APPENDIX 2.G. CHOWCHILLA SUBBASIN DOMESTIC WELL INVENTORY

Prepared as part of the

Groundwater Sustainability Plan
Chowchilla Subbasin

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GSP Team:

Davids Engineering, Inc
Luhdorff & Scalmanini
ERA Economics
Stillwater Sciences and
California State University, Sacramento

Technical Memorandum:

Domestic Well Inventory for the Chowchilla Subbasin

Prepared for Madera County and the
Chowchilla Subbasin Groundwater Sustainability Agencies

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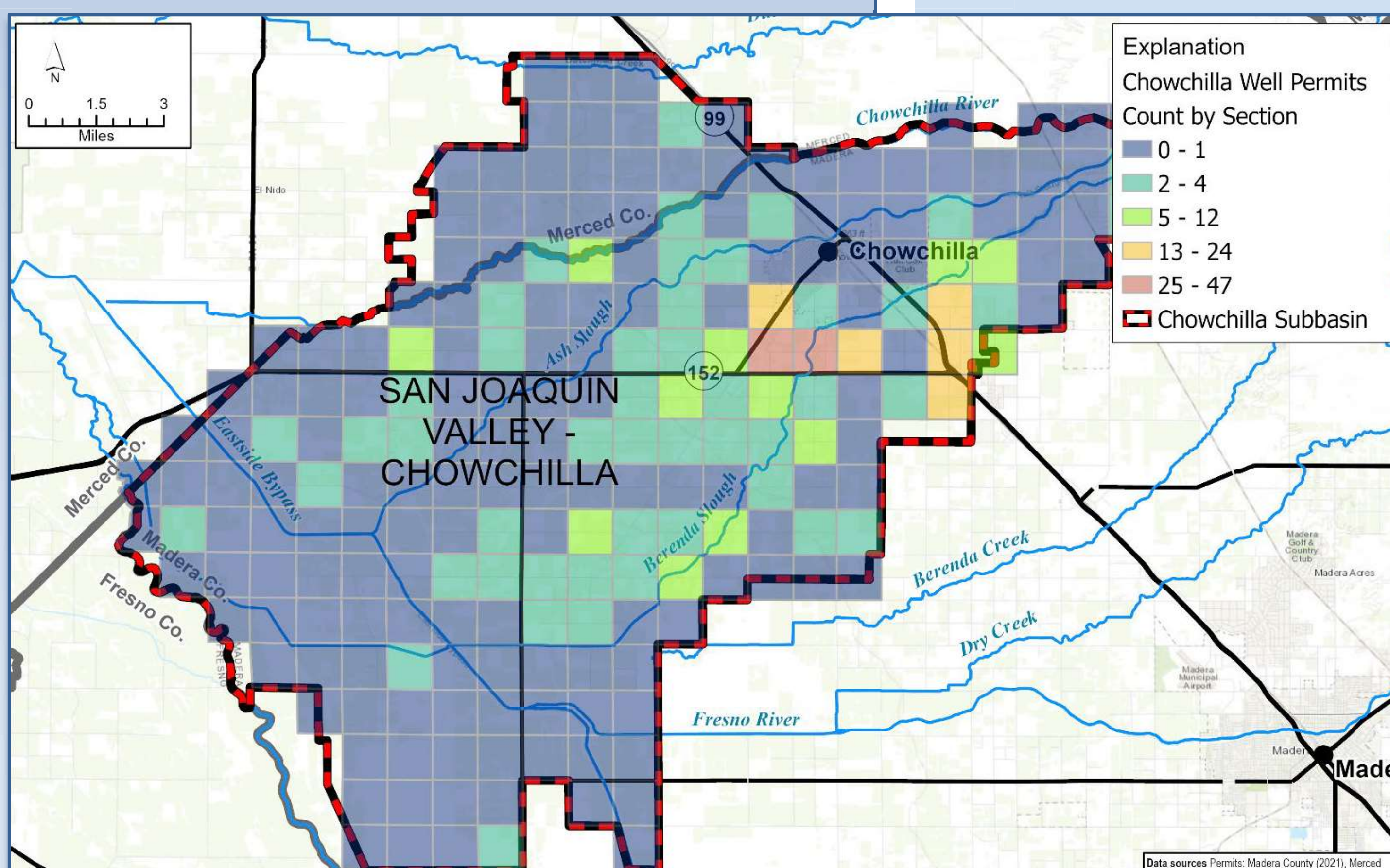
Prepared by

Luhdorff & Scalmanini
Consulting Engineers



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This memorandum was prepared for Madera County and the Chowchilla Subbasin Groundwater Sustainability Agencies to support implementation of the Chowchilla Subbasin Groundwater Sustainability Plan.

Luhdorff & Scalmanini Consulting Engineers

Luhdorff and Scalmanini Consulting Engineers conducted the Domestic Well Inventory project for the Chowchilla Subbasin and prepared this technical memorandum with assistance from ERA Economics.

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ATTACHMENTS

1. Domestic Well Replacement Economic Analysis – Chowchilla Subbasin Update
2. Chowchilla Subbasin – Evaluation of DWR Household Water Supply Shortage Reports and Self-Help Enterprises Tank Water Participants

LIST OF ABBREVIATIONS & ACRONYMS

Acronym	Meaning
APN	Assessor Parcel Number
CDP	Census-Designated Place
CDWR	California Department of Water Resources
CEHTP	California Environmental Health Tracking Program
DAC	Disadvantaged Communities
DDW	Division of Drinking Water
DTW	depth to water
GPS	Global Positioning Satellite
GSP	Groundwater Sustainability Plan
LSCE	Luhdorff & Scalmanini, Consulting Engineers
LSWS	Local Small Water System
MCSIM	groundwater model
MD	Maintenance District
MHI	median household income
OSWCR	Online System for WCRs
PLSS	Public Land Survey System
PWS	Public Water System
SDAC	Severely Disadvantaged Communities
SDWIS	Safe Drinking Water Information System
SGMA	Sustainable Groundwater Management Act
SHE	Self-Help Enterprises
SSWS	State Small Water System
SSWS	State Small Water System
SWRCB	State Water Resources Control Board
TM	Technical Memorandum
WCR	Well Completion Report

1 INTRODUCTION

The Chowchilla Subbasin Groundwater Sustainability Plan (GSP) includes maps, figures, analysis, and discussion of domestic wells and potential impacts from continued decline in regional groundwater levels during the GSP Implementation Period (2020 through 2040) while the Subbasin works to achieve sustainability. The GSP provided the background and data analyses to illustrate the need for a Domestic Well Mitigation Program in Chowchilla Subbasin and described how it is the most economically viable way to transition from current overdraft conditions to sustainable conditions in 2040. However, there was insufficient time during GSP development to conduct the more thorough inventory of domestic wells and the potential range of impacts to domestic wells under various scenarios of future groundwater conditions. This study supplements domestic well information provided in the GSP and provides an updated analysis that includes anticipated impacts to domestic wells during the GSP Implementation Period.

Madera County was successful in applying for a DWR grant under Prop 68 to conduct a more detailed well inventory, which is documented in this Technical Memorandum (TM). In addition, the grant funding provides for drilling and installation of nested monitoring wells at three sites in proximity to clusters of domestic wells to provide monitoring of current and future groundwater levels and quality. This TM includes recommendations for locations of these three nested well sites.

To prepare this domestic well inventory, approximations of the number, depths, and locations of domestic wells were developed from multiple available data sources. The total number of domestic wells indicated to be present according to different data sources were reviewed and compared. Domestic well depths were then compared to historical, current, and predicted future local groundwater depths based on observed and modeled data from the groundwater model (MCSIM) developed for and described in the 2020 Chowchilla Subbasin GSP. Due to the uncertainty in future climatic conditions for the GSP Implementation Period; two primary future condition scenarios were evaluated to bracket the range of domestic wells that are estimated to go dry during the GSP Implementation Period. Estimates of costs to replace domestic wells are included in this TM.

This TM documents the available data sources for estimating numbers and locations of domestic wells, domestic well construction details, and occurrence of domestic wells inside and outside of public and small community water systems, analyses to estimate the number of domestic wells that may go dry through 2040 based on two different climatic sequences, and sensitivity analyses to evaluate how various assumptions impact estimates of the number of dry wells. Using the results from the domestic well inventory and analysis, an updated economic analysis was also conducted comparing the tradeoffs of implementing a Domestic Well Mitigation Program during the Implementation Period versus immediately implementing demand reduction in the Subbasin to avoid significant and unreasonable adverse impacts on domestic well users. This economic analysis is included as **Attachment 1** (Domestic Well Replacement Economic Analysis) and provides an update to Appendix 3.C of the Chowchilla Subbasin GSP. **Attachment 1** incorporates the latest results from the domestic well inventory relative to the total number of domestic wells estimated to go dry during the GSP Implementation Period. The economic analysis evaluated the difference in costs for implementing a Domestic Well Mitigation

Program concurrent with gradual reductions in groundwater pumping over the twenty-year Implementation Period compared to not having a Domestic Well Mitigation Program and immediately implementing demand management and other PMAs to eliminate the overdraft in the Subbasin.

2 DOMESTIC WELL INVENTORY DATA SOURCES AND COMPILATION

Data from a variety of public agencies were assembled for consideration in the project. Compiled datasets included the following.

- Well Completion Report (WCR) Database from California Department of Water Resources (CDWR) Online System for WCRs (OSWCR)
- Madera County well permit database (records since 1990)
- Madera County Assessor's Parcel data
- Merced County well permit database (records since 1999)
- Merced County Assessor's Parcel data
- Public Water System (PWS) service area boundaries and PWS well locations from State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW)
- State Small Water System (SSWS) service area boundaries from Madera County
- Census block-level household counts from the US Census Bureau
- Disadvantaged Community boundaries from DWR

With the exception of the Madera and Merced County well permit databases, all of the above-listed datasets were available in geospatial (e.g., GIS) formats. The well permit databases were provided as tabular data, which were converted to geospatial information as described below.

2.1 DWR WCR Database

The primary source for well construction data in the Subbasin is the CDWR OSWCR database (CDWR, 2020). Well drillers are required to submit a WCR to DWR for all wells drilled and constructed in the State of California. DWR has tabulated information from WCRs for the State, including data from WCRs dating as far back as the early 1900s. The tabulated WCR information include well type and construction characteristics such as the intended use of the well, well depths, and screened intervals along with location, construction date, permit information, and other details included on the WCR. Although completed WCRs commonly include additional notes on borehole lithology and a variety of other types of information; however, lithology and some other well information included on WCRs is not entered or maintained in the OSWCR database. It is notable that many well attributes in the WCR database are blank or incomplete because of missing or illegible information provided on the WCRs. Additionally, well locations in the WCR database are commonly only provided to the center of the Public Land Survey System (PLSS) section in which it is located, which translates to a locational accuracy of approximately +/- 0.5 mile.

2.1.1 Domestic Well WCRs

As part of the project, initial quality checks were conducted on the WCR database to identify obvious inconsistencies in well data, including conflicting well locations (e.g., latitude, longitude, PLSS coordinates) and construction (e.g., well depths, top and bottom of screens). Such questionable information and records were flagged for additional consideration during subsequent analyses. For the purpose of this domestic well inventory project, only WCRs indicated to be domestic water supply wells were included in the analysis. To limit potential double counting of domestic wells, only WCRs for new well construction (i.e., not well repairs/modifications or destruction) were included in the domestic well inventory.

The number of well records within the Chowchilla Subbasin in the WCR database exhibit a notable increase starting in about 1970 as indicated by domestic WCR counts by decade presented in **Table 1**. This shift may be partly due to changes in the Water Code relating to well data collection methods and reporting requirements that were instituted in 1969. The number of WCRs for domestic wells in the Chowchilla Subbasin increased by a factor of two around 1970, from 46 WCRs in the 1960s to 76 in the 1970s.

2.1.2 WCR Dates

The typical lifespan of a small water well is estimated to be 30 to 50 years based on the durability and longevity of typical domestic well materials, which are commonly constructed of steel or polyvinyl chloride (PVC) casing. Wells drilled prior to 1970 are also less likely to still be in operation because of long-term trends in groundwater levels in the Subbasin.

For these reasons, only WCRs for wells with dates on or after 1970, were included in the domestic well inventory and associated analyses. The OSWCR database includes 62 domestic well new construction WCRs located in the Chowchilla Subbasin that do not have any recorded installation or permit dates. For this well inventory and analysis, these 62 wells were included in the analysis even though some fraction of them may have been constructed prior to 1970. A total of 500 domestic wells constructed since 1970 were considered in the project based on WCR records.

2.1.3 WCR Locations

Wells with WCRs marked as domestic were selected and mapped based on one of four geolocation methods, depending on what information was available in the tabulated data. Only wells with installations in 1970 or later were considered, or those with no available date of installation. The geolocation methods, in order of priority, are as follows:

1. Assessor Parcel Number (APN) – 236 wells
2. Address – 95 wells
3. Public Land Survey System (PLSS) – 169 wells

A total of 500 domestic well were located within the Chowchilla Subbasin using these methods (**Figure 1a**). Wells located by PLSS are typically placed at the center of the section in which they are located, and thus may be out of position by as much as about 0.5 mile (half the typical width of a section). Other sources of location error include changes in APNs over time; poorly matched addresses; and incorrect WCR entries for PLSS values, GPS coordinates, APNs, or addresses. Since many of the location dots for domestic wells plot on top of each other in **Figure 1a**, the locations of domestic wells in the Subbasin by Township/Range/Section are displayed in **Figure 1b**. Of the 500 domestic well WCRs, only 17 are located in Merced County, and the rest are located in Madera County.

2.2 Well Permit Records

Madera and Merced Counties require a well permit be obtained prior to drilling and constructing a domestic well. Records of well permits were provided by Madera and Merced Counties as tabular datasets (Madera County Environmental Health, 2020; Merced County Environmental Health, 2020); no GIS data were initially available for the well permits. The period of record for the well permits begins in 1990 for Madera County and 1998 for Merced County. Limited information on individual wells is available in the well permit dataset, although most well permits include Assessor Parcel Numbers (APNs) or well addresses that can be used for locating wells. Well uses in the permit dataset were inconsistently entered and required considerable review and assessment to standardize well uses for identifying likely domestic well permits.

2.2.1 Domestic Well Permits

2.2.1.1 Madera County Domestic Well Permits and Locations

A subset of 7,505 permits for all of Madera County was identified as likely domestic wells based on the indicated well use. The well uses retained as representative of likely domestic wells include the following:

1. Domestic (7300 permits),
2. Domestic Replacement (25 permits),
3. Shared (54 permits),
4. Dairy (36 permits),
5. No Use listed (90 permits).

“Shared” wells are typically domestic wells that are also used for irrigation. “Dairy” wells are typically used for semi-industrial, and irrigation uses on a dairy, but in some cases can also be used for domestic water supply. Wells without a listed use were included in an effort to be conservative in the domestic well inventory.

Of the 7,505 domestic well permits (7,362 with APNs) for all of Madera County, the portion applicable to Chowchilla Subbasin were identified based on locations derived from APNs and addresses. Multiple permits refer to the same APN in some cases with only 6,498 unique APNs listed as having domestic well permits in the database. Domestic well permits in the County well permit database were located by matching the listed APN with the county parcel data when possible. Following this approach, 426 permits were matched to 378 unique parcel locations within Chowchilla Subbasin. For the 143 Madera County well permits without APNs, 8 permits were expected to be located within the Subbasin based on the fraction of permits with APNs that were determined to be within the Subbasin.

In addition to APNs, the Madera well permit database includes site addresses for most (7,323) of the wells. Through geocoding of addresses in the well permit database, 6 more well permits were located within the Subbasin.

Through locating of well permits based on APNs and site addresses, approximate locations for 6,709 of the 7,505 Madera County domestic well permits were determined. Using these locations, the total number of domestic well permits in the Madera County portion of the Chowchilla Subbasin was determined to be 432 permits (at 384 unique locations) out of 7,505 domestic well permits in the data base. Madera County well permit information is summarized in **Table 2 and Figures 2a and 2b**.

2.2.1.2 Merced County Domestic Well Permits and Locations

Two datasets of well permit records were provided by Merced County. The first well permit dataset includes 2,034 domestic wells drilled since 1996, with depths and locations (as latitude and longitude) provided for all wells. Locations for these wells were determined using the coordinates included in the dataset. None of these wells are located in the Chowchilla Subbasin. The second dataset of well permit information available from Merced County includes 291 domestic wells that were installed in 1998 and later. These permit locations were determined based on addresses provided in the dataset for all wells. Most of these wells (all but 12) also have depth information. Seven of these 291 domestic wells with permits are located within the Chowchilla Subbasin. Merced County well permit information is summarized in **Table 2 and Figures 2a and 2b**.

2.3 County Assessor Parcel Data

County Assessor parcel GIS data were provided by Madera and Merced Counties (Madera County Assessor's Office, 2020; Merced County Assessor's Office, 2020), including land use and other characteristics for each APN indicating the presence of a dwelling. The Madera County parcels dataset includes 7,033 unique APNs within the Chowchilla Subbasin. Of those, 4,494 are listed as having dwellings associated with them. The Merced County parcels dataset includes 160 unique APNs within the Subbasin. Of those, four are listed as having dwellings associated with them, for a total of 4,498 in the Subbasin (**Figure 3)**. Although the County parcel datasets do not include records related to the presence of domestic wells on parcels, the presence of a dwelling on a parcel is interpreted to suggest the presence of a drinking water supply, including in some areas the potential for a domestic well to exist. This includes parcels that are located within a public water system service area.

2.4 Water System Data

Public Water System (PWS), State Small Water System (SSWS), and Local Small Water System (LSWS) service area boundaries from State and local data sources were used to map and evaluate where and how many inferred well locations occur inside of a water system service area and therefore may not be supplied by a domestic well. Water system boundaries are a key dataset for comparing with potential domestic well locations identified through analysis of WCRs, parcels, and permits. The service area boundaries for water systems identified in the Subbasin are presented on **Figure 4** based on the evaluation of PWS, SSWS, and LSWS boundaries as described below

2.4.1 State Regulated Systems

The PWS boundaries are part of an archived dataset developed by the California Environmental Health Tracking Program (CEHTP) and now maintained by the State Water Resources Control Board (SWRCB) Division of Drinking Water (DDW) (SWRCB, 2021). This dataset is a publicly available GIS feature class of system boundaries provided voluntarily by water system operators over the period from 2012 to 2019. Previous assessments of this dataset suggest it includes approximately 85 percent of community water systems, although this can vary by region within the state. Of the state regulated community PWS boundaries, two were identified to have service areas within Chowchilla Subbasin.

2.4.2 County Regulated Systems

The PWS service area dataset from DDW is not intended to include county-regulated systems. Madera County Public Works provided additional service area boundary data for county-regulated water systems (Madera County Environmental Health, 2021), but none of these County water system boundaries are within the Chowchilla Subbasin. Merced County Environmental Health was asked to provide locations of county-regulated systems in the Chowchilla Subbasin and indicated that none exist in that area.

2.4.3 Public Water System Wells

PWS well locations were downloaded from the SWRCB GAMA website (SWRCB, 2021) and used to check for any water system wells in areas not covered by the water systems service area boundaries data. All PWS wells were located within previously delineated water system service area boundaries.

2.5 Community Data

2.5.1 Census

United States Census data (US Census, 2016) were used for cross-checking and comparison with domestic well WCRs, domestic well permits, and parcels with dwellings in the Subbasin. The Census data include counts of households by Census area (e.g., block, tract, designated place). The Census data were evaluated to assess whether they could inform the count and locations of domestic wells in the Subbasin. To approximate the number of households that might have a domestic well, Census block area were converted to randomly located points within each block equal in number to the count of households per block. The resulting 2,739 points represent an estimate of the total number of households within the Subbasin that might have a domestic well (**Figure 5**). This includes households that are included within a public water system service area.

2.5.2 Disadvantaged Communities

DWR defines Disadvantaged Communities (DACs) as communities with an annual median household income (MHI) less than 80 percent of the Statewide annual MHI (PRC Section 75005(g)), and SDACs as communities with an annual MHI less than 60 percent of the Statewide annual MHI. The statewide median household income (MHI) for the Census American Community Survey (ACS): 2014-2018 dataset is $71,228. Therefore, a community where the MHI is less than $56,982 meets the DAC threshold and a community where the MHI is less than $42,737 meets the SDAC threshold.

DWR provides a standardized GIS layer of Disadvantaged Communities and Severely Disadvantaged Communities (DACs, SDACs) (DWR, 2021). These data are available as Census Designated Places, Census Tracts, or Census Blockgroups. The Tract-level data are simply aggregated from the Blockgroup-level data and were not used in the current analysis. Place-level data are not congruent with Blockgroups or Tracts, typically following established neighborhood boundaries. Place-level data provide a more focused description of the regions that qualify as DAC or SDAC; however, the Place-level data is only available in Census-Designated Places (CDPs), and these do not capture more diffuse residential neighborhoods. DACs and SDACs are found in both urban and rural areas in Chowchilla Subbasin. **Figure 6** shows the locations of the Census Designated Places and Census Blockgroups identified as DACs or SDACs by the definition above.

3 ANALYSIS AND RESULTS

Estimates of domestic wells were developed through analysis and comparison of the data sources discussed above. Evaluation of the number and locations of domestic wells in Chowchilla Subbasin were made using four different sources of data and approaches: from WCRs, well permits, parcels with dwellings, and Census households. Domestic well WCRs and well permits provide a more direct indication of the existence (past or present) of a domestic well, whereas the parcel data and Census data provide a basis for inferring the existence of domestic wells. The County well permit databases are believed to provide the most accurate estimate of the numbers and locations of domestic wells constructed during the available data record (since 1990 in Madera County and from 1998 in Merced County).

The completeness of the well records in County well permit data are expected to be greater than the WCR database because although regulations state that WCRs are required to be submitted to DWR for all constructed wells, there has historically been little or no verification at the County or State level that a well driller submits a WCR to DWR after a well is completed. In cases where a WCR is submitted, the time elapsed between when a well is drilled and when a WCR is submitted to DWR can be highly variable and information provided on WCRs may not be complete. There are also additional steps involved in entering WCRs into DWR’s database after receiving a WCR, which may also introduce timing delays or data entry errors. In contrast, although there is generally no information about a given well’s design provided in the County well permit database, there is a fee to obtain a well permit and permits are typically obtained by the driller immediately prior to starting work on a project. Therefore, it is believed that most permitted wells are constructed even if a corresponding WCR is never submitted to DWR by the well driller.

The locational accuracy of well permit records are also believed to be better because most well permit records include data on the parcel where the well is permitted. Many of the WCR records only indicate location by the PLSS section in which the well is located.

Although the well permit data are believed to be more complete and provide better locational accuracy of wells, only the WCR data have information on well depths and other well construction details (**Figure 7a**, **Figure 7b**). Additionally, while WCRs and well permits generally have a date associated with each record indicating the approximate date of well construction, the parcel and Census datasets do not.

However, estimates of well counts based on parcel and Census data do provide a sense for the maximum possible number of domestic wells, and also a comparative check on the relative spatial density of domestic wells in the Subbasin.

Water system service area boundaries were used to refine domestic well estimates derived from parcel and Census household counts, with the expectation that all parcels and households within a water system boundary are served water from the water system and therefore do not rely on a domestic well. The locations and count of permits and WCRs were assumed to be correct, regardless of their location relative to a PWS service area.

With this information, estimated locations and counts of domestic wells in the Subbasin were developed and well depths were compared to historical groundwater levels and model-simulated future groundwater levels (based on the modeling conducted during GSP development) to evaluate potential impacts to domestic wells from changing groundwater levels in the Subbasin. The methods and results from these analyses are described below.

3.1 Analysis of Domestic Well Locations and Counts

3.1.1 Domestic Well WCRs

The domestic well WCRs since 1970 were compared with water system boundaries. Because the WCRs are records of actual wells that were constructed, those located within a water system service area are assumed to be correctly located. It is possible that wells that pre-existed the establishment of a water system in an area may remain in use after the water system is operational; however, the frequency of this occurring is not known.

Of the 500 domestic wells represented by WCRs in the Subbasin, 12 are located within the known water system boundaries (**Figure 8**). This represents 2.4 percent of the domestic well WCRs in the Subbasin. Some of these domestic well WCRs may be associated with wells that no longer actively supply domestic drinking water. Nevertheless, WCRs within a water service area boundary were still considered in the domestic well inventory and analysis described below, which is a conservative assumption relative to likely domestic well counts.

3.1.2 Domestic Well Permits

Similar to the WCR estimate, permits are expected to accurately identify well locations, but domestic well permits may exist for wells drilled and constructed prior to the operation of a water system in an area. The use of such wells may have been discontinued when a residence was hooked up to a water system, although this may not always be the case and some domestic wells within water system service areas may still be operational.

