvium if it is less than 200 feet deep).
3. Enter the instantaneous pumping rate for the well and the number of hours per day that the well will be operated. The Calculator will calculate the average pumping rate (Q) at the well serving the new use by multiplying the instantaneous maximum pumping rate (gpm) by the number of hours the well will be operated per day and dividing by 24 hours.
4. The Calculator then computes the radial distance the offset credit well must fall within in order to meet this proximity requirement. Offset credits may not be allowed in cases where there is a documented barrier to groundwater movement (e.g., fold or fault) that exists between the new groundwater use and the offset credit. A screen shot of the Offset Distance Calculator is shown below.

USER-DEFINED INPUT VALUES

OFFSET DISTANCE CALCULATION		
(1) Subarea	Creston	
(2) Geologic Unit	Paso Robles FM	
Transmissivity	7,800	gallons per day per foot (gpd/ft)
Storativity	0.003	dimensionless
(3) Instantaneous Pumping Rate	1200	gallons per minute (gpm)
(4) Average Hours Pumping Per Day	8	hours
Average Pumping Rate Per Day	400	gpm
Distance from Existing Well =	**19,600**	**feet**

How to Use the Offset Distance Calculator

(1) Subarea - Select the subarea location that the well serving the new water use is located (e.g., Creston) by clicking on the cell and using the drop-down menu provided.

(2) Geologic Unit - Select the geologic unit that the well serving the new water use is completed (e.g., Paso Robles FM) by clicking on the cell and using the drop-down menu provided.

(3) Instantaneous Pumping Rate - In the space provided, enter the instantaneous pumping rate (in gallons per minute) for the well.

(4) Average Hours Pumping Per Day - In the space provided, enter the average number of hours per day that the well will be operated.

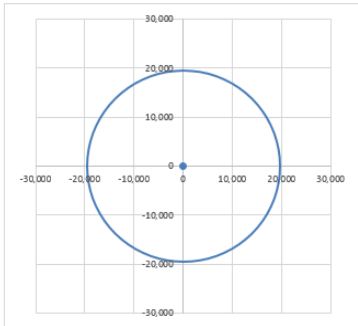


Figure C-1 is a map that shows two examples of the offset distance calculation in different parts of the basin (Well X and Well Y). The circles represent the computed distance away from the well serving the new use where the water level drawdown is 2 feet. An offset credit well that falls within these circles

meets the Category 4 proximity criteria. The Well X circle is bigger than the Well Y circle because the aquifer near Well Y is more permeable and the planned average pumping rate is lower at Well Y than at Well X.

