ARCADIS

Mr. Timothy A. Cazier, P.E.
Environmental Protection Specialist
Colorado Division of Reclamation, Mining and Safety
Department of Natural Resources
1313 Sherman Street, Room 215
Denver, Colorado 80203

Arcadis U.S., Inc.
630 Plaza Drive
Suite 200
Highlands Ranch
Colorado 80129
Phone: 720 344 3500
Fax: 720 344 3535
www.arcadis.com

Date: June 13, 2022
Our Ref: 30113015
Subject: REVISED Holcim (US) Inc. Portland, Colorado
2022 Groundwater Monitoring Report
DRMS Permit No. M-1977-344, Technical Revision No. 6

Dear Mr. Cazier,

On behalf of Holcim (US) Inc. (Holcim), please find enclosed one copy of the REVISED Final 2022 Groundwater Monitoring Report, which summarizes analytical results for groundwater samples collected on March 23, 2022.

The 2022 sampling results indicate that except for total iron in monitoring well MW-7 and sulfate in monitoring well MW-13, concentrations of all analytes measured in the two downgradient wells, MW-7 and MW-13, were below respective numeric protection levels. As we discussed, moving forward iron in the groundwater will be evaluated using dissolved, not total concentrations. This is discussed in the text of the report.

Based on the March 2022 sampling results that indicate there is no discernible impact from CKD, annual groundwater monitoring will resume unless future results require increased monitoring frequency.

Please contact me if you have any questions.

Sincerely,
Arcadis U.S., Inc.

Christopher S. Peters, CPG
Vice President

Email: chris.peters@arcadis.com
Direct Line: 517 324 5052

CC. Derrick Dease, Holcim (US) Inc.
Treck Hohman, Arcadis
File

[Full Name]
[Company]
[Date]

Enclosure: REVISED Final 2022 Groundwater Monitoring Report

Holcim (US) Inc.

2022 Groundwater Monitoring Report

DRMS Permit No. M-1977-344, Technical Revision No. 6 Florence, Colorado

May 2022
Revised June 2022

2022 Groundwater Monitoring Report

DRMS Permit No. M-1977-344, Technical Revision No. 6
Florence Colorable

May 2022

Revised June 2022

Prepared By:
Arcadis U.S., Inc.
630 Plaza Drive, Suite 200
Highlands Ranch
Colorado 80129
Phone: 720 344 3500
Fax: 303 470 2989

Prepared For:
Holcim (US) Inc.
3500 Highway 120
Florence, CO 81226
719.288.1423

Our Ref:
30113015

Treck Hohman
Environmental Scientist

Christopher S. Peters, PG
Certified Principal in Charge

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Acronyms and Abbreviations

ACZ	ACZ Laboratories, Inc., located in Steamboat Springs, Colorado
Arcadis	Arcadis U.S., Inc.
BBL	Blasland, Bouck & Lee, Inc.
bypass dust	alkali bypass dust
CDPHE	Colorado Department of Public Health and Environment
CKD	cement kiln dust
CKD disposal area	cement kiln dust and alkali bypass dust disposal area
DMG	Division of Minerals and Geology
DRMS	Colorado Division of Reclamation Mining and Safety
GMP	Groundwater Monitoring Plan
Holcim	Holcim (US) Inc.
MLRB	Mined Land Reclamation Board
NPL	numeric protection level
permit	State of Colorado Mining Permit No. M-77-344
plant	Portland Plant
report	2022 Groundwater Monitoring Report
RGI	Resource Geoscience, Inc.
site	Holcim Portland Plant, located in Florence, Colorado
TDS	total dissolved solids
tpy	tons per year
TR-06	Mine Permit Technical Revision TR-06
TSS	total suspended solids
WQCC	Water Quality Control Commission
WWTP	wastewater treatment plant

1 Introduction

Holcim (US) Inc. (Holcim) retained Arcadis U.S., Inc. (Arcadis) to sample the groundwater monitoring wells adjacent to the cement kiln dust and alkali bypass dust disposal area (CKD disposal area) at the Holcim Portland Plant quarry, located at 3500 Highway 120 in Florence, Colorado (site). The sampling was performed to fulfill the requirements of the Colorado Division of Reclamation Mining and Safety (DRMS) as a result of a December 2007 DRMS inspection, which is discussed further in Section 1.3. The sampling was performed on March 23, 2022. This 2022 Groundwater Monitoring Report (report) describes the procedures used to measure the depth to groundwater at all quarry monitoring wells and piezometers and to collect groundwater samples at selected quarry monitoring wells. This report also presents the results of the groundwater depth measurements and groundwater sample laboratory analysis.

The remainder of this section presents the site location and history of the site that is relevant to groundwater quality. Section 2 describes the field activities for the measurement of groundwater levels and sampling of existing monitoring wells. Section 3 presents results for the groundwater analyses and groundwater elevation measurements. Section 4 presents the conclusions of the 2022 annual sampling event and provides recommendations. Section 5 lists the references cited throughout this report.

1.1 Site Location

The Portland Plant (plant), which manufactures Portland cement, is located in Fremont County, Colorado (**Figure 1**) on the southern side of the Arkansas River. The quarry that supplies the limestone for the plant used in the manufacturing process is located on the northern side of the Arkansas River. The total area of the site, including the quarry, is approximately 3,400 acres.

1.2 Site History

Cement manufacturing operations at the site began in 1897. Prior to 2001, three long, wet kilns with a combined cement production of approximately 937,000 tons per year (tpy) were in service. Cement kiln dust (CKD) is waste material that was generated by the cement kiln and associated equipment. Using the wet kiln process, approximately 25,000 to 100,000 tpy of CKD were generated during the production of cement at the site (Resource Geoscience, Inc. [RGI] 1999). Historically, sludge from the nearby Fremont Sanitation District wastewater treatment plant (WWTP) was added to the CKD disposal area as a daily cover. The sludge also served as a means of dust control.

In 2001, the three wet kilns were replaced by one dry kiln with a clinker capacity of 1,873,898 tpy. In the dry kiln, all of the dust generated within the kiln during the manufacturing process is recycled within the process. However, during the production of low-alkali clinker, calcium chloride is added to the process to assist with removal of alkalis from the raw material. Some of the alkalis are removed by taking a portion of the raw material out of the process via the alkali bypass system. The alkali bypass dust (bypass dust) removed from the process is similar in chemistry to the CKD that was historically disposed of and transported to the CKD disposal area in the quarry. When possible, bypass dust is sold to customers to eliminate the need for disposal on site. Alternative uses for the bypass dust must be approved by Holcim. Bypass dust is currently produced at a lower rate than CKD when the wet kiln system was in operation. Between 2005 and 2021, an average of approximately 10,000 tons of bypass dust was placed in the CKD disposal area each year.

In 2001, with the construction of the dry kiln, a pug mill was installed to add water to the bypass dust prior to transporting the bypass dust to the CKD disposal area in the quarry, in order to reduce dust emissions. With the addition of the pug mill, Holcim discontinued the use of sludge from the Fremont Sanitation District WWTP for dust control. The pug mill was removed from service in 2003, and Holcim currently uses a combination of chemical additive and water for dust control.

Bypass dust is currently disposed of in a previously mined section (cut) of the limestone quarry to the south of former monitoring well MW-10. The locations of cuts previously used for CKD disposal are shown on **Figure 2**. The bottoms of these cuts coincide with the top of the underlying Codell Sandstone, which is the primary water-bearing unit in the quarry area. To prevent contact of CKD and bypass dust with this groundwater, approximately 10 feet of shale was backfilled and compacted in the bottom of these cuts prior to placement of CKD and bypass dust. The site geology and hydrogeology are described in the Groundwater Monitoring Plan (GMP; Blasland, Bouck & Lee, Inc. [BBL] 2002).

1.3 Site Regulatory History

In Colorado, the DRMS is responsible for regulating CKD and bypass dust disposal. Therefore, the requirements for CKD and bypass dust management are incorporated into each facility's Mined Land Reclamation Permit. The plant is permitted to dispose of CKD and bypass dust (although CKD is no longer generated by the plant) in the quarry under State of Colorado Mining Permit No. M-77-344 (permit). Specific requirements for protection of groundwater are described in Rule 3.1.7(7)(i) through (viii) of the Construction Material Rules and Regulations (Mined Land Reclamation Board [MLRB] 2001) and the Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Commission (WQCC) Regulation No. 41, Basic Standards for Ground Water (CDPHE 2008).

1.3.1 Baseline Groundwater Monitoring Program

On August 16, 1999, Holcim submitted a request to the DRMS for a Mine Permit Technical Revision TR-06 (TR-06) to its permit for the disposal of CKD in previously mined areas at the quarry (K-S & Company 1999). TR-06 describes the CKD disposal procedures and facilities, a closure plan for the disposal areas, erosion control measures used at the site, CKD sampling and analysis, and hydrogeologic conditions at the site. The DRMS, formerly the Division of Minerals and Geology (DMG), reviewed TR-06 and responded with an initial adequacy review letter on January 18, 2000 (DMG 2000). On behalf of Holcim, K-S & Company submitted responses to DMG's adequacy review letter in May 2001 (Holnam 2001). The DMG responded with a second adequacy review letter on October 22, 2002 (DMG 2002).

Holcim retained Arcadis to provide technical support for TR-06. In partial fulfilment of the DRMS requirements for TR-06, a GMP (BBL 2002) was developed for the approximately 1,330 acres included within the boundaries of the mining permit (**Figure 2**). The main purpose of the GMP was to meet the requirements of the MLRB's Construction Materials Rules and Regulations Rule 3.1.7 for the protection of existing and reasonably potential future uses of the unclassified groundwater located beneath the quarry (MLRB 2001). These requirements were triggered by the disposal of CKD into previously mined sections of the site and the potential for leachate from CKD to adversely impact ambient groundwater quality for existing and reasonably potential future uses.

In 2004, all requirements from the DRMS's adequacy reviews were fulfilled with the submittal of the final quarter of data for monitoring well MW-10 (BBL 2004). The data from the groundwater monitoring program was provided to the DRMS for use in establishing ambient groundwater concentrations and a parameter list for future monitoring. Holcim was to initiate annual groundwater monitoring per the GMP (BBL 2002) once the ambient groundwater concentrations and parameter list were established by the DRMS.

The DRMS responded to the BBL (2004) report as part of a December 2007 site inspection. As a result of the site inspection, Holcim performed a site-wide monitoring event in March 2008. Subsequent to that monitoring event and based on further discussions with the DRMS, Holcim prepared several revisions to the GMP (BBL 2002), which are discussed in Sections 1.3.2 through 1.3.5.

1.3.2 November 21, 2008 Groundwater Monitoring Plan

A revised GMP, dated November 21, 2008 (Holcim 2008), proposed the following activities:

- Install one new monitoring well (MW-13) located hydraulically downgradient of the CKD disposal area.
- Perform annual monitoring of new monitoring well MW-13, plus existing monitoring wells MW-7 and MW-12.
- Abandon monitoring wells MW-6, MW-8, and MW-10, which were no longer usable and/or no longer serve any purpose in the monitoring program.

