



December 2, 2009
Project No. 09-1-013

Mr. Jan Alfson
Central Valley Regional Water Quality Control Board
1685 E Street, Suite 100
Fresno, CA 93706-2007

**SUBJECT: REVISED COMMENTS ON THE STEFFENS PONDS CLOSURE PLAN,
SPRECKELS SUGAR CO., MENDOTA, CA**

Dear Mr. Alfson:

At the request of the Mendota Pool Group (MPG), Luhdorff and Scalmanini Consulting Engineers (LSCE) has reviewed the Steffens Ponds Closure Plan (Plan) for Spreckels Sugar Co. (Spreckels) in Mendota, CA, prepared by John Minney (February 1, 2009). Our initial comments on the Plan were submitted on July 16, 2009. This updated comment letter contains additional detail and a revised evaluation of background water quality at the site. Revisions to the background water quality estimates are due in part to additional historical groundwater quality data provided by Spreckels.

Much of the groundwater data summarized in the Plan are excerpted from the 2007 MPG Annual Report, which was jointly prepared by LSCE and Kenneth D. Schmidt and Associates (KDSA) in May 2008 (LSCE and KDSA, 2008). However, the Plan contains both factually wrong and misleading statements. More importantly, the Plan contains two critical flaws:

1. Selection of Background Wells: Wells used for the calculation of background groundwater quality are not representative of background conditions at the Spreckels' site (Site). No Spreckels' wells were used in the analysis, and the selected wells were chosen without spatial or temporal considerations.
2. Statistical Analysis: The Plan employed a statistical analysis that (i) implicitly assumes a Gaussian (normal) distribution of water quality data, (ii) does not take into account the size of the statistical sample, and (iii) does not evaluate statistical confidence.

Either of the above flaws would invalidate the results of the analysis included in the Plan. The Plan calculates inflated background groundwater quality values and, as a result, erroneously concludes that groundwater is only minimally contaminated by wastewater disposal practices at the Site.

In this letter, general observations pertaining to groundwater quality in the Mendota area are discussed in *Section 1.0*, and historical groundwater conditions at the Site are discussed in

Section 2.0. Section 3.0 contains detailed comments on (i) the selection of background wells and the statistical analysis used in the Plan, (ii) factually wrong or misleading statements, (iii) the Plan's proposed monitoring program, and (iv) the Plan's proposed remediation. In *Section 4.0*, a superior statistical method is introduced and applied to the historical data for Spreckels' and other nearby wells to estimate background groundwater quality at the Site.

1.0 General Observations

Groundwater conditions discussed in this letter are limited to groundwater levels and quality in the "upper aquifer" above the Corcoran Clay, because the "lower aquifer" (below the Corcoran Clay) is not tapped by wells in the vicinity of the Spreckels' property or the Mendota Pool (Pool). The upper aquifer has been subdivided into two principal water-bearing zones, with the term "shallow zone" used for the zone above the A-clay or its equivalent depth (between 70 and 110 feet in the Mendota area). The A-clay is typically 10 to 15 feet thick but is discontinuous in the vicinity of the Site and is considered to pinch out east of San Mateo Avenue. The "deep zone" represents the zone between the A-clay and the Corcoran Clay (approximately 430 feet deep in the vicinity of the Site).

A Site location map is provided in **Figure 1**. Although water quality degradation has occurred historically in different portions of the Mendota area, the cause and amount of degradation varies greatly with location. West of the Fresno Slough and the San Joaquin River (north of Mendota Dam), easterly movement of naturally occurring high-salinity groundwater combined with irrigation tailwater is the primary cause of water quality degradation. The leading edge of this poor quality groundwater is referred to as the saline front. Movement of the saline front has caused significant salinity increases in wells located west of the Fresno Slough. The majority of the MPG production wells are located in this area along with monitoring wells installed by the U.S. Geological Survey (USGS) and others, and many of these wells have experienced large salinity increases over time. Contour maps of total dissolved solids (TDS) concentrations in the shallow and deep zones in the Mendota area prepared for the 2003 MPG Annual Report (LSCE and KDSA, 2004) included in **Appendix A** show the spatial variability of groundwater quality in the Mendota area. The approximate location of the saline front is indicated by closely spaced TDS contours (concentrations greater than 1,000 mg/L) west of the Fresno Slough and the San Joaquin River. The saline front is present in both the deep and shallow zones, but its location is most apparent on the TDS contour map for the deep zone because data were available for more deep zone wells.

East of the San Joaquin River (north of Mendota Dam) and the Fresno Slough (south of Mendota Dam), some wells near the River and Slough have experienced much smaller salinity increases due to the saline front. Elsewhere in western Madera County, where the Paramount Farming Co. (PFC) and Columbia Canal Co. (CCC) wells are located, groundwater quality has generally been stable except for small salinity increases attributed to irrigation practices and the lack of good quality surface-water recharge away from the River or the Pool. East of the Slough and south of the River, the saline front has affected groundwater quality in the western portion of the Site, but Spreckels' wastewater disposal practices are the primary cause of significant water quality

degradation. Low salinity surface-water recharge by the Meyers Farm Water Bank (Bank) has improved groundwater quality by diluting and/or displacing degraded groundwater in the western portion of the Site beginning in 2002.

2.0 Historical Groundwater Conditions at the Spreckels Site

2.1 Groundwater Flow

Contour maps of shallow groundwater elevations prepared for MPG annual reports (**Appendix B**) show that shallow groundwater flows toward the Spreckels' area from two directions. West of the Fresno Slough, groundwater flows toward the Slough from the west. Under most conditions, however, there is no gradient to cause shallow groundwater to flow beneath the Slough in an easterly direction. When the MPG wells west of the Slough are pumping, there is a cone of depression beneath the MPG well field that can result in shallow groundwater flow beneath the Slough in a westerly direction. When the MPG wells west of the Slough are not pumping, a recharge mound beneath the Slough causes shallow groundwater to flow away from the Slough to both the east and west. In recent years, a recharge mound beneath the Bank has resulted in groundwater to flow away from the Bank's recharge ponds in all directions (**Figure 2**). Groundwater flow beneath the Slough in an easterly direction may occur on a limited basis during the transition between MPG pumping and non-pumping periods and during periods of extraction from the Bank.

Shallow groundwater flow into the Spreckels' area also occurs in a southwesterly direction from an area of recharge in the vicinity of the San Joaquin River north and northeast of the Site (**Appendix B**). This southwesterly groundwater flow pattern is most apparent when groundwater levels beneath the River are high during periods of flow in the River.

Contour maps of groundwater elevations in the deep zone prepared for MPG annual reports show that there is less variation in the direction of groundwater flow in this zone. Deep groundwater consistently flows in a northeasterly direction toward an overdrafted area in Madera County east of the Chowchilla Bypass (**Appendix C**). However, groundwater flow conditions are also locally affected by deep-zone pumping by the MPG west of the Fresno Slough and in Farmers Water District (FWD). Beneath the Site, the direction of groundwater flow in the deep zone is typically to the north or northeast toward the FWD wells and the Madera County pumping depression.

2.1 Groundwater Quality

Shallow Zone

Historical data showing background conditions at the Site are limited because most Spreckels' monitoring wells were not constructed until after the onset of groundwater contamination, which

began prior to the 1980s (KDSA, 1983). **Figure 3** shows contours of historical TDS concentrations in nine shallow Spreckels' monitoring wells and a number of shallow MPG wells both east and west of the Fresno Slough. Although TDS data shown for the Spreckels' monitoring wells extend over a period of nine years (from 1982 to 1991), the groundwater samples were all retrieved before the occurrence of significant groundwater contamination. Therefore, the contour map is believed to represent pre-contamination conditions at the Site as accurately as possible based on the existing data record. The historical TDS concentrations vary considerably across the site, ranging from about 1,000 mg/L in the west to 200 mg/L in the northeast. The low salinity observed in the northeastern portion of the site is influenced by recharge from the San Joaquin River north and east of the Site. In the central portion of the Site, which was most affected by Steffens waste in later years, the historical TDS concentration shown on **Figure 3** is about 600 mg/L.

Higher historical TDS concentrations (900 to 1,100 mg/L) in the western portion of the Site measured in samples collected from Spreckels' MW-1 from 1982 to 1990 appear to be due to easterly movement of the saline front beneath the Slough. However, rapid TDS increases at MW-1 after 1990 are due to Spreckels' use of factory wastewater to irrigate permanent pasture in the western portion of the Site. The TDS concentration at MW-1 increased from 940 mg/L in 1990 to 3,100 mg/L in 2006 due to these wastewater disposal practices. Irrigation with factory wastewater in this area has been discontinued, and the TDS concentration had decreased to 1,000 mg/L by 2009 due to the change in wastewater disposal and recharge by the Bank. Pumping of nearby MPG wells at Jack's Resort east of the Slough (the Coelho West wells) and the Five Star wells west of the Slough creates a gradient for high-salinity wastewater (historically) or low-salinity banked water (in recent years) to flow to the west toward MW-1 and the Coelho West wells.