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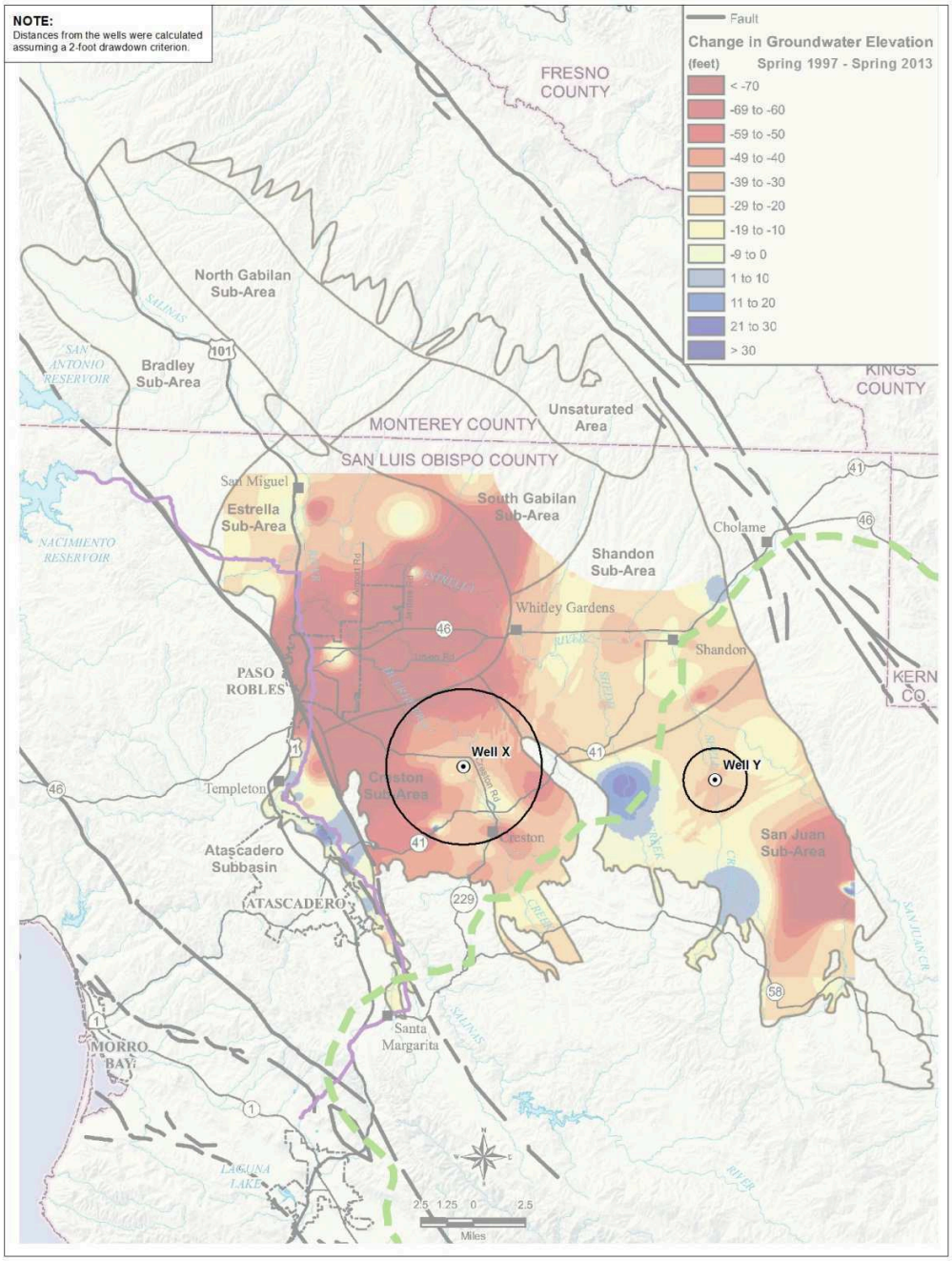
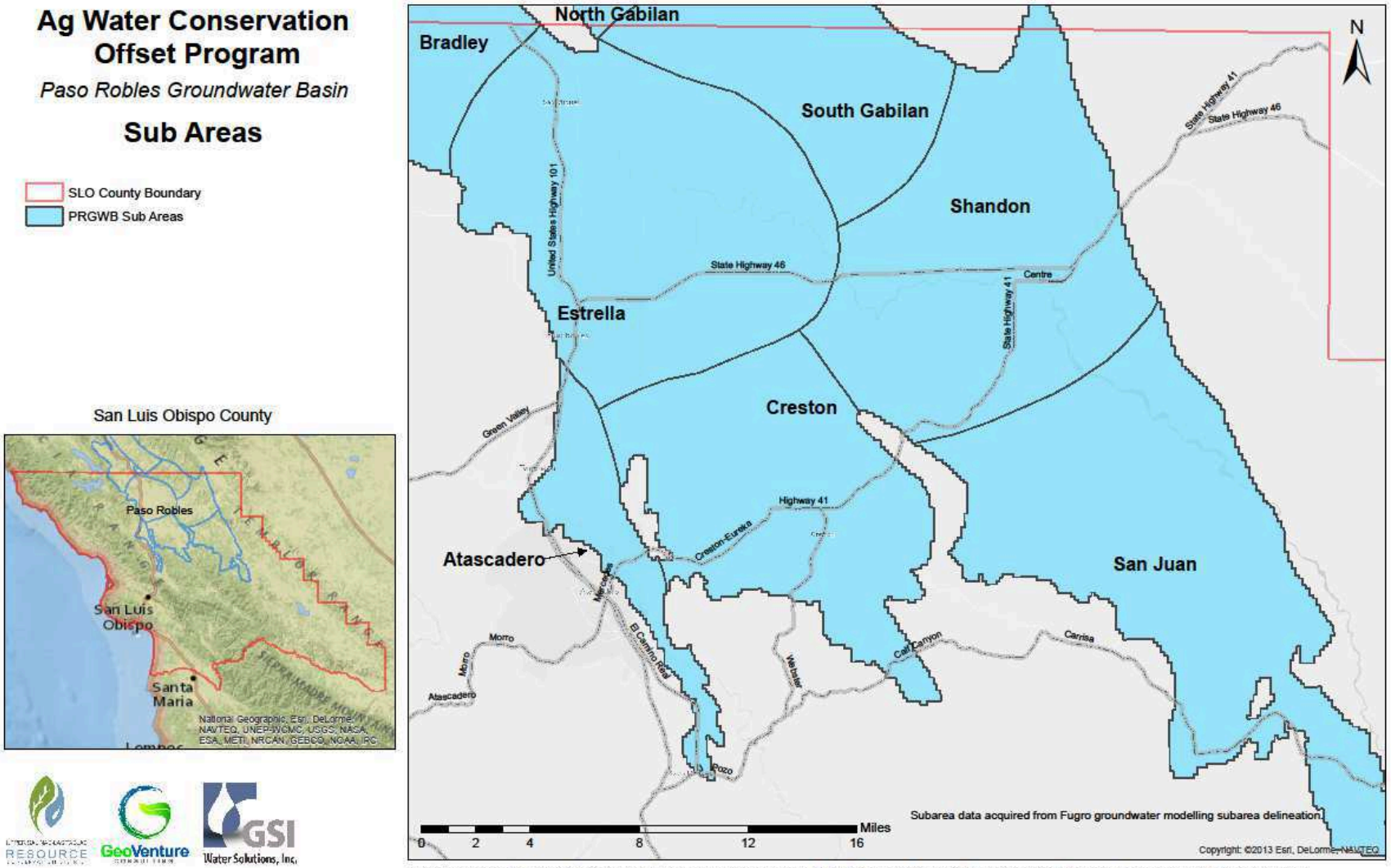
Figure C-1: Proximity Analysis Example