1.3.3 February 17, 2009 Groundwater Monitoring Plan

A revised GMP, dated February 17, 2009 (Holcim 2009, and Appendix A), proposed numeric protection levels (NPLs) for downgradient monitoring well MW-7, based upon the highest historical analyte concentrations (see Section 3.2). The revised GMP (Appendix A) and the NPLs were approved by the DRMS on February 24, 2009 (DRMS 2009, Appendix A), with the condition that well MW-13 be monitored for five successive quarters to establish NPLs for that well. The DRMS approval letter stipulated that if two or more analytical parameters in monitoring well MW-7 exceed their respective compliance standards by more than 10 percent, semi-annual sampling for those parameters would be required.

In April 2009, Holcim retained Arcadis to install a new groundwater monitoring well (MW-13) downgradient of the quarry disposal area and to abandon three groundwater monitoring wells that were no longer in service. The field activities performed as part of the groundwater monitoring well installation and abandonments are discussed in the Final April 2009 Groundwater Monitoring Report (Arcadis 2009).

Following installation in April 2009, MW-13 was sampled quarterly for five consecutive quarters at the request of the DRMS to determine appropriate parameters and establish NPLs for the well. Analytical results are presented in the March 2010 Groundwater Monitoring Report (Arcadis 2010). Subsequently, MW-13 was added to the annual groundwater monitoring program in March 2011.

1.3.4 July 7, 2010 Groundwater Monitoring Plan

On July 7, 2010, Holcim proposed another revision to the GMP, including proposed compliance standards for MW-13. The revised GMP dated July 7, 2010 is provided in Appendix A. The DRMS responded with NPLs for MW-13 in a letter dated November 27, 2012 (DRMS 2012, included in Appendix A). The DRMS approval letter stipulated that in addition to MW-7, if the concentrations of the parameters analyzed in MW-13 exceed their respective NPL by more than 10 percent, semi-annual sampling for those parameters would commence.

1.3.5 October 17, 2014 Proposal to Remove Sodium as a Groundwater Quality Parameter

In a letter to the DRMS dated October 17, 2014 (Arcadis 2014, Appendix B), Holcim proposed to remove sodium as a groundwater quality parameter used to evaluate the potential impact from leaching of CKD and bypass dust. Additionally, Holcim proposed a potassium to sodium ratio using an NPL of 0.5 to replace sodium as one of the primary water quality indicators of impact from the CKD landfill. Approval was received from the DRMS in a letter dated February 25, 2015 (also included in Appendix B).

2 Groundwater Sampling Activities

This section discusses the groundwater sample collection methods, and sample handling and chain of custody procedures. Groundwater sampling was conducted at monitoring wells MW-7, MW-12, and MW-13 (**Figure 2**) on March 23, 2022.

Groundwater sampling activities included measurement of the depth to groundwater and depth to well bottom at monitoring wells MW-7, MW-9, MW-11, MW-12, MW-13, DP-1, and NP-1; and piezometers P-2 and P-3. Depth to groundwater was measured using an electronic water level indicator. Depth to groundwater and well bottom was measured prior to purging and sampling monitoring wells MW-7, MW-12, and MW-13.

The groundwater samples were collected in accordance with the groundwater monitoring protocol set forth in the GMP (BBL 2002). Prior to collecting the groundwater samples, these monitoring wells were purged using a disposable Teflon® bailer. In general, three well volumes in each well were removed before collecting a water sample. However, due to the slow recharge in MW-7 it was not possible to purge three well volumes from MW-7 within a reasonable period of time. MW-7 was purged dry and left to recharge prior to collecting the sample. The field water quality parameters in wells MW-12 and MW-13, including temperature, pH, and specific conductivity were stable (i.e., less than a 10 percent change between readings) after three well volumes were removed. Samples for laboratory analysis were subsequently collected from each well using the disposable bailer. One duplicate sample was collected from MW-12. Samples were placed directly into laboratory-supplied containers and kept on ice in a cooler. Copies of the groundwater sampling forms are included in Appendix C.

The unfiltered groundwater samples were then shipped to ACZ Laboratories, Inc. (ACZ) located in Steamboat Springs, Colorado. The samples were submitted for analysis of metals (iron, manganese, potassium, and sodium), total dissolved solids (TDS), total suspended solids (TSS), and sulfate. TSS was added to the list of analytes in 2021 to monitor the correlation of concentrations of suspended solids and total iron. The samples collected for dissolved analytes were lab filtered upon receipt at the laboratory. In addition, temperature, pH, and specific conductivity were measured in the field.

3 Results

3.1 Groundwater Elevations and Flow Characteristics

Measured depths to the groundwater surface (**Table 1**) were used to develop groundwater elevation contours (**Figure 2**). The water table is encountered in the Codell Sandstone Member of the Carlile Formation (RGI 1999), which underlies the quarried rock. All of the monitoring wells are screened in the Codell Sandstone. The groundwater flow pattern is similar to what has been observed in the past.

Groundwater generally flows south toward the Arkansas River, which is the major groundwater discharge zone in the area, as reported by previous investigators (i.e., BBL 2002; RGI 1999).

Based upon an average measured horizontal groundwater gradient of 0.02 foot per foot, a Codell Sandstone hydraulic conductivity of approximately 4.5×10^{-6} centimeters per second (RGI 1999), and a range of effective porosities for sandstone of 5 to 30 percent (Freeze and Cherry 1979), the resulting groundwater velocity is 0.33 foot to 1.99 feet per year. The resulting groundwater velocity, when including wells NP-1 and DP-1 in the average hydraulic gradient calculation, is 0.36 foot to 2.19 feet per year. The range in 2022 was similar to previously reported values by RGI (1999) and previous groundwater monitoring reports for this site.

3.2 Analytical Results

Laboratory analyses of the 2022 groundwater samples were conducted by ACZ. Results of the laboratory analyses are provided in **Table 2**. The laboratory report is provided as Appendix D. Historical groundwater quality data are provided in Appendix E (updated with results through 2022).

Concentrations of metals and other constituents measured in groundwater at well MW-7 were compared to the NPLs approved by the DRMS in February 2009 and the potassium to sodium ratio NPL (0.5) approved by the DRMS in February 2015 (see Section 1.3.5). The concentration of total iron exceeded the approved NPL by more than 10 percent. However, per discussions with DRMS in 2021, beginning in 2022 the NPL will be compared to dissolved iron concentrations. The dissolved iron concentration was 0.08 mg/L, well below the NPL of 4.5 mg/L. Because the current NPL is based on total iron concentrations, a revised NPL based on dissolved iron concentrations may need to be established. A formal request to establish the NPL will be submitted to DRMS in the near future.

No other exceedances were observed. Therefore, pursuant to the DRMS (2009) GMP approval letter, and in recognition the fact that comparison to the NPL is based on dissolved iron concentrations, resampling of MW-7 is not required. Sampling of MW-7 will remain on an annual schedule.

In addition to MW-7, groundwater monitoring wells MW-12 (upgradient well) and MW-13 (compliance well) were sampled as part of the annual groundwater monitoring program. Analytical results are presented in **Table 2**.

As discussed in Section 1.3.4 of this report, the DRMS set NPLs for MW-13 in a letter dated November 27, 2012 (Appendix A). All analytes measured in MW-13 were below their respective NPLs except for sulfate. However, sulfate concentrations did not exceed the NPL by more than 10 percent and therefore, monitoring frequency will remain on an annual schedule per the DRMS (2012) NPL determination letter.

Time series graphs of the potassium to sodium ratio, TDS, sulfate, manganese, total iron and TSS, and dissolved iron for MW-7, MW-12, and MW-13 were prepared (**Figures 3, 4, 5, 6, 7, and 8** respectively) to evaluate potential impacts of CKD disposal to the groundwater.

In general, the following trends area observed:

- **Potassium to Sodium Ratio**: As shown in **Table 2** and on **Figure 3**, the potassium to sodium ratio in all monitoring wells continues to be generally less than 0.10, indicating that there is no discernible impact from the CKD disposal area. The K:Na ratios have stabilized or are declining in the last few years.
- **Total Dissolved Solids**: TDS concentrations in MW-7 are generally decreasing through time and have remained stable in recent years (**Figure 4**). The concentrations of TDS in MW-12 and MW-13 are generally stable. All TDS concentrations remain below their respective NPLs.
- **Sulfate**: Sulfate concentrations show a similar trend as TDS (**Figure 5**). MW-7 concentrations are generally decreasing through time and have remained stable in recent years. Concentrations are generally stable in MW-12 and MW-13, and though sulfate concentrations at MW-13 exceeded the NPL in 2022, the exceedance was not by more than 10 percent.
- **Manganese**: Manganese concentrations in MW-7, MW-12, and MW-13 have decreased over time and have stabilized in the last 7 to 8 years (**Figure 6**). Manganese concentrations remain well below the respective NPLs at MW-7 and MW-13.
- **Total Iron**: Total iron concentrations have exhibited considerable fluctuations at all three wells since monitoring for this parameter began in 2003 (**Figure 7**). Because total iron concentrations are strongly correlated to the amount of suspended solids contained in a groundwater sample, it is not surprising to observe these fluctuations in concentrations as small differences in how a sample was collected could impact the suspended solids concentration in that sample. For this reason, TSS was added to the list of analytes in 2021. Analytical results are included in Figure 7 and the correlation between Total Iron and TSS is evident.
- **Dissolved Iron**: Dissolved iron has stabilized at all three wells (**Figure 8**) and concentrations in MW-13 have remained below the DRMS issued NPL since 2009. Also note that future comparisons to the NPL will be based on dissolved iron.
- The concentrations of analytes found in monitoring well MW-12, which is considered the background well, from the March 2022 sampling event (**Table 2 and Figures 3, 4, 5, 6, and 8**) remain generally higher than the wells installed downgradient of the CKD.

4 Conclusions and Recommendations

Arcadis presents the following conclusions based on the information presented in this report:

- For the March 2022 groundwater sampling event, concentrations of all analytes measured in the two downgradient wells, MW-7 and MW-13, were below the NPLs except for the total iron result for MW-7. The concentration of total iron in monitoring well MW-7 was more than 10% over the NPL. However, based on discussions with DRMS, dissolved iron concentrations will be used for comparison to the NPL. In recognition of this and because no other exceedances were observed, per the revised GMP MW-7 can continue to be sampled annually.
- Concentrations of TDS have been generally stable for several years at MW-7 and MW-13 and remain below the NPL.
- Concentrations of sulfate at MW-7 have remained stable for several years. Concentrations have been generally stable at MW-12 and MW-13, and though the MW-13 result exceeded the NPL, it was not by more than 10 percent.
- Generally stable or decreasing concentration trends for manganese, dissolved iron, and potassium to sodium ratios continue to be observed in wells MW-7 and MW-13.
- Groundwater flow is to the south and velocity is 0.36 foot to 2.19 feet per year, which is consistent with historical data. In addition, groundwater elevations and interpreted flow direction are similar to previous sample rounds.

Based on March 2022 sampling results that indicate there is no discernible impact from the CKD disposal area and that only one parameter exceeded its NPL at both MW-7 (total iron) and MW-13 (sulfate), Arcadis recommends that groundwater monitoring continue on an annual basis. Furthermore, a revised NPL for dissolved iron should be developed for monitoring well MW-7.

