

APPENDIX F-3





FOCUSED WATER QUALITY ASSESSMENT LAKE B COMPONENT ELIOT QUARRY RECLAMATION PLAN AMENDMENT PROJECT ALAMEDA, CALIFORNIA

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A Report Prepared for:

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FOCUSED WATER QUALITY ASSESSMENT, LAKE B COMPONENT, ELIOT QUARRY RECLAMATION PLAN AMENDMENT PROJECT, ALAMEDA, CALIFORNIA

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EXECUTIVE SUMMARY

Kleinfelder prepared this Focused Water Quality Assessment for the area referred to as Lake B within RMC Pacific Materials, LLC's (CEMEX), Eliot Quarry to determine potential differences in water quality between the Upper and Lower Aquifers in the vicinity of Lake B and to evaluate if the proposed increase in depth of Lake B has the potential to substantially degrade water quality in the Lower Aquifer. A water quality dataset from 1980 to 2019 provided by the Zone 7 Water Agency, which includes water constituents in the Upper and Lower Aquifers and water constituents observed in several mining ponds in the vicinity of the Eliot Quarry, was used for the analysis.

Parametric statistics (mean, maximum and minimum) were calculated for each constituent: arsenic, boron, calcium, chloride, bicarbonate, carbonate, chromium, iron, potassium, magnesium, sodium, nitrate (N), sulfate, silica, total dissolved solids (TDS), and pH. Non-parametric statistics were calculated for the constituents of interest listed in the Alternative Groundwater Sustainability Plan for the Livermore Valley Groundwater Basin (Zone 7 Water Agency, 2016b): nitrate (N), boron, chromium, and TDS. The average concentrations for most wells and mining ponds in the vicinity of Eliot Quarry are below the maximum thresholds of these parameters.

The analysis of hydrochemical facies using Piper, Durov, and Schoeller diagrams indicate the water characteristics in the Upper Aquifer, Lower Aquifer, and surface water are similar. The hydrochemical facies derived for the latest ten-years are typical of shallow fresh groundwaters and were observed in both Upper and Lower Aquifers suggesting waters are similar in the different levels.

The findings of the Focused Water Quality Assessment of Lake B indicate there are no distinct water quality characteristics in the vicinity of Eliot Quarry that would uniquely distinguish an individual well or aquifer unit within the basin. Therefore, it is not anticipated that there will be any undesirable effects related to water quality as a result of the increase of the depth of Lake B by the proposed 100 feet.



1 INTRODUCTION

Kleinfelder is submitting this focused water quality assessment for the area referred to as Lake B within RMC Pacific Materials, LLC's (CEMEX), Eliot Quarry. This work is being conducted as part of the proposed amendments to the existing SMP-23 Reclamation Plan for the CEMEX Eliot Quarry. The scope of work developed for this task order is included on the February 20, 2020 Kleinfelder proposal approved by Compass Land Group.

CEMEX owns and operates the Eliot Quarry, a ±920-acre sand and gravel mining facility located between the cities of Livermore and Pleasanton at 1544 Stanley Boulevard in unincorporated Alameda County. **Figure 1.1** presents the site vicinity. CEMEX and its predecessors-in-interest have been continuously mining for sand and gravel at the Eliot Quarry since at least 1906. In addition to mining and reclamation, existing permitted and accessory uses at the Eliot Quarry include aggregate, asphalt, and ready-mix concrete processing as well as ancillary uses such as aggregate stockpiling, load-out, sales, construction materials recycling, and equipment storage and maintenance. CEMEX's mining operations at the site are vested pursuant to pre-1957 mining activities and Alameda County Quarry Permits Q-1 (1957), Q-4 (1957), and Q-76 (1969). Surface mining reclamation activities at the site are currently conducted pursuant to Surface Mining Permit and Reclamation Plan No. SMP-23 ("SMP-23") approved in 1987. Reclamation plans are mandated by state law under the California Surface Mining and Reclamation Act (Cal. Public Resources Code Section 2710 et seq.). Thus, not implementing a reclamation plan at this site is not an option.

Project Description

In March 2019 CEMEX submitted an application for proposed amendments to the 1987 SMP-23 Reclamation Plan to Alameda County and the Zone 7 Water Agency that included a 100-foot decrease in the bottom elevation of Lake B from 250 feet mean sea level (msl) to 150 feet msl. Lake B is part of ten mining quarry lakes referred to as the Chain of Lakes. This decrease in the bottom elevation of Lake B would extend the mining operations from the hydrostratigraphic zone referred to as the Upper Aquifer to the hydrostratigraphic zone referred to as the Lower Aquifer. Included with CEMEX's application was a hydrology and water quality report (EMKO Environmental [EMKO], 2019) that contained a limited evaluation of groundwater quality impacts within the Lower Aquifer Zone from the proposed decrease in the bottom elevation of Lake B.





This report was revised in March 2020 but the substantive findings did not change. Based on this evaluation, EMKO concluded that, in the area of Lake B, the Upper and Lower Aquifers are hydraulically connected and that variations in water chemistry within the Upper Aquifer and water in Lake B do not result in any potential incompatibilities with other water types in the basin. The hydraulic connection between the Upper and Lower Aquifers and absence of a continuous aquitard in this area was supported by the report entitled *3D Clay Bed Geologic Model and Lack of Evidence for the Presence of Aquitards, Alameda County, California* prepared by Jeff Light Geologic Consulting dated November 12, 2019.

This report is also included as part of the March 2019 proposed amendments to the 1987 SMP-23 Reclamation Plan. After review of the application, in a letter dated June 6, 2019, the Zone 7 Water Agency requested Alameda County retain additional services to assess if the proposed increase in depth of Lake B could adversely affect groundwater quality.

The Eliot Quarry is located within the Livermore Valley Groundwater Basin or Basin Number 2-10 as defined by the California Department of Water Resources (DWR) California's Groundwater, Bulletin 118 – Update 2003. Under California's Sustainable Groundwater Management Act (SGMA) passed in 2014, the Zone 7 Water Agency is designated as the exclusive Groundwater Sustainability Agency (GSA) for the Livermore Valley Groundwater Basin. In compliance with the SGMA regulations, the GSA must prepare either a Groundwater Sustainability Plan (GSP) or an Alternative Plan. An Alternative Plan must be functionally equivalent to a GSP and demonstrate that the entire basin has been operating within its sustainable yield for at least 10 years. In December 2016 the Zone 7 Water Agency submitted an Alternative Plan for the Livermore Valley Groundwater Sustainability Plan for the Livermore Valley DWR approved the Alternative Groundwater Sustainability Plan for the Livermore Valley Groundwater Basin.

In accordance with SGMA, sustainability plans must address sustainability indicators that effect groundwater conditions occurring throughout the basin that, when significant and unreasonable, become undesirable results. SGMA lists six undesirable results, one of which is significant and unreasonable degraded water quality including the migration of contaminant plumes that impair water supplies. For groundwater quality within the area of the Eliot Quarry, the Zone 7 Water Agency's Alternative Plan states undesirable results are defined as the loss of beneficial uses as measured in basin municipal wells that provide drinking water supply for the basin. This result would be caused by degradation of the Lower Aquifer such that constituent levels in municipal wellfields cannot be managed to provide drinking water supply. The Alternative Plan lists five specific constituents identified in the basin that could result in undesirable results including total



dissolved solids (TDS), nitrate, boron, hexavalent chromium, and toxic sites. Toxic sites are those sites that generally have been impacted by fuels and industrial chemicals (Zone 7 Water Agency, 2014c). Based on review of the Alternative Plan and the 2018 Annual Water Monitoring Report for the basin, no toxic sites have been identified in the vicinity of the Eliot Mine. For hexavalent chromium, the Alternative Plan states that values of total chromium are exclusively hexavalent chromium.

Pursuant to SGMA, minimum thresholds must be established to assess if undesirable results are occurring. For the five constituents listed above, the minimum thresholds as defined by the Zone 7 Water Agency in the Alternative Plan are as follows:

- TDS 500 milligrams per liter (mg/L)
- Nitrate as nitrogen (N) 10 mg/L
- Boron 1.4 mg/L
- Hexavalent Chromium 10 µg/L (assumes all total chromium is hexavalent chromium)
- Toxic Sites Primary Maximum Contaminant Levels (MCLs) established by Federal and State Agencies. As stated above, there are currently no toxic sites identified in the area of the Eliot Mine.

Consistent with the Alternative Groundwater Sustainability Plan developed by the Zone 7 Water Agency, these constituents and established minimum thresholds are used to assess if the proposed increase in depth of Lake B could adversely affect groundwater quality.



2 OBJECTIVES

The purpose of the Focused Water Quality Assessment is to evaluate if changing the bottom elevation of Lake B to 150 feet msl could adversely affect groundwater quality within the Lower Aquifer of the Livermore Valley Groundwater Basin. The primary objective of this assessment is to answer the following questions:

- Is there an appreciable difference in water quality between the Upper and Lower Aquifers in the vicinity of Lake B?
- Will the increase in depth of Lake B have potential to substantially degrade water quality in the Lower Aquifer?

The assessment includes an evaluation of data collected for groundwater and surface water by the Zone 7 Water Agency in the area including general parameters, cations, and anions but will focus on the five constituents listed in the Alternative Groundwater Sustainability Plan for the basin with stated minimum thresholds – TDS, nitrate, boron, hexavalent and chromium. If warranted, the assessment will also include steps that can be taken so that groundwater quality is protected during the course of mining and reclamation and if potential impacts to water quality are observed what treatment would be needed to meet water quality criteria.



3 AQUIFER PROPERTIES

The Eliot Quarry is located within the Livermore-Amador Valley, an east-west trending inland alluvial basin located in northeastern Alameda County. An alluvial basin is a valley that has been filled with sediments deposited predominantly by streams and rivers. The basin is surrounded primarily by north-south trending faults and hills of the Diablo Range. The geology and aquifer characteristics summarized in this section are described in detail by Zone 7 Water Agency (2011).

The Livermore-Amador Valley encompasses approximately 42,000 acres, is about 14 miles long (east to west) and varies from three miles to six miles wide (north to south). The Livermore Valley Groundwater Basin is located in the central part of the Livermore-Amador Valley. The Main Basin is the part of the Livermore Valley Groundwater Basin that contains the highest-yielding aquifers and the best groundwater quality. **Figure 3.1** shows the Livermore-Amador Valley Basin, subbasins and the CEMEX site.

The Valley is partially filled with recent alluvial fan, stream and lake deposits (of Pleistocene-Holocene age; less than about 1.6 million years old) that range in thickness from a few feet along the margins to nearly 800 feet in the west-central portion. The alluvium consists of unconsolidated gravel, sand, silt, and clay. The southeastern region of the Valley, the proximal (upstream) portion of the alluvial fan deposits, is the most important groundwater recharge area and consists mainly of sand and gravel that was deposited by the ancestral and present Arroyo Valle and Arroyo Mocho. The coarse alluvial fan deposits are economically important aggregate deposits, which has resulted in widespread aggregate mining in the Main Basin area.

The Livermore Formation (Pleistocene age; 11,000 to 1.6 million years old), found below the majority of the alluvium in the groundwater basin, consists of beds of clayey gravel and sand, silt, and clay that are unconsolidated to semi-consolidated. This formation is estimated to be 4,000 feet thick in the southern and western portion of the basin. These sediments display lower groundwater yields in the upland areas.



Path: C:\Users\MCerucci\OneDrive - Kleinfelder\Myfiles\CEMEX\Figures\Cemex Figure 3-1.mxd User: MCerucci Date: 3/19/2020



The Tassajara and Green Valley Formations, located in the Tassajara Uplands north of the Valley, are roughly Pliocene in age (1.6 to 5.3 million years old). They consist of sandstone, tuffaceous sandstone/siltstone, conglomerate, shale, and limestone. Water movement from these formations to the alluvium of the fringe and Main Basins is diminished by faults and angular unconformities or by stratigraphic disconformities along the formation-alluvium contacts.

Within the Livermore Valley groundwater basin, faults are the major structural features known to have marked effect on the movement of groundwater. Faults in this region tend to act as barriers to the lateral movement of groundwater. The resulting groundwater levels stand higher on the up-gradient side. The Livermore, Pleasanton, and Parks faults act as such barriers, dividing the Quaternary Alluvium into five groundwater sub-basins (DWR, 2006).

The Eliot Quarry is located approximately within the southeast corner of the Main Basin. East of Isabel Avenue, in the Lake A area, groundwater occurs within a relatively thin layer of alluvium (approximately 80 to 100 feet thick) and within the underlying Livermore Formation. West of Isabel Avenue, groundwater occurs entirely within the alluvium, which extends to at least 600 feet below the surface in the area of Lake B (EMKO, 2020). The Pleistocene Livermore Formation was folded and faulted before deposition of the Recent Alluvium. This older geologic formation consists of a range of sediments that were deposited in a lake environment, referred to as lacustrine deposits. These deposits include oxidized, unoxidized, and sheared clay, freshwater limestone referred to as marl, and interbedded fine sand, silt, and clay that were deposited along the shoreline of and within the lacustrine environment, and preponderance of fine-grained deposits, the sediments of the Livermore Formation are not a part of the Upper or Lower Aquifers within the Recent Alluvium that is present in the Main Basin. This difference in the formation characteristics east and west of Isabel Avenue could result in some discrepancies in the chemical composition of groundwater in the east and west portions of Eliot Quarry and suggests that they not be evaluated together.

Numerous studies of the hydrogeology of the Livermore-Amador Valley Groundwater Basin have been conducted. In general, groundwater within the alluvium has been classified as being part of two main aquifer zones. In some parts of the groundwater basin, the two aquifer zones are separated by a silty clay aquitard up to 50 feet thick that prevents or limits the vertical migration of groundwater between the two zones. Based on the evaluations and analysis presented by EMKO (2019 and 2020) the aquitard layer is not present everywhere in the groundwater basin, contains zones of coarser-grained material, or is very thin in some locations. In addition to areas where it is absent, in areas where these variations occur the aquitard is referred to as "leaky,"



because it allows groundwater to be transmitted between the two aquifers. The absence of a continuous silty clay aquitard is indicated by the 3D geologic model prepared by JLGC (2019).