In contrast to the WCR dataset, which relies on submittal and entry of a WCR in DWR's database, the County well permit datasets are expected to be a more comprehensive representation of the wells drilled in the County for the period it covers (1990 to present for Madera, 1998 to present for Merced). Although the comparisons across different datasets described below highlight differences between data sources and the estimates of domestic wells derived from each, this study did not attempt to assess the accuracy of the well permit database in relation to actual domestic wells.

Of the 439 domestic well permits in the Subbasin, two are located within known water system boundaries, which represents about 0.5 percent of the domestic well permits in the Subbasin. These two permits within a water service area boundary were still considered in the domestic well inventory and analysis described below.

3.1.3 Parcels with Dwellings

For the purpose of assessing the maximum possible number of domestic wells in the Subbasin, all parcels with a dwelling but not within a water system service area were counted. In this approach, a parcel is considered within a water system service area if its centroid is within the service area.

Based on these criteria, within the Chowchilla Subbasin there are a total of 4,498 parcels with dwellings, 967 (963 in Madera County, four in Merced County) of which are outside of water system service area boundaries. These 967 parcels representing potential domestic well locations are presented on **Figure 9**. There are several areas within the Chowchilla Subbasin with a relatively high density of parcels with dwellings that are not covered by a water system boundary.

3.1.4 Census households

Due to the irregular shape of Census blocks and the inconsistent alignment of blocks with other important boundaries in the Subbasin (e.g., Subbasin, water service areas) the Census data provided have limited utility to inventory domestic wells, although they do provide an approximate check on the maximum overall number of potential domestic wells in the Subbasin. Conversion of the Census household counts to points and comparing to water system service areas provides as estimate of 1,294 potential households outside of water system service areas. Within that set of 1,294 potential wells, 1,241 are in Madera County, and 53 are in Merced County. Although the total number of parcels with dwellings is almost twice as large as the total number of households within the Subbasin, the number of households estimated to be outside of the water system service areas is about 33% higher than the number of parcels outside of the water system service areas.

3.1.5 Comparisons of Domestic Well Location Information Sources

3.1.5.1 Domestic Wells Within PWS Service Areas

While most residences within a PWS service area are supplied with drinking water by that PWS, it is not unusual for wells drilled prior to the creation of the PWS would be retained and used for part or all of a residence's use, including for drinking water or landscape irrigation.

Of the 500 WCRs since 1970 located in the Chowchilla Subbasin, 12 are located within a water system service area. Of the 436 permits (since 1990) located within the Madera County portion of the Chowchilla Subbasin, two were located within a water system service area. None of the seven permits (since 1998) located within the Merced County portion of the Chowchilla Subbasin were located within a water system service area. Overall, less than 0.5 percent of domestic well permits are located within a water system service area.

Of the 4,498 parcels with dwellings noted in the two county APN datasets, 3,531 are within a water system boundary. Of the 2,739 households in the Subbasin indicated by the 2010 Census data, 1,445 are within a water system service area.

The count of known locations of permits and WCRs within water systems, when compared to the number of residences within those systems based on parcel and Census data, represent between zero and three percent of the number of residences within those service areas. This suggests that the number of domestic well permits and WCRs located within water system boundaries is a very small fraction of the number of likely residences within those water system areas. Accordingly, this comparison suggests that neither the WCR nor well permit data identify a large number of domestic wells within water system boundaries. Although this does not speak to the accuracy of the WCR and well permit data in locating wells in other areas of the Subbasin, they do not appear to identify an unreasonable number of domestic wells within areas covered by water systems.

3.1.5.2 Comparing WCR Locations to Well Permits

The Madera County well permits dataset is believed to be more complete in representing wells drilled in the County, but it only extends back to 1990. To provide an appropriate comparison between the WCR dataset and the well permit dataset, a subset of the WCRs since 1990 (those dated after 1989), were considered. In the Madera County portion of Chowchilla Subbasin, 304 domestic well WCRs have construction dates after 1989. An additional 58 domestic well WCRs have no installation date recorded. For this analysis, WCR records without dates are assumed to be drilled in 1990.

The subset of domestic wells with WCRs since 1990 has many similar characteristics as the dataset for WCRs since 1970, with several noteworthy differences. As shown in **Table 3**, proportionally, the WCR dataset since 1990 has fewer WCR records located in water system service areas. This is reasonable, as it is consistent with the understanding that many of the domestic well WCRs located within water system service areas are for wells drilled prior to the creation or expansion of those water systems.

There is no direct linkage between WCRs and well permits on record (i.e., WCRs commonly do not indicate well permit numbers) for majority of the wells, and the available method for geolocating records for a given well present in both datasets may differ. However, it was determined that 166 of the parcels associated with permit locations coincided with WCR locations for domestic wells for Madera County (and another two wells for Merced County), and the spatial distribution of Madera and Merced County domestic well permits and WCRs are similar within the Subbasin (**Figure 10**).

This relatively low rate of coincidence is most likely a function of poor accuracy of the WCR locations. The permit location error is generally related to the area of the parcel within which they are located and is commonly less than half the distance of the maximum parcel dimension. As parcel size decreases, the accuracy of the locating of well permits tends to increase. Many WCR locations have much higher error, especially those that rely on locations from the PLSS section centroid. In addition, the subset of domestic well WCRs since 1990 in the Madera County portion of the Chowchilla Subbasin has a similar spatial distribution to the dataset of WCRs since 1970. Therefore, the WCRs since 1970 likely reasonably represent the distribution of permits since 1970 similar to the way WCRs from 1990 and later represent permits from 1990 and later.

The Merced County well permits dataset only has records for 1998 and later, so a comparison with the WCRs for the Merced County portion of the Chowchilla Subbasin can only be made with WCRs from 1998 and later. Of the 17 WCRs for wells in the Merced County portion of the Chowchilla Subbasin, eight were installed after 1998. Four more WCRs in the area had no installation date.

Two of the seven permits for wells in the Merced County portion of the Chowchilla Subbasin are on the same parcel as WCRs for the area. Of those two, one also shares an address with the WCR that overlies it. Another permit shares an address with a WCR, but is not located on the same parcel, based on the APN location of the WCR. This may be due to an error on the WCR, or to changes in the APN since the well was installed. The APN identified on the permit matches the APN identified on a WCR for four of the wells.

3.1.5.3 Comparing Domestic Well Permits with Parcel Characteristics

Of the 439 domestic well permit locations identified within the Chowchilla Subbasin, 350 (80 percent) are located on parcels with dwellings, as indicated in the parcel datasets for Madera and Merced Counties, suggesting that a residence is present on the parcel associated with the well permit (**Figures 11a and 11b**).

3.1.5.4 Comparisons of Parcels with Dwellings and WCRs

Of the 967 parcels listed as having dwellings in the Chowchilla Subbasin, and not within a water system boundary, 202 coincide with the location of domestic well WCRs located as described above. All 202 of these were in Madera County. Only one parcel listed (in Madera County) with a dwelling was located within a water system and also coincided with a WCR location (**Figure 12**). As discussed above, WCRs are poorly located due to lack of APN, GPS, or address data.

3.1.6 Final Domestic Well Count and Location Estimates

The Madera County permit database includes 432 domestic (or considered domestic for this analysis) wells installed since 1990. For providing a direct comparison of the domestic wells counts from the WCR database, the count of WCRs was limited to WCRs with dates since 1990 (362 domestic well WCRs) to allow for direct comparison to available County permits. This comparison yields a ratio of 1.19 between the domestic well permit count and the domestic well WCR count. Well permits are believed to provide a more complete representation of wells constructed in the Subbasin, but these permit records do not contain information on well perforations and depths and only date back to 1990. As a result, the ration of well permits to WCRs for the period since 1990 provides a useful scaling metric of results derived during the evaluation of potential impacts on domestic wells from changing water levels, an analysis which relies heavily on well construction information available only on WCRs. The domestic well impacts analysis is described below.

3.2 Evaluation of Potential Domestic Well Impacts

A key consideration in the implementation of the GSP for the Chowchilla Subbasin is the potential occurrence of impacts to domestic well users due to declining water levels. As part of implementing the GSP, the Subbasin is in the process of evaluating and designing a Domestic Well Mitigation Program targeting domestic wells that may be impacted by future declines in groundwater levels. To support this effort, the effects of historical and future groundwater levels on domestic wells in the Subbasin were evaluated.

This analysis involved comparing domestic well perforation and depth information to historical groundwater levels and potential future groundwater levels, as simulated by the groundwater model (MCSim) utilized during the GSP development. Simulated groundwater level conditions from MCSim were used to estimate the number of domestic wells that may go dry during the GSP implementation period from 2020 through 2040, the period during which the Subbasin will be working towards achieving sustainability as required by SGMA. WCR records for domestic wells (and the well construction information provided on WCRs) were used to estimate well depth information for evaluating impacts. The ratio of well permits to WCRs (1.19) was used to upscale the results derived from these analyses conducted using WCR data.

3.2.1 WCR Domestic Well Construction Information

Of the 500 domestic well WCRs in the Chowchilla Subbasin, 479 included some information on bottom of perforated interval (top and bottom of perforations) or total depth. As mentioned earlier, several inconsistencies in construction information were noted in the initial WCR dataset (e.g., total well depth less than depth to top of perforations, depth to bottom of perforations less than top of perforations), so multiple levels of quality checks were conducted on the well construction data in the WCR database to assess the reliability of the information. Only WCR records determined to have sufficiently reliable well construction information (i.e., lack of obviously conflicting information on the well construction) were included in the summary and analyses relating to domestic well construction in the Subbasin. In analyses using well perforations (screens), where data for bottom of perforations was not available, the reported total well depth was used. A total of 454 WCRs included top of screened interval information. For wells lacking information for either bottom of perforations or top of perforations, the average values for wells in the same section were used. Where a section had fewer than three wells with reported depth or top of screen data, the average values from wells in the same section and the eight surrounding sections were used. This resulted in estimates of top and bottom of perforated Intervals for all 500 domestic well WCRs in the Subbasin. **Figure 7a** and **Figure 7b** show the depth of domestic wells in the Subbasin based on these estimates.

3.2.2 Domestic Well Impacts Analysis Methods

Simulated groundwater levels output from the MCSim model developed by Luhdorff & Scalmanini Consulting Engineers (LSCE) and described in the 2020 GSP for Chowchilla Subbasin were queried to produce depth to water (DTW) datasets for the Subbasin for the period from 1989 through 2070. MCSim is a multi-layered model and based on review of the well data and consideration of the hydrogeologic conceptual model and groundwater conditions described in the GSP, model layers 3 and 4 were determined to most appropriately correspond with the production zones for most domestic wells in the Subbasin. The simulated DTW datasets for model Layers 3 and 4 were used to extract DTW values for different time periods at all WCR locations; DTW values at each domestic well WCR location were compared with the top and bottom of perforations (screens) values for each WCR. Based on this comparison, the wells were assigned DTW values for either model Layer 3 or 4. If a well was screened at least 50 percent in Layer 4 or deeper, the well was assigned DTW values for Layer 4. If more than 50 percent of the screened interval was above Layer 4 (in Layer 3 or shallower) then Layer 3 DTW values were assigned to the well.

Simulated depth to water model output for Layers 3 and 4 for the years from 1989 to 2039 were then compared to the screened intervals for each domestic well (WCR) to assess if each well was wet or dry during each year. For each year, the fall simulated DTW (on October 31st) in Layers 3 and 4 of the model were assessed for each well location.

The analysis was performed using different analysis periods and methods. Generally, the analysis was conducted using five-year analysis periods, with the first analysis period starting in 1989 and extending to 2014 or 2015 followed by shorter five-year intervals thereafter. Analyses included comparisons based on snapshots of DTW conditions at the end of each analysis interval (generally five-year analysis periods) and separate comparisons based on the maximum depth to water found during each analysis period. Variations of analyses were also performed using simulated model output from the projected model run used in the GSP, and also separately for a model run utilizing a projected future hydrology that included drier conditions during the early years of the GSP Implementation Period, conditions that are more consistent with the recent hydrology experienced in the area. In all analyses, if the simulated DTW in the assigned model layer at a well location falls below the required minimum level of saturation in relation to the depth of the well, either at the end of each analysis period (or in the year within each five-year period that generally had the lowest water levels for the maximum DTW scenario), the well was considered to have gone dry during the analysis period. Once a well was concluded to have gone dry in an analysis scenario, it was removed from the pool of potential wells that could go dry in subsequent years. The sensitivity of model results to different assumptions, analysis periods, and WCR data restrictions were tested and evaluated.

The parameters used in the analysis are defined as follows:

P = the base year for the analysis periods. This defines the end of the initial historical analysis period (after 1989) during which wells were evaluated for historically having gone dry. This is generally Fall 2019, indicating a historical analysis period of 1989-2019, but 2018 was also used as the ending year for the historical period during sensitivity analyses (because groundwater levels in 2018 were generally lower than in 2019).

S = minimum saturation threshold above the well total depth for a well to remain wetted. This is assumed to be 10 feet in the baseline analysis, but the sensitivity of analysis results to varying this value was conducted to evaluate the influence of this parameter on analysis results.

E = the earliest year of installation for the WCRs considered. This reflects the cutoff year for the construction date on WCRs intended to reflect wells that may have been active at the time of the base year considered based on typical domestic well life expectancy.

Appropriate scaling of the results of these impacts analyses based on WCR was also considered based on the ratio (1.19) of domestic well permits to domestic well WCRs determined previously. The ratio is developed from a direct comparison of domestic well permits and WCRs with dates since 1990. The scaling ratio is applied for the entire Subbasin (including the Merced County portion) and is assumed to have limited spatial or temporal bias across the Subbasin or across the period since 1990. The potential for bias in the ratio has not been evaluated.

The baseline analysis scenario of potential domestic well impacts involved the parameters listed below.

- Snapshots of DTW at the end of each analysis period
- The ending year for historical analysis is 2019, with historical analysis period 1989-2019 (P = 2019). Corresponding analysis periods as follows:
    - 1989-2019
    - 2020-2024
    - 2025-2029
    - 2030-2034
    - 2035-2039

  The analysis periods were selected to correspond with the dates of the Interim Milestones and preparation of Five-Year Update Reports.

- Minimum well saturation threshold of 10 feet (S = 10).
- Using projected model run from GSP (without early sequence of dry years).
- Wells analyzed based on the WCR count of wells installed since 1970 (E = 1970).

Because the early years of the projected model period, including during the early GSP implementation period, have been dry, an alternative analysis scenario evaluated potential domestic well impacts based on simulated groundwater levels from a model run that starts with a drier sequence of years. This analysis involved the same parameters as the baseline analysis (described above) but used simulated groundwater levels from a different projected model run with an early dry period.

3.2.3 Results of Domestic Well Impacts Analyses for Baseline GSP Climate Scenario

In the baseline analysis scenario described above, a total of 95 of the 500 domestic wells (from WCRs) analyzed are indicated to have gone dry during years prior to 2020. A total of 83 wells are projected to go dry between 2020 and 2039 (**Table 4a**). The analysis suggests 40 of the total of 83 domestic wells are estimated to become dry between 2020 and 2024. **Table 5a** includes the results for this analysis when scaled up by a multiplier of 1.19, the ratio of well permits to WCRs.

3.2.3.1 Spatial Distribution of Dry Wells

Figures 13a to **13e** show the distribution of dry wells (and remaining wetted wells) in each of the analysis years for the baseline analysis. The predicted dry wells are generally north of Highway 152 and south of the Chowchilla River.

Most of the domestic wells that are predicted to go dry over the 20-Year GSP Implementation Period in the Base Case occur in the 2020-2024 and 2030-2034 five-year intervals (**Tables 4a and 5a**). Groundwater levels stabilize and begin to recover after 2035 and no additional wells are predicted to go dry in the Base Case after 2035. The timing of domestic wells going dry is closely related to the assumed sequence of average, dry, and wet years applied for the Base Case, which is based on a historical sequence of years that represent overall average conditions for the 20-year Period.

3.2.3.2 Impacts on Disadvantaged Communities

Some dry domestic wells are predicted to occur in DAC and SDAC areas, but these areas are not disproportionately impacted by groundwater level declines. The analysis suggests that the percent of domestic wells in DAC/SDAC areas estimated to go dry is similar to the Subbasin as a whole although it is slightly lower than for areas outside of DACs or SDACs..

Some DACs and SDACs in the Chowchilla Subbasin are located near urban centers, and thus near existing water system service areas. Opportunities for annexation or consolidation of DACs and SDACs in close proximity to existing (or creating new) State- or County-regulated systems may provide a better solution than replacement of existing wells in these areas.

3.2.3.3 Scaling Estimates

The previous analyses are all based on WCR counts of wells drilled since 1970 or 1990. A more accurate number of wells, however, is more likely the number of Permits in the permit database provided by Madera County.

Figure 14 shows that the spatial distributions of the two datasets are similar. As shown in that figure, the agreement between WCR and permit data is relatively good in most of Madera County; however, interspersed throughout the region there are sections with some differences between the numbers of permits and WCRs. The largest portion of the Subbasin is represented by ratios (permits to WCRs) near 1.0 (from 0.5 to 1.5). One section near the town of Chowchilla had notably higher numbers of permits compared to WCRs, but this is likely due to the denser population and presence of municipal water systems in that area of the Subbasin. The relatively similar distributions of permits and WCRs indicates that simply scaling the count of wells up for each period should be adequate. The number of Permits for wells installed since 1990 is 119% of the number of WCRs for wells in the same period, averaged over the Subbasin (**Table 2**).

Scaling the results up to match the expected number of wells based on the Permits-to-WCRs ratio of 1.19:1 yields 99 domestic wells going dry between 2020 and 2040 (**Table 5a**).

3.2.4 Results of Domestic Well Impacts Analyses for Alternative Dry-Start Climate Scenario

The same analysis was conducted as described above for the GSP Climate Scenario, but instead using an alternative climate sequence for the GSP Implementation Period with more dry years at the beginning of the 20-year climate sequence. In the alternative analysis scenario, a total of 100 of the 500 domestic wells (from WCRs) analyzed are indicated to have gone dry during years prior to 2020. A total of 147 wells are projected to go dry between 2020 and 2039 (**Table 4b**); the analysis suggests 85 dry wells of the total of 147 occurring during the period 2020-2024. **Table 5b** includes the results for this analysis when scaled up by a multiplier of 1.19 based on the ratio of well permits to WCRs.

3.2.5 Sensitivity Analyses on Potential Domestic Well Impacts

To understand influences from different analysis assumptions and parameters, sensitivity analyses were conducted on a number of aspects of the analysis. These sensitivity analyses evaluated different approaches to evaluating the DTW at well locations over each analysis period (e.g., DTW at end of period vs maximum DTW during analysis period), the required minimum saturation threshold for concluding a well is dry, and different cutoff dates for WCRs included in the analysis.

3.2.5.1 Snapshot of Depth at End of Reporting Period vs. Maximum Depth During Reporting Period

The baseline analysis described above compares domestic well depths to groundwater levels at the end of each Five-Year Update reporting period using the years 2019, 2024, 2029, 2034 and 2039. As noted previously, these baseline analysis periods were selected because the final year of each period aligns with the IM and Five-Year Update reporting periods. However, if the lowest groundwater levels do not align with the end of each analysis period, this method may not capture the full extent of potential impacts on domestic wells.

By choosing analysis period ending years as 2023, 2028, 2033, and 2038, the lowest groundwater levels in each five-year period will typically be captured along with the lowest pre-2020 groundwater levels (generally occurring in 2015 or 2018). Therefore, a separate analysis was performed using the maximum DTW in each five-year period. This analysis results in a slight decrease (2 wells) in the total number of wells (81) expected to go dry between 2020 and 2040 compared to the Base Case (**Table 6**). The reason for the decrease of dry well occurrence between 2020 and 2040 is this analysis has more wells going dry prior to the start of the GSP implementation period in 2020 due to the lowest pre-2020 groundwater levels occurring prior to Fall 2019, (which is the year used in the Base Case to determine well going dry prior to 2020). Therefore, the base case with a greater number of wells going dry between 2020 and 2040 is used for further sensitivity analyses described below because it is a more conservative estimate of dry wells.

3.2.5.2 Minimum Saturation Threshold

The baseline analysis comparing DTW, and total well depths included a minimum well saturation threshold that a well is considered dry when the groundwater levels fall below a level less than 10 feet above the bottom of the well. This baseline assumption was based on the expectation that the required saturation in a domestic well is not great because of the generally low pumping rates required for domestic wells. The sensitivity of analysis results for this minimum saturation assumption were evaluated using alternative minimum well saturation levels. Sensitivity to the minimum saturation threshold was tested by varying the parameter (S) and observing the change in the count of wells going dry in each analysis period (**Table 7**).

The number of wells going dry over the period from 2020 to 2039 increases as the minimum saturation threshold is increased from 0 feet to 30 feet and then decreases with greater minimum saturation thresholds (**Figure 15**). The reason for this pattern is that at minimum saturation thresholds exceeding 30 feet, more wells are considered to be going dry before 2020 relative to after 2020 for those greater thresholds (i.e., the threshold applies both before and after 2020). The number of dry wells at the saturation threshold of 10 feet is 83 wells, it increases to 100 wells at 30 feet, and at 50 feet it declines to 84 wells. This analysis suggests that the number of wells expected to go dry is sensitive to the saturation threshold applied, but the relationship between saturation threshold and number of dry wells predicted after 2019 varies depending on how many wells go dry before 2020. Considering the results of this sensitivity analysis and the previous discussion regarding saturation needed to support typical domestic well pumping rates, the application of a minimum saturation threshold of 10 feet is interpreted to be a reasonable threshold for estimating the potential number of domestic wells that may go dry during the GSP implementation period.

3.2.5.3 WCR Cutoff Dates

The influence on results from varying the earliest year of WCR records used in the dry well analysis was also evaluated. As expected, the average well depths for older wells tend to be shallower than younger wells, likely because of the declining water levels that have occurred in the area and the resulting need to drill to greater depths to ensure reliable water supply. This trend towards deeper wells is illustrated in a comparison of the average total well depths for WCRs since 1970 and those since 1990 and 1998, as presented in **Table 3.**

The changes in the numbers of total wells analyzed and the resulting numbers of dry wells drop as the cutoff date for WCRs is increased. The change from a WCR cutoff year of 1970 to 1975 has minimal (less than 10 percent) impact on all counts, but as this cutoff date in increased further the dry well count drops faster than the total well count (**Table 8**). The implication of this trend is that as the WCR cutoff date is moved forward in time from 1970, older wells that would be counted as going dry are not included in the analysis, resulting in a smaller number of wells predicted to go dry. Although many wells constructed since 1970 likely are no longer in existence or active use, the 1970 WCR cutoff date provides an appropriately conservative estimate of wells predicted to go dry during the implementation period.

3.2.6 Potential Replacement Costs for Wells Impacted

The potential costs for addressing domestic well issues were evaluated in some detail. These costs were largely based on discussions with drillers who install domestic wells and replace pumps on a regular basis. These costs are summarized in **Table 9**, and include lowering a domestic well pump ($1,000 to $2,000), replacing a domestic well pump ($5,000 to $7,000), and drilling/installing a new domestic well to replace an existing well ($25,000 to $35,000). Estimates of total costs for a Domestic Well Mitigation Program were based on estimates of total number of dry wells expected to occur between 2020 to 2039, with WCRs scaled to the number of County well permits and considering both the GSP climate scenario and the alternative dry-start climate scenario for the GSP Implementation Period.

3.2.7 Updated Economic Analysis

As described in the Introduction, **Attachment 1** (Domestic Well Replacement Economic Analysis) incorporates updated estimates provided in this TM for the number of dry domestic wells into an economic analysis intended to replace Appendix 3.C of the Chowchilla Subbasin GSP with newer information. The economic analysis evaluated the difference in costs for implementing a Domestic Well Mitigation Program concurrent with gradual reductions in groundwater pumping over a twenty-year period vs. not having a Domestic Well Mitigation Program and immediately implementing demand management and other PMAs to eliminate the overdraft in the subbasin to avoid significant and unreasonable adverse impacts on domestic well users. The overall conclusion remains consistent with the GSP: the cost of implementing a Domestic Well Mitigation Program is significantly less than the alternative.

3.3 Public Water System Wells

PWS wells data are maintained by the State Water Resources Control Board Division of Drinking Water in the Safe Drinking Water Information System (SDWIS); however, these data are incomplete at this time. In the Chowchilla Subbasin, only 8 PWS wells (7 for Chowchilla City Water Department, and one for Valeta Municipal Services District 85) are listed in SDWIS. Therefore, the WCR database was queried for PWS wells. There were 18 PWS wells drilled in the Subbasin and tagged as “Municipal” or “Public” on the WCR. This discrepancy may be due, in part, to the fact that WCRs do not typically distinguish between Public Water Systems and other residential water systems serving more than one household. When a well driller fills out the WCR, the “Municipal” box is checked if the well is to be used for any purpose other than irrigation, industrial processes, or domestic single-household use. These can include PWS wells but can also include Local Small and State Small Water System wells (LSWS and SSWS, respectively), and wells used for drinking water at facilities such as rest stops, churches, schools, and other locations that sometimes are not supplied by a local PWS. The wells identified here are shown in **Figure 16**.