5 References

Arcadis. 2009. Final April 2009 Groundwater Monitoring Report, Portland, Florence, Colorado. Prepared for Holcim (US) Inc., Florence, Colorado. July.

Arcadis. 2010. March 2010 Groundwater Monitoring Report, Florence, Colorado. Prepared for Holcim (US) Inc., Florence, Colorado. July.

Arcadis. 2014. Proposal to Remove Sodium as a Groundwater Quality Parameter, DRMS Permit No. M-1977-344, Technical Revision No. 6. Prepared for Holcim (US) Inc., Portland, Colorado. October.

BBL. 2002. Groundwater Monitoring Plan, Holcim (US) Inc., Portland Plant, Florence, Colorado. Prepared for Holcim (US) Inc., Florence, Colorado. December.

BBL. 2004. Quarterly Groundwater Monitoring Report, DMG Permit No. M-1977-344, Technical Revision No. 6, Holcim (US0 Inc. Portland, Colorado Plant, November 22, 2004.

Colorado Department of Public Health and Environment. 2008. Water Quality Control Commission Regulation No. 41 The Basic Standards for Groundwater. Adopted January 5, 1987.Mined Land Reclamation Board, 2001. Construction Material Rules and Regulations.

Division of Mineral and Geology letter to K-S & Company regarding Technical Revision No. 6, Holnam, Inc., Portland Limestone Quarry, Permit No. M-77-344, January 18, 2000.

Division of Minerals and Geology. 2002. Letter to Holnam regarding Technical Revision No. 6 (Cement Kiln Dust disposal) Second Adequacy Review, Portland Limestone Quarry, Permit No. M-77-344, October 8, 2002.

Division of Reclamation, Mining, and Safety. 2009. Letter to Holcim (US) Inc. Regarding Proposed Groundwater Monitoring Plan, DRMS Permit # M-1977-344 Portland Cement Plant. February 24, 2009.

Division of Reclamation, Mining, and Safety. 2012. Letter to Holcim (US) Inc. Regarding Portland Limestone Quarry, Permit No. M-1977-344, Revised Groundwater Monitoring Plan. November 27, 2012.

Freeze, R.A., and J.A. Cherry. 1979. Groundwater. Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

Holnam, Inc. 2001. Letter to Division of Minerals and Geology regarding Permit No. M-77-344, Technical Revision No. 6, Adequacy Review Response, Holnam, Inc. Quarry, Portland, Colorado, May 10, 2001.

K-S & Company. 1999. Letter to Division of Minerals and Geology regarding Permit No. M-77-344, Technical Revision No. 6, Holnam, Inc. Quarry, Portland, Colorado, August 16, 1999.

MLRB. 2001. Mineral Rules and Regulations of the Colorado Mined Land Reclamation Board for Hard Rock, Metal and Designated Mining Operations. Promulgated May 1977.

Resource Geoscience, Inc. 1999. Hydrogeologic Assessment Holnam, Inc., Portland, Colorado. Prepared for Holnam, Inc., Florence, Colorado. January 27, 1999.

Tables

Table 1

March 2022 Depth to Groundwater Measurements and Groundwater Elevations

Holcim (US) Inc.
Florence, Colorado

Well Number	Well Diameter (inches)	TOC Elevation (ft amsl)	Depth to GW March 2022 (ft btoc)	Depth to Well Bottom March 2022 (ft btoc)	GW Elevation March 2022 (ft amsl)	Total Depth (ft bgs)	Screened Interval (ft bgs)
MW-7	4	5056.26	27.28	50.30	5028.98	47	17-42
MW-9	4	5121.90	7.75	45.55	5114.15	42	17-37
MW-11	2	5095.87	54.60	105.65	5041.27	103	58-103
MW-12	2	5254.04	100.06	150.30	5153.98	148	103-148
MW-13	2	5040.00	13.95	31.95	5026.05	30	15-30
P-2	1.5	5079.46	5.50	29.05	5073.96	36	31-36
P-3	1.5	5063.28	26.87	39.45	5036.41	37	32-37
DP-1	2	5069.70	10.59	36.50	5059.11	34	24-34
NP-1	2	5147.40	43.62	73.50	5103.78	70	60-70

Notes:
ft amsl - Feet above mean sea level.
ft bgs - Feet below ground surface.
ft btoc - Feet below top of casing.
GW - Groundwater.
MW - Monitoring well.
NA - Not available.
P - Piezometer.
TOC - Top of casing.
Groundwater levels measured on March 24, 2022

Table 2

March 2022 Field and Analytical Results

Holcim (US) Inc.
Florence, Colorado

Analyte		March 2022 Analytical Results					
Field Parameters	**Units**	**MW-7 NPLs**	**MW-7**	**MW-12**	**MW-12 DUP**	**MW-13**	**MW-13 NPLs**
pH	std. units	6.5-8.5[a]	7.81	6.88	--	7.34	NA
Specific Conductivity	mS/cm	NA	1.874	3.716	--	3.591	NA
Temperature	°C	NA	14.9	14.6	--	14.2	NA
Laboratory Results							
Total dissolved solids	mg/L	3918	944	3740	3710	3580	4026
Total suspended solids	mg/L	--	184	157	102	36	--
Sulfate	mg/L	2080	108	2550	2500	**2420**	2200
Iron (total)	mg/L	4.5	**8.9**	6.26	5.11	1.1	NA
Iron (dissolved)	mg/L	4.5 [2]	0.08 J	0.248 J	0.220 J	0.12 U	0.13
Manganese (dissolved)	mg/L	0.88	0.03 J	0.599	0.552	0.02 U	0.3
Potassium (dissolved)	mg/L	17	6.6	12.7	12.8	7.94	13
Sodium (dissolved) [1]	mg/L	NA	264	144	143	280	NA
K:Na ratio	mg/L	0.5	0.03	0.09	0.09	0.03	0.5

Notes:

NPLs - numeric protection levels issued by Division of Reclamation, Mining and Safety

Bolded values - NPL exceeded

[1] - Sodium was removed as a groundwater quality parameter and replaced with a potassium to sodium (K:Na) ratio per Division of Reclamation, Mining and Safety approval letter dated February 25, 2015.

[2] - Beginning in 2022 the NPL will be compared to dissolved iron concentrations. A revised NPL based on dissolved iron concentrations may need to be established.

K - potassium

Na - sodium

J - Analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity.

NA - Not applicable.

U - The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

[a]MCL source: Table 2 Secondary Drinking Water Standards, Regulation 41.

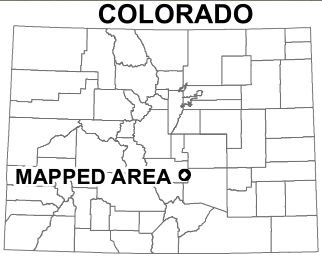
MCL - Maximum concentration limit.

MDL - Method Detection Limit

PQL - Practical Quantitation Limit

Figures

COLORADO



0 1,500 3,000 Feet

GRAPHIC SCALE

HOLCIM (US) INC.
PORTLAND PLANT, FLORENCE, COLORADO

MARCH 2022
GROUNDWATER MONITORING REPORT

SITE LOCATION MAP

ARCADIS

FIGURE
1

City: CITRIX Div/Group: IM/DV Created By: K. SINSABAUGH Last Saved By: ksinsabaugh
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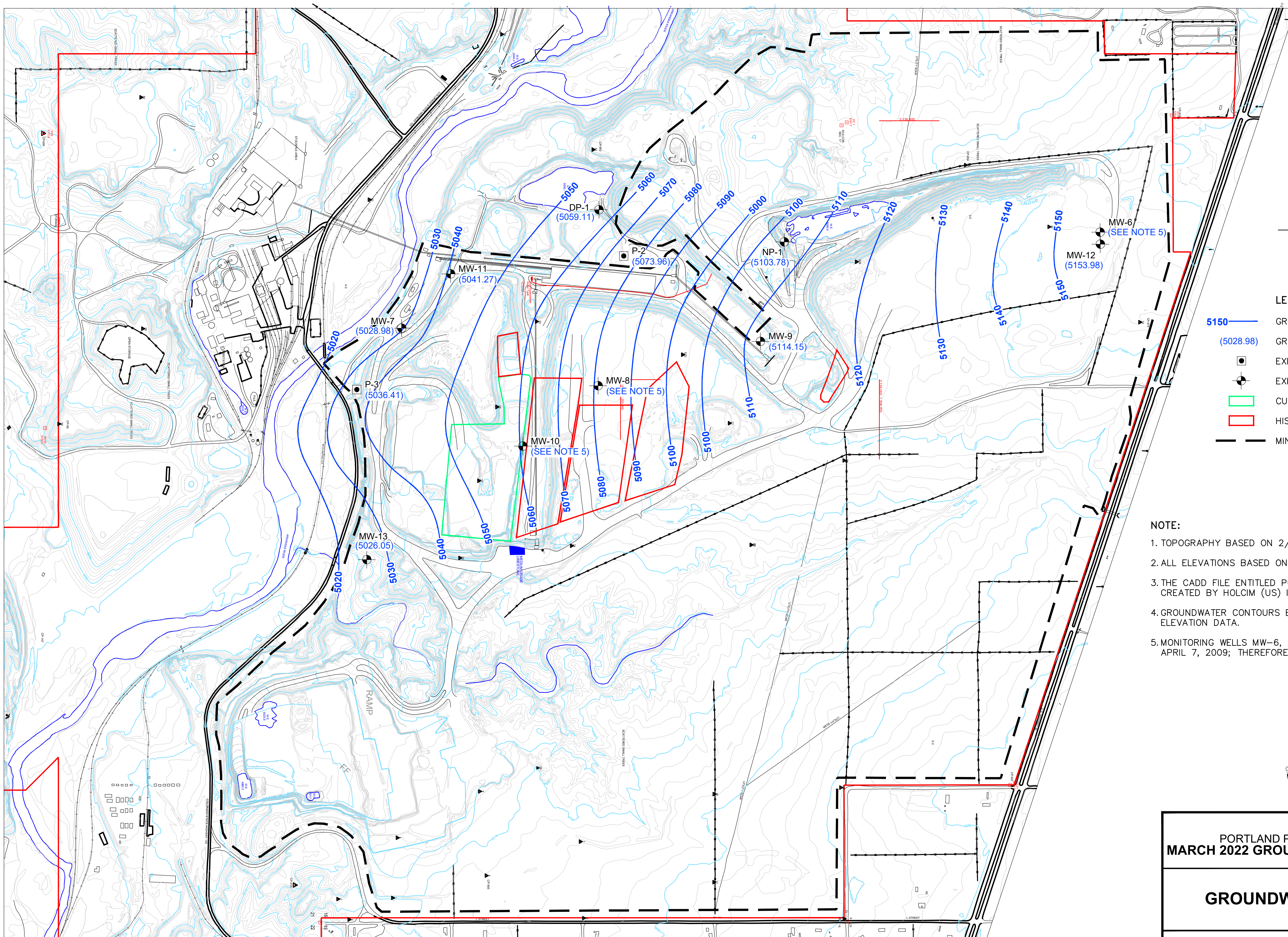


LEGEND:

5150	GROUNDWATER CONTOUR
(5028.98)	GROUNDWATER ELEVATION
	EXISTING PIEZOMETERS
	EXISTING MONITORING WELLS
	CURRENT BYPASS DUST DISPOSAL AREA
	HISTORIC CKD DISPOSAL AREA
	MINE PERMIT BOUNDARY

NOTE:

1. TOPOGRAPHY BASED ON 2/6/04 AERIAL PHOTOGRAPH.
2. ALL ELEVATIONS BASED ON MSL.
3. THE CADD FILE ENTITLED PORTLAND 2005 UPDATED 2–21–05.DWG CREATED BY HOLCIM (US) INC. WAS UTILIZED AS THE BASE MAP.
4. GROUNDWATER CONTOURS BASED ON MARCH 2022 GROUNDWATER ELEVATION DATA.
5. MONITORING WELLS MW–6, MW–8, AND MW–10 WERE ABANDONED ON APRIL 7, 2009; THEREFORE, GROUNDWATER LEVELS ARE UNAVAILABLE.