As stated in Zone 7 Water Agency *Annual Report for the Groundwater Management Program, 2012 Water Year* (2013), the two aquifer zones are designated as:

- Upper Aquifer Zone The Upper Aquifer Zone consists of alluvial materials, including primarily sandy gravel and sandy clayey gravel. Gravel is usually encountered underneath the surficial clays typically 5 to 70 feet below ground surface (bgs) in the west and exposed at the surface in the east. The base of the Upper Aquifer Zone is approximately 80 to 150 feet bgs. Groundwater in this zone is generally unconfined; however, when water levels are high, portions of the Upper Aquifer Zone in the western portion of the Main Basin can become confined.
- Lower Aquifer Zone Sediments encountered below the aquitard in the central portion of the basin have been known collectively as the Lower Aquifer Zone. The aquifer materials consist of semi-confined to confined, coarse-grained, water-bearing units interbedded with relatively low permeability, fine-grained units. It is believed that the Lower Aquifer Zone derives most of its water from the Upper Aquifer Zone through the leaky aquitard(s) when groundwater heads in the upper zone are greater than those in the lower zone."

The water-level trends evaluated by EMKO (2019, 2020) show an appreciable difference in the water level behavior in wells and ponds along and south of Arroyo del Valle when compared to that in wells and ponds north of Arroyo del Valle. The water levels in the wells and ponds along and south of Arroyo del Valle have remained relatively stable for many decades and show minimal influence from drought periods. The Arroyo flows into or through several of these ponds (referred to as breached quarry ponds). These ponds are hydrologically connected to the arroyo. There is very little groundwater pumping south of Arroyo del Valle, so it is likely that recharge from the arroyo is sufficient to maintain the water levels in wells to the south and the ponds along the channel.

In contrast, the water levels in the wells and ponds north of Arroyo del Valle fluctuate cyclically in response to annual pumping and to drought and wet climatic cycles. Ponds that are not breached are generally not hydrologically connected at the surface with the Arroyo. Zone 7 Water Agency (2012, 2013, 2014a, 2015, 2016, 2017, 2018, 2019) indicates that the reach of Arroyo del Valle adjacent to Lake B is a losing stream, meaning that the groundwater elevation is below the base



of the stream bed and water from the stream percolates downward to the groundwater table. In addition, lack of recharge during drought periods combined with groundwater pumping and mine dewatering to the north of Arroyo del Valle appear to cause the cyclical water level trends at the monitoring locations north of the Arroyo.



4 WATER QUALITY ASSESSMENT

4.1 DATA COLLECTION AND DATA ANALYSIS METHODS

The datasets for the Lake B Focused Water Quality Assessment include existing water quality, well construction details, and spatial data in the vicinity of the mine. Information was obtained from the Zone 7 Water Agency and from CEMEX. Spatial data acquired for the project is referenced to the California State Plane Zone III coordinate system. The water-quality data provided by Zone 7 Water Agency are available in electronic format in **Appendix F**. The information provided by the Zone 7 Water Agency includes water quality parameters measured in samples from wells located in the Upper Aquifer, Lower Aquifer and the Livermore Formation and parameters measured in several mining ponds in the vicinity of the Eliot Quarry (surface water). Data from 36 sampling locations within 1-mile from the project site were used. **Figure 4.1** presents the locations of wells and mining ponds with water-quality data. **Table 4.1** presents the well and mining ponds characteristics.

The wells and surface water observations are not evenly distributed in space and time. The southeast portion of the site has more groundwater samples whereas the central and northwest portions of the site have a greater number of surface water samples. Also, the sampling timeframe is not consistent for all sampling locations. Some monitoring locations are sampled multiple times every year while others have a period of several years between samples. The frequency of sampling also varies according to the water-quality parameter. The spatial and temporal variabilities are inherent to the dataset and a potential source of bias for the statistical analysis. Thus, the data were grouped, presented, and evaluated in different ways to reduce the effect of potential bias in the conclusions.

The Focused Water Quality Assessment was based on general chemical parameter values provided by The Zone 7 Water Agency: arsenic, boron, calcium, chloride, bicarbonate, carbonate, chromium, iron, potassium, magnesium, sodium, nitrate (N), sulfate, silica, TDS, and pH. Data are available for several wells from the 1980s to the present, although the frequency of sampling varies by location. Graphing tools such as Piper, Schoeller, and Durov diagrams were applied to evaluate hydrochemical facies (water types), mixing of waters, and potential sources. These graphical presentation and analysis tools are standard approaches for evaluating water quality (Hem, 1989).





	Well ID	Туре	Use	Aquifer	Depth (feet)
	13P5	well-static	nested	upper	135
	13P6	well-static	nested	lower	255
	13P7	well-static	nested	lower	375
	13P8	well-static	nested	lower	605
	14B1	well-supply	industrial	lower	435
	19D10	well-static	nested	lower	470
٩Ľ	19D7	well-static	nested	upper	180
vati	19D8	well-static	nested	lower	260
vbn	19D9	well-static	nested	lower	390
lou	19N3	well-static	nested	upper	120
ō	19N4*	well-static	nested	lower	203
	20M1*	well-supply	supply	lower	184
	23J1	well-supply	supply	lower	120
	25C3	well-static	monitor	upper	146
	29F4	well-static	monitor	upper	36
	30C1*	well-supply	supply	lower	150
	30D2	well-static	monitor	upper	44
	C1	mining pond	mining	upper	NA
	K18	mining pond	mining	upper	NA
	P10	mining pond	mining	upper	NA
	P11	mining pond	mining	upper	NA
	P12	mining pond	mining	upper	NA
	P13	mining pond	mining	upper	NA
	P27	mining pond	mining	upper	NA
ter	P28	mining pond	mining	upper	NA
Wat	P40	mining pond	mining	upper	NA
ce	P41	mining pond	mining	upper	NA
Irfa	P42	mining pond	mining	upper	NA
Su	P44	mining pond	mining	upper	NA
	P45	mining pond	mining	upper	NA
	P46	mining pond	mining	upper	NA
	R24	mining pond	mining	upper	NA
	R28	mining pond	mining	upper	NA
	R3	mining pond	mining	upper	NA
	R4	mining pond	mining	upper	NA
	K15	mining pond	mining	upper	NA

Table 4-1: Well and Mining Pond Characteristics

N.A. = Not Applicable * Livermore Formation



Hydrochemical facies are a means of describing the chemical characteristics of water that enable the classification of water on the basis of six chemical components - calcium, magnesium, sodium plus potassium, chloride, sulfate, and carbonate plus bicarbonate. Water constituent data available for the most recent 10 years (2010 through 2019) were used for the analysis of hydrochemical facies. This period includes a range of drought to wet years (https://water.ca.gov/Water-Basics/Drought).

The SGMA sustainability indicators that affect groundwater conditions occurring throughout the basin (i.e., significant and unreasonable degraded water quality) were also evaluated using descriptive statistics (box-whisker plots), non-parametric statistics (percentiles), and parametric statistics (mean, maximum, and minimum) for selected parameters. The analysis with descriptive and non-parametric statistical analysis was applied for chromium, boron, TDS, nitrate (N), arsenic, iron, and silica. Parametric statistics were used to for the evaluation of calcium, magnesium, sodium, potassium, chloride, sulfate, carbonate plus bicarbonate, chromium, boron, TDS, nitrate (N), arsenic (N), arsenic, iron, and silica.

The box-whisker plot is a method for graphically depicting groups of numerical data through their quartiles (Tukey, 1977). As shown in **Appendix A**, the lines extending from the boxes (whiskers) indicate variability outside the upper and lower quartiles according to the interguartile range (IQR). The upper quartile (Q3) corresponds to the 75th percentile. The lower quartile (Q1) corresponds to the 25th percentile. The IQR is a measure of dispersion of the data calculated as the difference between the upper and lower quartiles. Inner and outer fences of the data are calculated as a function of the IQR, Q1 and Q3. According to Tukey (1977), the edge of the inner fence is defined by 1.5 times the IQR from the upper and lower quartiles. The edge of the outer fence is defined by 3.0 times the IQR from the upper and lower quartiles. The IQR and the edge of Tukey's fences are not necessarily shown in the plot, but they determine the position of the whiskers, possible and probable outliers. The position of the whiskers corresponds to the last data value within the inner or outer fence. A data value between the inner and outer fences is a possible outlier. An extreme value beyond the outer fence is considered a probable outlier. Thus, only data values beyond the outer fence (3.0 IQR) were considered outliers for the Lake B Focused Water Quality Assessment and were plotted as individual points. The plots shown in Appendix A also indicate the number of samples represented by each.

The parametric statistics for chromium, boron, TDS, nitrate (N), arsenic, iron, and silica were calculated without outliers. Because these parameters are subject to water quality thresholds,



outliers could impact the calculated statistics and lead to erroneous conclusions. Detection limits of some parameters can also affect calculated averages. Some samples have detection limits above the water quality threshold. These samples may have been subject to quality control issues or dilution by the laboratory and were not considered valid for the statistical analysis. Observations reported as detection limits equal or below the water quality threshold were not excluded from statistics calculations. Probable outliers were not identified for calcium, magnesium, sodium, potassium, chloride, sulfate, and carbonate plus bicarbonate, because these parameters were evaluated according to their relative concentrations in Piper, Schoeller, and Durov diagrams and are not subject to thresholds as per SGMA Alternative Plan.

The sampling wells and ponds were grouped according to location to evaluate spatial characteristics of surface water and groundwater. Three lateral spatial groups were defined: Lake A, North-South Lake B, and West Lake B. The groups are shown on **Figure 4.1**. These groups were further subdivided into Upper Aquifer and Lower Aquifer. The Upper Aquifer group includes samples from Upper Aquifer wells and from mining ponds. While the spatial distribution of sampling locations per group is not the same among the sample types (Upper Aquifer, Lower Aquifer and surface water), it is possible to derive general conclusions based on the calculated averages per group. Because the sediments of the Lower Livermore Formation are not a part of the Upper or Lower Aquifers within the Recent Alluvium present in the Main Basin, the statistical analysis was conducted with and without Lower Aquifer Lake A wells to evaluate potential bias introduced by these wells in the overall analysis.

4.2 STATISTICAL ANALYSIS

Box-whiskers plots were used to evaluate potential outliers for nitrate, arsenic, boron, chromium, TDS, silica, and iron (**Appendix A**). **Table 4.2, Table 4.3** and **Table 4.4** present the average, maximum, and minimum concentrations of nitrate, arsenic, boron, chromium, TDS, silica, and iron without outliers. **Table 4.5** presents the parametric and non-parametric statistics for nitrate, arsenic, boron, chromium, TDS, silica, iron, and pH. Non-parametric statistics considered outliers. **Table 4.6** presents the average, maximum, and minimum concentrations by lateral spatial groups (North-South Lake B, West Lake B, Lake A), Upper Aquifer, and Lower Aquifer. The Livermore Formation wells of Lake A group (20M1, 19N4 and 30C1) were not included in the overall statistics presented in the above-referenced tables, because these wells are screened in a different formation. An additional set of tables including in the statistics the Livermore Formation wells of the Lake A group are presented in **Appendix B**. The overall averages and non-parametric statistics calculated with and without Livermore Formation wells in Lake A group are very similar.



Although the Livermore Formation wells are not included in the overall statistics presented below, they are referenced in the discussion if the calculated average for the well is above the Alternative Plan threshold for a water quality parameter.

TDS values and statistics that do not include outliers nor Livermore Formation wells 20M1, 19N4 and 30C1 (except as noted) indicate the following:

- The average TDS concentration for groundwater and pond samples in the vicinity of the Eliot Quarry is 404.6 mg/L for the 1980-2019 period.
- The TDS average in the mining ponds is 405.3 mg/L, which is very similar to the average for groundwater samples of 400.6 mg/L.
- TDS concentrations for groundwater samples range from 144 mg/L to 802 mg/L. TDS concentrations for mining ponds range from 64 mg/L to 1057 mg/L.
- Pond P13, located northwest of Lake B, have average TDS concentrations of 588 mg/L, which is above the maximum Alternative Plan threshold of 500 mg/L. However, mining pond P13 has only one TDS observation.
- Groundwater wells 19D7, 19D8, 29F4 and mining ponds C1, K18, P10, P11, P12, P13, P28, P41, R24, R3, R4 and K15 have at least one sample above the maximum threshold (excluding outliers). However, inspection of the box-whisker plots (Appendix A) indicates the median is consistently below the threshold for each sampling location.
- Well 20M1 (Livermore Formation) has an average TDS concentration of 514 mg/L (Appendix B). This well was not included in the overall statistics because it is located in a different geologic formation.
- TDS is below the maximum Alternative Plan threshold in 81.1% of pond and groundwater samples (including outliers).
- The percent of samples below the Alternative Plan threshold for the Upper Aquifer and Lower Aquifer are 80.9% and 82.9%, respectively (Including outliers).

According to the statistics calculated by spatial group, TDS average concentrations are somewhat similar for all groups.



Boron values and statistics that do not include outliers nor Livermore Formation wells 20M1, 19N4 and 30C1 (except as noted) indicate the following:

- The average boron concentration is $395.9 \ \mu g/L$ for the 1980-2019 period.
- The average boron concentration of 466.5 µg/L was calculated for the mining ponds, which is almost double of the average concentration of 287.5 µg/L calculated for groundwater samples.
- No groundwater or mining pond sampling location has an average boron concentration above the 1,400 μg/L Alternative Plan threshold.
- Boron concentrations for groundwater samples range from <100 μg/L (limit of detection) to 1,400 μg/L. Boron concentrations for mining ponds range from <100 μg/L (limit of detection) to 2,480 μg/L.
- No groundwater samples have a boron concentration above the Alternative Plan threshold. Mining ponds C1 and K15 have at least one sample at or above the maximum threshold of 1,400 μg/L.
- Boron is below the maximum Alternative Plan threshold in 98.6% of pond and groundwater samples (includes outliers).
- The percent of samples below the Alternative Plan threshold for the Upper Aquifer and Lower Aquifer are 98.3% and 100%, respectively (includes outliers).

Boron is present in higher concentrations in the Upper Aquifer for all lateral spatial groups, but average and median values are below the 1,400 µg/L threshold.

Nitrate values and statistics that do not include outliers nor Livermore Formation wells 20M1, 19N4 and 30C1 (except as noted) indicate the following:

- The average nitrate concentration is 1.3 mg/L for the 1980-2019 period.
- The average nitrate concentration of 0.1 mg/L was calculated for the mining ponds, which is about 30 times lower than the average concentration of 2.8 mg/L calculated for groundwater samples.