Depth to the bottom of perforated interval ranged from 174 to 980 feet below ground surface in these wells. Of the 18 PWS wells, three were drilled prior to 1970 and are not considered here. The remaining 15 wells were compared to the snapshots of groundwater DTW results for the model years 2019, 2024, 2029, 2034, and 2039, with the GSP climate scenario. **Table 10** shows the results of this analysis.

Based on the comparison with the modeled groundwater levels at the 5-year intervals, one PWS well is expected to have gone dry by 2020, and another one over the implementation period. Further analysis with data provided by individual well-operators would be required to identify specific water systems that are vulnerable.

3.4 Comparison of Estimated Domestic Well Impacts to Online Databases

The estimated numbers and locations of dry wells described in this TM (modeled dry wells) were compared to two available datasets related to reported domestic well supply issues: DWR’s Household Water Supply Shortage Reporting System, and Self-Help Enterprises (SHE) Tank Water Program participants (**Attachment 2**). While the assumptions underlying the estimates of modeled dry wells in this TM differ in some regards to the well issues included in these two datasets, the spatial patterns in modeled dry wells are very similar to the spatial patterns in the DWR and SHE datasets. Overall, the total numbers of modeled dry wells estimated in this TM are greater than the number of well issues included in the DWR and SHE datasets; however, it is likely that not all dry wells have been reported in these other two datasets. More details on the DWR Household Water Supply Shortage Reporting System dataset and the SHE Tank Water Program participants dataset and comparisons of these datasets to modeled dry wells presented in this TM are provided in **Attachment 2**.

4 PRIORITIZATION OF AREAS FOR ADDITIONAL MONITORING

Expansion of monitoring network is important for areas of the Subbasin with higher densities of domestic drinking water wells. In addition, the domestic well impacts analyses provide a guide to locating areas that should be more closely monitored. The monitoring network should consider the presence of vulnerable populations, such as those reliant on groundwater and DAC/SDAC areas. Another key variable was to consider the locations of existing nested monitoring wells installed recently at eight locations throughout the Chowchilla Subbasin.

The domestic well inventory analysis conducted for this study illustrates that domestic wells are most concentrated along the Highway 152 corridor, and that the occurrence of dry domestic wells are predicted to be most common along and just north of Highway 152. There are four existing nested monitoring wells relatively far to the north of Highway 152, and four existing nested monitoring wells relatively far to the south of Highway 152 in Chowchilla Subbasin. Two large and dense clusters of domestic wells occur just north of the junction of Highway 152 and Highway 99 and just northeast of the junction of Highway 152 and Highway 233 (Robertson Blvd.). These are considered primary areas for siting of new nested monitoring wells (**Figure 17**). A third primary area is located further west and south of Highway 152 between Robertson Blvd. and Berenda Slough. Two secondary areas for potential consideration of monitoring well siting are in areas of significant, but somewhat less dense, clusters of domestic wells; these locations would fill gaps between existing nested monitoring wells and improve overall spacing and density of dedicated nested well monitoring sites in the Chowchilla Subbasin.

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6 TABLES

Table 1. Summary of Domestic Well WCRs by Decade (no WCRs prior to 1950).

WCR Date Range	WCRs in Date Range	Cumulative WCRs
1950-1959	3	3
1960-1969	46	49
1970-1979	76	125
1980-1989	49	174
1990-1999	82	256
2000-2009	123	379
2010-2019	107	486
2020-Plus	1	487
Unknown	62	549

Table 2. Comparisons Between Different Domestic Well Count Estimation Methods.

	WCRs Chowchilla SB 1970+	WCRs Madera Co. Chowchilla SB 1990+	WCRs Merced Co. Chowchilla SB 1999+	Permits Madera Co. Chowchilla SB 1990+	Permits Merced Co. Chowchilla SB 1999+
Domestic Well Count	500	362	12	436	7
Domestic Well Count Outside of Water System Boundaries	488	350	12	434	7
Domestic Well Count Inside Water System Boundaries	12	12	0	2	0
Percent of WCR-Based Count (since Permit earliest date)	n/a	n/a	n/a	120%	58%
With Depth Recorded	500	362	12	0	7
Location Precision	Varies	Varies	Varies	Parcel	Parcel

Table 3. Relative Similarity Between Wells Recorded Since 1970 and Those Recorded Since 1990.

	Count of WCRs within the Chowchilla Subbasin		
	Since 1970	Since 1990	Since 1999
Total Count	500	375	303
Count within PWS	12	8	7
Count Outside of PWS	488	367	296
Average Total Depth (ft)	377	402	423

Table 4a. Summary of Dry Wells for Base Case. Wells drilled in 1970 or later, based on snapshot of depth to groundwater at end of period. Assumes 10 feet of well saturation above bottom of screen.

Year Range	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells
2020 to 2024	6	405	**40**	365	40
2025 to 2029	0	365	**0**	365	40
2030 to 2034	0	365	**42**	323	82
2035 to 2039	0	323	**1**	322	83
During the period 1989 to 2019, prior to the implementation period, the model suggests 95 wells went dry.				Total	**83**

Table 4b. Summary of Dry Wells for Dry Start Case. Wells drilled in 1970 or later, based on snapshot of depth to groundwater at end of period. Assumes 10 feet of well saturation above bottom of screen.

Year Range	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells
2020 to 2024	6	400	**85**	315	85
2025 to 2029	0	315	**61**	254	146
2030 to 2034	0	254	**1**	253	147
2035 to 2039	0	253	**0**	253	147
During the period 1989 to 2019, prior to the implementation period, the model suggests 100 wells went dry.				Total	147

Table 5a: Adjusted Estimates of Dry Wells for Base Case Based on WCRs Since 1970 Upscaled Using Ratio of Permits to WCRs (1.19).

Year Range (Oct 31st Minimums)	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells
2020 to 2024	7	486	48	438	48
2025 to 2029	0	438	0	438	48
2030 to 2034	0	438	50	388	98
2035 to 2039	0	388	1	387	99
During the period 1989 to 2019, prior to the implementation period, the model suggests 114 wells went dry.				Total	99

Table 5b: Adjusted Estimates of Dry Wells for Dry Start Case Based on WCRs Since 1970 Upscaled Using Ratio of Permits to WCRs (1.19).

Year Range (Oct 31st Minimums)	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells
2020 to 2024	7	480	102	378	102
2025 to 2029	0	378	73	305	175
2030 to 2034	0	305	1	304	176
2035 to 2039	0	304	0	304	176
During the period 1989 to 2019, prior to the implementation period, the model suggests 120 wells went dry.				Total	176

Table 6: Dry Well Summary Based on Snapshots of Groundwater Depth at End of Periods Ending in 2015, 2018, 2023, 2028, 2033, and 2038.

Year Range (Oct 31st Minimums)	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells Based on 5-Year Minimum
2019 to 2023	10	378	**30**	348	30
2024 to 2028	0	348	**1**	347	31
2029 to 2033	0	347	**50**	297	81
2034 to 2038	0	297	**0**	297	81
During the period 1989 to 2018, prior to the period described in this table, the model suggests 122 wells went dry.				Total	81

Table 7: Effect of Varying Saturation Requirement on Dry Well Counts.

Saturation Setting	Dry Wells Total After 2019
0	76
10	83
20	98
30	100
40	90
50	84
60	72
70	66
80	63
90	60
100	55

Table 8: Effect of Varying Minimum Installation Year on Counts of Wells and Dry Wells.

Well Counts	Earliest Installation Year						
	1970	1975	1980	1985	1990	1995	2000
Total Count of WCRs in Comparison	500	459	424	401	375	331	293
Fraction of 1970 (Total Count of Wells)	1.00	0.92	0.85	0.80	0.75	0.66	0.59
Total Count of Dry Wells	178	159	144	127	117	91	67
Fraction of 1970 (Dry Wells)	1.00	0.89	0.81	0.71	0.66	0.51	0.38
Count of Dry Wells Prior to 2020	95	85	77	66	59	41	30
Fraction of 1970 (Dry Prior to 2020)	1.00	0.89	0.81	0.69	0.62	0.43	0.32
Count of Dry Wells from 2020 to 2039	83	74	67	61	58	50	37
Fraction of 1970 (Dry Wells 2020 to 2039)	1.00	0.89	0.81	0.73	0.70	0.60	0.45

Table 9: Summary of Domestic Pump and Well Costs.

Issue	Type of Problem	Solution	Related to GSP	Typical Cost
Water level in well below pump setting depth	**Pump**	**Lower Pump**	**Yes/No**	**$1,000 to $2,000**
Pump not working (old age or pump-related issue)	**Pump**	**Replace Pump and Equipment**	**No**	**$5,000 to $7,000**
Well casing/screen failure (due to old age)	**Well**	**Replace Well**	**No**	**$25,000 to $35,000**
Water level below bottom of well	**Aquifer**	**Replace Well**	**Yes**	**$25,000 to $35,000**

Table 10: PWS and other Municipal Wells - Dry Well Summary Based on Snapshots of Groundwater Depth at End of Periods ending in 2024, 2029, 2034, and 2039, for the Base Case Climate Scenario.

Year Range (Oct 31st Minimums)	New Wells Drilled	Total Wetted Wells Year Start	**Wells Going Dry**	Total Wetted Wells Year End	Sum Of Dry Wells
2020 to 2024	1	15	1	14	1
2025 to 2029	0	14	0	14	1
2030 to 2034	0	14	0	14	1
2035 to 2039	0	14	0	14	1
During the period 1989 to 2019, prior to the implementation period, the model suggests one well went dry.				Total	1

7 FIGURES

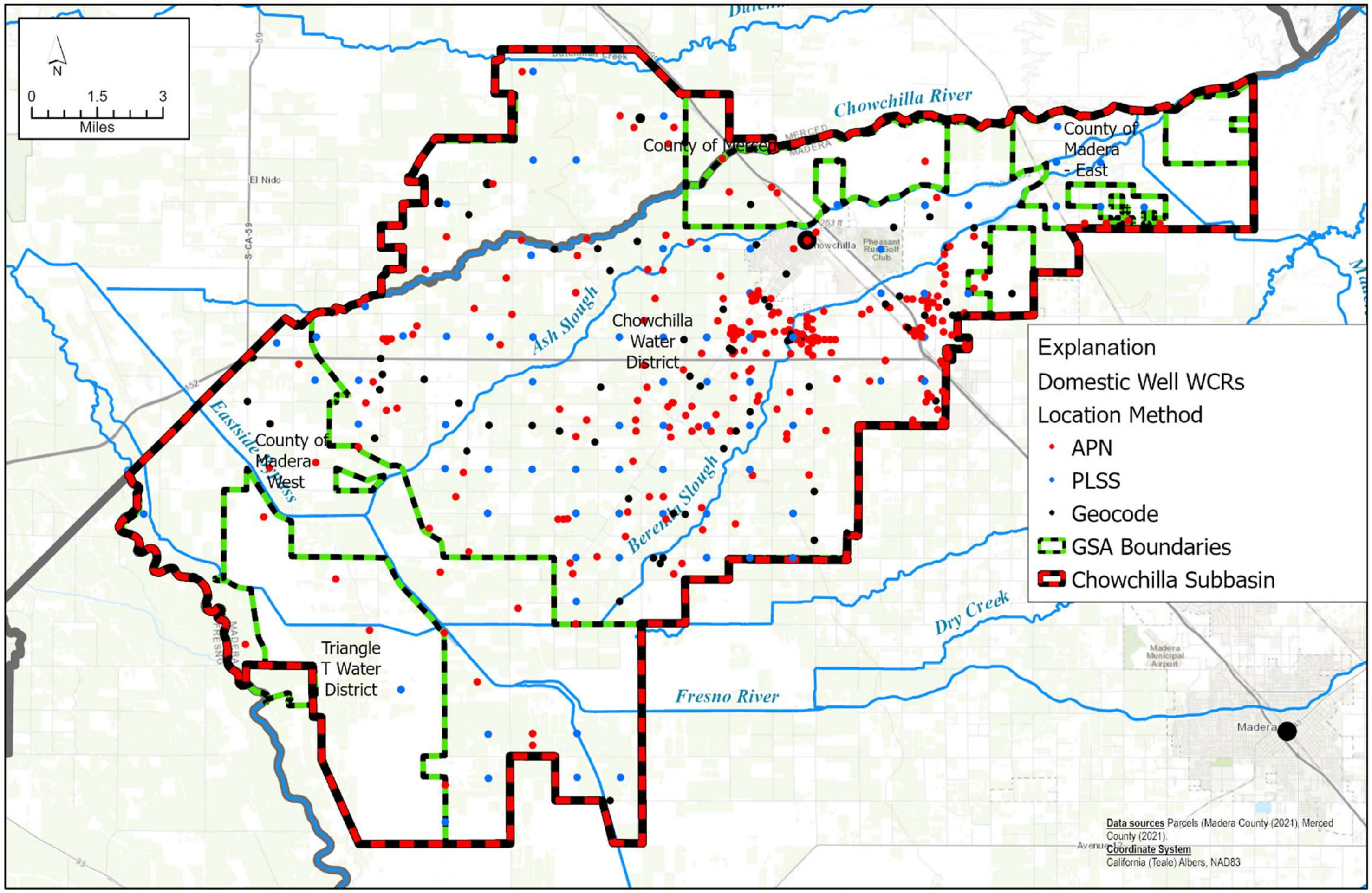

Figure 1a. Well Completion Report new construction domestic wells located by best available method.

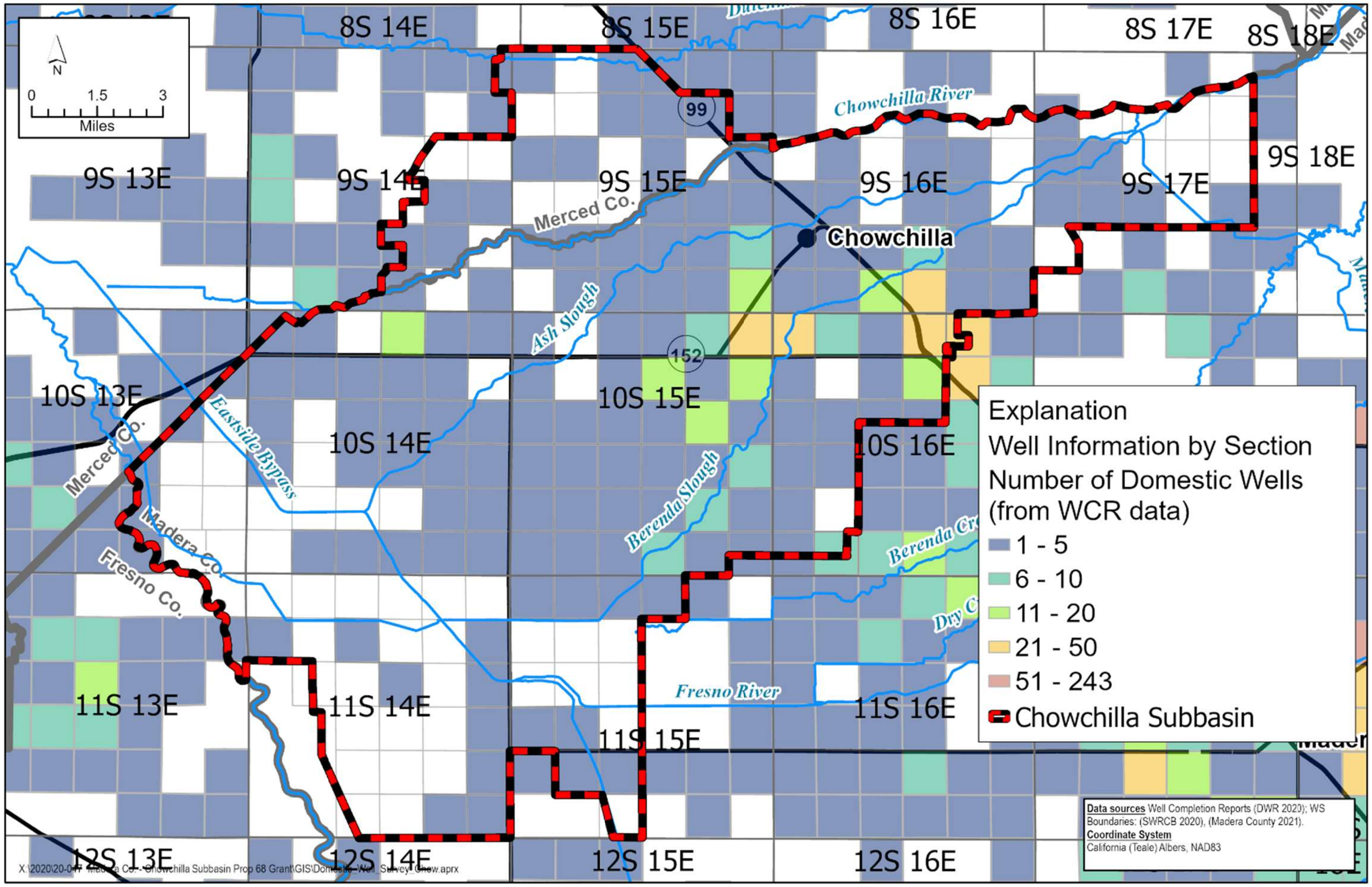

Figure 1b. Well Completion Report new construction domestic well counts by Section.

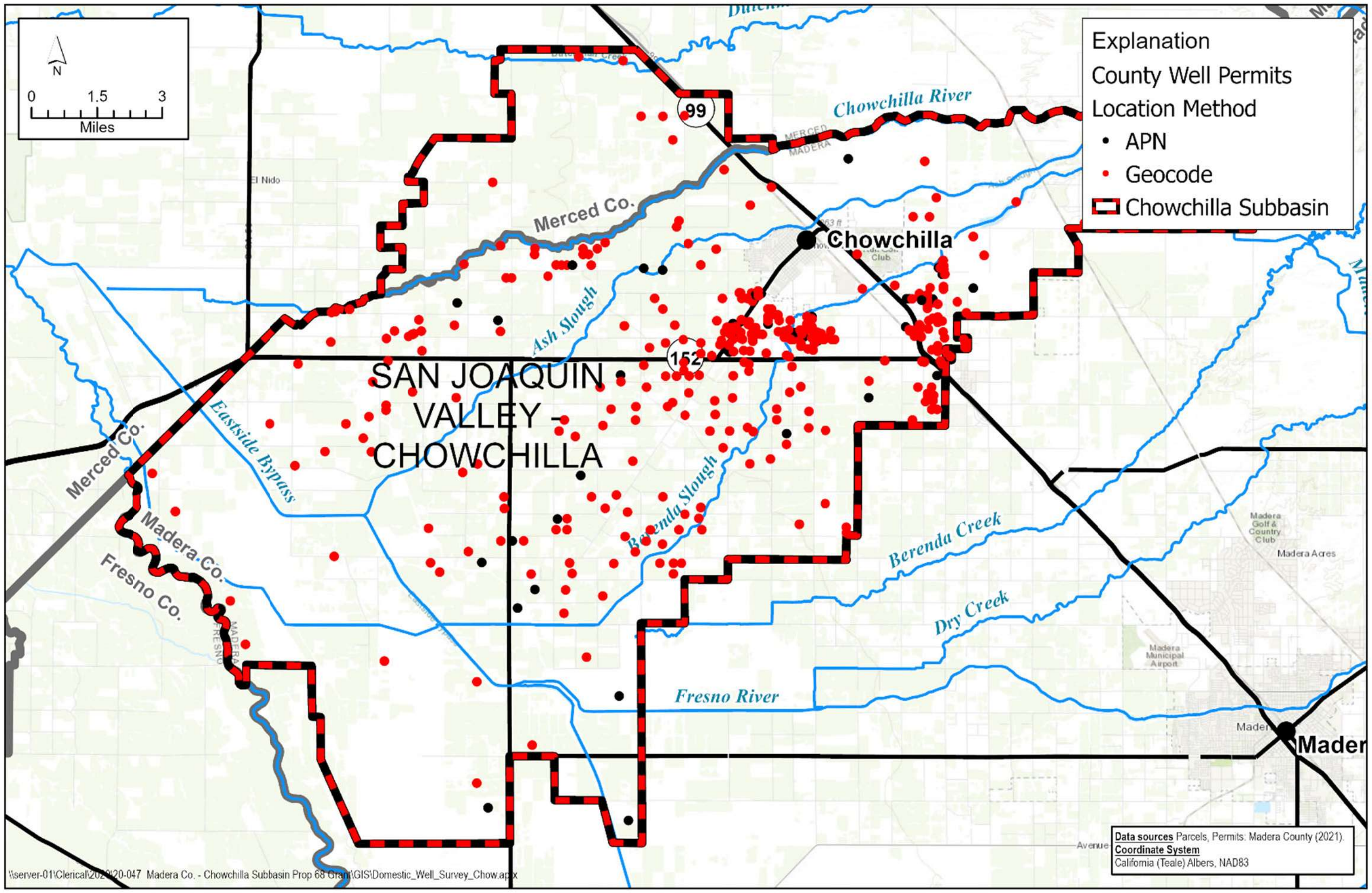

Figure 2a: Permit locations and geolocation method in Chowchilla Subbasin.

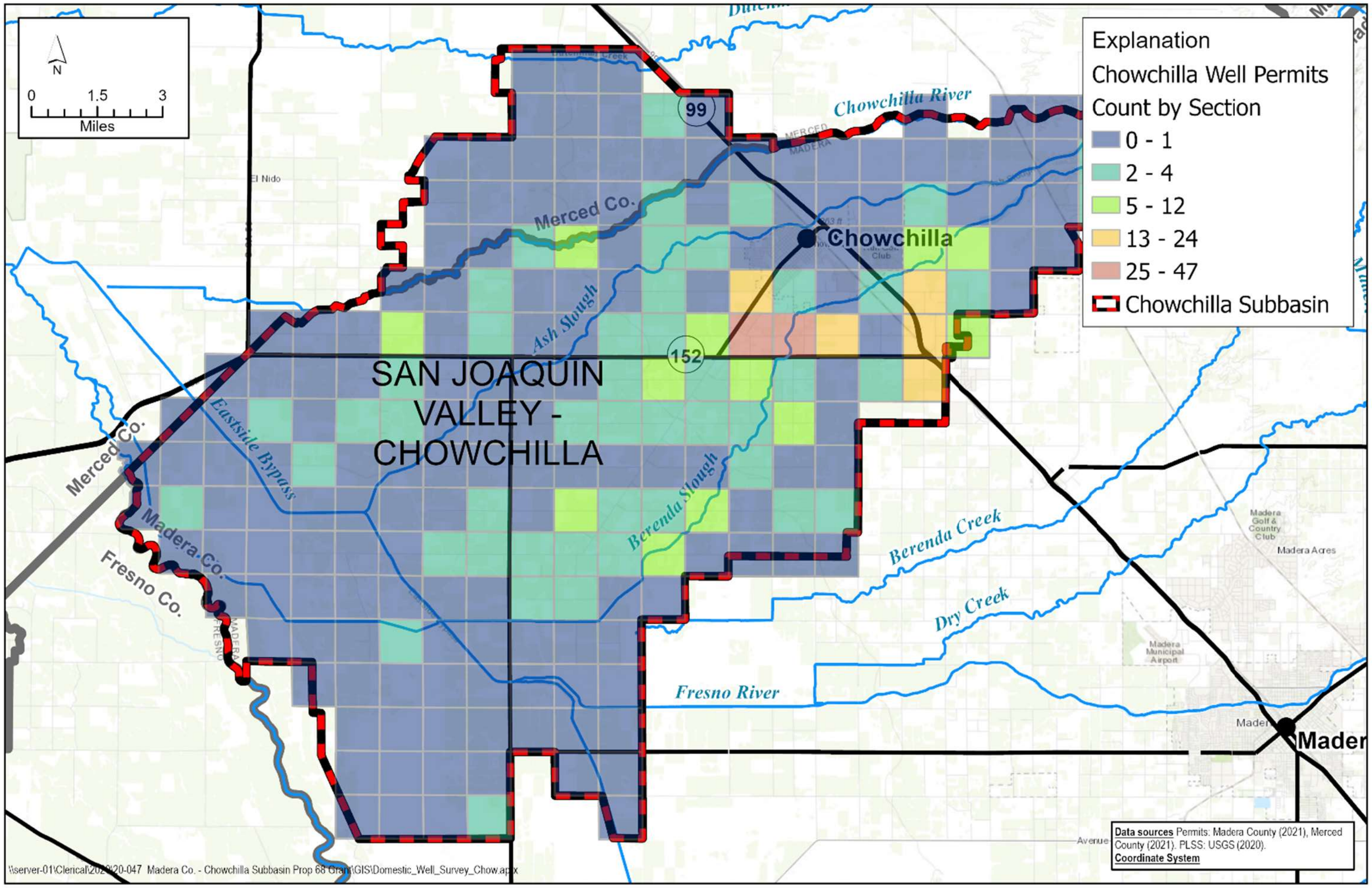

Figure 2b. Permit location counts by Township/Range/Section.