0 500' 1000'
GRAPHIC SCALE

HOLCIM (US) INC.
PORTLAND PLANT, FLORENCE, COLORADO
MARCH 2022 GROUNDWATER MONITORING REPORT

GROUNDWATER CONTOUR MAP

ARCADIS

FIGURE
2

C:\Users\jlharris\OneDrive - ARCADIS\BIM360 - OneDrive Sync Location\AUS-HOLCIM-PORTLAND PLANT-FLORENCE Colorado\2022\01-In Progress\01-DWG\GWMR-2022Q1-GWE.dwg LAYOUT: 2 SAVED: 4/20/2022 8:11 AM ACADVER: 24.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE:
PLTFULL.CTB PLOTTED: 4/20/2022 8:16 AM BY: HARRIS, JESS
XREFS: IMAGES: PROJECTNAME: ----
GEN-X-BASE Arcadis Logo_2021.PNG

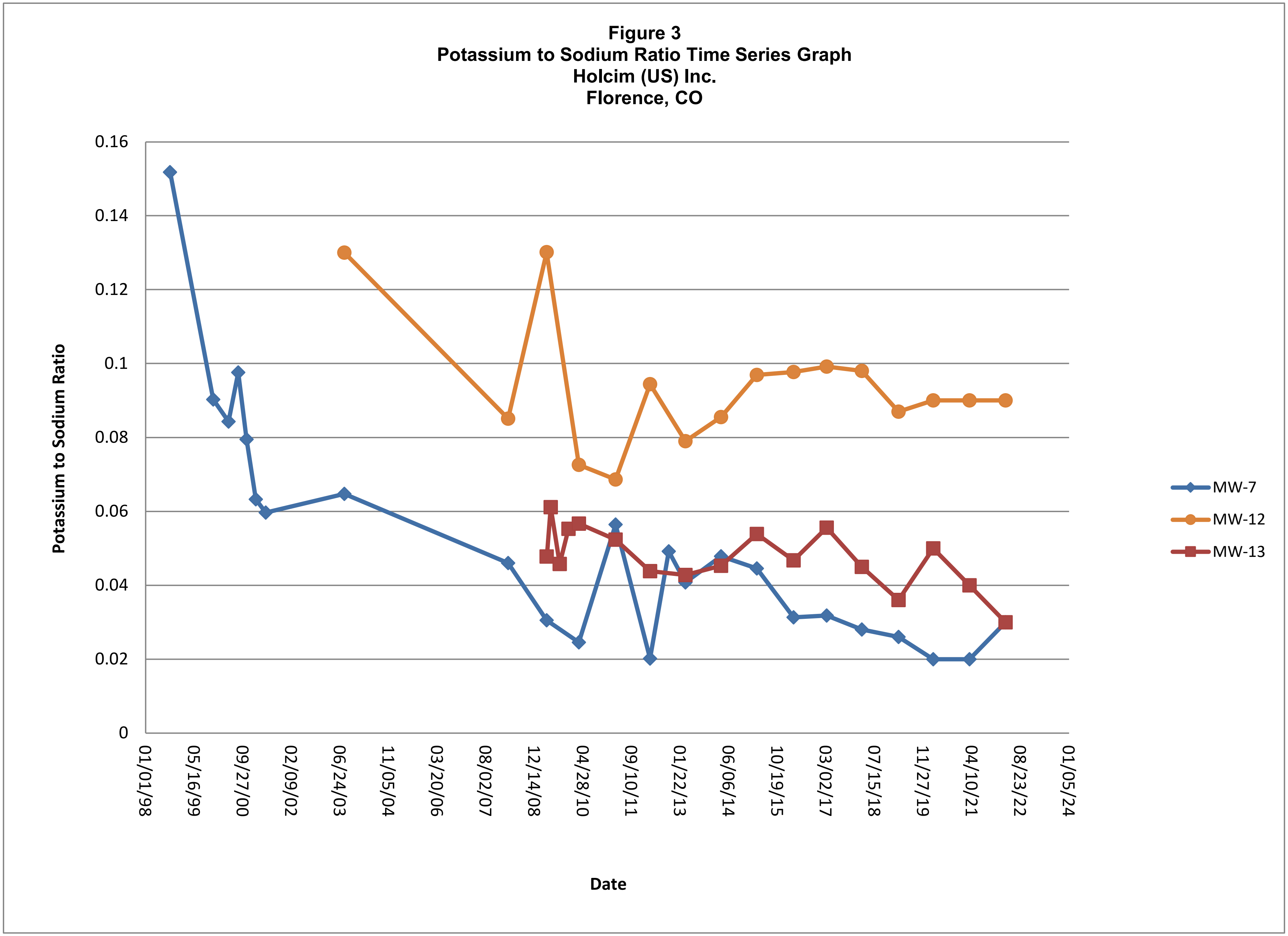


Figure 3
Potassium to Sodium Ratio Time Series Graph
Holcim (US) Inc.
Florence, CO
Potassium to Sodium Ratio
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
01/01/98
05/16/99
09/27/00
02/09/02
06/24/03
11/05/04
03/20/06
08/02/07
12/14/08
04/28/10
09/10/11
01/22/13
06/06/14
10/19/15
03/02/17
07/15/18
11/27/19
04/10/21
08/23/22
01/05/24
Date
MW-7
MW-12
MW-13

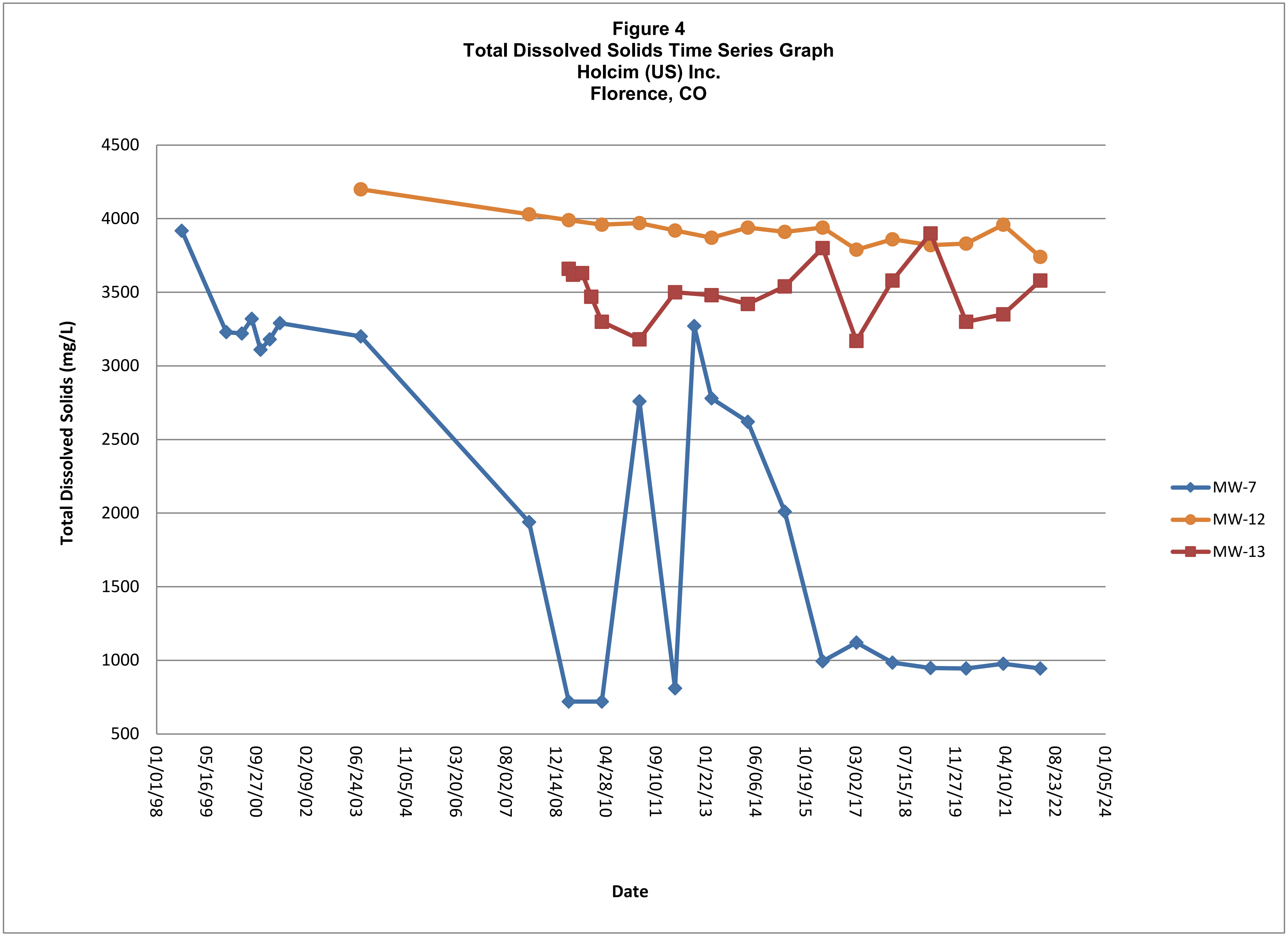


Figure 4
Total Dissolved Solids Time Series Graph
Holcim (US) Inc.
Florence, CO
Total Dissolved Solids (mg/L)
4500
4000
3500
3000
2500
2000
1500
1000
500
01/01/98
05/16/99
09/27/00
02/09/02
06/24/03
11/05/04
03/20/06
08/02/07
12/14/08
04/28/10
09/10/11
01/22/13
06/06/14
10/19/15
03/02/17
07/15/18
11/27/19
04/10/21
08/23/22
01/05/24
Date
MW-7
MW-12
MW-13

