GROUNDWATER HYDROLOGY AND WATER QUALITY ANALYSIS REPORT FOR THE CEMEX ELIOT QUARRY SMP-23 RECLAMATION PLAN AMENDMENT PROJECT ALAMEDA COUNTY, CALIFORNIA

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GROUNDWATER HYDROLOGY AND WATER QUALITY ANALYSIS REPORT FOR THE CEMEX ELIOT QUARRY SMP-23 RECLAMATION PLAN AMENDMENT PROJECT ALAMEDA COUNTY, CALIFORNIA

1.0 Introduction

The purpose of this report is to provide an analysis of hydrology and water quality conditions for the proposed amendments to the existing SMP-23 Reclamation Plan for the CEMEX Eliot Quarry in unincorporated Alameda County, California. This technical report provides a description of existing, or baseline, conditions as well as a discussion of conditions that will exist at the site once reclamation is completed. This report also analyzes water surface, berm, and overflow spillway elevations, stormwater conveyance and retention, as well as the effects of Project silt storage in the groundwater aquifer. This report has been prepared to provide the appropriate technical data and evaluations to support the current Application for Reclamation Plan Amendment.

Section 2.0 of this report provides a summary of the proposed Reclamation Plan Amendment, also referred to as the Proposed Project. Section 3.0 presents a description of existing conditions at the Eliot Quarry related to groundwater and water quality. Section 4.0 documents the current water demand at the Site, as well as the anticipated water demand needed to implement the proposed amendments to the reclamation plan. Section 5.0 includes descriptions of conditions that will occur as a result of the Proposed Project related to pit conditions and water levels, runoff, groundwater flow, and water quality.

2.0 Project Description

CEMEX Construction Materials Pacific, LLC. ("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. 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 per 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.

Under the Eliot Quarry SMP-23 Reclamation Plan Amendment Project ("Project"), CEMEX proposes a revised Reclamation Plan that serves to adjust reclamation boundaries and contours, enhance drainage and water conveyance facilities, incorporate a pedestrian and bike trail, and achieve current surface mining reclamation standards. The planned post-mining end uses are water management, open space, and agriculture (non-prime).

Consistent with prior approvals, the Project will develop Lake A and Lake B, which are the first two lakes in the Chain of Lakes pursuant to the *Alameda County Specific Plan for Livermore-Amador Valley Quarry Area Reclamation* adopted in 1981 ("Specific Plan"). Upon reclamation, Lake A and Lake B, along with their appurtenant water conveyance facilities, will be dedicated to the Zone 7 Water Agency ("Zone 7") for purposes of water storage, conveyance and recharge management.

Lake A reclamation will include installation of a surface water diversion from the Arroyo del Valle ("ADV") to Lake A; conversion of a berm that is currently located in Lake A that blocks water to a small island to allow water to flow across the lake; installation of a water conveyance pipeline from Lake A to future Lake C (located off-site to the northwest); and an overflow outlet to allow water to flow back into ADV when Lake A water levels are high to prevent flooding in the localized area. The final surface area of Lake A will be 81 acres as compared to 208 acres in SMP-23. No further mining will occur in Lake A.

Lake B reclamation will include installation of a pipeline turn-out from Lake A, a water pipeline conduit to future Lake C, and an overflow outlet to allow water to flow back into ADV when Lake B water levels are high. The final bottom elevation of Lake B is proposed at 150 feet above mean sea level ("msl"), in order to maximize the available aggregate resource. The final surface area of Lake B will be 208 acres as compared to 243 acres in SMP-23.

To facilitate the southerly progression of Lake B, the Project includes realignment and restoration of a ±5,800 linear foot reach of the ADV. The proposed ADV realignment will result in an enhanced riparian corridor that flows around, rather than through (as currently anticipated in SMP-23), Lake B. The ADV realignment was contemplated in the Specific Plan and subject to environmental review in 1981.

Outside of Lake A and Lake B, reclamation treatment for other disturbed areas, including the Lake J excavation (not part of the Chain of Lakes), processing plant sites, and process water ponds will involve backfills and/or grading for a return to open space and/or agriculture.

The Project is a modification of an approved project. Except as outlined above, CEMEX proposes no change to any fundamental element of the existing operation (e.g., mining methods, processing operations, production levels, truck traffic, or hours of operation). A more complete description of the proposed Project is contained in CEMEX's Project Description, Revised Reclamation Plan, and other application materials provided to the County.

3.0 Existing Conditions

There are three primary mining areas at the Eliot Quarry, referred to as Lake A, Lake B, and Lake J. Lake A is located east of Isabel Avenue (State Route 84). Surface elevations around the perimeter of Lake A range from approximately 445 feet above mean sea level (ft msl) on the northeast side of the pit to approximately 415 ft msl on the southwest side of the pit. The elevation of the bottom of Lake A ranges from approximately 390 ft msl to 350 ft msl. Mining has not occurred in Lake A for approximately 10 to 15 years.

Lake B is located west of Isabel Avenue. Surface elevations around the perimeter of Lake B range from approximately 410 ft msl on the east side of the pit to approximately 373 ft msl on the west side of the pit. Mining activity is currently occurring in Lake B, with the elevation of the bottom ranging from approximately 325 ft msl to 265 ft msl, as indicated on the Revised Reclamation Plan Sheets included with the Reclamation Plan Amendment application.

Mining in Lake J, adjacent to the existing aggregate processing plant areas, began in 2014. The current surface elevation of the plant site area around Lake J is approximately 380 ft msl. As of April 2018, the mining depth in Lake J was approximately 254 ft msl.

The information presented in this section has been summarized primarily from the *Hydrostratigraphic Investigations of the Aquifer Recharge Potential for Lakes C and D of the Chain of Lakes, Livermore, California* (Alameda County Flood Control and Water Conservation District Zone 7, 2011), the *Groundwater Management Plan for Livermore-Amador Valley Groundwater Basin* (Prepared for Zone 7 Water Agency by Jones and Stokes, 2005), Zone 7 annual monitoring reports (Zone 7, 2011, 2012, 2013, 014a, 2015, 2016), and groundwater and surface water data provided by Zone 7 staff. Additional interpretation is also provided based on studies conducted by DWR (1966, 1974, 2003) and the U.S. Geological Survey (1989a), studies conducted for adjacent quarry permits (SMP-16) (Brown & Caldwell, 2004), borehole data obtained by CEMEX in 2013, and borehole data obtained by CEMEX and Zone 7 in 2018.

The discussion below is focused on the following existing hydrogeologic conditions:

- Hydrostratigraphy;
- Aquifer properties;
- Water level trends; and
- Water quality.

Each of these hydrogeologic conditions is described in detail below.

3.1 Hydrostratigraphy

<u>Setting</u>

This section describes the hydrostratigraphy in the vicinity of the Eliot Quarry. Hydrostratigraphy is a term that refers to the layering of the underlying geologic sediments (e.g. alternating layers of gravels and clays) and how that layering may affect the occurrence and movement of groundwater.

The Eliot Quarry is located within the Livermore-Amador Valley, an east-west trending inland alluvial basin located in northeastern Alameda County (Figure 1). 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 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. The Eliot Quarry is located 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 Lower 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 and Lake J. These conditions are discussed in more detail, below.

The Livermore-Amador Valley is partially filled with alluvial fan, stream, and lake deposits, collectively referred to as alluvium. The alluvium in the valley consists of unconsolidated gravel, sand, silt, and clay. Alluvial fans occur where streams and rivers from hilly or mountainous areas enter a valley and deposit very coarse sediment, primarily sand and gravel, as part of a braided stream system. The silt and clay were deposited in floodplain areas or lakes that developed at different times across the basin. The alluvium is relatively young from a geologic perspective, being deposited during the Pleistocene and Holocene geologic epochs (younger than 1.6 million years old). In the west-central area of the basin, the alluvium is up to 800 feet thick, but thins along the margins of the valley.

The southeastern and central parts of the Main Basin area contain the coarsest alluvial fan deposits. These alluvial fan deposits were formed by the ancestral and present Arroyo del 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 coarse alluvial fan deposits also comprise some of the most significant groundwater recharge areas in the Livermore-Amador Valley.

<u>Prior Studies and Interpretations</u>

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 layer up to 50 feet thick that prevents or limits the vertical migration of groundwater between the two zones. This silty clay layer is referred to as an aquitard. Based on the evaluations and analysis presented in this report, 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 areas where these variations occur, the aquitard is referred to as “leaky” because it allows groundwater to be transmitted between the two aquifers.

As stated in *Hydrostratigraphic Investigations of the Aquifer Recharge Potential for Lakes C and D of the Chain of Lakes, Livermore, California* (Zone 7, 2011, page 5), the two aquifer zones are designated as the:

> "Upper Aquifer Zone – The upper aquifer zone consists of alluvial materials, including primarily sandy gravel and sandy clayey gravels. These gravels are 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 at about 80 to 150 ft 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."

and:

> "Lower Aquifer Zone – All sediments encountered below the clay aquitard in the center 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."

Recent investigations conducted on behalf of Zone 7 have been used to refine the interpretation of subsurface conditions based on specific stratigraphic depositional sequences, or the specific layering of the sediments that occur from changes in the conditions at the time the aggregate material was deposited. The 2011 Zone 7 study cited above describes four main stratigraphic sequences. From shallowest to deepest, these sequences are referred to as the Cyan Unit, the Gray Unit, the Purple Unit, and the Red Unit. The Cyan Unit corresponds with the Upper Aquifer Zone, as described above. The Gray Unit, Purple Unit, and Red Unit correspond collectively to the Lower Aquifer Zone.

Figure 2 shows the locations of several cross sections prepared by Zone 7 (2011) in the Chain of Lakes area of the Main Basin. The cross sections are shown on Figures 3 and 4. The cross sections show the relationships between the various aquifer zones and units. They also show the projected future depths of several of the mining pits that will become part of the Chain of Lakes, including Lake B and Lakes C and D being mined by Vulcan Materials Company immediately north of Lake B. Lakes C and D are part of Alameda County Surface Mining Permit and Reclamation Plan No. 16 (SMP-16). The

Zone 7 cross sections provided in Figures 3 and 4 show that in the vicinity of Lakes C and D and the Eliot Quarry, the aquitard layer between the upper and lower aquifer zones (i.e. between the Gray Unit and the Cyan Unit) is thin or not present. As discussed further below, aquifer tests conducted by Zone 7 in 2011 show that the shallower aquifer units (Cyan and Gray) are in hydraulic communication with the deeper aquifer units (Purple and Red).

The aquifer materials present in the southeastern part of the Amador sub-basin were deposited by ancestral streams that flowed in the same areas from which Arroyo del Valle and Arroyo Mocho currently originate within the Livermore highlands to the south (DWR, 1966). While lakes formed intermittently in the central and western parts of the basin, the area south of Stanley Boulevard, in the current area of Lakes B, C, and D of the Chain of Lakes, was part of a large alluvial fan system emanating from the hills to the south (Alameda County Planning Department, 1979). Deposition of fine clays and silts in the lakes that formed away from the alluvial fan created the aquitard units between the main aquifers. The alternating deposition of coarse-grained aquifer materials and fine-grained aquitards materials outside of the alluvial fan resulted in the depositional sequences that were identified in the recent investigations conducted on behalf of Zone 7 (2011).

The ancestral stream channels for Arroyo del Valle and Arroyo Mocho were identified by DWR (1966). Figures 5 and 6 are copies of a part of Plates 7 and 6, respectively, from the DWR (1966) study of the geology of the Livermore Valley. Figure 5 shows the gross thickness of aquifer materials in the depth interval between 100 ft bgs and 200 ft bgs in the Amador sub-basin. The ancestral axes of the major stream depositional channels, along with the present-day alignment of Stanley Boulevard are shown and labelled on Figure 5. In the area south of Stanley Boulevard and west of Isabel Avenue, the ancestral channel of Arroyo del Valle deposited as much as 90 feet of coarse-grained aquifer material within the 100-foot interval between 100 ft bgs to 200 ft bgs. The ancestral Arroyo del Valle channel depicted on Figure 5 is located along the northern and northeastern sides of Lake B. In contrast, north of Stanley Boulevard, the aquifer material comprises only 40 percent to 60 percent of the total sediment present in the interval between 100 ft bgs and 200 ft bgs. The information presented by DWR (1966), as shown on Figure 5, suggests that the aquitards are much thicker and more consistent in the area north of Stanley Boulevard than they are in the area of Lake B. Figure 5 also indicates that the Quaternary Alluvium is not present in the depth interval from 100 ft bgs to 200 ft bgs east of Isabel Avenue and south of Alden Lane, in the area of Lake A.

Figure 6 shows the gross thickness of aquifer materials in the depth interval between the ground surface and 100 ft bgs in the Amador sub-basin. The ancestral axes of the major stream depositional channels, along with the present-day alignment of Stanley Boulevard, are shown and labelled on Figure 6. The approximate outline of the Eliot Quarry and the location of several boreholes are also indicated on Figure 6. Deposition associated with the ancestral Arroyo del Valle channel within the depth interval down to 100 ft bgs extends east of Vallecitos Road. In the western part of Lake A, the eastern part of Lake B, and along the north side of Lake B, the coarse-grained aquifer deposits comprise over 90 percent of the material deposited by the ancestral Arroyo del Valle. It is also important to note that, while the ancestral stream channel follows the current stream channel in the Lake A area, it turns to the north in the Lake B area and then parallels the current location of Stanley Boulevard.

<u>CEMEX Investigations and Interpretations</u>

In April 2013, CEMEX drilled and logged 22 boreholes at the Eliot Quarry. The boreholes were drilled using a Becker Hammer drill rig. The borehole locations are shown on Figure 7. Five boreholes were drilled along the west and south sides Lake A, 14 boreholes were drilled around the perimeter of and within Lake B, and three boreholes were drilled in the existing plant area (Lake J). At Lake A the boreholes were drilled to depths of 110 feet below ground surface (ft bgs) to 200 ft bgs, corresponding to elevations of approximately 320 ft msl down to 220 ft msl. At Lake B the boreholes were drilled to depths of 200 ft bgs to 220 ft bgs within the pit and 280 ft bgs to 300 ft bgs around the perimeter, corresponding to elevations of approximately 136 ft msl down to 96 ft msl, except for the two shallow holes within the pit, which were drilled to 50 ft bgs and only reached an elevation of approximately 250 ft msl. In the plant area the boreholes were drilled to depths of 280 ft bgs to 290 ft bgs, corresponding to elevations of approximately 100 ft msl and 90 ft msl, respectively. Detailed borehole logs are provided as an Appendix to the Revised Reclamation Plan submittal by CEMEX.

In May through July 2018, CEMEX and Zone 7 jointly drilled four boreholes around the perimeter of Lake B and one borehole to the west of Lake A. The borehole locations are shown on Figures 8, 9, and 10 and are designated 2017-A through 2017-E, with the year 2017 representing the year in which CEMEX applied for drilling permits. At each location, a sonic drilling rig was initially used to obtain geologic cores to provide a visual understanding of the vertical distribution of coarse and fine-grained deposits. The sonic core holes were drilled to depths ranging from 250 ft bgs to 283 ft bgs, corresponding to elevations of approximately 166 ft msl to 121 ft msl. After the sonic core holes were drilled and plugged, a second set of borings were drilled at the same locations using a mud-rotary rig so that electric (geophysical) logs could be obtained from each borehole.

The mud-rotary holes were drilled to depths ranging from 220 ft bgs to 360 ft bgs, corresponding to elevations of approximately 197 ft msl to 21 ft msl. Natural gamma ray and self-potential logs were obtained from each of the mud rotary boreholes, in addition to long-normal, short-normal, and single-point resistivity logs. A detailed evaluation of the drilling, geologic core, and electric logs is provided in *Clay Bed Modeling, Eliot Quarry-CEMEX Aggregates, Alameda County, California* (Jeff Light Geologic Consulting, 2018).

Zone 7 had previously raised concerns regarding the ability of the 2013 Becker Hammer drilling method to accurately identify clay layers in the subsurface, even though this method is commonly used in the aggregate industry for geologic modeling of the distribution of lenses of sands, gravels, and clays. The 2018 drilling program was conducted, in part, to address the concerns of Zone 7. Evaluation of the logs from the sonic cores, the cuttings logs from the mud rotary holes, and the electric logs from the mud rotary holes indicates the following:

1. The sonic cores provide the highest detail and greatest resolution of the variations in the stratigraphy, with the ability to easily discern clay layers that are much less than one-foot thick.
2. The cuttings logs from the mud rotary holes have the lowest resolution and occasionally miss important stratigraphic changes;
3. The electric logs provide a reasonable representation of subsurface conditions but they can be difficult to interpret in the absence of core data. For example, in several instances, the electric logs were unable to detect clay layers up to two feet thick that were readily apparent in the sonic cores.

Based on these observations, a comparison was made between the percent of clay identified in the logs from four different series of boreholes, including the 2013 Becker Hammer logs, the electric logs from 86-series and 2012-series of boreholes obtained by Zone 7, and the sonic core logs from 2018. The comparison is presented on Figure 11, which shows the range in the percent of clay identified in each borehole from each series of boreholes. The data presented on Figure 11 demonstrate that there is no perceptible bias in the percent of clay identified in any of the different series of boreholes. More specifically, the range of clay percentage identified in the 2013 Becker Hammer logs falls within the same range as the clay percentage identified for all other series of boreholes. The data presented on Figure 11 clearly demonstrate that there is no defensible scientific basis to selectively disregard any of the available borehole data. As a result, the cross sections shown in Figures 8, 9, and 10 (Cross Sections A-A', B-B', and C-C', respectively), and the interpretations presented below, are based on all of the available data. The cross section locations are shown on each figure.

Cross Section A-A’ (Figure 8) extends from the processing plant area at the Eliot Quarry, near Stanley Boulevard, toward the southeast through Lake B and along the south side of Lake A to Vallecitos Road. In the Lake A area, the sand and gravel deposits that constitute the Quaternary Alluvium are approximately 100 feet thick, as indicated in boreholes 2017-E, BH2013-17, BH2013-19, BH2013-20, and BH2013-21. The alluvium is underlain by deposits that consist of gray and blue clays, partially-cemented gravels, and tuffs (volcanic ash). The deposits that are present beneath the alluvium are consistent with the description of the Lower Livermore Formation as defined by Barlock (U.S. Geological Survey, 1989a). The relatively thin Quaternary Alluvium in the Lake A area was also identified by DWR (1966), as indicated on Figures 5 and 6, which do not show the presence of alluvial deposits from ancestral Arroyo del Valle east of Isabel Avenue in the depth interval from 100 ft bgs to 200 ft bgs, but do show the occurrence of these deposits and the course of the ancestral streambed in the depth interval from the ground surface down to 100 ft bgs.

In the area of Isabel Avenue, between boreholes BH2013-17 and BH2013-1, the sand and gravel deposits of the Quaternary Alluvium become much thicker due to the presence of a major erosional unconformity. As indicated on Figure 8, the thickness of the alluvium is at least 300 feet in the area of Lake B. However, the total thickness of the alluvium is unknown because none of the boreholes drilled in the Lake B area encountered the base of the alluvium.

The depth ranges and interpreted lateral extent of clay and silt deposits within the Quaternary Alluvium that were encountered in the boreholes are shown on each of the cross sections (Figures 8, 9 and 10). These clay and silt deposits typically form the aquitard units in the main part of the Amador sub-basin. As shown on Figure 8, the clay and silt deposits under Lake B are primarily thin and discontinuous. For example, there is a substantial variation in the thickness and extent of the clay units encountered in boreholes 2017-C, BH2013-5, BH2013-4, and 2017-B, which are located across a distance of less than 2,000 feet. In addition, the sonic core logs from boreholes 2017-B and 2017-D, located on opposite sides of Lake B and about 1,800 feet apart, show substantial differences in the thickness and number of clay units encountered. Furthermore, the sonic core log from borehole 2017-B encountered appreciably less total thickness of clay than did borehole BH2013-4, even though these two boreholes are less than 350 feet apart.

The approximate depth range of the various aquifer and aquitard units identified by Zone 7 (2011) are indicated along the left side of Cross Section A-A’ on Figure 8. It is readily apparent that there are not any continuous aquitard units present across the entire area of Cross Section A-A' and that the various aquifer units are in hydraulic communication with each other (meaning that the sand and gravel deposits are interconnected and not separated by low-permeability, fine-grained material).

Cross Section B-B' (Figure 9) extends from near the southeast corner of the Main Silt Pond on the Eliot Quarry toward the south-southeast along the northeast side of Lake B and eventually crosses Lake B near the east end of the pit, approximately 1,500 feet west of Isabel Avenue. The bottom of borehole BH2013-1 encounters the unconformity between the Quaternary Alluvium and the Lower Livermore Formation discussed above and shown on Figure 8. The Lower Livermore Formation was not encountered in BH2013-8 on the south side of Lake B, which was drilled to a depth that is 35 feet deeper than BH2013-1. The Lower Livermore Formation was also not encountered in boreholes BH2013-2, 2017-B, and BH2013-3 to the north-northwest of BH2013-1. Thus, BH2013-1 is interpreted to have encountered a ridge or "nose" on the surface of the unconformity that projects under Isabel Avenue in the vicinity of that borehole. Field reconnaissance conducted by staff and consultants for CEMEX in May 2014 confirmed that the Lower Livermore Formation is not present in the east wall of Lake B (personal communication, Joseph Renner, Kane GeoTech, May 8, 2014).

The four boreholes drilled in 2013 and 2017 that are shown on Figure 9 consist predominantly of sand and gravel. Clay or silt layers were not identified in BH2013-8. Clay or silt layers were also not identified in BH2013-2 below an elevation of 360 ft msl. In boreholes BH2013-1 and BH2013-3, relatively thin fine-grained layers were logged at approximately 165 ft msl and 175 ft msl, respectively, but these layers were not encountered in the nearest adjacent boreholes. Borehole 2017-B is located within 750 feet to 800 feet of both BH2013-2 and BH-2013-3. However, there is no correlation at all between the clay layers encountered in each of these three boreholes, further illustrating the discontinuous nature of clay deposits within the braided stream deposits in the alluvial fan present at the Eliot Quarry.

The north end of Cross Section B-B' (Figure 9) occurs at the borehole for the 13P well cluster drilled for Zone 7 in 2010. The 2013 boreholes drilled for CEMEX extended to a maximum depth of approximately 300 feet, or an elevation of 100 ft msl. However, the 13P borehole was drilled to a maximum depth of 618 feet, or an elevation of -239 ft msl, substantially deeper than the proposed maximum depth of mining in Lake B. As shown on Figure 9, silts or clays were not encountered in the 13P borehole between approximately 325 ft msl and approximately 95 ft msl. A silty sand and gravel unit was encountered from approximately 95 ft msl to approximately 55 ft msl. This silty sand and gravel unit may function as an aquitard, or be laterally equivalent to a finer-grained aquitard layer toward the center of the sub-basin. However, fine-grained units that could potentially function as aquitards were not identified on the log for the 13P borehole from 325 ft msl to 95 ft msl, which is more than 50 feet below the proposed maximum mining depth for Lake B.

The borehole logs shown on Cross Section B-B' (Figure 9) indicate a substantial lack of fine-grained units above an elevation of 100 ft msl. Thus, there is no indication of the occurrence of any laterally continuous aquitard layers along the east and northeast side of Lake B within the proposed mining depth. This finding is consistent with the interpretation presented by DWR (1966), as shown on Figures 5 and 6. JLGC's interpretations (JLGC 2018) are also consistent with the DWR (1966) findings. Cross Section B-B' roughly follows the path of the ancestral Arroyo del Valle channel and represents the area where the thickest and most continuous deposits of coarse-grained material exist within the Amador sub-basin. The information presented on Figure 9 clearly demonstrates that there are no confining layers in the area represented by Cross Section B-B' and that the Upper and Lower Aquifer Zones, as well as each of the depositional sequences from the Cyan Aquifer down to at least the Purple Aquifer are in direct hydraulic communication along the east and northeast sides of Lake B. The Zone 7 (2011) designated aquifer and aquitard intervals are shown along the left vertical axis of Cross Section B-B' on Figure 9.

Cross Section C-C' (Figure 10) extends along the Arroyo del Valle channel and south side of Lake B eastward to the west end of Lake A. On the east side of this cross section, the major erosional unconformity between the Quaternary Alluvium and the Lower Livermore Gravels is present in borehole 2017-E, as previously described in the discussion of Cross Section A-A', above. On the west side of Isabel Avenue, at borehole BH2013-8, the ancestral Arroyo del Valle channel is present, as indicated by the complete lack of observed fine-grained silt or clay deposits. Moving away from the location of the ancestral arroyo channel toward the west, thicker and more continuous silt and clay layers are present, and may become consistent aquitard layers away from the Eliot Quarry. The most continuous clay layers and lenses occur within the general range of 295 ft msl down to 240 ft msl. These discontinuous clay layers and lenses are laterally equivalent to the aquitards separating the Upper and Lower Aquifer Zones and have also been referred to as the Cyan-Gray Aquitard (Zone 7, 2011). A shallower fine-grained zone, up to 40 feet thick, is also present within the Upper Aquifer Zone (also referred to as the Cyan Aquifer) to the south of the current Arroyo del Valle channel. In the interval between 250 ft msl and 150 ft msl, however, only thin and/or discontinuous fine-grained deposits are observed and there are not any laterally consistent aquitard zones present. The presence of the thicker and more continuous aquitard zones at the west end of Cross Section C-C' is consistent with the interpretations of DWR (1966). As shown on Figures 5 and 6, the percentage of coarse deposits present in the depth ranges between 100 ft bgs to 200 ft bgs and between ground surface and 100 ft bgs, respectively, increases rapidly toward the southwest, across the axis of the ancestral Arroyo del Valle channel.

Field observations made by EMKO and JLGC as part of the evaluations presented in this report also reveal that shallower clay layers are either not present at the Eliot Quarry or are discontinuous. For example, continuous clay layers and discontinuous clay lenses have not been observed in the walls of Lake B down to an elevation of approximately 300 ft msl, as indicated on Figure 8. At Pond C, at least one clay or silt layer can be observed in some parts of the pit sidewalls, but that layer is not continuous across Pond C and is not consistently present in the sidewalls. Therefore, any past or current interpretations of subsurface conditions at the Eliot Quarry that project continuous aquitard layers through the current locations and depths of Lake B and Pond C are not consistent with conditions that have been observed in the field.

The lack of continuous aquitard layers and the hydraulic communication between the different aquifer zones and depositional sequences in the area of Lake B has also been recognized by the Alameda County Planning Department (1979) in the Specific Plan EIR. The Specific Plan EIR identifies the area between Stanley Boulevard and Arroyo del Valle as the “forebay area” and states that it is the primary recharge area for the aquifers in the Amador sub-basin. Section 3.a(3)(b) on page 15 of the Specific Plan EIR states that the area south of Stanley Boulevard, roughly coincident to the area of the Eliot Quarry and parts of Lakes C and D, is the “major forebay for the confined aquifers in the northern portion of the Santa Rita (Amador) subbasin. Groundwater recharged in the forebay moves north and west toward areas of depletion, becoming confined under pressure beneath the progressively thickening aquicludes.” DWR also states (1974, pages 67-68) that “[m]any of the aquifers merge near the course of Arroyo Valle (sic), where the combined aquifers are present as a deposit of sandy gravel up to 300 feet in thickness.” The description of the forebay area as the primary recharge area for the aquifers in the Amador sub-basin by the Alameda County Planning Department (1979) and DWR (1974) is consistent with the lack of aquitard layers under much of the Lake B area, as shown on Cross Sections A-A’ through C-C’ (Figures 8 through 10).

Additional documentation from other independent studies that concluded that the aquitard between the Upper and Lower Aquifer Zones is either discontinuous or not present in the area of the Eliot Quarry includes:

1. The California Department of Water Resources (DWR) states in *Livermore and Sunol Valleys, Evaluation of Ground Water Resources, Appendix A: Geology* (DWR Bulletin No. 118-2, Appendix A, August 1966):

    a. "…the aquicludes in the alluvium become gradually more permeable, thinner, and more difficult to distinguish on well logs toward the southeast" (page 48).
    b. "The second aquiclude becomes indistinguishable in well logs as a recognizable layer somewhat further south [of Stanley Boulevard]" (pages 48-49).
    c. "The portion of the subbasin south of [Stanley Boulevard] is the major forebay for the confined aquifers in the north portions of the…subbasin" (page 49).
2. Brown and Caldwell on behalf of Vulcan (SMP-16) at Lakes C and D in the *Final Report, Pleasanton Quarry Hydrogeologic Data Evaluation for Calmat Co. dba Vulcan Materials Company, Western Division* (Brown and Caldwell, August 2004) states that:
    a. "Increasingly thin and discontinuous clay is thus common in the forebay (recharge area) of basins" (page 7-1).
    b. "Water levels in the area of…SMP-23…appear to be consistent with the presence of a window [i.e. gap in the aquitard] between wells screened above and below [the aquitards]" (page 7-1).
3. Zone 7 states in the *Hydrostratigraphic Investigation of the Aquifer Recharge Potential for Lakes C and D of the Chain of Lakes, Livermore, California* (Zone 7 Water Agency, May 2011):
    a. "…lacustrine [aquitard] deposits at the top of the…Units appear to thin, and, in at least one case, are non-existent…to the south and east" (page 25).
    b. "The fine-grained overbank deposits within the…Units also appear to thin and/or have been completely eroded to the south and east" (page 25).
    c. "The boundary between the [Upper and Lower Aquifers] does not provide much of a hydrostratigraphic flow boundary" (page 27).
    d. "The boundary between the…Units appears to be less of a hydrostratigraphic flow boundary in the study area than it is to the north" (page 28).
    e. "The aquitards…that act as vertical flow boundaries appear to thin or are completely eroded to the south and east…" (page 28).
    f. "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" (page 5).

As demonstrated above, there is substantial evidence, based on multiple studies conducted by DWR, USGS, Zone 7, and consultant reports from other nearby mining operations, that the clay layers at the Eliot Quarry are discontinuous and do not act as aquitards separating the Upper and Lower Aquifer Zones.

3.2 Aquifer Properties

The aquifer properties addressed in the discussion below are the transmissivity and the storativity of the aquifer units. The transmissivity is a measurement of the ability of the aquifer to transmit water and is correlated to the permeability of the geologic material and the thickness of the aquifer. The storativity is a measurement of how much water the aquifer will provide when pumped, expressed as a fraction of the total volume of the geologic material and void space that comprises the aquifer.

As part of the *Hydrostratigraphic Investigations of the Aquifer Recharge Potential for Lakes C and D of the Chain of Lakes, Livermore, California* (Zone 7, 2011), Zone 7 installed new monitoring wells and conducted an aquifer pumping test with grant funds from the California Department of Water Resources. The maximum, minimum, and average aquifer parameters identified by the interpretation of the pumping test results are summarized in Table 1. During the aquifer pumping test, drawdown was observed in the shallower aquifer units (Cyan and Gray) as a result of pumping in deeper units (Purple and Red). The apparent hydraulic connection between the shallower aquifer units and the deeper aquifer units is consistent with the occurrence of thin or discontinuous aquitard units in the area of Lake B. This observation is also consistent with the discussion of the clay layers and lenses presented in Section 3.1, above.

Table 1. Aquifer Properties.

PARAMETER	UNITS	MAXIMUM	MINIMUM	AVERAGE	BEST FIT
Transmissivity (T)	Feet squared per day (ft^2/d)	6900	2400	4600	4350
Storativity	Unit-less	0.001	0.00012	0.0007	0.0007

To provide a more accurate representation of aquifer properties for the Lake B area, analytical simulations were conducted by EMKO in May 2013 to simulate the drawdown conditions in Lake B that occurred as a result of dewatering. Dewatering rates in 2012 and 2013 were reported by CEMEX to be approximately 3,400 gpm. As discussed further in Section 3.3, the average groundwater elevation around the perimeter of Lake B was 360 ft msl, whereas the elevation of the water in the west end of Lake B was about 280 ft msl, as measured by Zone 7 in 2012 and 2013. Thus, the maximum drawdown from dewatering was about 80 feet. In addition, the depth to groundwater as measured in the April 2013 boreholes suggests that at a distance of approximately 3,600 feet from the deepest part of the pit, the groundwater elevation was about 320 ft msl, equivalent to a drawdown of 40 feet.

The analytical model prepared by EMKO to simulate the drawdowns due to dewatering is based on the Theis equation and was run in an Excel spreadsheet using approximations for the Well Function (Wu). The model was run for the average, maximum, and minimum transmissivity values shown in Table 1. The results from these initial runs were then used to identify the best-fit transmissivity and storativity values for the observed conditions described in the paragraph above. As indicated in Table 1, the best-fit transmissivity value is 4,350 ft^2/d.

A sensitivity analysis was also conducted for the range of storativity values. The sensitivity analysis simulations were conducted using the best-fit transmissivity, comparing predicted drawdowns at 330 feet and 3,600 feet from the center of pumping for various pumping durations. The difference in the predicted drawdowns for the maximum storativity value of 0.001 and the average value of 0.0007 vary by only four to eight percent. The difference in the predicted drawdowns for the minimum storativity value of 0.00012 and the average value of 0.0007, however, vary by 18 to 38 percent. Smaller storativity values (e.g. 0.00012) result in higher predicted drawdowns whereas larger storativity values (e.g. 0.001) result in lower predicted drawdowns for the same transmissivity and pumping rate. The sensitivity analysis for storativity indicates that the average value provides an appropriately conservative (i.e. does not over-estimate drawdown as the minimum value of 0.00012 might) and stable value for this parameter.

The analytical model was also used to estimate more recent dewatering rates. The most recent time for which water levels in both the bottom of Lake B and in surrounding wells is available is September 2017 (Zone 7, 2018). At that time, the reported water level in the bottom of Lake B was 282 ft msl, comparable to the elevations reported in 2012 and 2013, as described above. The average groundwater elevation around the perimeter of Lake B was 365 ft msl in September 2017, whereas the groundwater elevation at a distance of approximately 2,300 feet away from Lake B was 350 ft msl. Thus, there was approximately 83 feet of drawdown within Lake B and 68 feet of drawdown at a distance of 2,300 feet from Lake B. Based on these values, the analytical model indicates the dewatering rate at Lake B was approximately 3,650 gpm in late 2017. The maximum depth of mining and the amount of water to be removed from Lake B has not changed appreciably since late 2017, so the current dewatering rate is anticipated to be in the same range as that estimated for late 2017.

3.3 Water Level Trends

For the purpose of evaluating groundwater levels, a distinction must be made between operating and non-operating baseline conditions. Operating baseline conditions are what can be observed at the Eliot Quarry at this time, with current topography and on-going mining and dewatering. In comparison, non-operating baseline conditions would occur if mining and dewatering were to cease while the current topography exists.

Existing groundwater conditions (i.e. operating baseline conditions) are affected by dewatering at SMP-23 and SMP-16, which substantially alters the groundwater levels north of Arroyo del Valle and west of Isabel Avenue. As discussed in more detail below, south of the arroyo and east of Isabel Avenue, groundwater levels reflect natural climatic and arroyo flow patterns, whereas in the areas affected by current dewatering the groundwater levels are maintained at artificially low elevations to facilitate aggregate mining.

The discussion below also addresses the potential water levels that would occur in the various excavations at the Eliot Quarry if mining and dewatering were to cease under current baseline topographic conditions (i.e. non-operating baseline conditions). As described further below in this section, in some excavations, the baseline water level trends and fluctuations would be contained by the existing topography. However, in other excavations, the baseline water level trends would result in discharge of water during certain times when the water level fluctuations would exceed the minimum existing topographic elevation at the perimeter of these excavations.

<u>Operating Baseline Conditions</u>

Water level data were requested and received from Zone 7 in May 2013 for 17 wells in the vicinity of Lake A and Lake B. More recent water level data have been obtained from Zone 7 annual monitoring reports (Zone 7, 2014a, 2015, 2016). Figure 12 is a hydrograph of the water levels measured in the 17 wells from which data were obtained from Zone 7. The well designations are listed in the legend of Figure 12. The well locations are shown on Figure 13, which is a copy of Figure 3.2-1 of the 2011 Annual Report from Zone 7, which is available on the Zone 7 website (http://www.zone7water.com/). The wells are designated based on the township, range, section, and 16th-section designation in accordance with California Department of Water

Resources standards. For example, well 3S-2E_30D02, as listed in the legend for Figure 12, is located in Township 3 South, Range 2 East, in the northwest corner of Section 30 (Mount Diablo Base and Meridian). For brevity, this well is referred to as well 30D2 in this report.

Water level records are available for two wells (13P1 and 20M1) since 1948 and from an additional well (23J1) since 1958. The water level data show that in most wells, the water levels have tended to fluctuate based on rainfall patterns. For example, significant dry periods in the late 1980s-early 1990s, in the early 2000s, and for the most recent drought period are reflected in lower water levels at many locations. There are, however, exceptions to this pattern. Water levels in wells 29F4 and 30D2 show very little fluctuation over time. These two wells are both completed in the upper aquifer and located east of Isabel Avenue adjacent to the Arroyo del Valle.

To provide a closer focus on more recent water level trends, Figure 14 shows the water level data for the same 17 wells since 1999. This figure provides an even clearer depiction of the wells with relatively stable water levels and those with more cyclical water levels. The wells with water levels above 350 ft msl tend to exhibit more stable and less cyclical water levels over time. These wells include 23J1, 25C3, 20M1, 29F4, 30D2, and 30G1, which are all located south of the Arroyo del Valle or east of Lake A. The data indicate that these six wells are in locations that are not affected by dewatering and pumping activities within the main groundwater basin. These characteristics may be attributed to wells located in recharge areas, wells located some distance upgradient of groundwater extraction areas, or wells completed within the Lower Livermore Formation, beneath the alluvium.