Figure 3 also shows historical water quality data from the nearby MPG wells. These include the Coelho West wells east of the Slough and the Five Star, Meyers Farming, Coelho-Gardner-Hansen (CGH), and Silver Creek wells west of the Slough. Data from the Coelho West wells are difficult to interpret because the water quality has been affected by both the saline front and Spreckels' wastewater. The effect of the saline front is much more apparent in the MPG wells west of the Slough, particularly the westernmost wells in the Five Star and CGH well fields. In 2001, TDS concentrations at four of the western Five Star wells (FS-6 through 9) ranged from 1,290 to 1,600 mg/L, while concentrations at the four eastern wells (FS-1 through 4) ranged from 740 to 1,060 mg/L. This salinity gradient is due to the combined effects of degradation due to the saline front and improved water quality due to surface-water recharge for the wells closest to the Pool.

Deep Zone

Similar to the shallow wells, there are only a few deep wells in the vicinity of the Site that have not been affected by Spreckels' wastewater. **Figure 4** shows historical deep-zone TDS concentrations prior to most of the effects of Spreckels' wastewater disposal practices. The map

shows data from 11 Spreckels' production wells, three Spreckels' monitoring well, two nearby FWD production wells, one Meyers Farm production well, and several deep MPG wells located west of the Fresno Slough over a period of 46 years (from 1962 to 2008). The data were not contoured because some of the observed variability over this extended time period is due to temporal rather than spatial factors.

Early TDS concentrations (from 1962-63) were very low in the central portion of the Site (ranging from 121 to 235 mg/L at PW-1, 2, 3, and 5). Substantial TDS concentration increases observed at PW-1 (to 400 mg/L in 1986) and PW-2 (to 376 mg/L in 1980) suggest that water quality at the other Spreckels' production wells had already been impacted by wastewater disposal by the time of the initial sample. Despite this, most of these data are included on the map and used in the background calculations discussed below because they are similar to off-site groundwater quality in nearby FWD wells R-1 and R-3. As such, much of the initial data from the Spreckels' production wells could be interpreted as reflective of natural spatial variability. PW-9 had a TDS concentration of 670 mg/L when it was first sampled in 1984; this is the only initial sample from the Spreckels' production wells that is not shown on **Figure 4**.

It appears that deep-zone groundwater quality in the western portion of the Site had already been affected by the saline front by the time of the first sample collected from MW-14 in 1987. The TDS concentration at MW-14 was 920 mg/L in 1987 and remained relatively stable until the start of Bank recharge in 2002. The lack of additional degradation at MW-14 due to the saline front is in contrast to the deep MPG wells located west of the Fresno Slough. TDS concentrations at the deep MPG wells ranged from 1,600 mg/L to 2,600 mg/L in 1999; and some of these wells have experienced additional water quality degradation since that time. The relative stability at MW-14 suggests that the leading edge of the saline front has not continued to move eastward beneath the Fresno Slough for the last 20 plus years (see *Section 3.3*).

3.0 Comments on the Plan

3.1 Selection of Background Wells

For purposes of calculating background groundwater quality, the Plan used data excerpted from the 2007 MPG Annual Report (LSCE and KDSA, 2008) for 40 shallow wells and 46 deep wells. These wells were selected primarily based on data availability, with no apparent consideration given to well locations or groundwater quality trends.

The shallow wells included 31 wells west of the Fresno Slough (26 MPG production wells and five monitoring wells) and four PFC monitoring wells north of the San Joaquin River. The only wells east of the Fresno Slough were the five Coelho West wells at Jack's Resort. None of the Spreckels' wells were included in the selected data set. The deep wells were distributed over an even larger area and included six wells in the Central California Irrigation District (CCID) service area, seven wells in the CCC service area, eight PFC wells, eight wells west of the Fresno Slough, and 17 wells east of the Slough (north of the Site). Again, no Spreckels' wells were

included in the analysis. As a result of this approach, neither the shallow nor the deep “background wells” were representative of background groundwater conditions in the vicinity of the Site. For example, almost all of the MPG wells and monitoring wells included in the group of shallow “background” wells are located west of the Fresno Slough, which is the area most affected by the saline front. The improper selection of background wells results in extremely high estimates of “background” concentrations. A superior method for the selection of background wells is provided in *Section 4.1*.

3.2 Employed Statistical Analysis

The employed statistical analysis is critically flawed. First, the statistical distribution of the data record used in the statistical analysis was not tested. Rather, the analysis relies on the implicitly assumed Gaussian (i.e., normal) distribution of water quality data. Environmental variables (such as groundwater quality) do not typically follow a normal distribution. Even if the data were approximately normally distributed, the chosen method remains inadequate and greatly inferior to other available methods for determining statistical intervals. Second, the size of the statistical samples was not taken into account in the analysis as is common practice in statistical testing. Both the statistical significance of and confidence in the results depend on the sample size. Third, the Plan did not evaluate statistical confidence, which leaves the reader without a means to interpret the significance of the results.

3.3 Specific Comments

Page 2, 5th paragraph and page 3, 3rd paragraph: *“The reason why the MPG shallow wells are increasing is likely the result of the substantial decline in good quality surface water being delivered to this area.”*

This is an unsubstantiated assertion without factual support. On the contrary, neither the quantity nor the quality of surface water delivered to the area has been declining. The record of almost daily electrical conductivity (EC) readings (1965-2008) at the terminus (Check 21) of the Delta-Mendota Canal (DMC) demonstrates large seasonal salinity fluctuations but stable overall conditions (**Appendix D**). Notably, mean daily EC data since the year 2000 have been generally lower than in the preceding decade. Further, water deliveries to the Pool via the DMC occur even in dry hydrologic years, and the San Luis and Delta-Mendota Water Authority (Authority) maintains a relatively constant stage in the Pool. Therefore, the quantity and quality of groundwater recharge from the Pool has remained relatively constant for decades.

Page 3, last paragraph: *“There is likely an inherent bias in the MPG Well data against Spreckels. MPG well data very likely understates groundwater conditions as compared to the Spreckels data.”*

There is also no factual support for this statement. On the contrary, the MPG data have the opposite bias because so many of the MPG wells are located west of the Fresno Slough in an area of high salinity attributed to easterly movement of the saline front. Also, due to strict



monitoring requirements, more of the MPG wells are sampled than deep wells owned by other entities. For example, only 13 of the PFC wells are routinely sampled, and the water quality data for these wells show mean EC values far below the "Mean MPG Deep EC" of 1272 $\mu\text{mhos/cm}$ calculated for the Plan. Inclusion of EC data from the remaining 70 plus PFC wells would undoubtedly result in a much lower mean EC for deep wells.

Page 7, 1st paragraph: *"However, when the wells are projected forward for fifteen years based upon the historical straight line trends, the Spreckels Deep wells are lower in mean Ec and TDS than the MPG "background" wells. That means that continuation of the current extraction practices at the factory site for fifteen years would be expected to result in the site meeting the "background" conditions."*

The above reasoning is based on three assumptions, (i) historical degradation rates observed in deep MPG wells located west of the Fresno Slough are linear, (ii) the historical degradation rates provide a valid means to estimate water quality at these wells in 2024, and (iii) the calculated constituent concentrations are applicable to deep Spreckels wells located east of the Slough. None of these assumptions are supported by the data record. Graphs of concentrations versus time included in the Plan clearly show that water quality degradation does not progress linearly. Initially high rates of degradation often diminish over time until concentrations stabilize, and substantial groundwater quality improvements have often been observed after periods of degradation. There is no evidence that the saline front has affected deep wells east of the Fresno Slough except for the wells closest to the Slough. Spreckels' monitoring well MW-14 (located approximately 1,500 feet east of the eastern shoreline of the Slough) is the only deep well east of the Slough with historical data that appears to show the effect of the saline front. As discussed above, data from MW-14 suggest that the leading edge of the saline front has been essentially stable beneath the Fresno Slough and has not continued to move eastward beneath the Slough for the last 20 plus years.

Pages 9-12: *Off-site migration of the Steffens plume.*

This portion of the Plan addresses the issue of off-site movement of the Steffens plume to the north or east and states that the occurrence of off-site contaminant migration is currently unknown. Although Spreckels does not have any monitoring wells along the northern Site boundary or north of the boundary in FWD, the movement of the plume in the deep zone is clearly documented by historical degradation observed at Spreckels' production wells located along the northern boundary (**Table E-4 in Appendix E**) and shown on historical plume maps prepared by LSCE for 1988 and 2001 (**Appendix F**). Contamination of FWD wells R-3 and R-11, which are located about 2,500 feet north of the Spreckels' property, has been reported in MPG annual reports beginning in 2001.