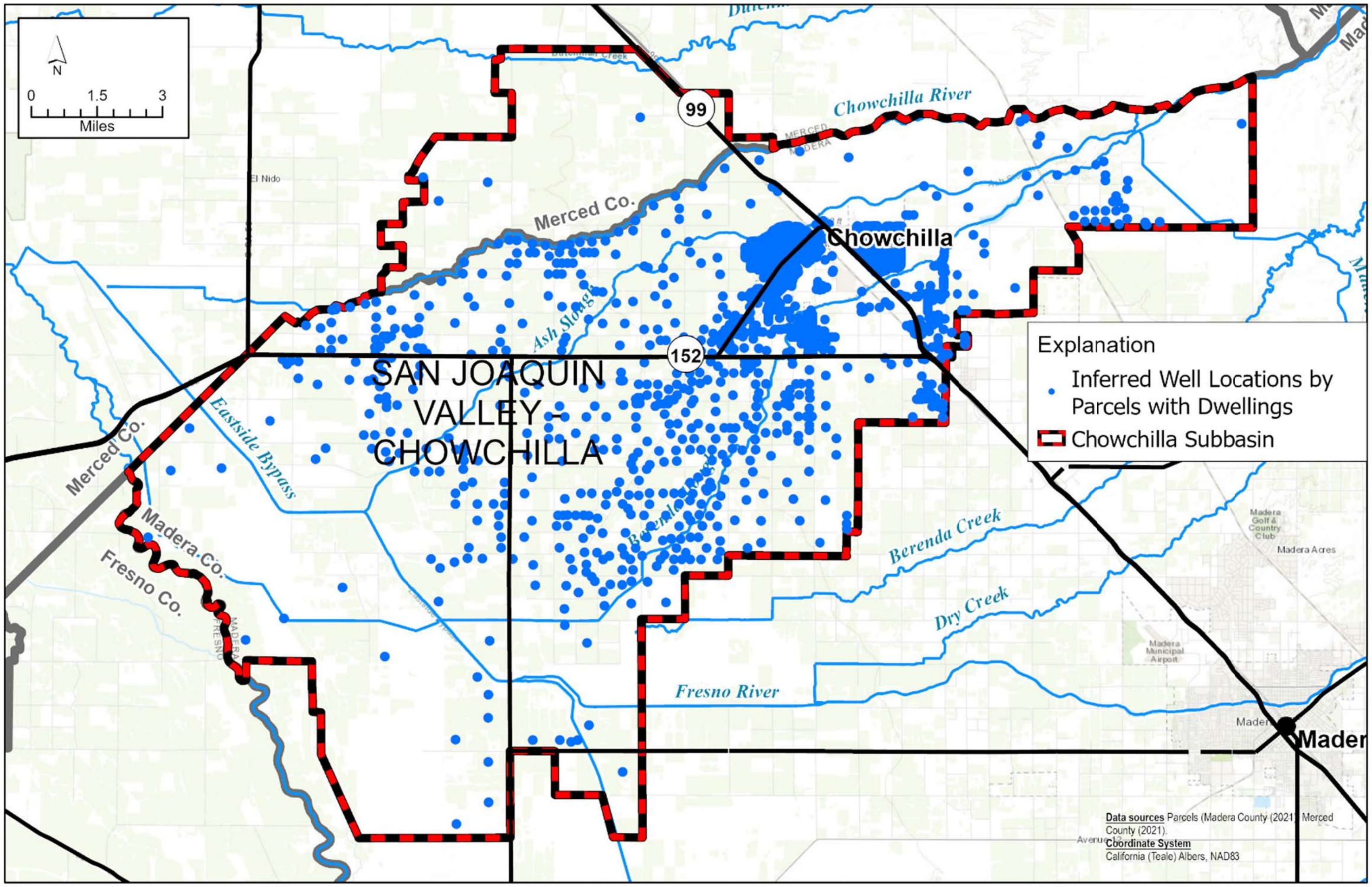

Figure 3: Inferred well locations based on Parcel Dwelling Status.

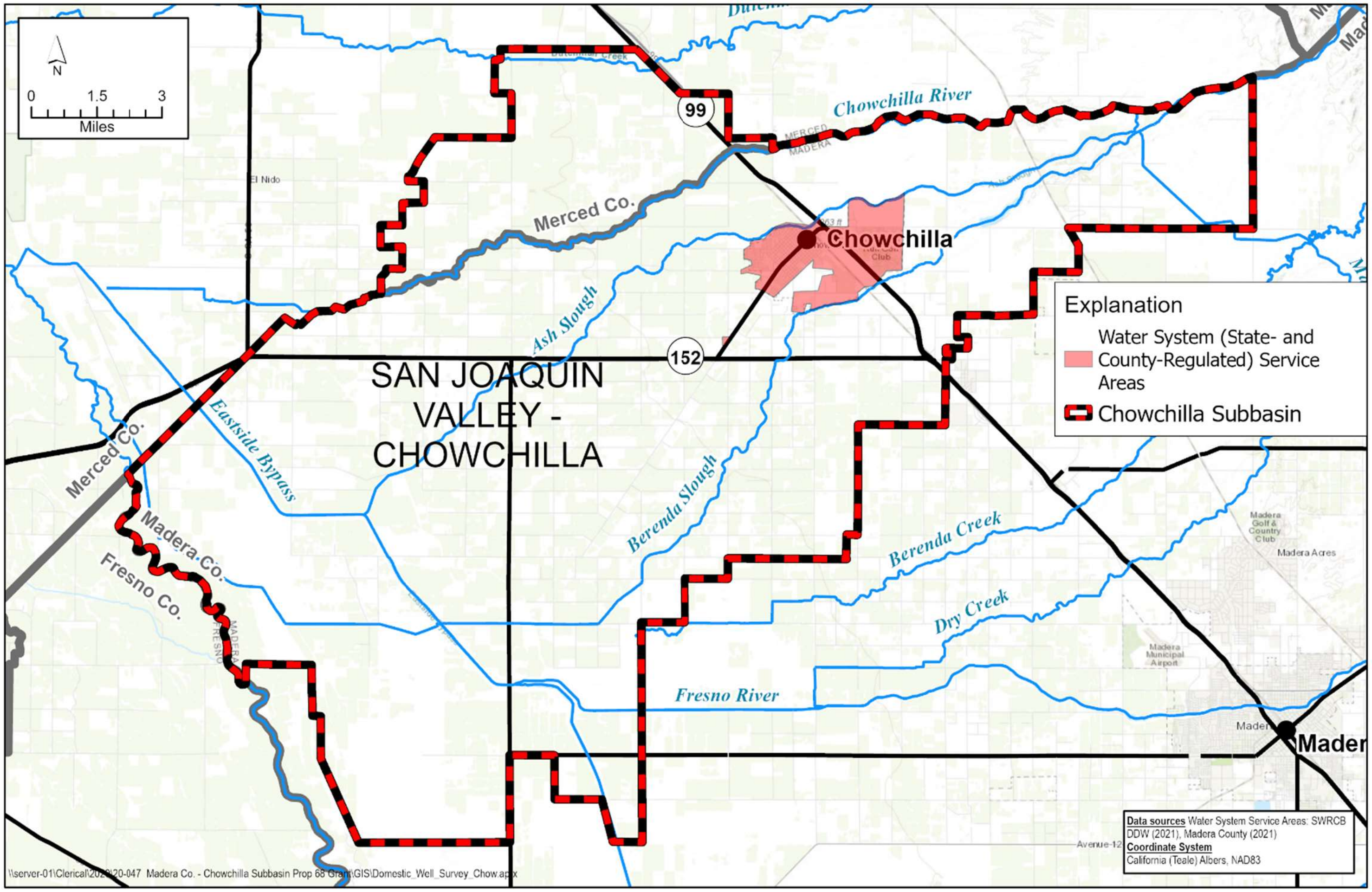

Figure 4: Water System Boundaries in Madera County.

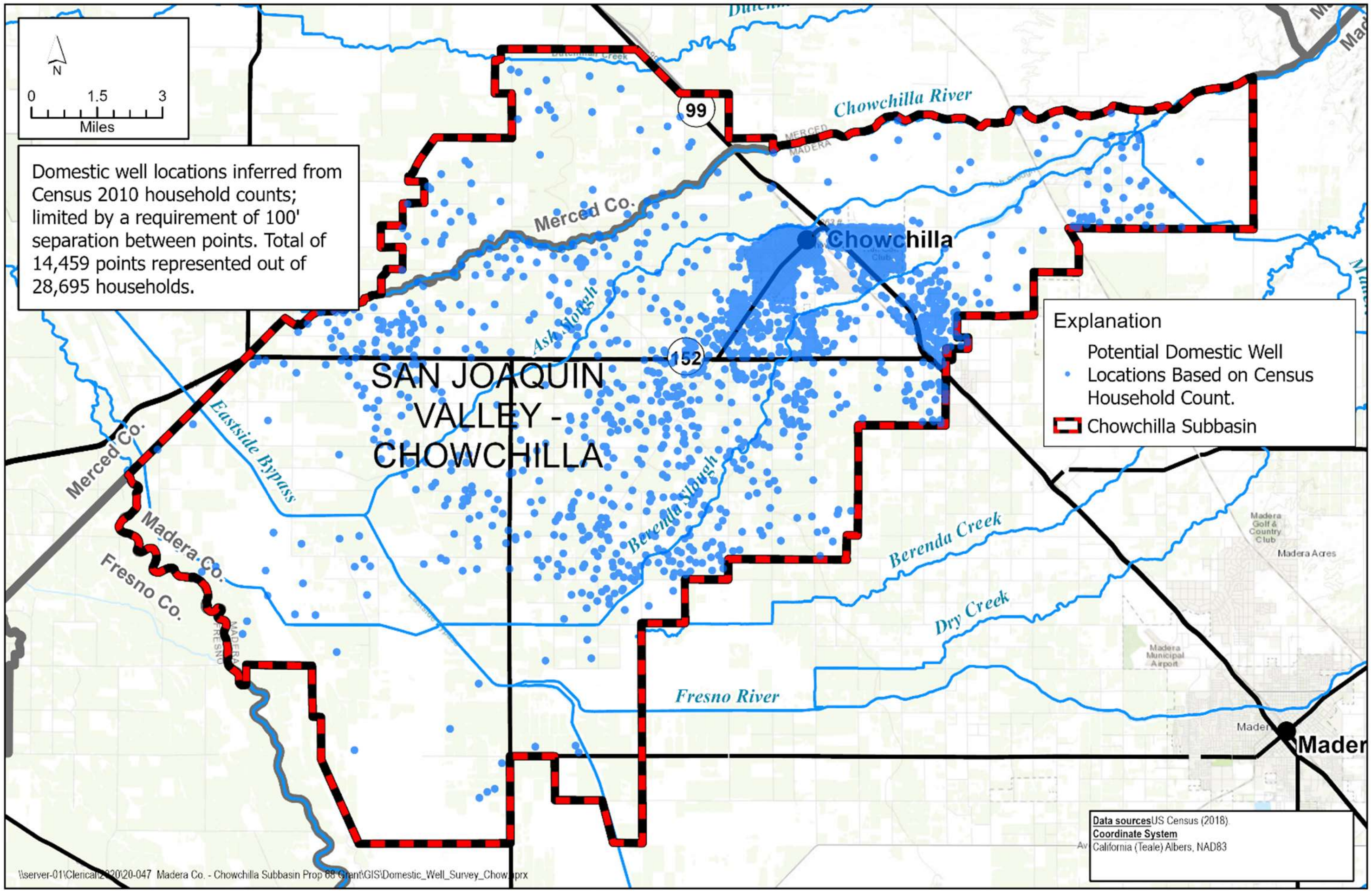

Figure 5: Inferred well locations based on 2010 Census Household counts.

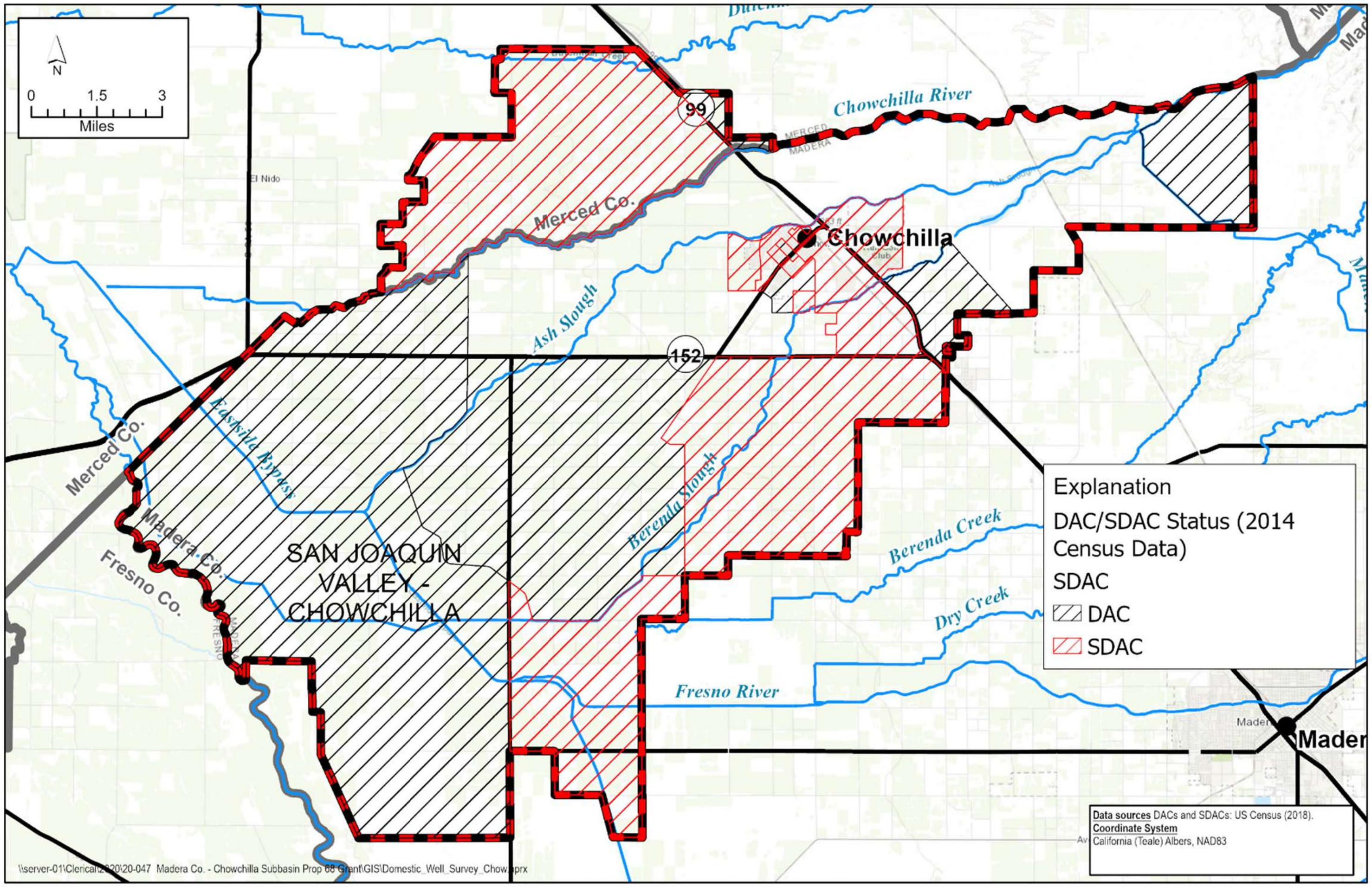

Figure 6: DACs and SDACs in the Chowchilla Subbasin.

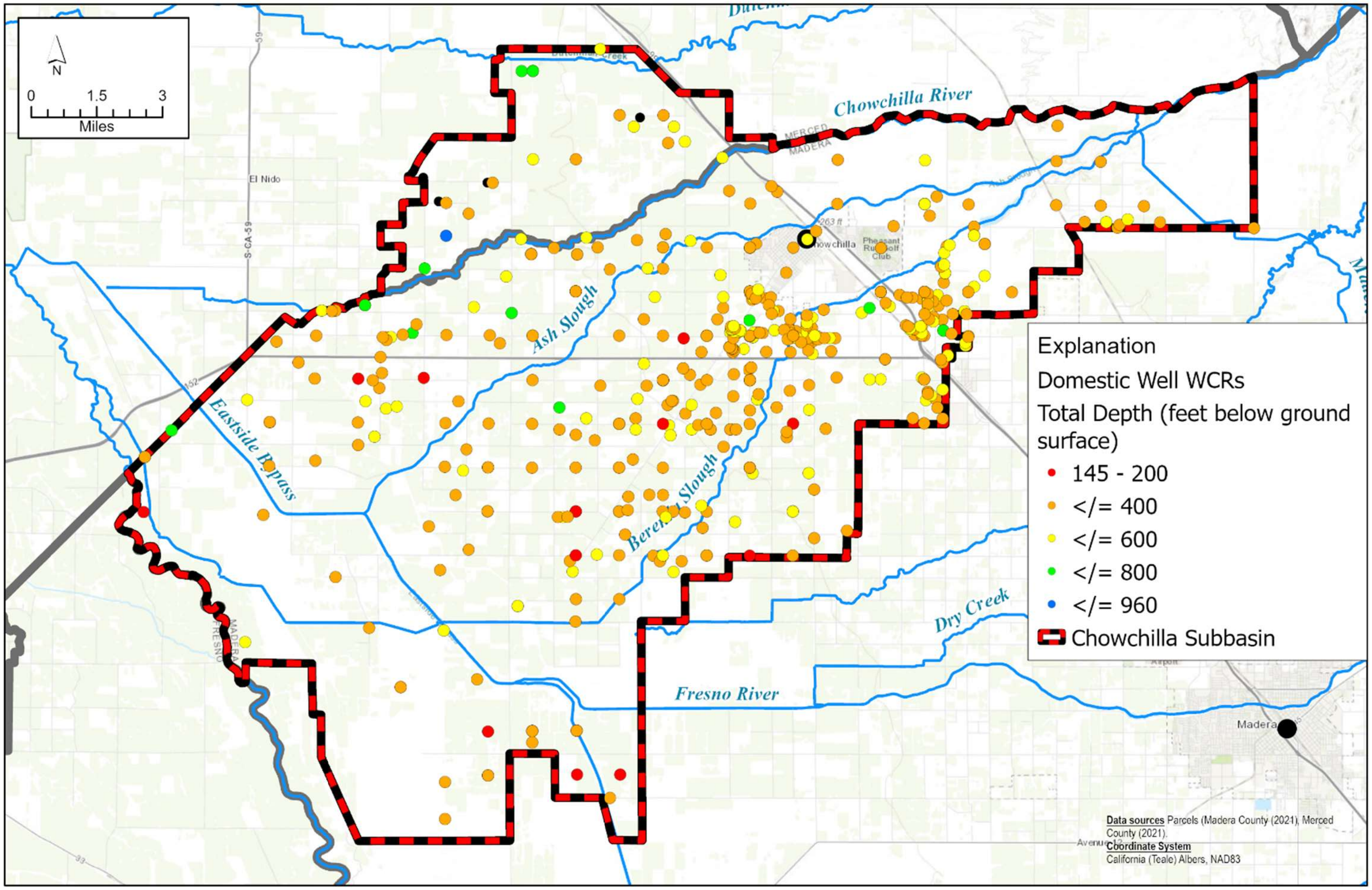

Figure 7a: Domestic wells in Chowchilla Subbasin with depth from WCR.

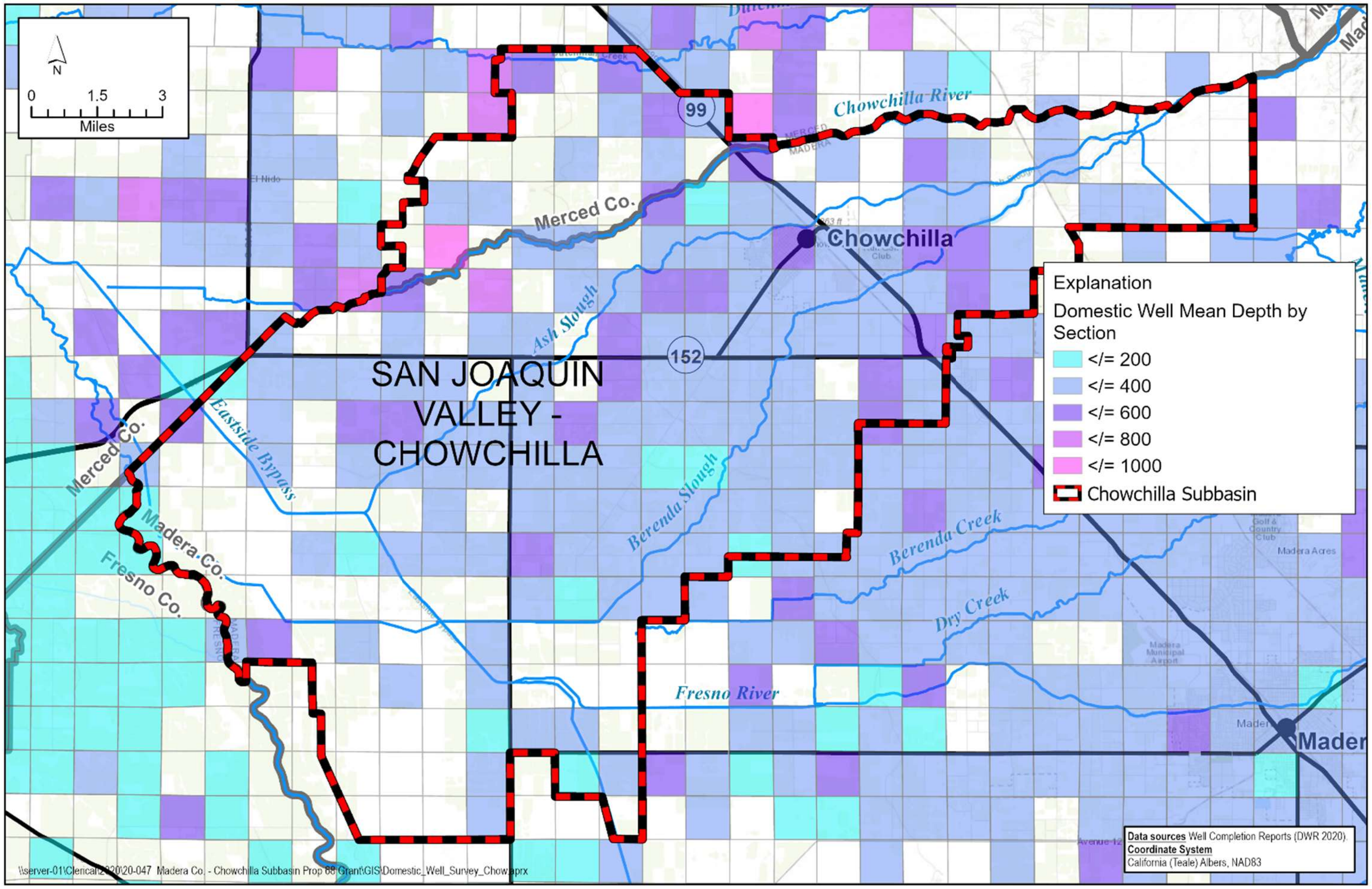

Figure 7b. Domestic Wells in Chowchilla Subbasin with Average Depth by Township/Range/Section from WCRs.