APPENDIX E. REFERENCE MAPS

See Following Pages

1. Paso Robles Sub Basin Sub-Areas



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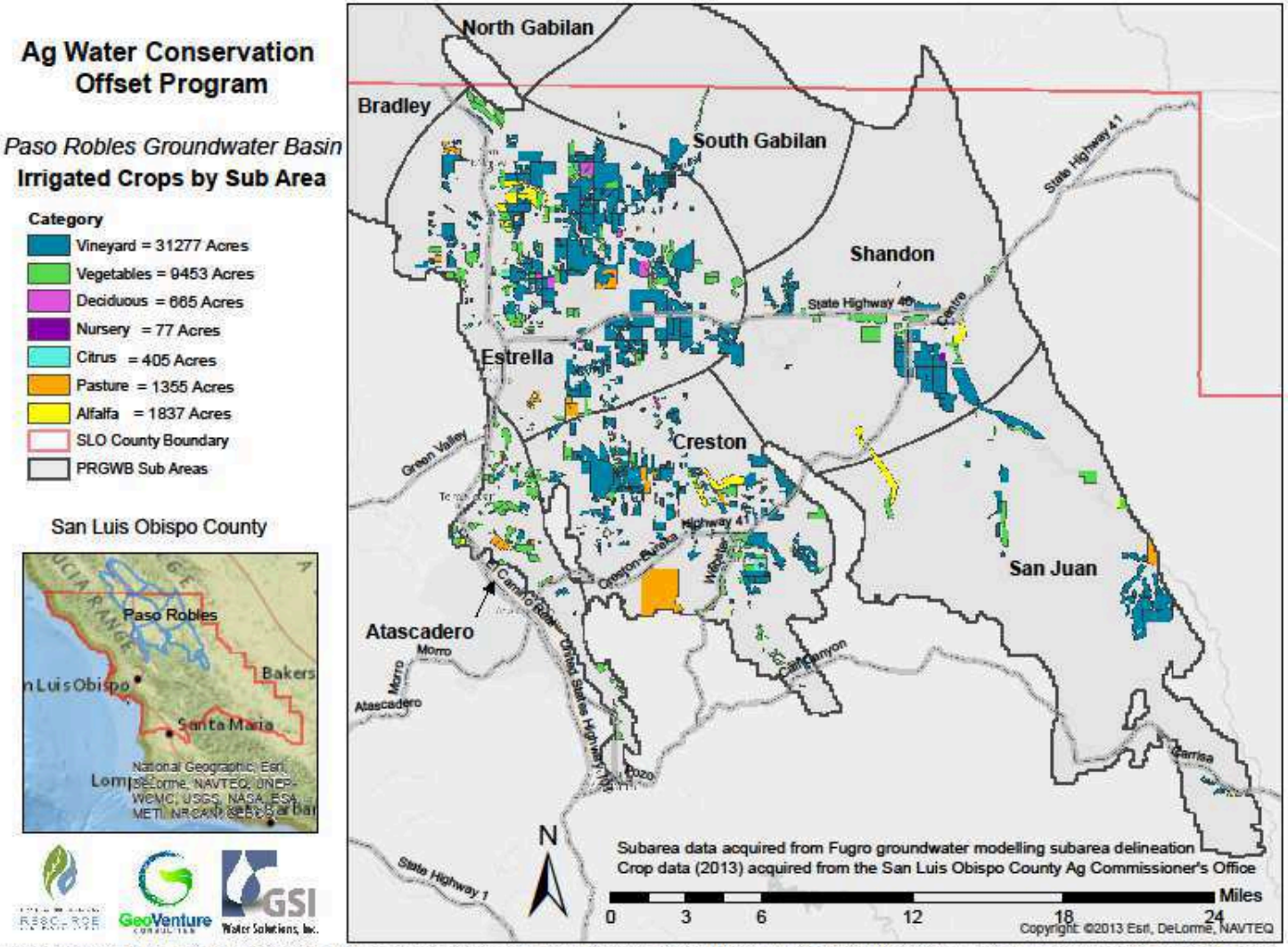
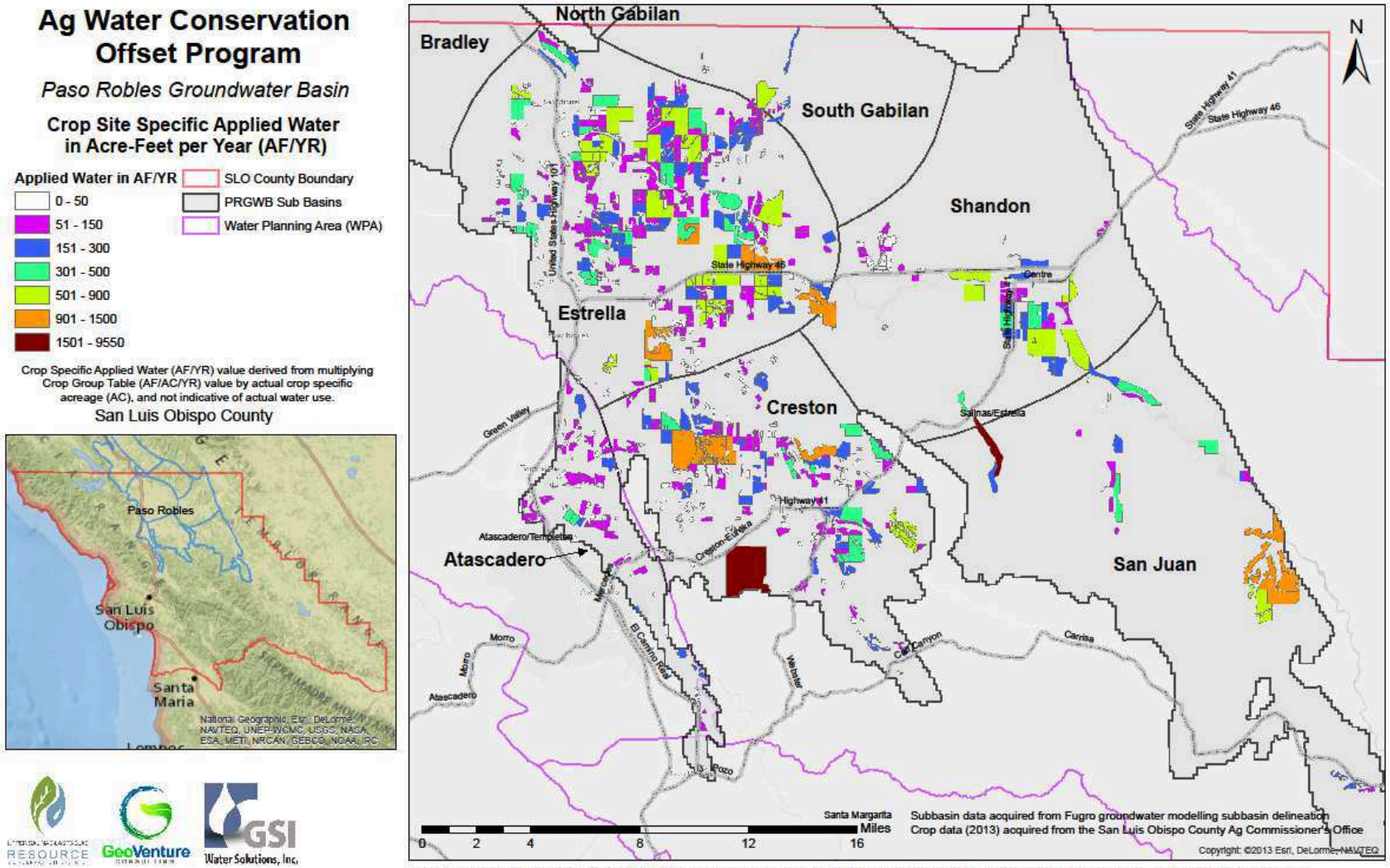
2. IRRIGATED CROPS BY SUB-AREA