- Lower Aquifer well 19D10 has average nitrate concentration of 12.0 mg/L, which is above the maximum Alternative Plan threshold of 10 mg/L.
- Nitrate concentrations for groundwater samples range from <0.01 mg/L (limit of detection) to 13.5 mg/L. Nitrate concentrations for mining ponds range from <0.01 mg/L to 1.3 mg/L.
- Nitrate is below the maximum Alternative Plan threshold in 96.5% of pond and groundwater samples (including outliers).
- The percents of samples below the Alternative Plan threshold for the Upper aquifer and Lower aquifer are 100% and 78.2%, respectively (including outliers).
- Wells 19D10 and 19D9 have at least one sample above 10 mg/L.
- Well 20M1 (Livermore Formation) has at least one sample above 10 mg/L (Appendix B). This well was not included in the overall statistics because it is located in a different geologic formation.
- No mining ponds and Upper Aquifer wells have samples at or above the maximum threshold.

The Lower Aquifer has the highest nitrate average concentrations, especially in the North-South Lake B group.

Chromium values and statistics that do not include outliers nor Livermore Formation wells 20M1, 19N4 and 30C1 (except as noted) indicate the following:

- The average chromium concentration is 2.6 µg/L for the 1980-2019 period.
- The average concentrations of chromium for mining ponds and groundwater samples are similar, 2.4 μg/L and 3.0 μg/L, respectively.
- No groundwater or mining pond sampling location has an average chromium concentration above the maximum Alternative Plan threshold of 10 μg/L.
- Chromium concentrations for groundwater samples range from <1.0 μg/L to 12.0 μg/L.
 Concentrations of chromium for mining ponds range from <1.0 μg/L to 17.0 μg/L.



- Chromium is below the maximum Alternative Plan threshold in 97.8% of pond and groundwater samples (including outliers).
- The percent of samples below the Alternative Plan threshold for the Upper Aquifer and Lower Aquifer are 97.5% and 99.0%, respectively (including outliers).
- Generally, the chromium limit of detection has been 1 µg/L. However, some results with a limit of detection of 20 µg/L and 25 µg/L may have been subject to sample dilution by the laboratory or may be due to quality control issues. Elevated detection limits included in the statistics would increase the calculated average concentration and decrease the percent below threshold non-parametric statistics. Therefore, samples with detection limits greater than 10 µg/L were not considered valid for the statistical analysis, since these samples could artificially affect the calculated statistics and results may not be representative of actual conditions. Non-detect results with elevated detection limits (>10 µg/L) have been removed from the box-whiskers plots to improve the clarity of the results; the remaining 10 µg/L non-detect results are obvious on the mining-pond plot.
- Wells 19D7 and 29F4 have at least one sample at or >10 μ g/L. Mining ponds R24 and R3 have at least one sample >10 μ g/L.

The chromium averages among the groups vary from 1.51 μ g/L to 2.26 μ g/L, which are within the same magnitude and an indication that there is little spatial variation in chromium concentrations.

Arsenic values and statistics that do not include outliers nor Livermore Formation wells 20M1, 19N4 and 30C1 (except as noted) indicate the following:

- The average arsenic concentration is $1.9 \ \mu g/L$ for the 1980-2019 period.
- The highest average for groundwater wells is 6.2 µg/L for Upper Aquifer well 19N3, which has only two samples.
- Livermore Formation well 19N4 has an average of 19.5 µg/L (**Appendix B**). This well was not included in the overall statistics because it is located in a different geologic formation.
- An average arsenic concentration of 2.2 µg/L was calculated for the mining ponds, which is similar to the average concentration of 1.5 µg/L calculated for groundwater samples.



- For mining ponds, C1 has the highest average arsenic concentration of 6.6 μg/L, which is approximately double of the second highest average of 3.2 μg/L for mining pond K15.
- No maximum threshold for arsenic is defined by Zone 7 Water Agency. The EPA drinking water standard for Arsenic is 10 µg/L. Except for Upper Aquifer well 19N3, the arsenic average for groundwater wells and mining ponds is consistently below the EPA drinking water standard.
- Livermore Formation well 19N4, which is the nested pair of 19N3, has average arsenic concentration above 10 µg/L (Appendix B). This well was not included in the overall statistics because it is located in a different geologic formation.
- Arsenic concentrations for groundwater samples range from <0.001 µg/L to 9.1 µg/L. Arsenic concentrations for the mining ponds range from <0.001 µg/L to 13 µg/L. The limit of detection for arsenic is generally 1 µg/L. However, a small number of samples have a 100 µg/L or 50 µg/L limit of detection. As for chromium, the variation of detection limits could be related to sample dilution, laboratory, or quality control issues. Samples with a detection limit greater than 50 µg/L were not used for the calculation of statistical parameters as they were not considered representative.

Except for the influence of well 19N3 on Lake A spatial group, there are no significant differences in the average concentrations of arsenic within the lateral groups. Average arsenic concentrations are higher for mining ponds, but still lower than the EPA drinking water standard.

Silica values and statistics that do not include outliers nor Livermore Formation wells 20M1, 19N4 and 30C1 (except as noted) indicate the following:

- The average silica concentration is 13.5 mg/L for the 1980-2019 period.
- An average silica concentration of 8.6 mg/L was calculated for the mining ponds, which is less than half of the average concentration of 21.0 mg/L calculated for groundwater samples.
- The highest average silica concentration (35.4 mg/L) was calculated for groundwater well 23J1.
- The highest average for mining ponds is 19.0 mg/L at P46.



- No maximum threshold is defined by Zone 7 Water Agency for silica. There are no primary or secondary regulations for general silicates in drinking water.
- Silica concentrations for groundwater samples range from 0.2 mg/L to 38.7 mg/L. Silica concentrations for mining ponds range from 0.2 mg/L to 24.4 mg/L.

Similar to nitrate, concentrations of silica in the Upper Aquifer are consistently lower than in the Lower Aquifer.

Iron values and statistics that do not include outliers nor Livermore Formation wells 20M1, 19N4 and 30C1 (except as noted) indicate the following:

- The average iron concentration is 162.9 μ g/L for the 1980-2019 period.
- The average concentration of iron for mining ponds of 212.3 μ g/L is almost three times the average for groundwater samples of 89.1 μ g/L.
- No maximum threshold is defined by Zone 7 Water Agency for iron. The EPA secondary MCL for iron is 300 µg/L.
- Mining ponds R3, P40, P45, R24, and R28 have average iron concentrations above 300 μg/L.
- Iron concentrations for groundwater samples range from no detection to 680 μg/L. Iron concentrations for mining ponds range from no detection to 3,500 μg/L.

Iron is present in higher concentrations in the surface water and could eventually migrate into the Lower Aquifer. However, iron is not identified in the Alternative Groundwater Sustainability Plan for the Livermore Valley Groundwater Basin (Zone 7 Water Agency, 2016b), and elevated dissolved concentrations are common in silt ponds and reclaimed mine pits with substantial vegetative growth that creates reducing conditions when the vegetation dies and decays. Concentrations would likely reduce rapidly upon contact with different redox conditions in the aquifer. In addition, only pond P45 (with a total of four samples) has a median value of iron above $300 \mu g/L$.



	Well	Nitrate	Boron	Chromium	TDS	Arsenic	Silica	Iron
	ID	mg/L	μg/L	μg/L	mg/L	μg/L	mg/L	μg/L
	13P5	0.2	342.5	1.7	349.4	1.0	14.1	59.1
	13P6	0.8	313.8	3.2	409.0	1.0	20.7	224.1
	13P7	0.1	194.3	2.3	314.1	1.0	22.5	171.0
	13P8	1.1	268.8	1.3	373.3	1.0	25.6	80.0
	14B1	1.8	318.0	3.6	406.5	1.0	18.9	50.0
ter	19D10	12.0	124.2	1.8	440.6	1.0	28.3	50.0
dwa	19D7	5.5	100.0	6.3	422.9	1.0	25.0	66.2
ouno	19D8	5.4	100.0	5.8	418.7	1.0	25.3	50.0
Gro	19D9	9.8	100.0	3.1	261.6	1.0	26.0	70.7
	19N3	0.4	235.0	1.0	346.0	6.2	25.7	100.0
	23J1	5.4	137.4	1.7	396.7	1.0	35.4	50.0
	25C3	4.2	331.7	1.7	440.7	1.0	26.0	75.5
	29F4	0.3	437.6	3.0	427.7	3.0	15.3	143.7
	30D2	0.6	326.1	1.8	372.2	1.0	15.9	46.3
	C1	0.1	935.9	1.6	429.3	6.6	5.7	70.6
	K18	0.1	254.1	2.1	334.2	1.6	7.3	70.2
	P10	0.1	387.5	1.6	346.6	2.6	5.9	75.1
	P11	0.1	358.6	2.0	335.4	1.3	12.5	132.7
	P12	0.1	264.6	1.8	315.7	1.6	9.2	144.2
	P13	N.A.	N.A.	N.A.	588.0	N.A.	N.A.	N.A.
	P27	0.1	394.9	1.7	287.1	2.3	11.0	119.7
ъ.	P28	0.1	369.3	2.0	342.2	2.9	4.6	143.9
Vati	P40	0.1	495.0	2.1	389.3	2.5	4.6	549.0
ce /	P41	0.1	324.4	1.8	416.8	2.4	5.5	90.8
urfa	P42	0.3	339.4	2.5	381.6	1.2	15.2	288.7
SI	P44	0.1	369.1	2.3	369.2	1.2	9.8	205.4
	P45	0.2	400.0	2.4	361.7	1.8	11.0	437.5
	P46	1.3	420.0	1.0	476.0	1.0	19.0	100.0
	R24	0.1	446.0	4.1	377.5	2.2	9.4	354.9
	R28	0.2	343.3	2.8	368.1	1.0	14.2	301.4
	R3	0.1	449.1	4.1	461.1	1.5	13.2	767.6
	R4	0.1	461.9	3.0	438.9	1.6	14.1	259.9
	K15	0.1	680.1	2.0	478.8	3.2	5.5	58.9
Av	erages	1.3	395.9	2.6	404.6	1.9	13.5	162.9



Table 4.3: Maximum Concentration	n of Constituents 1980-2019
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	Well ID	Nitrate	Boron	Chromium	TDS	Arsenic	Silica	Iron
		mg/L	μg/L	μg/L	mg/L	μg/L	mg/L	μg/L
	13P5	0.4	410.0	3.6	366.0	< 1.0	17.1	< 100.0
	13P6	0.9	390.0	4.6	424.0	< 1.0	23.5	680.0
	13P7	0.2	210.0	6.5	322.0	< 1.0	23.8	490.0
	13P8	1.1	330.0	< 2.0	385.0	< 1.0	27.8	170.0
	14B1	2.7	390.0	6.0	457.0	< 1.0	21.4	< 50.0
iter	19D10	13.5	220.0	2.7	469.0	< 1.0	36.2	< 50.0
dwa	19D7	8.3	100.0	12.0	802.0	< 1.0	28.9	140.0
ounc	19D8	6.7	100.0	8.3	587.0	< 1.0	27.2	< 50.0
ъ С	19D9	13.1	100.0	6.7	297.0	< 1.0	28.2	200.0
	19N3	0.6	240.0	< 1.0	361.0	9.1	27.8	< 100.0
	23J1	7.9	340.0	5.0	486.0	< 1.0	38.7	< 50.0
	25C3	5.0	410.0	2.0	465.0	< 1.0	29.3	120.0
	29F4	1.3	1400.0	11.0	655.0	8.0	25.3	540.0
	30D2	1.8	800.0	4.4	494.0	< 1.0	25.2	< 100.0
	C1	0.3	2480.0	2.0	1057.0	13.0	22.0	220.0
	K18	0.3	420.0	< 5.0	553.0	2.1	11.4	< 100.0
	P10	0.3	1000.0	2.3	662.0	5.9	22.3	210.0
	P11	0.6	700.0	3.0	524.0	2.0	20.2	350.0
	P12	0.3	440.0	3.1	516.0	3.9	21.4	510.0
	P13	N.A.	N.A.	N.A.	588.0	N.A.	N.A.	N.A.
	P27	0.3	560.0	2.7	447.0	5.0	20.3	290.0
۲.	P28	0.1	680.0	< 5.0	544.0	4.9	13.9	520.0
Vate	P40	0.1	650.0	4.3	484.0	3.5	17.1	2100.0
Se V	P41	0.1	590.0	4.1	555.0	4.0	13.8	300.0
Irfa	P42	0.7	400.0	9.6	423.0	2.4	20.1	1160.0
Su	P44	0.1	530.0	6.3	428.0	2.0	12.4	660.0
	P45	0.3	500.0	3.8	377.0	3.9	11.2	890.0
	P46	1.3	420.0	1.0	476.0	< 1.0	19.0	< 100.0
	R24	0.3	810.0	17.0	567.0	4.0	19.4	940.0
	R28	0.6	470.0	8.1	407.0	< 1.0	18.2	1200.0
	R3	0.5	930.0	11.0	690.0	2.1	23.1	3500.0
	R4	0.6	930.0	6.7	631.0	3.2	24.4	960.0
	K15	0.3	410.0	2.1	747.0	4.8	14.0	130.0