The water levels for the other 11 wells shown on Figures 12 and 14 typically have a dual cyclical pattern. As discussed above, long-term cycles are related to climatic changes such as wet periods and drought periods. Annual cycles are due to recharge during the wet season and extraction during the dry season. Peak water levels generally occur between March and May each year, and minimum water levels generally occur in August or September. The long term climatic cycles can result in water-level changes of up to 100 feet. The annual cycles typically range in magnitude from about 15 feet to 40 feet.

There are two well clusters included in the data evaluated for this study. Well cluster 13P5 through 13P8 is located just north of Lake B, between the SMP-23 main silt pond and future Lake D. Well cluster 19D7 through 19D10 is located along Isabel Avenue east of future Lake C. In each cluster, the screened interval is deeper with the higher number designation (i.e. 13P5 is the shallowest well and 13P8 is the deepest). At both clusters, the screened intervals correlate to the Cyan, Grey, Purple, and Red aquifer zones, respectively, as indicated on Figure 3. At both well cluster locations, the water levels show a downward vertical gradient, except between the Gray and the Purple units. Thus, the groundwater elevation in the Cyan unit is typically at a higher elevation than that in the Gray unit, and the water level in the Gray unit is typically higher than that in the Red unit, while the water level in the Purple unit is typically between that measured in the Cyan and Gray units.

Zone 7 also measures the water surface elevation in various ponds and mine pits in the Chain of Lakes area. Figure 15 shows the water surface elevations measured in these ponds in 2011, prior to the beginning of the most recent drought. Comparison with water levels in the same ponds at Lake A, adjacent to Lake B, and at Shadow Cliffs Lake in the fall of 2015 (Zone 7, 2016, Figure 5-9) indicates that the water levels have changed by less than two feet over this time period. For example, Ponds P41 and P28 are the eastern and western mine pits, respectively, at Lake A. The 2011 and 2015 measurements, respectively, in these ponds is approximately 409 ft msl versus 410 ft msl in P41 and 401 ft msl versus 403 ft msl in P28. Ponds K18 and P12 (also referred to as Lake Boris and Island Pond, respectively) are located along the channel of the Arroyo del Valle south of Shadow Cliffs, west of Lake B. The water surface elevation in these two ponds has remained relatively stable at approximately 350 ft msl for many decades. Based on a comparison of the water levels in the ponds discussed in this paragraph with the water levels in adjacent or nearby wells south of Arroyo del Valle, the water surface in the ponds described above appears to coincide with that of the groundwater in the shallow aquifer (Cyan zone).

Based on groundwater contours prepared by Zone 7 (2012, 2013, 2014a, 2015, 2016) and the observed elevation of seepage along the east and south sides of the existing mine pit, the elevation of the groundwater surface at the existing perimeter of Lake B appears to remain relatively constant at approximately 360 ft msl. Groundwater flow into the pit occurs primarily along the south side, and to a lesser extent along the east side. The north and west sides of the current Lake B pit are adjacent to former silt ponds and seepage into the pit is not observed in these areas.

Pond P42 is the sump at the western end of Lake B, which represents the depth from which the groundwater is pumped for dewatering of the mine. The water level in the pit has ranged from about 278 ft msl to 290 ft msl in prior years. In October 2015, however, the water level had dropped below 270 ft msl (Zone 7, 2016).

The water level trends appear to 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 remain 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. Ponds that are not breached are generally not hydrologically connected at the surface with the arroyo. Zone 7 (2012, 2013, 2014a, 2015, 2016) 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 a losing stream, changes in stream flow may affect the amount of recharge and alter the groundwater table, but changes in the groundwater table do not affect or alter the amount of flow in the stream because the groundwater table is disconnected (i.e. below) the bottom of the stream bed.

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. 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, 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.

Non-Operating Baseline Conditions

If mining and dewatering were to cease at the current time (i.e. non-operating baseline conditions), groundwater would enter the mining excavations. As discussed in more detail in Section 5.1, and shown in Tables 5, 6, 7, and 8, if pumping ceased at this time then the groundwater level in Lake A would reach a median[1] elevation of 420 ft msl, the groundwater level in Lake B would reach a median elevation of 373 ft msl, and the groundwater level in Lake J would reach a median elevation of 330 ft msl.

At Lake A, the current minimum topographic elevation around the perimeter of the lake is 415 ft msl, in the southwest corner. Thus, under non-operating baseline conditions, overflow of water at Lake A would occur frequently, and such conditions were observed by Zone 7 staff (personal communication, Zone 7, 2017a) during the exceptionally wet winter in 2017.

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[1] **The median elevation is defined for this analysis as the elevation at which half the measurements in the historic water level record are lower and the other half of the measurements in the historic water level record are higher. Thus, 50 percent of the time, water levels will be lower than the median elevation and 50 percent of the time, water levels will be higher than the median elevation.**

At Lake B, the median water surface elevation of 373 ft msl is equal to the existing minimum topographic elevation around the perimeter of the lake, along the west side. Thus, if all mining and dewatering were to cease, under existing topographic conditions groundwater may overflow from Lake B toward the west into the plant area approximately 50 percent of the time.

At Lake J, the surrounding ground surface is much higher than the anticipated maximum groundwater elevation, such that overflow from Lake J would not occur under non-operating baseline conditions.

Other existing excavations at the Eliot Quarry include the main silt pond, two freshwater ponds, Pond C and Pond D. The range of water surface elevations and topographic control for these ponds is identified in Table 5 for baseline topographic conditions and assuming that all mining and dewatering were to cease. For the main silt pond, the water level will recover to a median elevation of 350 ft msl, which is below the current minimum surrounding topographic elevation of 368 ft msl, so there would be no anticipated overflow under non-operating baseline conditions. For the freshwater ponds, the water level will recover to a median elevation of 372 ft msl, which is slightly below the current minimum surrounding topographic elevation of 376 ft msl. Thus, there could be some limited overflow from the freshwater ponds under non-operating baseline conditions.

For Pond C, the water level will recover to a median elevation of 370 ft msl, which is higher than the current minimum surrounding topographic elevation of 350 ft msl on the west end of the pond. Thus, if mining and dewatering were to cease under existing baseline topographic conditions, water from Pond C would overflow into Pond D most of the time.

For Pond D, the water level will recover to a median elevation of 370 ft msl, which is higher than the current minimum surrounding topographic elevation of 347 ft msl on the northeast side of the pond. Thus, if mining and dewatering were to cease under existing baseline topographic conditions, water from Pond D would overflow into Lake D (Vulcan SMP-16) most of the time.

3.4 Existing Water Quality

Water quality data were obtained from Zone 7 for wells and surface water locations in the vicinity of the Eliot Quarry. Figures 13 and 15 show the locations of wells and surface water bodies that are sampled by Zone 7 throughout the groundwater basin and Chain of Lakes area, respectively. Only the locations shown on these figures that are near the Eliot Quarry were evaluated for this report. The water quality data are provided in Tables 2 and 3 for groundwater and surface water, respectively. The water quality data are evaluated using a combination of Stiff plots, Piper diagrams, Durov diagrams, and Schoeller diagrams. These graphical presentation and analysis tools are standard approaches for evaluating general mineral water quality data (US Geological Survey, 1989b).

For the groundwater wells and surface water sample locations evaluated, data obtained by Zone 7 for 2012 were evaluated. The 2012 samples were obtained prior to the most recent drought and, thus, represent water quality conditions during a normal climatic period, without influence from drought. Data plots for the 2012 groundwater data are provided in Appendix A. For several wells, water-quality data since the 1970s is available. To evaluate any trends or major changes in water quality over time, the data from well 13P1, located near the southeast corner of the main silt pond on the Eliot facility, were used. Data plots for the historical data evaluation of well 13P1 are provided in Appendix B. Surface water data plots are provided in Appendix C.

The 2012 groundwater data (Table 2) indicate that TDS levels range fairly uniformly from about 300 milligrams per liter (mg/L) to about 550 mg/L, as indicated on the Durov diagram in Appendix A. The pH ranges from 6.8 to 8.0, with all but two values being between 7.2 and 7.7. The predominant anion (negatively charged ion) is bicarbonate in all wells except 23J1, where chloride is the predominant anion. Calcium is the predominant cation (positively charged ion), however magnesium is slightly more predominant in wells 19D7 and 19D8, while sodium is more predominant in 25C3. The predominant dissolved solids are demonstrated by the Stiff plots in Appendix A. As shown in the Piper diagram in Appendix A, most of the data points cluster together, except for well 13P7. The Schoeller diagram demonstrates that well 13P7 has lower levels of chloride and magnesium than the other groundwater wells. The variations in TDS, pH, anions and cations between the various wells described above are within the natural range of typical water quality variations observed in the data collected throughout the groundwater basin (Zone 7, 2011, 2012, 2013, 2014a, 2015, 2016, 2017b, 2018), and do not indicate the potential for incompatible water types[2]. The findings of this analysis are consistent with those of Zone 7 (2011), which reports that

[2] Incompatible water types are those that could react due to major pH differences, or those that could result in precipitation of mineral salts if the different water types were commingled. Such reactions could result in a degradation of water quality or alter the hydraulic conductivity of the aquifer.

there are not any distinct water quality characteristics that uniquely distinguish an individual well or aquifer unit within the basin.

As stated above, the data from well 13P1 from 1971 through 2012 were also evaluated to assess variations or trends over time. Appendix B contains a Piper diagram, Durov diagram, and Schoeller diagram of the well 13P1 data. Over the 41-year period analyzed, the TDS levels in well 13P1 have ranged from 307 mg/L to 445 mg/L. All but two values are between 350 mg/L and 416 mg/L. The TDS levels tend to be somewhat higher during the low-rainfall period from approximately 1987 to 1992 than at other times. The pH ranges from 6.8 to 7.9, but does not show any correlation with wet or dry climatic periods. The predominant anion is bicarbonate and the predominant cation is calcium. The slightly increased TDS levels from 1987 to 1992 are primarily due to increased concentrations of bicarbonate and calcium. The concentrations of other anions and cations may vary somewhat over time. However, unlike bicarbonate and calcium, the variations in the other anions and cations are not consistently correlated with climatic conditions. The variations that do occur over time do not alter the overall water chemistry and water quality in a significant manner and do not result in any potential incompatibilities with other water types in the basin.

Surface water quality data are presented in Table 3, based on samples collected by Zone 7 (2013). Water quality plots are presented in Appendix C. Surface water samples were collected from the east and west parts of Lake A, the pond at the bottom of Lake B, the ponds along Arroyo del Valle at the Topcon site, Island Pond, and Lake Boris. The ponds at the Topcon Site, Island Pond, and Lake Boris are historical aggregate mining pits along Arroyo del Valle. Island Pond and Lake Boris are located south of Shadow Cliffs Lake. The surface water data suggest that the general water chemistry is slightly different at Lake A compared to downstream locations. At Lake A, the water chemistry is similar to that for groundwater in nearby wells, with TDS levels in the range of 450 mg/L to 490 mg/L, and with magnesium, sodium, and chloride present at higher proportions than at other locations. At the locations downstream from Lake A, the TDS is less than 340 mg/L, the predominant cation alternates between calcium and sodium, and the predominant anion is bicarbonate. The pH at all surface water locations ranges from 8.4 to 8.9. The general water chemistry at P42 within Lake B is comparable to the water chemistry of the surface water locations along Arroyo del Valle, especially that at Island Pond. Field observations indicate that most of the water that seeps into Lake B enters along the south side of the mining excavation, adjacent to Arroyo del Valle (e.g. see cover photo on this report showing abundant vegetation on the south wall of Lake B, adjacent to the arroyo).

The water chemistry data evaluated for this analysis indicate that the surface water related to Arroyo del Valle has a lower TDS concentration than the groundwater in the vicinity of the Eliot Quarry. The predominant anions and cations for both surface water and groundwater are comparable.

TABLE 2

Groundwater Quality Data

Parameter	Units	13P1	13P05	13P06	13P07	13P08	23J01	25C03	19D07	19D08	19D09	19D10	20M01	29F04	30D02
	Well	4/17/2012	4/17/2012	4/17/2012	4/17/2012	4/17/2012	2/8/2012	2/8/2012	4/16/2012	4/16/2012	4/16/2012	4/16/2012	2/8/2012	4/16/2012	5/30/2012
Calcium	mg/L	56	50	86	49	61	53	56	75	88	44	61	73	64	44
Magnesium	mg/L	18	22	22	12	17	30	23	51	56	15	30	33	26	22
Sodium	mg/L	48	49	34	50	52	58	69	30	32	27	44	68	38	37
Potassium	mg/L	1.8	1.7	2.0	2.0	2.1	1.0	1.3	2.1	2.3	1.4	1.8	1.7	1.9	1.9
Bicarbonate (as CaCO3)	mg/L	188	182	267	246	229	166	254	281	304	133	208	326	285	202
Sulfate	mg/L	45	45	42	40	43	13	31	22	25	10	32	53	56	43
Chloride	mg/L	80	83	69	16	56	144	96	135	152	48	97	89	42	54
TDS	mg/L	357	359	415	316	376	447	446	501	553	294	449	511	391	326
SpecificConductivity	umho/cm	623	621	704	506	628	813	763	902	988	467	735	881	657	566
pH	std units	7.4	7.4	7.3	7.7	7.3	8.0	6.8	7.2	7.3	7.4	7.3	7.6	7.6	7.7

TABLE 3

Surface Water Quality Data

Sample No.		P41	P28	P42	P10	P12	K18
Location		Lake A East	Lake A West	Lake B	Topcon	Island Pond	Lake Boris
Parameter	Units	5/29/2012	5/29/2012	5/29/2012	5/29/2012	5/29/2012	5/29/2012
Calcium	mg/L	52	35	47	25	40	36
Magnesium	mg/L	36	42	23	26	18	17
Sodium	mg/L	62	83	41	53	41	49
Potassium	mg/L	2.5	2.4	1.4	2.4	2.0	2.1
Bicarbonate (as CaCO3)	mg/L	236	216	202	173	164	138
Sulfate	mg/L	39	52	41	21	45	45
Chloride	mg/L	130	153	66	72	71	70
TDS	mg/L	457	487	339	310	313	308
SpecificConductivity	umho/cm	851	883	617	558	568	539
pH	std units	8.6	8.6	8.4	8.7	8.4	8.9

4.0 Baseline and Project Water Demand

As described in Section 2.0, the proposed Project is a change to the reclaimed conditions at the Eliot Quarry. As a result, the Project water demand includes the water anticipated to reclaim the site and the subsequent consumptive water use of the proposed reclaimed conditions, which will not be fully implemented for several decades. This section provides a comparison between the water demand of the existing baseline conditions at the Eliot Quarry and the anticipated water demand from the proposed amendments to the SMP-23 Reclamation Plan.

<u>Baseline Water Demand</u>

There is not always a clear distinction between certain reclamation actions and mining-related activities. For example, realignment of Arroyo del Valle would be conducted before mining in Lake B can extend farther to the south. While realignment of the arroyo changes the reclaimed configuration of Lake B, it is not being conducted to reclaim the Lake B mining disturbance. Thus, water use for the realignment (primarily construction-related dust control and water added to fill material to reach compaction specs) will be a mining-related water use and is not included in this analysis.

In addition, current dewatering of the Lake B and Lake J mining pits are not consumptive uses of water. The water pumped from the active excavations offsets groundwater pumping for consumptive uses such as dust control and aggregate processing, or it is routed to onsite ponds where it may percolate back into the subsurface. Evaporation from these ponds, however, is a baseline consumptive use and is discussed below.

Two different baseline consumptive water use conditions are considered in this report. The first is the consumptive water use under the current operating conditions (i.e. operating baseline conditions). The second is the consumptive water use that would occur under existing conditions if all operations ceased and water was allowed to fill the existing excavations (i.e. non-operating baseline conditions).

Current operating water uses at the Eliot Quarry include water that is used to process the aggregate and remains in the product that is shipped from the site, dust control, water provided to East Bay Regional Park District (EBRPD) to help maintain the water level in Shadow Cliffs Lake[3], water used to manufacture concrete, potable water use, and water used for landscape irrigation along the Lake A trail. Additional consumptive water demand occurs due to evaporation from existing water surfaces on the site. Water for aggregate processing, dust control, and Shadow Cliffs is supplied from ponds that hold water that is pumped from the active mining pits (Lake B and Lake J) to keep them dewatered. Based on aggregate production information provided by CEMEX (personal communication, 2013-2017 Mining Operation Annual Reports, Deborah Haldeman of CEMEX to Yasha Saber of Compass Land Group), an average of 1,182,325 tons of aggregate are produced per year at the Eliot Quarry. The produced aggregate is assumed to have a moisture content of 5 percent by weight, based on reported field capacities for such material (https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/field-capacity; https://nrcca.cals.cornell.edu/soil/CA2/CA0212.1-3.php; both accessed February 1, 2019). Therefore, approximately 44 AF/yr are shipped with the aggregate product. Dust control consumes approximately 100,000 gallons per day on average, with peak dry season dust control water use up to 128,000 gallons per day (personal communication, Grantt Franco of CEMEX to Yasha Saber of Compass Land Group, February 5, 2019). Assuming that dust control occurs for 200 days per year, the existing dust control water demand is approximately 61 AF/yr. Pumping to Shadow Cliffs is approximated at 10 AF/yr. A well located on the Project site is used to provide water for ready mix concrete and potable supply for employee restrooms. The annual use for concrete ranges from 6 AF to 9 AF based on an average annual concrete production of 90,338 cubic yards (personal communication, Michelle Bunch of CEMEX to Yasha Saber of Compass Land Group, December 4, 2018) and a water requirement of 20 gallons to 30 gallons per cubic yard (U.S. EPA, 2006; https://www.concretenetwork.com/concrete/slabs/ratio.htm; https://www.concretenetwork.com/concrete/slabs/ratio.htm; both accessed February 1, 2019). Approximately 240,000 tons of hot-mix asphalt were shipped from the site on average per year for the period 2013-2017 (personal communication, Donald Roland of Granite Construction Company to Yasha Saber of Compass Land Group, November 26, 2018). Water is not used to manufacture hot-mix asphalt, other than for dust control, which is included in the dust control estimate provided above in this paragraph.

According to the American Water Works Association (http://www.drinktap.org/consumerdnn/Home/WaterInformation/Conservation/WaterUseStatistics/tabid/85/Default.aspx, accessed 2016), water use in a commercial setting (i.e.

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[3] SMP-23 discharges to Shadow Cliffs occur pursuant to Waste Discharge Requirements Regionwide National Pollutant Discharge Elimination System ("NPDES") Permit No. CAG982001 under Order No. R2-2015-0035, as originally documented in a Notice of General Permit Coverage issued on March 25, 2003.

toilets and faucets using water-efficient fixtures) is approximately 20 gallons per worker per day. Approximately 55 persons are currently employed at the Project site (Compass Land Group 2019a, based on the production information sources cited in the paragraph above). Therefore, the anticipated potable water demand is anticipated to be 1,100 gallons per day for 200 days per year, which is approximately 0.75 AF/yr. According to CEMEX, based on irrigation parameters in the *CEMEX Lake A – Trail Corridor Revised Landscape Plan* (Teichert Materials, May 2016) and the as-built *CEMEX Lake A – Vineyard Trail Corridor Landscape Planting Summary* (Triangle Properties, 2017), approximately 0.25 AF per year are used to irrigate the recently installed landscaping along the Lake A trail. Thus, the current operational demand is approximately 125 AF/yr, based on information provided by CEMEX.

Existing water surfaces on the site include Lake A, the Main Silt Pond, the freshwater pond north of Lake B, an area in the western part of Lake B, a makeup water pond for the aggregate plant, Ponds C and D that are located east of the freshwater pond and west of Lakes C and D, respectively, and several former mining pits located along Arroyo del Valle. The existing water surface area for these features is approximately 231.5 acres, as summarized in Table 4. Evaporative loss is estimated based on an average Class A Pan evaporation rate for the region of about 63 inches per year and a lake evaporation factor of 0.7 (DWR, 1975). Thus, for the existing water surface area at the Eliot Quarry, the baseline evaporative loss is approximately 850 AF/yr.

If all operations ceased and water was allowed to fill the existing excavations, the total water surface area would be 400 acres. This total includes approximately 16 acres of former mining pits located along Arroyo del Valle and the acreages for Lake A, Lake B, Lake J, the Main Silt Pond, the freshwater pond north of Lake B, and Ponds C and D, which are shown in Table 5. The acreages and water volumes shown in Table 5 were calculated based on the elevation of what is referred to as the controlling water surface. The controlling water surface is the lower of either the median groundwater elevation in the absence of dewatering at each water body, or the elevation of the lowest point at which water could currently leave that feature. For example, once dewatering ceases, it is estimated that the median water surface elevation at Lake A will be 420 ft msl (see Section 5.1). However, the current lowest elevation around the perimeter of Lake A occurs near the southwest corner of the lake and is at 415 ft msl. Thus, if all mining and dewatering activities were stopped at this time, the water level could not rise above 415 ft msl in Lake A before spilling into Arroyo del Valle. As shown in Table 5, this would also occur at Ponds C and D, with the water in Pond C spilling into Pond C and then the water in Pond D spilling into Lake D. Under the non-operating baseline conditions, the annual evaporative loss from the 400 acres of water surface would be approximately

1,470 AF/yr and the irrigation demand for the Lake A trail landscaping would be 0.25 AF/yr.

TABLE 4. Current Operating Baseline Water Surface Areas	
Water Body	Area (Acres)
Lake A	77
Lake B	10
Lake J	0
Makeup Water Pond	1.5
Main Silt Pond	97
Pond C	4.5
Pond D	10
Fresh Water Pond	34
Quarry Ponds south of Arroyo del Valle	16
TOTAL	231.5

Thus, for baseline conditions, the total consumptive use of water ranges from 975 AF/yr for active operating conditions to 1,470 AF/yr if all mining and dewatering were to cease. The active operating baseline scenario includes 125 AF/yr for operational demand and 850 AF/yr of evaporation from existing water surfaces. The non-operating baseline scenario of 1,470 AF/yr consists of evaporation and landscaping irrigation only, since there would be no ongoing operations.

<u>Project Water Demand</u>

Water demand during reclamation will be variable. The primary water demand during construction will be primarily for dust control and to aid in compaction. In addition, reclamation will be conducted, at least in part, concurrently with mining (e.g. Lake A will likely be reclaimed while mining is occurring in Lake J). The overall annual construction water demand is anticipated to be comparable to the current dust control water use at the site, which is estimated to be approximately 61 AF/yr.

Once reclamation is completed, the total area of water surface will be 355 acres, as documented in Table 6. The annual average evaporation from this surface area will be 1,300 AF/yr, based on the parameters described in Section 4.0. Irrigation water demand will include 0.25 AF/yr for the Lake A trail and 0.45 AF/yr for the landscaping improvements that would be installed around the perimeter of Lake A (personal communication, Michael Engle of Cunningham Engineering to Yasha Saber of

Compass Land Group, January 29, 2019). Thus, the total Project water demand would be up to 1,362 AF/yr, with 95 percent of that demand being evaporation from water surfaces that would be dedicated to Zone 7 (Lake A, Lake B, Pond C, Pond D, and the Fresh Water Pond that would become part of Lake B). The large proportion of Project water demand due to evaporation demonstrates that potential additional irrigation demand that may occur on other parts of the reclaimed Project Site would be de minimis and would not affect the overall evaluation of the potential impacts related to water use.

Comparison of Baseline to Project Water Demand

The overall reclamation demand of up to 1,362 AF/yr is more than the baseline operational water demand of 975 AF/yr but less than the baseline non-operational water demand of 1,470 AF/yr if all mining and dewatering were to cease at this time.

TABLE 5

Baseline Non-Operating Water Surface Areas and Volumes

Area	**BASELINE**						
	Lowest Bottom Elevation	Average Water Surface Elevation	Controlling Water Surface	Water Surface Area (acres)	Volume (acre-feet)		
					Total Volume Ac-Ft		Baseline Use
Lake A	350	419	415 (6)	77	3,296		Lake (el 350 to 415)
Lake B	265(1)	373	373	121	7,460		Pond (Elev 265 to 373)
Lake J	254 (1)	330	330	12	520		Pond (Elev 254 - 330)
Main Silt Pond	334 (2)	350	350	97	834		Pond (Elev 334 to 350)
Pond C	310	370	350 (4)	8	194		Pond (Elev 310 - 350)
Pond D	246 (3)	370	347 (5)	31	1672		Pond (Elev 246 - 347)
North and South Fresh Water Ponds	246 (3)	372	372	39	2402		Pond (Elev 246 - 372)

(1) From April 2018 Topographic Survey
(2) From August 2018 Bathymetric survey
(3) From 2013 Bathymetric survey
ft bgs = feet below ground surface
ft msl = feet above mean sea level
(4) Pond C Avg. Water Surface is Elev 370 but perimeter low point is el 350
(5) Pond D Avg. Water Surface is Elev 370 but perimeter low point is el 347 on north side.
(6) Lake A controlling water surface is Elev 415, low point at SW corner.
Baseline conditions include the current topography and average water levels that would occur if all pumping from and to individual mining areas and ponds were to cease at this time.

TABLE 6

Reclaimed Water Surface Areas and Volumes

Lake A - RECLAMATION

Document/Permit	Maximum Mining Depth (ft bgs)	Elevation of pit bottom (ft msl)	Water Surface Area (acres) Elev 419	Volume (acre-feet) Total	Above Lake A to C pipe Elev 390	Below Lake A to C pipe Elev 390	Notes
1981 Specific Plan	80	340	165	7,900	7,900	0	
1987 SMP-23	80	340	208	9,960	9,960	0	
2013 Lake B Corrective Action Plan	NA	NA	NA	NA	NA	NA	
2014 Zone 7 Estimates [(1)]	100	320	118	4,537	4,024	513	assumes GWSE = 410 ft msl
2018 Amendment at **Avg. WS El 420**	70 (1)	350 (1)	81	3,610	2,000	1,610	

(1) From April 2018 Topographic Survey and the Cotton and Shires, Lake A Corrective Action Topo. (Elev 420 - Elev 350 = 70')

Lake B - RECLAMATION

Document/Permit	Maximum Mining Depth (ft bgs)	Elevation of pit bottom (ft msl)	Water Surface Area (acres) Elev 369 (1)	Volume (acre-feet) Total	Above Lake B to C pipe Elev 349	Below Lake B to C pipe Elev 349	Notes
1981 Specific Plan	80	340	147	2,000	0	2,000	Assumed no pipe to Lake C
1987 SMP-23	60	340	243	3,300	1,750	1,550	
2013 Lake B Corrective Action Plan	150	250	106	7,950	NA	NA	Volume at end of 2013
2014 Zone 7 Estimates [(1)]	230	150	220	35,300	6,300	29,000	Assumes GWSE = 370 ft msl
2018 Amendment **Control WS El 369**	250 (2)	150	208	28,660 (3)	4,020	24640 (3)	Avg. WS El 373; Controlling El 369

(1) Spillway Elev 369 controls since lower than Avg. WS Elev 373.

(2) From April 2018 Topographic Survey and November 2018 SMP-23 Reclamation Plan Amendment. (Elev 400 - Elev 150 = 250')

(3) Volume reduced for east-side dry and silt fill area.

Lake J - RECLAMATION

Document/Permit	Maximum Mining Depth (ft bgs)	Elevation of pit bottom (ft msl)	Water Surface Area (acres)	Volume (acre-feet) Total			Notes
1981 Specific Plan	50	330	90	4,400			Identified as Optional
1987 SMP-23	NDP	NDP	NDP	NDP			Mining to Max Depth of Agg
2013 Lake B Corrective Action Plan	NA	NA	NA	NA			
2014 Zone 7 Estimates (1)	NA	NA	NA	NA			Not included
2018 Amendment at **Avg. WS El 330**	250 (1)	360 (2)	NA (2)	NA			

(1) From April 2018 Topographic Survey and November 2018 SMP-23 Reclamation Plan Amendment. (Elev 380 - Elev 130 = 250')

(2) No water storage because final silt Elev 360 is above Avg WS Elev. 330

Pond C - 'L' shaped pond next to SMP-16 - RECLAMATION

Document/Permit	Maximum Mining Depth (ft bgs)	Elevation of top of silt (ft msl)	Water Surface Area (acres) Elev 350	Volume (acre-feet) Total			Notes
2018 Amendment Control **WS El 350**	90 (1)	330 (2)	8	125			

(1) From April 2018 Topographic Survey and Nov 2018 SMP-23 Reclamation Plan Amendment. (El 400 - El 310 = 90')

(2) Top of Silt at Elev 330. Controlling WS Elev 350 west side into Lake D.

Pond D - Rectangular pond next to SMP-16 - RECLAMATION

Document/Permit	Maximum Mining Depth (ft bgs)	Elevation of top of silt (ft msl)	Water Surface Area (acres) Elev 347	Volume (acre-feet) Total			Notes
2018 Amendment Control **WS El 347**	154 (1)	330 (1)	39	457			Avg WS Elev 370, Control Elev 347

(1) From April 2018 Topographic Survey, 2013 Bathymetic Survey and November 2018 SMP-23 Reclamation Plan Amendment. (El 400 - El 246 = 154')

(2) Controlling WS Elev 347 (LP) north side into SMP-16

Fresh Water Pond - RECLAMATION

Document/Permit	Maximum Mining Depth (ft bgs)	Elevation of pit bottom (ft msl)	Water Surface Area (acres) Elev 369	Volume (acre-feet) Total			Notes
2018 Amendment Contro **WS El 369**	144 (1)	256 (1)	18	1,030			Spillway control WS Elev 369

(1) From April 2018 Topographic Survey, 2013 Bathymetic Survey and Nov 2018 SMP-23 Reclamation Plan Amendment. (El 400 - El 256 = 144')

Main Silt Pond - RECLAMATION

Document/Permit	Maximum Mining Depth (ft bgs)	Elevation of top of silt (ft msl)	Water Surface Area (acres)	Volume (acre-feet) Total			Notes
2018 Amendment at **Avg. WS El 350**	NA	366 (1)	NA (2)	NA			

(1) From April 2018 Topographic Survey, Aug 2018 Bathymetic Survey.

(2) No water storage because final silt Elev 366 is above the Avg WS Elev 350.

General Notes

GWSE = Groundwater surface elevation in feet above mean sea level

ft bgs = feet below ground surface

ft msl = feet above mean sea level

NA = Not Applicable

NDP = Not Defined in Previous Documents

5.0 Project Effects

As discussed above, the purpose of this report is to provide an analysis of hydrology and water quality conditions for the proposed amendments to the existing SMP-23 Reclamation Plan. This section describes the anticipated conditions that will occur related to hydrology and water quality after mining is completed.

5.1 Post-Mining Water Levels in Lake A, Lake B, Pond C, and Pond D

The focus of this discussion of post-mining water levels is Lake A and Lake B, which are the first two lakes in the Chain of Lakes envisioned under the Specific Plan. Once mining is completed, groundwater levels north of Arroyo del Valle at and adjacent to the Eliot Quarry are expected to change appreciably from those that currently exist because the dewatering that is occurring at several quarry sites south of Stanley Boulevard, including Lake B, Lake J, and Lake D (separately operated by Vulcan), will cease once mining is completed. Water level data from several wells adjacent to Lake A and Lake B were obtained from Zone 7 to evaluate anticipated post-mining groundwater elevations and related water levels within Lake A and Lake B. The water levels obtained from Zone 7 include data from wells that may not be routinely reported in Zone 7 annual monitoring reports.

There are not any wells near Pond C or Pond D with a sufficiently long record to adequately evaluate post-mining water levels in those two excavations. Therefore, post-mining water levels in Pond C and Pond D have been estimated based on the Lake B water level data with an elevation adjustment based on regional groundwater contours (Zone 7, 2012, 2013, 2014a, 2015, 2016).

<u>Summary of Findings</u>

For Lake A, the following main findings relate to post-mining water level conditions:

1. Groundwater level data prior to 1993 and after 1993 are appreciably different in all three wells evaluated (30D2, 30H1, and 29F4).

2. There is no correlation between groundwater levels, rainfall, stream flow in Arroyo del Valle, and water levels in the two existing Lake A mining pits.

3. Regression analysis indicates that the data from Wells 30D2 and 30H1 measured through April 1993 can be used to generate a synthetic hydrograph of Lake A water levels applicable to post-mining conditions.

4. The synthetic hydrograph indicates that the appropriate design elevation for post-reclamation water levels in Lake A is 420 ft msl.

For Lake B, the following main findings define post-reclamation conditions:

1. After correcting for the effects of dewatering throughout the Chain of Lakes area, the locations of wells 24K1 and 25C3 appear to be consistent with the area that may reasonably represent post-mining water levels in Lake B.

2. There is a strong correlation between groundwater levels in wells south of Lake B and rainfall.

3. Wells 24K1 and 25C3 are not currently monitored and their respective data sets provide an incomplete picture of historic water levels in the area of Lake B. However, use of regression analysis provides a correlation between the relatively short data records from these two wells and the 60-year record of groundwater levels from Well 23J1 so that a synthetic hydrograph of Lake B water levels can be created.

4. The synthetic hydrograph indicates that the median water level elevation in Lake B post-reclamation would be 373 ft msl.

For Pond C and Pond D, the median post-mining water level would be approximately 370 ft msl.

The basis for the above findings are provided below.

Lake A

Evaluation of post-mining water levels for Lake A is based on water level data from Well 30D2, Well 30H1, and Well 29F4. Water level data from Well 30D2 have been measured since 1979. Water levels in Well 30H1 have been measured from 1969 to 2002. Water levels in Well 29F4 have been measured from 1976 to the present. Mining in Lake A began in late 1993 or in 1994, with dewatering beginning by 1995. Dewatering ended in 2002, except for the period from June 2008 to the end of 2009, when dewatering occurred to accommodate installation of the corrective action buttress adjacent to Lakeside Circle.

Figure 16 shows the locations of Wells 30D2, 30H1, and 29F4. Well 30D2 is located south of Arroyo del Valle and approximately 1,400 feet east of the west end of Lake A. Well 30H1 is located south of Arroyo del Valle and in approximate alignment (relative to the orientation of the groundwater contours) with the east end of Lake A. Well 29F4 is located north of Arroyo del Valle, approximately 1,100 feet east of the east end of Lake A.

Analysis of the groundwater levels in Wells 30D2, 30H1, and 29F4 indicate that there is a significant difference in the data for the period prior to 1993 and the period after 1993, as shown on Figure 17. It is uncertain if this difference is due to dewatering of Lake A, dewatering of Lake B, or realignment of Arroyo del Valle that occurred in 1993 or 1994 to accommodate mining in Lake A. Realignment of the arroyo resulted in the formation of a gaining reach of the stream toward the west end of the Lake A area, which could locally control groundwater levels. In any case, the groundwater levels in the three Lake A area wells would not have been affected by mining-related activities prior to mid-1993. Therefore, evaluation of the potential post-reclamation water levels in Lake A is based on data measured through April 1993, as shown on Figure 18.

Regression analysis of the data for all three wells demonstrates that there is a strong correlation between the data from Well 29F4 and Well 30H1 (Figure 19). The data from Well 30D2 also correlates well with the data from Wells 29F4 and 30H1 (Figures 20 and 21, respectively). Due to the correlation between the groundwater level data in all three wells, the projected water level conditions in Lake A after reclamation are based on a linear interpolation of the Well 30D2 data adjusted for the well's distance relative to the midpoint of Lake A and the difference between the groundwater levels in Wells 30D2 and 30H1. Based on this relationship, a synthetic hydrograph for the water level in Lake A was created, as shown on Figure 22 along with the measured water levels in Wells 30D2 and 30H1. The interpolated Lake A water levels range from approximately 2.4 feet to 3.1 feet greater than the water levels in Well 30D2. Table 7 shows the key statistics for the interpolated Lake A water levels.

Lake A Water Level Statistics		
Median Elevation	419.21	ft msl
Maximum Elevation	419.84	ft msl
95th Percentile	419.82	ft msl

Table 7. Lake A Water Level Statistics

Due to the relative consistency of the groundwater level data in the Lake A area wells through April 1993, there is very little difference between the median, maximum and 95^{th} percentile water level elevations. Based on the information in Table 7, the appropriate post-reclamation design water level elevation for Lake A is 420 ft msl.

Lake B

Evaluation of post-mining water levels in Lake B is based on data from Well 23J1, Well 24K1, and Well 25C3. Water level data from Well 23J1 have been measured for 60 years, from 1958 to 2018. Water levels in Well 24K1 were measured from 1978 to 1985. Water levels in Well 25C3 were measured from 1994 to 1999 and from 2007 to the present. Figure 23 shows the available groundwater level data from Wells 23J1, 24K1, and 25C3. Figure 23 also shows the annual water-year precipitation. Unlike the wells in the Lake A area, the groundwater levels in the three wells adjacent to Lake B show a strong correlation to annual rainfall.

Figure 24 shows the locations of Wells 23J1, 24K1, and 25C3. All three wells are located south of Arroyo del Valle. Well 23J1 is located to the southwest of the former mining ponds in the Topcon area. Wells 24K1 and 25C3 are aligned along the same approximate groundwater contour to the southeast of the Topcon area. The groundwater contours in the area of these three wells are affected by dewatering of Lake B, flow in Arroyo del Valle, and potentially by groundwater pumping, in addition to local rainfall.