One reason for the author's expressed uncertainty about off-site impacts is that the Plan does not contain groundwater quality contour maps showing the current shape of the Steffens plume in either water-bearing zone. Figures 99 and 100 show a crude approximation of the on-site

Steffens plume in the shallow zone in 2000 and 2008, respectively, but there are no corresponding maps for the deep zone. It is not possible to adequately plan for monitoring and remediation of the site without knowing the current extent and distribution of the plume. Therefore, LSCE has prepared TDS concentration contour maps for the shallow and deep zones based on fall 2008 data (**Figures 5 and 6**).

In fall 2008, the highest TDS concentrations (over 5,000 mg/L) in the shallow zone occurred northeast of the former Steffens and lime wastewater ponds (**Figure 5**). The plume extended east of San Mateo Avenue and appeared to be moving to the northeast, with the leading edge apparently located between Spreckels' monitoring wells MW-31 and 32. Comparing this map to previous plume contour maps prepared by LSCE (**Appendix F**) suggests that the rate of plume movement is very slow due to the lack of shallow-zone pumping in the Spreckels' area. There was substantial groundwater quality improvement in the western portion of the Site in 2008 due to changes in Spreckels' wastewater disposal practices and low-salinity surface water recharged by the Bank.

In the deep zone, the highest TDS concentration (4,000 mg/L) in fall 2008 also occurred northeast of the former Steffens and lime wastewater ponds (see **Figure 6**). Off-site plume movement began between 1984 and 1986 based on historical data from PW-8 and PW-9. By 1999, the TDS concentration had reached 1,500 mg/L at PW-1 and 1,700 mg/L at PW-8. Although those wells have been abandoned, northerly plume migration has continued as evidenced by increasing salinity at other production wells along Spreckels' northern property line. For example, the TDS concentration at PW-9 reached a peak of 2,200 mg/L in 2008. The plume is moving to the north toward FWD wells R-3 and R-11, and impacts to those wells appear to have occurred by 2000 or 2001. The rate of plume movement is faster in the deep zone due to the gradient caused by pumping occurring in FWD and north of the River in Madera County. It is anticipated that the salinity at both FWD wells R-3 and R-11 will continue to increase due to northerly movement of the plume unless steps are taken to remediate contamination in the deep zone. Deep-zone groundwater quality improvements in the western portion of the Spreckels' property at MW-14 (640 mg/L in 2008 compared to about 1,000 mg/L in the 1990s) is attributed to low-salinity surface water recharged by the Bank.

Page 11, 1st paragraph: *“As shown on Figure 36, R-3 sits in an area that has the remnants of an old channel in the vicinity, which is referred to locally as the little San Joaquin. It is possible that groundwater from the wells degraded by overpumping along the Fresno slough could be traveling up the channel to R-3.”*

The speculation that water quality degradation at FWD R-3 may be due to groundwater pumped by MPG wells west of the Fresno Slough moving up the small channel referred to as the “little San Joaquin” is unfounded partly because there is clear evidence of off-site Steffens plume migration toward R-3. Any water from the Fresno Slough moving east into the “little San Joaquin” would be a mixture of generally high-quality surface water from the DMC and a much smaller volume of water pumped by MPG wells. From 2000 through 2008, the volume of water

pumped to the Fresno Slough by MPG wells averaged less than 15 percent of the south flow in this portion of the Pool contributed by the DMC. It has been amply documented by the Authority and in MPG annual reports that the flow direction in the Fresno Slough is to the south during the irrigation season, and the MPG wells with the highest salinity are located south of the “little San Joaquin”. The unsubstantiated theory about contamination via the “little San Joaquin” does not alter the clear evidence that the Steffens plume has been moving off-site to the north for more than 20 years.

3.4 Proposed Monitoring

The Plan proposes to install a new shallow monitoring well (MW-33S) along the northern property line next to PW-1 if concentrations of constituents such as TDS and chloride continue to increase at MW-9 during a one-year period. Although additional monitoring wells along Spreckels’ northern property line are important to protect off-site groundwater quality beneath FWD, the installation of shallow monitoring wells in this area is a lower priority than construction of deep monitoring wells. We would suggest that data from five downgradient shallow monitoring wells (MW-5, 6, 8, 24, and 29) be evaluated over a longer period (e.g., three years) to determine if salinity is increasing in the northern portion of the site. Increasing salinity at any of these wells would indicate that one or more shallow monitoring wells should be installed along the northern property line. The location of the new monitoring well(s) should be determined based on updated plume contour maps (similar to **Figure 5**). We anticipate that any new shallow monitoring wells would be installed east of the location proposed in the Plan and possibly east of San Mateo Avenue, since the Steffens plume appears to be moving in a northeasterly direction in the shallow zone.

The Plan also proposes to install a new deep monitoring well (MW-34D) along the northern property line east of PW-11. We agree that additional deep-zone monitoring is needed along the northern property line but don’t believe that a deep monitoring well east of San Mateo Avenue is needed at this time because groundwater quality can continue to be monitored using the existing production wells in this area. Although PW-11 appeared to exhibit some impacts due to the Steffens plume during 2005-07, it currently has excellent water quality, and the plume is generally moving north, not east, in the deep zone. The new monitoring well should be installed west of San Mateo Avenue near PW-8 (now abandoned), which is located in the central portion of the plume shown on **Figure 6**.

The Plan proposes that data from three FWD production wells (R-3, R-10, and R-11) be included in future Spreckels’ annual reports. We agree that data from R-3 and R-11 should be included but believe that the third FWD well should be R-1 instead of R-10. R-10 is located almost one mile north of the Spreckels’ property and is less likely to be impacted by the Steffens plume than R-1, which is located about 1,800 feet northeast of PW-11. We would also recommend that Spreckels install a deep off-site monitoring well on FWD property north of PW-8. Data from this well should be used to show the northerly movement of the Steffens plume beneath FWD property and provide early warning of future impacts to FWD wells R-3 and R-11.

3.5 Proposed Remediation

The principal remediation activities proposed in the Plan are as follows:

- The former Steffens ponds would be capped with a one-foot thick clay liner topped with four feet of soil cover. The cap would be constructed incrementally over a 15-year period. Soil removed from the factory wastewater ponds would be used to construct most of the cap, but material for the clay liner would be obtained from a separate borrow site that was not used for wastewater disposal. A portion of this cap is apparently existing and was constructed to a one-percent grade. A one-half percent grade is proposed for the future cap.
- The factory wastewater ponds would be closed by removing most of the pond levees and impacted soil on the bottom of the ponds. Soil removed from these ponds would be used to construct the cap over the former Steffens ponds.
- The lime wastewater ponds would be closed by removing all lime waste within five years. The lime waste would continue to be sold as a soil amendment during this period.
- Approximately 600 acres at the site would be planted to salt-tolerant crops. These crops would be irrigated with approximately 1,060 acre feet of water pumped from six on-site deep production wells. The Plan indicates that water from these wells had an average TDS concentration of 860 mg/L in 2008.
- According to the Plan, extraction of contaminated groundwater from the shallow zone would continue at a low rate using three existing monitoring wells (MW-15, 19, and 26). One deep-zone monitoring well (MW-16) would also be used as an extraction well. These four wells would pump a combined 44 gallons per minute (gpm) from the heart of the Steffens plume. This water would be pumped to an existing 8.8-acre clay-lined pond for evaporation.

Comments on Proposed Remediation

- The remediation plan is not clearly explained, and much of the necessary detail and engineering calculations are lacking. The discussion of proposed remediation is poorly organized and confusing, partly because it is mixed in with responses to questions by the Regional Water Quality Control Board instead of being in a separate section.
- Maps and cross sections of the existing and proposed Steffens pond liner and cap are needed. The Plan does not state how long it will take to complete the one-foot clay liner, and it is unclear why it would require 15 years to complete construction of the cap.
- The proposed extraction rate (a total of 44 gpm from three shallow wells and one deep well) is insufficient to provide plume containment in both water-bearing zones. Use of a simple groundwater flow model is recommended to determine the extraction rate necessary to contain the Steffens plume. It is likely that additional extraction wells will be needed in the shallow zone unless larger pumps can be installed in existing wells. In the deep zone, more extraction wells and a much higher pumping rate will be needed to provide plume containment, but some containment could be achieved if continuous pumping from the production wells along the northern property line was possible, as discussed below.