Table 4.4: Minimum (Concentration of Constituents	1980-2019
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	Well ID	Nitrate	Boron	Chromium	TDS	Arsenic	Silica	Iron
		mg/L	μg/L	μg/L	mg/L	μg/L	mg/L	μg/L
	13P5	<0.1	270.0	< 1.0	302.0	< 1.0	11.3	< 50.0
	13P6	0.6	260.0	< 2.0	384.0	< 1.0	19.0	< 50.0
	13P7	<0.1	190.0	< 1.0	303.0	< 1.0	19.9	< 50.0
	13P8	1.0	230.0	< 1.0	363.0	< 1.0	22.9	< 50.0
	14B1	1.0	270.0	< 1.0	369.0	< 1.0	14.8	< 50.0
iter	19D10	11.2	< 100.0	< 1.0	400.0	< 1.0	22.0	< 50.0
dwa	19D7	1.7	< 100.0	< 1.0	210.0	< 1.0	23.1	< 20.0
uno	19D8	4.1	< 100.0	< 1.0	234.0	< 1.0	23.5	< 50.0
Gro	19D9	5.9	< 100.0	< 1.0	210.0	<1.0	22.7	< 20.0
	19N3	<0.1	230.0	< 1.0	331.0	3.2	23.5	< 100.0
	23J1	<0.1	< 100	< 1.0	292.0	< 1.0	25.7	< 50.0
	25C3	3.6	280.0	< 1.0	416.0	< 1.0	22.5	< 50.0
	29F4	<0.01	< 100	< 1.0	144.0	< 0.002	0.3	0.01
	30D2	<0.1	< 200	< 1.0	256.0	< 1.0	9.7	0.01
	C1	<0.01	< 100	< 1.0	260.0	2.7	0.3	0.03
	K18	<0.01	< 100	< 1.0	220.0	< 1.0	2.9	< 50.0
	P10	<0.01	< 100	< 1.0	206.0	< 1.0	0.6	0.03
	P11	<0.01	< 100	1.3	229.0	< 1.0	5.7	54.0
	P12	<0.01	< 100	< 1.0	221.0	< 1.0	0.6	< 50.0
	P13	N.A.	N.A.	N.A.	588.0	N.A.	N.A.	N.A.
	P27	<0.01	< 200	< 1.0	64.0	<1.0	2.9	< 50.0
۲.	P28	<0.1	< 100	< 1.0	208.0	1.4	0.9	< 50.0
Vate	P40	<0.1	280.0	< 1.0	348.0	1.1	0.5	< 50.0
Ce V	P41	<0.1	150.0	< 1.0	319.0	<1.0	1.8	< 50.0
Irfa	P42	<0.1	250.0	< 1.0	333.0	< 1.0	11.9	< 50.0
SL	P44	<0.1	240.0	< 1.0	325.0	< 1.0	7.2	< 50.0
	P45	<0.1	340.0	< 1.0	332.0	< 1.0	10.7	110.0
	P46	1.3	420.0	< 1.0	476.0	< 1.0	19.0	< 100.0
	R24	<0.01	290.0	< 1.0	174.0	< 1.0	1.0	90.0
	R28	<0.1	240.0	< 1.0	325.0	< 1.0	10.6	55.0
	R3	<0.01	250.0	< 1.0	331.0	< 1.0	8.3	< 50.0
	R4	<0.01	< 100	< 1.0	237.0	< 1.0	3.4	< 50.0
	K15	<0.01	< 100	< 1.0	319.0	1.1	0.2	0.01



	Nitrate (mg/L)						
Statistics without outliers	All Samples	Upper Aquifer	Lower Aquifer				
Mean	1.3	0.4	5.7				
Maximum	13.5	8.3	13.5				
Minimum	< 0.01	< 0.01	0.1				
Sample count	722	602	120				
Percentiles with	Percent samples <=	Percent samples <=	Percent samples <=				
outliers	Standard	Standard	Standard				
10 mg/L Standard	96.5%	100.0%	78.2%				
	TDS (mg/L)					
Statistics without							
outliers	All Samples	Upper Aquifer	Lower Aquifer				
Mean	404.6	406.0	382.6				
Maximum	1057.0	1057.0	587.0				
Minimum	64.0	64.0	210.0				
Sample count	2014	1897	117				
Percentiles with	Percent samples <=	Percent samples <=	Percent samples <=				
outliers	Standard	Standard	Standard				
500 mg/L Standard	81.1%	80.9%	82.9%				
	Boron	(µg/L)					
Statistics without							
outliers	All Samples	Upper Aquifer	Lower Aquifer				
Mean	395.9	437.8	174.9				
Maximum	2480.0	2480.0	390.0				
Minimum	< 50.0	< 50.0	< 100.0				
Sample count	698	587	111				
Percentiles with	Percent samples <=	Percent samples <=	Percent samples <=				
outliers	Standard	Standard	Standard				
1400 μg/L Standard	98.6%	98.3%	100.0%				
	Chromiu	im (μg/L)					
Statistics without							
outliers	All Samples	Upper Aquifer	Lower Aquifer				
Mean	2.6	2.5	3.1				
Maximum	17	17	8.3				
Minimum	<1	<1	<1				
Sample count	428	331	97				
Percentiles with	Percent samples <=	Percent samples <=	Percent samples <=				
outliers	Standard	Standard	Standard				
10 μg/L Standard	97.8%	97.5%	99.0%				

Table 4.5: Parametric and Non-Parametric Statistics for All Samples 1980-2019



Table 4.5 (Cont.): Parametric and Non-	-Parametric Statistics	for All Samples	1980-2019
Table 4.5 (Cont.). Farametric and Non-		IOI All Samples	5 1900-2019

Arsenic (μg/L)							
Statistics without	All Samplos	Lippor Aquifor	Lower Aquifor				
outliers	All Samples	Opper Aquiler	Lower Aquiler				
Mean	1.9	2.2	1.0				
Maximum	26.0	13.0	1.0				
Minimum	< 0.002	< 0.002	1.0				
Sample count	488	387	101				
	Percent samples <=	Percent samples <=	Percent samples <=				
	Standard	Standard	Standard				
No MCL	N.A	N.A	N.A				
	Iron	(µg/L)					
Statistics without outliers	All Samples	Upper Aquifer	Lower Aquifer				
Mean	162.9	182.2	82.3				
Maximum	3500.0	3500.0	680.0				
Minimum	0.01	0.01	20.0				
Sample count	419	338	81				
	Percent samples <=	Percent samples <=	Percent samples <=				
	Standard	Standard	Standard				
No MCL	N.A	N.A	N.A				
	Silica	(mg/L)					
Statistics without outliers	All Samples	Upper Aquifer	Lower Aquifer				
Mean	13.5	11.1	26.2				
Maximum	38.7	29.3	38.7				
Minimum	0.2	0.2	14.8				
Sample count	732	617	115				
	Percent samples <=	Percent samples <=	Percent samples <=				
	Standard	Standard	Standard				
No MCL	N.A	N.A	N.A				
	p	H					
	All Samples	Upper Aquifer	Lower Aquifer				
Mean	8.0	8.1	7.5				
Maximum	10.7	10.7	9.0				
Minimum	6.4	6.4	6.4				
Sample count	769	644	125				
	Percent samples <=	Percent samples <=	Percent samples <=				
	Standard	Standard	Standard				
No MCL	N.A	N.A	N.A				

N.A. = Not Applicable



	Group	Nitrate	Boron	Chromium	TDS	Arsenic	Silica	Iron
	Average							
	N-S Lake B	0.83	459.37	2.62	373.27	2.04	11.61	173.85
pper	Lake A	0.29	386.64	2.26	387.18	2.57	12.85	111.99
	West Lake B	0.10	462.49	2.82	432.57	1.93	9.06	249.10
	N-S Lake B	6.27	152.50	3.04	379.11	1.00	27.34	87.91
ower	Lake A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
	West Lake B	1.82	318.00	3.62	406.53	1.00	18.89	50.00
				Ma	ximum			
	N-S Lake B	8.30	2480.00	12.00	1057.00	13.00	29.30	2100.00
Ippei	Lake A	3.60	1400.00	11.00	655.00	9.10	27.80	540.00
	West Lake B	1.27	1770.00	17.00	747.00	4.80	24.40	3500.00
<u>ـ</u>	N-S Lake B	13.50	390.00	8.30	587.00	1.00	38.70	680.00
owe	Lake A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
	West Lake B	2.70	390.00	6.00	457.00	1.00	21.40	50.00
				Mir	nimum			
<u>ـ</u>	N-S Lake B	<0.01	<50.00	<1.00	64.00	<1.0	0.30	0.03
Jppe	Lake A	<0.10	<100.00	<1.00	144.00	<0.002	0.30	<0.01
	West Lake B	<0.10	<100.00	<1.00	174.00	<1.0	0.20	<0.01
-	N-S Lake B	<0.10	<100.00	<1.00	210.00	<1.0	19.00	20.00
owei	Lake A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
-	West Lake B	1.01	270.00	<1.00	369.00	<1.0	14.80	50.00

Table 4.6: Constituent Statistics for	Grouped Samples 1980-2019
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N.A. = Not Applicable

Table 4.7, **Table 4.8** and **Table 4.9** present the average, maximum and minimum of calcium, chloride, bicarbonate plus carbonate, potassium, magnesium, sodium, and sulfate for groundwater and surface water. **Table 4.10** presents the average, maximum, and minimum concentrations for sampling locations grouped according to proximity of Lake A and Lake B for



anions and cations. The distribution of anions and cations is discussed in detail in Section 4.3, Hydrochemical Facies.

	Well ID	Calcium	Chloride	Bicarbonate plus	Potassium	Magnesium	Sodium	Sulfate
	1205		01 5	166.7	1.6	mg/L	/7 2	mg/L 51.0
	1206	74.6	91.3 67.0	272.0	2.1	25.0	47.3	52.0
	1207	74.0	17.0	275.9	1.0	12.6	59.4	32.0
	1209	44.5 EE 0	5/1	250.5	1.9	12.0	55.5	47.4
	1401	55.8	70.0	250.2	1.9	18.0	30.3	43.0
Ŀ	10010	62.4	70.9	204.1	1.0	28.1	31.7	20.6
vat	19010	66.2	00.4 101.6	214.5	1.0	27.0	44.1 29.1	29.0
١pu	1907	67.0	101.0	240.0	1.7	37.1	20.1	16.0
rou	1908	67.0	100.5	244.0	1.7	35.8	28.0	16.0
G	1909	40.7	43.5	145.4	1.2	15.5	27.2	9.7
	19N3	39.0	42.0	267.8	2.2	16.5	56.5	28.5
	23J1	41.0	105.8	163.9	1.3	23.6	53.9	14.9
	2503	52.3	92.2	252.5	1.4	26.1	67.3	29.4
	29F4	68.1	61.5	282.9	2.7	26.2	46.4	68.6
	30D2	51.3	63.8	232.8	2.2	24.1	51.0	51.4
	C1	34.7	132.0	275.5	3.1	39.6	106.9	67.5
	K18	39.5	65.5	188.0	2.5	21.7	47.9	41.5
	P10	38.7	66.6	193.0	3.0	24.3	46.7	43.8
	P11	49.4	60.9	211.0	2.4	20.1	45.6	45.6
	P12	42.3	66.6	194.0	2.5	21.5	47.7	42.9
	P13	NA	NA	NA	NA	NA	NA	NA
	P27	43.0	91.5	194.7	1.7	31.4	48.4	54.4
ter	P28	34.8	116.3	200.5	2.5	34.7	66.0	40.6
Wai	P40	40.1	396.6	362.2	2.5	95.9	317.7	162.4
ce	P41	38.0	123.9	230.9	2.6	38.7	69.9	39.1
urfa	P42	50.4	73.9	224.1	1.7	27.0	48.5	48.1
S	P44	43.3	88.4	170.0	2.2	24.1	52.9	56.1
	P45	49.5	73.0	193.3	1.7	20.8	48.0	54.0
	P46	64.0	101.0	282.7	1.8	35.0	57.0	53.0
	R24	31.1	93.0	208.8	1.5	41.6	53.4	50.3
	R28	42.3	86.1	188.9	1.8	28.3	50.9	48.7
	R3	44.3	96.2	227.5	2.9	36.6	53.5	53.1
	R4	43.4	93.2	226.5	2.2	37.1	51.9	52.7
	K15	35.5	114.0	221.3	3.4	40.6	73.3	68.8



Table 4.8: Maximum Concentration of	f Cations and Anions 1980-2019
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	Well ID	Calcium	Chloride	Bicarbonate plus	Potassium	Magnesium	Sodium	Sulfate
	13P5	mg/L 51.0	mg/L 127.0	182.7	тд/L 1.9	27.0	55.0	mg/L 70.0
	13P6	88.0	90.0	295.4	3.6	30.0	90.0	83.0
	13P7	49.0	26.0	259.0	2.3	17.0	103.0	72.0
	13P8	61.0	56.0	245.6	2.4	20.0	73.0	19.0
	14B1	92.0	90.0	288.7	2.0	34.0	40.0	4J.0
er	19D10	75.0	102.0	234.4	2.2	37.0	52.0	34.0
wat	19D7	121.0	241.0	436.8	4.1	84.0	41.0	46.0
pur	19D8	101.0	165.0	331.8	2.5	59.0	41.0	27.0
Grou	19D9	68.0	98.0	227.1	1.7	31.0	45.0	30.0
Ŭ	19N3	43.0	44.0	269.7	2.9	20.0	62.0	31.0
	23J1	78.0	179.0	190.2	4.6	39.0	110.0	45.0
	25C3	62.0	109.0	266.3	2.1	32.0	84.0	32.0
	29F4	125.0	163.0	423.0	5.4	54.0	96.0	140.0
	30D2	84.0	115.0	311.5	3.9	37.0	72.0	96.0
	C1	131.0	420.0	419.7	4.8	121.0	206.0	115.0
	K18	50.0	158.0	268.7	4.2	48.0	92.0	78.0
	P10	104.0	212.0	270.0	5.8	55.0	105.0	195.0
	P11	83.0	112.0	253.0	3.8	31.0	68.0	90.0
	P12	58.0	161.0	234.4	5.6	44.0	87.0	98.0
	P13	NA	NA	NA	NA	NA	NA	NA
	P27	74.0	126.0	265.1	2.2	35.0	68.0	75.0
L.	P28	55.0	200.0	263.1	4.5	54.0	110.0	57.0
Vate	P40	131.0	2220.0	1278.5	11.0	447.0	1860.0	885.0
Ce V	P41	67.0	184.0	274.6	3.9	58.0	104.0	72.0
Irfa	P42	61.0	105.0	272.0	2.3	37.0	59.0	60.0
SL	P44	62.0	131.0	198.8	3.1	30.0	74.0	74.0
	P45	55.0	74.0	222.1	2.0	25.0	52.0	62.0
	P46	64.0	101.0	282.7	1.8	35.0	57.0	53.0
	R24	48.0	182.0	249.8	2.4	66.0	98.0	96.0
	R28	52.0	120.0	237.3	2.7	35.0	61.0	62.0
	R3	90.0	146.0	274.1	3.7	51.0	84.0	86.0
	R4	63.0	145.0	290.7	3.0	50.0	77.0	82.0
	K15	50.0	175.0	268.7	4.9	63.0	105.0	102.0