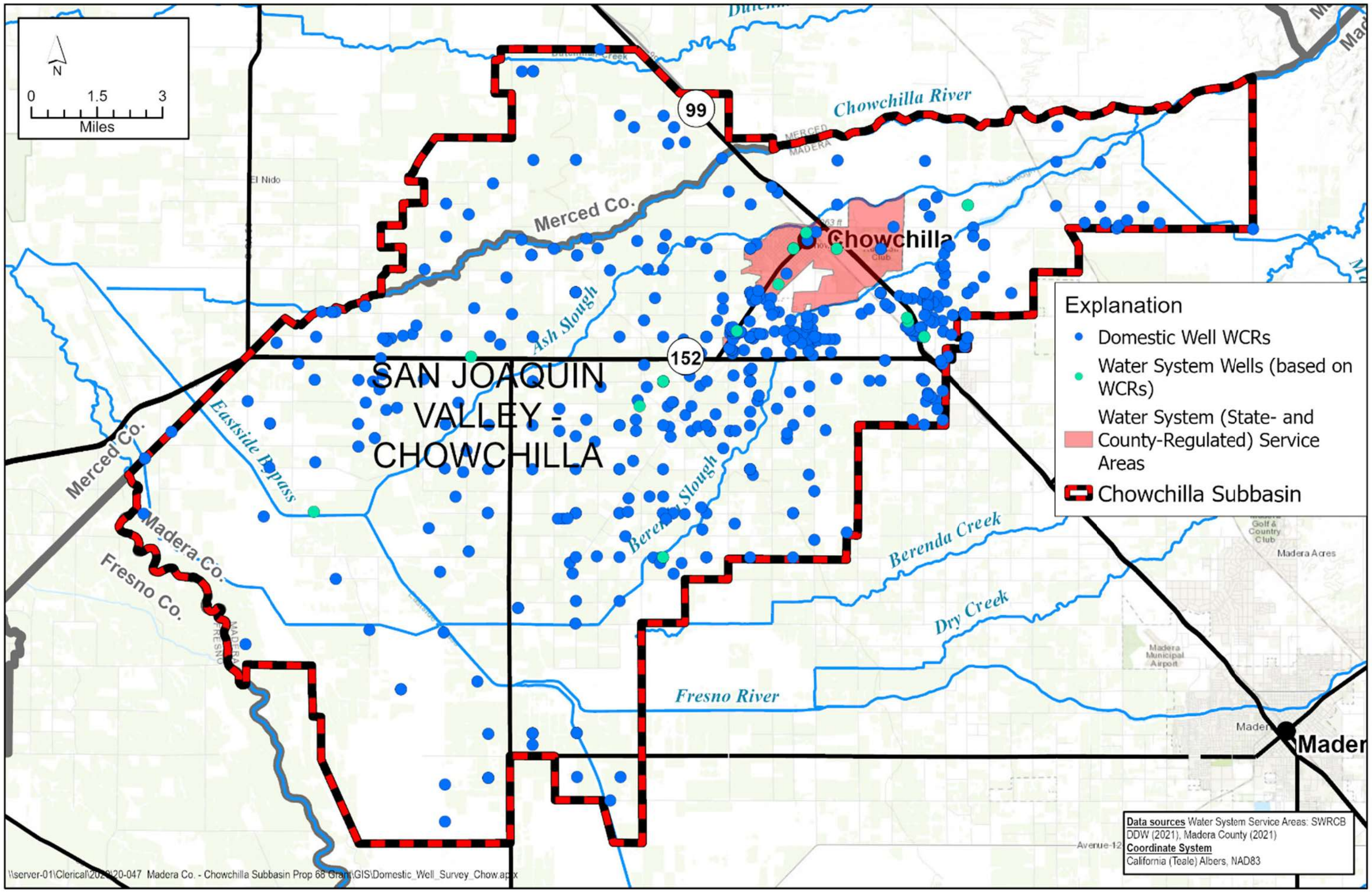

Figure 8: Domestic WCRs compared with Community PWS, County Maintenance Districts, and Community Service Areas.

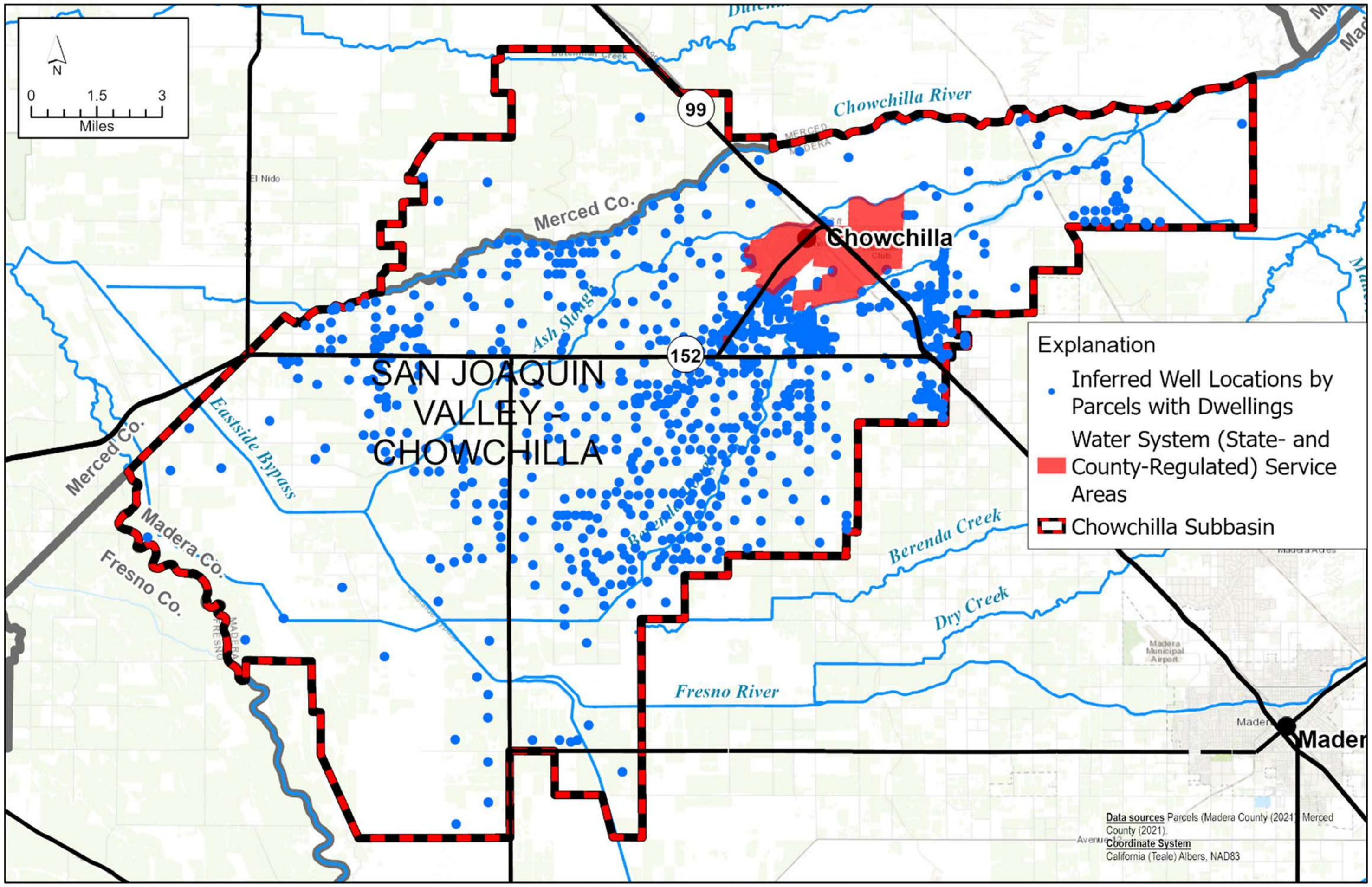

Figure 9: Parcels with Dwellings as Inferred Well Locations, outside of Community PWS, County Maintenance Districts, and Community Service Areas.

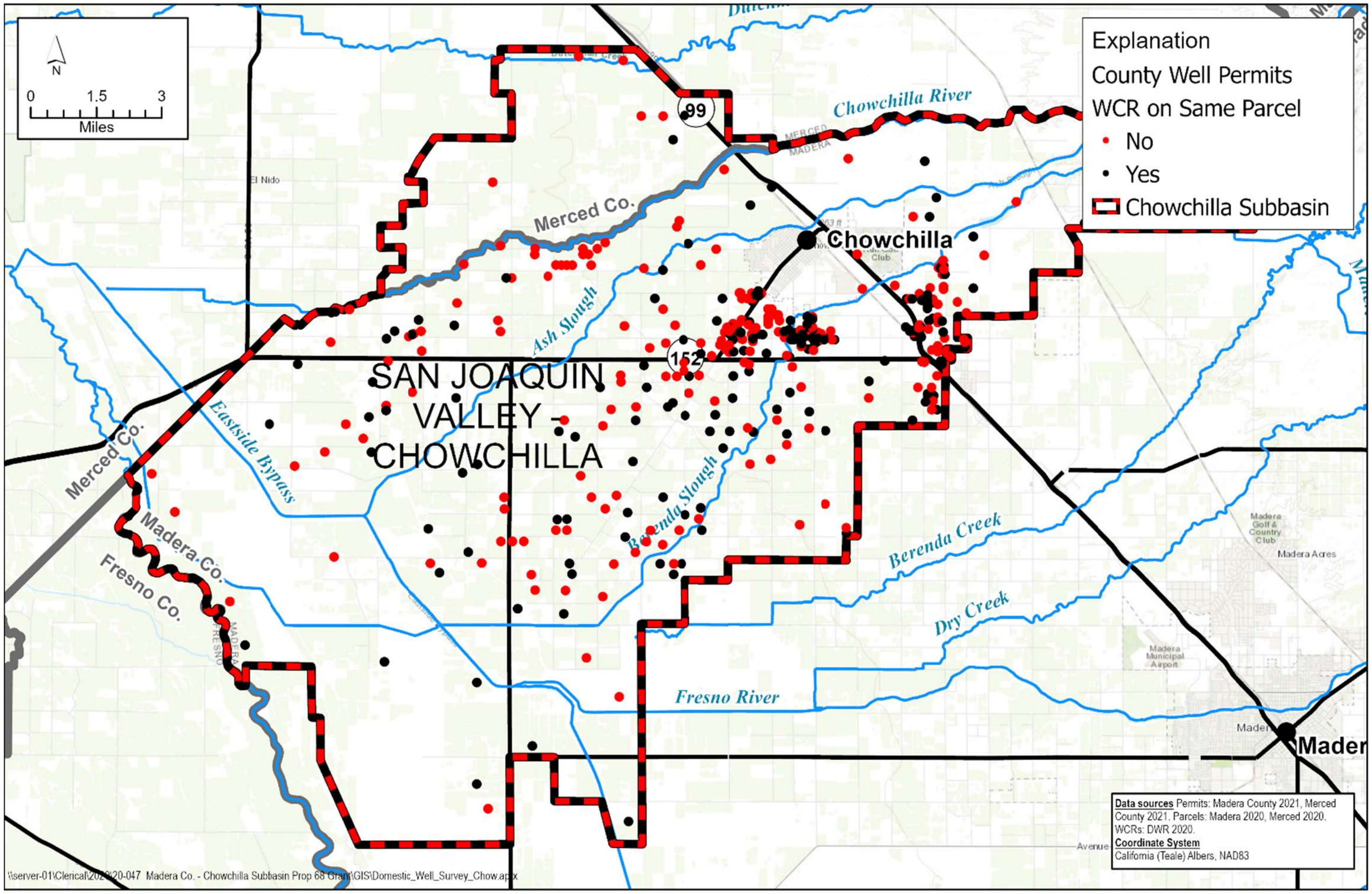

Figure 10: Parcels with Permits and WCRs.

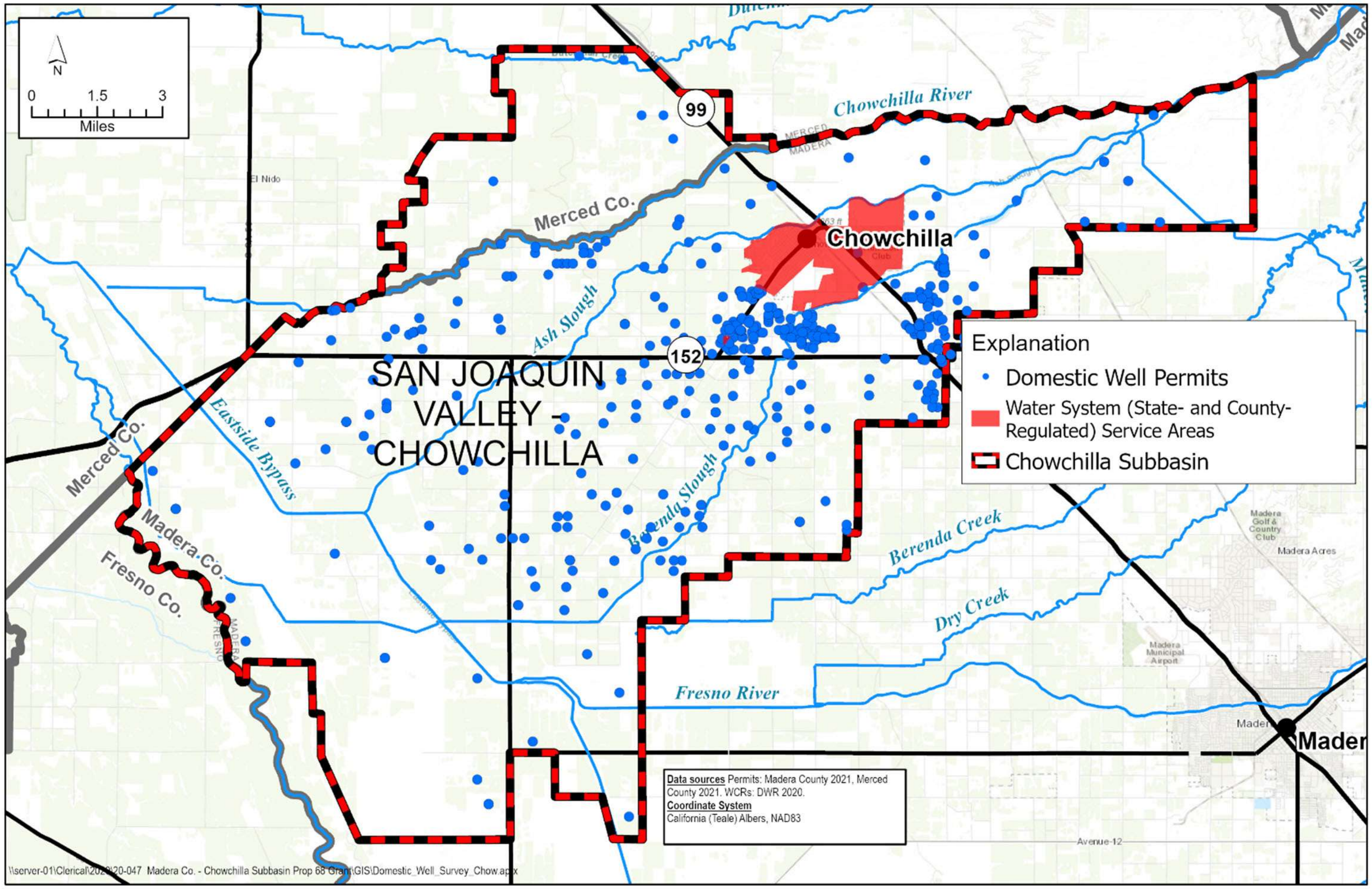

Figure 11a: Domestic Well Permits Compared with PWS, Community Service Districts and County Maintenance Districts.

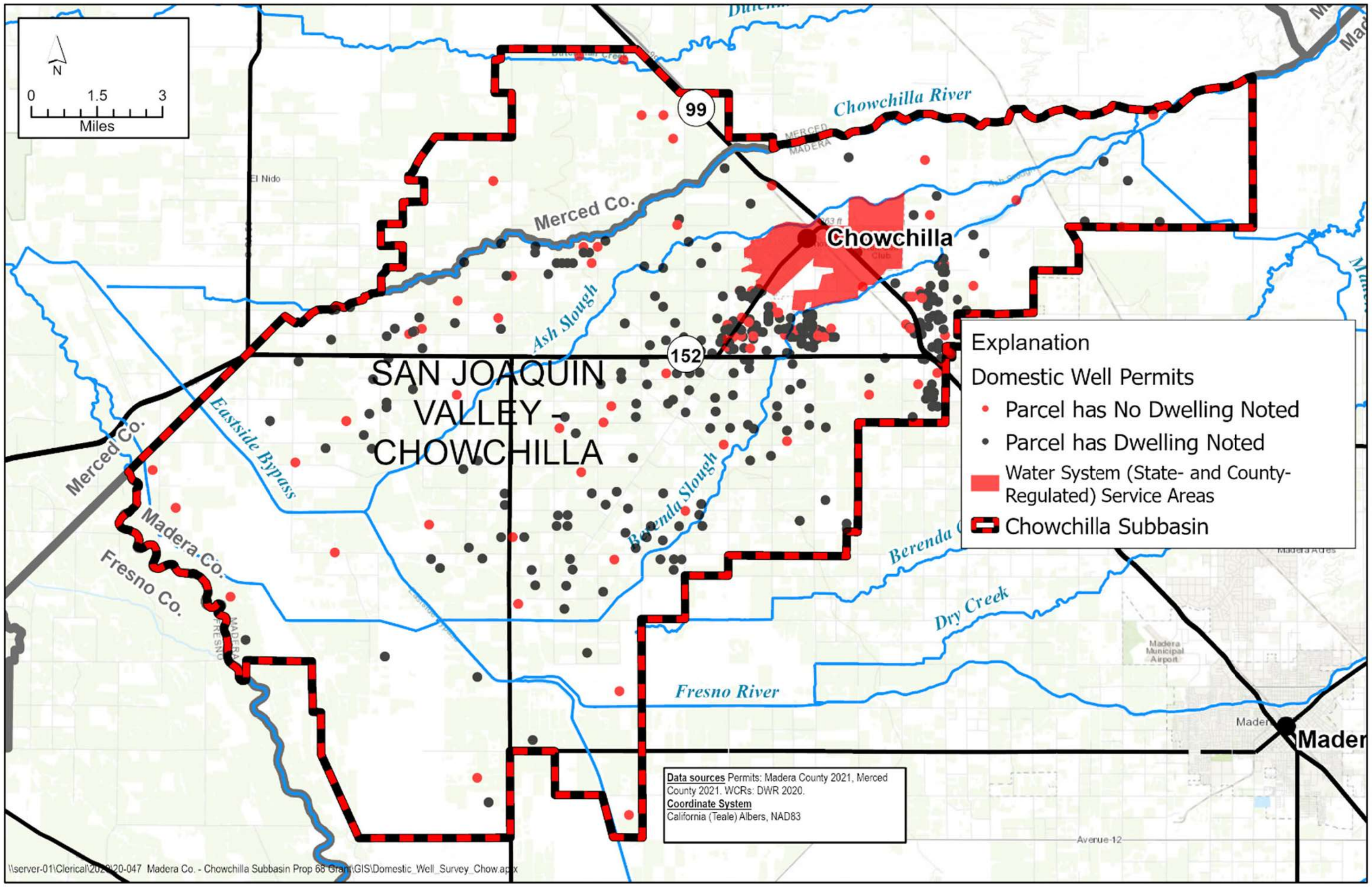

Figure 11b: Domestic Well Permits Compared with Parcel Characteristics.

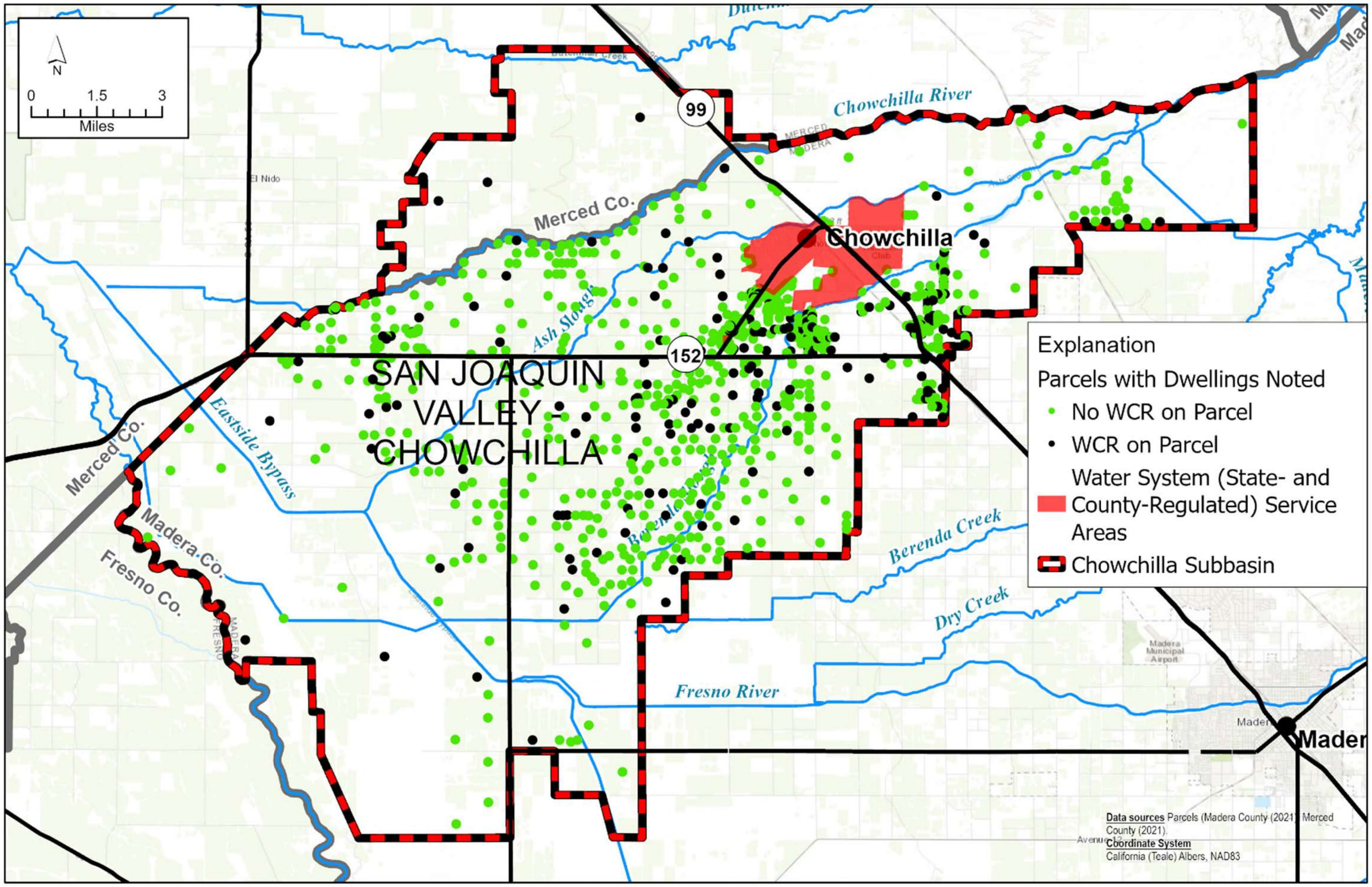

Figure 12: Inferred Domestic Well locations Based on Parcels with Dwellings, with Water Systems and Presence/Absence of WCRs on Parcel.

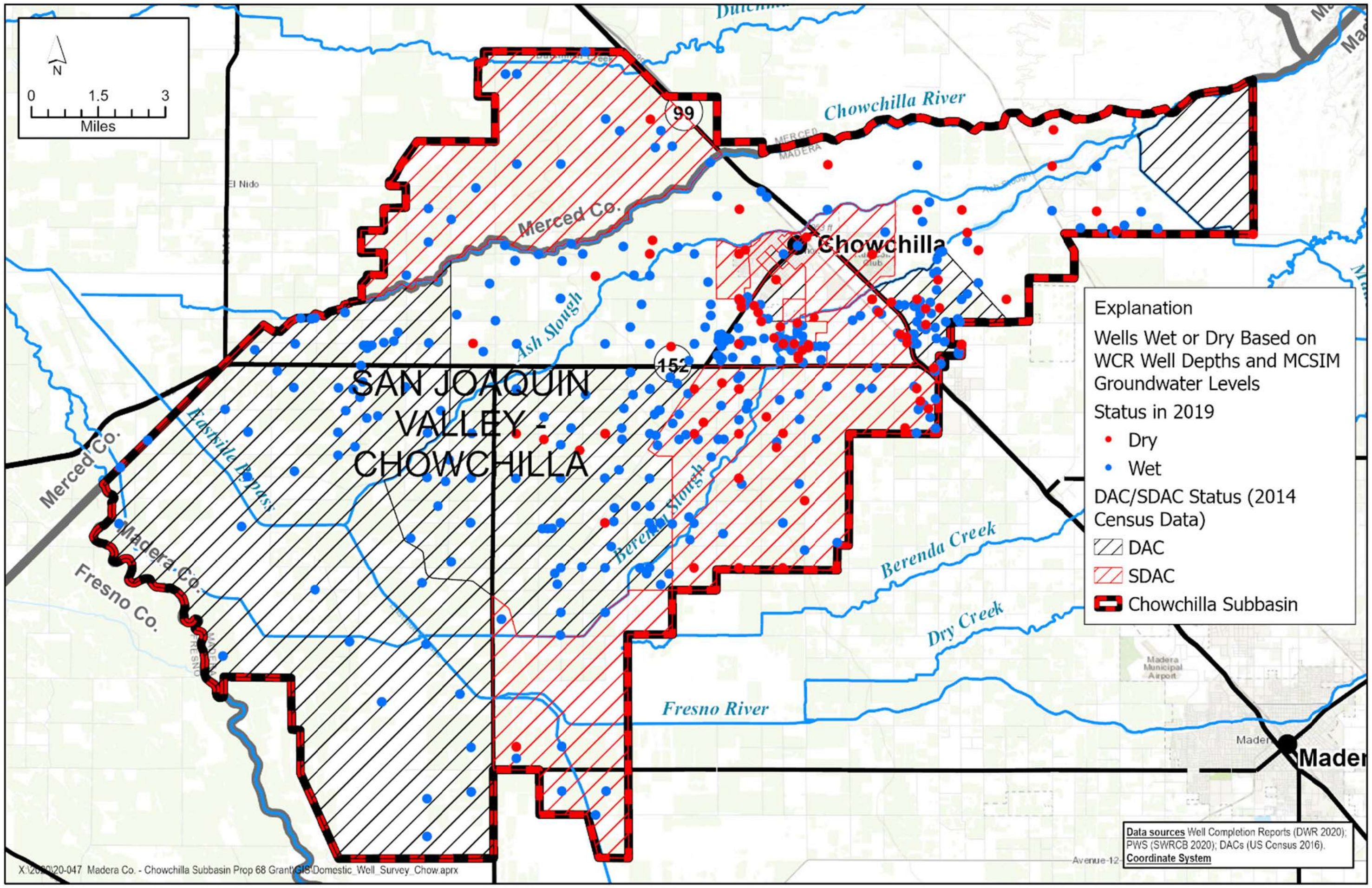

Figure 13a: Status of Domestic Wells in 2019 - Based on WCR Well Depths and Locations Compared to MCSIM Groundwater Depths.