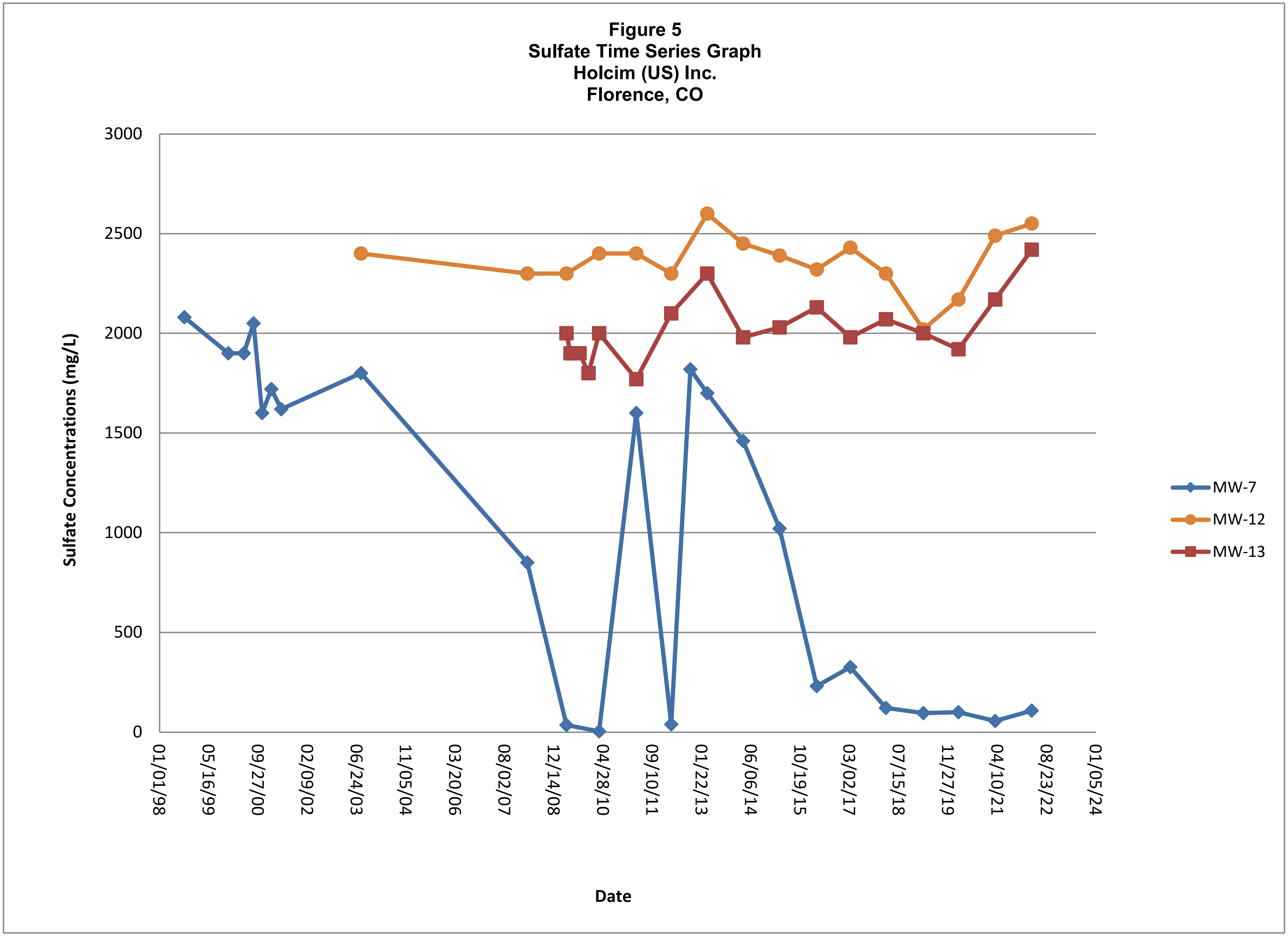


Figure 5
Sulfate Time Series Graph
Holcim (US) Inc.
Florence, CO
3000
2500
2000
1500
1000
500
0
Sulfate Concentrations (mg/L)
01/01/98
05/16/99
09/27/00
02/09/02
06/24/03
11/05/04
03/20/06
08/02/07
12/14/08
04/28/10
09/10/11
01/22/13
06/06/14
10/19/15
03/02/17
07/15/18
11/27/19
04/10/21
08/23/22
01/05/24
Date
MW-7
MW-12
MW-13

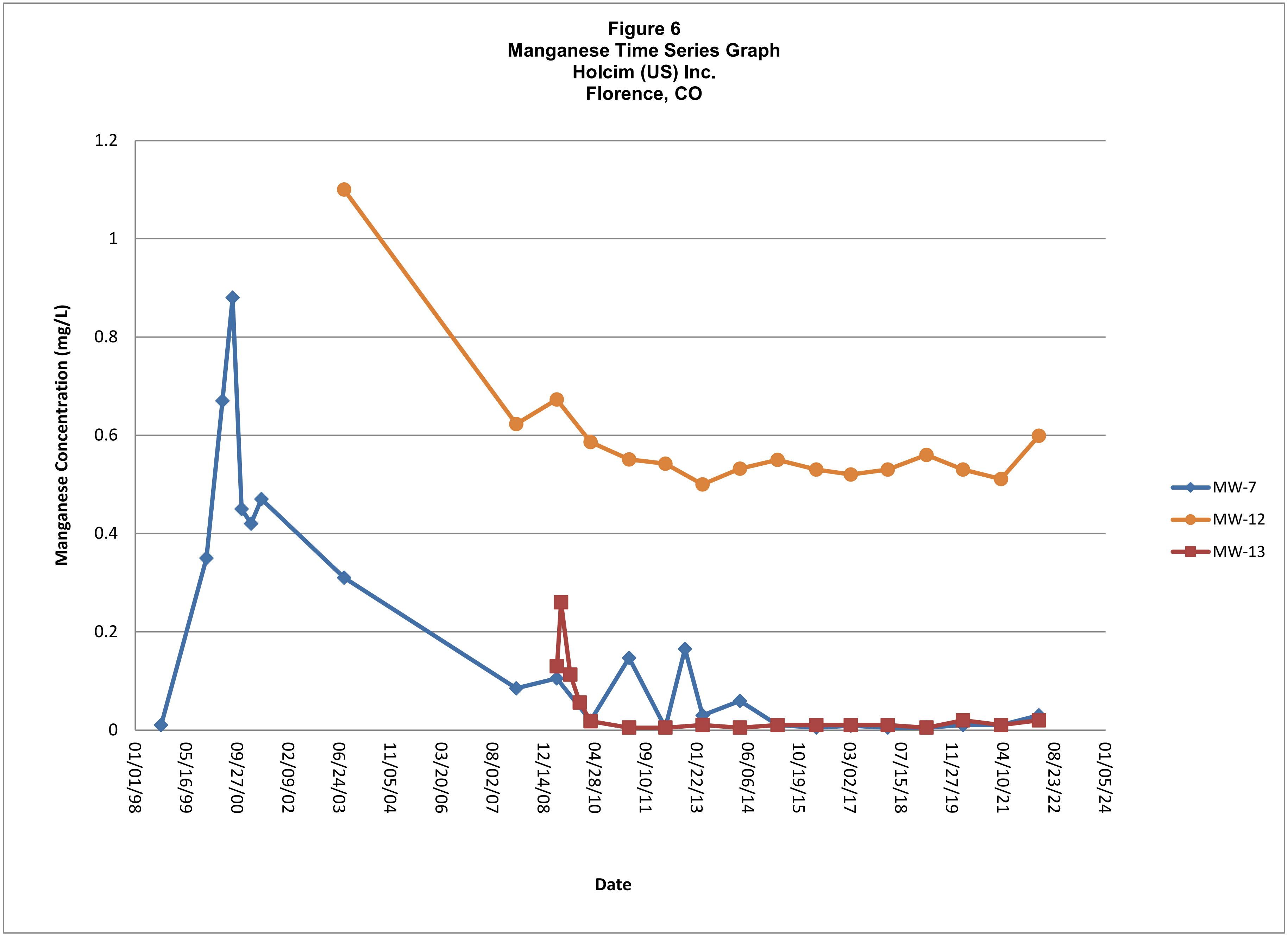
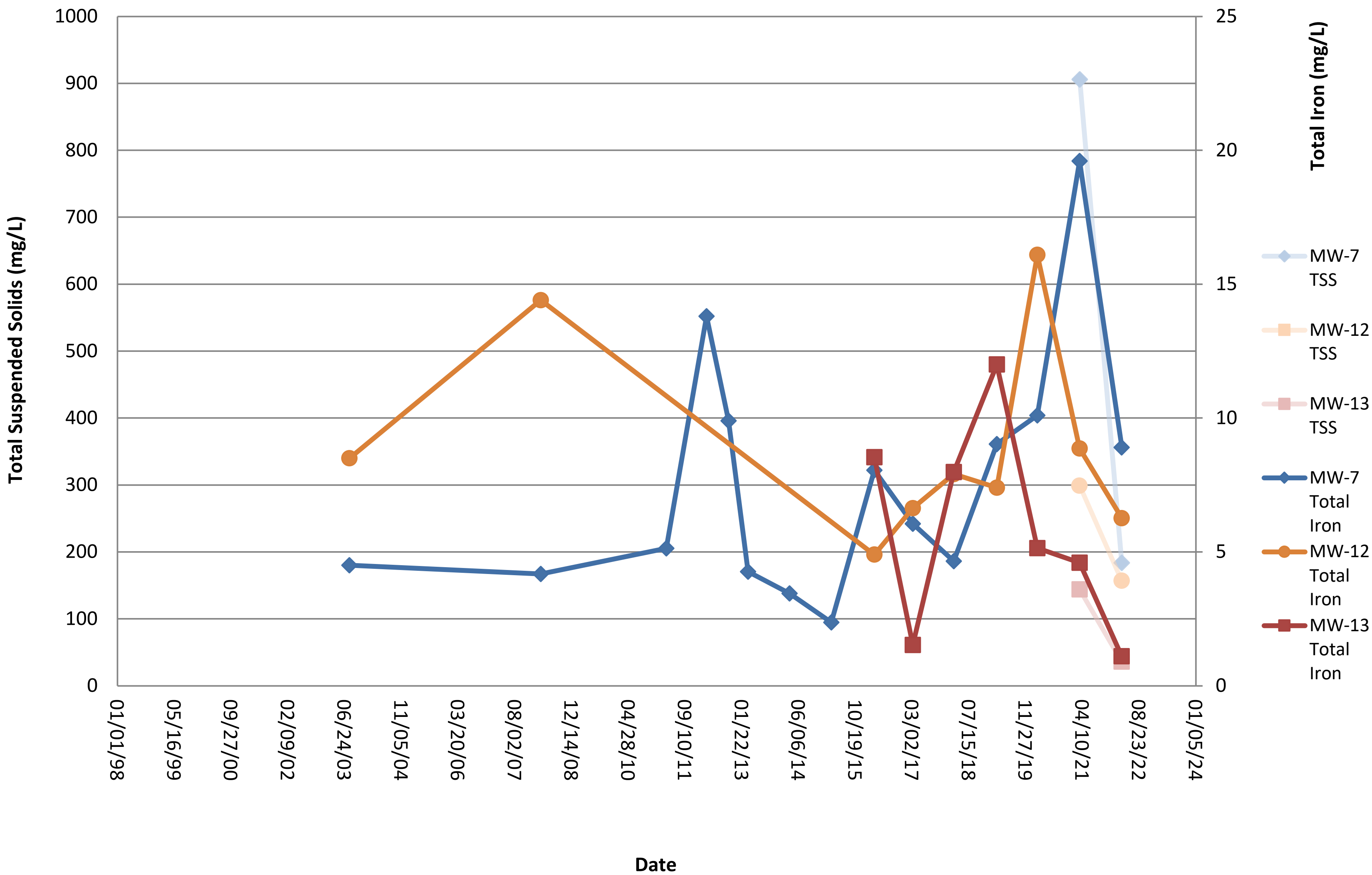