Table 4.9: Minimum	Concentration of	Cations and Ani	ons 1980-2019
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	Well ID	Calcium	Chloride	Bicarbonate plus	Potassium	Magnesium	Sodium	Sulfate
	1205	mg/L	mg/L	Carbonate mg/L	mg/L	mg/L	mg/L	mg/L
	13P5	51.0	127.0	182.7	1.9	27.0	55.0	45.0
	13P6	88.0	90.0	295.4	3.6	30.0	90.0	42.0
	13P7	49.0	26.0	259.0	2.3	17.0	103.0	40.0
	13P8	61.0	56.0	245.6	2.4	20.0	73.0	42.0
	14B1	92.0	90.0	288.7	2.0	34.0	40.0	39.0
ater	19D10	75.0	102.0	234.4	2.2	37.0	52.0	26.0
р	19D7	121.0	241.0	436.8	4.1	84.0	41.0	2.6
unc	19D8	101.0	165.0	331.8	2.5	59.0	41.0	4.0
ъ	19D9	68.0	98.0	227.1	1.7	31.0	45.0	3.0
	19N3	43.0	44.0	269.7	2.9	20.0	62.0	26.0
	23J1	78.0	179.0	190.2	4.6	39.0	110.0	10.0
	25C3	62.0	109.0	266.3	2.1	32.0	84.0	26.0
	29F4	125.0	163.0	423.0	5.4	54.0	96.0	11.0
	30D2	84.0	115.0	311.5	3.9	37.0	72.0	18.0
	C1	131.0	420.0	419.7	4.8	121.0	206.0	35.0
	K18	50.0	158.0	268.7	4.2	48.0	92.0	24.0
	P10	104.0	212.0	270.0	5.8	55.0	105.0	14.0
	P11	83.0	112.0	253.0	3.8	31.0	68.0	29.0
	P12	58.0	161.0	234.4	5.6	44.0	87.0	23.0
	P13	NA	NA	NA	NA	NA	NA	NA
	P27	74.0	126.0	265.1	2.2	35.0	68.0	47.0
5	P28	55.0	200.0	263.1	4.5	54.0	110.0	30.0
/ate	P40	131.0	2220.0	1278.5	11.0	447.0	1860.0	35.0
e N	P41	67.0	184.0	274.6	3.9	58.0	104.0	29.0
rfac	P42	61.0	105.0	272.0	2.3	37.0	59.0	35.0
Su	P44	62.0	131.0	198.8	3.1	30.0	74.0	41.0
	P45	55.0	74.0	222.1	2.0	25.0	52.0	45.0
	P46	64.0	101.0	282.7	1.8	35.0	57.0	53.0
	R24	48.0	182.0	249.8	2.4	66.0	98.0	31.0
	R28	52.0	120.0	237.3	2.7	35.0	61.0	30.0
	R3	90.0	146.0	274.1	3,7	51.0	84.0	25.0
	R4	63.0	145.0	290.7	3.0	50.0	77.0	20.0
	K15	50.0	175.0	268.7	4.9	63.0	105.0	46.0



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	Group	Calcium	Chloride	Bicarbonate plus	Potassium mg/l	Magnesium mg/l	Sodium	Sulfate
				Avera	age			
	N-S Lake B	44.63	99.41	217.35	2.33	31.09	66.68	51.81
Jpper	Lake A	56.23	74.85	251.32	2.54	28.36	52.98	57.05
ר	West Lake B	39.17	92.20	206.29	2.68	33.82	57.50	54.67
	N-S Lake B	53.42	76.84	203.67	1.57	23.96	40.92	24.24
ower	Lake A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
	West Lake B	72.73	70.93	263.07	1.59	28.07	31.73	44.07
				Maxim	num			
	N-S Lake B	131.00	2220.00	1255.00	11.00	447.00	1860.00	885.00
Upper	Lake A	125.00	200.00	423.00	5.40	58.00	110.00	140.00
	West Lake B	90.00	182.00	284.00	5.60	66.00	105.00	102.00
ower	N-S Lake B	101.00	179.00	331.00	4.60	59.00	110.00	83.00
	Lake A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
	West Lake B	92.00	90.00	288.00	2.00	34.00	40.00	51.00
				Minim	ium			
	N-S Lake B	16.00	14.00	40.00	0.60	3.00	17.00	2.64
Jpper	Lake A	14.00	6.00	110.00	0.80	6.00	0.60	11.00
	West Lake B	12.00	27.00	89.00	0.80	4.00	25.00	23.00
	N-S Lake B	10.00	15.00	54.00	0.70	3.00	19.00	3.00
ower	Lake A	N.A	N.A	N.A	N.A	N.A	N.A	N.A
Ľ	West Lake B	60.00	54.00	245.00	1.00	15.00	27.00	39.00

N.A. = Not Applicable – wells in Livermore Formation


4.3 HYDROCHEMICAL FACIES

Piper diagrams are a graphical representation of the chemistry of water samples. The cations (positively charged ion) and anions (negatively charged ion) are shown by separate ternary plots. The apexes of the cation plot are calcium, magnesium and sodium plus potassium. The apexes of the anion plot are sulfate, chloride, and bicarbonate plus carbonate. The two ternary plots are then projected onto a diamond. The diamond is a matrix transformation of a graph of the anions (sulfate + chloride/ total anions) and cations (sodium + potassium/total cations). Three different types of Piper diagrams were derived for each of the ten years evaluated (2010-2019): all samples, Lower Aquifer samples and Upper Aquifer samples. The Piper diagrams are presented in **Appendix C**.

Different symbols were adopted to represent the type of sample (surface or groundwater) and their position in the aquifer (Upper or Lower). Transparent circles represent mining pond observations (surface water), solid symbols represent Lower Aquifer wells, and transparent noncircle symbols represent Upper Aquifer wells. The symbols were differentiated to compare hydrochemical facies for the Upper Aquifer, Lower Aquifer and surface water. The Livermore Formation wells (20M1, 19N4 and 30C1) were included in the geochemical analysis. Since data are not averaged for hydrochemical facies, potential discrepancies for individual wells can be easily identified in the diagrams.

The Piper diagram shows that most of the samples cluster together, which indicates the water has similar characteristics in the vicinity of the mine. The predominant anion is bicarbonate for most locations (groundwater and surface water). However, the predominant anion in well 23J1 and few mining ponds is chloride during some years (2010, 2013, 2014, 2015, 2016, 2017), which are characterized by drought conditions. Although, well 13P7 presents lower chloride during some drought years. Surface water presents more spatial variability than groundwater, for example, in 2016 chloride was the predominant anion in several mining ponds located in the region near Lake B and Lake A (P28, P41, P44 and C1).

Most sampling locations do not have a dominant cation. Magnesium is slightly more predominant in surface water and calcium slightly more predominant in groundwater. Sodium-potassium is predominant in well 23J1 for 2017, 2016 and 2015. The hydrochemical facies derived for the Eliot Quarry for the ten-year period are typical of shallow fresh groundwaters and were observed in both Upper and Lower Aquifers suggesting waters are similar in different levels and sections of the site.



Because the sampling is not continuous for all wells and mining ponds over the ten-year period, the number of groundwater and surface water samples shown in the Piper diagrams will vary. For example, year 2016 has a significantly higher percentage of mining pond samples but overall fewer samples than most years. However, even with this data limitation, the plots over the ten-year period show similar water chemistry. Wells 19N3 and 19N4, with samples only in 2019 and 2018, seem to present slightly different water chemistry characteristics, but only well 19N4 (screened in the Livermore Formation) shows a consistent difference for its two samples based on cations only.

The Durov diagram is an alternative to the Piper Diagram. The major ions are shown as percentages of milliequivalents in the two triangles. The totals of both the cations and anions are set to 100% and the data points in the two triangles are projected onto a square grid which lies perpendicular to the third axis in each triangle. TDS and pH are plotted perpendicularly to the sodium-potassium and chloride axis, respectively.

Durov diagrams were developed for the ten-year period (2010-2019) and are presented in **Appendix D**. The samples were grouped according to location (North-South Lake B, Lake A and West Lake B) and are represented with different colors: red for North-South Lake B, green for Lake A and blue for West Lake B.

As can be seen on the Durov diagrams, pH is higher for surface water samples, which are represented with transparent circles. The average pH for surface waters is approximately 8.5 whereas for groundwater the average is approximately 7.5, with slight variations according to the year. In 2017 a pH of 9 was measured at well 23J1. Values of pH higher than 8.5 and as high as 10.7 are sporadically observed in some mining ponds. TDS levels vary uniformly from about 250 mg/L to about 600 mg/L for most samples. However, TDS concentrations in mining ponds C1 and P40 located in the North-South Lake B region are higher during some years. The maximum TDS concentration in C1 and P40 is 1,057 mg/L and 6,199 mg/L, respectively (with outliers). The high TDS value observed in P40 in 2014 is a probable outlier according to the statistical analyses and as shown on box-whisker plots in **Appendix A**, and it was not considered in the parametric statistics calculations (**Table 4.2**). The average TDS for P40 without this outlier is 389.3 mg/L.



The variations in TDS, pH, cations, and anions among the sampling locations are within the natural range of typical fresh groundwater quality variations and do not indicate the potential for incompatible water types that could result in precipitation of mineral salts if different water types are mixed.

Four sampling locations were evaluated to assess variations over the 39-year period: P41; 23J1; 19D7; 19D10. These locations were selected because they were subject to consistent sampling over time and wells 19D7 and 19D10 are nested. Piper, Durov, and Schoeller diagrams were developed for each sampling location. The diagrams are presented in **Appendix E**. The samples projected onto the diagrams for each evaluated location are generally clustered together. The concentrations of cations and anions vary over time.

Scholler diagrams provide a good comparison of concentration variations over time. Lower aquifer well 23J1 is the location that presents more variability amongst the selected locations. Sulfate mole equivalent (normalized) concentrations for this well range from 0.2 to 1 milliequivalent per kilogram (meg/kg). Drought years, such as 2015 and 2016 resulted in higher sulfate concentrations. The normal range of bicarbonate concentrations for well 23J1 range approximately from 2 to 3 meq/kg except for 2017, 2016, 2015 and 2007. Drought years have higher chloride concentrations, up to 5 meg/kg. Magnesium is the cation that has the most variation, from 0.25 to 2.5 meg/kg. Mole equivalents of magnesium, calcium, sodium and potassium are mostly similar for each year except 1988, 2003 and 2006 when calcium is the dominant cation. In contrast to well 23J1, Lower Aquifer well 19D10 has the smallest variation for cations and anions. In most years calcium is the dominant cation and bicarbonate is the dominant anion. Calcium is slightly more dominant in 19D7 and bicarbonate is the dominant anion. The concentrations observed in the pair of nested wells (19D7 and 19D10 indicate that the Upper and Lower Aquifers have similar characteristics over time. Sulfate mole equivalent concentrations for mining pond P41 range mostly from 0.6 to 1.0 meg/kg. Carbonate plus bicarbonate range from 3 to 4.5 meq/kg. Chloride, magnesium, calcium and sodium have a larger range. Chloride, magnesium and sodium vary from 2 to about 5 meq/kg. Calcium vary from 1 to approximately 3.5 meg/kg for mining pond P41.



5 CONCLUSIONS

Kleinfelder prepared this Focused Water Quality Assessment for the area referred to as Lake B within CEMEX's Eliot Quarry. The study assessed potential differences in water quality between the Upper and Lower Aquifers in the vicinity of Lake B and whether the proposed 100-foot increase in the final depth of Lake B would substantially degrade water quality in the Lower Aquifer. As summarized in more detail below, Kleinfelder concludes that the proposed increase in depth would not degrade groundwater quality at Lake B. It is anticipated that the findings of this assessment will be incorporated by Alameda County into the Subsequent Environmental Impact Report prepared to review the Reclamation Plan Amendment project for purposes of the California Environmental Quality Act (CEQA).

Kleinfelder's assessment is based on an evaluation of data collected for groundwater and surface water by the Zone 7 Water Agency, with a focus on four of the five constituents listed in Zone 7's Alternative Groundwater Sustainability Plan for the Livermore Valley Groundwater Basin (i.e., TDS, nitrate, boron, and hexavalent chromium). The fifth constituent, toxic sites, does not apply to the Eliot Quarry. The Zone 7 Water Agency provided water quality data from 1980 to 2019, including water chemical parameters in the Upper and Lower Aquifers and the Livermore Formation and water chemical parameters measured in samples from several mining ponds in the vicinity of the Eliot Quarry. A total of 36 sampling locations were evaluated.

The chemical parameters evaluated were arsenic, boron, calcium, chloride, bicarbonate plus carbonate, chromium, iron, potassium, magnesium, sodium, nitrate (N), sulfate, silica, TDS, and pH. The graphing tools Piper, Schoeller, and Durov diagrams were used to evaluate hydrochemical facies (water types), mixing of waters, and potential sources. Box-whisker plots were prepared to identify outliers. Parametric statistics (mean, maximum, and minimum) were calculated for most parameters, and non-parametric statistics were derived for nitrate, boron, chromium, and TDS using the 40-year data record provided by Zone 7 Water Agency.

The statistical analysis provides an indication of areas of potential sources for the parameters of interest listed in the Alternative Groundwater Sustainability Plan for the Livermore Valley Groundwater Basin. The average concentrations calculated for most wells and mining ponds in the vicinity of Eliot Quarry are below the maximum thresholds of TDS, chromium, nitrate (N), and boron. For TDS, 97 percent of wells and ponds have average concentrations below the threshold



(without considering Livermore Formation wells 20M1, 19N4 and 30C1). When these wells are added to the overall statistics, 94 percent of wells and ponds have average concentrations below the threshold. For nitrate (N), 97 percent of sampling locations have average concentrations below the threshold (with and without Livermore Formation wells 20M1, 19N4 and 30C1). There are no sampling locations with average concentrations of chromium and boron above the threshold.