Some existing groundwater contour maps of the region suggest that the groundwater levels at Well 23J1 may align with the east-west center of Lake B during certain periods. However, consideration of the long-term effects of dewatering at Lake B, which has been occurring continuously since approximately 2001, indicates that after reclamation is completed, Wells 24K1 and 25C3 may be aligned with the approximate median groundwater level across Lake B. Since Wells 24K1 and 25C3 have relatively short records, regression analysis was used to compare the groundwater levels from these two wells with those from Well 23J1. The regression equations were then applied to the 60-year record of groundwater level data from Well 23J1 to create a synthetic hydrograph of the interpolated Lake B water levels.

Figure 25 shows the regression analysis of the groundwater level data from Wells 24K1 and 23J1. Figure 26 shows the regression analysis of the groundwater level data from Wells 25C3 and 23J1. While both plots show a reasonable correlation, the correlation is not consistent between Well 24K1 and Well 25C3. Therefore, a different correlation factor was used for data prior to 1990 and for data from 1990 to the present to create the synthetic hydrograph. Figure 27 shows the synthetic hydrograph, along with the data from all three wells. The interpolated Lake B water levels have a range of over 40 feet and vary from one foot to more than 30 feet higher than the water levels from Well 23J1. The difference between the interpolated water levels on the synthetic hydrograph and those from Well 23J1 are much less during periods of high groundwater and are greatest during periods of low groundwater elevation. Table 8 shows the key statistics for the interpolated Lake B water levels.

Lake B Water Level Statistics		
Median Elevation	372.8	ft msl
Maximum Elevation	394.9	ft msl
95th Percentile	382.3	ft msl

Table 8. Lake B Water Level Statistics

Despite the large range in water levels, the values of the arithmetic mean, the median, and the mode for the Lake B synthetic hydrograph vary by less than 0.5 ft, indicating that the data distribution is not skewed in any significant manner.

The data presented on Figure 27 indicate that the historic low groundwater elevation in Upper Aquifer wells in the vicinity of Lake B is about 323 ft msl. This elevation is well above the current and proposed maximum mining depths in Lake B. Thus, after mining is completed and dewatering ceases, groundwater seepage from the Upper Aquifer into Lake B would prevent Lake B from becoming dry, even during extended drought periods. Evaluations conducted by Zone 7 (March 2014, Appendix D) indicate that the groundwater elevations in the Lower Aquifer are consistently deeper than those in the Upper Aquifer. Thus, it would not be possible for water levels in Lake B to drop to a level where groundwater inflow to Lake B, and subsequent evaporative losses, would occur from the Lower Aquifer. The available data demonstrate that under any climatic condition, groundwater seepage from the Upper Aquifer into Lake B would provide recharge to the Lower Aquifer, and prevent any loss of water from the Lower Aquifer.

Pond C and Pond D

For Pond C and Pond D, the median post-mining water level would be approximately three feet lower than that at Lake B and the statistical distribution would be the same as at Lake B. It should be noted, however, that water levels in Pond C and Pond D are affected by dewatering at Lake C and Lake D at the adjacent Vulcan Quarry (SMP-16). Thus, the water level in each pond could vary depending on the timing of mining and magnitude of dewatering activities at each site.

Based on the Lake B historical range of water levels and statistical distribution defined above and presented in Table 8, the median post-mining water level for Pond C and Pond D would be approximately 370 ft msl, while the maximum potential water level for Pond C and Pond D could be as high as approximately 392 ft msl (based on a 3-foot subtraction from Table 8, above).

5.2 Pit Conditions

Once mining is completed, the reclaimed conditions within Lake A, Lake B, Pond C, and Pond D must be capable of managing the groundwater that will flow into the pits across a range of conditions. This section describes the freeboard requirements and berm elevations that are recommended to address the water level conditions described in Section 5.1, along with a discussion of the relationship between water levels in the lakes relative to Arroyo del Valle.

5.2.1 Freeboard Requirements

Background

Zone 7 has suggested that the appropriate freeboard for all lakes within the Chain of Lakes is 10 feet. Zone 7 staff have stated that the basis for the 10-ft freeboard is a recommendation provided by Miller Pacific Engineering Group (2004) for Lake H, Lake I, and Cope Lake. Section V.I of the Miller Pacific report presents a Geologic Hazards Evaluation for seiches. A seiche is an oscillating wave that forms within an enclosed water body, such as a lake or a pond, due to prolonged winds or an earthquake. If the height of the oscillating wave exceeds the freeboard of the enclosed water body, then surrounding properties could be inundated.

Section V.I of the Miller Pacific report states, in part, that "The extent and severity of a seiche would be dependent upon the ground motion and the fault offset from nearby active faults. There is some potential for seiches to occur after an earthquake, especially when water levels are high. Given the probable high cost of mitigation and the low risk of damage, extensive mitigation measures are not warranted." (page 22)

Miller Pacific then provides the following seiche mitigation measure: "Maintain adequate freeboard (10 feet minimum) above the lake water level to prevent a seiche from over-topping the lake slopes." (page 22) There are no technical evaluations or calculations provided by Miller Pacific to support the "10 feet minimum" freeboard recommendation. In addition, Miller Pacific did not evaluate the height or potential run-up of wind-generated waves, even though they noted that there was visible erosion along the north and east shore of Cope Lake. The Miller Pacific recommendations are incorporated into the Operations Plan and Performance Monitoring in Section 8 of the *Management Plan for Lakes H, I, and Cope Lake* prepared by Stetson Engineering in June 2004. Based on the lack of technical analysis, the freeboard height suggested by Zone 7 appears to be arbitrary and does not appear to have any scientific or engineering basis.

Proposed Project Evaluation

To evaluate appropriate freeboard requirements for Lake A, Lake B, Pond C, and Pond D at the Eliot Quarry, EMKO conducted a literature review and technical evaluation of the potential wave heights and wave run-up on the shore of the lakes based on both seiche and wind-generated waves. Literature citations are provided at the end of this Technical Report.

Seiche waves have a specific set of periods, or frequencies, based on the water depth, lake width, and lake length. The larger the water body, the longer the oscillation period will be. In general, shorter oscillation periods result in smaller seiche waves. In addition, the set of seiche wave periods that can occur in a water body must be in the same range as the period of the seismic waves that reach the water body.

The first-order period for Lake A and Lake B were calculated using the formula developed by Sorenson (1993), as presented in Ichinose, et al. (2000):

$$T = \frac{2}{\sqrt{gh}}\left[\left(\frac{1}{Lx}\right)^2 + \left(\frac{1}{Ly}\right)^2\right]^{-1/2}$$

Where T is the first order wave period in seconds, g is the acceleration due to gravity, h is the average water depth, Lx is the width of the lake and Ly is the length of the lake. Since Pond C and Pond D are smaller than Lake A and Lake B, and to provide some consistency in terms of proposed conditions, the freeboard recommendations for Lake A and Lake B, below, are also applied to Pond C and Pond D. The following parameters were used to calculate the seiche period for Lake A and Lake B:

Parameter	Units	Lake A	Lake B
g	m/s^2	9.8	9.8
h	m	15	60
Lx	m	200	500
Ly	m	1400	1750

Table 9. Parameters Used for Seiche Period Calculation

The first-order wave period is approximately 33 seconds for Lake A and 40 seconds for Lake B. In other words, during a seiche, it would take 33 seconds for the wave peak to wash from one side of Lake A to the other and return. For comparison, in Lake Tahoe, the first-order seiche period is 1011 seconds (almost 17 minutes) (Ichinose et al., 2000) and in Lake Erie, seiche periods of up to 14 hours occur (Farhadzadeh, 2017). Large seiche waves, with amplitudes up to 22 feet, can occur on the Great Lakes and other large water bodies due to large storm events (NOAA, 2017). Seismic energy transfer to water bodies located away from the location of the seismic displacement is typically much lower than that from storms. For example, the 1964 Magnitude 9.2 Alaska earthquake did not generate seiches at distances closer than 600 miles to the epicenter (McGarr and Vorhis, 1968), most likely due to the strength of the earthquake and potential lack of seismic waves with periods appropriate to generate a seiche. At distances beyond 600 miles from the epicenter, the maximum amplitude of seiche waves was about 3 ft (id.).

Studies of potential seiches at Lake Tahoe indicate that, while large seiches could occur due to fault displacement within the lake, seismic events outside the perimeter of the lake would result in seiche amplitudes of no more than 1.5 ft for a Magnitude 7.2 earthquake (Ichinose et al., 2000). The predominant earthquake in the area of the Eliot Quarry has a magnitude of 6.6 (Geocon, 2018). Based on the relatively low wave period and the magnitude of the predominant earthquake, the maximum amplitude of a seiche wave in Lake A or Lake B would be less than 1.5 ft.

Waves can also form due to prolonged wind events. Data from the Bay Area Air Quality Management District (BAAQMD) indicates that the predominant wind direction at the Livermore Municipal Airport is from the west, with a secondary direction from approximately 15 degrees north of west, as shown on Figure 28. These directions are oriented approximately parallel to the long axis of Lake A and Lake B, respectively, indicating that the long axis of both lakes would function as the potential fetch for wind-generated waves.

Approximately 98.9 percent of wind events at Livermore are less than 29 miles per hour and 99.8 percent of wind events at Livermore are less than 36 miles per hour, as shown on Figure 29, from BAAQMD. The U.S. Geological Survey (2015) has developed an online wave height calculation tool based on equations developed by the U.S. Army Corps of Engineers (1984). The calculation tool requires input of lake length, lake depth, and sustained wind speed. The values for lake length and lake depth for Lake A and Lake B shown in Table 9 for the seiche period calculations were also used for the wind-generated wave calculations. For sustained wind speeds of 30 miles per hour (mph), the peak wind wave generated in Lake A and Lake B would be 1.2 ft and 1.1 ft, respectively. At a sustained wind speed of 40 miles per hour (mph), the peak wind wave generated in Lake A and Lake B would increase to 1.7 ft and 1.5 ft, respectively.

When waves reach the edge of the lake, the wave energy is converted to kinetic energy and causes the wave to wash up onto the shore. This is called wave run-up. The magnitude of wave run-up has recently been evaluated for a quarry in Contra Costa County (Golder Associates Inc, 2016). That analysis found that the magnitude of run-up for 2:1 side slopes (horizontal:vertical) would be approximately 1.3 times the wave amplitude. Table 10 provides a summary of the amplitude, run-up, and total height for seiche and wind-generated waves for Lake A and Lake B.

As discussed above, a 40 mph wind event occurs less than 0.2 percent of the time in Livermore. Thus, the maximum potential combined wave height due to seiche and wind-generated waves would be contained with 3.5 feet of freeboard 99.8 percent of the time at Lake A and Lake B. However, to provide an additional measure of protectiveness, it is recommended that a freeboard of 4 feet be used as a design criterion for reclamation of Lake A and Lake B. This freeboard value is based on a technical evaluation of seiche and wind-generated wave conditions for Lake A and Lake B and is, therefore, more applicable and more defensible than the arbitrary value of 10 feet that was recommended for Lake H, Lake I, and Cope Lake discussed above.

As discussed in Section 5.1, the water levels in Pond C and Pond D may vary depending on the timing and magnitude of dewatering at the Eliot Quarry and in Lakes C and D at the adjacent Vulcan Quarry. If the water level in Pond C or Pond D temporarily rises such that the recommended 4 feet of freeboard would not be maintained due to variations in mining and dewatering by CEMEX and/or Vulcan, then water can be temporarily pumped to Lake B during such an occurrence to maintain adequate freeboard. Once dewatering ceases at both quarries, this provision would no longer be needed.

Wave Type	Lake A			Lake B		
	Amplitude	Run-up	Total Height	Amplitude	Run-up	Total Height
Seiche	1.5	2.0	3.5	1.5	2.0	3.5
30-mph Wind-Generated	1.2	1.6	2.8	1.1	1.4	2.5
40-mph Wind-Generated	1.7	2.2	3.9	1.5	2.0	3.5

All values in feet

Table 10. Wave Amplitude and Run-Up Values

5.2.2 Berm and Spillway Elevations

The historic high groundwater elevations described in Section 5.1 present a challenge for design and construction of berms and spillways that will be capable of retaining groundwater that enters Lake A and Lake B, while maintaining appropriate freeboard. In addition, it is uncertain what groundwater levels will be once Zone 7 begins diverting water from Arroyo del Valle and actively recharging the Shallow Aquifer through the

Chain of Lakes. At a minimum, the berms and spillways for Lake A and Lake B should prevent the 100-yr flood on Arroyo del Valle from flowing into the reclaimed lakes.

Lake A

Based on the evaluations described in Section 5.1, for Lake A the recommended design water level is 420 ft msl, and the recommended freeboard is four feet. Thus, the Lake A minimum berm elevation should be 424 ft msl, which is above the historic peak water level elevation. Consideration may need to be given to including a spillway at 420 ft msl near the southwest corner of Lake A to address the potential for overfilling of the lake due to excess diversion of water to or insufficient release of water from Lake A. The 100-year flood elevation at the west end of Lake A is approximately 410 ft msl (Brown & Caldwell, January 2019). A spillway at an elevation of 420 ft msl will exclude flood waters from entering Lake A through the spillway and, therefore, meets the applicable design criteria.

Since the predominant wind direction is from west to east, wind-generated waves will move away from the west side of Lake A, where the berms would be at or near the minimum design elevation. The wind-generated waves would reach their maximum height at the east side of Lake A, where the minimum natural topographic elevation around the edge of the lake is greater than 430 ft msl. Thus, wind-generated waves would only impact the east end of Lake A, where the natural ground surface is well above the design elevations. In addition, the localized influence of wave run-up would occur substantially below any neighboring developments to the north of Lake A, which vary in elevation from approximately 425 ft msl on the north side of Alden Lane to over 450 ft msl at Lakeside Circle.

The spillway elevation of 420 ft msl may not provide sufficient freeboard to fully retain a seiche if one were to occur during a time when the peak water level existed in Lake A. The historic peak groundwater elevation occurred for a period of only two to three weeks in February 1980. The second-highest historic groundwater elevation in the Lake A area occurred for a period of two to three weeks in March 1991, at an elevation of 417.8 ft msl.

EMKO estimated the volume of water that would potentially overtop and flow over the Lake A spillway as the result of a seiche, assuming the initial water level in Lake A was at the spillway elevation. The first order seiche period for Lake A is 40 seconds, as described above. This means that the water level during a seiche at any specific location in the lake will exceed the normal water level for 20 seconds per wave cycle and will be less than the normal water level for 20 seconds per wave cycle. The average water height of a seiche above the spillway elevation during the 20-second timeframe above the normal water level would be 0.75 ft. The rate of flow over the spillway under these conditions would be approximately 3,855 cfs. For each 20-second overtopping event, the total volume of water that would spill into the arroyo from Lake A would be approximately 77,100 cubic feet, or about 1.77 acre-feet. Due to friction loss from wave run-up on the sides of Lake A and the loss of water over the berm, it is anticipated that the seiche would attenuate relatively rapidly. If the seiche oscillated for five periods before the amplitude became too small to result in any additional water loss, then less than 8.85 acre-feet of water would be released to Arroyo del Valle. These results are based on the predominant earthquake, ground shaking with a period comparable to that for a seiche in Lake A, and Lake A being full to the spillway level all occurring at the same time. Such a coincidental event is extremely unlikely.

Based on the above analysis, the recommended design elevation and freeboard would retain all naturally-occurring groundwater, prevent overtopping from wind-generated waves, and would only allow a minimal release of water into Arroyo del Valle in the unlikely occurrence of a seiche during the relatively brief periods that water levels would reach the elevation of the spillway.

Lake B

Various spillway or berm elevations for Lake B have been proposed over the past 37 years. The 1981 Specific Plan and 1987 SMP-23 Reclamation Plan ("approved plans") both show a spillway elevation of 360 ft msl. The current Reclamation Plan sheets show the spillway elevation at 369 ft msl. The 100-year flood elevation in the area of the spillway is just below 369 ft msl (Brown and Caldwell, January 2019). A spillway elevation of 369 ft msl is assumed to be the minimum design elevation to exclude the 100-year flood along Arroyo del Valle from entering Lake B at the spillway location. To achieve the recommended four feet of freeboard, the minimum berm height adjacent to the spillway is 373 ft msl. The berm and spillway design for Lake B are further limited by the area needed to re-align Arroyo del Valle, such that the berms along the southwest side of Lake B do not encroach into the necessary floodway for the arroyo. Taller berms would require a wider footprint given the angle of the sideslopes, which would limit the width of the re-aligned arroyo and constrain the floodplain.

Similar to Lake A, wind-generated waves will move away from the west side of Lake B, where the berms would be at or near the minimum design elevation. The wind-generated waves would reach their maximum height at the east side of Lake B, where the minimum natural topographic elevation around the edge of the lake is greater than

400 ft msl. Thus, wind-generated waves would only be impacting the east end of Lake B, where the natural ground surface is well above the design elevations.

EMKO estimated the volume of water that may spill from Lake B based on the rate of groundwater flow into Lake B. Groundwater flow is calculated using Darcy's Law, which states that the flow is equivalent to the hydraulic conductivity of the aquifer (K) times the hydraulic gradient (i), which is the slope of the groundwater surface, times the area (A) across which the groundwater is flowing:

$$Q = K * i * A$$

Zone 7 (2014b) specifies that a hydraulic conductivity of 198.5 ft/day should be used for all lakes within the Chain of Lakes. Groundwater contour maps prepared by Zone 7 (2011, 2012, 2013, 2014a, 2015, 2016, 2017b, 2018) indicate that the slope of the groundwater surface after Lake B has been reclaimed will be approximately $6.4X10^{-3}$ ft/ft (equivalent to a vertical change in the groundwater surface of 64 feet for every 10,000 feet of distance).

The current controlling (baseline) elevation for Lake B is 373 ft msl (see Sections 4.0 and 5.1). At this elevation, the total groundwater flow through Lake B would be approximately 7,900 AF per year in the non-operating baseline condition. The median Lake B water level elevation is 373 ft msl, which by coincidence is the same as the controlling baseline elevation (see Table 5). Since the actual water level is constantly fluctuating, as shown in Figure 27, the median value infers that half the time the water level will be above that elevation and half the time the water level will be below that elevation. With a maximum potential Lake B water level of about 395 ft msl, the average elevation of the water surface during the times when the water surface is above the median water level would be 384 ft msl. Based on these parameters, under non-operating baseline conditions, the average rate of overflow from Lake B would be approximately 465 AF/yr for periods when the water level is above the median. However, since the water level is above the median only half the time, the long-term average non-operating baseline overflow would be one-half that value, or approximately 235 AF/yr.

Under operating baseline conditions, there would be no overflow from Lake B since the mining excavation is dewatered.

As discussed in Section 5.1 and shown on Figure 27, the fluctuations in water levels follow major climatic cycles of 10 to 20 years. Thus, under actual conditions, there may be no overflow for a decade or more, followed by a period of several years where there may be constant overflow above the non-operating baseline controlling elevation. The annual averages described in the above and in the paragraph below are not meant to infer that overflow might occur every year. The annual averages are provided solely as a means for comparison of baseline and proposed Project conditions.

As part of the Project, the proposed spillway elevation for Lake B is 369 ft msl. At this elevation, the total groundwater flow through Lake B would be approximately 7,700 AF/yr under reclaimed conditions. Thus, the amount of water that overflows from Lake B via the spillway under Project conditions would be 200 AF/yr greater, on average, than under non-operating baseline conditions (i.e. 7,900 AF/yr minus 7,700 AF/yr). This represents only about a 2.6 percent increase in water that overflows from Lake B. Based on the Lake B water levels presented on Figure 27, water would flow over the spillway at 369 ft msl over 80 percent of the time, on a long-term basis.

There is no overflow from Lake B under operating baseline conditions.

Although not germane to the evaluation of the Project's impacts pursuant to CEQA (since existing conditions will be used to define baseline), the 200 AF/yr (or 2.6 percent) increase of water overflow under Project conditions as compared to non-operating baseline, and the total average annual overflow of 435 AF/yr under Project conditions (i.e. 235 AF/yr at 373 ft msl plus 200 AF/yr incremental additional at 369 ft msl), are much less water loss than would occur under implementation of SMP-23 with a spillway at 360 ft msl (i.e. nine feet lower than Project conditions).

5.2.3 Relationship between Lake Water Level Elevations and Arroyo del Valle

Once mining is completed in Lake A, Lake B, Pond C, and Pond D, these basins will be provided to Zone 7 for operation of the Chain of Lakes. The Chain of Lakes will be operated to recharge groundwater in the Livermore Amador Valley Groundwater Basin. Other quarries to the north of Lake B will also be part of the Chain of Lakes and operated as Lake C through Lake I. The general operation of the Chain of Lakes, as outlined in the Specific Plan, will include diversion of water from Arroyo del Valle into Lake A and then transfer of water from Lake A to Lake C for further conveyance to Lake I. Under the Specific Plan, Lake B is an ancillary lake that may provide temporary storage but is not a main component of the conveyance or recharge functions of the Chain of Lakes.

After mining is completed, there will be two significant changes to the groundwater system. The first is that dewatering of the active mining pits will cease. The second is that operation of the Chain of Lakes will result in increased groundwater recharge. These two changes are anticipated to result in more stable groundwater levels throughout the basin than have occurred in the past. While fluctuations in groundwater elevations may be reduced, there are physical constraints that are likely to limit peak groundwater levels to within the range of historic high elevations discussed in Section 5.1.

At Lake A, dewatering has not occurred for almost 10 years. The western end of Lake A is 10 to 15 feet higher than the elevation of the thalweg in Arroyo del Valle. This segment of the arroyo is already identified as a gaining reach (Zone 7, 2011, 2012, 2013, 2014a, 2015, 2016). Therefore, groundwater levels in the Lake A area are not expected to increase beyond those that have been observed historically (see Section 5.2) because any rise in the groundwater level would result in increased discharge to the arroyo and moderate the groundwater level rise.

At Lake B, the future thalweg elevation of Arroyo del Valle near the southwest part of the lake will be below the projected water level in Lake B (see Section 5.2). Once Lake B is reclaimed, the segment of Arroyo del Valle near the west end of Lake B will become a gaining stream. Thus, the maximum groundwater elevations in the Lake B area will be controlled to some extent by the elevation of the arroyo along the length of Lake B.

Pond C and Pond D are separated from the arroyo by Lake B. As a result, there is not any anticipated influence of these two ponds on flow in the arroyo, or influence of the arroyo on water levels in these two ponds.

5.3 Stormwater Runoff

An analysis has been conducted of the volume of storm water that will runoff from the Main Silt Pond (MSP), the reclaimed area of the Granite asphalt plant and site entrance (HMA area), and the combined aggregate processing plant and silt backfill area in the vicinity of Lake J (PAB area) once those locations have been reclaimed. These areas are collectively referred to as the North Reclamation Areas in the Revised Reclamation Plan (Compass Land Group, 2019b) submitted by CEMEX. The analysis was conducted using the standards provided in the 2016 version of the Alameda County Flood Control and Water Conservation District (the "District) Hydrology and Hydraulics Manual (the "Manual"). Runoff velocities were calculated for a 100-yr, 24-hr storm event and retention pond sizing was calculated based on Equation 30 in the District's Manual. Section 3706(d) of the SMARA regulations requires that erosion control and runoff features at reclaimed surface mining sites be capable of handling the runoff from a 20-yr, 1-hr storm event. At the Eliot Quarry, a 100-yr, 24-hr storm event would produce more runoff than a 20-yr, 1-hr storm event.

For the MSP, storm water runoff will move by sheet flow toward the northeast corner of the reclaimed pond, as shown on Reclamation Plan Sheet (Sheet) R-1. Final grading will result in slopes of less than 2 percent. Total area of the reclaimed MSP will be approximately 135 acres. The appropriate retention pond size for the MSP runoff is 27 acre-feet, according to Equation 30 in the District’s Manual. The MSP retention pond shown on Sheet R-1 has a capacity of 27 acre-feet. To accommodate 27 acre-feet requires a retention pond that is 10 feet deep and covers about 3 acres. County standards require 1 foot of freeboard.

Storm water runoff from the HMA area will move by sheet flow into a retention pond on the north side of the backfilled Lake J (see Sheet R-1). The final graded slopes will be less than 2 percent. Total area of the reclaimed HMA area will be approximately 32 acres. The appropriate retention pond size for the HMA area is 6 acre-feet, according to Equation 30 in the District’s Manual. The HMA area retention pond shown on Sheet R-1 has a capacity of 6 acre-feet. To accommodate 6 AF requires a retention pond that is 10 feet deep and covers less than 1 acre.

If it is determined at the time of reclamation that proper grading to direct stormwater runoff from the HMA area into Lake J by sheet flow cannot be accomplished, a 3-ft deep v-ditch with 2:1 side slopes and a 1 percent slope would be more than adequate to convey the runoff to Lake J. A ditch with these dimensions will convey the 100-yr, 24 hr storm event, which is greater than the SMARA requirement to convey the 20-yr, 1-hr storm runoff.

Storm water runoff from the PAB area will move by sheet flow into a retention pond on the south side of Lake J (see Sheet R-1). The final graded slopes in the PAB area will be less than 2 percent. Total area of the reclaimed PAB area will be roughly 93 acres. The appropriate retention pond size for the PAB area is 18 acre-feet, according to Equation 30 in the District’s Manual. The PAB area retention pond shown on Sheet R-1 has a capacity of 18 acre-feet. To accommodate 18 AF requires a retention pond that is 10 feet deep and covers approximately 2.5 acres.

If it is determined at the time of reclamation that proper grading to direct stormwater runoff from the PAB area into the retention pond on the south side of Lake J by sheet flow cannot be accomplished, a 4-ft deep v-ditch with 2:1 side slopes and 1 percent slope would be more than adequate to convey the runoff to Lake J. A ditch with these dimensions will convey the 100-yr, 24 hr storm event, which is greater than the SMARA requirement to convey the 20-yr, 1-hr storm runoff.

5.4 Silt Storage

Silt and other fine-grained material that is washed from the aggregate will be deposited in several areas of the site. The current location is the Main Silt Pond in the northeast corner of the Eliot Quarry, adjacent to Stanley Boulevard. However, prior to the completion of the Project, the Main Silt Pond will become filled and additional capacity will be required in other locations. These locations include Lake J and Ponds C & D along the east side of the Eliot Quarry, located adjacent to Lakes C & D, respectively. Lake J is anticipated to be converted to use as the next primary silt pond once the MSP reaches its capacity. The east end of Lake B will also be partially backfilled with dry silt and overburden. The analysis presented below identifies the cross-sectional area of the aquifer that would be replaced by silt and the effects of this material on groundwater flow.

5.4.1 Lake B

Approximately 2.1 million cubic yards of dry silt and overburden may be placed in the east end of Lake B, as shown on Sheets R-2 and R-3. The lowest elevation of silt will be at approximately 230 ft msl while the top elevation will be 340 ft msl, which is 29 feet below the anticipated water surface elevation in Lake B of 369 ft msl (see Sections 5.1 and 5.2.2). The width of the top of the silt will be approximately 630 feet. The cross-sectional area of the silt placement relative to the total cross-sectional area of the aquifer is identified in Table 11. These cross-sectional areas are oriented perpendicular to the direction of groundwater flow.

TABLE 11
Cross-Sectional Areas
Perpendicular to the Direction of Groundwater Flow

Location	Silt Backfill				Across Eliot Facility			Percent of Area	Open Water Area
	Top Width	Bottom Width	Thickness	Area	Width	Thickness	Area	Backfilled	Relative to Backfill
Lake B Fill	630	0	110	34650	1350	223	301050	12%	
Lake B Above Fill	770	630	29	20300					59%
Lake J Fill	1450	200	200	165000	2250	200	450000	37%	
Ponds C & D Fill	1400	900	170	195500	5150	220	1133000	17%	
C & D Above Fill	1560	1400	40	59200					30%

All distances in Feet
All areas in Square Feet

As shown in Table 11, the cross-sectional area of the fill will be 34,650 square feet, while the cross-sectional area of the aquifer across this part of the Eliot Quarry is

301,050 square feet. The cross-sectional area of the aquifer is calculated based on the width of the Eliot Quarry in the east side of Lake B (1,350 feet) and the vertical distance between the bottom elevation of proposed mining (150 ft msl) and the average groundwater surface elevation for Lake B (373 ft msl), or 223 feet, as shown in Table 11.   Based on the cross-sectional area of the fill and the cross-sectional area of the aquifer, the fill would replace about 12 percent of the aquifer cross section with silt and overburden. However, the silt will not extend to the top of the water surface in Lake B. The cross-sectional area of water above the silt will be 20,300 square feet, which is roughly 60 percent of the fill cross-sectional area.

In accordance with the Alameda County Surface Mining Ordinance (ACSMO – Title 6, Chapter 6.80.240.C.2), while the silt and overburden placement in the east end of Lake B will reduce part of the area available for groundwater flow, the open-water area above the fill provides the ability for unrestricted water flow across the east end of Lake B. Assuming that the natural aquifer material has a porosity of 30 percent, the cross-sectional area of the pore space available for groundwater movement across the area that will be backfilled with silt would have been about 10,400 square feet (34,650 X 0.3) prior to mining in the east part of Lake B. The cross-sectional area of the pore space in the area that will become open water from 340 ft msl to 369 ft msl would have been about 6,100 square feet (20,300 X 0.3) prior to mining. The cross sectional area of open water of 20,300 square feet, with unrestricted transmissivity, exceeds the cross-sectional area of the pore space present prior to mining of 16,500 square feet. Thus, the silt placement in the east end of Lake B will not reduce the transmissivity or area through which water may flow.

5.4.1.1 Effect on Water Conveyance

The following water conveyance structures will be installed in or near the east end of Lake B:

- 84” pipe from Lake A to Lake C capable of conveying up to 500 cubic feet per second (cfs);
- 30” pipe between Lake B and Lake C at an invert elevation of 349 ft msl capable of conveying up to 100 cfs in either direction, depending on water-level differences in the two lakes; and
- 30” pipe from Lake A to Lake B capable of conveying up to 400 cfs.

The 84” pipe from Lake A to Lake C would not enter or convey any water to Lake B. Therefore, water conveyance from Lake A to Lake C would not be affected by the silt storage area in the east end of Lake B.

As indicated on Sheet R-2, the pipe between Lake B and Lake C will be located northwest of the silt storage area, and the invert elevation will be nine feet above the top elevation of the silt. Therefore, silt storage in the east end of Lake B will not affect water conveyance using the pipe between Lake B and Lake C.

The 30” pipe from Lake A to Lake B would discharge water down the east slope of Lake B. Energy dissipation and erosion protection along the east face of Lake B would be included to prevent the discharge from eroding the east face of Lake B if the discharge occurred at times when Lake B was not full. If discharge to Lake B occurred at times when the water level in Lake B was below or within roughly 10 feet above the elevation of the top of the silt (e.g. when Lake B is first being filled after mining is completed), the flow could disturb the silt and cause it to be redistributed throughout Lake B. To prevent any disruption to the silt caused by conveyance of water from Lake A to Lake B, a ditch could be constructed from the outfall end of the Lake A to Lake B pipeline turnout across the east slope of Lake B and then either across the north or south slope of Lake B to a point beyond (i.e. west of) the location of the silt backfill.

As an example, a five-foot deep ditch, with a five-foot bottom width, 2:1 (H:V) side slopes, and a 2-percent slope would be capable of conveying the flow from the end of the Lake A to Lake B pipeline around the silt storage area. Such a ditch should be lined with gravel or cobbles to minimize the potential for erosion or sediment transport. CEMEX currently uses a similar ditch to convey seepage from the south face of Lake B northwestward past active mining areas to the current pond area in the northwest corner of Lake B. Thus, proof of concept already exists within Lake B.

5.4.2 Lake J

It is proposed that approximately 6.4 million cubic yards of backfill materials (silts and overburden) be placed in Lake J, to an elevation of 360 ft msl to 380 ft msl, and be contoured in to the final reclaimed ground surface, as shown on Sheets R-1 and R-3. Silts and overburden may be blended as backfill occurs. The lowest elevation of silt will be at approximately 130 ft msl while the anticipated post-mining groundwater elevation at Lake J is anticipated to be 330 ft msl, coincident with the water level in the Shadow Cliffs Lake to the west. Thus, the silt backfill would extend 30 feet to 50 feet above the groundwater surface after reclamation. The width of the top of the silt backfill at the groundwater surface elevation will be approximately 1,450 feet, in the direction perpendicular to groundwater flow. The width of the silt at the bottom of Lake J, at 130 ft msl, will be about 200 feet. The cross-sectional area of the silt placement relative to the total cross-sectional area of the aquifer is identified in Table 11. These cross-sectional areas are oriented perpendicular to the direction of groundwater flow.

As shown in Table 11, the cross-sectional area of the fill in Lake J below the water table will be 165,000 square feet, while the cross-sectional area of the aquifer across this part of the Eliot Quarry is 450,000 square feet. The cross-sectional area of the aquifer is calculated based on the width of the Eliot Quarry across the Lake J area (2,250 feet) and the vertical distance between the bottom elevation of proposed mining (130 ft msl) and the groundwater surface elevation for Lake J (330 ft msl), or 200 feet, as shown in Table 11. Based on the cross-sectional area of the fill and the cross-sectional area of the aquifer, the fill would replace about 37 percent of the aquifer cross section with silt.

5.4.3 Ponds C & D

It is proposed that additional mining will occur in Pond D to an elevation of 200 ft msl. Approximately 140,000 cubic yards of silt backfill would then be placed in Pond C and approximately 1.6 million cubic yards of silt backfill would be placed in Pond D, up to an elevation of 330 ft msl. The anticipated groundwater surface elevation in the vicinity of Ponds C & D after mining and dewatering is completed at both SMP-23 and SMP-16 is approximately 370 ft msl. The width of the top of the silt will be approximately 1,400 feet and the width of the bottom of the silt will be approximately 900 feet, in the direction perpendicular to groundwater flow. As shown in Table 11, the cross-sectional area of the fill will be 195,500 square feet, while the cross-sectional area of the aquifer across this part of the Eliot Quarry is 1,133,000 square feet. The cross-sectional area of the aquifer is calculated based on the width of the Eliot Quarry across the Pond D area (5,150 feet) and the vertical distance between the bottom elevation of proposed mining under the Reclamation Plan Amendment (150 ft msl) and the groundwater surface elevation for Ponds C and D (370 ft msl), or 220 feet, as shown in Table 11. Based on the cross-sectional area of the fill and the cross-sectional area of the aquifer, the fill would replace about 17 percent of the aquifer cross section with silt. However, the silt will not extend to the top of the water surface in Ponds C and D. The cross-sectional area of water above the silt will be 59,200 square feet, which is roughly 30 percent of the fill cross-sectional area.

While the silt placement in Ponds C and D will reduce part of the area available for groundwater flow, the open-water area above the fill provides the ability for unrestricted water flow across Ponds C and D. As a result, the silt placement in Ponds C and D will not reduce the transmissivity or area through which water may flow.

5.5 Water Quality

As part of reclamation, the surface will be graded so that storm water from areas reclaimed to open space and/or agriculture will not enter Lake A and Lake B. Storm water runoff will be directed to retention ponds within the North Reclamation Areas, including the Main Silt Pond and the backfilled Lake J, or to Arroyo del Valle. The Eliot Quarry operates under Waste Discharge Requirements General Permit No. R2-2015-0035 (NPDES No. CAG982001) for discharge of aggregate wash water and groundwater to Shadow Cliffs and the Arroyo del Valle (collectively referred to as the WDRs). For ongoing mining operations, the WDRs require monitoring of discharges for compliance with specific water quality standards, as presented in Table 12. Comparison of the standards in Table 12 with the water-quality data from Lake B and surrounding surface water and groundwater samples (see Tables 2 and 3) indicates that the future discharge of water pumped from Lake B for reclamation purposes will meet the water quality standards specified in the WDRs. If, however, water may be discharged to an offsite location other than Shadow Cliffs or the Arroyo del Valle, then it will be necessary for CEMEX to submit a Notice of Intent (NOI) to RWQCB and the State Water Resources Control Board to modify the point of discharge in the WDRs.

Once mining is completed, several actions will be appropriate to protect water quality. The area around Lake B and any other remaining ponds will need to be graded to prevent runoff from agricultural areas, roads, and developed areas from entering the water bodies. Runoff from these areas could contain contaminants that might affect groundwater quality. Therefore, preventing runoff from entering reclaimed pits and ponds will protect groundwater quality.

Reclamation may also need to be conducted in accordance with a stormwater pollution prevention plan (SWPPP) for the reclamation construction activities. CEMEX will need to file a Notice of Intent to comply with the stormwater regulations with both the State Water Resources Control Board and the Regional Water Quality Control Board. Since stormwater runoff will be retained onsite, as described in Section 5.3, a Notice of Non-Applicability (NONA) can be filed in lieu of a SWPPP. The NONA will need to identify the measures that will be taken to ensure that stormwater is retained on the Project site, including appropriate hydrologic calculations identifying runoff quantities and necessary retention capacities.

TABLE 12

Water Quality Standards and Effluent Limitations

Parameter	Units	Daily Maximum	30-Day Arithmetic Mean	7-Day Arithmetic Mean	90-Day Arithmetic Mean
TDS	mg/L	500			360
Chlorides	mg/L	250			60
Total Suspended Solids	mg/L		30	45	
Turbidity	NTU	40			
Total Settleable Solids	mL/hr	0.2	0.1		
Chlorine Residual	mg/L	0.0			
pH	std units	6.5-8.5			
Acute Toxicity (96-hr)		70% survival			

Notes:

1. TDS and Chlorides limits are applicable only to discharges to Alameda Creek watershed above Niles. Exceedance of the dissolved solids or chloride limits will not constitute a violation of this Order if the discharger demonstrates that the source water is also high in dissolved solids or chloride concentration and the exceedance is not caused by its facility operation.
2. Chlorine residual limit is applicable only to sand washing facilities that use municipal water supply as wash water.
3. Exceedance of pH limit will not constitute a violation of the WDRs if the discharger demonstrates that the source water is also high in pH and the high pH in its discharge effluent is not caused by the facility's operation.