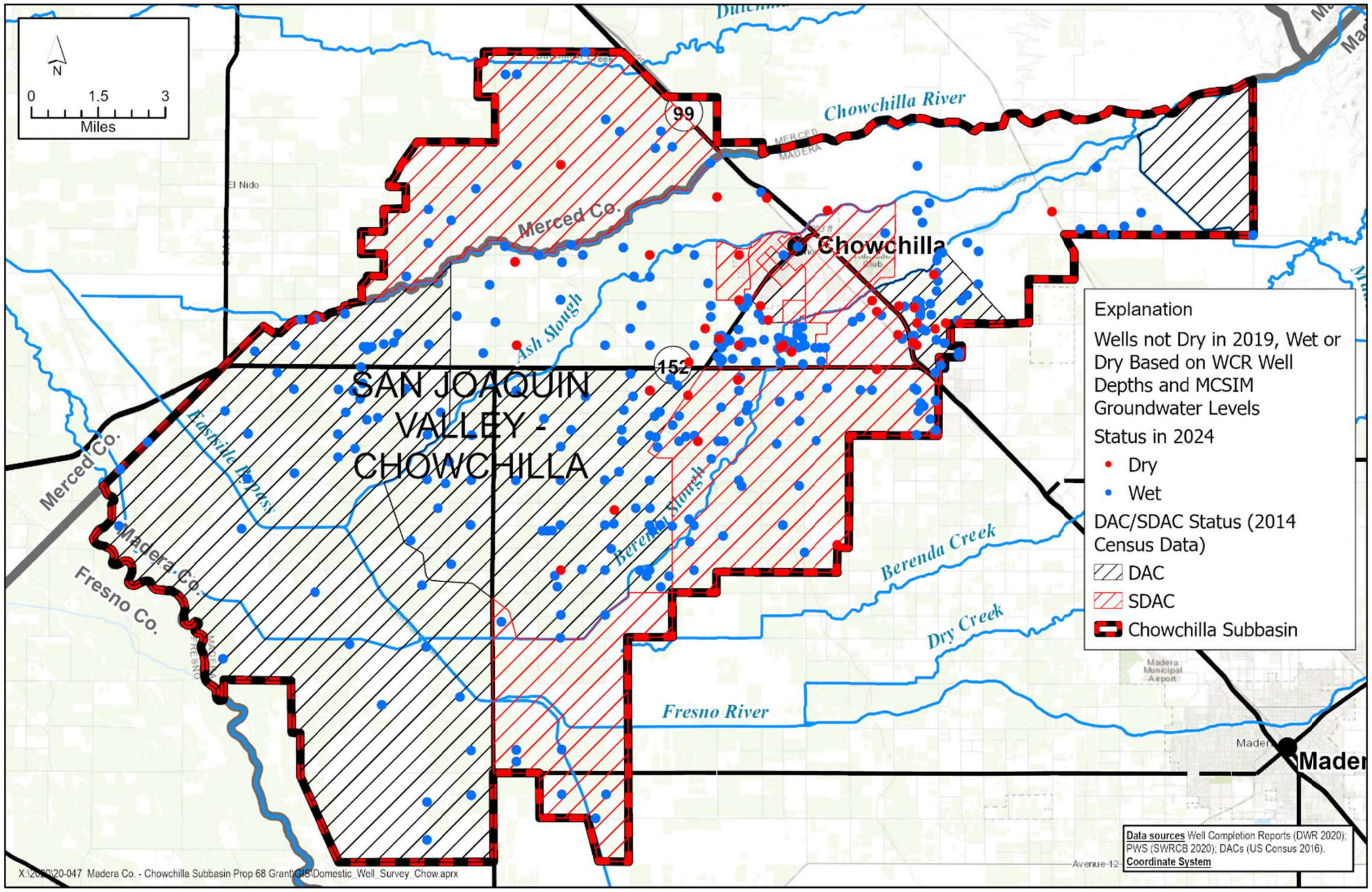

Figure 13b: Status of Wells in 2024 - Based on WCR Well Depths and Locations Compared to MCSIM Groundwater Depths.

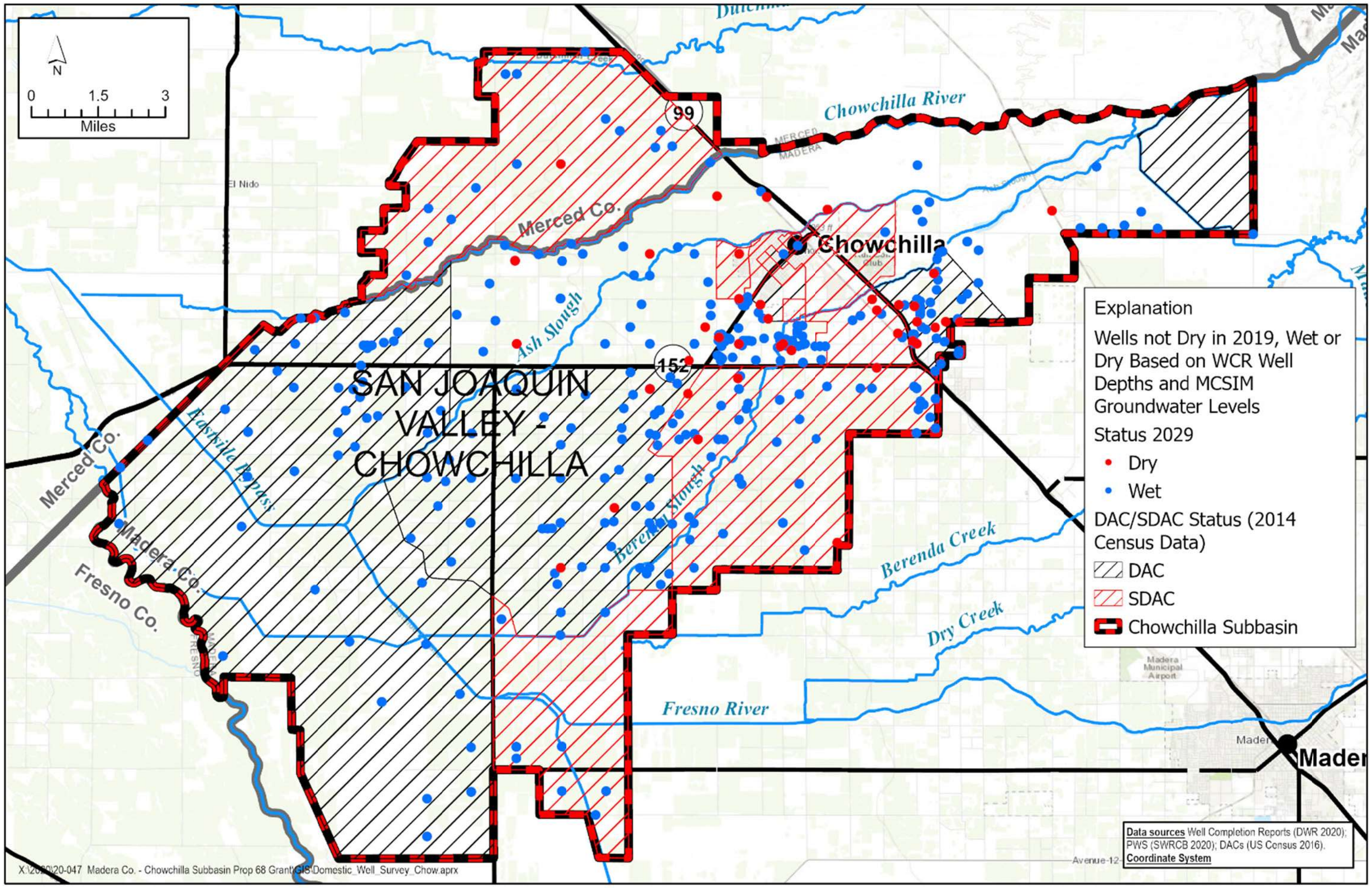

Figure 13c: Status of Wells in 2029 - Based on WCR Well Depths and Locations Compared to MCSIM Groundwater Depths.

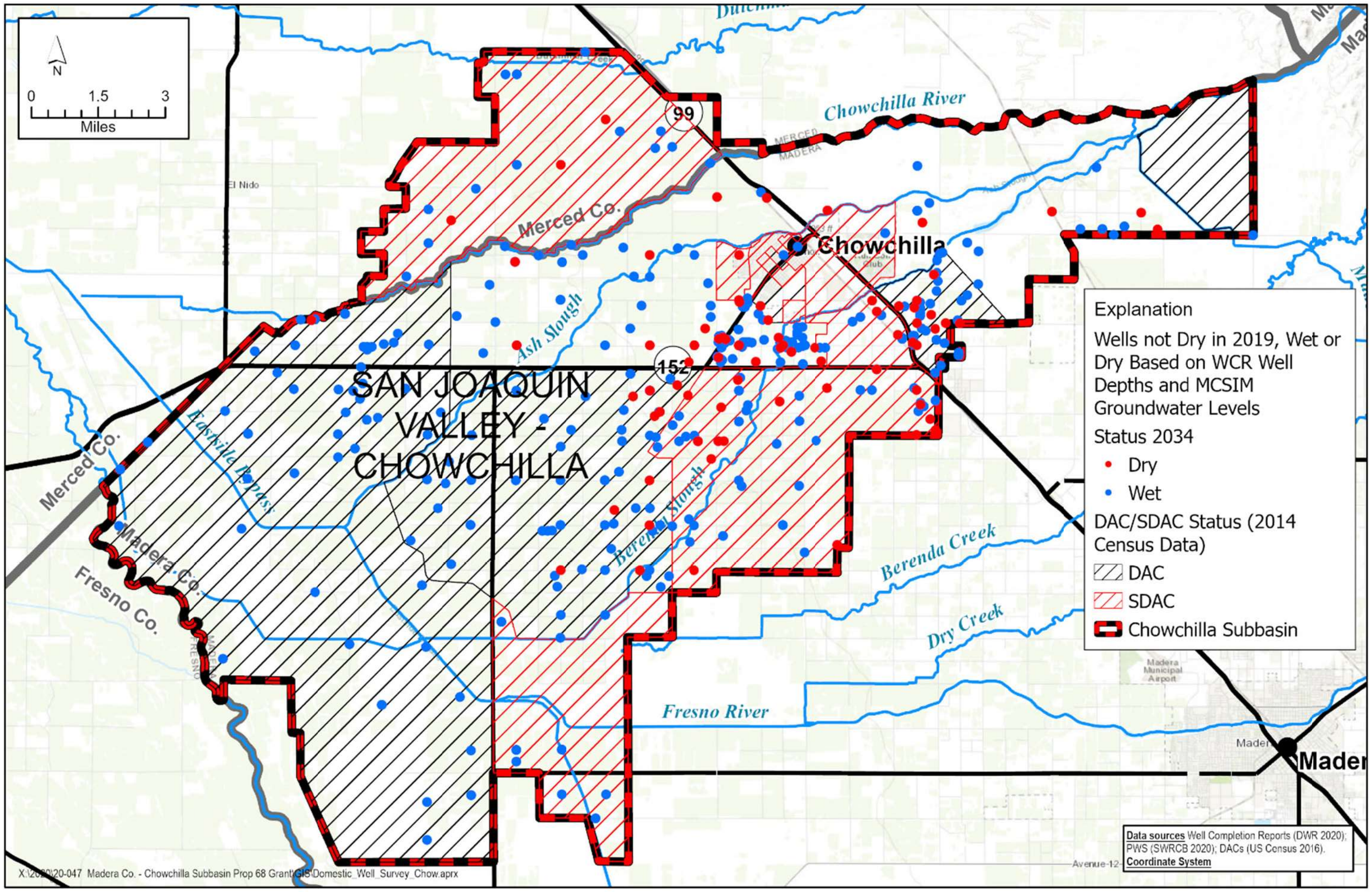

Figure 13d: Status of Wells in 2034 - Based on WCR Well Depths and Locations Compared to MCSIM Groundwater Depths.

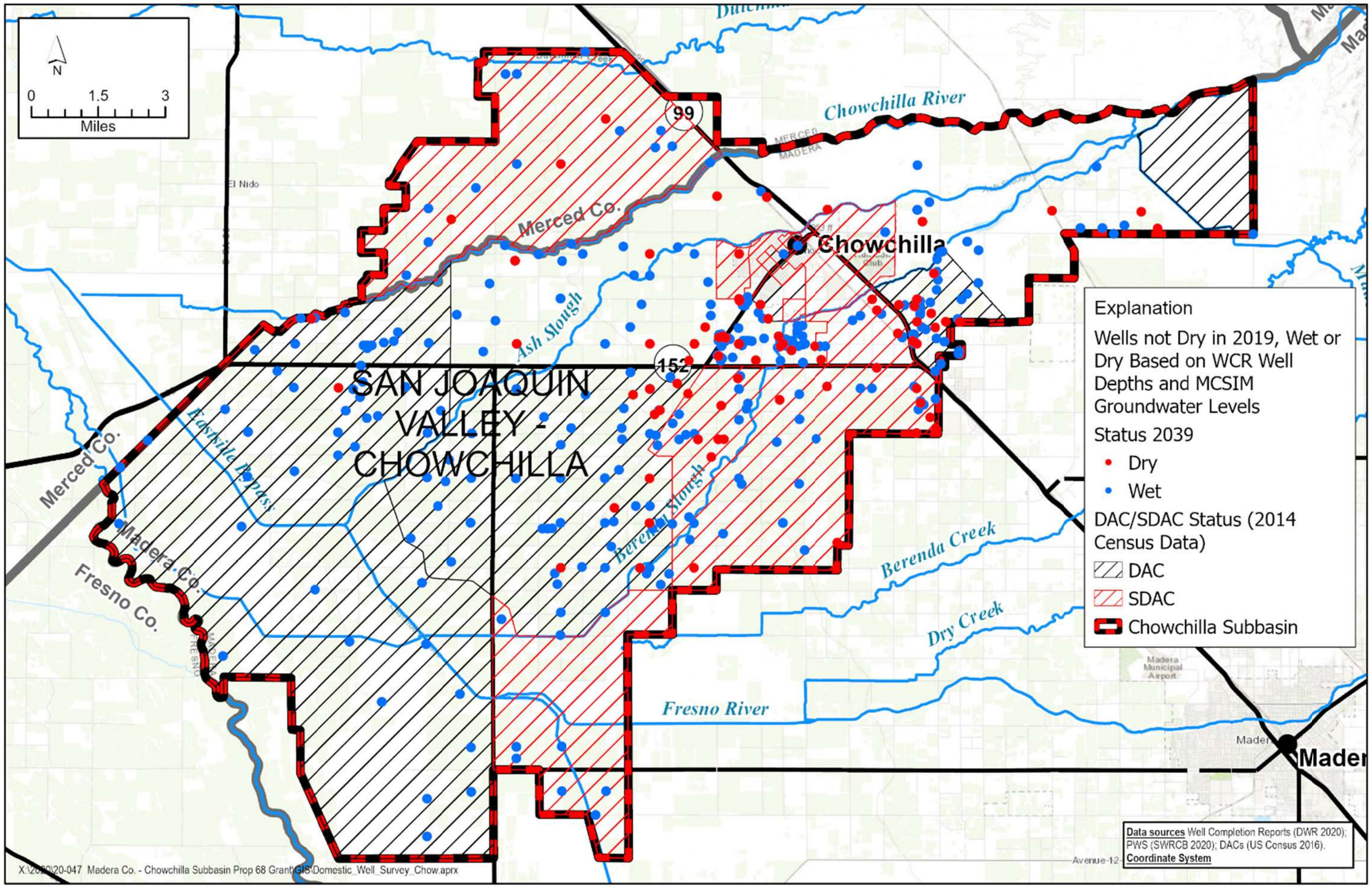

Figure 13e: Status of Wells in 2039 - Based on WCR Well Depths and Locations Compared to MCSIM Groundwater Depths.

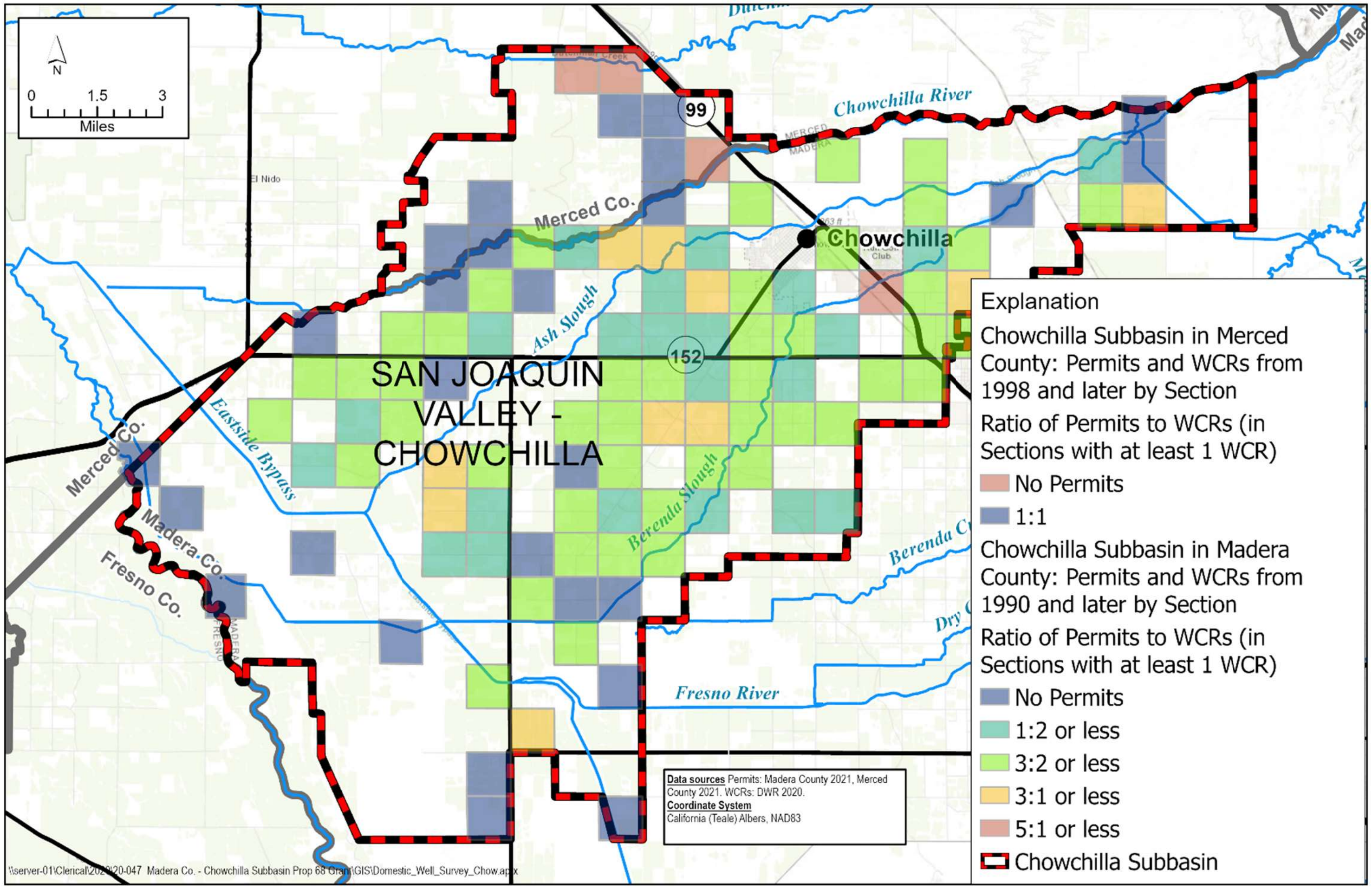

Figure 14: Map of Domestic Well Permits Compared to Domestic Well WCR (from 1990 and later) Locations.

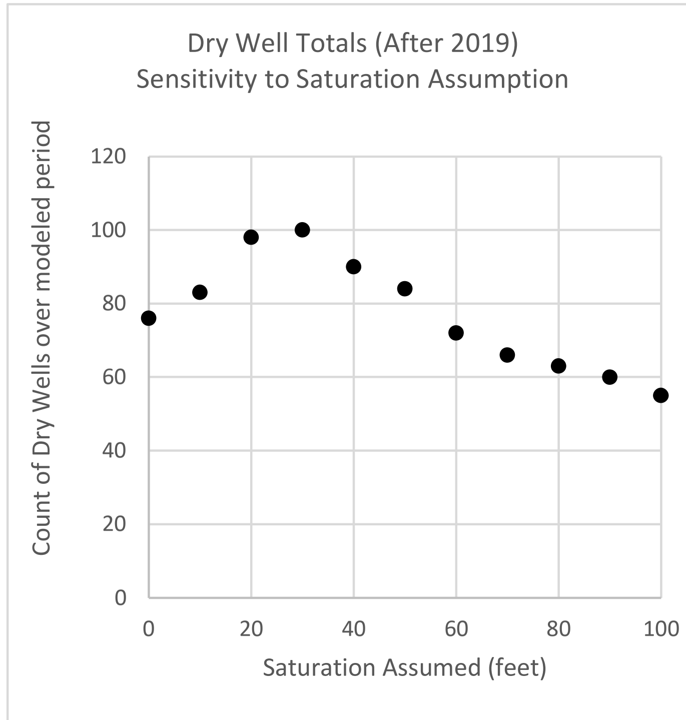

Figure 15: Counts of Dry Wells as a Function of Minimum Saturation Threshold.

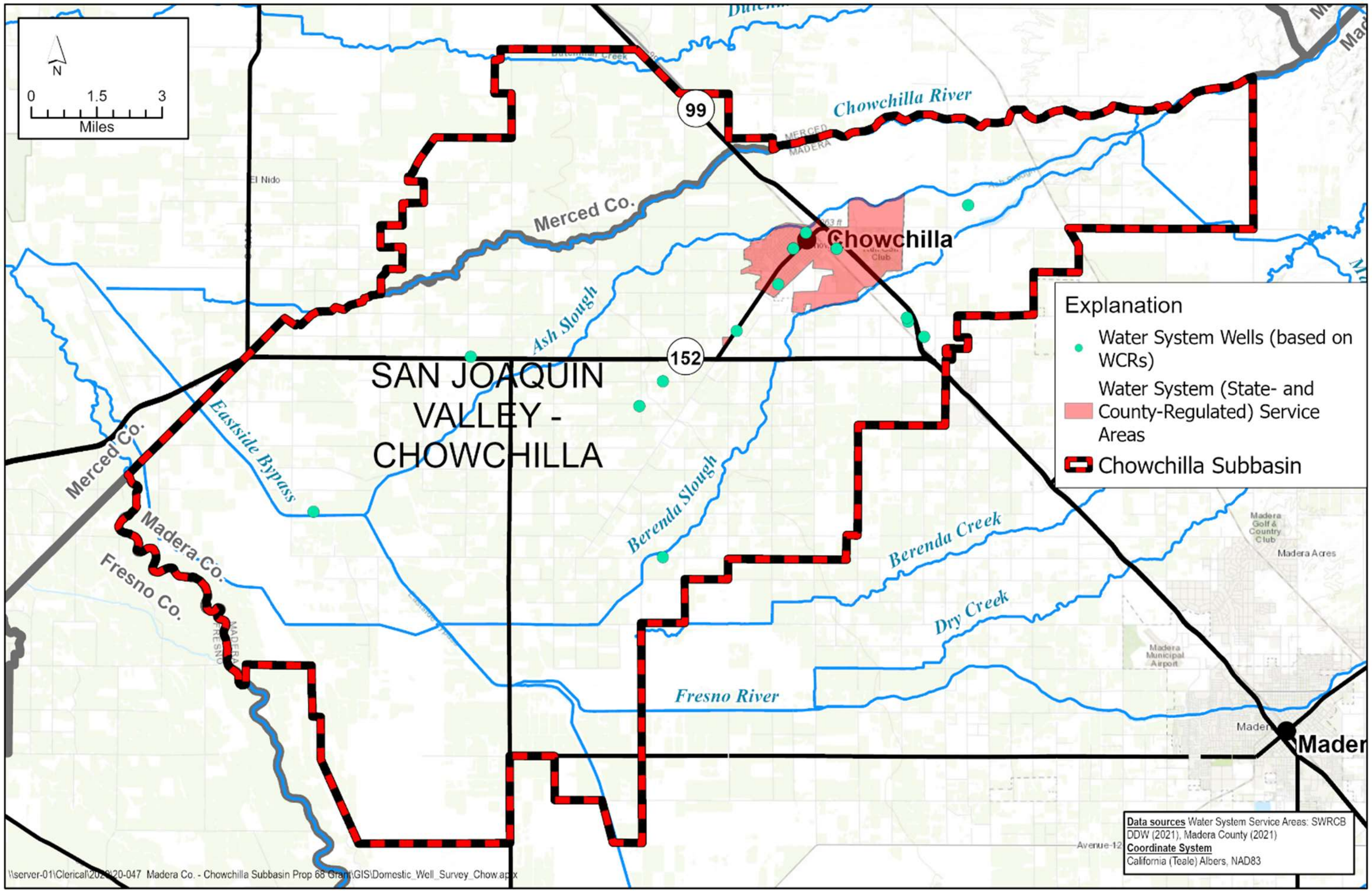

Figure 16: Public Water System and Other Municipal or Community Water System Wells. Based on WCR data.