Summary results for TDS, nitrate (N), chromium, and boron, which are the priority constituents listed in the Alternative Groundwater Sustainability Plan, are as follows:

- TDS: Average TDS concentration varies from 373 mg/L in the Upper Aquifer of North-South Lake B area to 432.57 mg/L in the Upper Aquifer west of Lake B area. An individual elevated TDS result for mining pond P40 (6,199 mg/L) is recognized as an outlier and was not used in the parametric statistical analyses. Subsequent sampling performed in 2017 indicated significantly lower levels of TDS in P40 (380 mg/L).
- Nitrate: Nitrate levels are lower for the Upper Aquifer wells and mining ponds. Lower Aquifer well 19D10 has an average nitrate concentration above the 10 mg/L Alternative Plan threshold. This is an indication that water from the Upper Aquifer in the vicinity of nested well 19D10 would not degrade water quality in the Lower Aquifer with respect to nitrate. Silica also has higher concentrations in the Lower Aquifer.
- Chromium: The averages of chromium for the different spatial clusters are within the same order of magnitude and well below the 10 µg/L Alternative Plan threshold. The analysis of samples according to their position in the aquifer does not indicate significant differences in chromium concentrations for the Upper and Lower Aquifers. Thus, based on concentrations it is unlikely that the mixing of Upper and Lower aquifer waters will significantly change chromium concentrations in the Lower Aquifer.
- Boron: The average boron concentration is higher in the Upper Aquifer, mainly in surface water. However, the average concentrations are significantly lower than the 1,400 µg/L Alternative Plan threshold. It is possible that concentrations of boron in the Lower Aquifer will increase over time due to mixing if surface water infiltrates from the Upper Aquifer. Because higher boron concentrations are normally found in surface water, the existing grading was designed to divert stormwater from reclaimed areas to retention ponds to prevent it entering Lake A and Lake B. However, Kleinfelder recommends the preparation



of an adaptive management plan (AMP) to monitor whether the existing grading is sufficient to prevent potential boron concentration increase in the Upper or Lower Aquifer, and to take corrective action if boron concentrations in aquifer wells increases outside of the historical range.

The existing grading, designed to divert stormwater to retention ponds, will also reduce the likelihood of higher iron concentrations in surface water reaching the Lower Aquifer. Although iron is not identified in the Alternative Groundwater Sustainability Plan for the Livermore Valley Groundwater Basin as a constituent that could cause undesirable results, the average iron concentration in surface water is approximately double of the average calculated for the Lower Aquifer. The averages of some mining ponds (P40, P45, R24 and R28) are above the 300 µg/L drinking water standard. Elevated iron is common in silt ponds and reclaimed mine pits with substantial vegetative growth that creates reducing conditions when the vegetation dies and decays, so concentrations would likely decrease rapidly upon contact with different redox conditions (i.e., oxidizing conditions) in the aquifer. The average iron concentration in Upper Aquifer wells is $95.5 \,\mu$ g/L, which is very close to the Lower Aquifer well average of $82.3 \,\mu$ g/L, and both are significantly below the drinking water standard for iron. Based on concentrations, it is unlikely that the mixing of Upper and Lower Aquifer waters will significantly change iron concentrations in the Lower Aquifer. However, an adaptive management plan (AMP) that addresses the potential for elevated iron in the mining ponds was prepared by EMKO Environmental, Inc., on July 6, 2020, and is titled "Adaptive Management Program to address the potential for elevated iron concentrations to occur in reclaimed silt ponds and mining excavations at the Eliot Facility and to prevent potential impacts to water quality in the Upper and Lower Aquifers."

The parametric and non-parametric statistics calculated for the water quality parameters discussed above with and without Livermore Formation wells 20M1, 19N4 and 30C1 are not significantly different. This is an indication that considering or disregarding these wells in the overall statistical analysis would not introduce bias.

The analysis of cations and anions with Piper, Durov, and Schoeller diagrams indicates the hydrochemical facies of the Upper Aquifer, Lower Aquifer, Livermore Formation, and surface water are similar. The predominant anion is bicarbonate for most locations, with chloride predominant during drought conditions at some locations. Surface water has more spatial variability than groundwater. Most sampling locations do not have a dominant cation and are classified as mixed water. Magnesium is slightly more predominant in surface water and calcium



slightly more predominant in groundwater. The hydrochemical facies derived for the 10-year period are typical for shallow fresh groundwaters and were identified in both Upper and Lower Aquifers suggesting shallow and deep waters are similar.

The findings of the Focused Water Quality Assessment of Lake B indicate that there are no distinct water quality characteristics in the vicinity of Eliot Quarry that would uniquely distinguish an individual well or aquifer unit within the basin. Therefore, the proposed 100-foot depth increase in the final elevation of Lake B is not anticipated to result in undesirable effects or degrade groundwater quality. No additional measures are deemed necessary to protect groundwater quality during the course of mining or reclamation at Lake B.



6 LIMITATIONS

This work was performed in a manner consistent with that level of care and skill ordinarily exercised by other members of Kleinfelder's profession practicing in the same locality, under similar conditions and at the date the services are provided. Our conclusions, opinions, and recommendations are based on observations and data provided by Zone 7 Water Agency and CEMEX. It is possible that conditions could vary between or beyond the data evaluated. Kleinfelder makes no other representation, guarantee, or warranty, expressed or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.



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APPENDIX A

Box-Whisker Plots Explanation



The box-whisker plot is a method for graphically depicting groups of numerical data through their quartiles (Tukey, 1977). The lines extending from the boxes (whiskers) indicate variability outside the upper and lower quartiles according to the interquartile range (IQR). The upper quartile (Q3) corresponds to the 75th percentile. The lower quartile (Q1) corresponds to the 25th percentile. The IQR is a measure of dispersion of the data calculated as the difference between the upper and lower quartiles. Inner and outer fences of the data are calculated as a function of the IQR, Q1 and Q3. According to Tukey (1977), the edge of the inner fence is defined by 1.5 times IQR from the upper and lower quartiles. The edge of the outer fence is defined by 3.0 times IQR from the upper and lower quartiles. The IQR and the edge of Tukey's fences are not shown in the plot, but they determine the position of the whiskers, possible and probable outliers. The position of the whiskers corresponds to the last data value within the inner or outer fence. A data value between the inner and outer fences is a possible outlier. An extreme value beyond the outer fence is considered a probable outlier.

TDS (mg/L) - Groundwater



TDS (mg/L) - Mining Ponds



Nitrate (mg/L) Groundwater



Nitrate (mg/L) Mining Ponds



Boron (µg/L) Groundwater



Boron (μ g/L) Mining Ponds



Chromium (μ g/L) Groundwater



Chromium (µg/L) Mining Ponds



Arsenic (μ g/L) Groundwater



Arsenic (µg/L) Mining Ponds



Iron (μ g/L) Groundwater



Iron (μ g/L) Mining Ponds



Silica (mg/L) Groundwater



Silica (mg/L) Mining Ponds





APPENDIX B



Table 4.2B: Average Concentration of Constituents 1980-2019

	Well	Nitrate	Boron	Chromium	TDS	Arsenic	Silica	Iron
	ID	mg/L	μg/L	μg/L	mg/L	μg/L	mg/L	μg/L
	13P5	0.2	342.5	1.7	349.4	1.0	14.1	59.1
	13P6	0.8	313.8	3.2	409.0	1.0	20.7	224.1
	13P7	0.1	194.3	2.3	314.1	1.0	22.5	171.0
	13P8	1.1	268.8	1.3	373.3	1.0	25.6	80.0
	14B1	1.8	318.0	3.6	406.5	1.0	18.9	50.0
	19D10	12.0	124.2	1.8	440.6	1.0	28.3	50.0
ž	19D7	5.5	100.0	6.3	422.9	1.0	25.0	66.2
vate	19D8	5.4	100.0	5.8	418.7	1.0	25.3	50.0
ndv	19D9	9.8	100.0	3.1	261.6	1.0	26.0	70.7
irou	19N3	0.4	235.0	1.0	346.0	6.2	25.7	100.0
G	19N4	0.1	355.0	1.8	409.5	19.5	15.5	100.0
	20M1	4.3	271.2	1.5	514.0	1.2	22.8	49.8
	23J1	5.4	137.4	1.7	396.7	1.0	35.4	50.0
	25C3	4.2	331.7	1.7	440.7	1.0	26.0	75.5
	29F4	0.3	437.6	3.0	427.7	3.0	15.3	143.7
	30C1	3.8	250.0	N.A.	421.0	2.0	27.6	N.A.
	30D2	0.6	326.1	1.8	372.2	1.0	15.9	46.3
	C1	0.1	935.9	1.6	429.3	6.6	5.7	70.6
	K18	0.1	254.1	2.1	334.2	1.6	7.3	70.2
	P10	0.1	387.5	1.6	346.6	2.6	5.9	75.1
	P11	0.1	358.6	2.0	335.4	1.3	12.5	132.7
	P12	0.1	264.6	1.8	315.7	1.6	9.2	144.2
	P13	N.A.	N.A.	N.A.	588.0	N.A.	N.A.	N.A.
	P27	0.1	394.9	1.7	287.1	2.3	11.0	119.7
Ŀ	P28	0.1	369.3	2.0	342.2	2.9	4.6	143.9
Vat	P40	0.1	495.0	2.1	389.3	2.5	4.6	549.0
ce /	P41	0.1	324.4	1.8	416.8	2.4	5.5	90.8
urfa	P42	0.3	339.4	2.5	381.6	1.2	15.2	288.7
S	P44	0.1	369.1	2.3	369.2	1.2	9.8	205.4
	P45	0.2	400.0	2.4	361.7	1.8	11.0	437.5
	P46	1.3	420.0	1.0	476.0	1.0	19.0	100.0
	R24	0.1	446.0	4.1	377.5	2.2	9.4	354.9
	R28	0.2	343.3	2.8	368.1	1.0	14.2	301.4
	R3	0.1	449.1	4.1	461.1	1.5	13.2	767.6
	R4	0.1	461.9	3.0	438.9	1.6	14.1	259.9
	K15	0.1	680.1	2.0	478.8	3.2	5.5	58.9
Av	erages	1.4	391.2	2.6	406.0	2.0	13.8	159.5



Table 4.3B: Maximum	Concentration of	f Constituents	1980-2019
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	Well ID	Nitrate mg/L	Boron ug/L	Chromium ug/L	TDS mg/L	Arsenic ug/L	Silica mg/L	lron ug/L
	13P5	0.4	410.0	3.6	366.0	< 1.0	17.1	< 100.0
	13P6	0.9	390.0	4.6	424.0	< 1.0	23.5	680.0
	13P7	0.2	210.0	6.5	322.0	< 1.0	23.8	490.0
	13P8	1.1	330.0	< 2.0	385.0	< 1.0	27.8	170.0
	14B1	2.7	390.0	6.0	457.0	< 1.0	21.4	< 50.0
	19D10	13.5	220.0	2.7	469.0	< 1.0	36.2	< 50.0
5	19D7	8.3	100.0	12.0	802.0	< 1.0	28.9	140.0
vate	19D8	6.7	100.0	8.3	587.0	< 1.0	27.2	< 50.0
ndv	19D9	13.1	100.0	6.7	297.0	< 1.0	28.2	200.0
rou	19N3	0.6	240.0	< 1.0	361.0	9.1	27.8	< 100.0
G	19N4	0.1	360.0	2.5	491.0	26.0	16.7	< 100.0
	20M1	10.7	380.0	2.4	590.0	2.2	30.3	77.0
	23J1	7.9	340.0	5.0	486.0	< 1.0	38.7	< 50.0
	25C3	5.0	410.0	2.0	465.0	< 1.0	29.3	120.0
	29F4	1.3	1400.0	11.0	655.0	8.0	25.3	540.0
	30C1	3.9	300.0	N.A.	421.0	2.0	27.8	N.A.
	30D2	1.8	800.0	4.4	494.0	< 1.0	25.2	< 100.0
	C1	0.3	2480.0	2.0	1057.0	13.0	22.0	220.0
	K18	0.3	420.0	< 5.0	553.0	2.1	11.4	< 100.0
	P10	0.3	1000.0	2.3	662.0	5.9	22.3	210.0
	P11	0.6	700.0	3.0	524.0	2.0	20.2	350.0
	P12	0.3	440.0	3.1	516.0	3.9	21.4	510.0
	P13	N.A.	N.A.	N.A.	588.0	N.A.	N.A.	N.A.
	P27	0.3	560.0	2.7	447.0	5.0	20.3	290.0
er	P28	0.1	680.0	< 5.0	544.0	4.9	13.9	520.0
Nat	P40	0.1	650.0	4.3	484.0	3.5	17.1	2100.0
ce /	P41	0.1	590.0	4.1	555.0	4.0	13.8	300.0
urfa	P42	0.7	400.0	9.6	423.0	2.4	20.1	1160.0
S	P44	0.1	530.0	6.3	428.0	2.0	12.4	660.0
	P45	0.3	500.0	3.8	377.0	3.9	11.2	890.0
	P46	1.3	420.0	1.0	476.0	< 1.0	19.0	< 100.0
	R24	0.3	810.0	17.0	567.0	4.0	19.4	940.0
	R28	0.6	470.0	8.1	407.0	< 1.0	18.2	1200.0
	R3	0.5	930.0	11.0	690.0	2.1	23.1	3500.0
	R4	0.6	930.0	6.7	631.0	3.2	24.4	960.0
	K15	0.3	410.0	2.1	747.0	4.8	14.0	130.0