Zone 7 will be operator of the lakes, spillways, and pipelines and, thus, will be the party responsible for filing of any necessary NOIs and obtaining the appropriate permits for operation of the Chain of Lakes. The variations in water quality parameters between the various sampling locations described in Section 3.4 are within the natural range of typical water quality variations observed in the data collected throughout the groundwater basin (Zone 7, 2011, 2012, 2013, 2014a, 2015, 2016, 2017b, 2018), and do not indicate the potential for incompatible water types[4]. As discussed in Section 3.4, Zone 7 (2011) reports that there are not any distinct water quality characteristics that 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 diversion and recharge of water, after mining is completed, as part of the operation of the Chain of Lakes by Zone 7.

[4] **Incompatible water types are those that could react due to major pH differences, or those that could result in precipitation of mineral salts if the different water types were commingled. Such reactions could result in a degradation of water quality or alter the hydraulic conductivity of the aquifer.**

6.0 References Cited

Alameda County, 1981, Specific Plan for the Livermore-Amador Valley Quarry Area Reclamation.

Alameda County Community Development Agency, 2005, Initial Study and Mitigated Negative Declaration, Amendment to SMP-16 Reclamation Plan.

Alameda County Flood Control and Water Conservation District, 2016, Hydrology and Hydraulics Manual.

Bay Area Air Quality Management District (BAAQMD), https://www.arb.ca.gov/ch/communities/ra/westoakland/documents/appendixf_final.pdf

Brown & Caldwell, 2004, Final Report, Pleasanton Quarry Hydrogeologic Data Evaluation for CalMat Co. dba Vulcan Materials Company, Western Division.

Brown and Caldwell, January 2019, Hydraulic Design Study, Prepared for CEMEX Eliot Facility, CA Mine ID No. 91-01-0009, Alameda County, California.

Caltrans, 2008, State Route 84 Expressway Widening Project, Initial Study with Negative Declaration/Environmental Assessment with Finding of No Significant Impact.

Compass Land Group, 2019a, Eliot Quarry SMP-23 Reclamation Plan Amendment Air and Greenhouse Gas Emissions Study.

Compass Land Group, 2019b, Revised Reclamation Plan for the Eliot Quarry (SMP-23), including civil sheets prepared by Spinardi and Associates.

Department of Water Resources (DWR), 1966, Bulletin No. 118-2, Livermore and Sunol Valleys, Evaluation of Groundwater Resources, Appendix A: Geology.

DWR, 1974, California’s Groundwater, Bulletin No. 118-2, Evaluation of Groundwater Resources: Livermore and Sunol Valleys.

Department of Water Resources (DWR), 1975, Vegetative Water Use in California, 1974, Bulletin 113-3.

DWR, 2003, California’s Groundwater, Bulletin 118 – Update 2003.

Farhadzedeh, Ali, 2017, A study of Lake Erie seiche and low frequency water level fluctuations in the presence of surface ice, Ocean Engineering, v. 135, p. 117-136 (http://www.sciencedirect.com/science/article/pii/S0029801817300914)

Geocon, 2019, Geotechnical Investigation, CEMEX Eliot – SMP 23 Reclamation Plan Amendment, 1544 Stanley Boulevard, Alameda County, California.

Golder Associates Inc, 2016, Geohazard Analysis – Subaerial Landslide Generated Wave, which is Appendix C of Golder Associates Inc., 2017, Geotechnical Evaluations for Revised Reclamation Plan, Clayton Quarry, Clayton, California

Ichinose, Gene A., John G. Anderson, Kenji Satake, Rich A Schweickert, and Mary M. Lahren, 2000, The potential hazard from tsunami and seiche waves generated by large earthquakes within Lake Tahoe, California-Nevada, Geophysical Research Letters, v. 27, p. 1203-1206.

Jeff Light Geologic Consulting, 2018, Clay Bed Modeling, Eliot Quarry-CEMEX Aggregates, Alameda County, California.

Jones and Stokes, 2005, Groundwater Management Plan for Livermore-Amador Valley Groundwater Basin.

McGarr, Arthur and Robert C. Vorhis, 1968, Seismic seiches from the March 1964 Alaska Earthquake, U.S.G.S. Professional Paper 544-E.

Miller Pacific Engineering Group, 2004, Preliminary Report, Geotechnical Investigation, Zone 7 – Lakes H, I and Cope, Pleasanton, California.

NOAA, 2017, What is a seiche? https://oceanservice.noaa.gov/facts/seiche.html

Stetson Engineering, 2004, Management Plan for Lakes H, I, and Cope Lake.

Spinardi and Associates, 2014, Letter to Mr. James Gilford, Alameda County Community Development Agency, Neighborhood Preservation and Sustainability Department, RE: Topographic survey for Lake B of SMP-23, April 3, 2014.

U.S. Army Corps of Engineers, 1984, Shore Protection Manual, Coastal Engineering Research Center https://archive.org/details/shoreprotectionm01unit

U.S. EPA, 2006, AP-42: Compilation of Air Emissions Factors, Chapter 11.12, Concrete Batching.

U.S. Geological Survey (Barlock, Vincent E.), 1989a, Sedimentology of the Livermore Gravels (Miocene-Pleistocent), Southern Livermore Valley, California, Pen-File Report 89-131.

U. S. Geological Survey, 1989b, Study and Interpretation of the Chemical Characteristics of Natural Water, Water-Supply Paper 2254.

U.S. Geological Survey, 2015 https://woodshole.er.usgs.gov/project-pages/coastal_model/Tools/fetch_limited.html

WRECO, 2009, State Route 84 Expressway Widening Project, Cities of Livermore and Pleasanton, Alameda County, California, Bridge Design Hydraulic Study Report.

Zone 7, 2011, Hydrostratigraphic Investigations of the Aquifer Recharge Potential for Lakes C and D of the Chain of Lakes, Livermore, California.

Zone 7, 2012, Annual Report for the Groundwater Management Program, 2011 Water Year, Livermore Valley Groundwater Basin.

Zone 7, 2013, Annual Report for the Groundwater Management Program, 2012 Water Year, Livermore Valley Groundwater Basin.

Zone 7, 2014a, Annual Report for the Groundwater Management Program, 2013 Water Year (October 2012 through September 2013), Livermore Valley Groundwater Basin.

Zone 7, 2014b, Preliminary Lake Use Evaluation for the Chain of Lakes.

Zone 7, 2015, Annual Report for the Groundwater Management Program, 2014 Water Year, Livermore Valley Groundwater Basin.

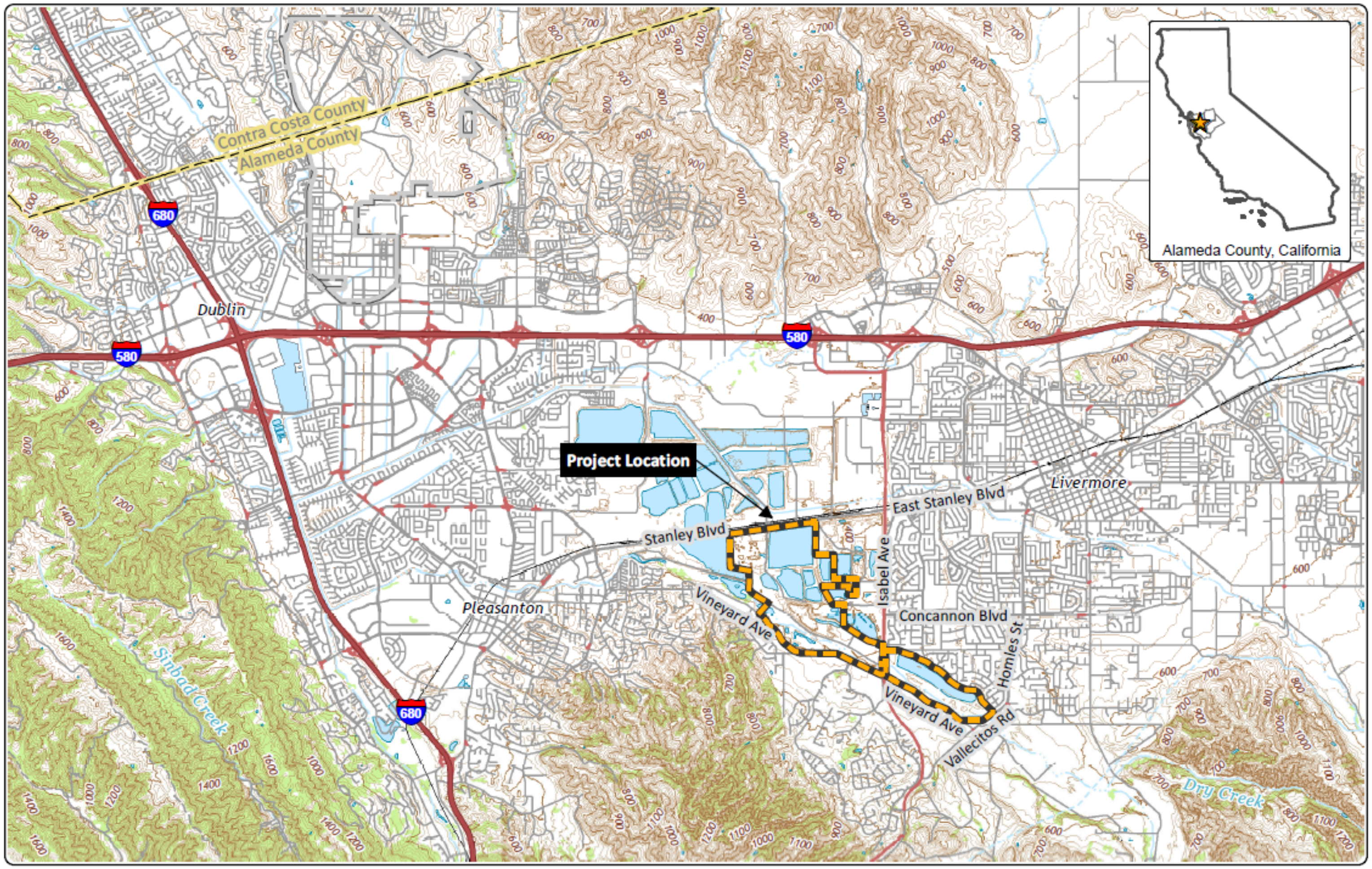
Zone 7, 2016, Annual Report for the Groundwater Management Program, 2015 Water Year, Livermore Valley Groundwater Basin.

Zone 7 Water Agency website (http://www.zone7water.com/), accessed multiple times in April, May, and June 2012; April and May 2013; February through May 2014; May through August 2016.

Zone 7, 2017a – personal communication, Draft Figure, Historical Highs (Update Feb 2017), Upper Aquifer, Livermore Valley Groundwater Basin, provided by Carol Mahoney, Colleen Winey, Tom Rooze and Matt Katen at a meeting between Zone 7 and CEMEX on August 14, 2017.

Zone 7, 2017b, Annual Report for the Groundwater Management Program, 2016 Water Year, Livermore Valley Groundwater Basin.

Zone 7, 2018, 2017 Water Year Groundwater Management Program Annual Report, Livermore Valley Groundwater Basin.



Data: United State Geological Survey, Altamont, Dublin, & Livermore Quadrangle California 7.5'. 2015. Data Downloadable Online. Accessed [09/18/2018].

Legend:

Project/Plan Boundary (920 acres)

0 1 2 3 Miles

N

Site Vicinity Map
Eliot Quarry - SMP 23
CEMEX Construction Materials Pacific, LLC.
Alameda County, California

Figure 1 12/19/2018

Disclaimer: The data was mapped for planning purposes only. No liability is assumed for accuracy of the data shown.

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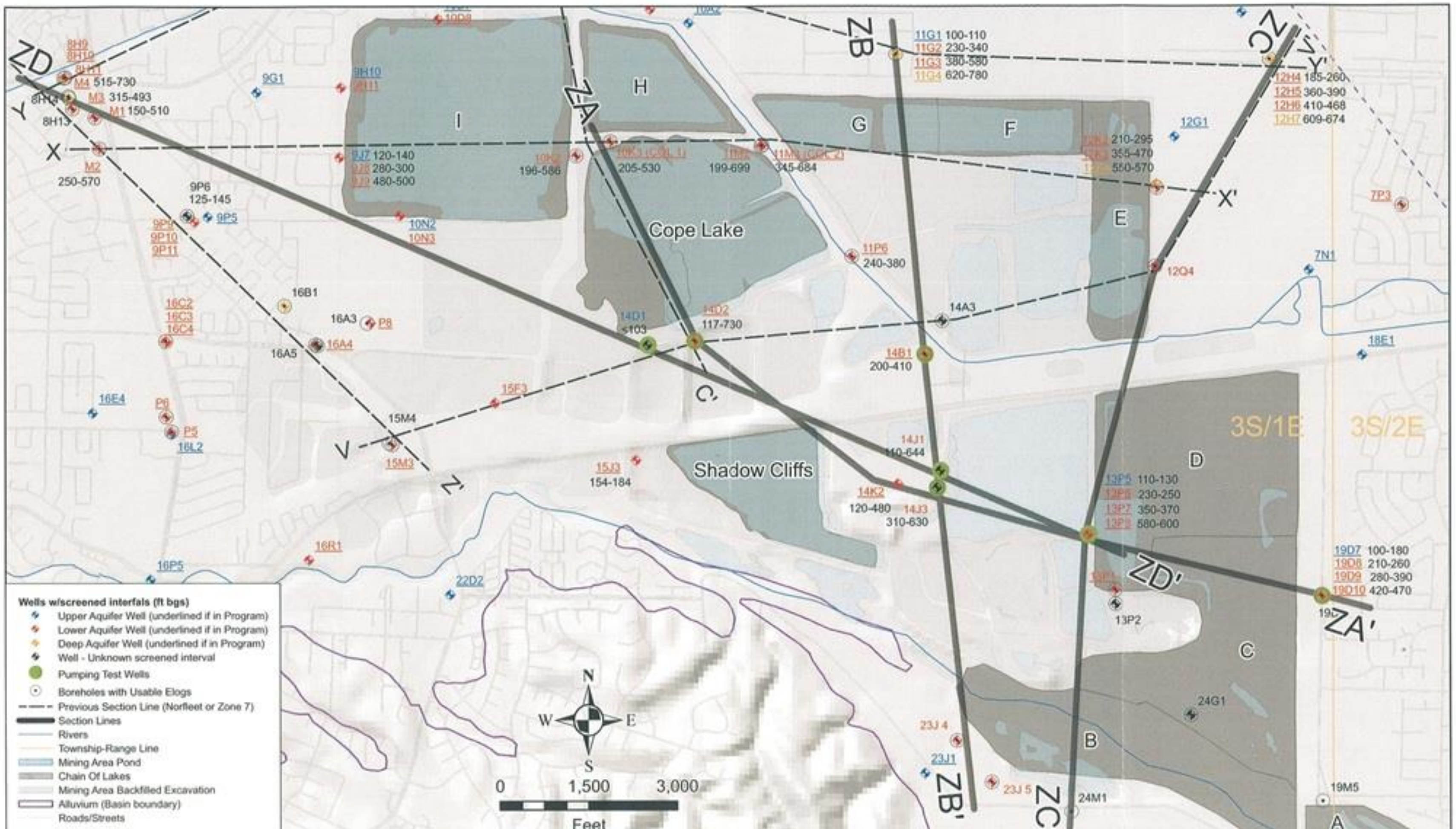
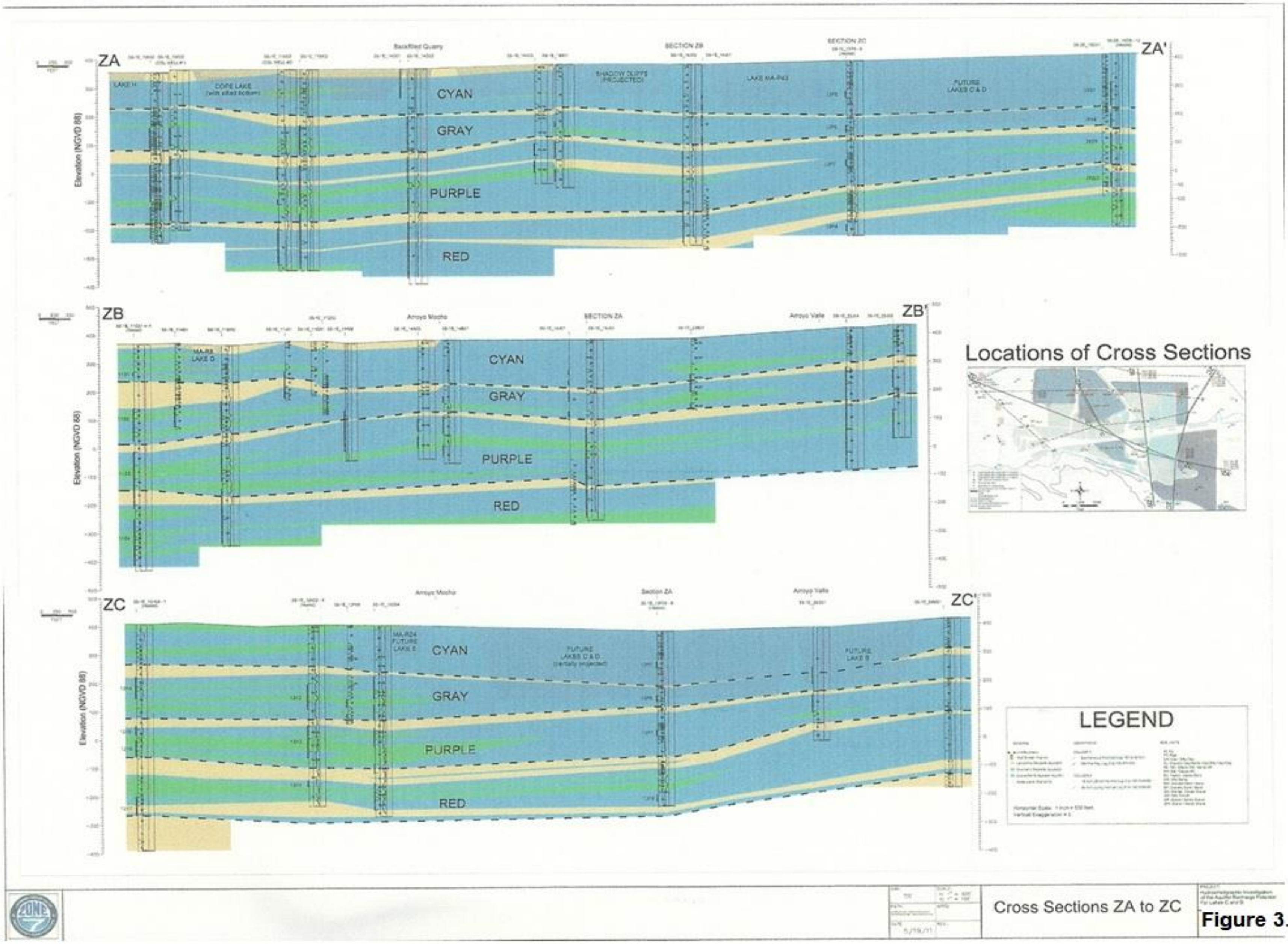
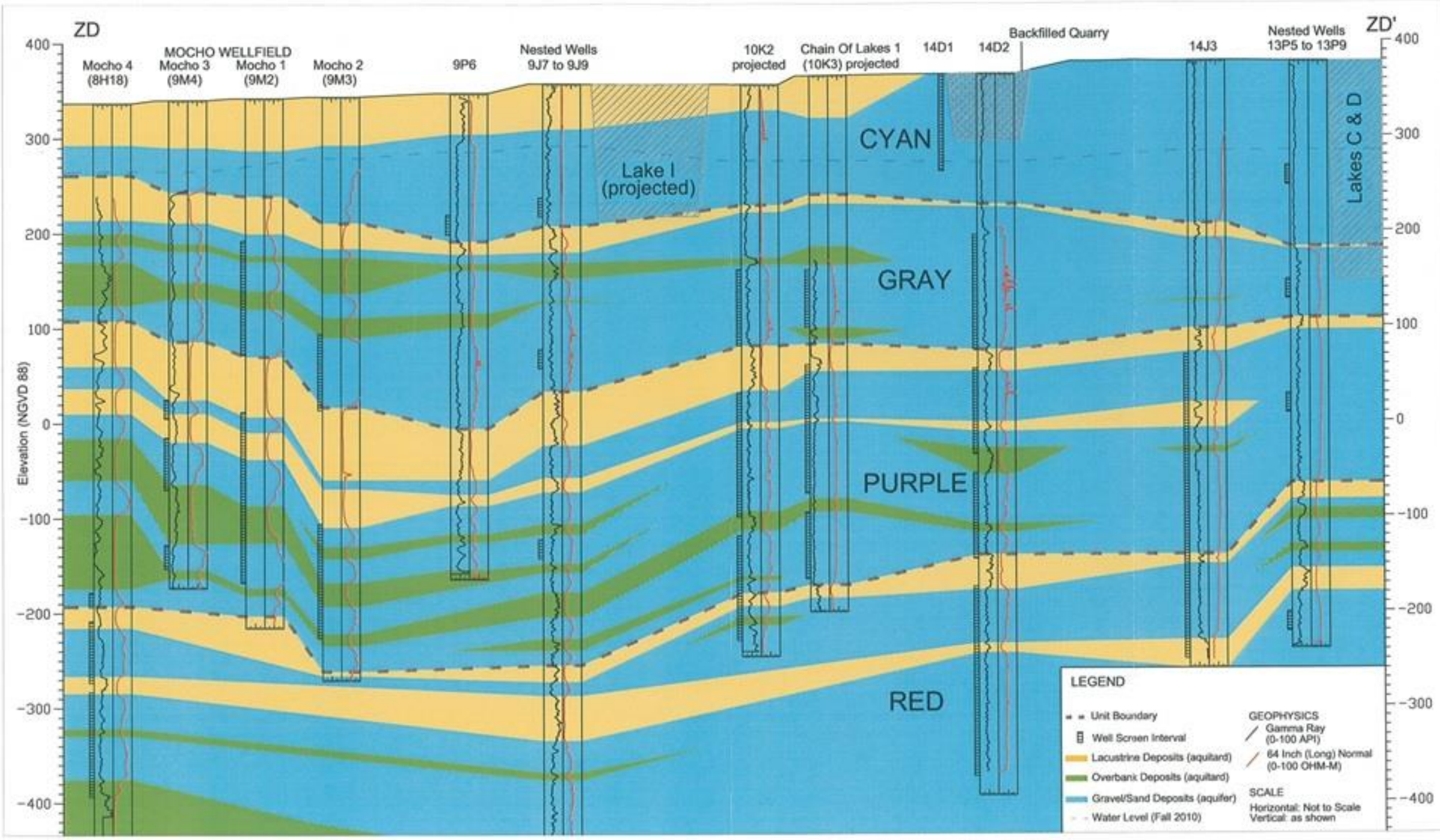


ZONE 7 WATER AGENCY 100 North Canyons Parkway Livermore, CA	DRAWN: TR	SCALE: 1 in = 1,500 ft	**Figure 2.** Locations of Wells and Stratigraphic Cross Sections (Source: Zone 7, 2011)
	REVIEWED: TR, MK	DATE: Apr 11, 2011	
	FILE: E:\PROJECTS\LGAGrantGWStudy2010\DWRGrantProjectMap.mxd		



ZA
ZA'
CYAN
GRAY
PURPLE
RED
ZB
ZB'
ZC
ZC'
Elevation (NGVD 88)
Locations of Cross Sections
LEGEND
Cross Sections ZA to ZC

Figure 3.



ZONE 7 WATER AGENCY
100 NORTH CANYONS PKWY
LIVERMORE, CA 94551

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DES.:	TR
CHK:	MK
APPD:	MK

SCALE: Horizontal: none; Vertical: 1"=100'
DATE: May 20, 2011
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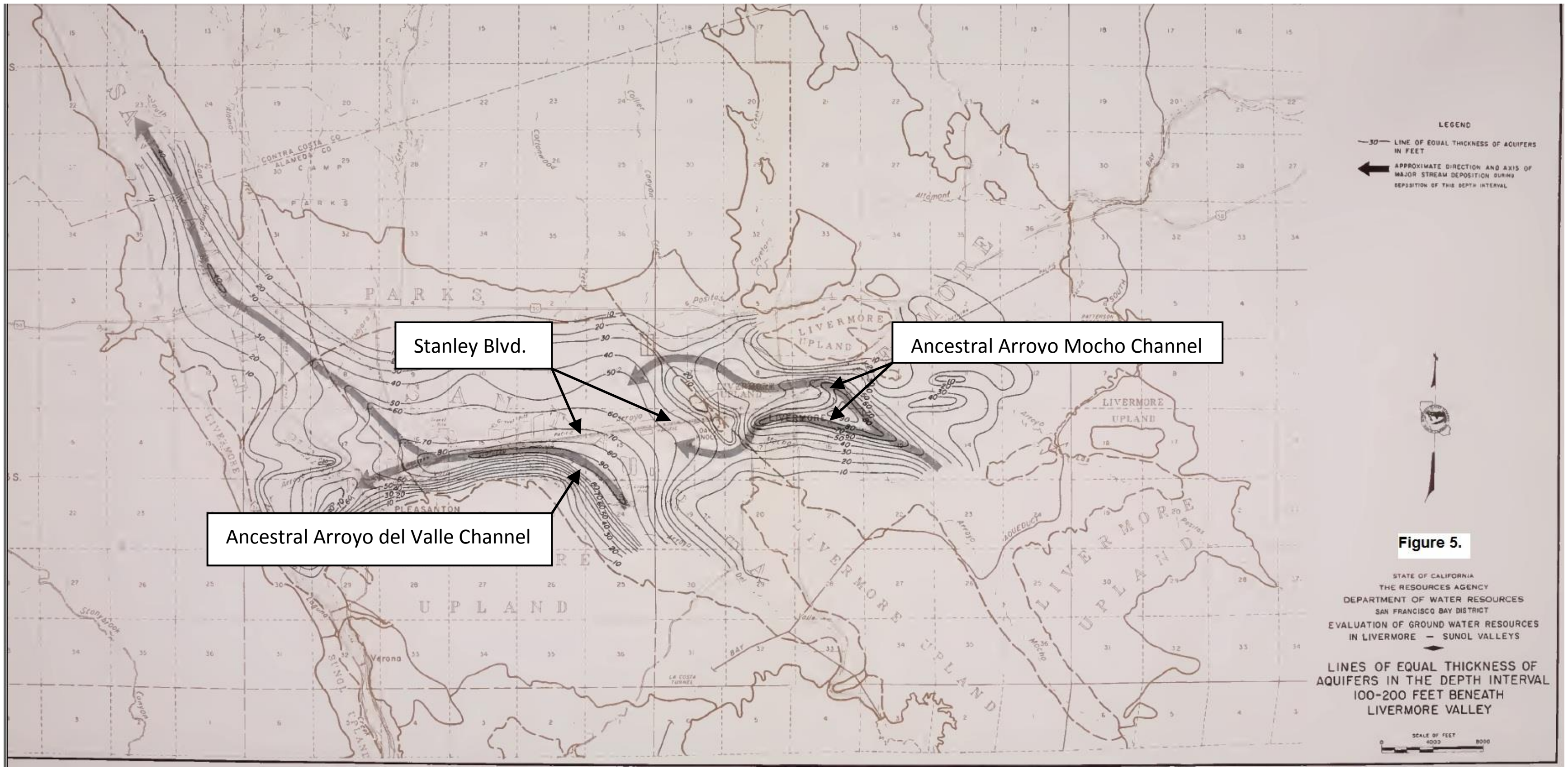
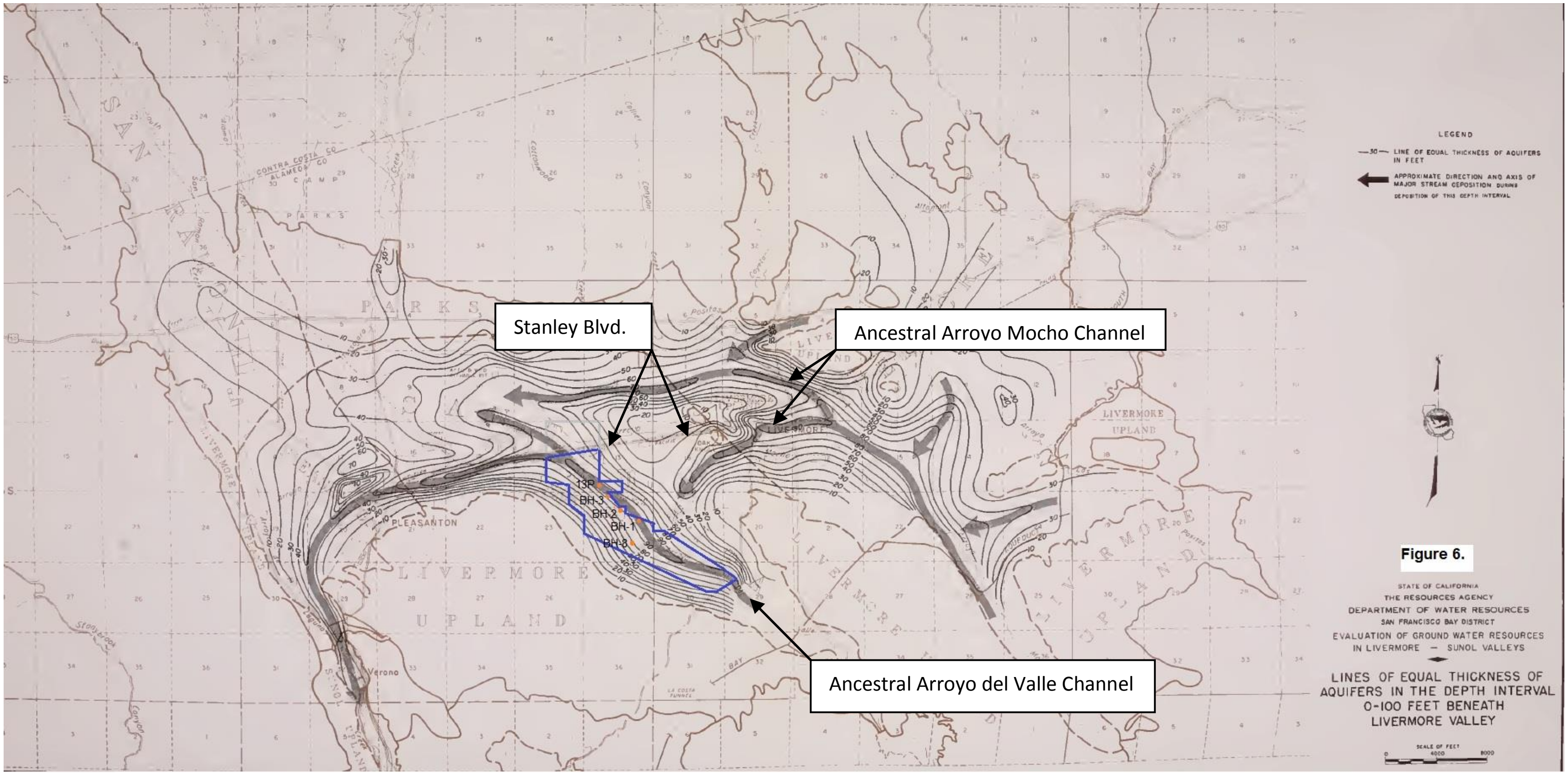
Figure 4.
CROSS SECTION ZD
Hydrostratigraphic Investigation for Lakes C and D


Stanley Blvd.
Ancestral Arrovo Mocho Channel
Ancestral Arroyo del Valle Channel
LEGEND
LINE OF EQUAL THICKNESS OF AQUIFERS IN FEET
APPROXIMATE DIRECTION AND AXIS OF MAJOR STREAM DEPOSITION DURING DEPOSITION OF THIS DEPTH INTERVAL
PARKS
PLEASANTON
LIVERMORE UPLAND
UPLAND
Verona
Altamont
Figure 5.
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SAN FRANCISCO BAY DISTRICT
EVALUATION OF GROUND WATER RESOURCES
IN LIVERMORE — SUNOL VALLEYS
LINES OF EQUAL THICKNESS OF
AQUIFERS IN THE DEPTH INTERVAL
100-200 FEET BENEATH
LIVERMORE VALLEY
SCALE OF FEET


Stanley Blvd.
Ancestral Arroyo Mocho Channel
Ancestral Arroyo del Valle Channel
13P
BH-3
BH-2
BH-1
BH-8
PLEASANTON
LIVERMORE UPLAND
LIVERMORE
CONTRA COSTA CO
ALAMEDA CO
CAMP PARKS
Verona
LEGEND
—30— LINE OF EQUAL THICKNESS OF AQUIFERS IN FEET
APPROXIMATE DIRECTION AND AXIS OF MAJOR STREAM DEPOSITION DURING DEPOSITION OF THIS DEPTH INTERVAL
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SAN FRANCISCO BAY DISTRICT
EVALUATION OF GROUND WATER RESOURCES
IN LIVERMORE — SUNOL VALLEYS
LINES OF EQUAL THICKNESS OF
AQUIFERS IN THE DEPTH INTERVAL
0-100 FEET BENEATH
LIVERMORE VALLEY
SCALE OF FEET
0 4000 8000
Figure 6.