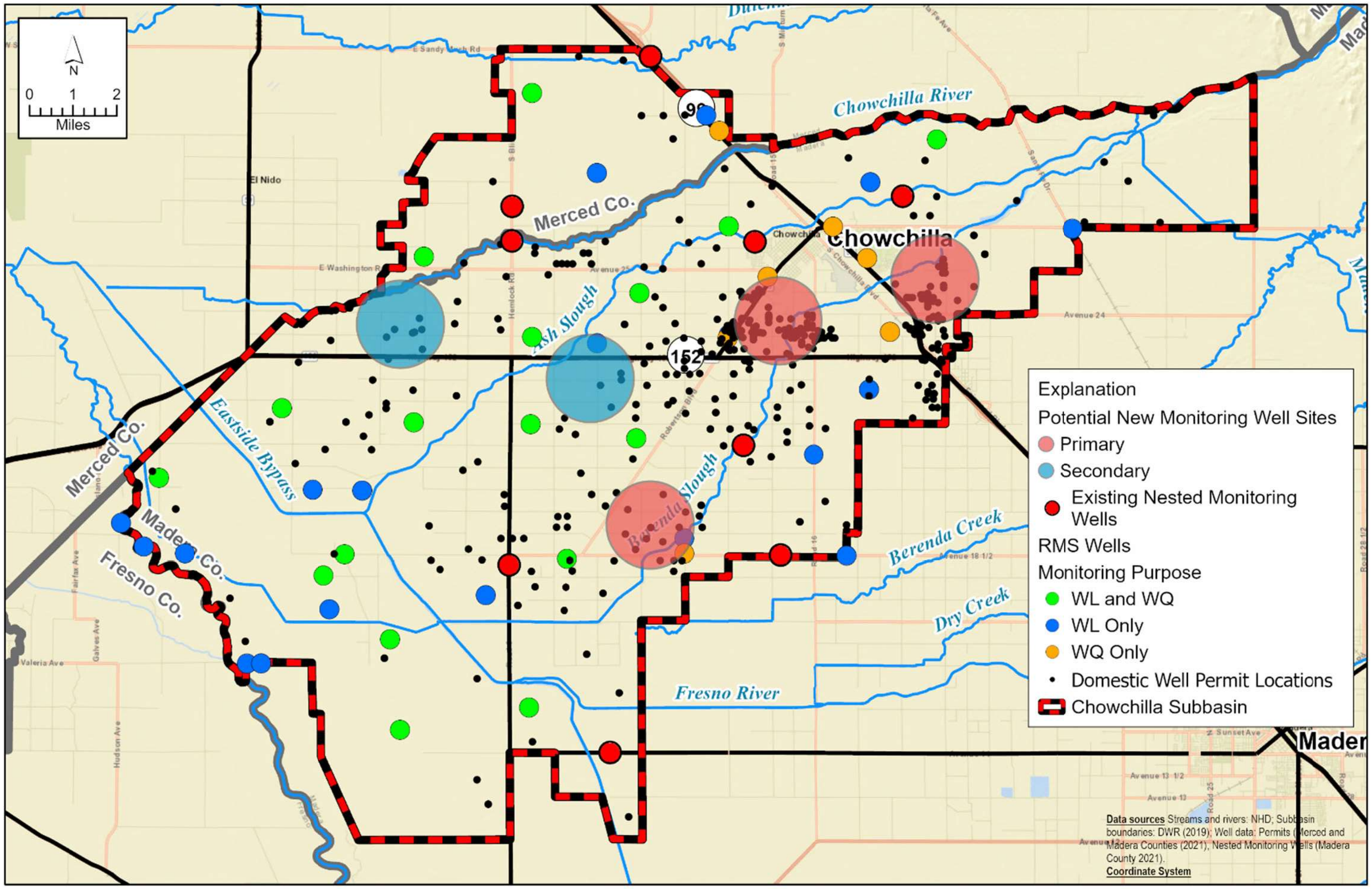

Figure 17: Map of Proposed New Monitoring Well Sites.

ATTACHMENT 1

Domestic Well Replacement Economic Analysis – Chowchilla Update

ERA Economics
Environment • Resources • Agriculture

ERA Economics
1111 Kennedy Place, Suite #4
Davis, CA 95616

Technical Memorandum

Subject: Domestic Well Replacement Economic Analysis – Chowchilla Update

By: ERA Economics

To: LSCE and the Madera County GSA

Date: January 10, 2022

Purpose and Background

In June 2019 ERA provided a technical memorandum (TM) estimating the cost and benefit of more rapid implementation of demand management under the Chowchilla Subbasin GSP. The economic analysis was included as Appendix 3C to the Chowchilla Subbasin GSP. The analysis was prepared with the best available data and information at that time. After finalizing the GSP, the LSCE and DE consultant teams have continued to assist the Chowchilla Subbasin GSAs with GSP implementation and annual GSP reporting. LSCE was engaged by the Madera County GSA to prepare an updated domestic well inventory for the subbasin.

The economic analysis included as Appendix 3C to the Chowchilla Subbasin GSP estimated the total cost of replacing domestic wells potentially impacted by declining groundwater levels under baseline conditions without SGMA and under the draft proposed GSP implementation plan (so-called "with-SGMA" scenario).

This technical memorandum (TM) serves as an update to those estimates by: (i) updating the project and demand management schedule to reflect the adopted allocation in the Chowchilla Subbasin, (ii) incorporating updated data and analysis on potentially impacted wells from the domestic well inventory, (iii) updating all costs and benefits to current dollars (e.g., well replacement costs), and (iv) refining the economic analysis to compare the cost and benefit of accelerating demand management specified in the GSP. That is, the 2019 analysis compared the draft GSP implementation to baseline conditions without SGMA, whereas this analysis compares the proposed plan with phased implementation of projects and management actions (PMAs) to an accelerated, immediate implementation of PMAs, notably with immediate full demand management to avoid further domestic well impacts.[1]

These updates to the data affect the resulting economic analysis and results. The 2019 estimate of domestic wells needing to be replaced without increased demand management was 40 wells, which at that time was doubled to account for potential under-reporting. In addition, a sensitivity calculation as

[1] Whereas the cost of immediate demand management implementation has been included, the effect on cost of accelerating recharge and supply projects has not yet been estimated. A full cost estimate of projects for all GSAs in the subbasin is still under development. If this additional cost were included, it would strengthen the conclusion of this analysis.

part of the earlier analysis verified that the conclusions would have held even if the number of affected wells were substantially larger. The updated domestic well inventory puts the number of domestic wells potentially needing replacement at 176 over the 20-year GSP implementation period. This TM briefly summarizes the updated analysis, results, and summary conclusions.

Summary Conclusions

Results of this updated analysis comparing the cost of accelerated PMA implementation to the benefit of avoided domestic well replacement costs support the general conclusion of the 2019 analysis. The loss in agricultural value from more rapid demand management still greatly exceeds domestic well replacement costs even though the estimated number of potentially dewatered domestic wells has increased and the cost of replacement for each domestic well has increased by 20 percent. That is, the results of the economic analysis show that the additional cost of more rapid demand management is substantially greater than the cost of replacing potentially dewatered domestic wells and paying higher pumping costs due to lower water levels. This supports the phased implementation schedule and domestic well mitigation program defined in the GSP.

Updated Assumptions

Assumptions and results below are summarized for each of the cost categories considered. All costs (or savings) are expressed as constant 2021 dollars converted to present value using a 3.5 percent real (inflation-free) discount rate[2]. The two implementation scenarios compared are referred to as *GSP implementation* (the phased implementation as described in the GSP) scenario and the *immediate demand reduction* (full demand reduction to eliminate overdraft from 2021 onward) scenario.

1. **Number of dewatered wells needing replacement**. Revised estimates of dewatered wells are calculated and described in the Technical Memorandum prepared by LSCE for the Chowchilla Subbasin Domestic Well Inventory. For this analysis, a total of 176 wells were estimated to be dewatered, spread across four 5-year periods. The cost analysis further assumed that well impacts would be evenly divided by year within each 5-year period[3]. For the comparison scenario with immediate demand reduction, it was assumed that none of those wells would need replacement.
2. **Costs to replace dewatered domestic wells**. The 2019 estimate of an average $25,000 per replaced domestic well is updated to $30,000 per domestic well.
3. **Groundwater pumping depth to water (DTW).** The average DTW for the GSP implementation scenario was provided from groundwater model projections described in the Chowchilla Subbasin GSP. The immediate demand reduction scenario is intended to represent immediate elimination of average annual overdraft. A time series was created that followed the

[2] The current federal discount rate for water projects is 2.25%, but a real rate of 3.5% better reflects borrowing conditions in Madera County. A 1.5% increase or decrease in the real discount rate does not affect the conclusions of the analysis.
[3] The timing of the well replacement within each 5-year period does not affect the conclusions of this analysis.

general hydrologic variation estimated for the GSP implementation scenario but held the DTW the same on average during the 2021-2040 implementation period. The ending (2040) difference in DTW between the two scenarios was then carried forward beyond 2040. These pumping depth differences are the basis for the estimated annual pumping cost savings.

4. **Changes in variable costs to pump groundwater, for both domestic and agricultural users.** Energy prices, estimated using a mix of PG&E's latest electricity rates for agricultural pumping, have increased substantially. The analysis now uses an average of PG&E's 2021 AG-B and AG-C peak and off-peak summer rates, resulting in an estimate of $0.40 per acre-foot per foot of lift for the variable cost to pump groundwater. As a result, more rapid demand management provides greater savings (avoided pumping lift) for domestic and agricultural pumping. All agricultural and domestic groundwater pumping in the basin would receive this avoided lift benefit from faster demand reduction.
5. **Costs of demand management under GSP implementation**. Costs of demand reduction have been revised based on the latest estimates of the net return to agricultural water use developed for planning the SALC program. In addition, pumping volumes have been updated to reflect current conditions and the planned ramp-down adopted in the Madera County GSA groundwater allocation ordinance (applicable to the GSP implementation scenario only). These values do not represent average returns to all lands and crops in the subbasin but rather the lands and crops more likely to participate in a demand reduction program. For purposes of this analysis, the lost net return from demand reduction is valued at $200 per acre-foot[4].

Results

The following discussion compares costs between the GSP implementation scenario and the (alternative) immediate demand management scenario. General observations are:

- Demand management costs are greater in the immediate implementation scenario because demand management would be implemented sooner (immediately) and for more years during the GSP implementation period. Recharge and supply projects' costs have not been included in this analysis, but their present value costs would also increase because they would be implemented sooner.
- Pumping costs are lower in the immediate demand reduction scenario because, by definition, the average annual overdraft is eliminated immediately. The effect (smaller DTW and lower pumping cost) is carried throughout the remaining years of GSP implementation and in perpetuity.

[4] The value of water depends on future crop market conditions. Note that a higher value (greater than $200 per acre-foot applied in this TM) would further increase the cost of accelerated demand management relative to avoided well replacement and additional pumping costs.

- Well replacement costs occur in the GSP implementation scenario but are not required in the immediate demand reduction scenario.
- The net effect of these differences in costs results in the GSP implementation scenario having a substantial cost advantage (by about $36 million in present value, or 16 percent) over the immediate demand reduction scenario. In other words, the Chowchilla Subbasin is better off (i.e., realizes benefits that exceed costs) implementing its phased GSP implementation plan and developing/funding the domestic well mitigation program to replace impacted wells than it is if it were to implement immediate demand reduction to avoid dewatering any domestic wells.

Table 1 summarizes the results of the economic analysis. All values are expressed in present value terms. The first two rows show the number of and cost to replace wells estimated to go dry in each scenario. The next rows present the pumping cost savings of the immediate demand reduction scenario relative to the GSP implementation scenario, broken down by domestic pumping and agricultural pumping. The next row shows the demand management costs. For the GSP implementation scenario, demand management is phased in at two percent per year initially, increasing to 6 percent per year until full demand management is reached by 2040. In contrast, the immediate demand reduction scenario implements the full demand management required in 2020, resulting in substantially higher demand management costs.

Table 1. Costs of GSP Implementation Scenario Compared to Costs of Immediate Demand Reduction Scenario - Summary Results for Chowchilla Subbasin, Present Value ($ in Millions)

	GSP Implementation with Well Replacement	Immediate Demand Reduction	Difference
Domestic Well Replacement			
Number	176	0	176
Cost, PV	$4.60	$0.0	$4.60
Pumping Cost (Savings), PV			
Domestic	NA	-$2.87	$2.87
Agricultural	NA	-$79.58	$79.58
Demand Mgmt. Cost, PV	$219.43	$342.37	-$122.94
Total Cost, PV*	$224.03	$259.91	-$35.88

* Totals may not add exactly due to rounding.

Discussion

Results indicate that the cost of implementing demand management on a faster trajectory (in this case, in year one of the implementation period) would not be cost effective from a subbasin-wide perspective. The avoided costs (fewer domestic wells requiring replacement) would be small ($4.6 million) relative to the additional lost agricultural net return[5] from immediate implementation ($122.9 million) for the Chowchilla Subbasin, even after accounting for pumping cost savings ($82.5 million). The general conclusions are robust to the assumptions used. That is, results are not sensitive to reasonable ranges in key assumptions, including the loss in net return per acre-foot of demand management, the total level of demand management, when demand management begins to scale in, or the cost of replacing a domestic well.

This analysis only compares the cost of well replacement to net costs of immediate demand management implementation; it has not considered the timing of other projects such as new surface water supplies or groundwater recharge. That comparison is not possible with current information, and the GSP implementation schedule already reflects an aggressive timeline for project implementation. The cost (in present value) of accelerating implementation of projects has also not been included here.The additional cost of accelerating a recharge project by, say five years, would be the increased present value of the project's capital and O&M cost stream. Costs of new supply and recharge projects have not been accelerated, so the present value of costs for immediate implementation is underestimated. Simply stated, including these additional costs would further support the conclusions of the analysis.

[5] Note that demand management would result in additional economic impacts to other county businesses and industries. These additional indirect impacts are not considered in this updated analysis but would only further support its conclusions.

ATTACHMENT 2

Chowchilla Subbasin – Evaluation of DWR Household Water Supply Shortage Reports and Self-Help Enterprises Tank Water Participants

Luhdorff & Scalmanini
Consulting Engineers

Technical Memorandum

DATE: February 8, 2022 PROJECT: 20-1-047

TO: File – Chowchilla Subbasin Domestic Well Inventory

FROM: Pete Leffler, Nick Watterson, Aaron King

SUBJECT: **Chowchilla Subbasin - Evaluation of DWR Household Water Supply Shortage Reports and Self-Help Enterprises Tank Water Participants**

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1. INTRODUCTION

To support efforts related to implementing the Chowchilla Subbasin Groundwater Sustainability Plan (GSP), the Subbasin completed a Domestic Well Inventory project that identified potential domestic wells in the Subbasin and analyzed potential impacts to domestic wells caused by lowering of groundwater levels historically and during the 20-year GSP implementation period starting in 2020. The Domestic Well Inventory for the Chowchilla Subbasin compiled information on domestic wells in the Subbasin from Well Completion Reports and County well permit datasets and compared these data to modeled groundwater levels in the Subbasin from the GSP over the period from 2014 through 2040. During development of the GSP, historical and future groundwater levels throughout the Subbasin were modeled based on historical conditions and projected future conditions. This memorandum summarizes a review of records in the Department of Water Resources (DWR) Household Water Supply Shortage Reporting System and also participants in the Self-Help Enterprises (SHE) Tank Water program, and includes a comparison of these two datasets with the results from analyses of domestic well impacts conducted as part of the Chowchilla Subbasin Domestic Well Inventory.

2. DWR HOUSEHOLD WATER SUPPLY SHORTAGE REPORTING SYSTEM

Overview of the Household Water Supply Shortage Reporting System

The DWR Household Water Supply Shortage Reporting System (https://mydrywell.water.ca.gov/report/) is a site for reporting of problems with private (self-managed, not served by public water system) household water supplies. The site was initially created in 2014 as part of drought emergency response efforts and continues to be used to collect information on household water supply shortages from private well or surface water sources. The data in the reporting system reflect information on water supply shortage issues voluntarily submitted by private, local, state, federal, and non-governmental individuals and organizations. Because the data do not undergo review or quality control by DWR, the reported information is not suggested to be complete in its accounting for all water supply shortages and it is also noted by DWR that there may be errors and omissions in data, duplicate entries, and records for non-household related water supply issues. Furthermore, during review of the data, many incomplete and inconsistent records were noted, with many reports providing very little detail for use in understanding the cause of the issue reported. There are a variety of potential causes for issues related to the quantity or quality of water produced by a well, and this can include issues related to the well pump, water distribution system, or the well structure, without relationship to groundwater conditions in the aquifer.

The submission of information to the Household Water Supply Shortage Reporting System is done through completion of a report submittal form (https://mydrywell.water.ca.gov/report/public/form), which includes questions related to the issue, including required entries on the following:

- Type of shortage: a) Dry well, b) low streamflow, or c) other
- Description of the water issue: a) well is dry (no longer producing water), b) reduction in water pressure/lower flows, c) well pumping sand/muddy water, d) well is catching air (have to wait to be able to pump, e) reduction in water quality, or f) other
- Primary use of the well or creek: a) household, b) agriculture/irrigation, c) combination of household/agriculture, or d) other
- Approximate date problem started
- County

As of January 2022, the reporting system included 3,769 entries across the state of California, with dates when the problem started spanning the period from 2012 through 2021.

Household Water Supply Shortage Records within Chowchilla Subbasin

The Household Water Supply Shortage Reporting System contains a total of 46 reports with locations in the Chowchilla Subbasin. The reports within the Subbasin were grouped into two categories according to the type of water supply issue indicated: 1) dry wells, and 2) reduced flow or impaired water quality. **Figure 1** presents the number of reported well-related issues by year within the Chowchilla Subbasin. Of the 46 reports within Chowchilla Subbasin, 41 were categorized as a dry well issue and six were categorized as reduced flow or impaired water quality issues. As illustrated on **Figure 1**, most water supply issues in the system were reported to have started in 2014, 2015, and 2021, with relatively fewer during other years. The greatest number of reports occurred during 2015 after multiple years of drought conditions in the area. **Figure 2** shows the locations of the water supply issue reports in the system. Most water shortage reports in the Subbasin are located in the central Subbasin.

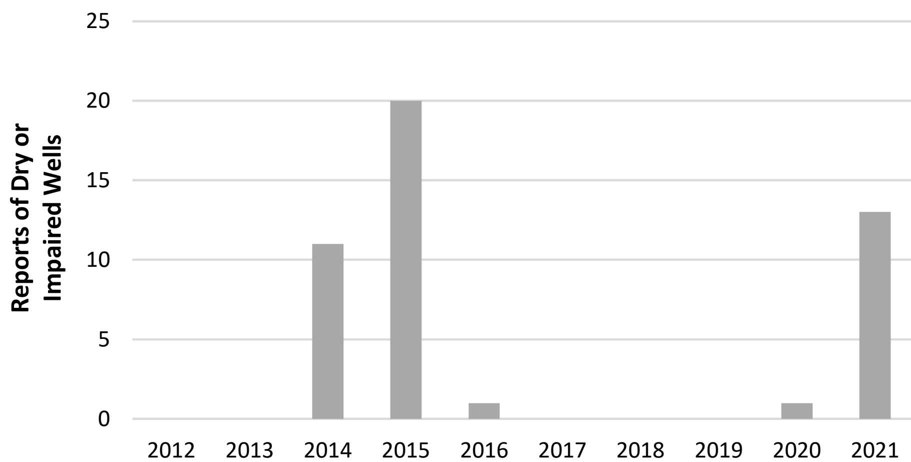

Figure 1. Chart of Household Water Supply Shortage Report Records in Chowchilla Subbasin

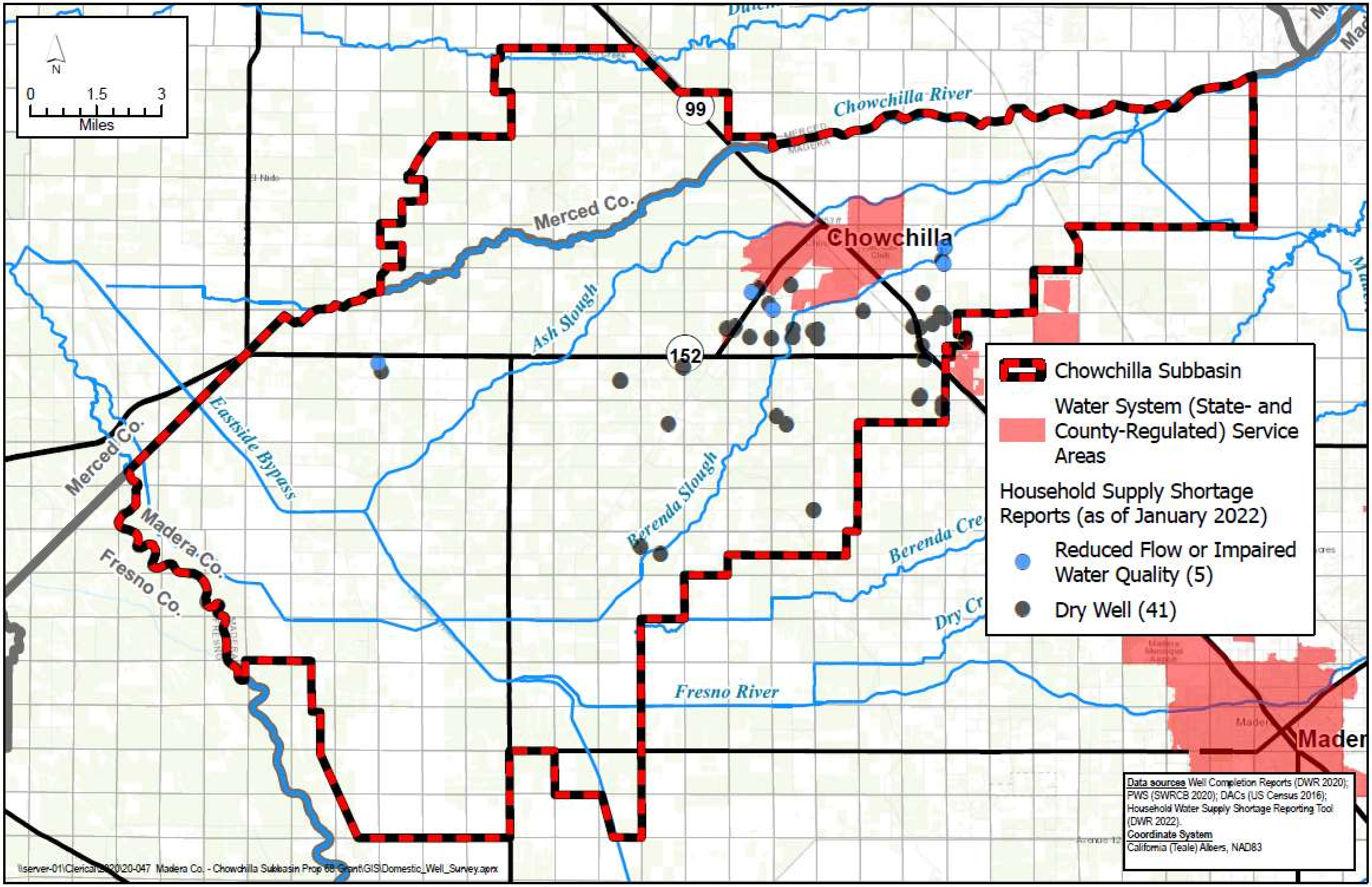

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Figure 2
DWR Household Water Supply Shortage Reporting Data

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3. SHE TANK WATER PROGRAM PARTICIPANT DATA

Overview of the SHE Tank Water Participant Data

The SHE Tank Water Program provides a temporary water supply solution for households experiencing a well water shortage in eight counties in and adjacent to the San Joaquin Valley: Fresno, Kern, Kings, Madera, Mariposa, Merced, Stanislaus, and Tulare. The SHE Water Tank Program assists households experiencing well water shortages by installing a water tank and hauling water and filling the tank to restore access to water for the home. The SHE Tank Water Program is intended as a short-term solution to provide participants access to water for one year while working towards a long-term solution. Data on participants in the SHE Water Tank Program as of January 2022 were provided by SHE (https://www.arcgis.com/home/webmap/viewer.html?webmap=377849cbc9c54046917d864a635e9674&extent=-120.0525,34.8083,-117.2593,36.0392). As of January 2022, the SHE Tank Water Program includes 769 participants in the eight-county area served by the program. The available Tank Water Program participant data only provide locations for participants without other attributes indicating the date or type of issue necessitating the reliance on tank water. There are a variety of potential causes for issues related to the quantity or quality of water produced by a well, and this can include issues related to the well pump, water distribution system, or the well structure, without relationship to groundwater conditions in the aquifer.