Table 4.4B: Minimum Concentration of Constituents 1980-2019

	Well ID	Nitrate	Boron	Chromium	TDS	Arsenic	Silica	Iron
		mg/L	μg/L	μg/L	mg/L	μg/L	mg/L	μg/L
	13P5	<0.1	270.0	< 1.0	302.0	< 1.0	11.3	< 50.0
	13P6	0.6	260.0	< 2.0	384.0	< 1.0	19.0	< 50.0
	13P7	<0.1	190.0	< 1.0	303.0	< 1.0	19.9	< 50.0
	13P8	1.0	230.0	< 1.0	363.0	< 1.0	22.9	< 50.0
	14B1	1.0	270.0	< 1.0	369.0	< 1.0	14.8	< 50.0
	19D10	11.2	< 100.0	< 1.0	400.0	< 1.0	22.0	< 50.0
ž	19D7	1.7	< 100.0	< 1.0	210.0	< 1.0	23.1	< 20.0
vate	19D8	4.1	< 100.0	< 1.0	234.0	< 1.0	23.5	< 50.0
vbn	19D9	5.9	< 100.0	< 1.0	210.0	<1.0	22.7	< 20.0
rou	19N3	<0.1	230.0	< 1.0	331.0	3.2	23.5	< 100.0
G	19N4	<0.1	350.0	< 1.0	328.0	13	14.3	< 100.0
	20M1	1.9	< 100	< 1.0	438.0	< 0.002	18.9	< 20.0
	23J1	<0.1	< 100	< 1.0	292.0	< 1.0	25.7	< 50.0
	25C3	3.6	280.0	< 1.0	416.0	< 1.0	22.5	< 50.0
	29F4	<0.01	< 100	< 1.0	144.0	< 0.002	0.3	0.01
	30C1	3.7	< 200	N.A.	421.0	2.0	27.3	N.A.
	30D2	<0.1	< 200	< 1.0	256.0	< 1.0	9.7	0.01
	C1	<0.01	< 100	< 1.0	260.0	2.7	0.3	0.03
	K18	<0.01	< 100	< 1.0	220.0	< 1.0	2.9	< 50.0
	P10	<0.01	< 100	< 1.0	206.0	< 1.0	0.6	0.03
	P11	<0.01	< 100	1.3	229.0	< 1.0	5.7	54.0
	P12	<0.01	< 100	< 1.0	221.0	< 1.0	0.6	< 50.0
	P13	N.A.	N.A.	N.A.	588.0	N.A.	N.A.	N.A.
	P27	<0.01	< 200	< 1.0	64.0	<1.0	2.9	< 50.0
5	P28	<0.1	< 100	< 1.0	208.0	1.4	0.9	< 50.0
Vate	P40	<0.1	280.0	< 1.0	348.0	1.1	0.5	< 50.0
Se V	P41	<0.1	150.0	< 1.0	319.0	<1.0	1.8	< 50.0
Irfa	P42	<0.1	250.0	< 1.0	333.0	< 1.0	11.9	< 50.0
Su	P44	<0.1	240.0	< 1.0	325.0	< 1.0	7.2	< 50.0
	P45	<0.1	340.0	< 1.0	332.0	< 1.0	10.7	110.0
	P46	1.3	420.0	< 1.0	476.0	< 1.0	19.0	< 100.0
	R24	<0.01	290.0	< 1.0	174.0	< 1.0	1.0	90.0
	R28	<0.1	240.0	< 1.0	325.0	< 1.0	10.6	55.0
	R3	<0.01	250.0	< 1.0	331.0	< 1.0	8.3	< 50.0
	R4	<0.01	< 100	< 1.0	237.0	< 1.0	3.4	< 50.0
	K15	<0.01	< 100	< 1.0	319.0	1.1	0.2	0.01



Table 4.5B: Parametric and	Non-Parametric Statistic	s for All Samples 1	980-2019

Nitrate (mg/L)							
Statistics without outliers	All Samples	Upper Aquifer	Lower Aquifer				
Mean	1.4	0.4	5.4				
Maximum	13.5	8.3	13.5				
Minimum	< 0.01	< 0.01	0.1				
Sample count	752	602	150				
Percentiles with	Percent samples <=	Percent samples <=	Percent samples <=				
outliers	Standard	Standard	Standard				
10 mg/L Standard	96.5%	100.0%	81.4%				
	TDS (mg/L)					
Statistics without							
outliers	All Samples	Upper Aquifer	Lower Aquifer				
Mean	406.0	406.0	406.0				
Maximum	1057.0	1057.0	590.0				
Minimum	64.0	64.0	210.0				
Sample count	2043	1897	146				
Percentiles with	Percent samples <=	Percent samples <=	Percent samples <=				
outliers	Standard	Standard	Standard				
500 mg/L Standard	81.3%	80.9%	86.2%				
Boron (µg/L)							
Statistics without							
outliers	All Samples	Upper Aquifer	Lower Aquifer				
Mean	391.2	437.8	195.7				
Maximum	2480.0	2480.0	390.0				
Minimum	< 50.0	< 50.0	< 100.0				
Sample count	727	587	140				
Percentiles with	Percent samples <=	Percent samples <=	Percent samples <=				
outliers	Standard	Standard	Standard				
1400 μg/L Standard	98.7%	98.3%	100.0%				
	Chromiu	im (μg/L)					
Statistics without							
outliers	All Samples	Upper Aquifer	Lower Aquifer				
Mean	2.6	2.5	2.9				
Maximum	17	17	8.3				
Minimum	<1	<1	<1				
Sample count	444	331	113				
Percentiles with	Percent samples <=	Percent samples <=	Percent samples <=				
outliers	Standard	Standard	Standard				
10 μg/L Standard	97.7%	97.5%	98.3%				



Arsenic (µg/L)						
Statistics without outliers	All Samples	Upper Aquifer	Lower Aquifer			
Mean	2.0	2.2	1.3			
Maximum	26.0	13.0	26.0			
Minimum	< 0.002	< 0.002	< 0.002			
Sample count	509	387	122			
	Percent samples <=	Percent samples <=	Percent samples <=			
	Standard	Standard	Standard			
No MCL	N.A	N.A	N.A			
	Iron	[μg/L)				
Statistics without outliers	All Samples	Upper Aquifer	Lower Aquifer			
Mean	159.5	182.2	78.6			
Maximum	3500.0	3500.0	680.0			
Minimum	0.01	0.01	20.0			
Sample count	433	338	95			
	Percent samples <=	Percent samples <=	Percent samples <=			
	Standard	Standard	Standard			
NO IVICL	N.A	N.A	N.A			
	Silica	(mg/L)	1			
outliers	All Samples	Upper Aquifer	Lower Aquifer			
Mean	13.8	11.1	25.5			
Maximum	38.7	29.3	38.7			
Minimum	0.2	0.2	14.3			
Sample count	761	617	144			
	Percent samples <= Standard	Percent samples <= Standard	Percent samples <= Standard			
No MCL	N.A	N.A	N.A			
	<u> </u>	H				
	All Samples	Upper Aquifer	Lower Aquifer			
Mean	8.0	8.1	7.5			
Maximum	10.7	10.7	9.0			
Minimum	6.4	6.4	6.4			
Sample count	799	644	155			
	Percent samples <= Standard	Percent samples <= Standard	Percent samples <= Standard			
No MCI	N.A	N.A	N.A			

Table 4.5B (Cont.): Parametric and Non-Parametric Statistics for All Samples 1980-2019

N.A. = Not Applicable



Table 4.6B: Constituent Statistics for Grouped Samples 1980-2019

	Group	Nitrate mg/L	Boron μg/L	Chromium µg/L	TDS mg/L	Arsenic μg/L	Silica mg/L	lron μg/L
				Av	erage			
	N-S Lake B	0.83	459.37	2.62	373.27	2.04	11.61	173.85
Ippei	Lake A	0.29	386.64	2.26	387.18	2.57	12.85	111.99
	West Lake B	0.10	462.49	2.82	432.57	1.93	9.06	249.10
	N-S Lake B	6.27	152.50	3.04	379.11	1.00	27.34	87.91
Iowo.	Lake A	3.95	275.52	1.51	500.41	3.00	22.59	56.93
	West Lake B	1.82	318.00	3.62	406.53	1.00	18.89	50.00
				Ма	ximum			
	N-S Lake B	8.30	2480.00	12.00	1057.00	13.00	29.30	2100.00
Jpper	Lake A	3.60	1400.00	11.00	655.00	9.10	27.80	540.00
	West Lake B	1.27	1770.00	17.00	747.00	4.80	24.40	3500.00
	N-S Lake B	13.50	390.00	8.30	587.00	1.00	38.70	680.00
owei	Lake A	10.70	380.00	2.50	590.00	26.00	30.30	100.00
-	West Lake B	2.70	390.00	6.00	457.00	1.00	21.40	50.00
				Mir	nimum			
	N-S Lake B	<0.01	<50.00	<1.00	64.00	<1.0	0.30	0.03
Jpper	Lake A	<0.10	<100.00	<1.00	144.00	<0.002	0.30	<0.01
	West Lake B	<0.10	<100.00	<1.00	174.00	<1.0	0.20	<0.01
<u>۔</u>	N-S Lake B	<0.10	<100.00	<1.00	210.00	<1.0	19.00	20.00
owei	Lake A	<0.10	<100.00	<1.00	328.00	<0.002	14.30	20.00
Ľ	West Lake B	1.01	270.00	<1.00	369.00	<1.0	14.80	50.00



Table 4.7B: Average Concentration of Cations and Anions 1980-2019

	Well ID	Calcium	Chloride	Bicarbonate plus	Potassium	Magnesium	Sodium	Sulfate
		mg/L	mg/L	Carbonate mg/L	mg/L	mg/L	mg/L	mg/L
	13P5	46.1	91.5	166.7	1.6	23.0	47.3	51.0
	13P6	74.6	67.9	273.9	2.1	25.0	39.4	52.0
	13P7	44.5	17.0	250.5	1.9	12.6	53.5	47.4
	13P8	55.8	54.1	238.2	1.9	18.0	50.5	45.6
	14B1	72.7	70.9	264.1	1.6	28.1	31.7	44.1
	19D10	63.4	88.4	214.3	1.6	27.8	44.1	29.6
Ŀ	19D7	66.2	101.6	246.0	1.7	37.1	28.1	16.8
vati	19D8	67.0	100.5	244.6	1.7	35.8	28.0	16.0
۸pu	19D9	40.7	43.5	145.4	1.2	15.5	27.2	9.7
rou	19N3	39.0	42.0	267.8	2.2	16.5	56.5	28.5
G	19N4	24.0	85.5	255.7	2.3	12.5	105.0	37.5
	20M1	70.0	95.8	293.4	2.0	36.5	61.0	51.7
	23J1	41.0	105.8	163.9	1.3	23.6	53.9	14.9
	25C3	52.3	92.2	252.5	1.4	26.1	67.3	29.4
	29F4	68.1	61.5	282.9	2.7	26.2	46.4	68.6
	30C1	60.0	56.0	278.9	1.6	25.0	52.0	44.5
	30D2	51.3	63.8	232.8	2.2	24.1	51.0	51.4
	C1	34.7	132.0	275.5	3.1	39.6	106.9	67.5
	K18	39.5	65.5	188.0	2.5	21.7	47.9	41.5
	P10	38.7	66.6	193.0	3.0	24.3	46.7	43.8
	P11	49.4	60.9	211.0	2.4	20.1	45.6	45.6
	P12	42.3	66.6	194.0	2.5	21.5	47.7	42.9
	P13	NA	NA	NA	NA	NA	NA	NA
	P27	43.0	91.5	194.7	1.7	31.4	48.4	54.4
er	P28	34.8	116.3	200.5	2.5	34.7	66.0	40.6
Nat	P40	40.1	396.6	362.2	2.5	95.9	317.7	162.4
ce /	P41	38.0	123.9	230.9	2.6	38.7	69.9	39.1
ırfa	P42	50.4	73.9	224.1	1.7	27.0	48.5	48.1
SI	P44	43.3	88.4	170.0	2.2	24.1	52.9	56.1
	P45	49.5	73.0	193.3	1.7	20.8	48.0	54.0
	P46	64.0	101.0	282.7	1.8	35.0	57.0	53.0
	R24	31.1	93.0	208.8	1.5	41.6	53.4	50.3
	R28	42.3	86.1	188.9	1.8	28.3	50.9	48.7
	R3	44.3	96.2	227.5	2.9	36.6	53.5	53.1
	R4	43.4	93.2	226.5	2.2	37.1	51.9	52.7
	K15	35.5	114.0	221.3	3.4	40.6	73.3	68.8



Table 4.8B: Maximum Concentration of Cations and Anions 1980-2019

	Well ID	Calcium	Chloride	Bicarbonate plus	Potassium	Magnesium	Sodium	Sulfate
		mg/L	mg/L	Carbonate mg/L	mg/L	mg/L	mg/L	mg/L
	13P5	51.0	127.0	182.7	1.9	27.0	55.0	70.0
	13P6	88.0	90.0	295.4	3.6	30.0	90.0	83.0
	13P7	49.0	26.0	259.0	2.3	17.0	103.0	72.0
	13P8	61.0	56.0	245.6	2.4	20.0	73.0	49.0
	14B1	92.0	90.0	288.7	2.0	34.0	40.0	51.0
	19D10	75.0	102.0	234.4	2.2	37.0	52.0	34.0
2	19D7	121.0	241.0	436.8	4.1	84.0	41.0	46.0
vate	19D8	101.0	165.0	331.8	2.5	59.0	41.0	27.0
vbn	19D9	68.0	98.0	227.1	1.7	31.0	45.0	30.0
rou	19N3	43.0	44.0	269.7	2.9	20.0	62.0	31.0
G	19N4	26.0	107.0	289.1	2.5	14.0	132.0	52.0
	20M1	90.0	138.0	344.3	5.6	54.0	73.0	71.0
	23J1	78.0	179.0	190.2	4.6	39.0	110.0	45.0
	25C3	62.0	109.0	266.3	2.1	32.0	84.0	32.0
	29F4	125.0	163.0	423.0	5.4	54.0	96.0	140.0
	30C1	65.0	57.0	279.6	1.8	26.0	54.0	49.0
	30D2	84.0	115.0	311.5	3.9	37.0	72.0	96.0
	C1	131.0	420.0	419.7	4.8	121.0	206.0	115.0
	K18	50.0	158.0	268.7	4.2	48.0	92.0	78.0
	P10	104.0	212.0	270.0	5.8	55.0	105.0	195.0
	P11	83.0	112.0	253.0	3.8	31.0	68.0	90.0
	P12	58.0	161.0	234.4	5.6	44.0	87.0	98.0
	P13	NA	NA	NA	NA	NA	NA	NA
	P27	74.0	126.0	265.1	2.2	35.0	68.0	75.0
ž	P28	55.0	200.0	263.1	4.5	54.0	110.0	57.0
Vate	P40	131.0	2220.0	1278.5	11.0	447.0	1860.0	885.0
Se V	P41	67.0	184.0	274.6	3.9	58.0	104.0	72.0
Irfa	P42	61.0	105.0	272.0	2.3	37.0	59.0	60.0
SL	P44	62.0	131.0	198.8	3.1	30.0	74.0	74.0
	P45	55.0	74.0	222.1	2.0	25.0	52.0	62.0
	P46	64.0	101.0	282.7	1.8	35.0	57.0	53.0
	R24	48.0	182.0	249.8	2.4	66.0	98.0	96.0
	R28	52.0	120.0	237.3	2.7	35.0	61.0	62.0
	R3	90.0	146.0	274.1	3.7	51.0	84.0	86.0
	R4	63.0	145.0	290.7	3.0	50.0	77.0	82.0
	K15	50.0	175.0	268.7	4.9	63.0	105.0	102.0