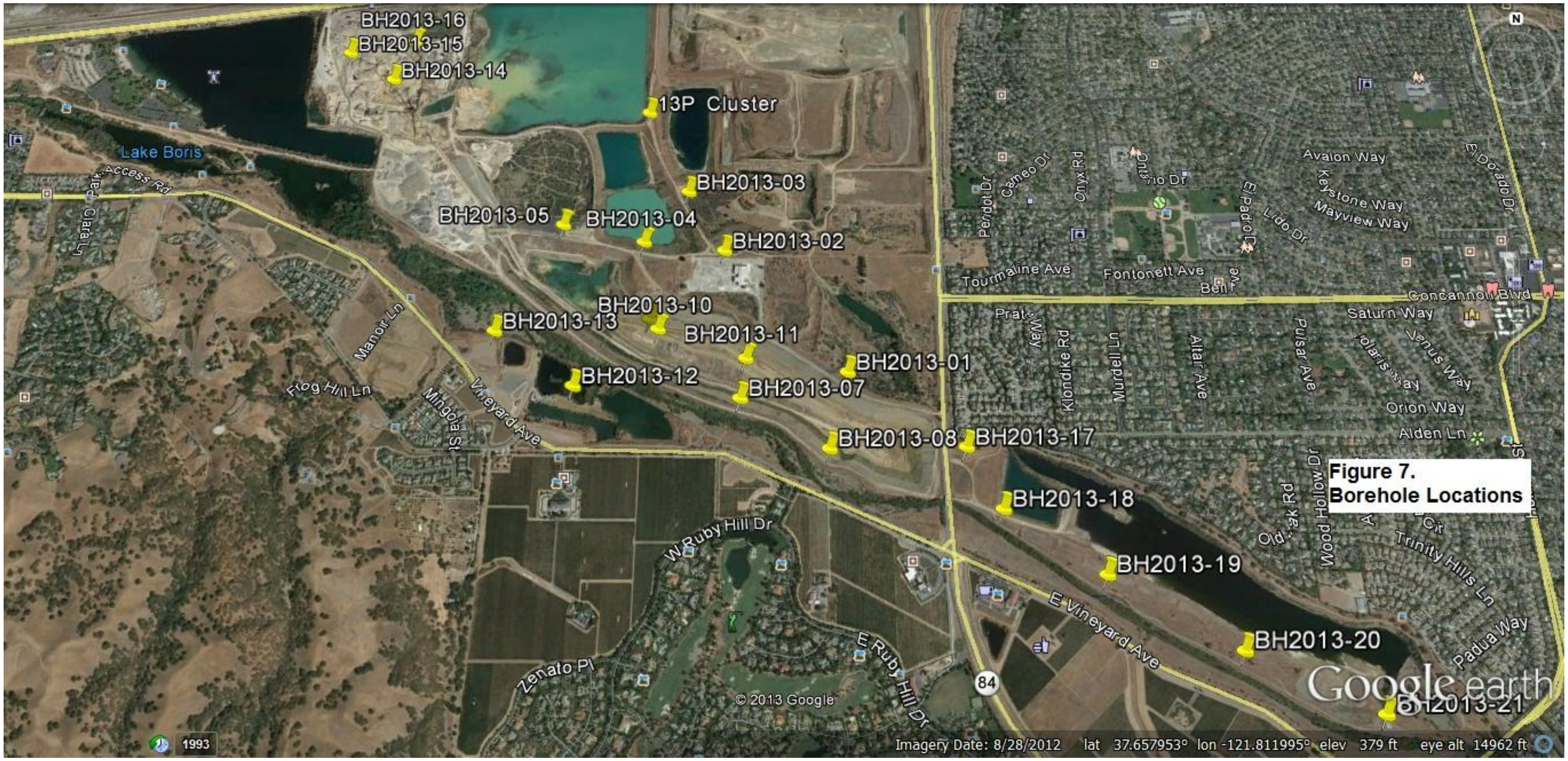
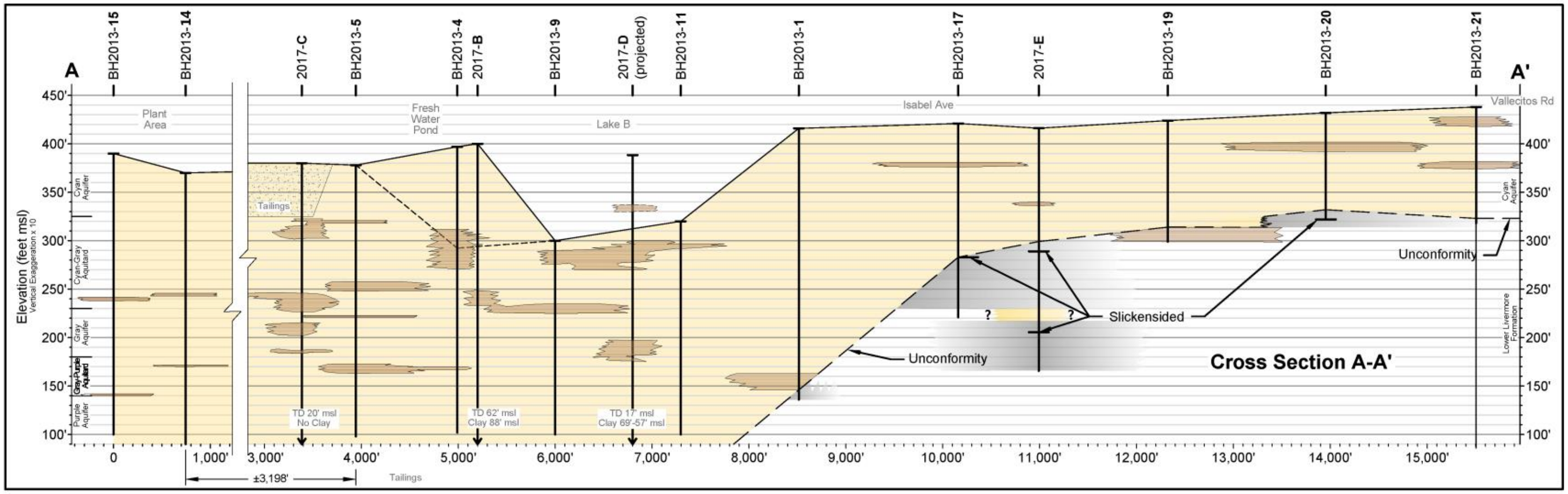
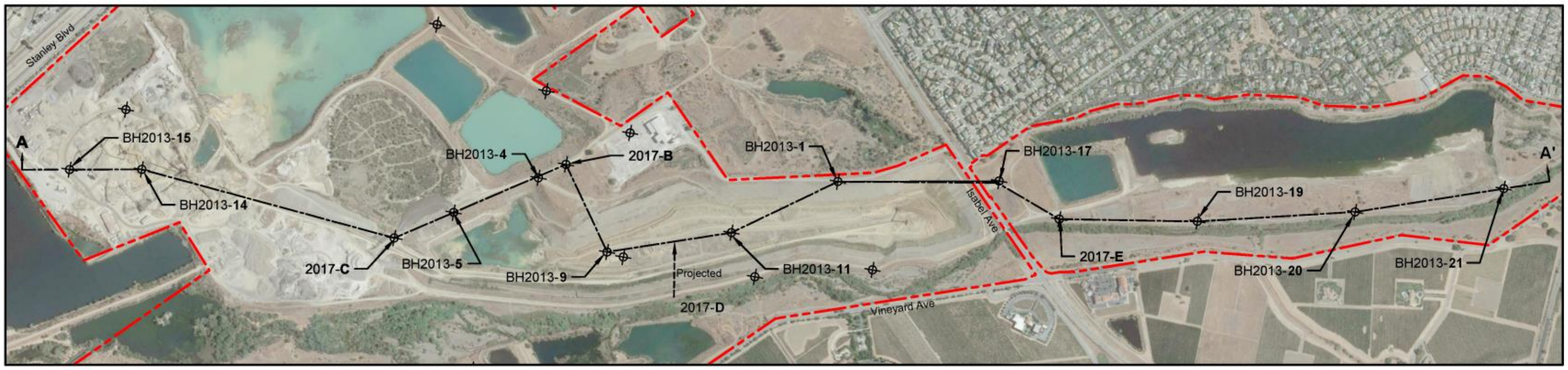


Figure 7.
Borehole Locations





Data Source: Goolge Earth Pro (2012-08-28)

0 1,000'
Scale: 1" = 1,000' *

EMKO Environmental, Inc.

Site Boundary

Sand and Gravel

Clay and Silt

Bore Hole Location

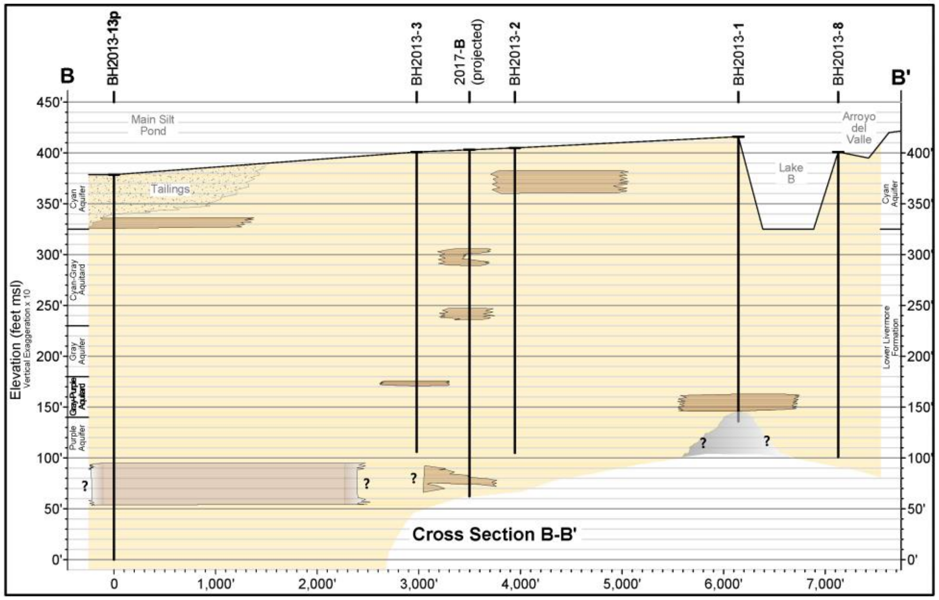
Gray and Blue Clays

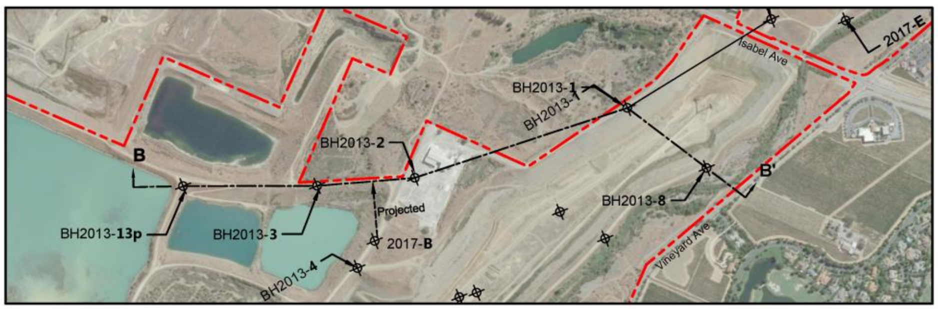
*when printed on 11"x17" paper.

Figure Title: Geologic Cross Section A-A'

Project: CEMEX - Eliot Quarry, Alameda County

Date: 1/22/2019 **Figure:** 8





Data Source: Goolge Earth Pro (2012-08-28)

0 1,000'
Scale: 1" = 1,000' *

EMKO Environmental, Inc.

Site Boundary

Sand and Gravel

Clay and Silt

Bore Hole Location

Gray and Blue Clays

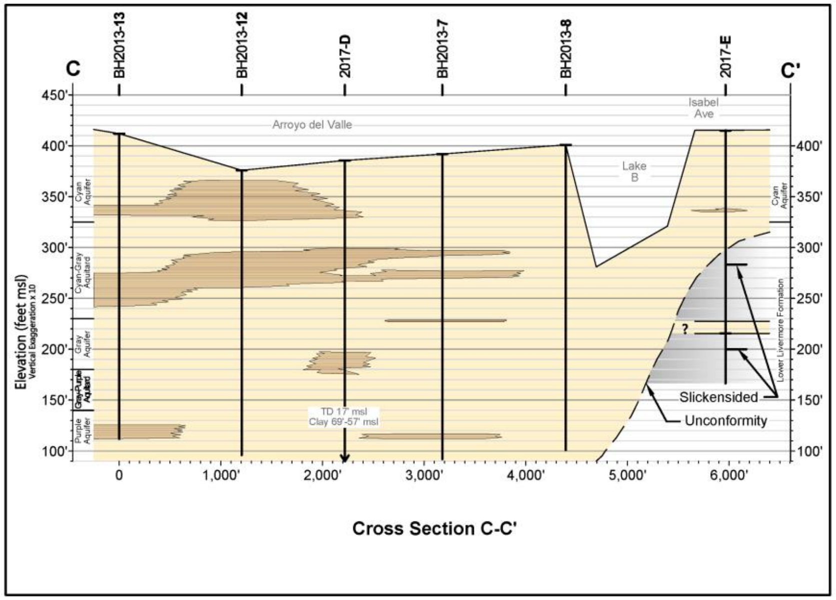
*when printed on 11"x17" paper.

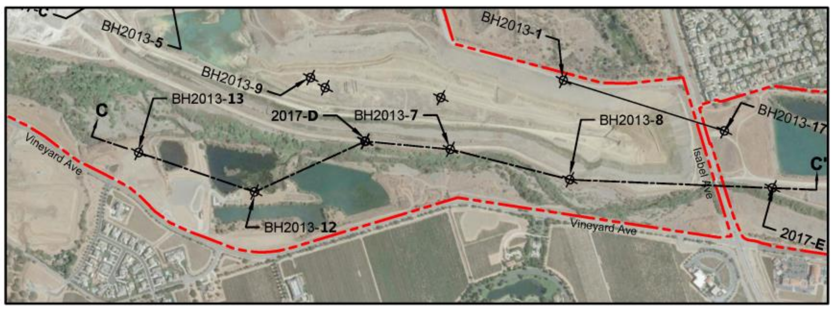
Figure Title: Geologic Cross Section B-B'

Project: CEMEX - Eliot Quarry, Alameda County

Date: 1/22/2019

Figure: 9





Data Source: Goolge Earth Pro (2012-08-28)

0 1,000'
Scale: 1" = 1,000' *

EMKO Environmental, Inc.

Site Boundary

Sand and Gravel

Clay and Silt

Bore Hole Location

Gray and Blue Clays

*when printed on 11"x17" paper.

Figure Title: Geologic Cross Section C-C'

Project: CEMEX - Eliot Quarry, Alameda County

Date: 1/22/2019 **Figure:** 10

Figure 11. Percentage of Clay Logged in Boreholes Drilled at Different Times with Different Drilling and Logging Methods

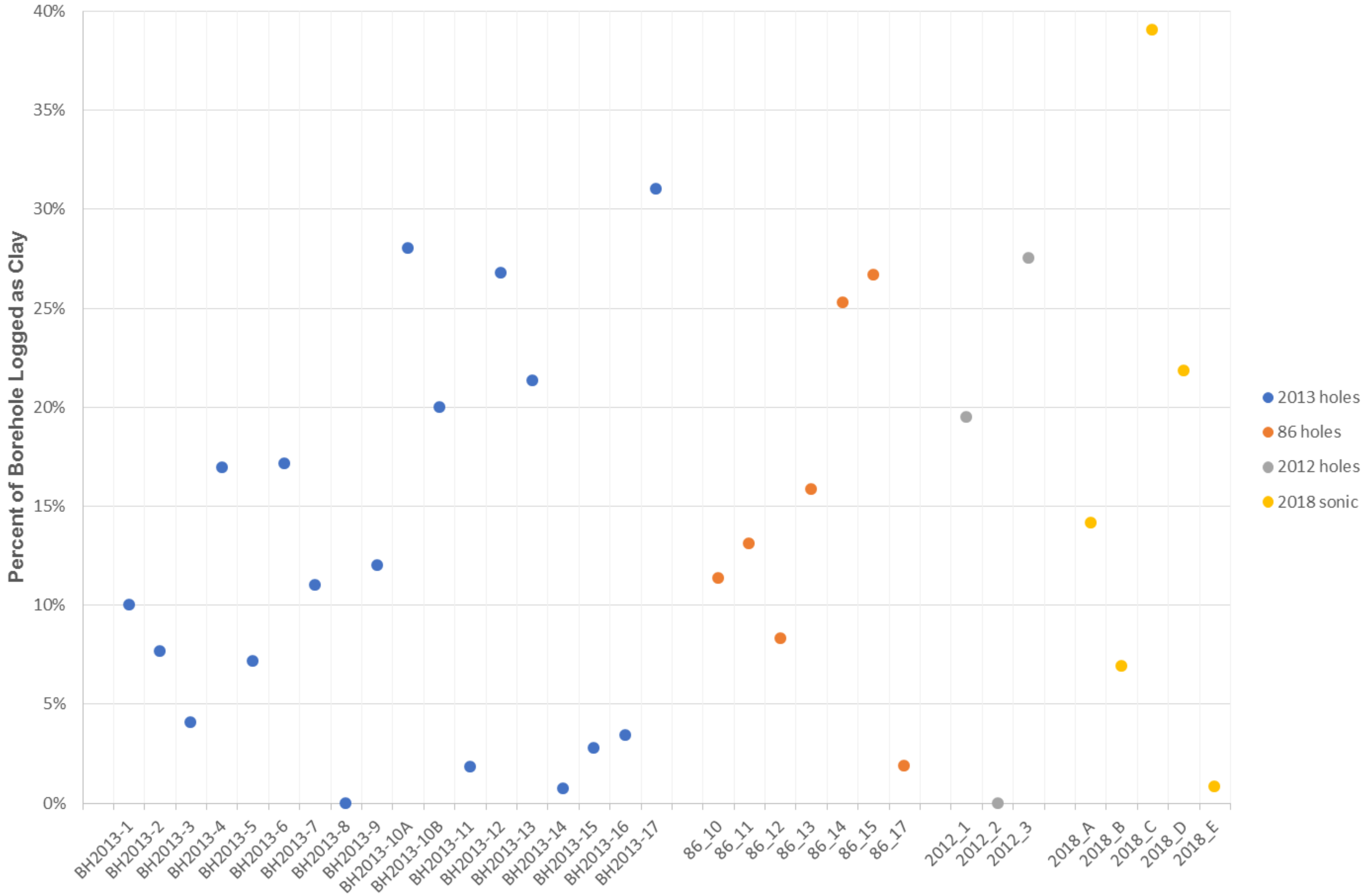
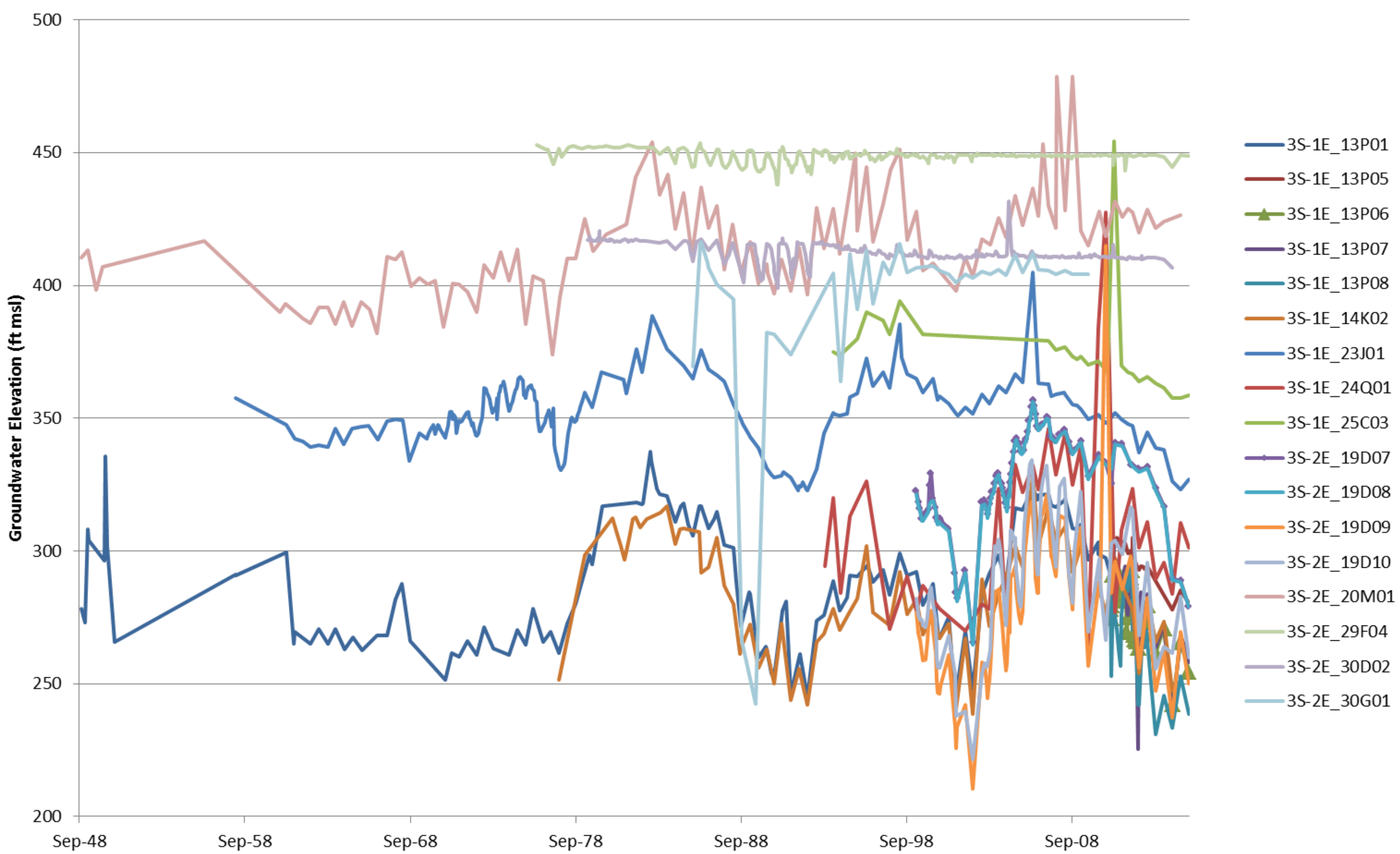
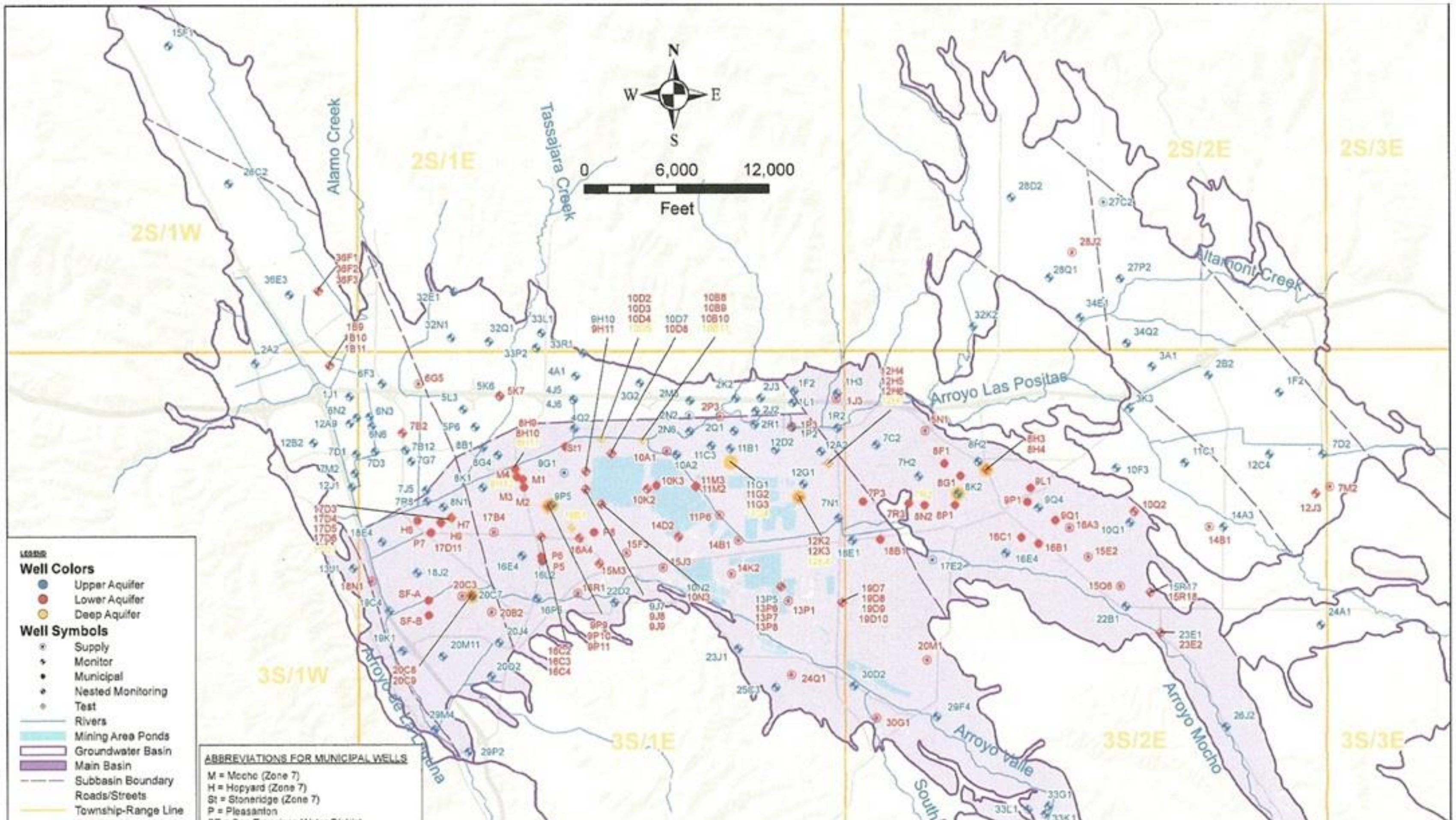


Figure 12. Hydrograph 1948-2015





ZONE 7 WATER AGENCY
100 North Canyons Parkway
Livermore, CA

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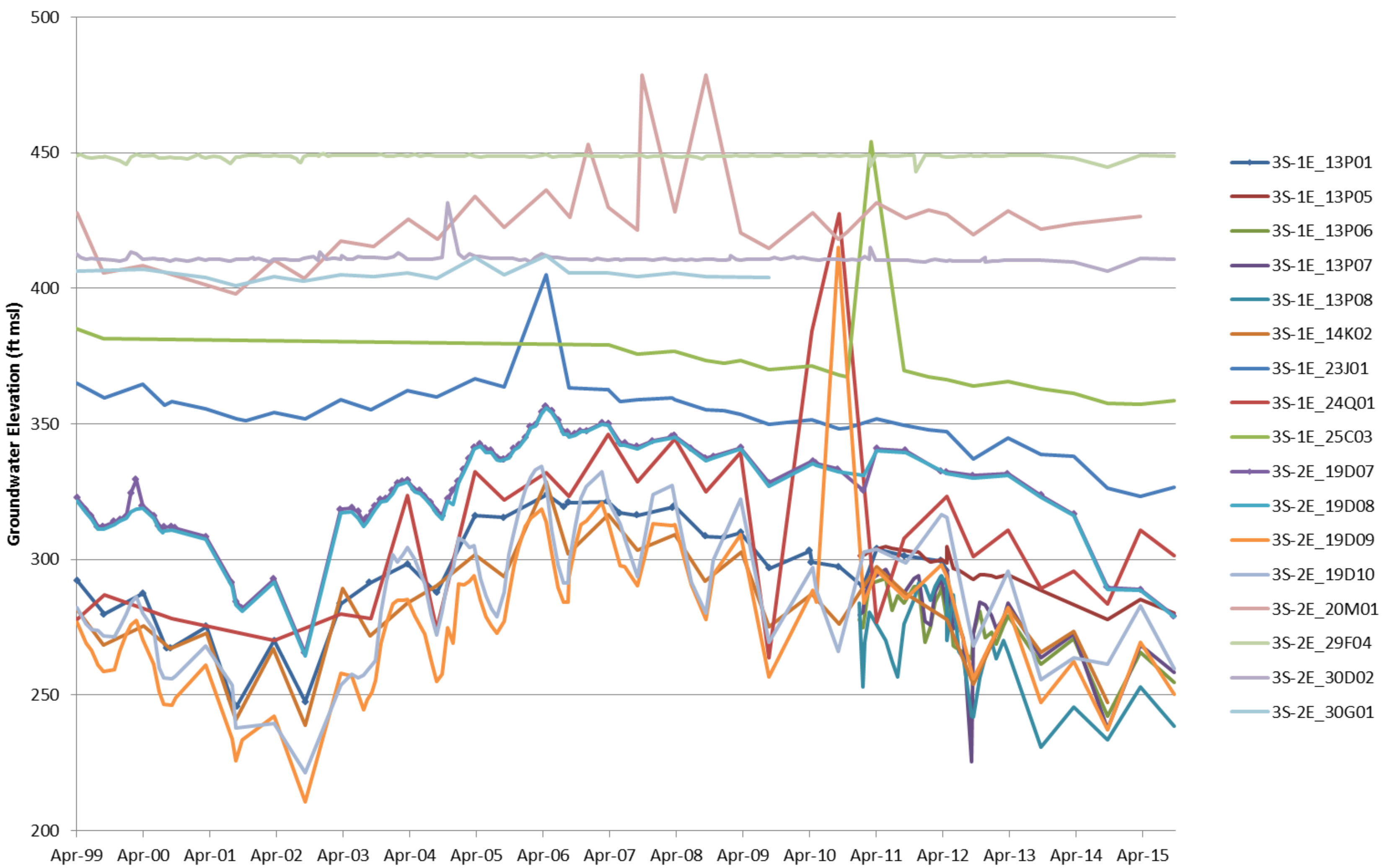
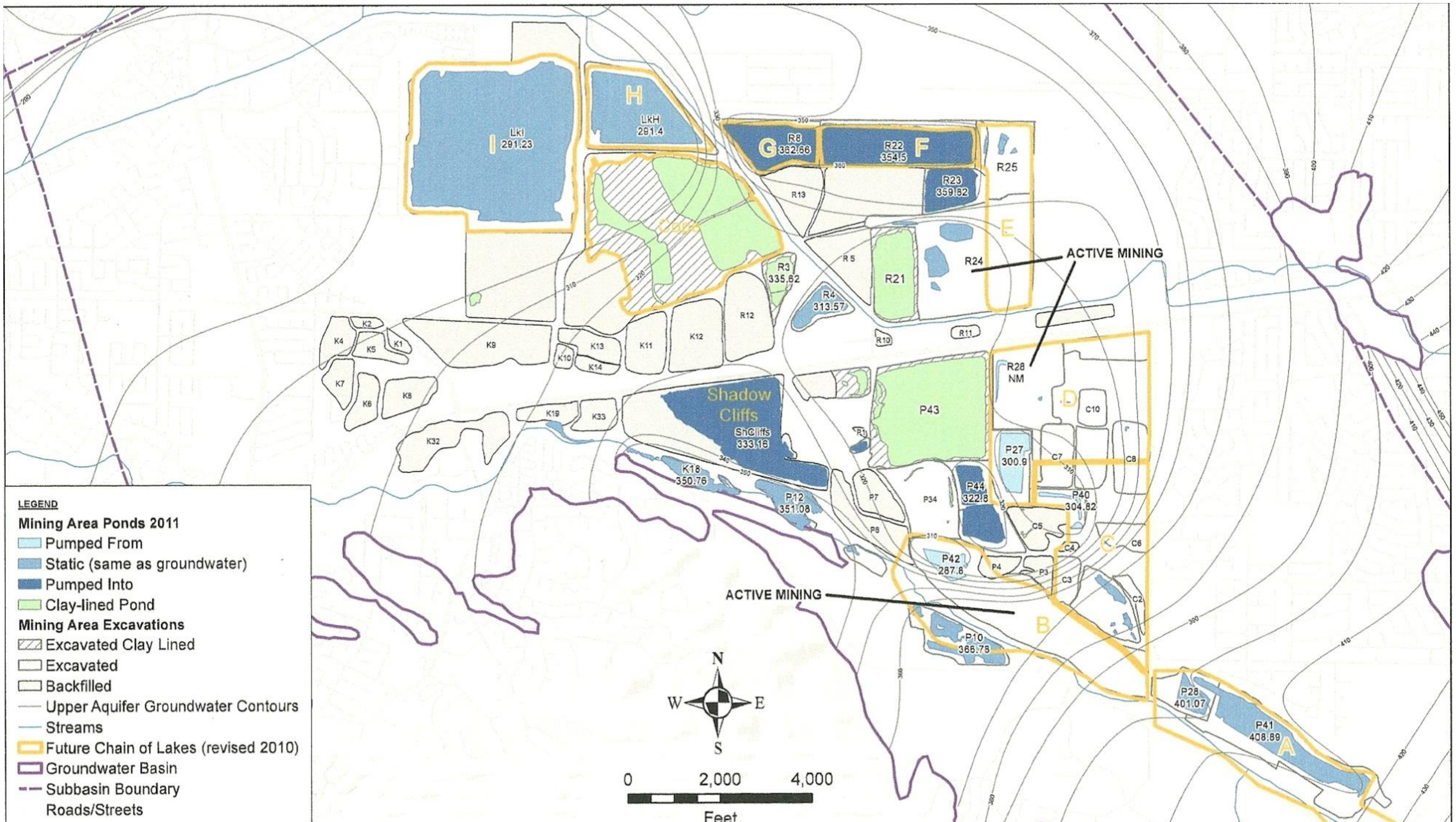
REVIEWED: CW	DATE: May 25, 2012
FILE: E:\MONITOR\GM\2011WY\AnnualReport\Fig3.2-01-AllWells2011.mxd	

Figure 13. Well Location Map

Figure 14. Hydrograph Since 1999





ZONE 7 WATER AGENCY
100 North Canyons Parkway
Livermore, CA

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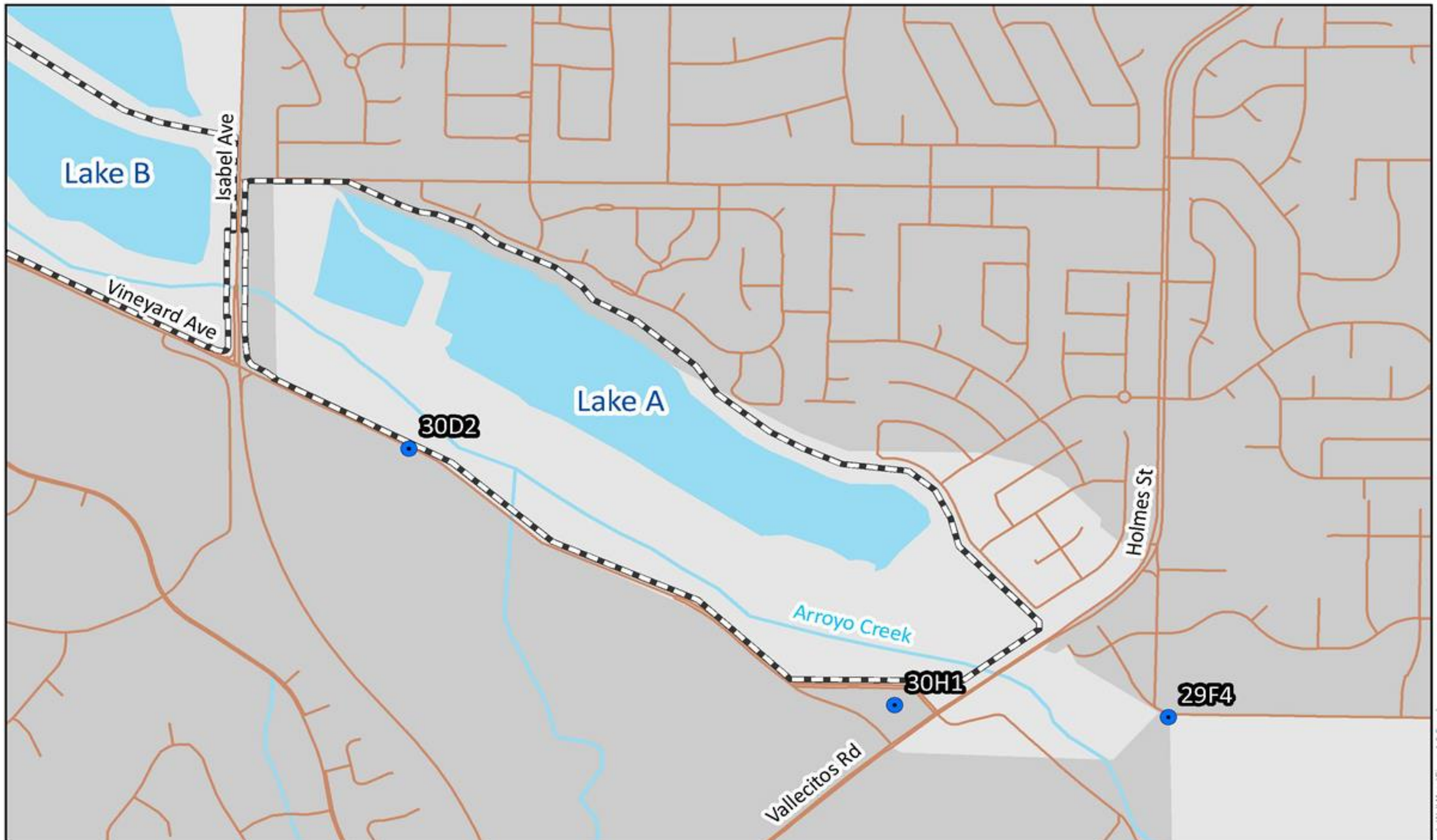
Figure 15. Pond Water Elevations and Surface Water Sampling Locations



Legend:
- Well
- Eliot Property Boundary
- Lake/Pond
- Stream/Waterway
- Roadway

0 500 1,000 1,500 2,000 Feet

N

Lake A Location Map
Eliot Quarry
1544 Stanley Blvd, Pleasanton, CA 94566

Fi **Figure 16**

Disclaimer: The data was mapped for planning purposes only. No liability is assumed for accuracy of the data shown.