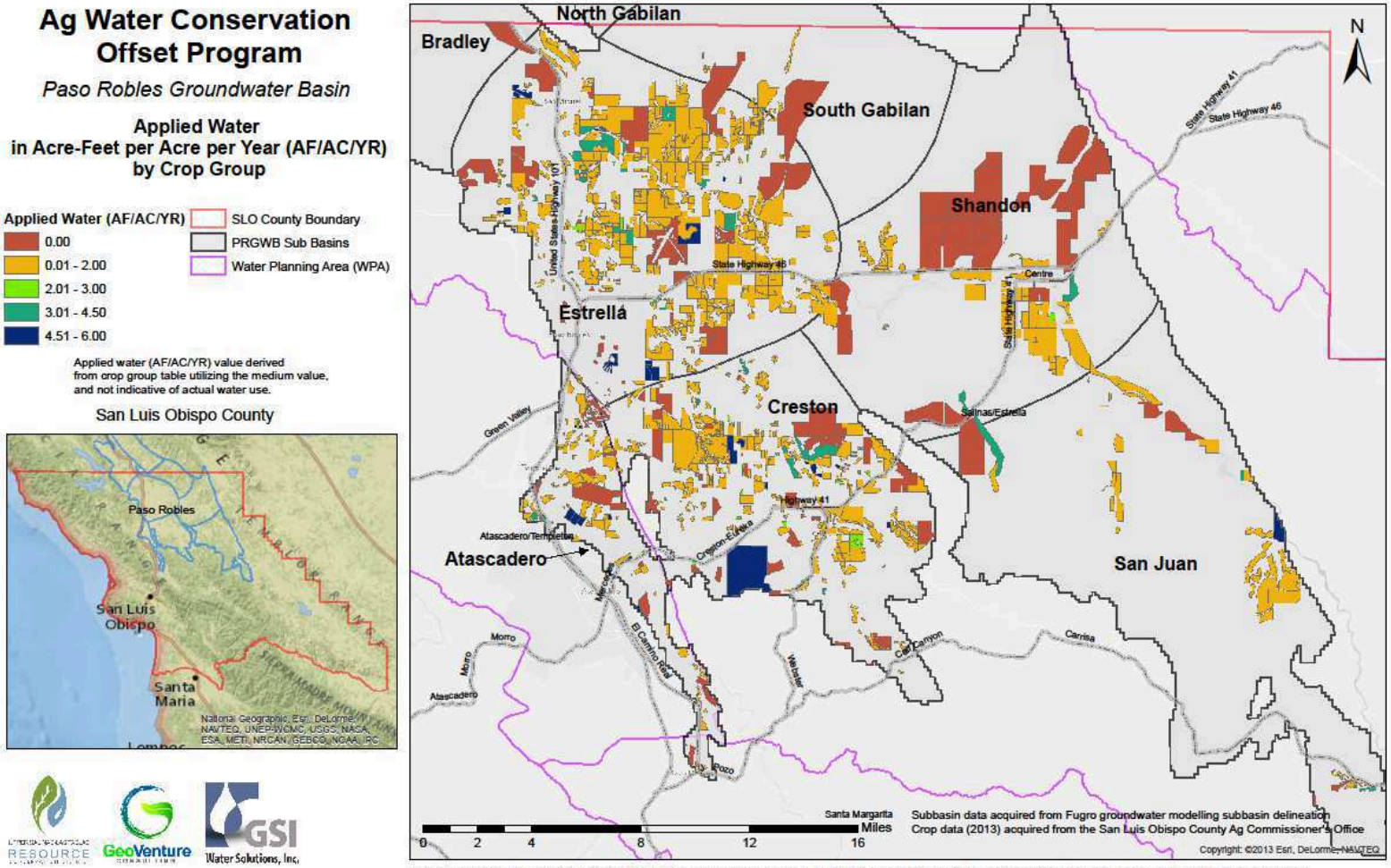


Disclaimer: GIS data are to be considered a generalized spatial representation that is subject to revisions. This product is for informational purposes and may not have been prepared for, or be suitable for legal, engineering, or surveying purposes. The US-LTRCD, US-MCRCD, GVC, or GSI assume no responsibility associated with its misuse.

3. APPLIED WATER BY CROP TYPE (AF/YR)



4. APPLIED WATER BY CROP GROUP (AF/AC/YR)



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