Table 4.9B: Minimum Concentration of Cations and Anions 1980-2019

	Well ID	Calcium	Chloride	Bicarbonate plus	Potassium	Magnesium	Sodium	Sulfate
		mg/L	mg/L	Carbonate mg/L	mg/L	mg/L	mg/L	mg/L
	13P5	51.0	127.0	182.7	1.9	27.0	55.0	45.0
	13P6	88.0	90.0	295.4	3.6	30.0	90.0	42.0
	13P7	49.0	26.0	259.0	2.3	17.0	103.0	40.0
	13P8	61.0	56.0	245.6	2.4	20.0	73.0	42.0
	14B1	92.0	90.0	288.7	2.0	34.0	40.0	39.0
	19D10	75.0	102.0	234.4	2.2	37.0	52.0	26.0
ž	19D7	121.0	241.0	436.8	4.1	84.0	41.0	2.6
vate	19D8	101.0	165.0	331.8	2.5	59.0	41.0	4.0
vbn	19D9	68.0	98.0	227.1	1.7	31.0	45.0	3.0
rou	19N3	43.0	44.0	269.7	2.9	20.0	62.0	26.0
G	19N4	26.0	107.0	289.1	2.5	14.0	132.0	23.0
	20M1	90.0	138.0	344.3	5.6	54.0	73.0	41.0
	23J1	78.0	179.0	190.2	4.6	39.0	110.0	10.0
	25C3	62.0	109.0	266.3	2.1	32.0	84.0	26.0
	29F4	125.0	163.0	423.0	5.4	54.0	96.0	11.0
	30C1	65.0	57.0	279.6	1.8	26.0	54.0	40.0
	30D2	84.0	115.0	311.5	3.9	37.0	72.0	18.0
	C1	131.0	420.0	419.7	4.8	121.0	206.0	35.0
	K18	50.0	158.0	268.7	4.2	48.0	92.0	24.0
	P10	104.0	212.0	270.0	5.8	55.0	105.0	14.0
	P11	83.0	112.0	253.0	3.8	31.0	68.0	29.0
	P12	58.0	161.0	234.4	5.6	44.0	87.0	23.0
	P13	NA	NA	NA	NA	NA	NA	NA
	P27	74.0	126.0	265.1	2.2	35.0	68.0	47.0
ž	P28	55.0	200.0	263.1	4.5	54.0	110.0	30.0
∕ate	P40	131.0	2220.0	1278.5	11.0	447.0	1860.0	35.0
Se V	P41	67.0	184.0	274.6	3.9	58.0	104.0	29.0
Irfa	P42	61.0	105.0	272.0	2.3	37.0	59.0	35.0
Su	P44	62.0	131.0	198.8	3.1	30.0	74.0	41.0
	P45	55.0	74.0	222.1	2.0	25.0	52.0	45.0
	P46	64.0	101.0	282.7	1.8	35.0	57.0	53.0
	R24	48.0	182.0	249.8	2.4	66.0	98.0	31.0
	R28	52.0	120.0	237.3	2.7	35.0	61.0	30.0
	R3	90.0	146.0	274.1	3.7	51.0	84.0	35.0
	R4	63.0	145.0	290.7	3.0	50.0	77.0	39.0
	K15	50.0	175.0	268.7	4.9	63.0	105.0	46.0


Table 4.10B: Anion and Cation Statistics for Grouped Samples 1980-2019

	Group	Calcium	Chloride	Bicarbonate plus	Potassium	Magnesium	Sodium	Sulfate
		mg/L	mg/L	Carbonate mg/L	mg/L	mg/L	mg/L	mg/L
	N-S							
Upper	Lake B	44.63	99.41	217.35	2.33	31.09	66.68	51.81
	Lake A	56.23	74.85	251.32	2.54	28.36	52.98	57.05
	West Lake B	39.17	92.20	206.29	2.68	33.82	57.50	54.67
	N-S Lake B	53.42	76.84	203.67	1.57	23.96	40.92	24.24
owe.	Lake A	66.14	92.38	308.83	1.98	34.07	63.38	50.21
-	West Lake B	72.73	70.93	263.07	1.59	28.07	31.73	44.07
		Maximum						
	N-S Lake B	131.00	2220.00	1255.00	11.00	447.00	1860.00	885.00
Jpper	Lake A	125.00	200.00	423.00	5.40	58.00	110.00	140.00
	West Lake B	90.00	182.00	284.00	5.60	66.00	105.00	102.00
	N-S Lake B	101.00	179.00	331.00	4.60	59.00	110.00	83.00
owei	Lake A	90.00	138.00	343.00	5.60	54.00	132.00	71.00
-	West Lake B	92.00	90.00	288.00	2.00	34.00	40.00	51.00
				Minim	um			
Jpper	N-S Lake B	16.00	14.00	40.00	0.60	3.00	17.00	2.64
	Lake A	14.00	6.00	110.00	0.80	6.00	0.60	11.00
	West Lake B	12.00	27.00	89.00	0.80	4.00	25.00	23.00
	N-S Lake B	10.00	15.00	54.00	0.70	3.00	19.00	3.00
owei	Lake A	22.00	55.00	219.00	1.30	11.00	39.00	23.00
	West Lake B	60.00	54.00	245.00	1.00	15.00	27.00	39.00



APPENDIX C



Solid symbols = Lower Aquifer Samples





Solid symbols = Lower Aquifer Samples





Solid symbols = Lower Aquifer Samples



Solid symbols = Lower Aquifer Samples



Solid symbols = Lower Aquifer Samples





Solid symbols = Lower Aquifer Samples



Solid symbols = Lower Aquifer Samples



Solid symbols = Lower Aquifer Samples





- △ Transparent symbols (non-circles) = Upper Aquifer Samples
- Solid symbols = Lower Aquifer Samples
- Transparent circles = Mining pond (surface water)



- △ Transparent symbols (non-circles) = Upper Aquifer Samples
- Solid symbols = Lower Aquifer Samples
- Transparent circles = Mining pond (surface water)

Piper Diagram - 2019 Upper Aquifer



Legend 3S/2E 29F 4 3S/1E 25C 3 3S/2E 19N 3 3S/2E 19D 7 3S/2E 30D 2 MA-R 4 MA-R 3 MA-R 28 MA-P 46 MA-P 44 MA-P 42 MA-P 41 MA-P 28 MA-P 27 MA-P 10 MA-C 1 MA-K 15 MA-P 12 MA-K 18 3S/2E 29F 4

Piper Diagram - 2019 Lower Aquifer



Legend 3S/2E 19N 4 3S/1E 14B 1 3S/2E 19D10 3S/2E 19D 8 3S/2E 19D 9 3S/2E 20M 1 x 3S/1E 23J 1

Piper Diagram - 2018 Lower Aquifer



Legend
O MA-R 4
○ MA-R 3
O MA-R 28
○ MA-C 1
O MA-K 15
O MA-P 44
O MA-P 42
O MA-P 41
O MA-P 28
MA-P 27
MA-P 12
O MA-P 10
O MA-K 18
🗙 3S/1E 25C 3
△ 3S/2E 29F 4
☆ 3S/2E 19N 3
△ 3S/2E 19D 7
X 3S/2E 30D 2
△ 3S/2E 29F 4





- △ Transparent symbols (non-circles) = Upper Aquifer Samples
- Solid symbols = Lower Aquifer Samples
- Transparent circles = Mining pond (surface water)

Piper Diagram - 2017 Upper Aquifer



Legend ○ MA-R 4 MA-R 3) MA-K 15) MA-P 44 MA-P 42 MA-P 41 MA-P 40 MA-P 28 O MA-P 27 MA-P 12 MA-P 10 MA-K 18 X 3S/2E 29F 4 △ 3S/1E 13P 5 3S/1E 25C 3 > 3S/2E 19D 7 7 3S/2E 30D 2

Piper Diagram - 2017 Lower Aquifer





Piper Diagram - 2016 Lower Aquifer



△ Transparent symbols (non-circles) = Upper Aquifer Samples

- Solid symbols = Lower Aquifer Samples
- Transparent circles = Mining pond (surface water)

Piper Diagram - 2016 Upper Aquifer



Legend
O MA-P 12
O MA-K 18
🔿 MA-K 15
○ MA-R 4
○ MA-R 3
O MA-R 28
O MA-P 44
O MA-P 42
O MA-P 41
O MA-P 28
O MA-P 27
○ MA-P 10
○ MA-C 1
X 3S/1E 25C 3

Piper Diagram - 2015 Upper Aquifer



Piper Diagram - 2014 Upper Aquifer



Legend	
O MA-K 15	L
○ MA-R 4	L
○ MA-R 3	L
O MA-P 44	L
O MA-P 42	L
O MA-P 41	L
O MA-P 28	L
O MA-P 27	L
O MA-P 12	L
O MA-P 10	L
O MA-K 18	L
○ MA-C 1	L
	l
♦ 3S/2E 29F 4	l
🛆 3S/1E 13P 5	l
O 3S/2E 30D 2	
☆ 3S/2E 19D 7	

Legend

3S/2E 19D 7

△ 3S/2E 30D 2

X 3S/2E 29F 4

MA-K 15

MA-P 12

MA-P 10 MA-K 18

MA-R 4 MA-R 3

MA-P 44

MA-P 42 MA-P 41

MA-P 28

MA-C 1

3S/2E 29F 4

3S/1E 25C 3

3S/2E 30D 2 3S/2E 19D 7

🕁 3S/1E 13P 5

3S/1E 13P 5

Piper Diagram - 2015 Lower Aquifer

Legend

3S/2E 19D 9

3S/2E 19D 8

3S/2E 19D10

3S/1E 13P 7

▼ 3S/1E 14B 1 3S/1E 23J 1

▲ 3S/2E 19D 9

3S/1E 13P 8 * 3S/1E 13P 7

3S/1E 13P 6



Piper Diagram - 2014 Lower Aquifer



Piper Diagram - 2013 Upper Aquifer



Piper Diagram - 2012 Upper Aquifer



Legend
○ MA-C 1
X 3S/2E 30D 2
MA-P 44
O MA-P 42
O MA-P 41
MA-P 40
O MA-P 28
O MA-P 27
MA-P 12
O MA-P 10
MA-K 18
O MA-K 15
○ MA-R 4
O MA-R 3
3S/1E 13P 5
☆ 3S/2E 29F 4
☆ 3S/2E 19D 7
🔀 3S/1E 25C 3

Legend

3S/2E 29F 4

🔾 MA-K 15

O MA-R 4

MA-R 3

D MA-P 44

) MA-P 42

O MA-P 41

O MA-P 40

O MA-P 28

MA-P 27
MA-P 12
MA-P 10
MA-K 18
MA-C 1
☆ 3S/1E 25C 3
♥ 3S/2E 29F 4
■ 3S/1E 13P 5

3S/2E 19D 7
3S/2E 30D 2
3S/2E 29F 4

Piper Diagram - 2013 Lower Aquifer

Legend

▲ 3S/2E 19D 8

🔷 3S/1E 23J 1

★ 3S/1E 14B 1

3S/1E 13P 8

▲ 3S/1E 13P 7

▼ 3S/1E 13P 6

▲ 3S/2E 19D 9

3S/2E 19D 8

▲ 3S/2E 19D10

◆ 3S/2E 20M 1



Piper Diagram - 2012 Lower Aquifer



△ Transparent symbols (non-circles) = Upper Aquifer Samples

- Solid symbols = Lower Aquifer Samples
- Transparent circles = Mining pond (surface water)



Piper Diagram - 2010 Upper Aquifer



Legend
△ 3S/2E 29F 4
△ 3S/1E 25C 3
O MA-K 15
O MA-P 28
O MA-P 27
O MA-P 12
MA-P 11
MA-P 10
O MA-K 18
O MA-C 1
△ 3S/2E 29F 4
△ 3S/2E 19D 7
O MA-R 4
MA-R 3
MA-R 28
O MA-R 24
O MA-P 44
O MA-P 42
O MA-P 41
MA-P 40

Legend

X 3S/2E 29F 4

○ MA-R 4

○ MA-R 3

O MA-P 44

O MA-P 42

O MA-P 41

MA-P 40

3S/2E 29F 4

▽ 3S/2E 19D 7

3S/1E 13P 5

△ 3S/1E 13P 5

20

Piper Diagram - 2011 Lower Aquifer

Legend



Piper Diagram - 2010 Lower Aquifer



- △ Transparent symbols (non-circles) = Upper Aquifer Samples
- Solid symbols = Lower Aquifer Samples
- Transparent circles = Mining pond (surface water)



APPENDIX D



Durov Diagram - 2019 Sampling



O MA-K 15

Durov Diagram - 2018 Sampling







Durov Diagram - 2017 Sampling







Durov Diagram - 2016 Sampling



Durov Diagram - 2015 Sampling





Durov Diagram - 2014 Sampling







Durov Diagram - 2013 Sampling







Durov Diagram - 2012 Sampling







Durov Diagram - 2011 Sampling





Durov Diagram - 2010 Sampling



3S/1E 14B 1



APPENDIX E

Durov Diagram Well 23J1



Schoeller Diagram Well 23J1 5 Legend ★ 5/14/2019 8/21/2017 ☆ 5/11/2016 ▼ 5/26/2015 0 4/16/2014 △ 4/25/2013 2 **X** 2/8/2012 **1**1/17/2010 **+** 12/22/2009 **1/14/2009** √ 4/2/2008 △ 6/20/2007 ∑ 9/14/2006 9/29/2003 11/7/2001 8/17/2000 8/19/1998 6/4/1998 0.5 ∑ 8/20/1996 **2**/23/1995 ▼ 6/23/1994 ▽ 9/8/1992 ☆ 7/26/1990 ZD¥, * 3/27/1989 ▽ 10/24/1988 SÕ4 $HCO_3 + CO_3$ CI Mg Ca Na + K

meq/kg

Piper Diagram Well 23J1



Piper Diagram Pond P41



Durov Diagram Pond P41



Schoeller Diagram Pond P41



meq/kg

Piper Diagram 19D7




Schoeller Diagram Well19D7

Durov Diagram Well 19D7



Piper Diagram Well 19D10





Durov Diagram Well 19D10



Legend 9/3/2019 З 0 8/13/2018 $\overline{\Gamma}$ 5/22/2017 ☆ 12/1/2015 ▽ 1/13/2015 1/14/2014 ∑ 3/27/2013 2 **4/16/2012** ☆ 2/15/2011 • 6/2/2010 **11/13/2008 X** 4/1/2008 0 6/20/2007 △ 6/13/2006 **v** 4/13/2004 **X** 9/3/2003 0 8/23/2001 **♦** 8/10/2000 0.9 0.8 0.7 0.6 SO4 $HCO_3 + CO_3$ CI Mg Са Na + K

Schoeller Diagram Well 19D10

meq/kg