- The existing 8.8-acre evaporation pond is too small to accommodate the need for increased evaporation based on a higher extraction rate. The least expensive option for increasing the evaporation pond area would be to convert the existing factory wastewater ponds to evaporation ponds instead of removing them. The Plan indicates that the total area of these ponds is about 150 acres, which would be more than enough to evaporate all the extracted groundwater. Although the factory wastewater ponds do not have a clay liner, they appear to be adequately sealed due to sediment deposited on the pond bottoms over decades of use. One indication of this is that these ponds still contained water in July 2009, even though they hadn't been used since the fall of 2008 and there was little precipitation in the winter of 2008-09. Four monitoring wells adjacent to the wastewater ponds (Spreckels' MW-3 and Meyers Farm MF-4, 8, and 9) have shown significant water quality improvements since the Bank began operation, which suggests that any leakage from these ponds is minimal compared to recharge from the Bank.
- The Plan needs to address how the evaporation ponds would be closed after extraction is complete.
- Planting of salt-tolerant crops appears to be a good option to deal with some of the saline groundwater pumped from the deep zone, but we have several concerns about the proposed plan:
 - Pumping deep wells along the northern property boundary only during the irrigation season is problematic because it would pull the Steffens plume north during the pumping period and then allow it to migrate off-site beneath FWD property during the rest of the year when the Spreckels' wells are shut off. If wells within the limits of the Steffens plume shown on **Figure 6** are to be pumped, some pumping should continue throughout the year to maintain plume containment. The amount of pumping required to contain the plume should be estimated with a groundwater flow model.
 - For the proposed 600 acres of new crops, the proposed application of blended water that contains more salts than can be utilized by crops, as proposed in the Plan, could exacerbate existing groundwater contamination problems. Spreckels' historical use of factory wastewater to irrigate permanent pasture in the western portion of the property caused widespread groundwater contamination beneath the pasture areas. For example, the TDS concentration at Spreckels' MW-1, located at the western edge of one of these pastures, increased from 940 mg/L in 1990 to 3,100 mg/L in 2006. Spreckels has discontinued the use of factory wastewater to irrigate pasture in this area in recent years, and the TDS concentration at MW-1 had declined to 820 mg/L by 2007 due to the change in irrigation practices and recharge from the Bank. Additional groundwater contamination beneath new croplands resulting from irrigation with blended water could offset water quality improvements due to the Bank. Installing shallow monitoring wells in or adjacent to these fields is recommended, and these wells should be sampled regularly to ensure that additional groundwater contamination does not occur due to the use of blended water for irrigation.

4.0 Suggested Alternative Statistical Analysis

4.1 Selection of Background Wells and Data Record

Background concentrations for the Spreckels' property would ideally be based on complete historical records obtained from wells on or near the Site that have not been affected either by Spreckels' wastewater disposal practices or by Bank recharge. Because very few wells meet these criteria, partial records had to be used in most cases. In addition, the pre-impact water quality variability across the Site was recognized. Consequently, data used to determine both shallow and deep-zone background concentrations were pooled into three groups (i.e., for the western, central, and eastern portions of the Site). Importantly, none of the selected data sets exhibit significant trends of either increasing or decreasing salinities. The complete historical record for all wells in the MPG database is compiled in **Appendix E**. Data for the Spreckels' and Meyers Farm Water Bank wells are provided in **Table E-4**.

Shallow Zone

The data used to calculate background TDS concentrations in shallow groundwater beneath the Site are summarized in **Table 1**. In the western area of the Site, the complete records for Coelho West wells CW-1, 2, and 3 were used, and partial records were used for CW-4 and Spreckels' MW-1. The initial sample collected from Spreckels' MW-3 in 1982 was also used in the analysis. The northernmost Coelho West well, CW-5, was considered to be impacted by Spreckels' wastewater used for irrigation prior to the first sample in 2001 and was not included in the analysis of background concentrations.

In the central portion of the Site, all shallow wells are currently impacted by Spreckels' wastewater, but historical pre-impact data from MW-4, 5, 6, and 9 are available. Accordingly, partial records for those wells were used to calculate background concentrations in the central area.

In the eastern area of the Site, MW-32 is the only shallow well that has not been impacted by Spreckels' wastewater, and all data from this well were used to establish background groundwater quality. Spreckels' monitoring wells MW-30 and 31 are currently impacted by the Steffens plume, but historical pre-impact data for these wells were used in the analysis.

Deep Zone

The data used to calculate background TDS concentrations in deep groundwater beneath the Site are summarized in **Table 2**. There are only two deep wells in the western portion of the Site, Spreckels' MW-14 and Meyers' DW-1. MW-14 exhibited substantial water quality improvement since 2003 due to the operation of the Bank, and those data were excluded from the analysis of background groundwater quality. The initial sample collected from DW-1

immediately after its construction in December 2007 was also excluded because it was considered to be affected by drilling fluids.

In the central area of the Site, partial data from two Spreckels' monitoring wells (MW-8 and 10) and nine production wells (PW-1, 2, 3, 4, 5, 6, 7, 8, and 10) were used in the analysis. The initial sample collected from FWD well R-3 in 1987 was also used.

In the eastern portion of the Site, all data from FWD well R-1 were used in the analysis because this well has not been affected by Spreckels' wastewater. Partial data from Spreckels' production wells PW-11 and 12 were also used.

4.2 Normality Testing

The selection of an appropriate statistical method depends on the underlying distribution of the statistical sample. Many methods assume a normal (Gaussian) distribution with known parameters of mean and standard deviation. Statistical methods that are based on a known statistical distribution are termed parametric methods because they assume certain population parameters. Statistical methods independent of the statistical distribution are termed nonparametric or distribution-free methods.

The normality hypothesis was tested on the pooled data sets using the Shapiro-Wilk normality test (Shapiro and Wilk, 1965). Three criteria were used in the evaluation of the approximation of the empirical sample distribution to the normal distribution:

1. Shapiro-Wilk W-statistic equal to or greater than 0.95;
2. p-value equal to or smaller than 0.05;
3. Visual inspection of:
 - a. quantile-quantile plots (Q-Q plots) and
 - b. normal probability plots.

The normality hypothesis was tested on each of the pooled TDS concentrations (i.e., the shallow and deep-zone data for the western, central, and eastern areas). It was rejected for all but one group based on the combination of W-statistics smaller than 0.95 and/or p-values greater than 0.05 (see **Tables 1 and 2**) and review of the Q-Q plots and normal probability plots.

Consequently, a non-parametric statistical method of analysis was chosen for the calculation of background concentrations. The TDS concentrations for the deep-zone central area is the only data set that approximates the normal distribution. Because non-parametric methods can also be used to analyze data that are normally distributed, the same statistical method was used for all of the pooled data.

4.3 Selection of Statistical Method

There are a number of statistical techniques that can be used to establish numerical values for background groundwater quality, and the tolerance interval is one of the most commonly used

methods. A tolerance interval is a statistical range within which a specified proportion of a population falls with a specified degree of confidence. Typically, a tolerance interval is developed to determine a concentration or concentration range that is constructed from a statistical sample obtained from a population that is assumed to be representative of background conditions. If a measured constituent concentration falls outside of the tolerance interval, it is concluded that it belongs to a different population, presumably affected by a contaminant release.

Another commonly used method is the prediction interval, which is calculated to contain one or more future observations from a previously sampled population. A prediction interval is more suitable in the context of a detection monitoring program (i.e., a program designed to identify effects of a potential future contaminant release). Therefore, the tolerance interval method was chosen for this application.

4.4 Tolerance Interval Procedure

A tolerance interval is constructed to contain a specified proportion of a population (p) with a specified confidence level $100(1-\alpha)\%$, where α is the significance level known from statistical hypothesis testing. The proportion of the population included in the interval, defined by an upper and a lower bound, is referred to as the coverage ($100p\%$). The confidence level is termed the tolerance coefficient. A one-sided upper tolerance bound was used for TDS concentrations because contamination is indicated by high concentrations. A one-sided upper tolerance bound is not exceeded by at least a specified proportion of the population with the specified degree of confidence. The concept of a one-sided tolerance bound is equivalent to a one-sided confidence bound on a distribution percentile, e.g., a one-sided 95 percent upper tolerance bound to be met by at least 99 percent of the population values is identical to an upper 95 percent confidence bound on the 99th percentile of the population distribution. It is generally recommended that a value of at least 95 percent be used for both the coverage and the tolerance coefficient. This means that there is a 95 percent confidence level that the tolerance interval will contain at least 95 percent of the distribution of observations from the background well data (EPA, 1989). However, this standard can often not be achieved with non-parametric methods due to small sample sizes, as is the case for some of the data from the Spreckels' site.

4.5 Assumptions

The computation of a tolerance interval, as for any other statistical interval, relies on the assumption of an infinite population, or at least a population that is very large relative to the sample size. As applied to this site, it also accounts for statistical uncertainty due to an often small random sample from the population. However, other sources of uncertainty exist, including: water quality analyses that may contain measurement errors due to calibration inaccuracies or human error, and errors that may be introduced due to the type and cleanliness of sampling containers. In addition, sample holding times may affect the results of some analyses more than others. These sources of error can contribute to uncertainty that is not quantified by

the method. Therefore, the statistical intervals calculated and described below are in effect a lower bound on the true, or total, uncertainty.