SHE Tank Water Participants within Chowchilla Subbasin

The Tank Water Program covers eight counties within the San Joaquin Valley, along with some areas located outside of the San Joaquin Valley and outside of DWR-designated groundwater basins (e.g., foothills areas). The SHE Tank Water Program includes 22 participants within the Chowchilla Subbasin. **Figure 3** presents a map of the Tank Water Program participants within the Chowchilla Subbasin. As illustrated on **Figure 3**, most of the Tank Water Program participants in the Chowchilla Subbasin are located in the area south of the City of Chowchilla. **Figure 4** is a map comparing the locations of SHE Tank Water participants and dry wells in the DWR Household Water Supply Shortage dataset. The spatial distribution of Tank Water participants and dry wells reported in the DWR dataset are very similar and likely include some of the same wells, although no information is available to evaluate such direct relationships in the two datasets.

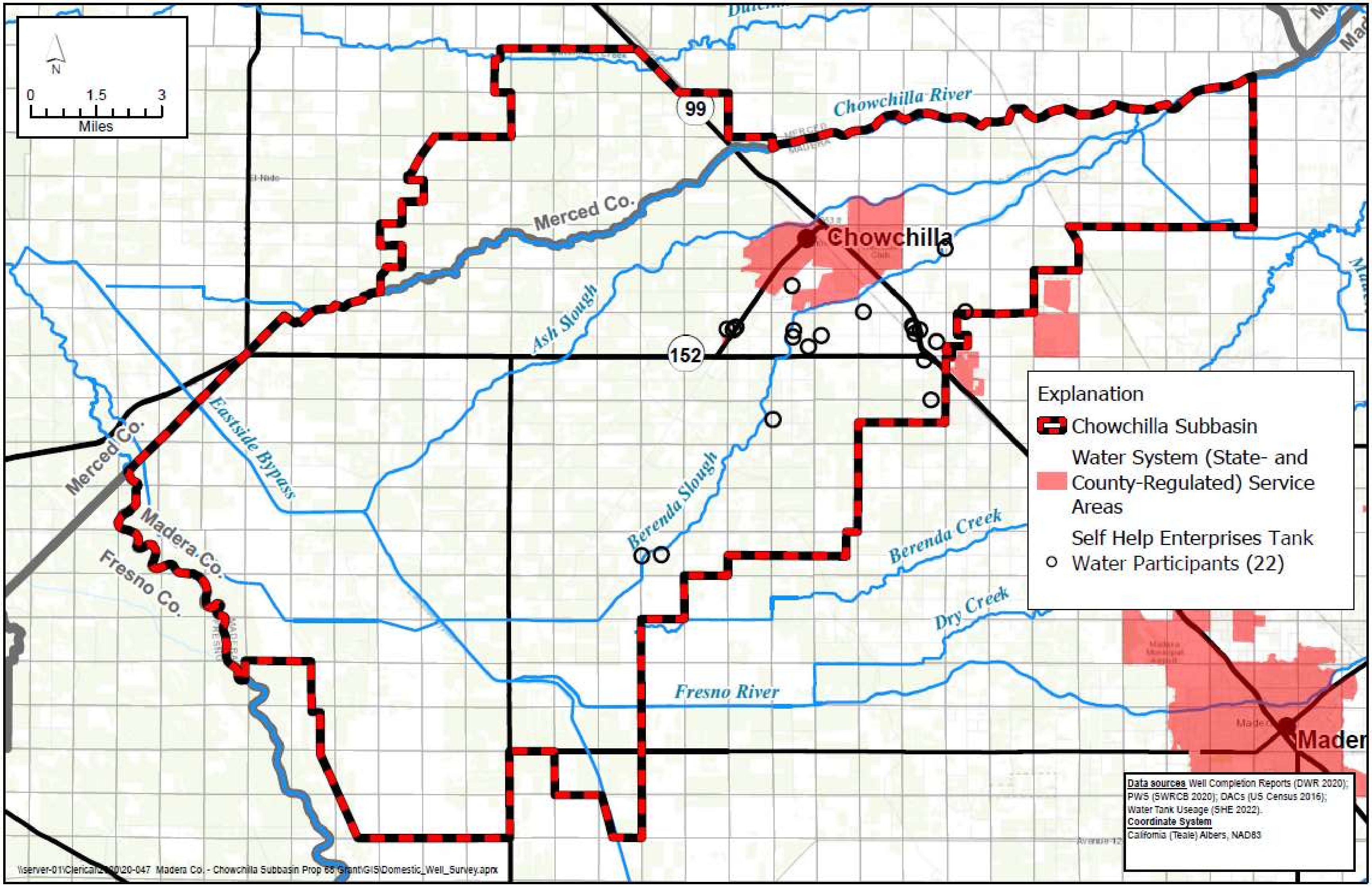

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Figure 3
Locations of Self Help Enterprises Tank Water Participants
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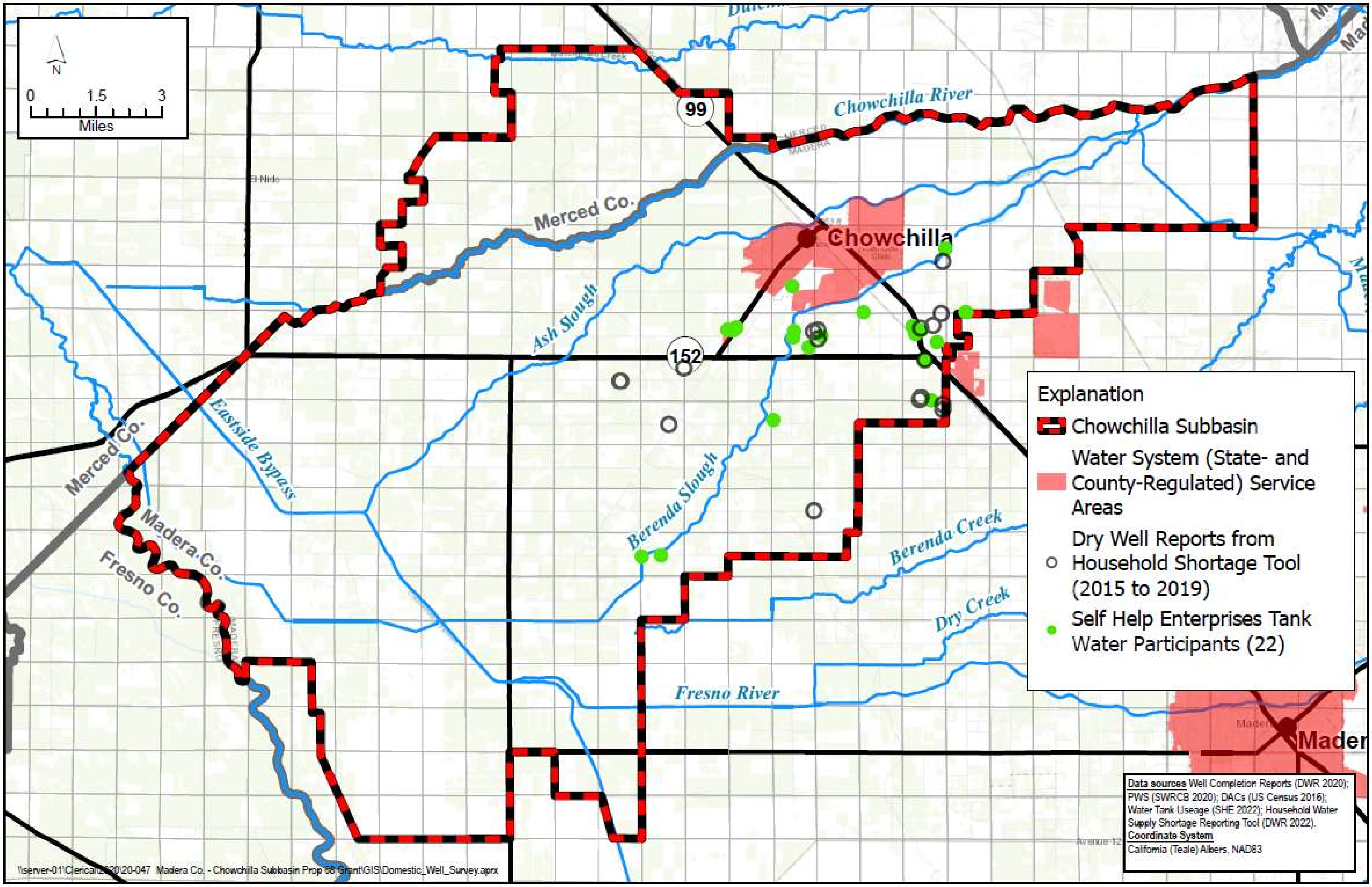

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Figure 4
Comparison of SHE Tank Water Participants and DWR Dry Well Reports
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4. COMPARISONS OF DWR DRY WELL RECORDS AND SHE TANK PARTICIPANTS WITH ANALYSES OF DRY WELLS FROM THE DOMESTIC WELL INVENTORY

Analyses of potential domestic well impacts in the Domestic Well Inventory were conducted at five-year intervals based on modeled groundwater levels across the Subbasin. To understand differences between dry wells reported to the Household Water Supply Shortage Reporting System and also SHE Tank Water Program participants in relation to estimates of potential dry wells from the Chowchilla Subbasin Domestic Well Inventory analyses, the spatial distribution of dry wells in the Household Water Supply Shortage Reporting System dataset and Tank Water Participants were compared with modeled dry wells over the period from 2015 through 2024.

The comparisons presented in this TM are intended to provide a general sense for the spatial distribution of the different datasets, recognizing the datasets present different types of information related to domestic well issues. As noted above, there are a variety of potential causes for a well experiencing issues related to the quantity of water produced by a well that may be unrelated to groundwater conditions in the aquifer. Some of these issues may be reflected in the DWR Water Supply Shortage Reports and SHE Tank Water Program participants list. It is also likely that many households with wells that have gone dry have not reported such occurrences to the DWR Household Water Supply Shortage Reporting System and many of these households have also not participated in the SHE Tank Water Program. As described in the technical memorandum summarizing the Chowchilla Subbasin Domestic Well Inventory, analyses of potential dry domestic wells in the Domestic Well Inventory are based only on the relationship between available well construction (e.g., screen depth and total well depth) and simulated groundwater levels at each domestic well location.

Comparison of DWR Dry Well Records with Modeled Dry Wells in the Domestic Well Inventory

Maps comparing dry well records in DWR's Household Water Supply Reporting System with dry wells modeled as part of the Domestic Well Inventory are presented in **Figures 5 and 6**. **Figure 5** presents a comparison of all reported dry wells in DWR's system (2012 through 2021) with modeled dry wells estimated for the period 2015 through 2024 in the Domestic Well Inventory. **Figure 6** presents a comparison of reported dry wells during the years 2015 through 2019 in DWR's system with modeled dry wells between 2015 and 2019 in the Domestic Well Inventory. **Figure 6** provides a more direct spatial comparison of dry wells in the two datasets over the same five-year period, whereas **Figure 5** presents an overview of the spatial relationship between the two datasets spanning a longer timeframe. Although there are considerably more modeled dry wells than reports of dry wells in DWR's system in either comparison, the spatial patterns in the two datasets show many similarities, with most modeled dry wells and reports of dry wells occurring in areas south and southwest of the City of Chowchilla. Some of the differences in locations between the modeled dry wells and reported dry wells in **Figures 5 and 6** are likely a result of differing resolutions of locational information available in the two datasets.

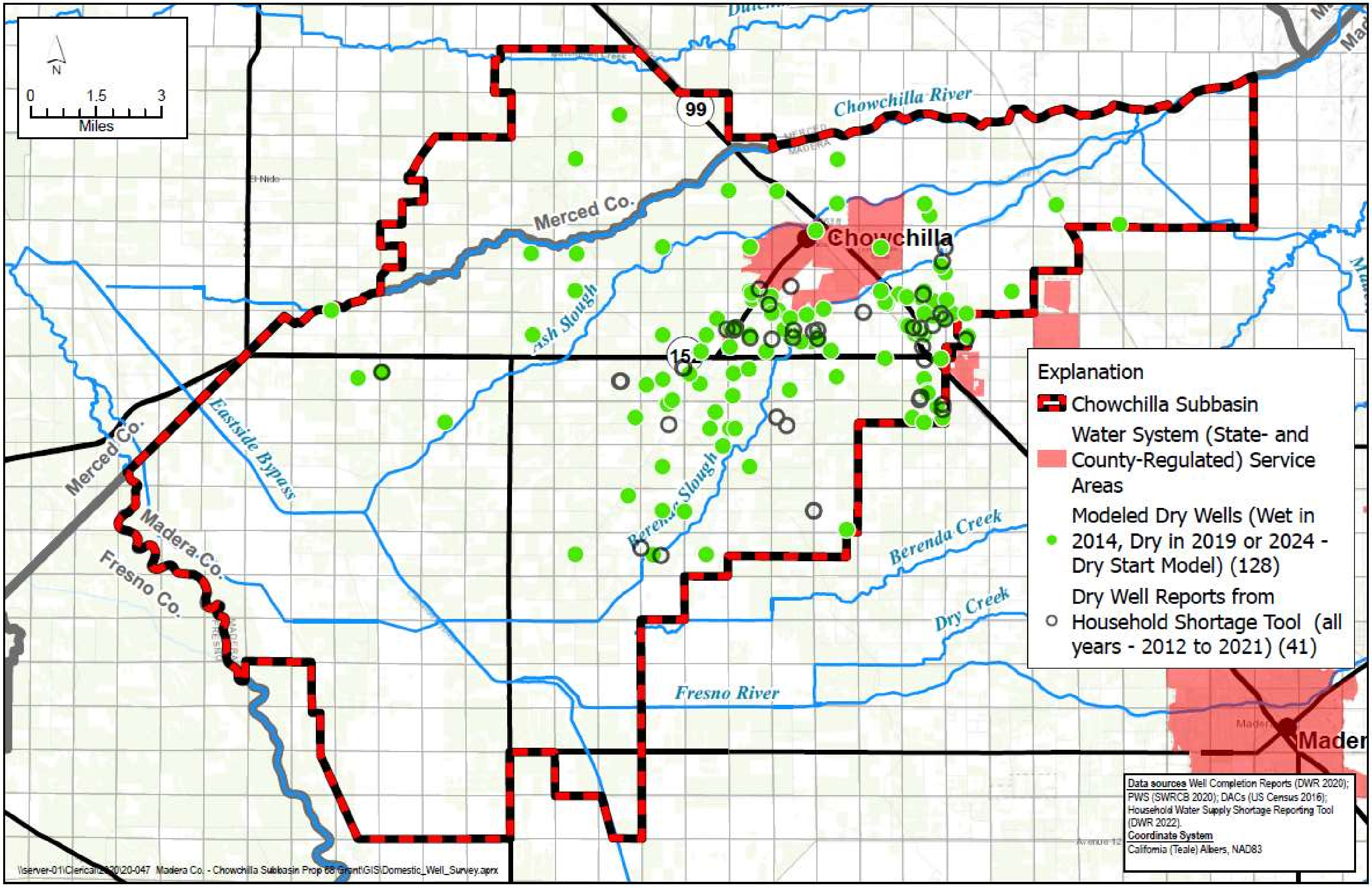

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Figure 5
Comparison of DWR Dry Well Reports with Modeled Dry Wells Between 2015 and 2024
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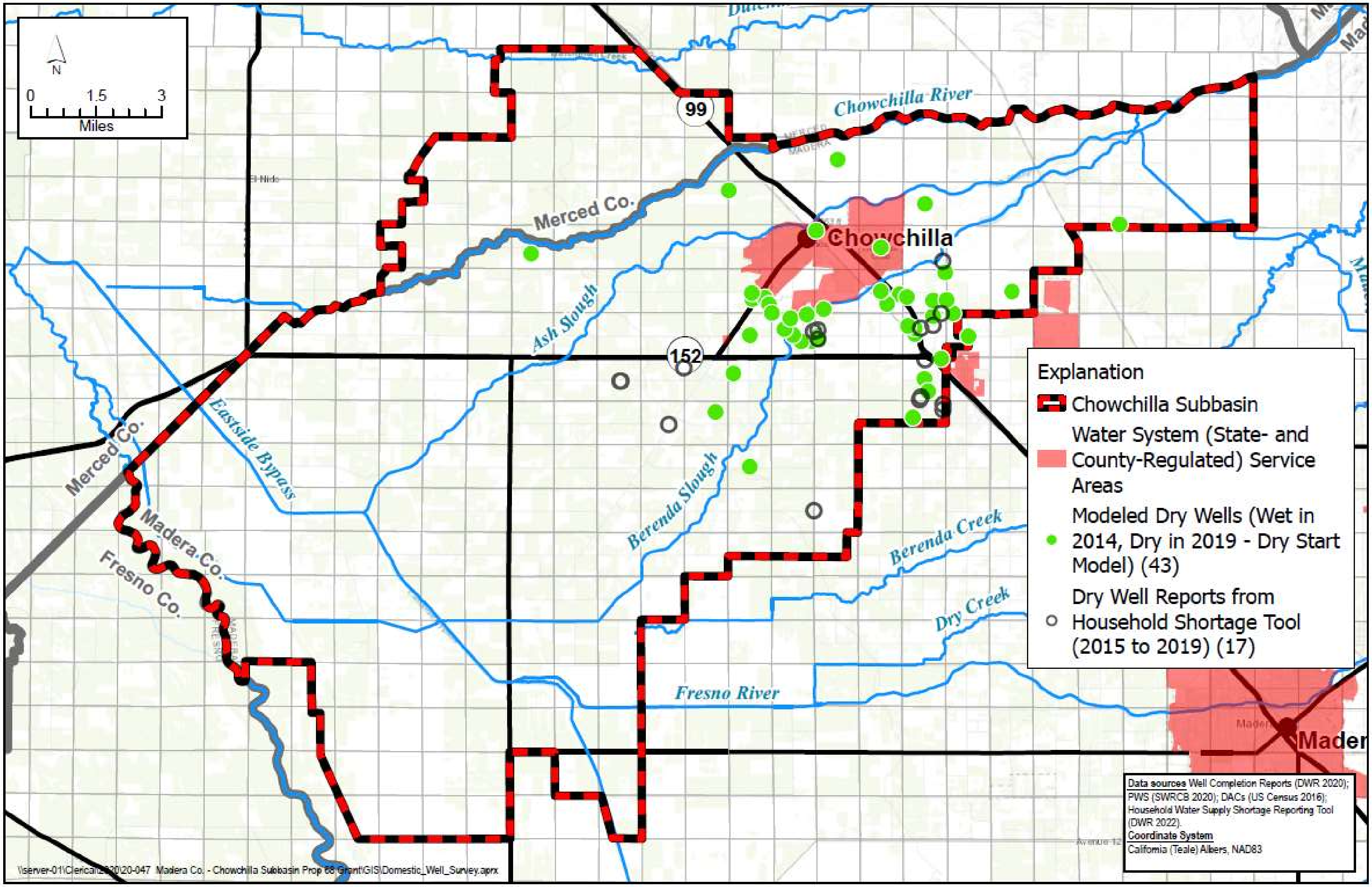

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Figure 6
Comparison of DWR Dry Well Reports with Modeled Dry Wells Between 2015 and 2019
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Comparison of SHE Tank Water Participants with Modeled Dry Wells in the Domestic Well Inventory

A map comparing SHE Tank Well Participants with dry wells modeled as part of the Chowchilla Subbasin Domestic Well Inventory are presented in **Figure 7**. **Figure 7** presents a comparison of all SHE Tank Water Program participants in the Subbasin as of January 2022 with modeled dry wells estimated for the period 2015 through 2024 in the Domestic Well Inventory. Although there are considerably more modeled dry wells than Tank Water Participants (as is the case with dry well reports in DWR's Household Water Supply Shortage System), the spatial patterns in the two datasets show many similarities with most modeled dry wells and SHE Tank Water Participants occurring in areas south and southwest of the City of Chowchilla.

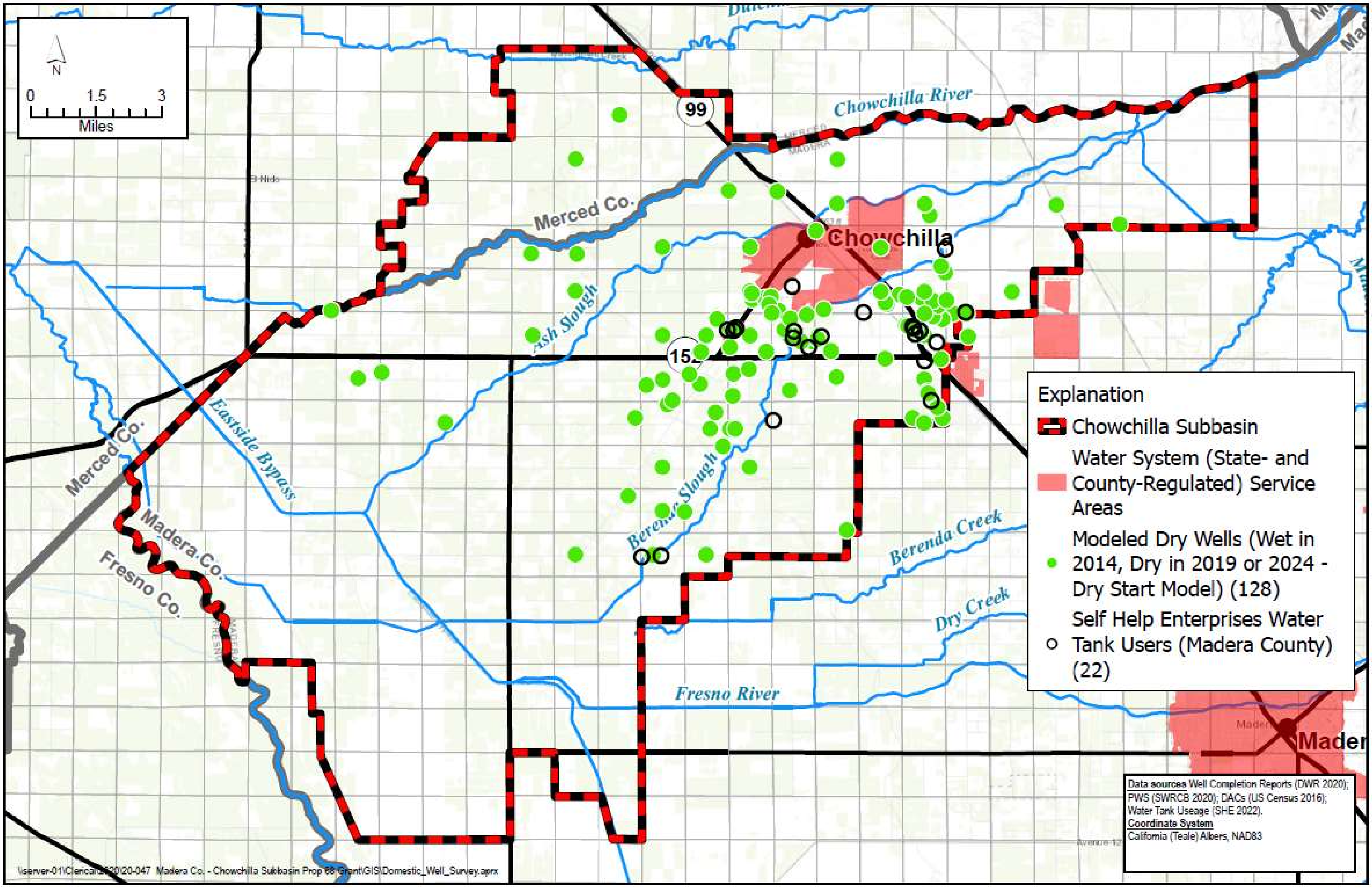

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Figure 7
Comparison of SHE Tank Water Participants with Modeled Dry Wells Between 2015 and 2024
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