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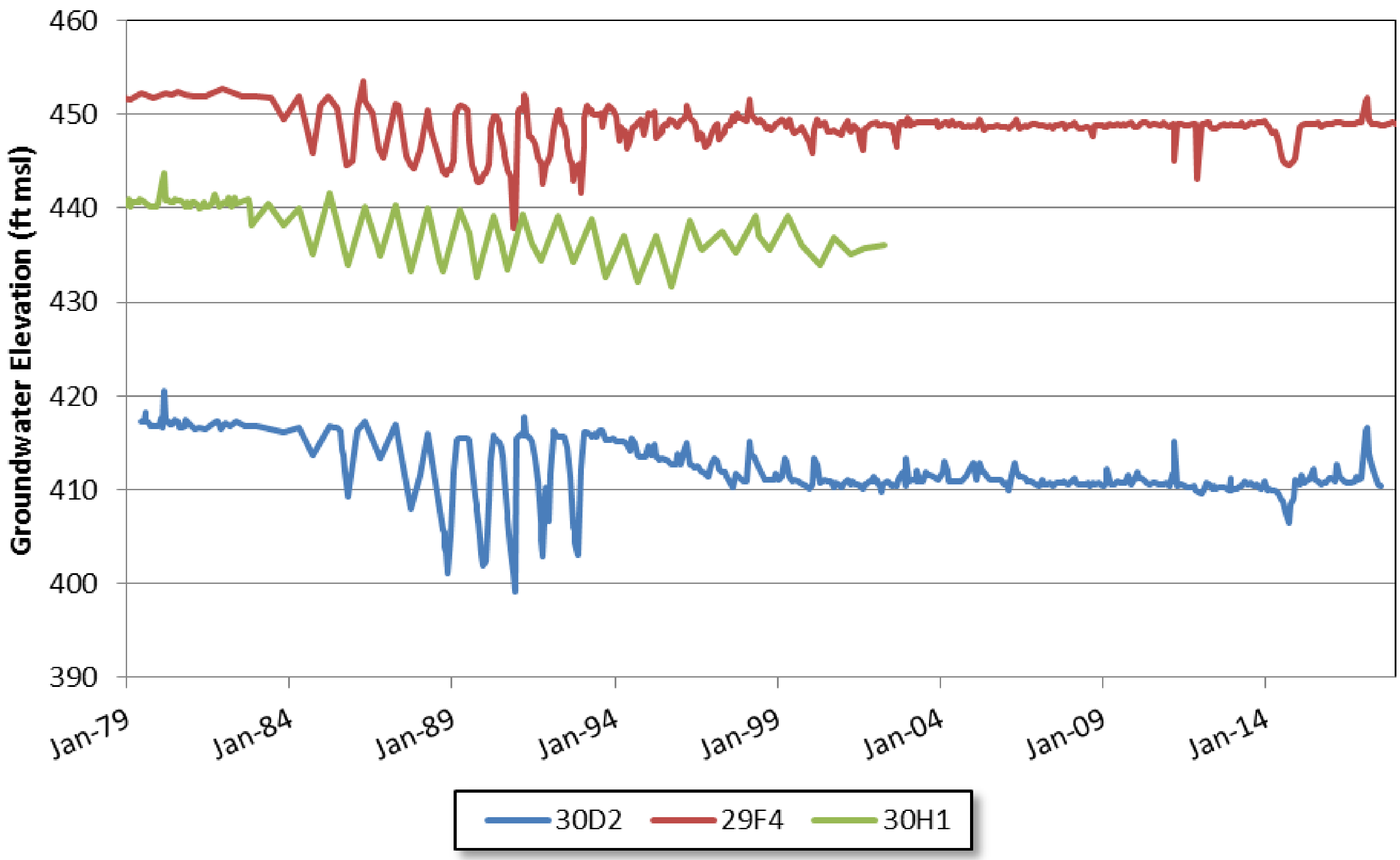
Date: 6/20/2018 Projects\012 - Cemex\Eliot\Andy Well Maps\Figure 1 & 9.mxd

Figure 17. Hydrograph - Wells 30D2, 29F4 & 30H1



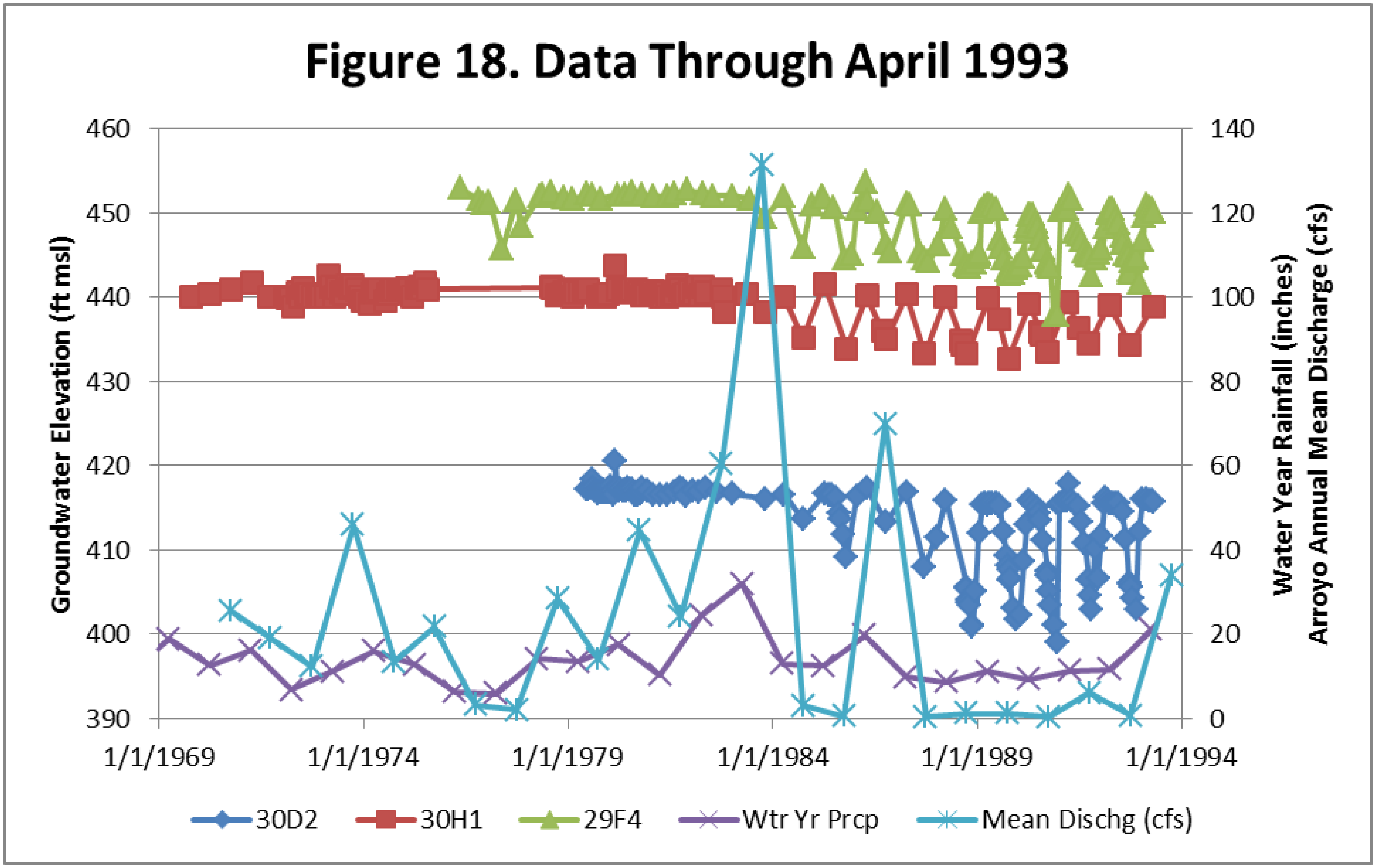


Figure 18. Data Through April 1993
Groundwater Elevation (ft msl)
460
450
440
430
420
410
400
390
Water Year Rainfall (inches)
Arroyo Annual Mean Discharge (cfs)
140
120
100
80
60
40
20
0
1/1/1969
1/1/1974
1/1/1979
1/1/1984
1/1/1989
1/1/1994
30D2
30H1
29F4
Wtr Yr Prcp
Mean Dischg (cfs)

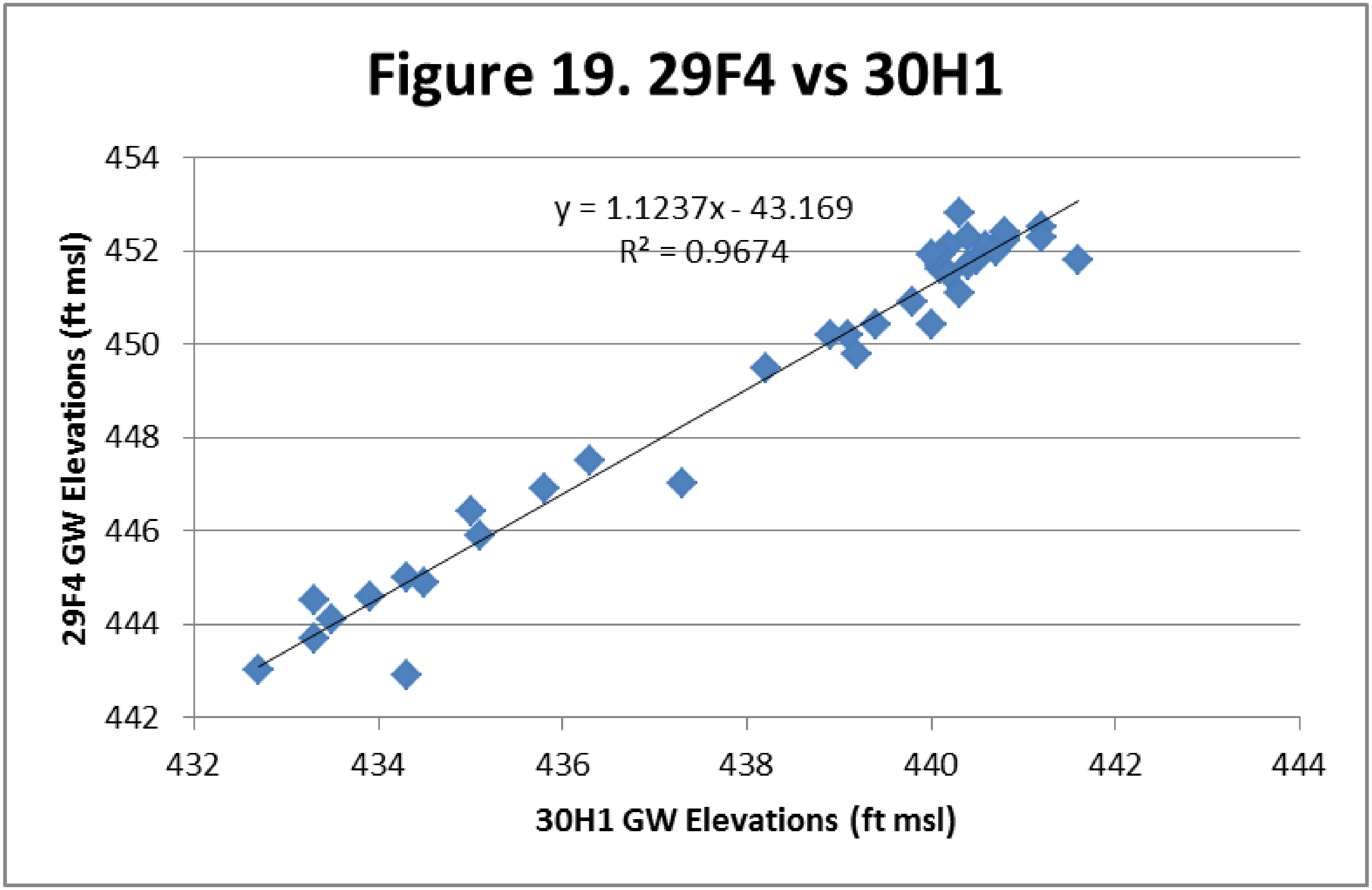


Figure 19. 29F4 vs 30H1
y = 1.1237x - 43.169
R² = 0.9674
29F4 GW Elevations (ft msl)
30H1 GW Elevations (ft msl)
454
452
450
448
446
444
442
432
434
436
438
440
442
444

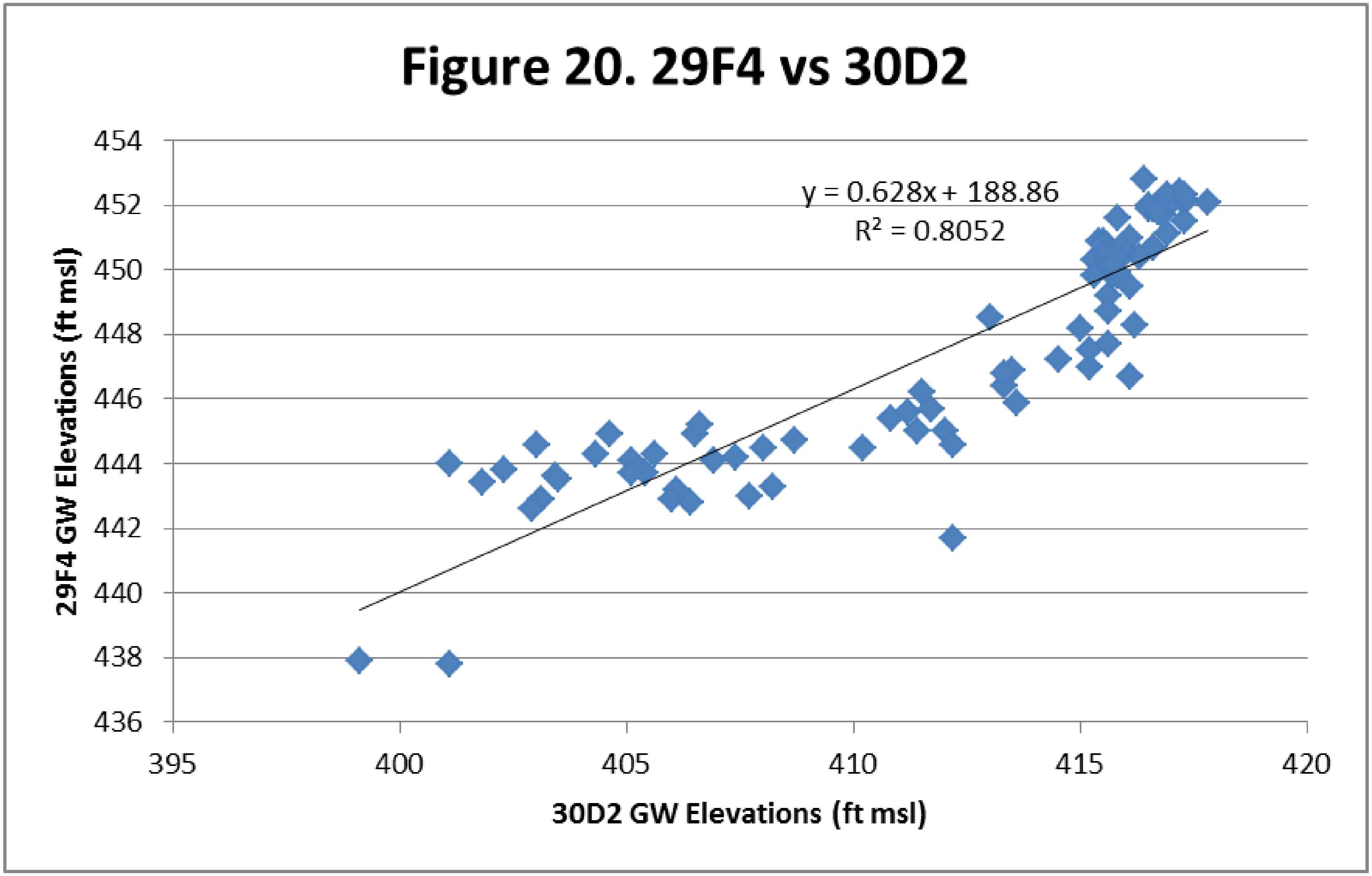


Figure 20. 29F4 vs 30D2
y = 0.628x + 188.86
R² = 0.8052
29F4 GW Elevations (ft msl)
30D2 GW Elevations (ft msl)
454
452
450
448
446
444
442
440
438
436
395
400
405
410
415
420

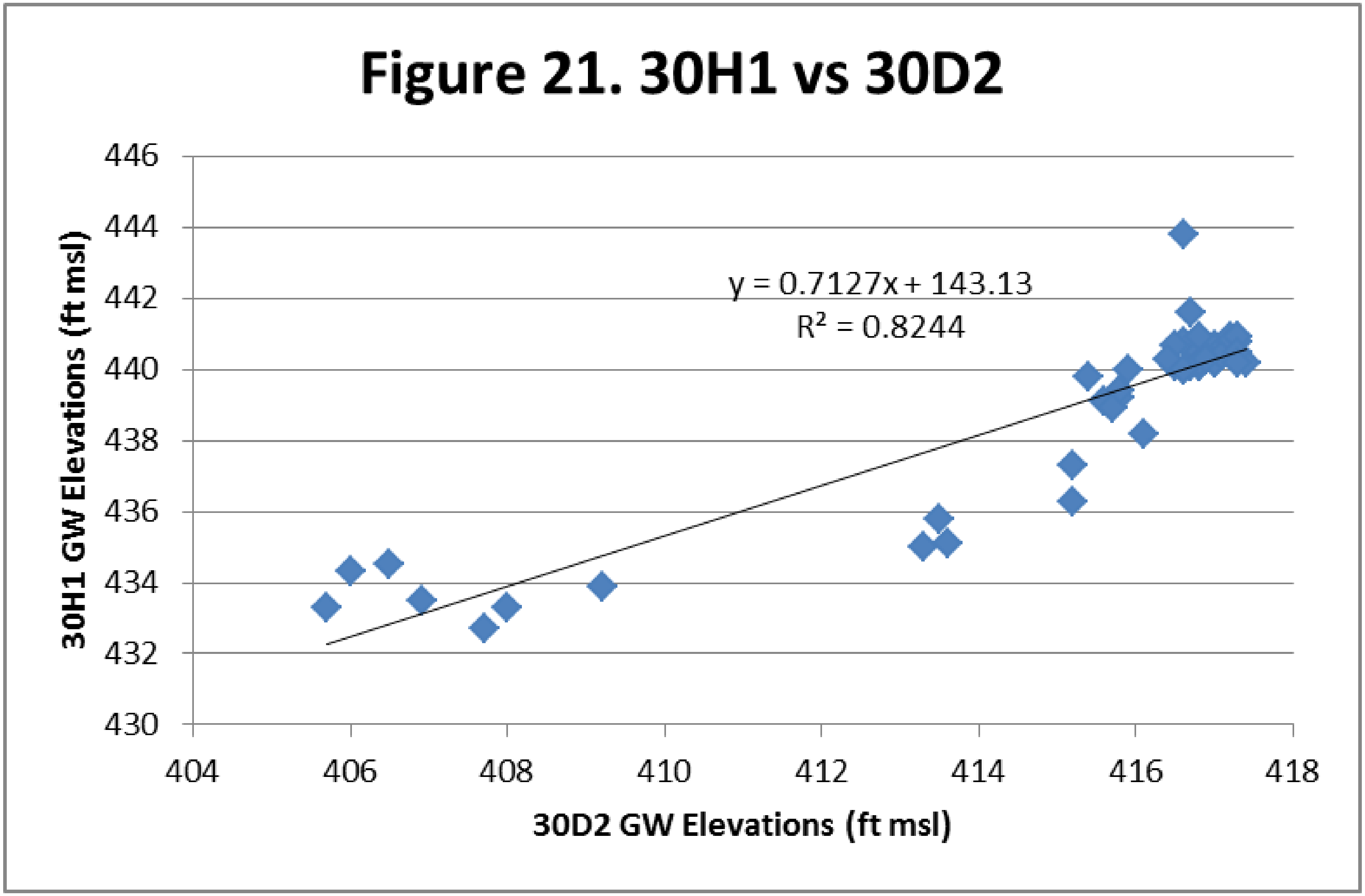


Figure 21. 30H1 vs 30D2
y = 0.7127x + 143.13
R² = 0.8244
446
444
442
440
438
436
434
432
430
404
406
408
410
412
414
416
418
30H1 GW Elevations (ft msl)
30D2 GW Elevations (ft msl)

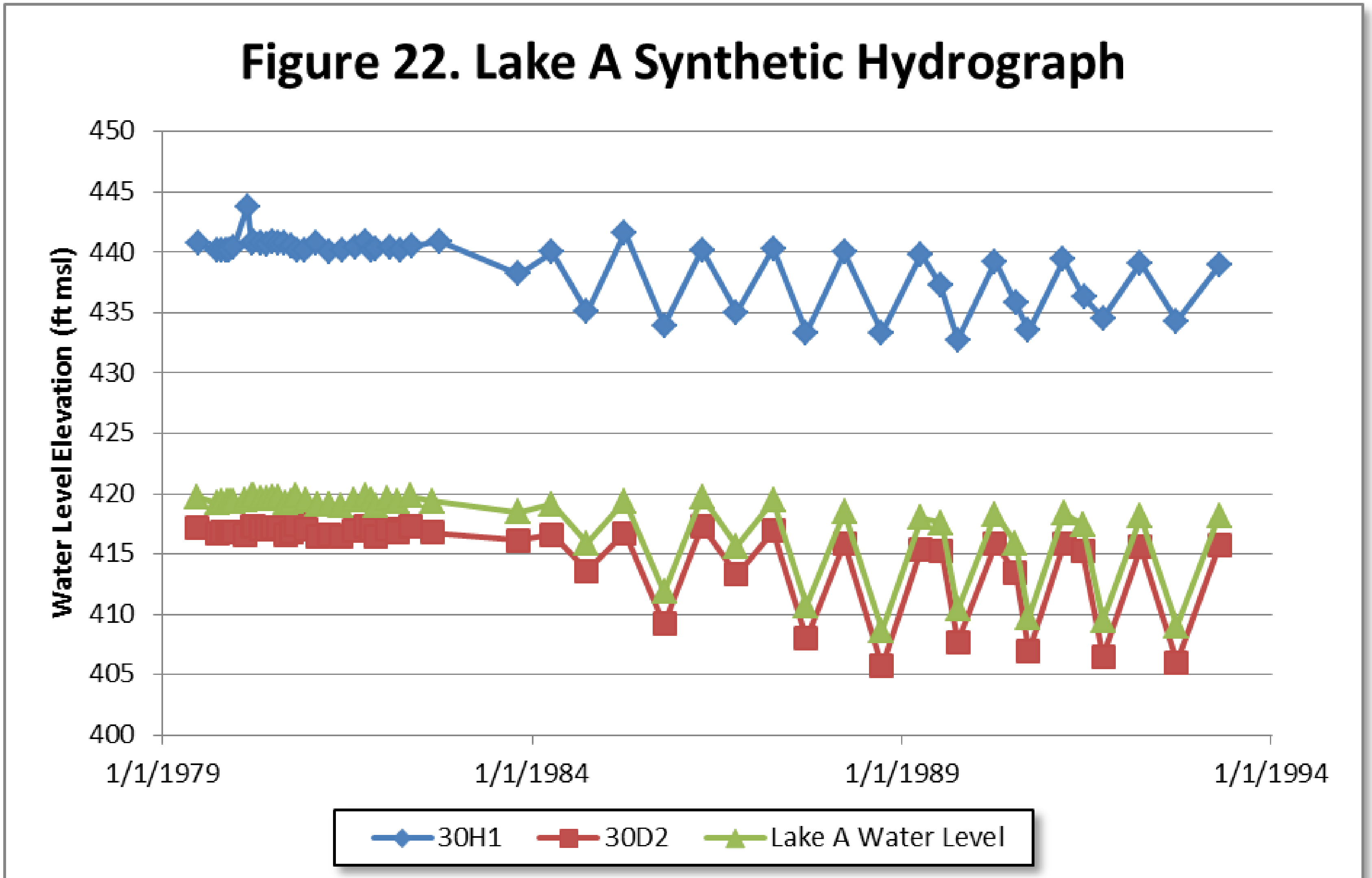


Figure 22. Lake A Synthetic Hydrograph
Water Level Elevation (ft msl)
450
445
440
435
430
425
420
415
410
405
400
1/1/1979
1/1/1984
1/1/1989
1/1/1994
30H1
30D2
Lake A Water Level

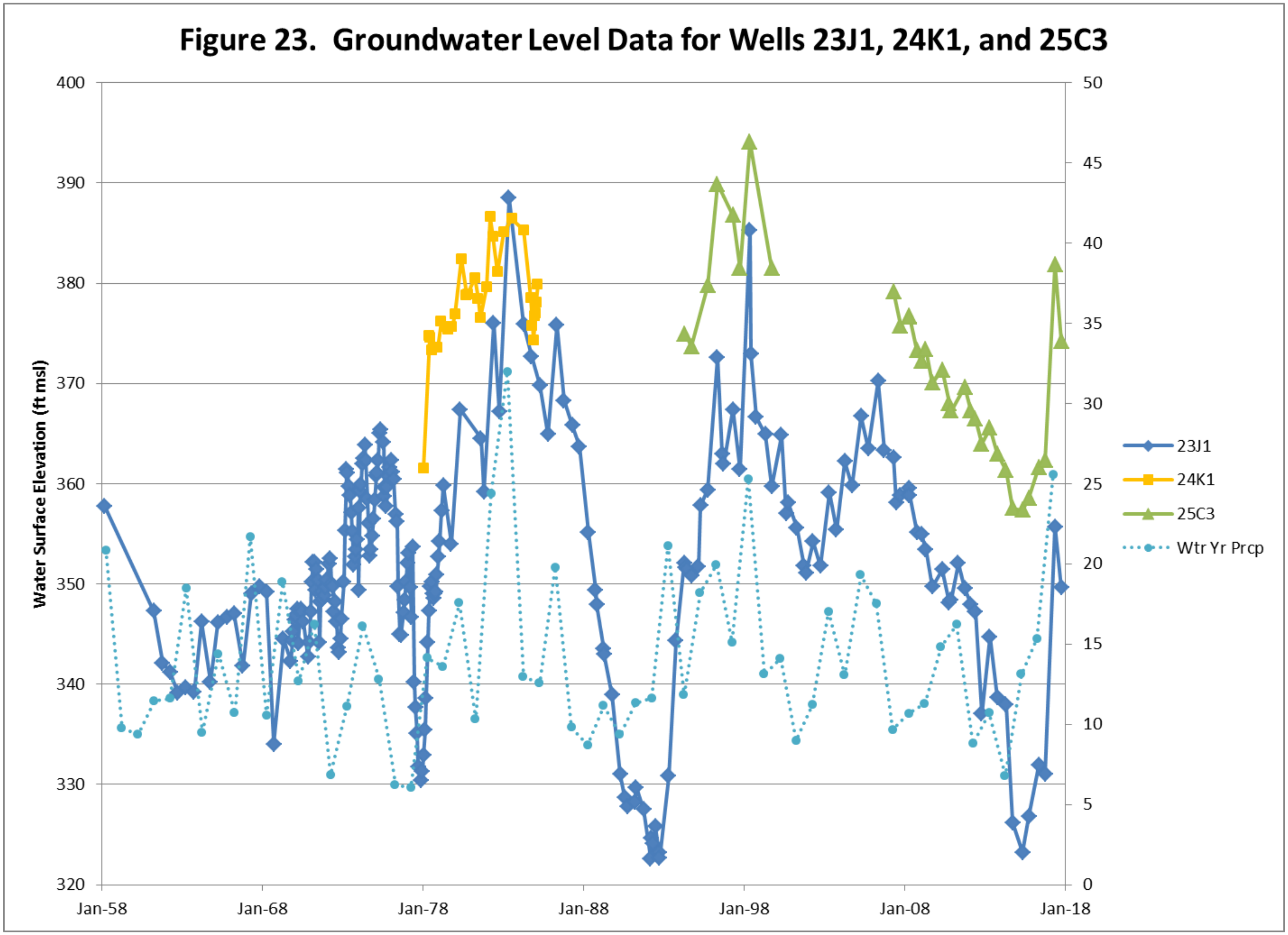
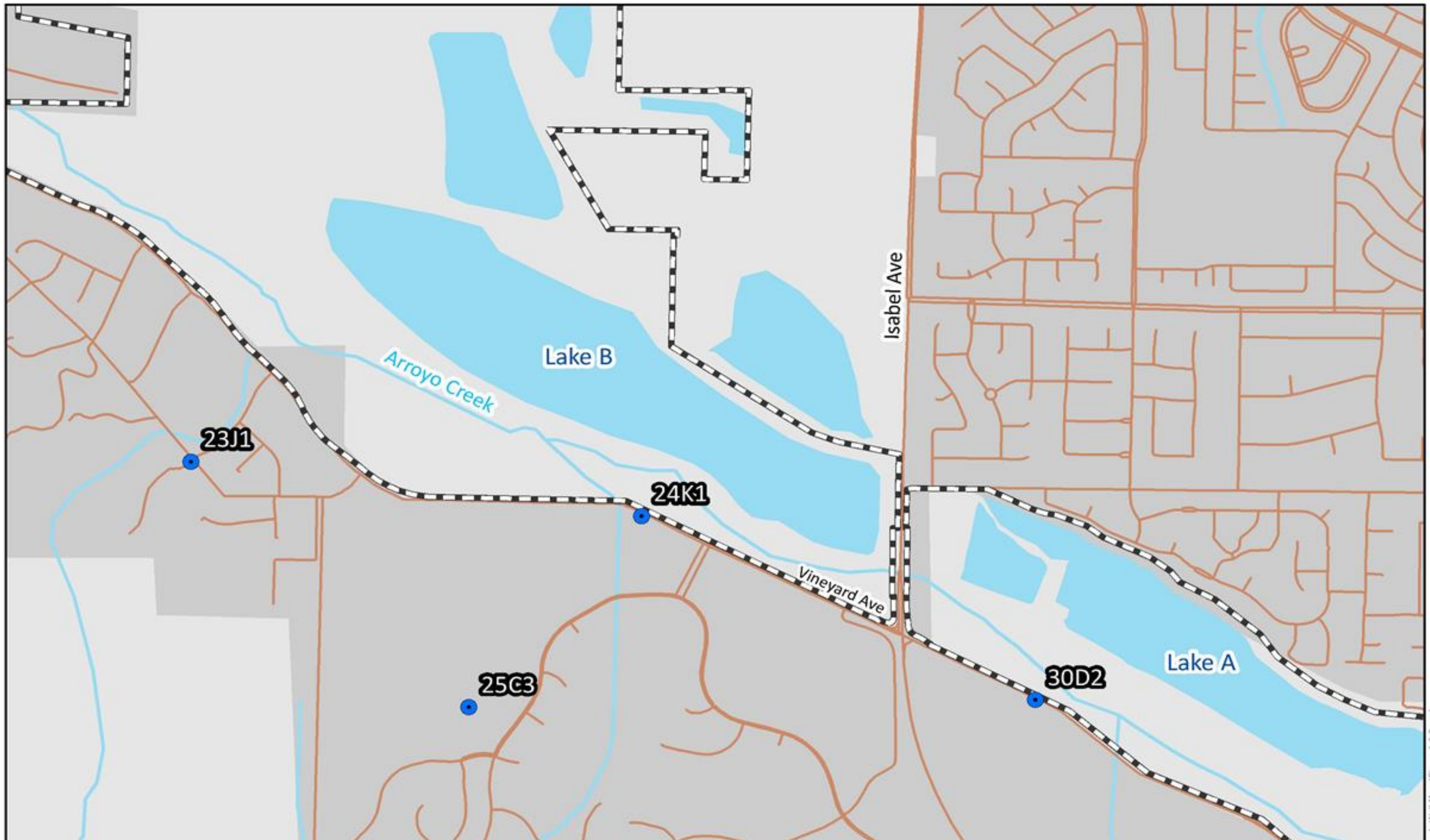


Figure 23. Groundwater Level Data for Wells 23J1, 24K1, and 25C3
Water Surface Elevation (ft msl)
400
390
380
370
360
350
340
330
320
50
45
40
35
30
25
20
15
10
5
0
Jan-58
Jan-68
Jan-78
Jan-88
Jan-98
Jan-08
Jan-18
23J1
24K1
25C3
Wtr Yr Prcp



Legend:

- Well
- Eliot Property Boundary
- Lake/Pond
- Stream/Waterway
- Roadway

0 500 1,000 1,500 2,000 2,500 Feet

N

Lake B Location Map

Eliot Quarry

1544 Stanley Blvd, Pleasanton, CA 94566

Figure 24

Disclaimer: The data was mapped for planning purposes only. No liability is assumed for accuracy of the data shown.

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Date: 6/20/2018 Projects\012 - Cemex\Eliot\Andy Well Maps\Figure 1 & 9.mxd

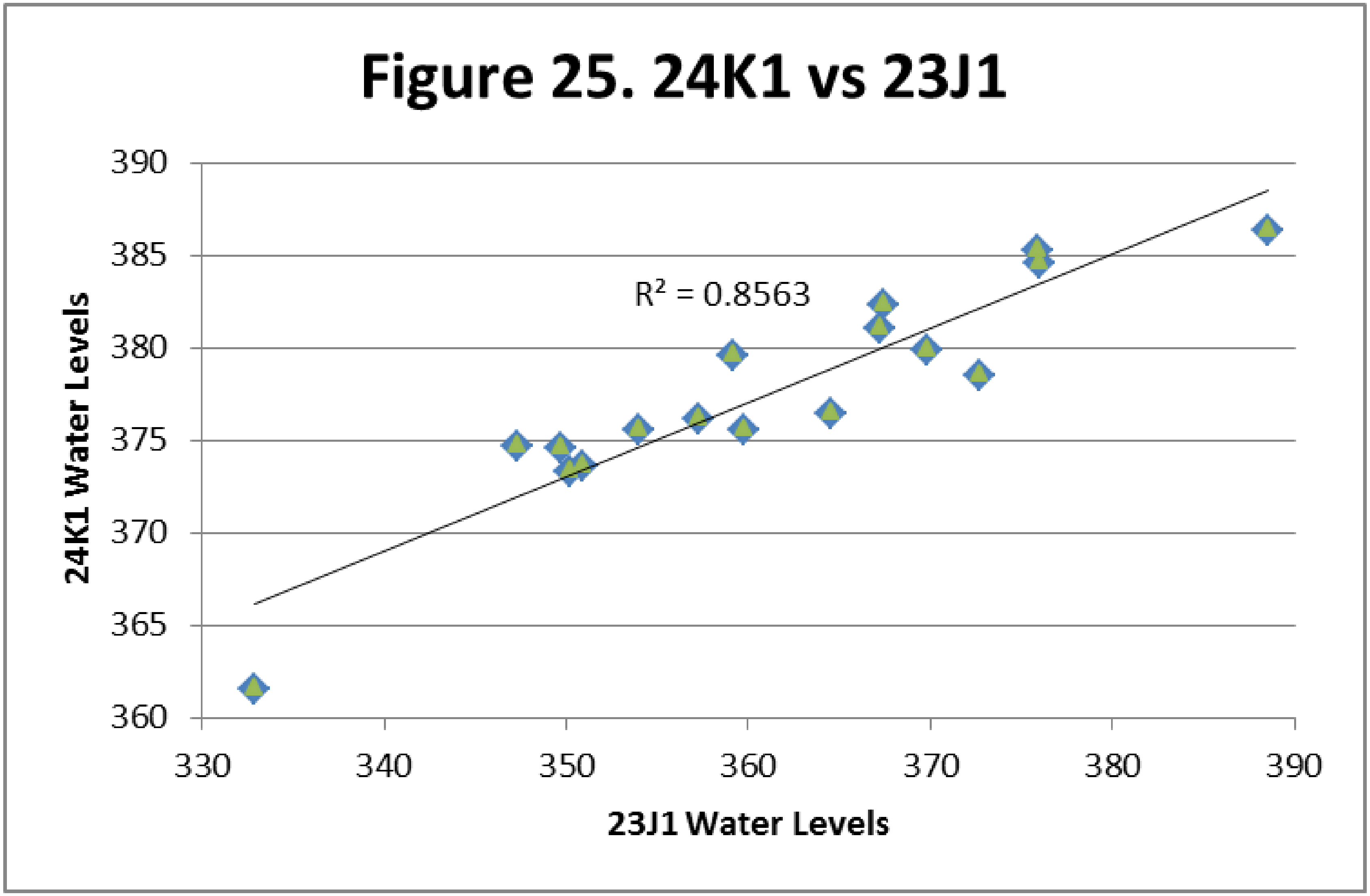


Figure 25. 24K1 vs 23J1
390
385
380
375
370
365
360
330
340
350
360
370
380
390
R² = 0.8563
24K1 Water Levels
23J1 Water Levels

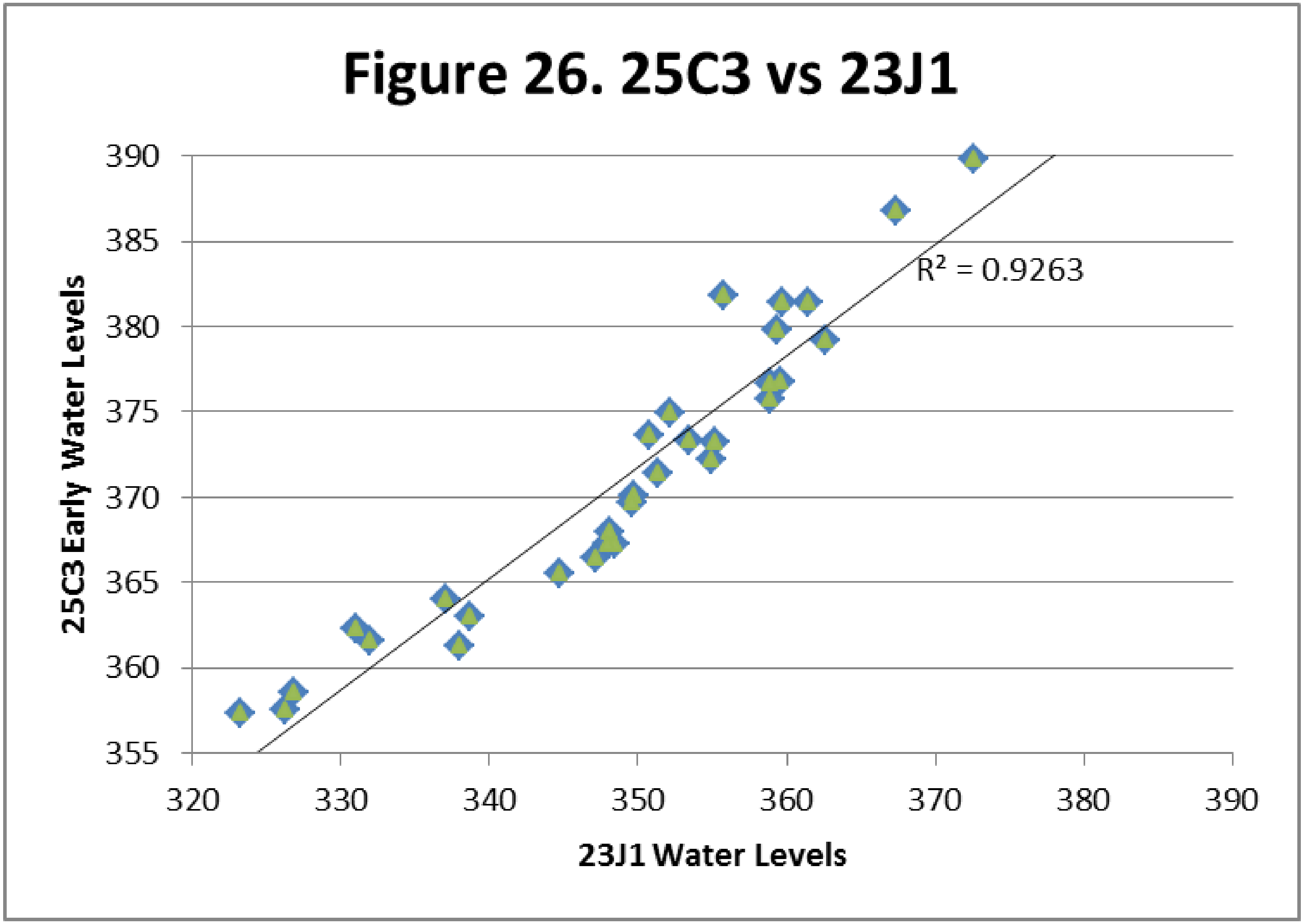


Figure 26. 25C3 vs 23J1
390
385
380
375
370
365
360
355
320
330
340
350
360
370
380
390
R² = 0.9263
25C3 Early Water Levels
23J1 Water Levels