Figure 6
Manganese Time Series Graph
Holcim (US) Inc.
Florence, CO
Manganese Concentration (mg/L)
1.2
1
0.8
0.6
0.4
0.2
0
01/01/98
05/16/99
09/27/00
02/09/02
06/24/03
11/05/04
03/20/06
08/02/07
12/14/08
04/28/10
09/10/11
01/22/13
06/06/14
10/19/15
03/02/17
07/15/18
11/27/19
04/10/21
08/23/22
01/05/24
Date
MW-7
MW-12
MW-13

Figure 7
Total Iron and Total Suspended Solids Time Series Graph
Holcim (US) Inc.
Florence, CO



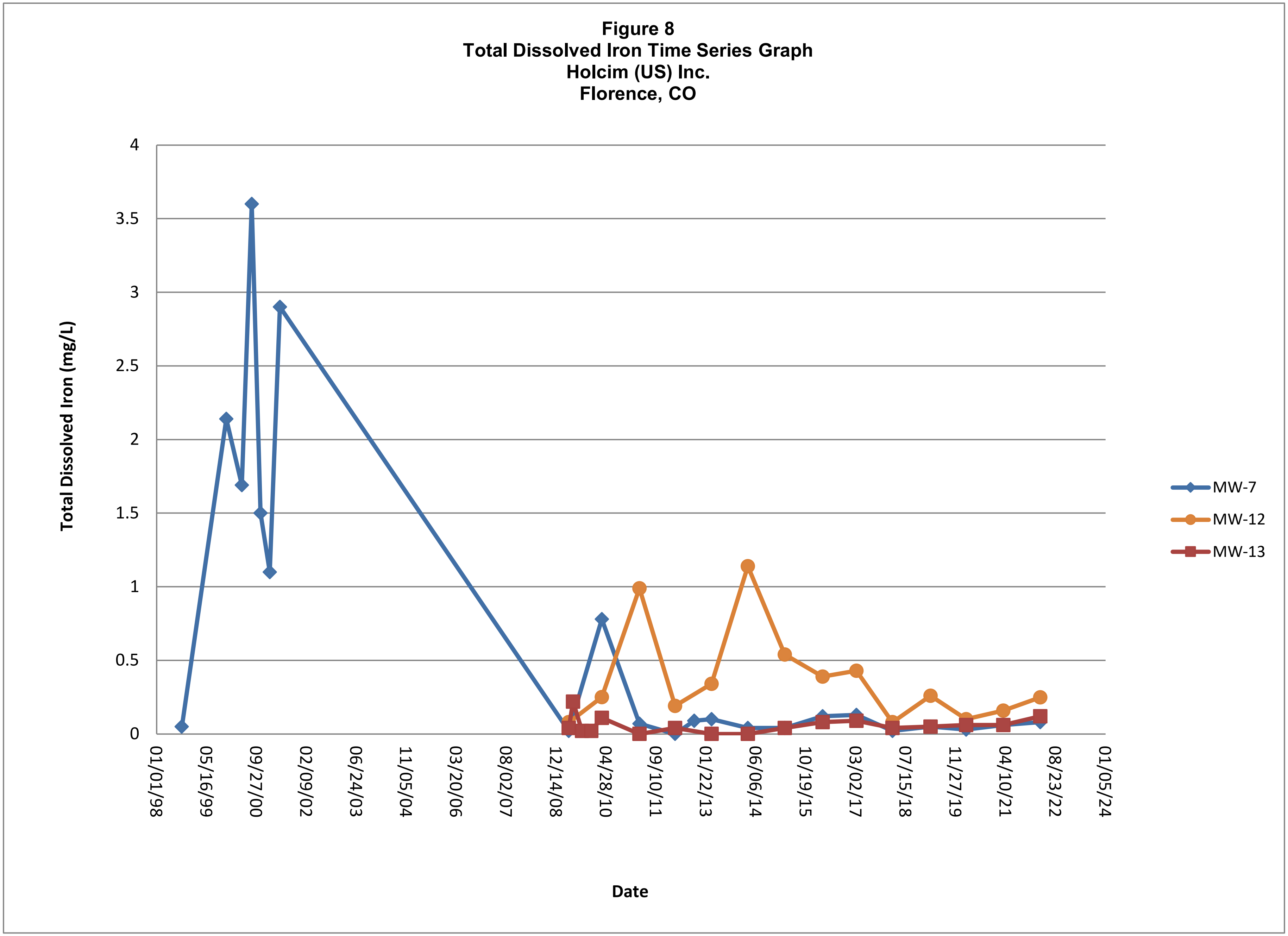


Figure 8
Total Dissolved Iron Time Series Graph
Holcim (US) Inc.
Florence, CO
Total Dissolved Iron (mg/L)
4
3.5
3
2.5
2
1.5
1
0.5
0
01/01/98
05/16/99
09/27/00
02/09/02
06/24/03
11/05/04
03/20/06
08/02/07
12/14/08
04/28/10
09/10/11
01/22/13
06/06/14
10/19/15
03/02/17
07/15/18
11/27/19
04/10/21
08/23/22
01/05/24
Date
MW-7
MW-12
MW-13

Appendix A

Groundwater Monitoring Plans dated February 17, 2009 and July 7, 2010 and Colorado Division Reclamation Mining and Safety Approval Letters

Portland Plant

Holcim

Holcim (US) Inc.
3500 Highway 120
Florence, CO 81226

Phone 719 784 6325
Fax 719 784 3470
www.holcim.com/us

February 17, 2009

Mr. Berhan Keffelew
Colorado Department of Natural Resources
Division of Reclamation, Mining and Safety
1313 Sherman Street, Room 215
Denver, CO 80203

Re: Proposed Groundwater Monitoring Plan, DRMS Permit M-1977-344

Dear Mr. Keffelew,

The purpose of this groundwater monitoring plan (GMP) is to fulfill the requirements of Technical Revision #6 (TR-06) to the Division of Mining, Reclamation and Safety Permit M-1977-344. This permit is for the Holcim (US) Portland Plant quarry located adjacent to the cement plant in Florence, Colorado.

The quarry is located on the north side of the Arkansas River. Groundwater in the area flows in a generally southerly direction toward the river. See Figure 2 attached from the March 2008 Groundwater Monitoring Report.

Holcim proposes annual sampling of the following monitoring wells:

- MW-12 - Background well located in the north end of the quarry.
- MW-7 - Compliance well located in the southwest side of the quarry.
- MW-13* - Compliance well to be located in the south side of the quarry in close proximity to Piezometer P-3 near the entrance to the quarry.

* Note, this well is proposed to be drilled in April 2009 and will be a 2" ID Schedule 40 PVC well approximately 50 feet in depth.

In addition, Holcim will continue monitoring water level in wells P-2, P-3, MW-9, and MW-11.

Holcim proposes abandoning the following wells:

- MW-6 - this well is located next to MW12 and is thus redundant and unnecessary.
- MW-8 - this well is located in an area that will be reclaimed, i.e. buried, in 2009.
- MW-10 - this well is too shallow to provide useful data.

The wells will be abandoned in accordance with Colorado rules and regulations governing well abandonment.

Holcim proposes monitoring for the following parameters:

- Total Dissolved Solids (TDS)
- Sulfate (SO4)
- Potassium (K)
- Sodium (Na)
- Iron (Fe)
- Manganese (Mn)

In addition, the following field parameters will be recorded.

- pH
- specific conductance
- temperature

Proposed standards are shown in table below.

TABLE 1 – PROPOSED STANDARDS

Parameter	Units	MW-7 Compliance[1]	MW-13 Compliance[2]
Total Dissolved Solids (TDS)	mg/L	3,918	TBD
Sulfate (SO4)	mg/L	2,080	TBD
Potassium (K)	mg/L	17	TBD
Sodium (Na)	mg/L	226	TBD
Iron (Fe)	mg/L	4.5	TBD
Manganese (Mn)	mg/L	0.88	TBD

[1] MW-7 Standards set based on nine (9) rounds of historical sampling.
[2] MW-13 Standards will be set based on sampling to be conducted in 2009-2010.

If you have any questions, please do not hesitate to call me at (719) 784-1118.

Sincerely,

Joel Bolduc

Joel Bolduc
Environmental Manager

STATE OF COLORADO

DIVISION OF RECLAMATION, MINING AND SAFETY
Department of Natural Resources
1313 Sherman St., Room 215
Denver, Colorado 80203
Phone: (303) 866-3567
FAX: (303) 832-8106

February 24, 2009

Mr. Joel Bolduc
Holcim, (US) Inc
3500 Highway 120
Florence, CO 81226

Re: Proposed Groundwater Monitoring Plan, DRMS Permit # M-1977-344 Portland Cement Plant.

Dear Mr. Joel

To fulfill the requirements of Technical Revision # 6, for permit # M-1977-344, Portland Cement quarry and plant, ground water monitoring plan, the Division sets the following monitoring and compliance wells . The site is located in Fremont County, North side of the Arkansas River. Groundwater flows in the area in a southerly direction towards the river.

Holcim will sample MW-7 WELL Compliance well, annually for the following parameters.

Total Dissolved Solids (TDS)	3,918 MG/L
Sulfate (SO4)	2,080 MG/L
Potassium (K)	17 MG/L
Sodium (Na)	226 MG/L
Iron (Fe)	4.5 MG/L
Manganese (Mn)	0.88 MG/L

In addition Holcium will drill in April 2009, compliance well MW-13 near the entrance to the quarry and will provide five quarters of data, so the Division will determine the appropriate parameters for the well. and set compliance parameters. In addition to MW-7, Holcim will also monitor MW-12, as a background well and provide the same parameters as MW-7 on an annual basis. When two consecutive parameters are exceeded more than 10%, during the reporting year for compliance well MV-7, Holcim will increase the frequency of monitoring to bi-yearly. If the upward trend continues, Holcim will submit an explanation and provide a remedial plan.

If you have questions, please contact me at 302 866-3567 xt 8129.

Sincerely,

Berhan Keffelew

Portland Plant

Holcim

Holcim (US) Inc.
3500 Highway 120
Florence, CO 81226

Phone 719 784 6325
Fax 719 784 3470
www.holcim.com/us

July 7, 2010

Mr. Berhan Keffelew
Colorado Department of Natural Resources
Division of Reclamation, Mining and Safety
1313 Sherman Street, Room 215
Denver, CO 80203

Re: Proposed Groundwater Monitoring Plan, DRMS Permit M-1977-344

Dear Mr. Keffelew,

The purpose of this groundwater monitoring plan (GMP) is to fulfill the requirements of Technical Revision #6 (TR-06) to the Division of Mining, Reclamation and Safety Permit M-1977-344. This permit is for the Holcim (US) Portland Plant quarry located adjacent to the cement plant in Florence, Colorado. The quarry is located on the north side of the Arkansas River. Groundwater in the area flows in a generally southerly direction toward the river.