4.6 Interpretation of Tolerance Bounds

Based on the theory of tolerance bounds, the interpretation of and conclusions drawn from tolerance bounds must not be limited to one statistical sample (a group of observations, i.e., the group of results for a particular constituent). Rather, if tolerance intervals or bounds are calculated from many independent groups of random samples, $100(1-\alpha)\%$ of the intervals would ultimately include at least the proportion of the population of interest ($100p\%$). The $100(1-\alpha)\%$ refers to the procedure for constructing the tolerance interval and not to any particular interval that is computed. The actual proportion of the population contained within the tolerance interval is *unknown* because this proportion depends on the population's unknown parameters. In contrast, when the population mean and standard deviation of a normally distributed random variable are known, then the statistical uncertainty inherent in the process of random sampling is removed, and tolerance intervals are not needed because the proportion of the population, e.g., within one, two, or three standard deviations, around the population mean are known.

In the case of groundwater quality data, a tolerance bound is developed through application of a statistical method to determine a concentration that is constructed from the data from background monitoring points, i.e., from a statistical sample (a group of observations) obtained from a population, presumably representative of background conditions. If a measured constituent concentration in a compliance well is greater than the established tolerance bound, it is concluded that it belongs to a different population, presumably affected by a contaminant release.

In this context, it is important to note that inherent in the application of tolerance intervals is the expectancy to observe constituent concentrations exceeding the tolerance bound. This expectancy is explicitly expressed with the confidence level. For example, given a tolerance bound with a coverage of 95 percent and a confidence level of 90 percent, it would be expected that, approximately, in 90 out of 100 statistical samples, at least 95 percent of the population would be contained within the tolerance bound and the remainder of the population would be expected to exceed the bound. This also means that, approximately, in 10 out of 100 statistical samples, less than 95 percent of the population would be contained within the bound, which corresponds to an increase in probability to exceed the bound.

4.7 Results and Discussion

Upper tolerance bounds were established using tabulated values in Table A.16 in Hahn and Meeker (1991) based on the data shown in **Table 1** (shallow zone) and **Table 2** (deep zone). Tolerance bounds calculated for both zones and the associated degree of confidence are shown in **Table 3**. Tolerance bounds were calculated based on a coverage of 95 percent. The target confidence level was also 95 percent, but this was not met in all cases.



For the shallow zone, a tolerance bound of 1,170 mg/L was calculated for the western area based on a sample size of 51; a tolerance bound of 740 mg/L was calculated for the central based on a sample size of 55; and a tolerance bound of 362 mg/L was calculated for the eastern area based on of a sample size of 70. For the deep zone, a tolerance bound of 1,100 mg/L was calculated for the western area based on a sample size of 35; a tolerance bound of 453 mg/L was calculated for the central area based on a sample size of 93; and a tolerance bound of 380 mg/L was calculated for the eastern area based on of a sample size of 26.

The sample size has a significant effect on statistical confidence levels regardless of whether parametric or non-parametric methods are employed. Given a statistical signal of equal strength, a small sample will have a smaller confidence level attached to its result than a large sample. Accordingly, the confidence levels attached to the tolerance bounds for the deep zone in the eastern area (n=26) was the lowest (between 72.26 and 78.54 percent). The confidence levels attached to the tolerance bounds for the deep zone in the central area (n=93) was the highest (between 98.35 and 99.41 percent).

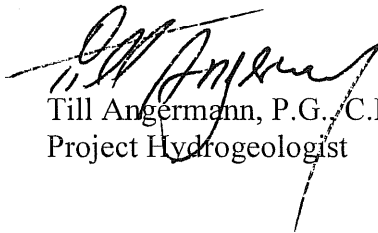
We appreciate this opportunity to submit these revised comments. Please call if you have any questions or need additional information.

Sincerely,

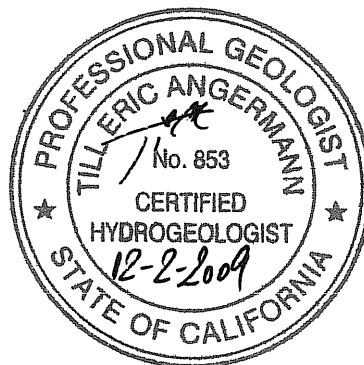
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Tables:

Table 1	Data Used to Calculate Tolerance Bounds for Total Dissolved Solids in Groundwater Above A-Clay at Spreckels Sugar Co.
Table 2	Data Used to Calculate Tolerance Bounds for Total Dissolved Solids in Groundwater Below A-Clay at Spreckels Sugar Co.
Table 3	Non-Parametric Tolerance Bounds and Associated Confidence Levels for Total Dissolved Solids at Spreckels Sugar Co.

Figures:

Figure 1	Spreckels Sugar Co. Location Map
Figure 2	Contours of Groundwater Elevation in Shallow Wells: Spring 2008
Figure 3	Historical TDS Concentrations in Groundwater Above A-Clay at Spreckels Sugar Co.
Figure 4	Historical TDS Concentrations in Groundwater Below A-Clay at Spreckels Sugar Co.

Figure 5 TDS Concentrations in Groundwater Above A-Clay at Spreckels Sugar Co. in Fall 2008

Figure 6 TDS Concentrations in Groundwater Below A-Clay at Spreckels Sugar Co. in September 2008

Appendices:

- Appendix A Mendota Area TDS Concentration Contour Maps
- Appendix B Mendota Area Groundwater Elevation Contour Maps (Shallow Zone)
- Appendix C Mendota Area Groundwater Elevation Contour Maps (Deep Zone)
- Appendix D Electrical Conductivity Record, Delta-Mendota Canal – Check 21 (1965-2008)
- Appendix E Tabulated Groundwater Quality Record
- Appendix F Historical Steffens Plume Contour Maps (1988 and 2001)

Tables and Figures

Table 1
Data Used to Calculate Tolerance Bounds for Total Dissolved
Solids in Groundwater Above A-Clay at Spreckels Sugar Co.

Western Area			Central Area			Eastern Area		
Well ID	Sample Date	TDS Conc. (mg/L)	Well ID	Sample Date	TDS Conc. (mg/L)	Well ID	Sample Date	TDS Conc. (mg/L)
CW-1	10/20/93	697	MW-4	11/24/82	630	MW-30	10/11/91	160
CW-1	09/12/01	780	MW-4	06/30/83	560	MW-30	10/26/92	160
CW-1	06/17/02	660	MW-4	10/07/83	610	MW-30	03/05/93	175
CW-1	08/21/02	630	MW-4	12/01/83	488 (1)	MW-30	09/24/93	160
CW-1	08/21/02	680	MW-4	03/07/84	650	MW-30	03/30/94	140
CW-1	08/21/02	640	MW-4	05/22/84	653	MW-30	04/13/94	215
CW-1	10/27/05	570	MW-4	07/18/84	687	MW-30	09/23/94	180
CW-1	05/15/07	500	MW-4	11/27/84	737	MW-30	03/30/95	215
CW-1	09/20/07	550	MW-4	04/23/85	663	MW-30	10/18/95	210
CW-1	09/16/08	710				MW-30	04/08/96	190
			MW-5	11/24/82	590	MW-30	10/09/96	235
CW-2	09/12/01	1,100	MW-5	05/05/83	587	MW-30	06/09/97	308
CW-2	06/05/02	670	MW-5	12/02/83	470	MW-30	03/26/98	310
CW-2	08/21/02	660				MW-30	04/21/99	370
CW-2	08/21/02	710	MW-6	05/06/82	670	MW-30	05/20/00	230
CW-2	08/21/02	690	MW-6	11/24/82	530	MW-30	12/17/00	240
CW-2	05/15/07	860	MW-6	12/02/82	620	MW-30	06/15/01	250
CW-2	09/20/07	910	MW-6	05/06/83	670	MW-30	10/03/01	230
CW-2	09/16/08	870	MW-6	05/23/84	623	MW-30	05/02/02	240
			MW-6	07/19/84	603	MW-30	12/13/02	280
CW-3	08/24/00	920	MW-6	11/28/84	637	MW-30	03/23/03	310
CW-3	06/25/01	1,050	MW-6	04/23/85	633			
CW-3	06/17/02	920	MW-6	11/04/85	655	MW-31	10/11/91	305
CW-3	08/21/02	940				MW-31	10/26/92	330
CW-3	08/21/02	1,020	MW-9	04/07/84	513	MW-31	03/05/93	335
CW-3	08/21/02	999	MW-9	07/19/84	550	MW-31	09/24/93	350
CW-3	07/09/03	810	MW-9	11/28/84	670	MW-31	03/30/94	360
CW-3	10/27/05	880	MW-9	04/24/85	740	MW-31	04/13/94	280
CW-3	05/15/07	1,100	MW-9	11/05/85	850	MW-31	09/23/94	315
CW-3	09/21/07	1,240	MW-9	09/24/86	620	MW-31	10/18/95	190
CW-3	09/16/08	1,170	MW-9	03/29/88	715	MW-31	04/08/96	320
			MW-9	12/14/89	690	MW-31	10/09/96	290
CW-4	04/09/93	1,050	MW-9	11/14/90	335	MW-31	06/09/97	362
CW-4	06/17/02	940	MW-9	06/20/91	685	MW-31	03/26/98	290
CW-4	08/21/02	970	MW-9	10/29/91	650	MW-31	08/29/98	350
CW-4	08/21/02	1,000	MW-9	02/24/92	660	MW-31	04/21/99	320
CW-4	08/21/02	960	MW-9	10/20/92	680			
CW-4	07/09/03	810	MW-9	03/01/93	720	MW-32	10/11/91	200
CW-4	10/27/05	870	MW-9	09/27/93	615	MW-32	03/19/92	185
CW-4	05/15/07	800	MW-9	03/10/94	540	MW-32	10/26/92	195
			MW-9	09/20/94	600	MW-32	03/05/93	185
MW-1	11/01/82	890	MW-9	03/16/95	735	MW-32	09/24/93	185
MW-1	05/05/83	973	MW-9	10/10/95	710	MW-32	04/12/94	175
MW-1	12/03/83	1,128	MW-9	04/06/96	695	MW-32	09/23/94	180
MW-1	05/22/84	1,083	MW-9	09/30/96	720	MW-32	03/30/95	263 (2)
MW-1	11/27/84	1,033	MW-9	06/30/97	580	MW-32	10/18/95	230
MW-1	11/01/85	865	MW-9	08/26/98	590	MW-32	04/08/96	173 (1)
MW-1	09/27/86	950	MW-9	04/21/99	610	MW-32	10/09/96	160