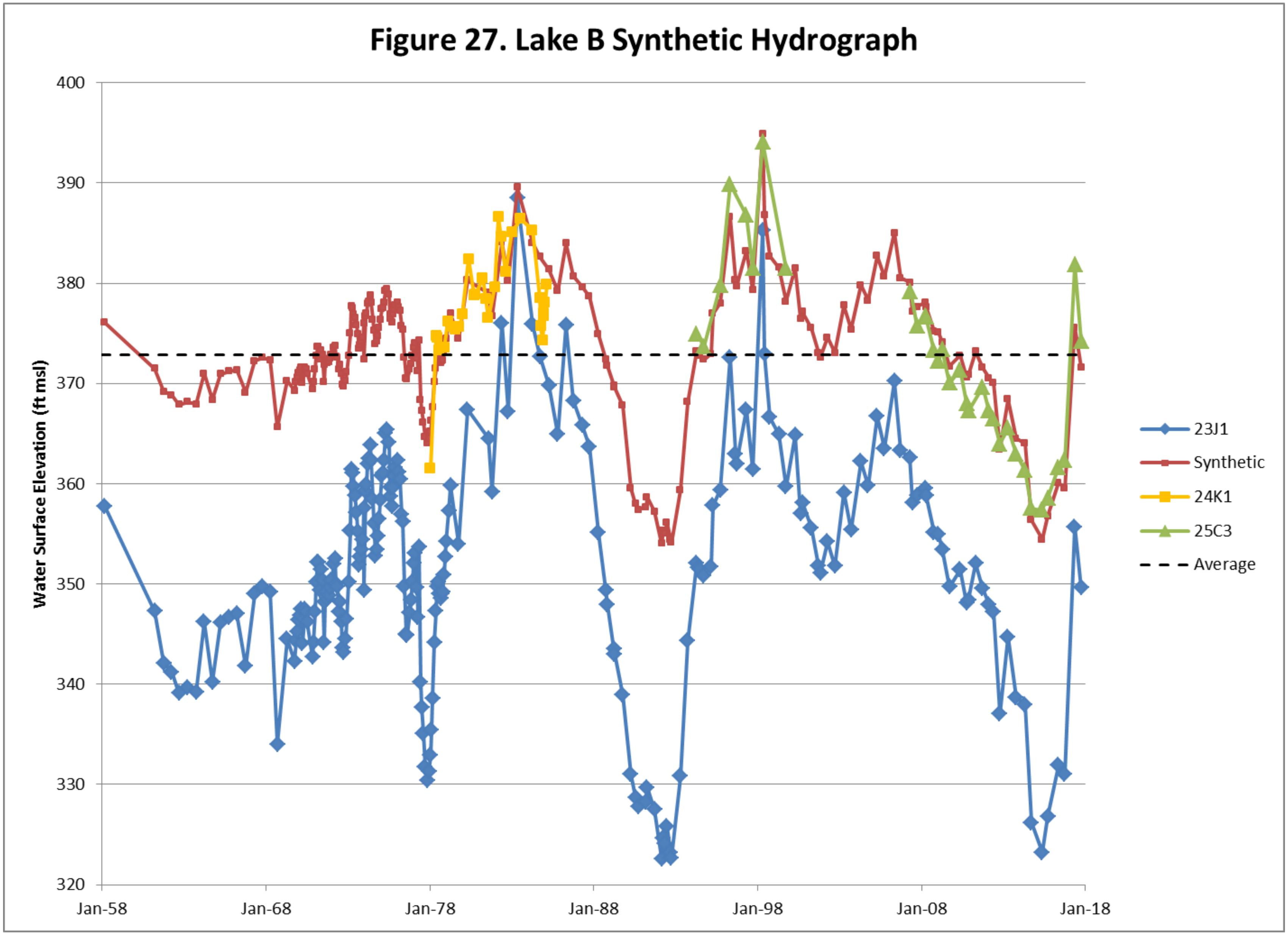
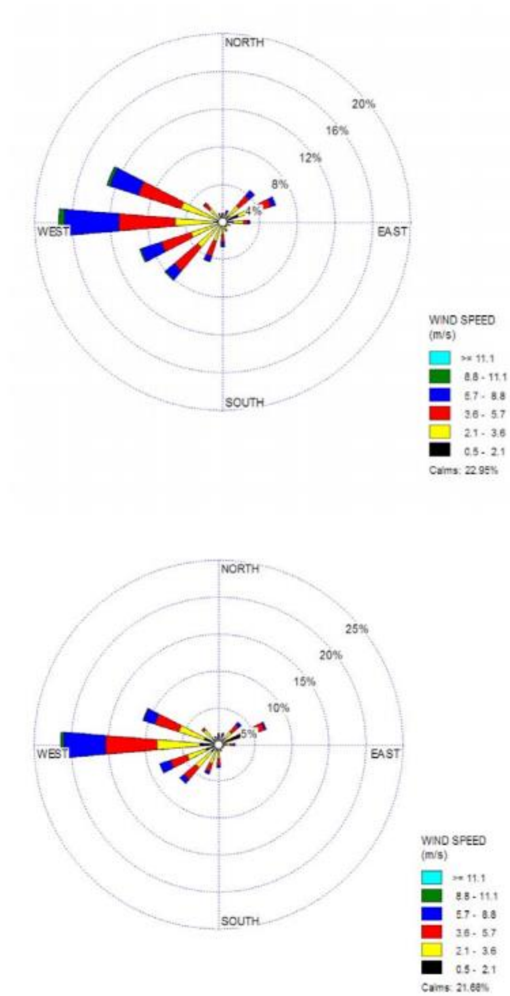


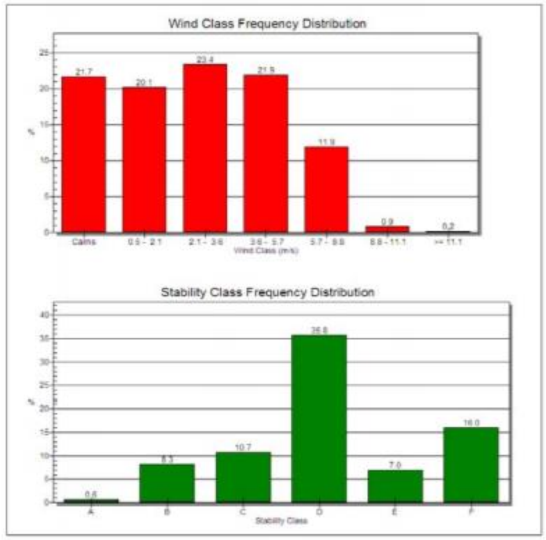
Figure 27. Lake B Synthetic Hydrograph
Water Surface Elevation (ft msl)
400
390
380
370
360
350
340
330
320
Jan-58
Jan-68
Jan-78
Jan-88
Jan-98
Jan-08
Jan-18
23J1
Synthetic
24K1
25C3
Average



Livermore Municipal (ID24927, NCDC): (top) Measured; (bottom) Predicted

F - 1

Figure 28. Predominant Wind Directions at Livermore Municipal Airport



Wind speed and stability class frequency distribution at Livermore municipal (ID24927)

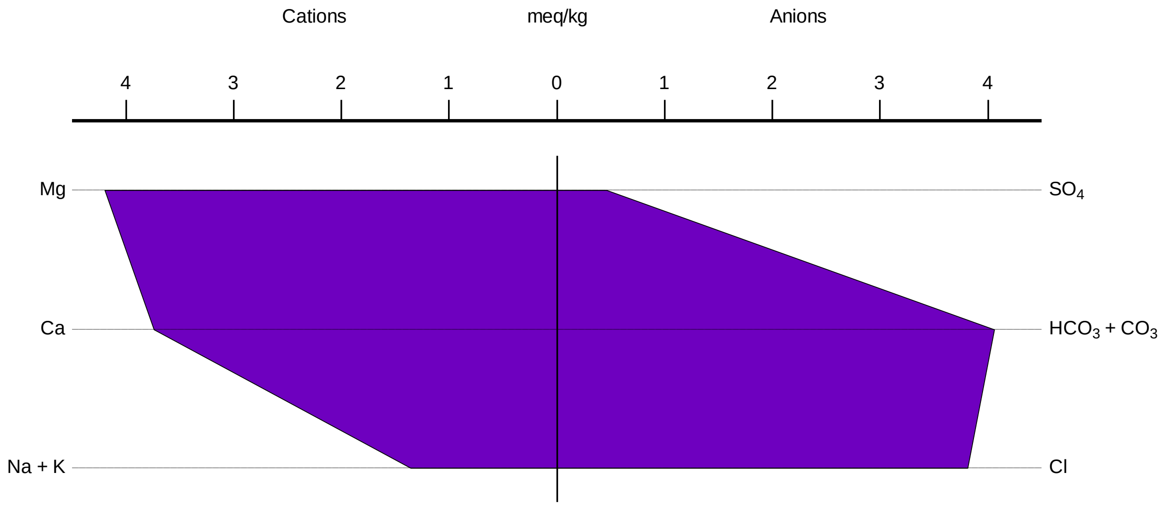
Figure 29.

APPENDICES

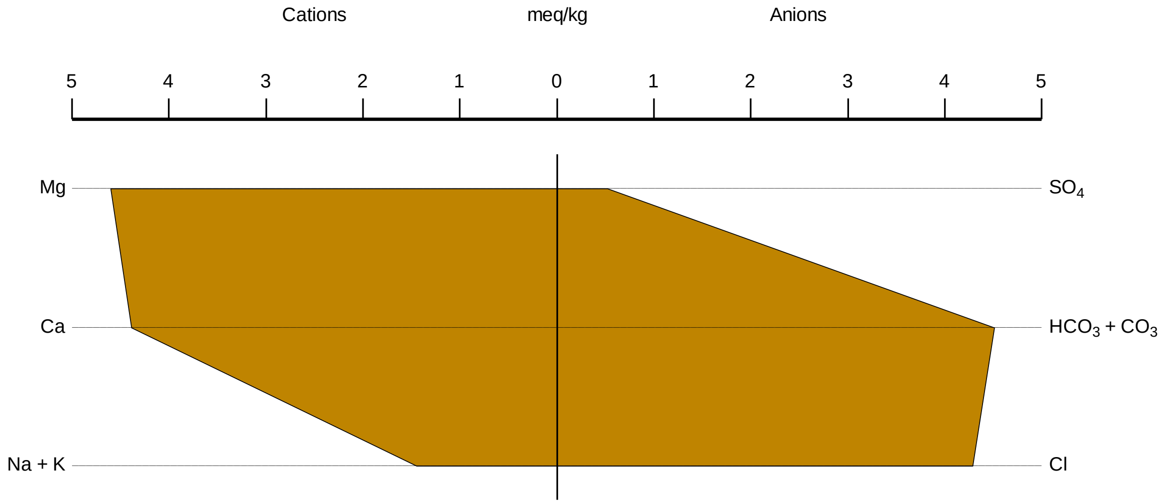
APPENDIX A

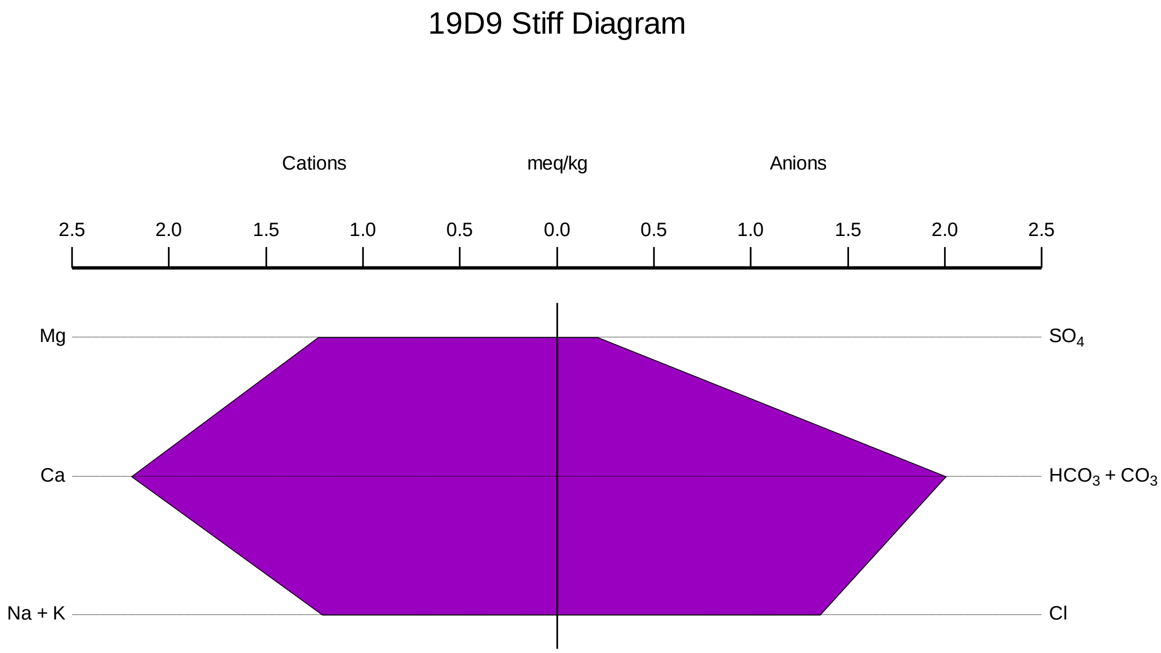
Water Quality Data Plots for Groundwater Wells near the Eliot Quarry

19D7 Stiff Diagram

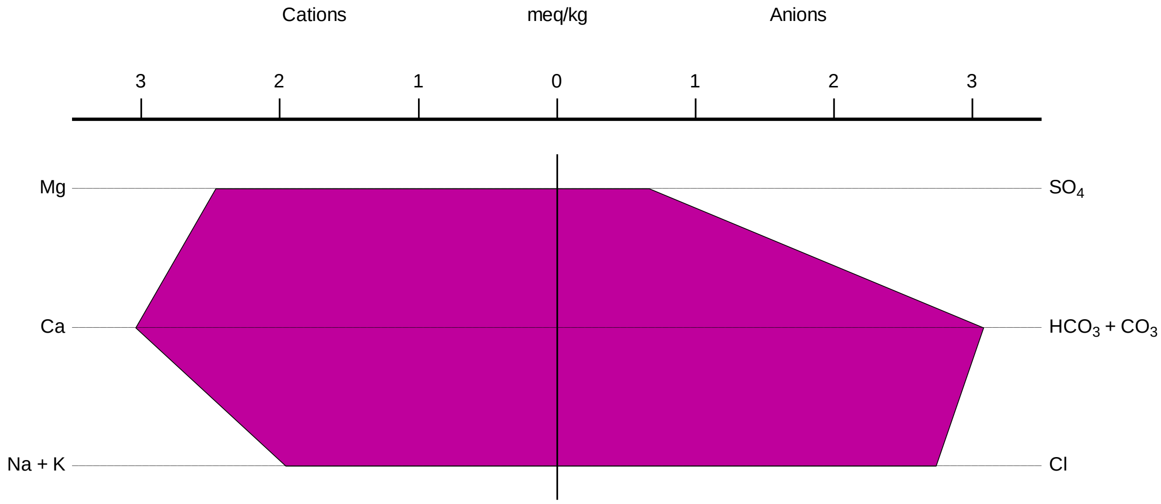


19D8 Stiff Diagram

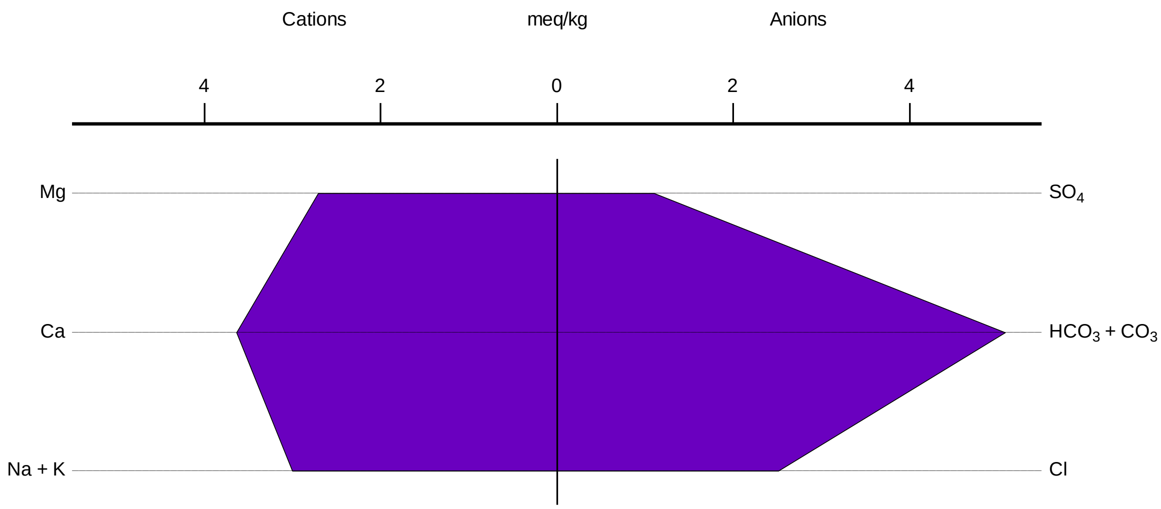



19D9 Stiff Diagram
Cations
meq/kg
Anions
2.5
2.0
1.5
1.0
0.5
0.0
0.5
1.0
1.5
2.0
2.5
Mg
Ca
Na + K
SO4
HCO3 + CO3
Cl