Holcim proposes annual sampling of the following monitoring wells:

- MW-12 - Background well located in the north end of the quarry.
- MW-7 - Compliance well located in the southwest area of the quarry (approximately ¼ mile inside the quarry main entrance).
- MW-13 - Compliance well located in the southeast area of the quarry, approximately 100 feet north west of the intersection of State Highway 120 and Bear Creek (approximately ¼ mile east of the main quarry entrance).

In addition, Holcim will continue monitoring water level in wells P-2, P-3, MW-9, and MW-11.

Holcim proposes monitoring for the following parameters:

- Total Dissolved Solids (TDS)
- Sulfate (SO4)
- Potassium (K)
- Sodium (Na)
- Iron (Fe)
- Manganese (Mn)

In addition, the following field parameters will be recorded.

- pH
- specific conductance
- temperature

Existing and proposed standards are shown in the table below.

TABLE 1 – EXISTING AND PROPOSED STANDARDS

Parameter	Units	MW-7 Existing Standards[1]	MW-13 Proposed Standards[2]	MW-13 Maximum[3]	MW-12 Background[4]
Total Dissolved Solids	mg/L	3,918	4,372	3,660	3,975
Sulfate (SO4)	mg/L	2,080	2,585	2,000	2,350
Potassium (K)	mg/L	17	17	12	12
Sodium (Na)	mg/L	226	274	249	171
Iron (Fe)	mg/L	4.5	0.19	0.11	0.17
Manganese (Mn)	mg/L	0.88	0.69	0.26	0.63

[1] MW-7 Standards set based on nine rounds of historical sampling, standards approved in 2009.
[2] MW-13 Proposed Standards are 110% of the Maximum value obtained during 2009-2010 testing or 110% of the average of the background well, whichever is greater.
[3] MW-13 Maximum is the maximum result obtained during five quarters of testing 2009-2010.
[4] MW-12 Background is the average of the results obtained in 2009 and 2010.

If you have any questions, please do not hesitate to call me at (719) 288-1427.

Sincerely,

Joel Bolduc

Joel Bolduc
Environmental Manager

STATE OF COLORADO

DIVISION OF RECLAMATION, MINING AND SAFETY
Department of Natural Resources

1313 Sherman St., Room 215
Denver, Colorado 80203
Phone: (303) 866-3567
FAX: (303) 832-8106

COLORADO DIVISION OF RECLAMATION MINING — & — SAFETY

John W. Hickenlooper
Governor

Mike King
Executive Director

Loretta E. Pineda
Director

November 27, 2012

Joe Lamanna
Holcim (US), Inc.
3500 Highway 120
Florence, CO 81226

Re: Portland Limestone Quarry, Permit No. M-1977-344, Revised Groundwater Monitoring Plan

Mr. Lamanna:

The Division of Reclamation, Mining and Safety (DRMS) has reviewed your proposed standards for MW-13 (reference Holcim letter to DRMS dated July 7, 2010). The data collected from MW-13 is intended to supplement data collected from MW-7. The DRMS approved numeric protection levels (NPLs) for MW-7 on February 24, 2009.

The DRMS determines NPLs based on the five quarters of monitoring data initially collected from a proposed monitoring well, not from nearby or upgradient wells. The selected NPL is typically the larger of two values: 110 percent of the maximum concentration of a constituent of interest observed during the five quarters of monitoring; or the mean observed concentration of the constituent plus two standard deviations. Based on the five quarters of data provided by Holcim for MW-13, the DRMS has determined the following NPLs are appropriate:

Parameter	NPL for MW-13		Previously Approved NPL for MW-7
Total Dissolved Solids (TDS)	4,026 mg/ℓ	*	3,918 mg/ℓ
Sulfate (SO_4)	2,200 mg/ℓ	*	2,080 mg/ℓ
Potassium (K)	13 mg/ℓ	*‡	17 mg/ℓ
Sodium (Na)	274 mg/ℓ	*	226 mg/ℓ
Iron (Fe – dissolved)	0.13 mg/ℓ	‡	4.5 mg/ℓ
Manganese (Mn - dissolved	0.30 mg/ℓ	‡	0.88 mg/ℓ

* 110% of maximum observed value
‡ Mean observed value plus 2 standard deviations

Holcim will continue to monitor MW-12 (background) and MW-7 (west compliance well), and provide results for the above parameters on an annual basis. When observed parameters in MW-7 and/or MW-13 (east compliance well) exceed the NPL by more than 10 percent, Holcim will increase the monitoring frequency to semi-annually.

Because both MW-7 sodium and iron concentrations were observed above their respective NPLs in March 2012, the DRMS acknowledges that Holcim has committed to sampling MW-7 semi-annually and expects to see results from the second 2012 sampling event as soon as Holcim receives these results.

Sincerely,

Timothy A. Cazier, P.E.
Environmental Protection Specialist

Enclosure

cc: Tom Kaldenbach, DRMS
Berhan Keffelew, DRMS

MW-13 - Compliance Well												
	Apr-09	Jun-09	Sep-09	Dec-09	Mar-10	**Mean**	**Max**	**110% Max‡**	Std Dev	Mean + 2 SD		**Holcim Proposed Std.***
TDS	3660	3620	3630	3470	3300	**3536**	**3660**	**4026**	**151.10**	3838.2		**4372**
Sulfate	2000	1900	1900	1800	2000	**1920**	**2000**	**2200**	**83.67**	2087.3		**2585**
Fe	0.04	0.07	0.02	0.02	0.11	**0.052**	**0.11**	0.12	**0.04**	**0.13**		**12**
Mn (diss)	0.13	0.26	0.113	0.056	0.018	**0.1154**	**0.26**	0.29	**0.09**	**0.30**		**0.69**
K (diss)	11.9	11.8	10.3	11	9.3	**10.86**	**11.90**	**13**	**1.09**	**13**		**17.0**
Na (diss)	249	193	225	199	164	**206**	**249**	**274**	**32.37**	270.7		**274**
pH	7.99	7.01	6.95	7	7.24	**7.238**	**7.99**	**8.79**	**0.44**	8.1		**?**

‡ 110% of Max MW-13 Results (DRMS Std)

* 110% of average background well results from 2009-2010

350 = DRMS NPL

Appendix B

Proposal to Remove Sodium as a Groundwater Quality Parameter dated October 17, 2014 and Colorado Division of Reclamation Mining and Safety Approval Letter

Holcim
Holcim (US) Inc.
3500 Highway 120
Florence, CO 81226
Phone 719 784 6325
Fax 719 784 3470
www.holcim.com/us

October 17, 2014

Mr. Timothy A Cazier, P.E.
Environmental Protection Specialist
Colorado Division of Mining and Reclamation and Safety
Department of Natural Resources
1313 Sherman Street, Room 215
Denver, CO 80203

Re: Holcim (US) Inc. – Portland Plant: M-1977-344
Request for Technical Revision

Mr. Cazier,

Holcim (US) Inc. owns and operates the Portland Plant in Fremont County pursuant to DRMS Permit No. M-1977-344. On August 4, 2014 Chris Peters with Arcadis submitted a request (see enclosed) to replace sodium as a groundwater monitoring parameter with a potassium/sodium ratio. Background information and justification for making such a change was included in this letter. Please accept this request from Arcadis on Holcim's behalf.

Also enclosed with this letter is the required DRMS technical revision form and associated fee ($216.00).

If you have any questions concerning this request, please contact me at 719.288.1423 or Chris Peters at 517.324.5052.

Sincerely,

Justin Andrews
Manager Enviro

Enclosed: DRMS Technical Revision Form
Technical Revision Fee (Check No 6000015622)
Original letter from Arcadis dated August 4, 2014

COLORADO DIVISION OF RECLAMATION, MINING AND SAFETY
1313 Sherman Street, Room 215, Denver, Colorado 80203 ph(303) 866-3567

REQUEST FOR TECHNICAL REVISION (TR) COVER SHEET

File No.: M- M-1977-344 Site Name: Portland Limestone Quarry

County Fremont TR# ____________ *(DRMS Use only)*

Permittee: Holcim (US) Inc.

Operator (If Other than Permittee): ____________

Permittee Representative: Justin Andrews

Please provide a brief description of the proposed revision: ____________

Proposal to remove sodium as groundwater quality parameter

As defined by the Minerals Rules, a Technical Revision (TR) is: "a change in the permit or application which does not have more than a minor effect upon the approved or proposed Reclamation or Environmental Protection Plan." The Division is charged with determining if the revision as submitted meets this definition. If the Division determines that the proposed revision is beyond the scope of a TR, the Division may require the submittal of a permit amendment to make the required or desired changes to the permit.

The request for a TR is not considered "filed for review" until the appropriate fee is received by the Division (as listed below by permit type). Please submit the appropriate fee with your request to expedite the review process. After the TR is submitted with the appropriate fee, the Division will determine if it is approvable within 30 days. If the Division requires additional information to approve a TR, you will be notified of specific deficiencies that will need to be addressed. If at the end of the 30 day review period there are still outstanding deficiencies, the Division must deny the TR unless the permittee requests additional time, in writing, to provide the required information.

There is no pre-defined format for the submittal of a TR; however, it is up to the permittee to provide sufficient information to the Division to approve the TR request, including updated mining and reclamation plan maps that accurately depict the changes proposed in the requested TR.

Required Fees for Technical Revision by Permit Type - Please mark the correct fee and submit it with your request for a Technical Revision.

Permit Type	**Required TR Fee**	**Submitted** (mark only one)
110c, 111, 112 construction materials, and 112 quarries	$216	☑
112 hard rock (not DMO)	$175	☐
110d, 112d(1, 2 or 3)	$1006	☐

ARCADIS
1687 Cole Blvd.
Suite 200
Lakewood
Colorado 80401
Tel 303.231.9115
Fax 303.231.9571
www.arcadis-us.com

Environment

Mr. Timothy A. Cazier, P.E.
Environmental Protection Specialist
Colorado Division of Mining Reclamation and Safety
Department of Natural Resources
1313 Sherman Street, Room 215
Denver, Colorado 80203

Subject:
Holcim (US) Inc. Portland, Colorado
Proposal to Remove Sodium as a Groundwater Quality Parameter
DRMS Permit No. M-1977-344, Technical Revision No. 6

Date:
August 4, 2014

Contact:
Chris Peters

Phone:
517.324.5052

Email:
chris.peters@arcadis-us.com

Our ref:
B0025510

Dear Mr. Cazier:

ARCADIS has prepared this letter on behalf of Holcim (US) Inc. (Holcim) to propose that sodium be removed as groundwater quality indicator parameter for the groundwater monitoring program from the above referenced permit. We have provided Site and literature data to show that sodium concentrations are not a useful indicator of groundwater impacts from leaching of cement kiln dust (CKD), which has been disposed at the Holcim Portland Quarry landfill (**Figure 1**) throughout the life of the permit.

The requirement for using sodium as an indicator parameter in groundwater monitoring is based on Division of Mining Reclamation and Safety (DRMS) letters from February 24, 2009 and November 27, 2012 to Holcim, setting the numeric protection limits (NPLs) for monitoring wells MW-7 and MW-13, respectively. These letters are included in **Attachment 1** to this letter.

Sodium concentrations in monitoring well MW-7 have increased over time as shown on **Table 1** and **Figure 2**, and continue to exceed the sodium NPL for that well. Based on the latest sampling event (March 2014), the sodium concentrations exceeds the NPL by approximately 12% (253 vs. 226 mg/L). We believe that the increases in sodium concentration are unrelated to releases from the CKD landfill, as discussed below.