Table 1 (continued)
Data Used to Calculate Tolerance Bounds for Total Dissolved Solids in Groundwater Above A-Clay at Spreckels Sugar Co.

Western Area			Central Area			Eastern Area		
Well ID	Sample Date	TDS Conc. (mg/L)	Well ID	Sample Date	TDS Conc. (mg/L)	Well ID	Sample Date	TDS Conc. (mg/L)
MW-1	04/21/87	935	MW-9	05/20/00	660	MW-32	06/09/97	192
MW-1	03/28/88	830	MW-9	12/17/00	600	MW-32	03/26/98	299 (1)
MW-1	12/21/88	925	MW-9	06/15/01	580	MW-32	08/29/98	330
MW-1	12/15/89	905	MW-9	10/03/01	620	MW-32	04/21/99	310
MW-1	04/11/90	940	MW-9	05/01/02	600	MW-32	05/20/00	170
MW-1	11/13/90	1,110	MW-9	12/10/02	640	MW-32	12/17/00	210
			MW-9	03/22/03	670	MW-32	06/05/01	220
MW-3	12/22/88	735	MW-9	10/24/03	610	MW-32	10/03/01	202 (1)
			MW-9	03/31/04	440	MW-32	05/02/02	160
			MW-9	11/13/04	660	MW-32	12/13/02	170
						MW-32	03/23/03	170
						MW-32	10/24/03	170
						MW-32	04/01/04	200
						MW-32	11/15/04	180
						MW-32	04/07/05	180
						MW-32	10/14/05	190
						MW-32	04/19/06	185
						MW-32	09/26/06	183
						MW-32	03/29/07	190
						MW-32	09/25/07	190
						MW-32	04/06/08	220
						MW-32	09/04/08	210
						MW-32	04/03/09	210
						MW-32	09/30/09	190
Sample Size (n)		51			55			70
Mean		875			628			232
Shapiro-Wilk W		0.9817			0.9453			0.8886
p-level		0.6111			0.0144			0.00001

1. TDS concentration estimated as EC x 0.65.
2. Reported TDS concentration of 2,630 mg/L considered questionable. TDS of 263 mg/L assumed based on EC of 400 umhos/cm.

Table 2
Data Used to Calculate Tolerance Bounds for Total Dissolved
Solids in Groundwater Below A-Clay at Spreckels Sugar Co.

Western Area			Central Area			Eastern Area		
Well ID	Sample Date	TDS Conc. (mg/L)	Well ID	Sample Date	TDS Conc. (mg/L)	Well ID	Sample Date	TDS Conc. (mg/L)
MW-14	07/23/87	920	MW-8	04/07/84	270	PW-11	10/04/01	195 (1)
MW-14	03/01/88	1,000	MW-8	07/19/84	327	PW-11	05/03/02	200
MW-14	03/31/84	707	MW-8	11/28/84	350	PW-11	12/13/02	220
MW-14	11/29/84	887	MW-8	04/24/85	377	PW-11	03/23/03	200
MW-14	11/05/85	765	MW-8	11/05/85	370	PW-11	10/24/03	380
MW-14	09/26/86	790	MW-8	09/24/86	390	PW-11	03/31/04	230
MW-14	07/23/87	920				PW-11	11/15/04	240
MW-14	03/01/88	1,000	MW-10	04/07/84	427	PW-11	04/06/05	280
MW-14	12/13/89	1,030	MW-10	07/19/84	460			
MW-14	11/15/90	575	MW-10	11/28/84	417	PW-12	03/31/04	320
MW-14	06/18/91	930	MW-10	04/24/85	453	PW-12	11/15/04	380
MW-14	10/25/91	860	MW-10	11/05/85	450	PW-12	04/06/05	360
MW-14	03/02/92	850	MW-10	09/24/86	450	PW-12	10/14/05	230
MW-14	10/22/92	710				PW-12	04/19/06	280
MW-14	03/04/93	860	PW-1	03/24/62	235	PW-12	09/26/06	397
MW-14	09/21/93	1,010	PW-1	10/24/63	114			
MW-14	03/10/94	820	PW-1	12/14/64	169	R-1	06/25/01	270
MW-14	03/17/95	895	PW-1	05/17/65	149	R-1	10/02/01	290
MW-14	10/15/95	890	PW-1	03/01/66	177	R-1	06/17/02	160
MW-14	04/05/96	885	PW-1	11/12/68	169	R-1	08/20/02	270
MW-14	10/20/96	960	PW-1	07/19/80	284	R-1	08/20/02	260
MW-14	06/10/97	1,190	PW-1	11/04/80	300	R-1	08/20/02	290
MW-14	03/18/98	940	PW-1	12/13/80	235	R-1	07/09/03	320
MW-14	08/25/98	970	PW-1	05/16/81	236	R-1	06/17/04	300
MW-14	04/11/99	920	PW-1	08/06/81	256	R-1	10/26/05	330
MW-14	11/01/99	900	PW-1	10/03/81	232	R-1	08/08/06	310
MW-14	05/21/00	960	PW-1	11/10/81	294	R-1	05/16/07	300
MW-14	12/19/00	910	PW-1	02/02/82	288	R-1	05/27/09	350
MW-14	06/06/01	980	PW-1	05/15/82	260			
MW-14	10/03/01	910	PW-1	10/08/82	240			
MW-14	05/01/02	840	PW-1	11/24/82	280			
MW-14	12/13/02	1,000	PW-1	05/06/83	168			
MW-14	03/23/03	840	PW-1	05/10/83	223			
			PW-1	12/02/83	283			
DW-1	04/17/08	1,100	PW-1	03/02/84	290			
DW-1	10/04/08	1,100	PW-1	05/22/84	280			
			PW-1	06/19/84	240			
			PW-1	07/17/84	303			
			PW-1	11/27/84	327			
			PW-1	04/29/85	337			
			PW-1	11/06/85	355			
			PW-2	10/24/63	121			
			PW-2	12/14/64	144			
			PW-2	05/17/65	156			
			PW-2	03/01/66	148			
			PW-2	11/12/68	186			
			PW-3	10/24/63	138			
			PW-3	03/01/66	293			
			PW-3	11/12/68	143			
			PW-4	10/24/63	382			
			PW-4	03/01/66	368			
			PW-4	11/12/68	434			

Table 2 (continued)
Data Used to Calculate Tolerance Bounds for Total Dissolved Solids in Groundwater Below A-Clay at Spreckels Sugar Co.