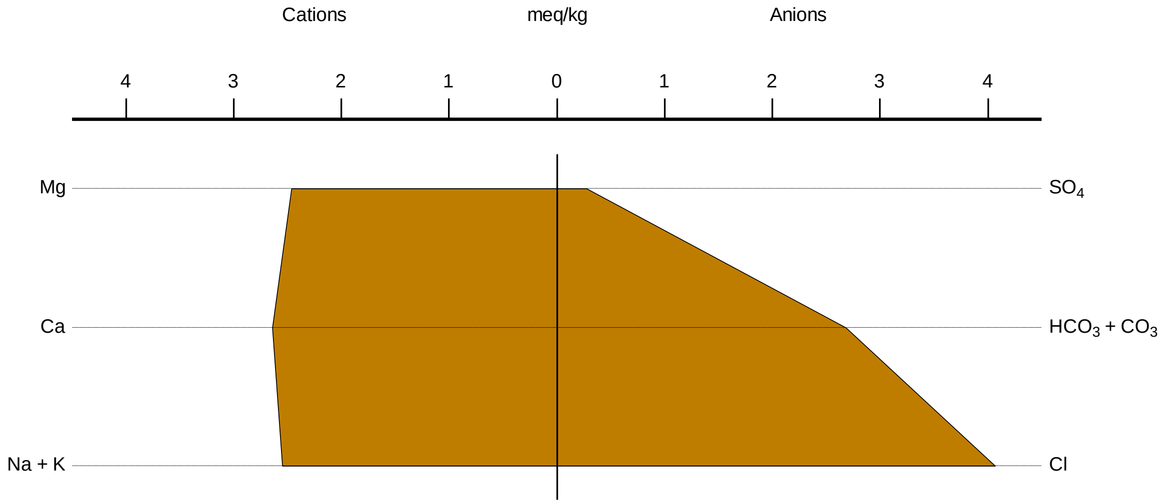
19D10 Stiff Diagram



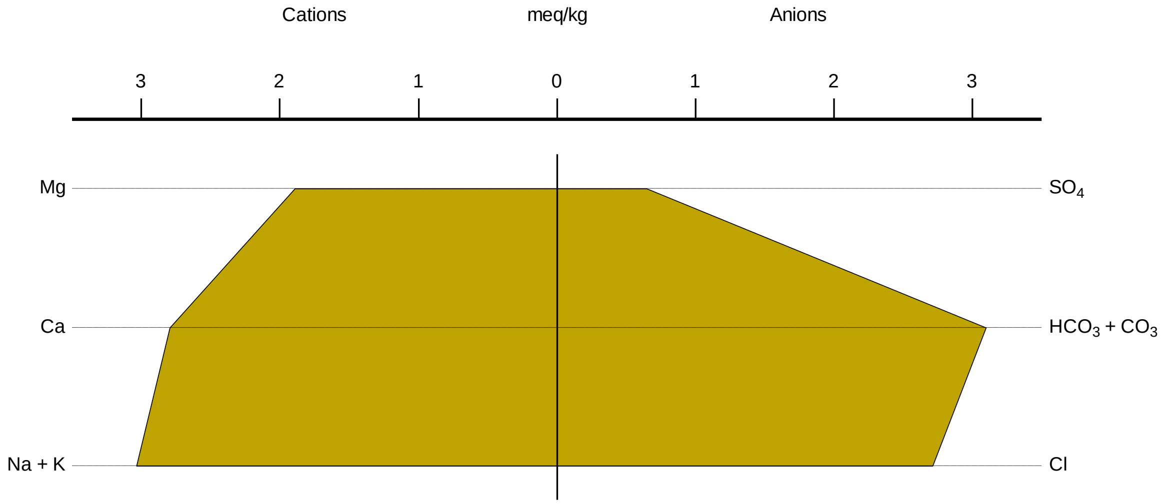
20M1 Stiff Diagram



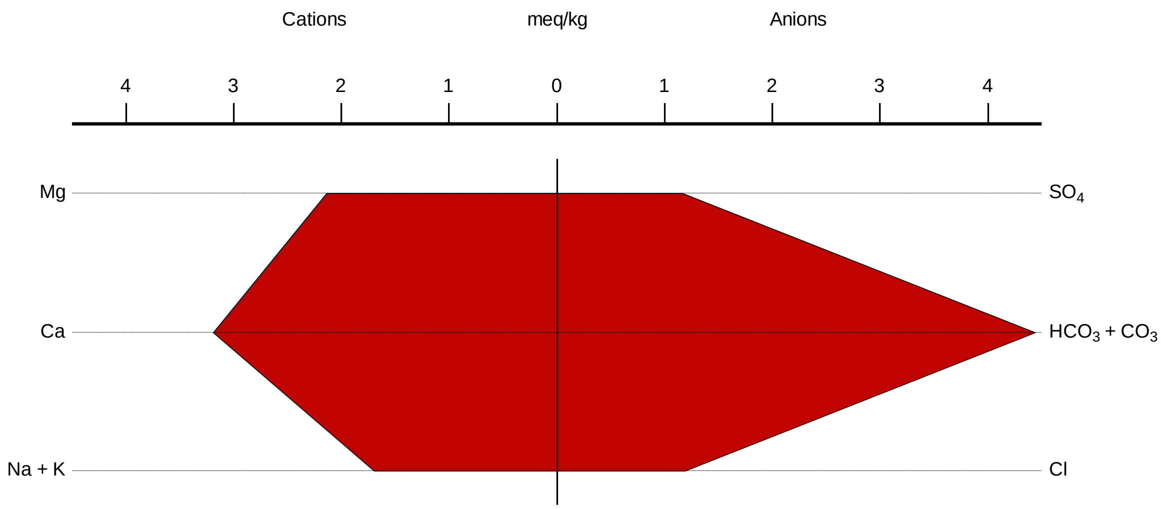
23J1 Stiff Diagram



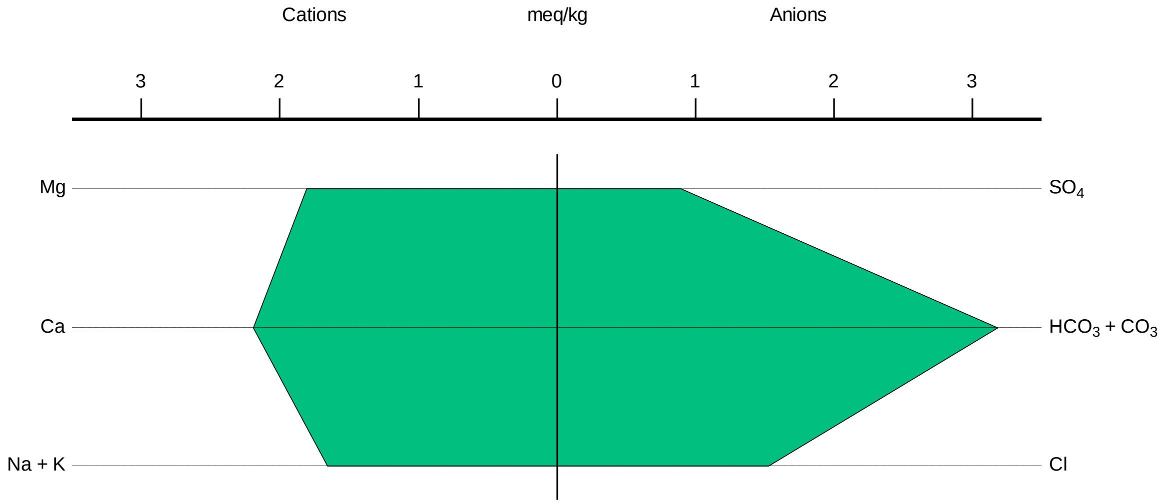
25C3 Stiff Diagram



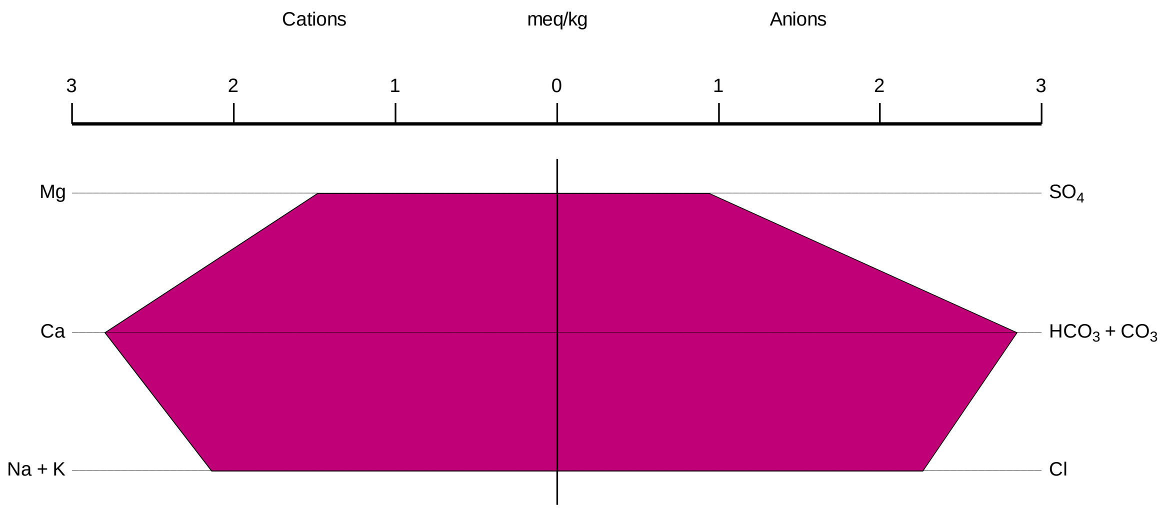
29F4 Stiff Diagram



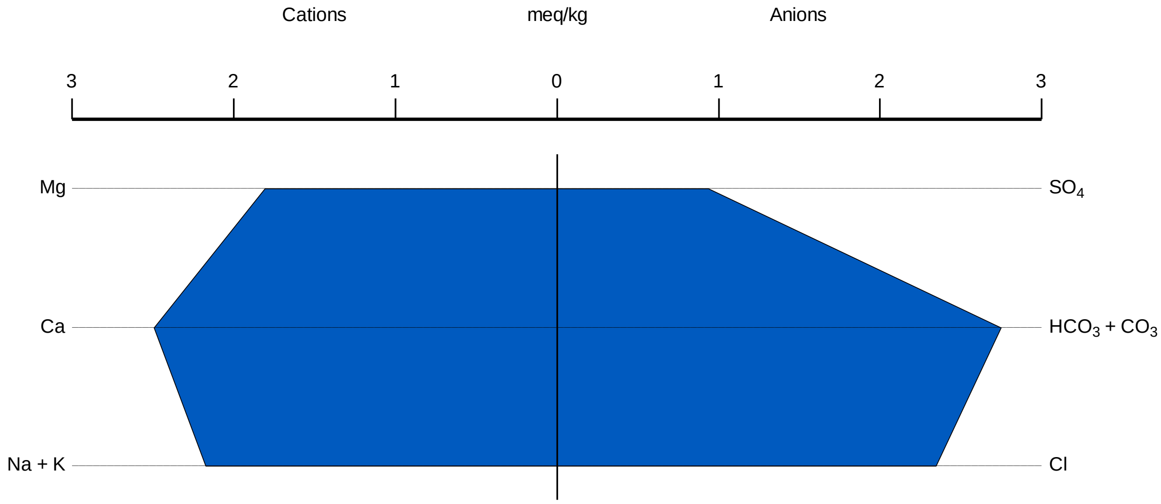
30D2 Stiff Diagram



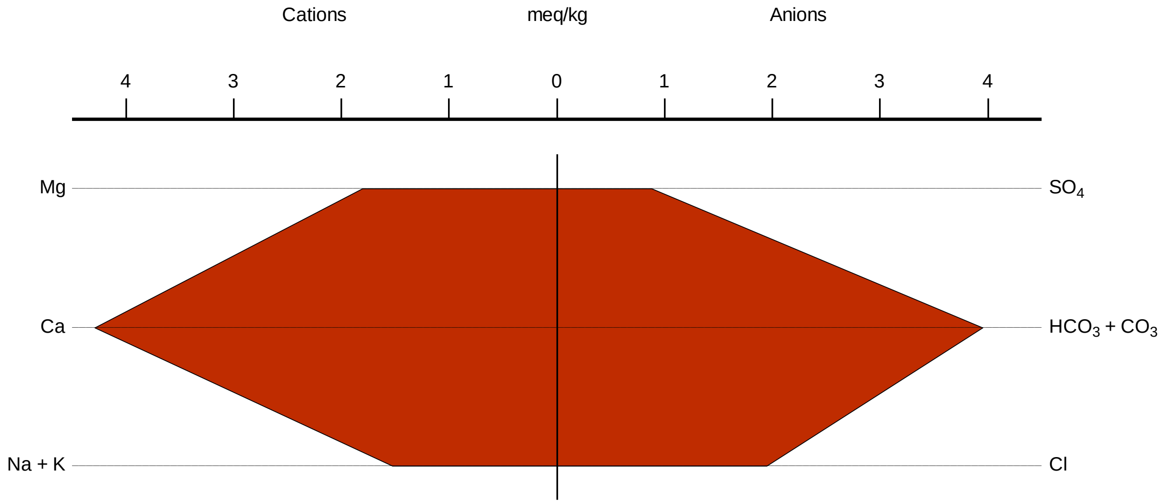
13P1 Stiff Diagram



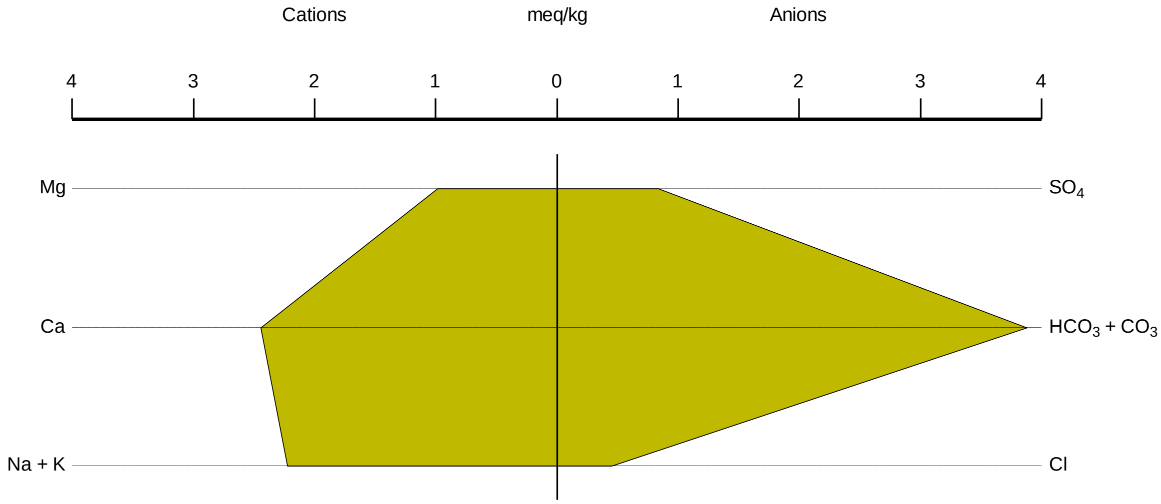
13P5 Stiff Diagram



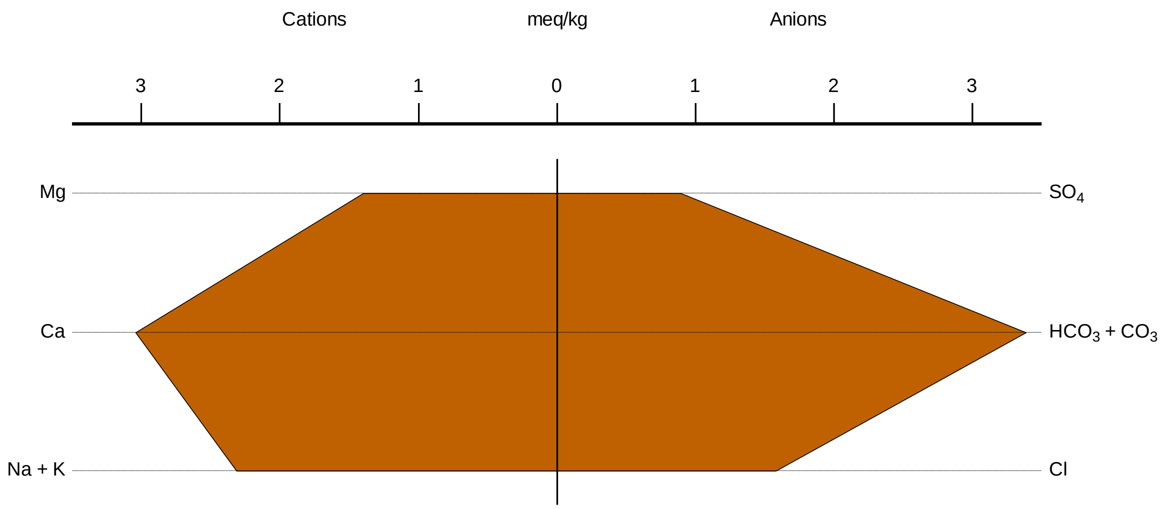
13P6 Stiff Diagram



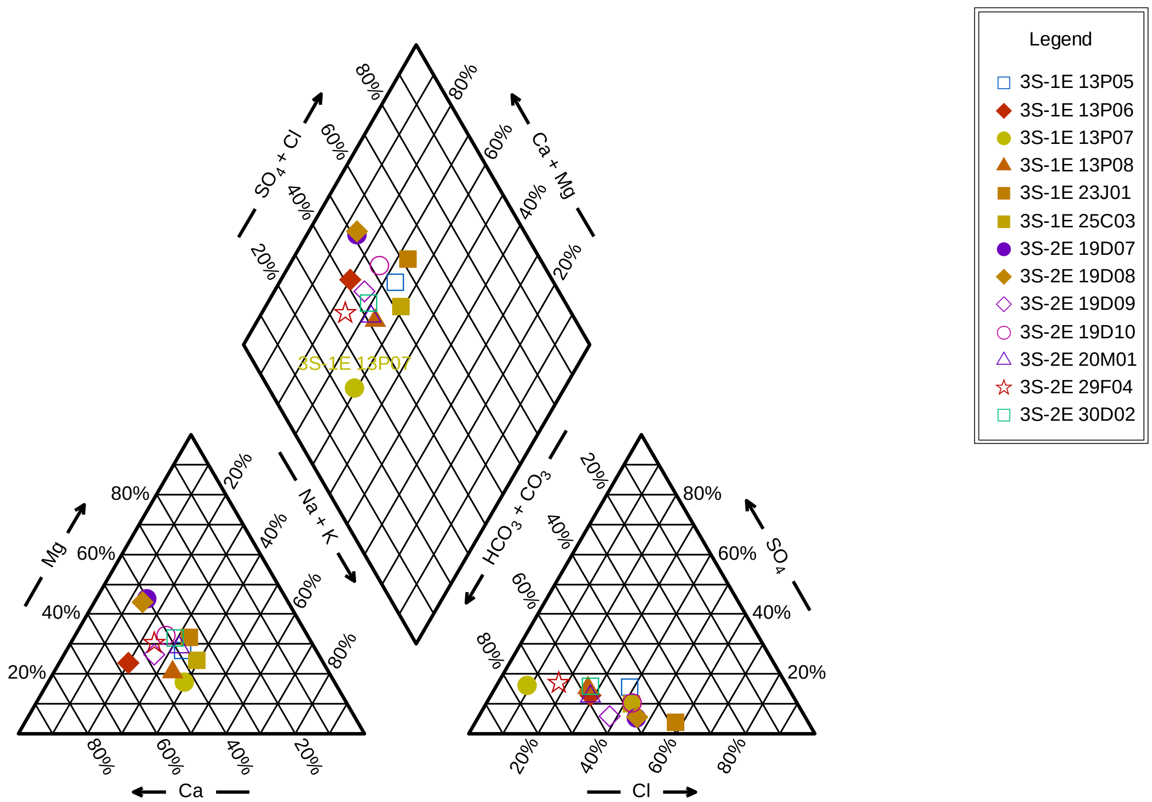
13P7 Stiff Diagram



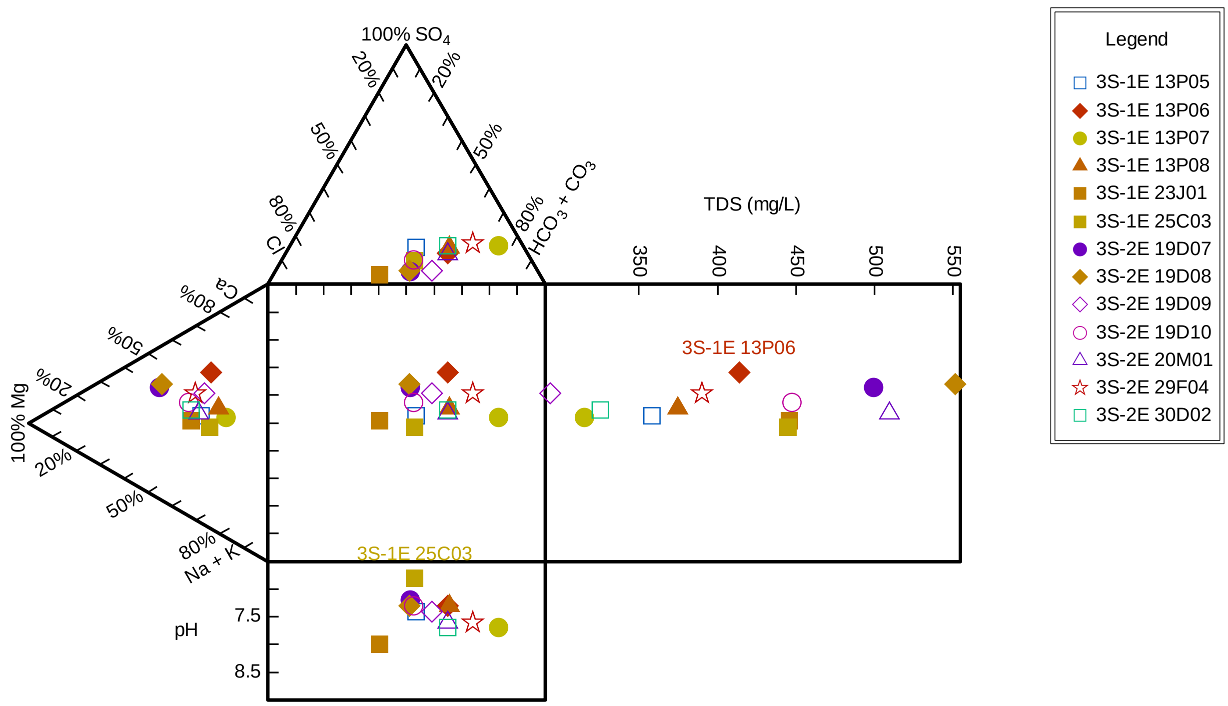
13P8 Stiff Diagram

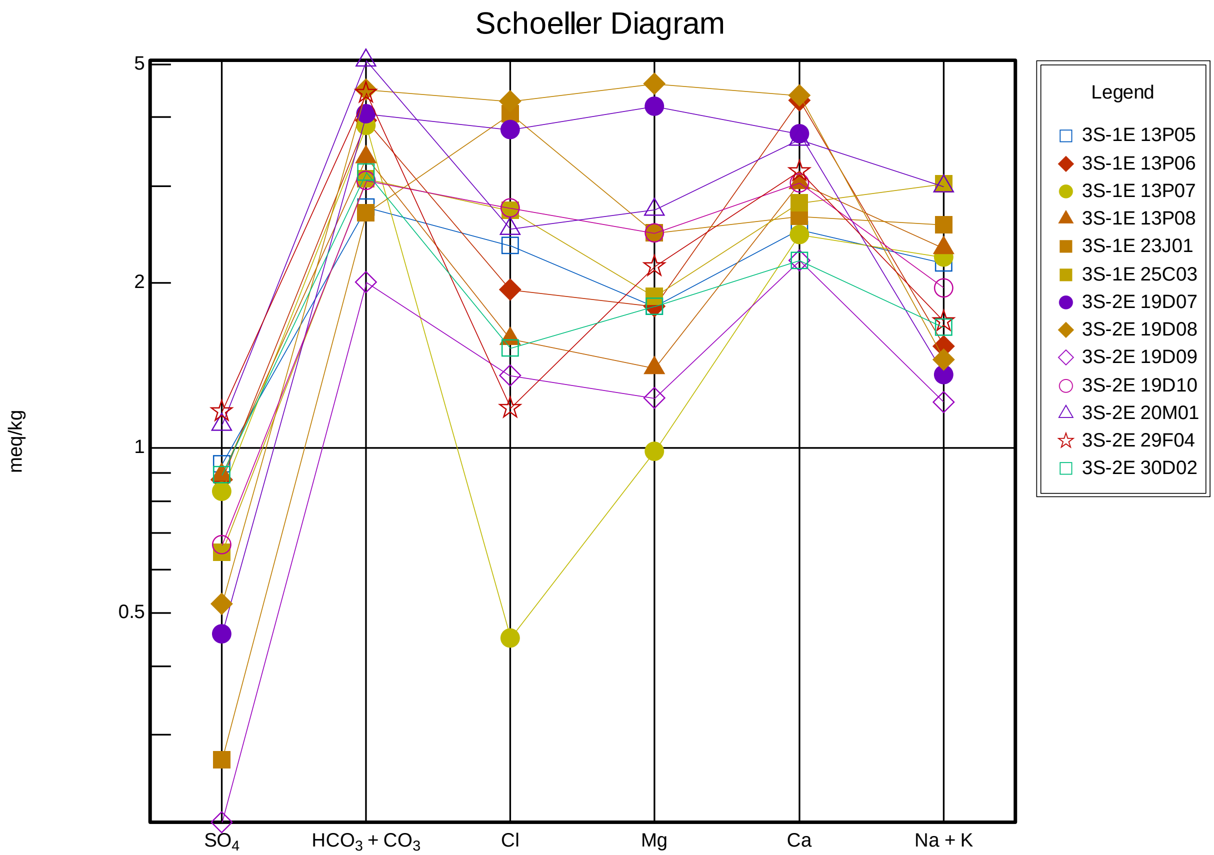


Piper Diagram



Durov Diagram

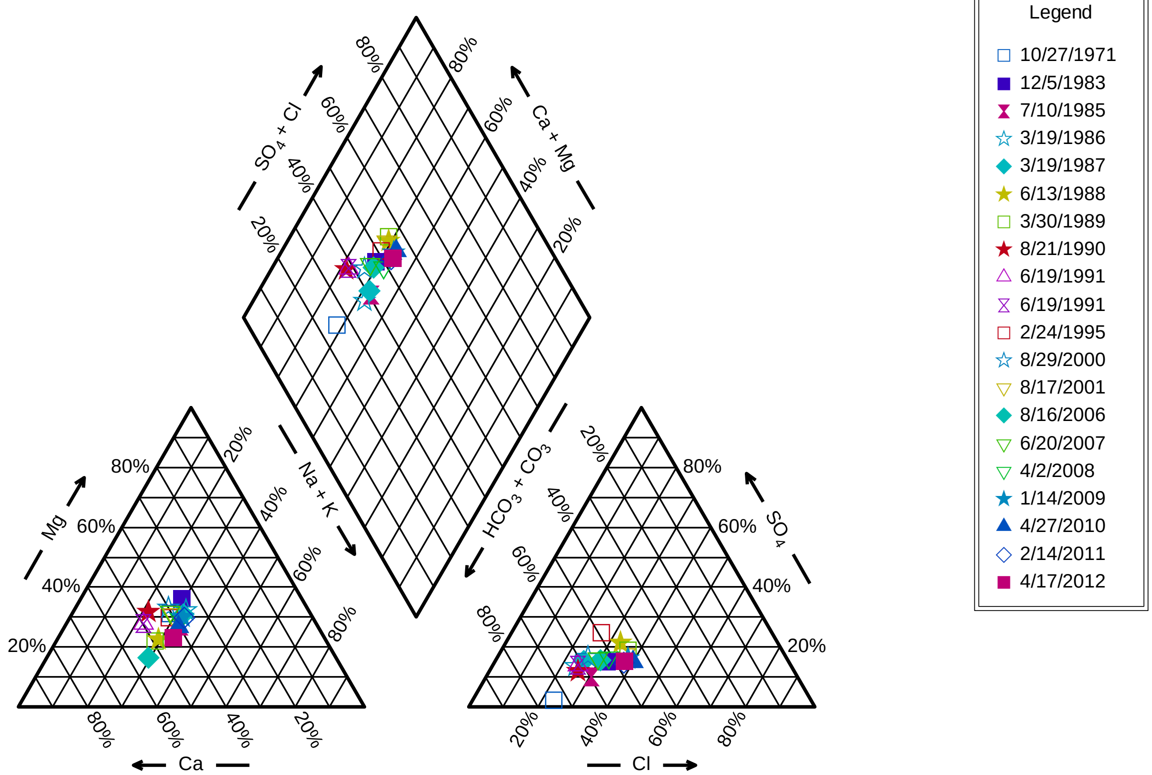



Schoeller Diagram
meq/kg
5
2
1
0.5
SO4
HCO3 + CO3
Cl
Mg
Ca
Na + K
Legend
3S-1E 13P05
3S-1E 13P06
3S-1E 13P07
3S-1E 13P08
3S-1E 23J01
3S-1E 25C03
3S-2E 19D07
3S-2E 19D08
3S-2E 19D09
3S-2E 19D10
3S-2E 20M01
3S-2E 29F04
3S-2E 30D02

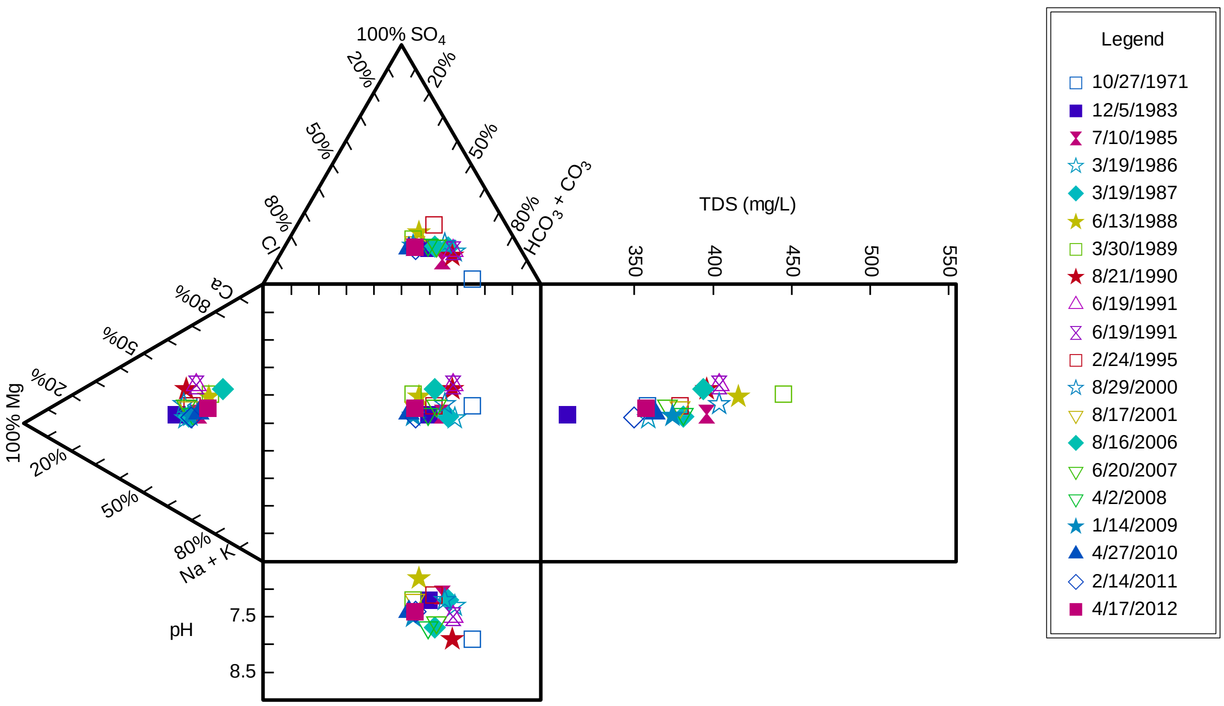
APPENDIX B

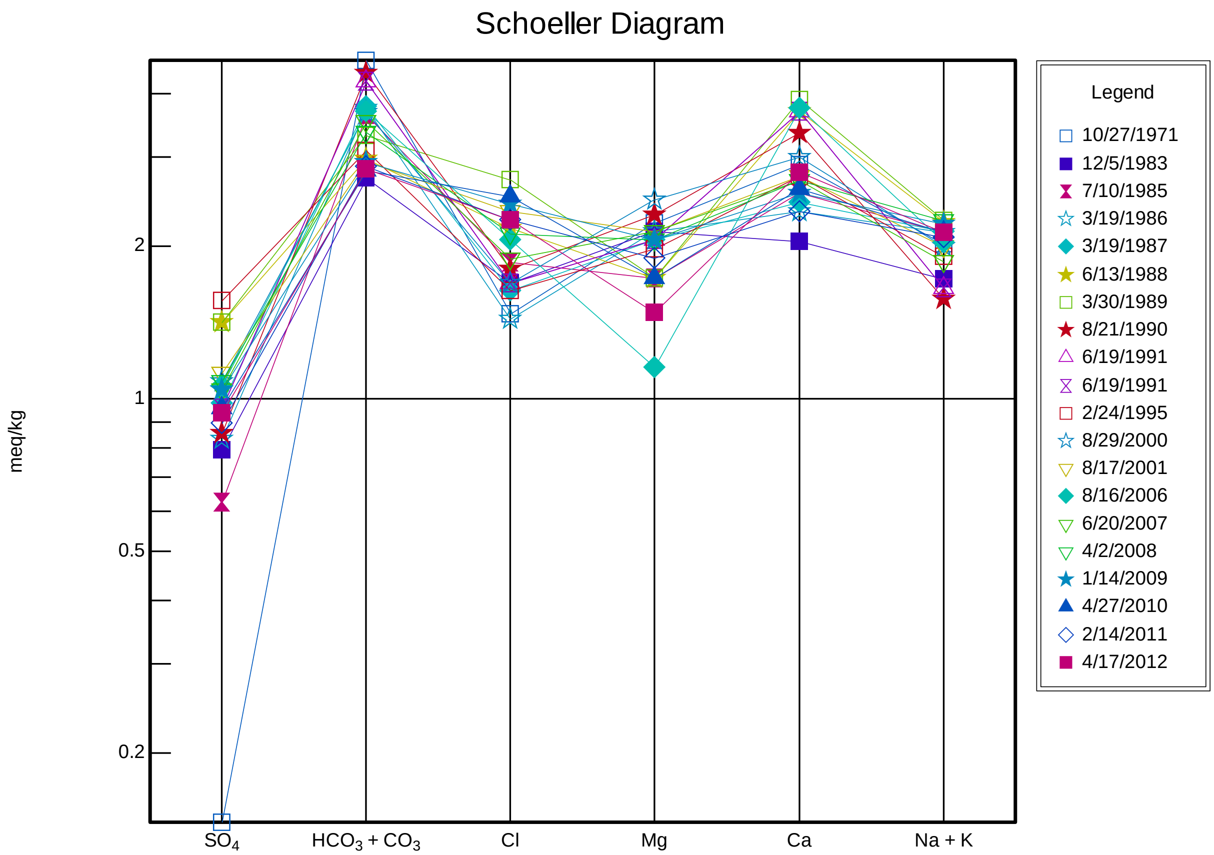
Water Quality Data Plots for Well 13P1
1971 through 2012

Piper Diagram



Durov Diagram



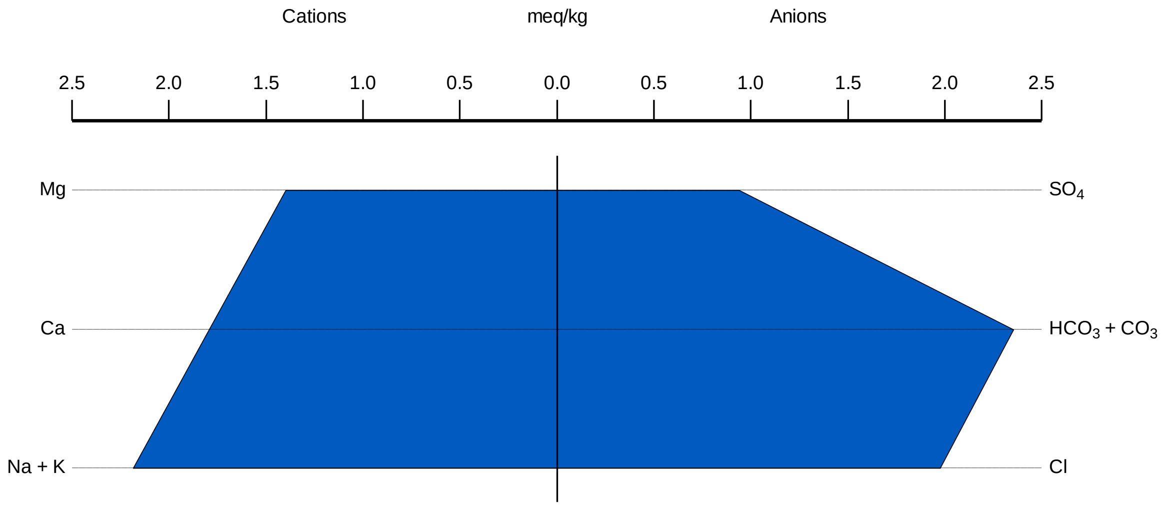


Schoeller Diagram
meq/kg
2
1
0.5
0.2
SO4
HCO3 + CO3
Cl
Mg
Ca
Na + K
Legend
10/27/1971
12/5/1983
7/10/1985
3/19/1986
3/19/1987
6/13/1988
3/30/1989
8/21/1990
6/19/1991
6/19/1991
2/24/1995
8/29/2000
8/17/2001
8/16/2006
6/20/2007
4/2/2008
1/14/2009
4/27/2010
2/14/2011
4/17/2012

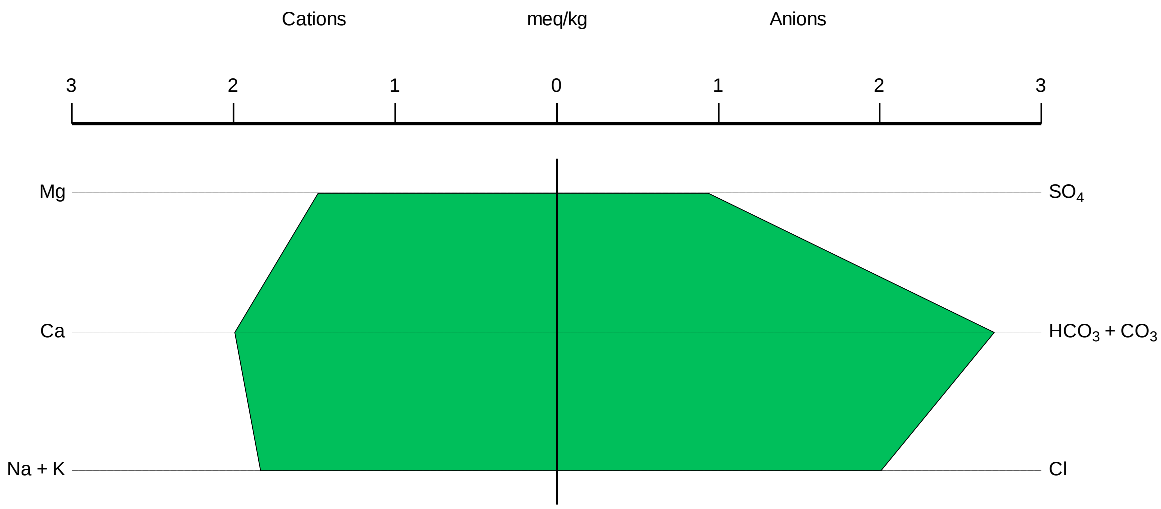
APPENDIX C

Water Quality Data Plots for Surface Water Locations near the Eliot Quarry

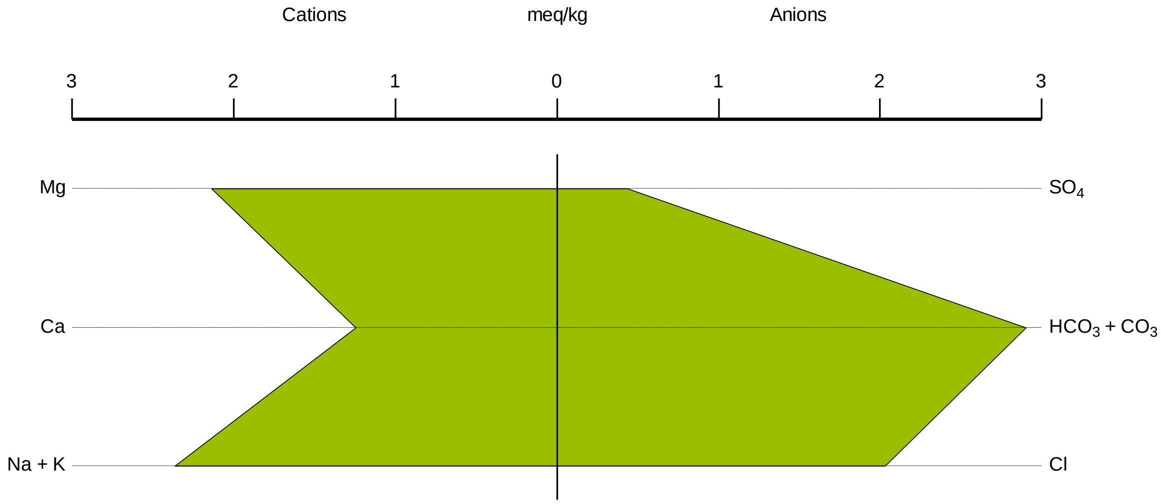
K-18 Stiff Diagram



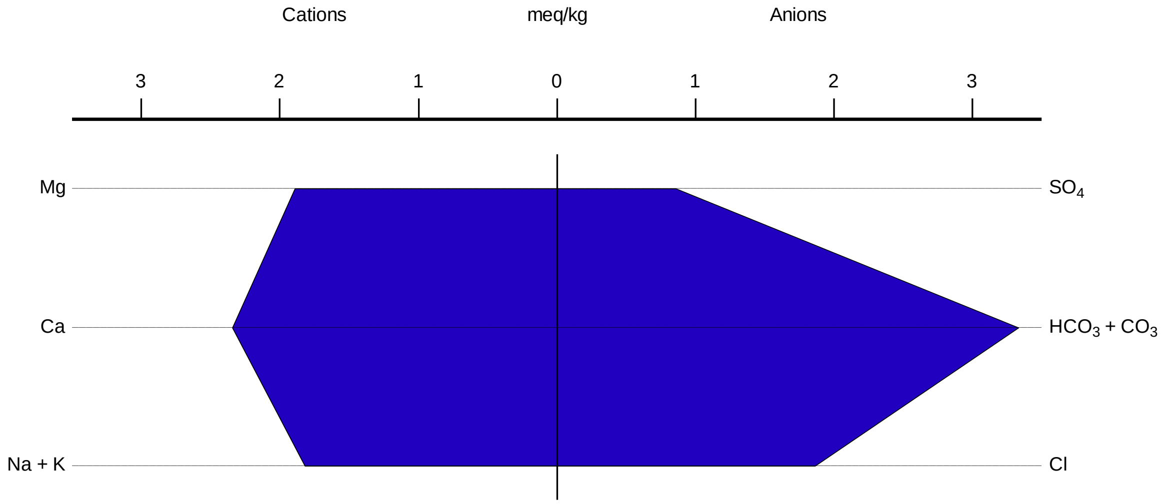
P-12 Stiff Diagram



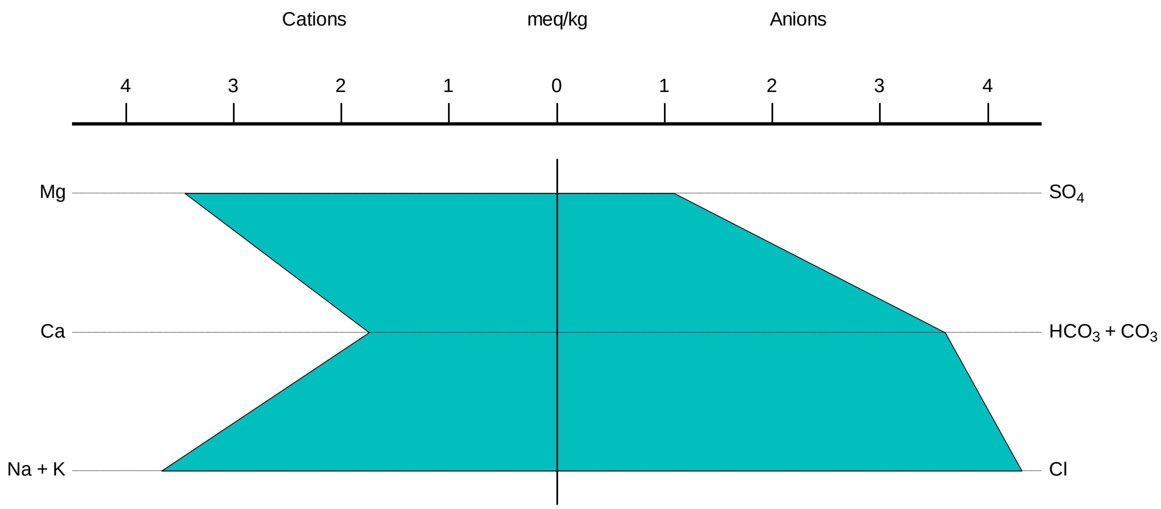
P-10 Stiff Diagram



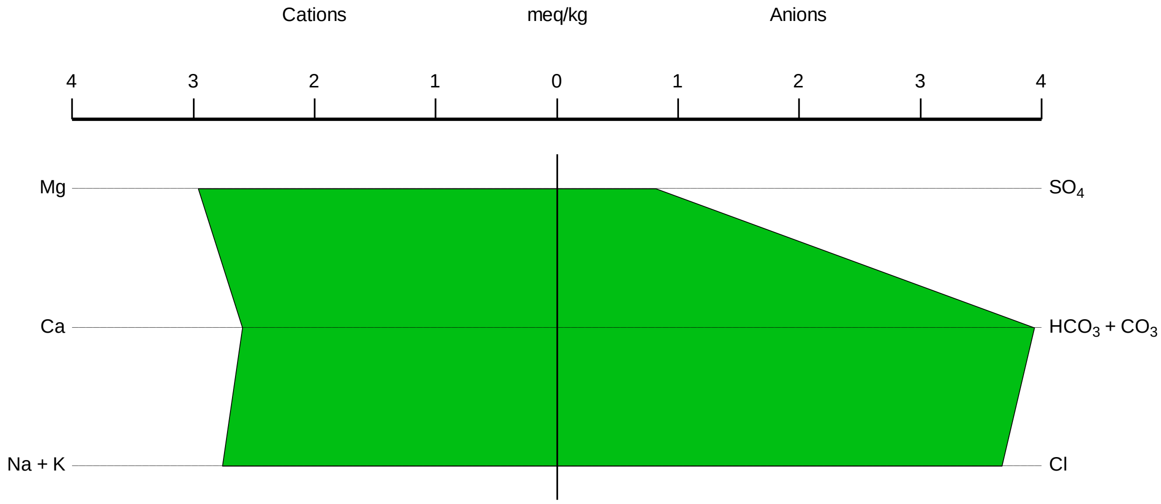
P-42 Stiff Diagram

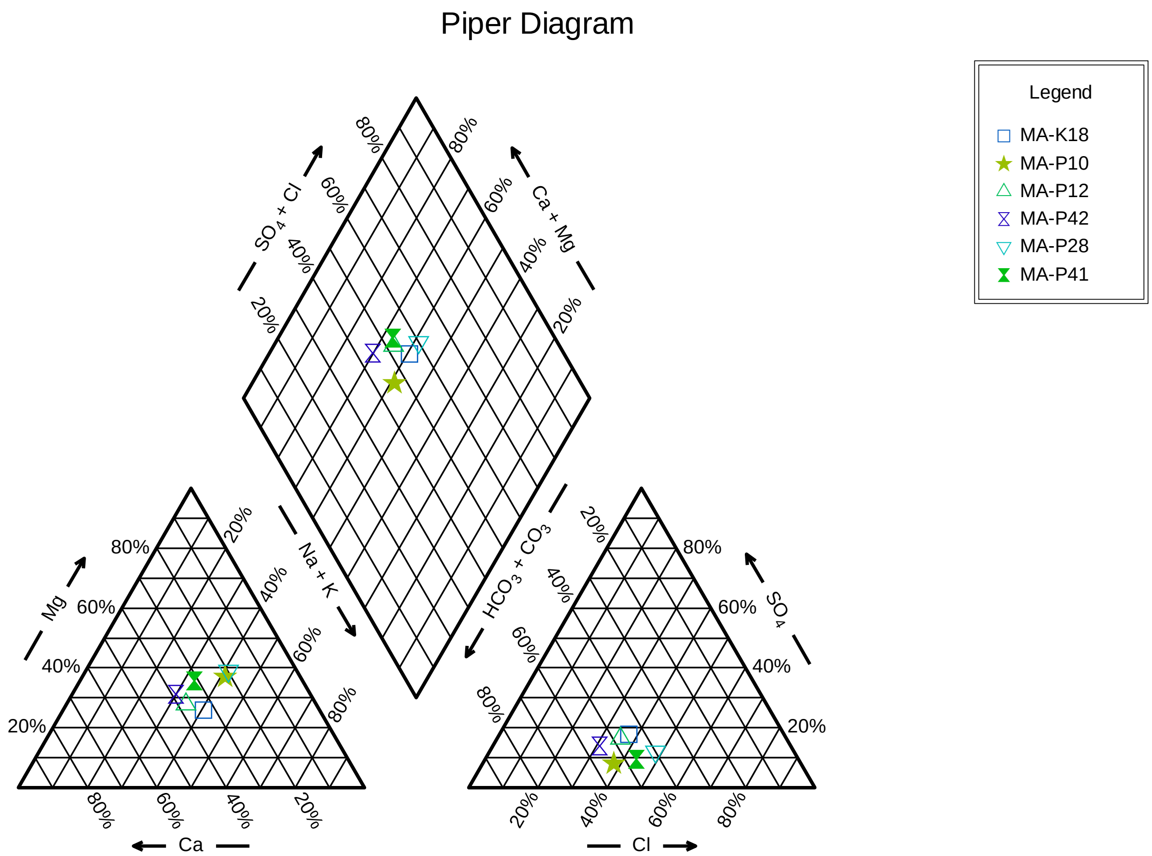


P-28 Stiff Diagram

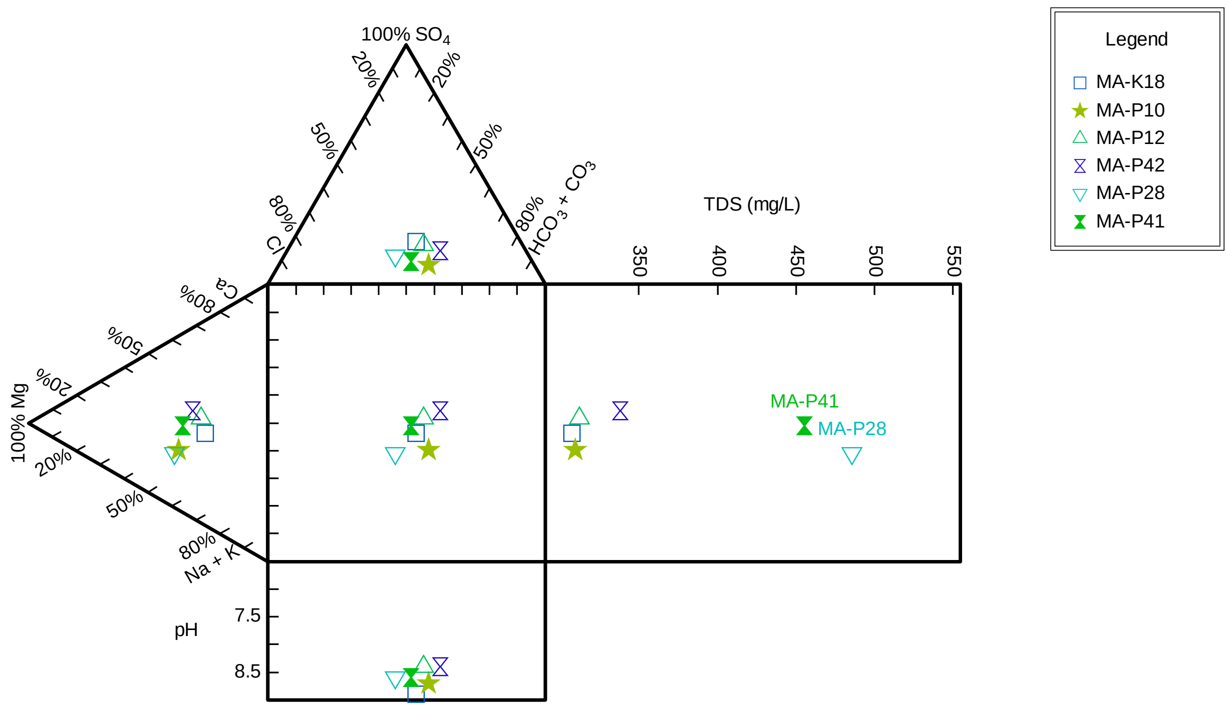


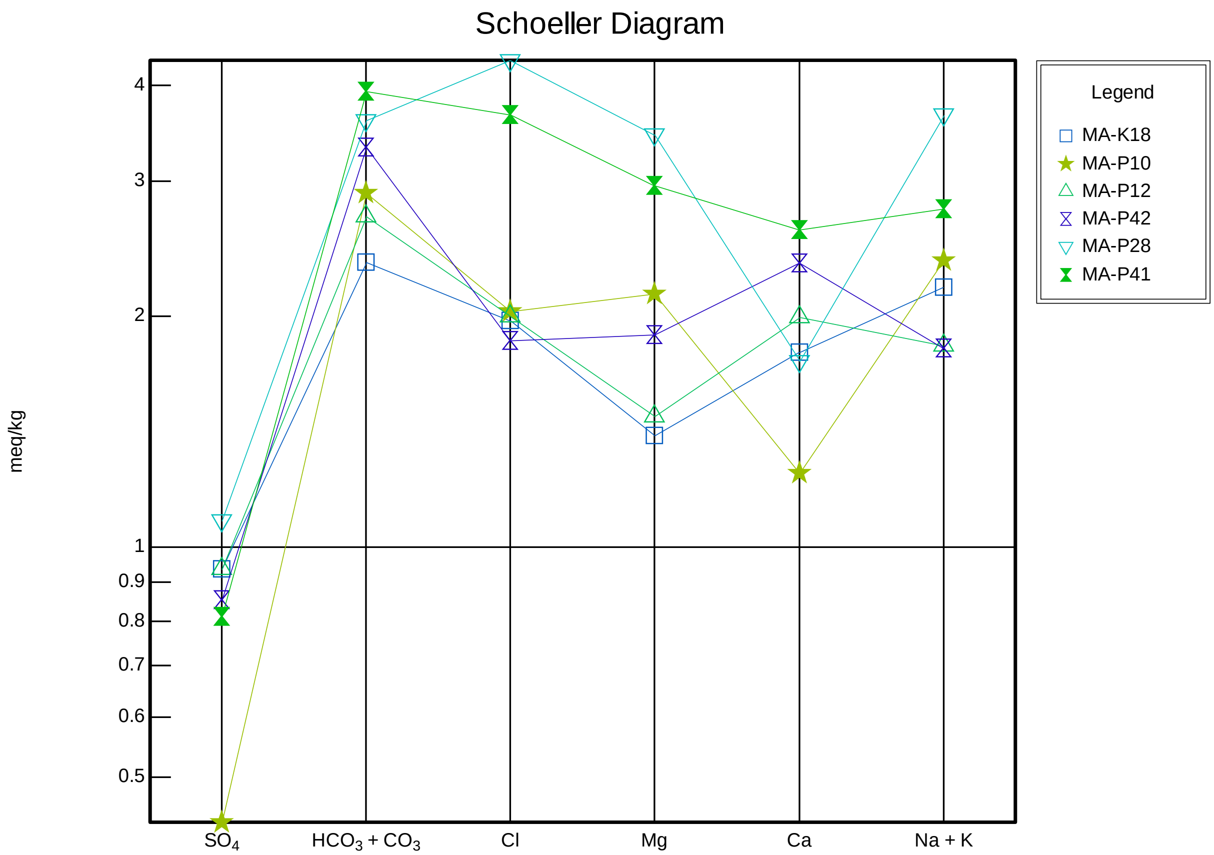
P-41 Stiff Diagram




Piper Diagram
Legend
MA-K18
MA-P10
MA-P12
MA-P42
MA-P28
MA-P41
SO4 + Cl
Ca + Mg
Na + K
HCO3 + CO3
Mg
Ca
Cl
SO4
20%
40%
60%
80%

Durov Diagram




Schoeller Diagram
meq/kg
4
3
2
1
0.9
0.8
0.7
0.6
0.5
SO4
HCO3 + CO3
Cl
Mg
Ca
Na + K
Legend
MA-K18
MA-P10
MA-P12
MA-P42
MA-P28
MA-P41