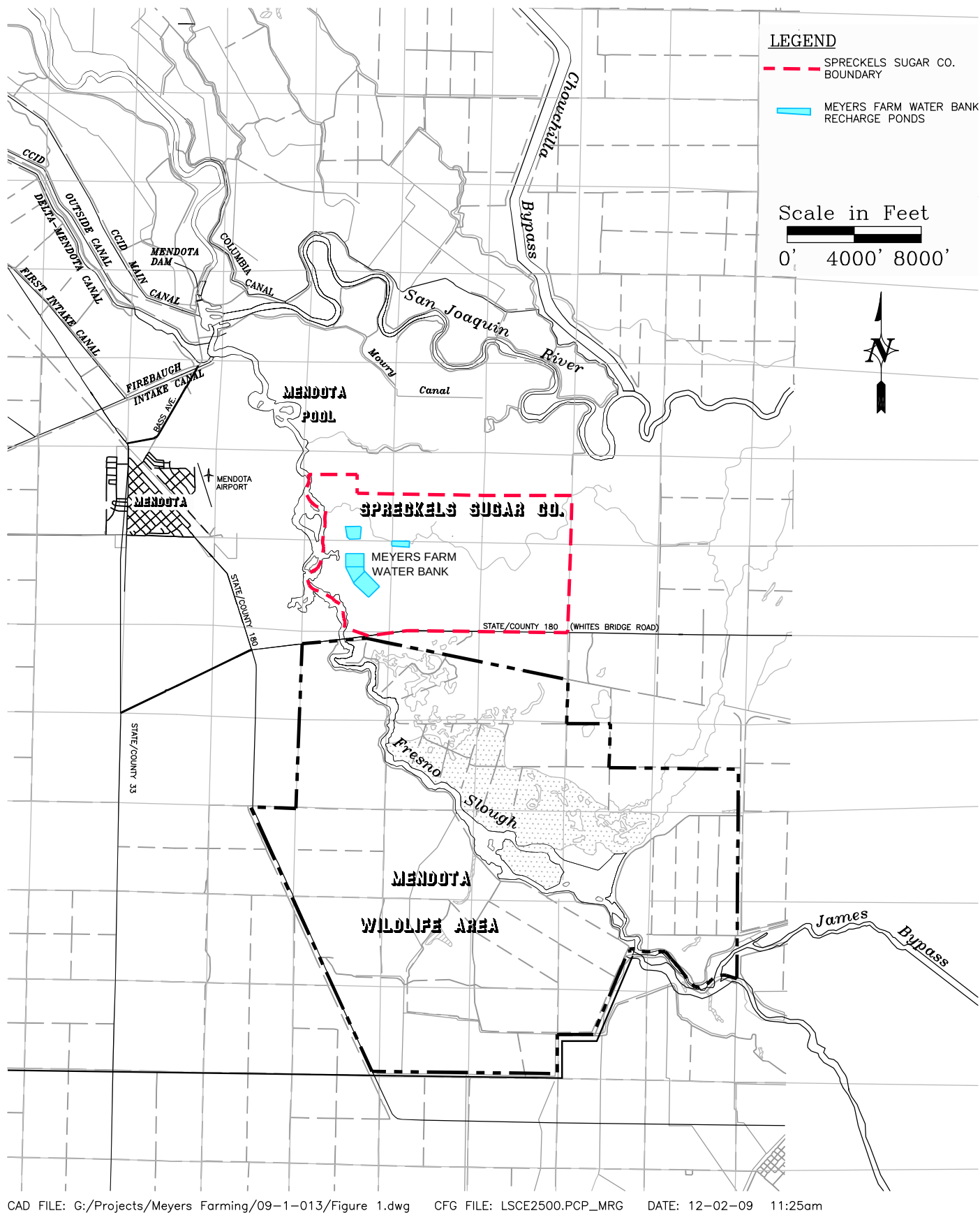
Western Area			Central Area			Eastern Area		
Well ID	Sample Date	TDS Conc. (mg/L)	Well ID	Sample Date	TDS Conc. (mg/L)	Well ID	Sample Date	TDS Conc. (mg/L)
			PW-5	10/24/63	134			
			PW-5	12/14/64	206			
			PW-5	03/01/66	167			
			PW-5	11/20/68	242			
			PW-6	04/30/83	300			
			PW-6	05/06/83	168			
			PW-6	12/03/83	256			
			PW-6	03/20/84	310			
			PW-6	05/22/84	333			
			PW-6	06/19/84	344			
			PW-6	07/17/84	337			
			PW-6	11/28/84	367			
			PW-6	04/29/85	333			
			PW-6	11/06/85	320			
			PW-6	09/24/86	385			
			PW-6	09/03/87	355			
			PW-6	03/28/88	375			
			PW-7	05/12/83	270			
			PW-7	05/13/83	280			
			PW-7	05/14/83	280			
			PW-7	12/02/83	308			
			PW-7	03/20/84	277			
			PW-7	05/22/84	270			
			PW-7	07/17/84	277			
			PW-7	11/28/84	317			
			PW-7	04/29/85	307			
			PW-7	11/06/85	325			
			PW-7	09/24/86	345			
			PW-7	09/03/87	340			
			PW-7	03/28/88	315			
			PW-7	12/16/88	300			
			PW-7	12/06/89	350			
			PW-7	11/09/90	335			
			PW-7	07/10/91	365			
			PW-7	10/30/91	365			
			PW-7	04/28/92	360			
			PW-8	09/11/84	265			
			PW-8	11/28/84	277			
			PW-8	04/22/85	327			
			PW-8	11/06/85	360			
			PW-10	12/14/88	390			
			PW-10	12/06/89	420			
			R-3	07/31/87	365			
Sample Size (n)		35			93			26
Mean		909			294			283
Shapiro-Wilk W		0.9705			0.9693			0.9801
p-level		0.4557			0.0248			0.8751

1. Reported TDS concentration of 96 mg/L considered questionable. TDS of 195 mg/L estimated as EC x 0.65

Table 3
Non-Parametric Tolerance Bounds and Associated Confidence
Levels for Total Dissolved Solids at Spreckels Sugar Co.

Zone	Location	Sample Size (n)	Attained Confidence Level (1-α)¹	Extreme Obs. to be Removed (ν)²	Upper Tolerance Bound³ (mg/L)
Shallow	Western Area	51	0.9231 < 1- α < 0.9539	1	1,170
	Central Area	55	0.9231 < 1- α < 0.9539	1	740
	Eastern Area	70	0.9539 < 1- α < 0.9835	1	362
Deep	Western Area	35	0.8339	1	1,100
	Central Area	93	0.9835 < 1- α < 0.9941	1	453
	Eastern Area	26	0.7226 < 1- α < 0.7854	1	380

1. Confidence levels are based on Table A.16 (Hahn and Meeker, 1991). A range is given when a value is not tabulated for a specific value of n. Based on a coverage of 95% and a target confidence level of 95%.
2. ν is the number of extreme observations to be removed from the upper end of a sample of size, n, to obtain a one-sided, distribution-free upper tolerance bound that contains at least 100p% of the sampled population with 100(1- α)% confidence.
3. Calculated based on a coverage of 95%.



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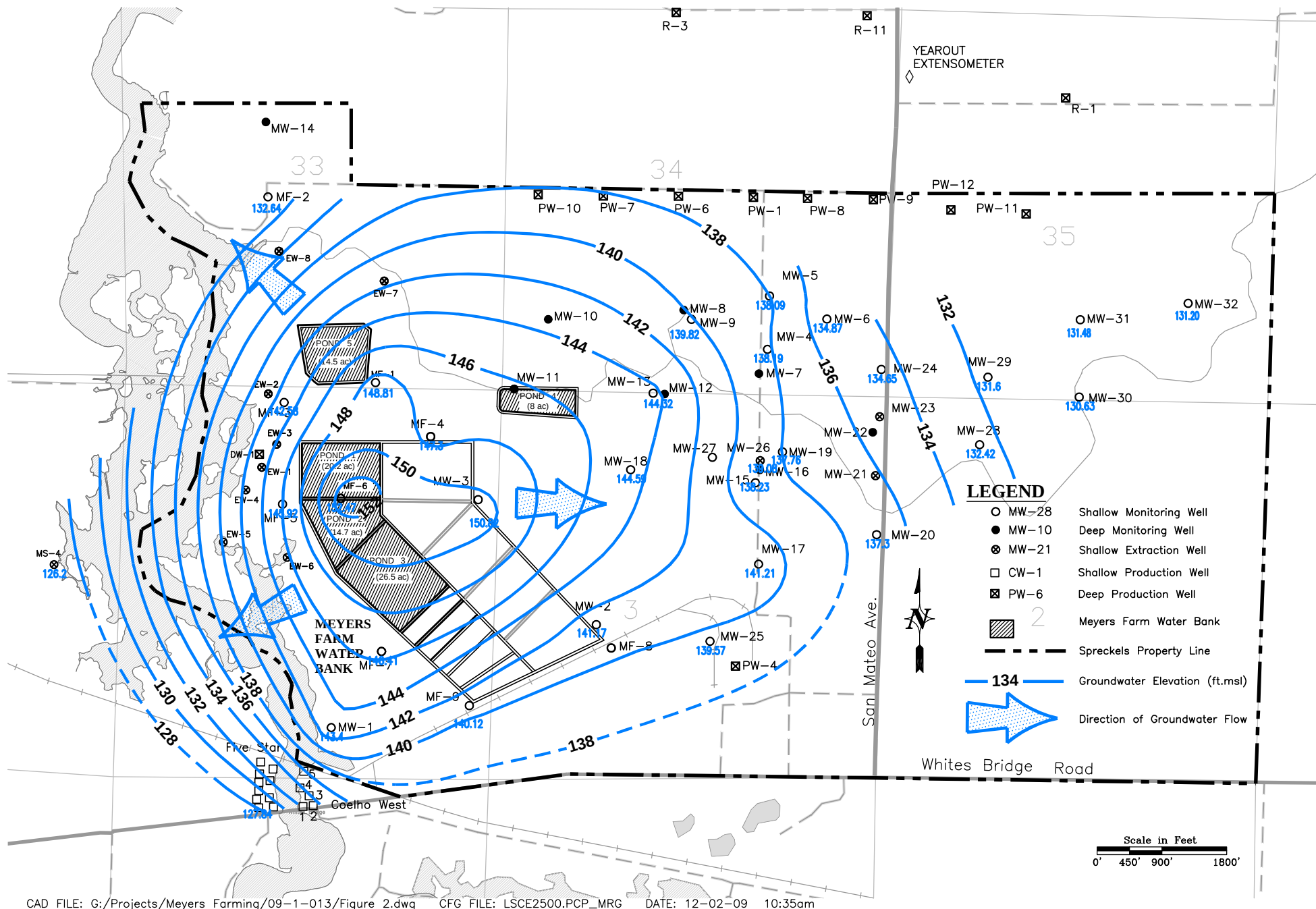
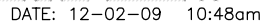
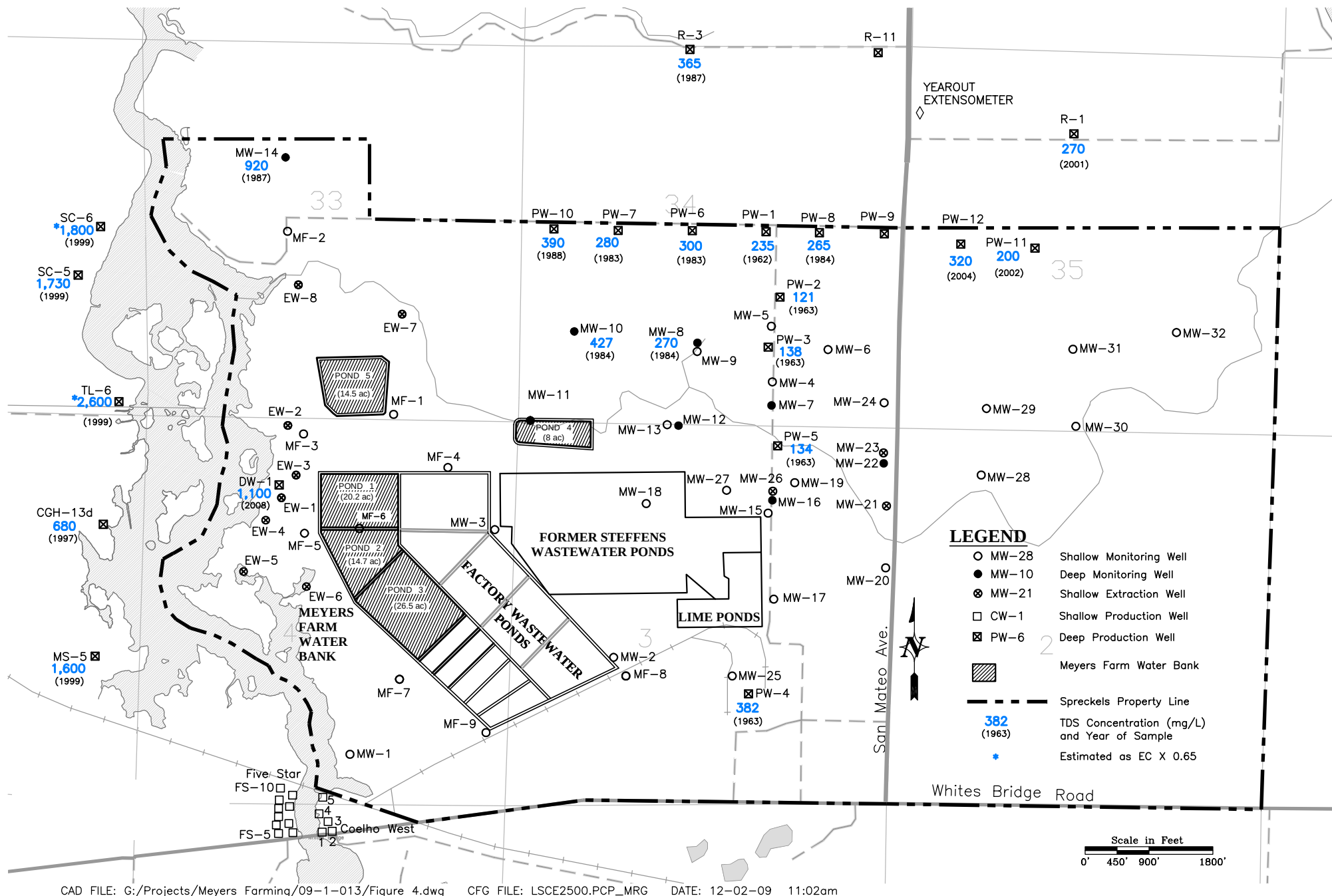


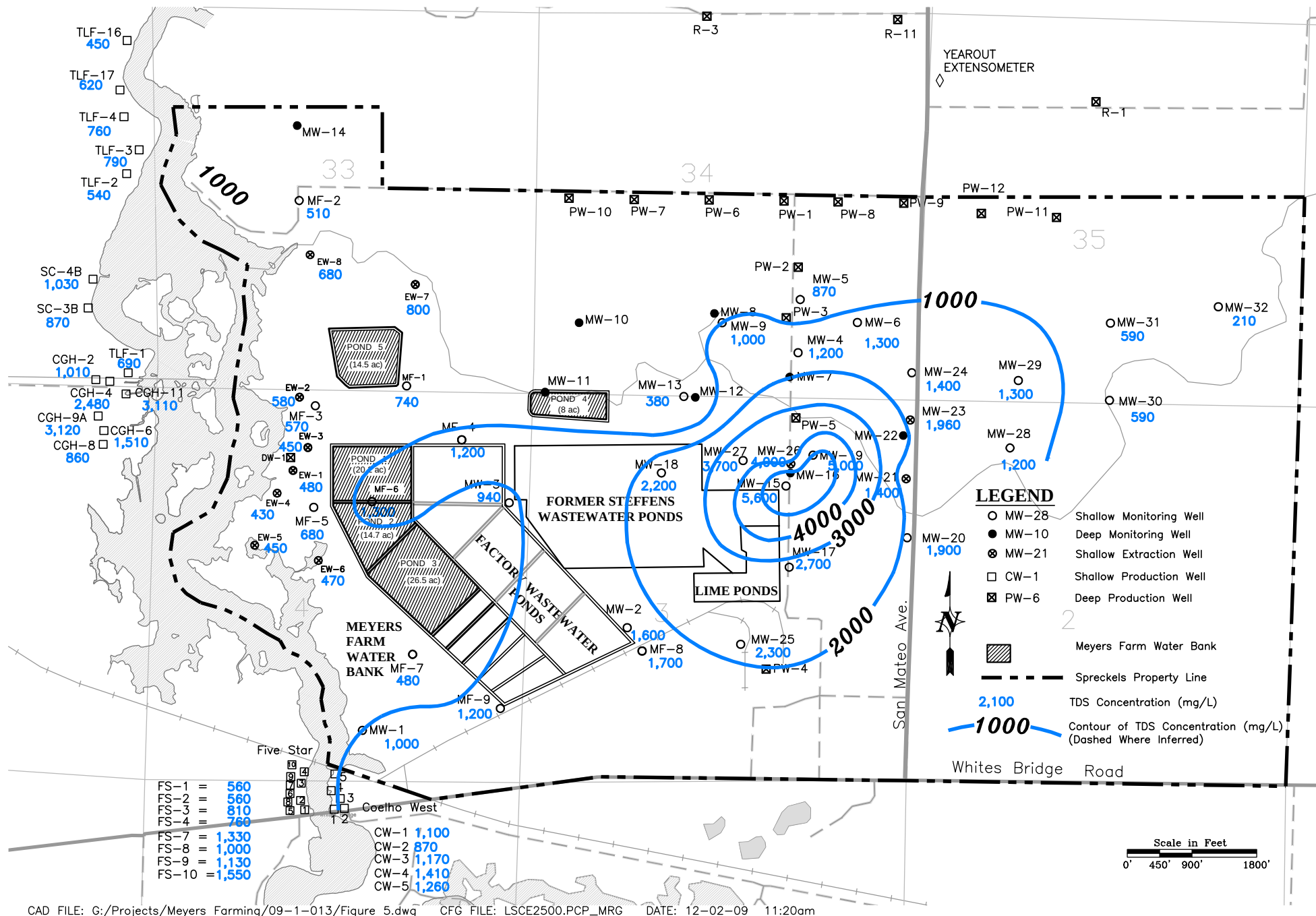
Figure 2
Contours of Groundwater Elevation
in Shallow Wells: Spring 2008





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Figure 4
Historical TDS Concentrations in Groundwater
Below A-Clay at Spreckels Sugar Co.



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Figure 5
TDS Concentrations in Groundwater Above
A-Clay at Spreckels Sugar Co. in Fall 2008