On-Site Data

Monitoring well MW-7 was installed in 1998 and has been sampled periodically since that time. As shown on **Table 1** and illustrated on **Figure 2**, there is a strong correlation between groundwater elevation (represented as depth to water) and sodium concentration. Depth to water (DTW) in MW-7 has increased since 1998.

Although not as strong, the correlation between DTW and sodium concentration is also exhibited in monitoring well MW-13 (**Figure 3**). In the case of MW-13, DTW has *decreased* over time and sodium concentrations have also decreased. The reason for the opposite trends in these two wells is not clear. Resource Geosciences, Inc. (RGI) speculated that groundwater levels in monitoring well MW-7 were influenced by the water level in the Arkansas River, owing to the relatively close proximity of this well to the river (about 250 feet) (RGI, 1999), whereas monitoring well MW-13 is located nearly 1000 feet from the river and would not be influenced by river level fluctuations. The geology at both MW-7 and MW-13 consists of the Codell Sandstone from the bedrock surface down to the water table, as shown in **Attachment 2**. Under these unconfined aquifer conditions, the depth to water/sodium concentration relationship observed is reasonable in that higher groundwater elevations equate to greater dilution and conversely lower groundwater elevations result in less water available for dilution.

As such, sodium concentration is not a good indicator of potential impact from the CKD landfill. As presented below, based on the chemistry of CKD, the use of potassium to sodium ratio (K:Na) is a much better indicator of groundwater impacts from CKD.

Literature Data

CKD is comprised of many alkaline compounds (commonly referred to as alkalis), including potassium and sodium oxides. As such, the leachate from CKD exhibits a very high pH. Thus elevated pH is the best indicator of CKD impacts in groundwater or surface water. However, because pH is essentially a measure of the hydrogen ion concentration, it decreases relatively quickly away from the CKD source, as the hydrogen ion concentration changes upon encountering more neutral pH values in the groundwater or surface water environments. On the contrary, both sodium and potassium are generally considered conservative in the environment in that they are not readily adsorbed to soil and are not generally reactive under varying water quality environments (for example changing pH and eH). In addition, because they are both highly leachable, the concentrations of sodium and potassium in water impacted by CKD would tend to mimic what is found in the CKD.

Table 2 was developed based on information provided in the *Report to Congress on Cement Kiln Dust* (RTC) (USEPA, 1993), for kilns similar to that found at the Portland plant (dry kiln with pre-heater). **Table 2** indicates that the range of concentrations for potassium is much higher than that of sodium. As a result, the K:Na in the environment downgradient of a CKD source should be elevated when compared to background.

Table 3 provides examples of sites in the United States that have exhibited groundwater and surface water impacts from leaching of CKD. Note that in all cases the impacted location exhibited elevated K:Na (ranging from 1.9 to 10), whereas the background locations exhibited K:Na from 0.1 to 0.3. Based on our experience at CKD impacted sites, a K:Na of greater than 0.5 to 1 is a good indicator of impact from CKD.

Summary

The information provided herein indicates that sodium is not a good indicator of impacts from CKD. Accordingly, we propose to remove sodium as an indicator parameter from the groundwater monitoring plan for DRMS Permit No. M-1977-344 (Holcim – Portland, Colorado quarry) that was last updated by DRMS on November 27, 2012. We propose to amend the plan by replacing sodium with the K:Na, and would propose a NPL of 0.5. Potassium should remain on the plan as an indicator parameter.

References

Peters, C.S., 2000. *Attenuation of Cement Kiln Dust Leachate by Clay Soils.* Air and Waste Management Association – Publications – VIP, 31-44. 14 pages.

Resource Geosciences, Inc. 1999. Hydrogeologic Assessment, HOLNAM, Inc., Portland , Colorado. RGI Project Number 04548198. January 27, 1999.

USEPA,1993. *Report to Congress on Cement Kiln Dust.* United States Environmental Protection Agency – Office of Solid Waste and Emergency Response. EPA–530–R–97–001. December 1993.

We look forward to your response. Please contact me at 517.324 5052 (office) or 517.927.3611 (cell) if you have any questions.

Sincerely,
ARCADIS

Christopher S. Peters, CPG
Vice President

Attachments:

Table 1 - Depth to Water and Sodium Concentrations for Holcim-Portland Quarry Monitoring Wells
Table 2 – Bulk Concentration Range for Potassium and Sodium Oxides in Cement Kiln Dust
Table 3 –Historical Potassium to Sodium Ratios in Water Samples at Cement Plant Sites
Figure 1 – Holcim Portland Quarry Groundwater Flow Map (March 2014)
Figure 2 – Monitoring Well MW-7 Sodium and Depth to Water Over Time
Figure 3 – Monitoring Well MW-13 Sodium and Depth to Water Over Time
Attachment 1 – DRMS Approval Letters for Groundwater Monitoring Plan
Attachment 2 – Well Construction and Geologic Logs

Copies:
Justin Andrews, Holcim (US) Inc.
Lauri Yusko, ARCADIS
File

ARCADIS

Tables

Tables 1,2,3

Table 1
Depth to Water and Sodium Concentrations
for Holcim-Portland Quarry Monitoring Wells MW-7 & MW-13

Date	MW-7		MW-13	
	DTW (ft)	Sodium (mg/L)	DTW (ft)	Sodium (mg/L)
8/29/1998	22.25	--	--	--
9/11/1998		112	--	--
5/20/1999	21.53	--	--	--
9/14/1999	22.7	--	--	--
11/30/1999	23.21	144	--	--
5/5/2000	--	185	--	--
8/11/2000	--	164	--	--
11/7/2000	--	161	--	--
2/8/2001	--	177	--	--
5/21/2001	--	186	--	--
8/8/2003	--	170	--	--
7/9/2004	21.14	--	--	--
3/19/2008	25	226	--	--
4/21/2009	25.33	236	18.43	249
6/1/2009	25.17	--	17.69	193
9/1/2009	25.17	--	19.16	225
12/1/2009	25.29	--	13.89	199
3/18/2010	25.62	228	13.98	164
3/30/2011	25.02	231	15.78	170
3/19/2012	25.65	258	16.6	203
9/28/2012	24.99	250	17.91	--
3/18/2013	25.73	297	14.63	201
3/19/2014	25.26	253	15.41	181

Notes:
ft - feet
mg/L - milligrams per liter

Table 2. Bulk Concentration Range for Potassium and Sodium Oxides in Cement Kiln Dust (weight percent) (Long Dry Kilns and Dry Kilns with Pre-heater and/or Pre-calciner)

Constituent	Concentration Range
K_2O	0.2-9.7
Na_2O	0.07-1.2

Source: Report to Congress on Cement Kiln Dust. USEPA Office of Solid Waste , 1993.

Table 3. Historical Water Quality Data from Cement Plants

Site	Location	Approx. K:Na Ratio	Data Source
Holcim-Mason City City, IA	Seep	1.9	EPA Report to Congress, 1993
	West Quarry	10	
	Surrounding GW	6 to 9	
	Background GW	0.1	
Lehigh-Mason City, IA	Quarry Ponds	2 to 4	EPA Report to Congress, 1993
	Tile Drain from Ponds	2	
Holcim-Dundee, MI	Background GW	0.2 to 0.3	Peters, 2000
	GW Adjacent to CKD Waste Area	2 to 6	

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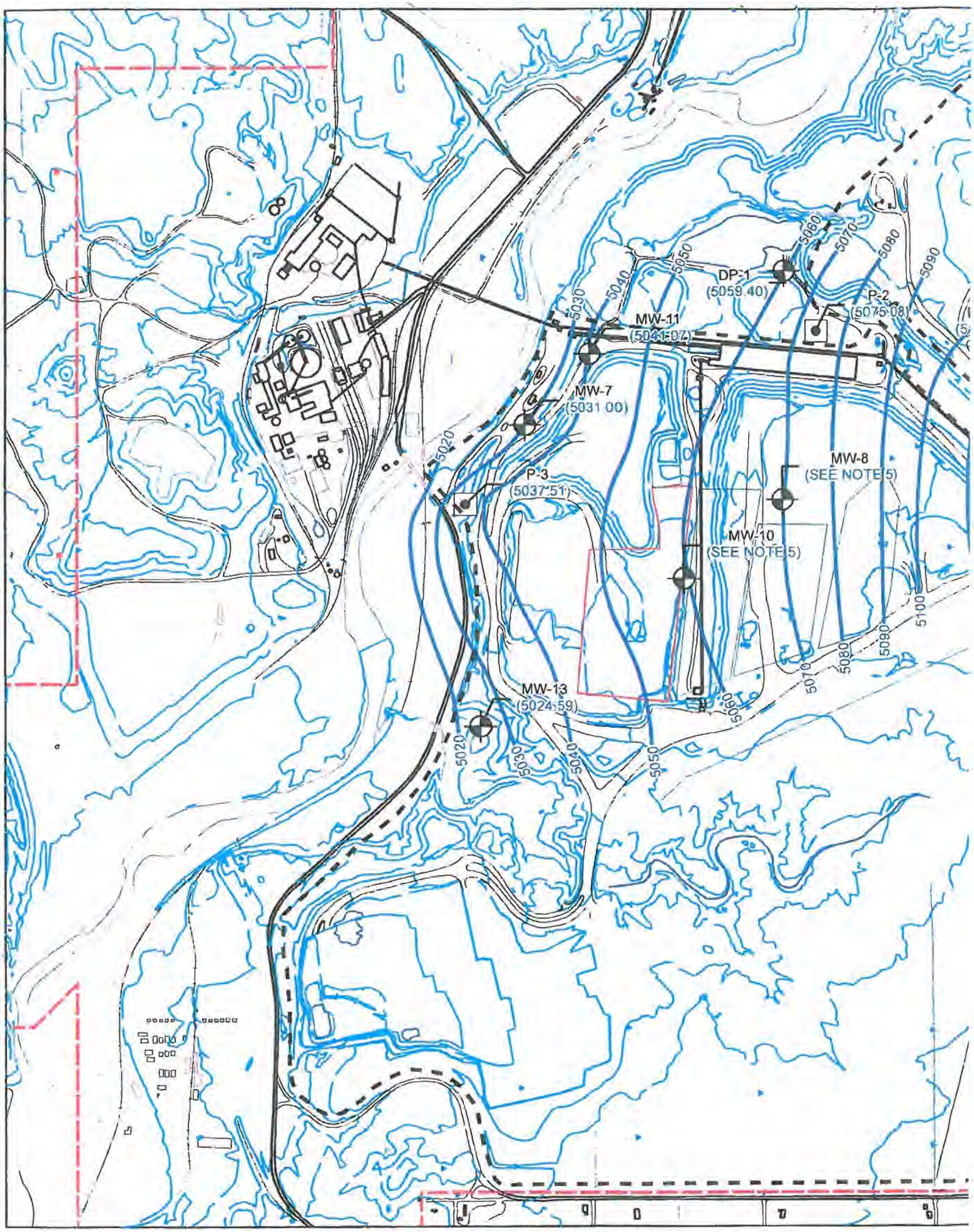
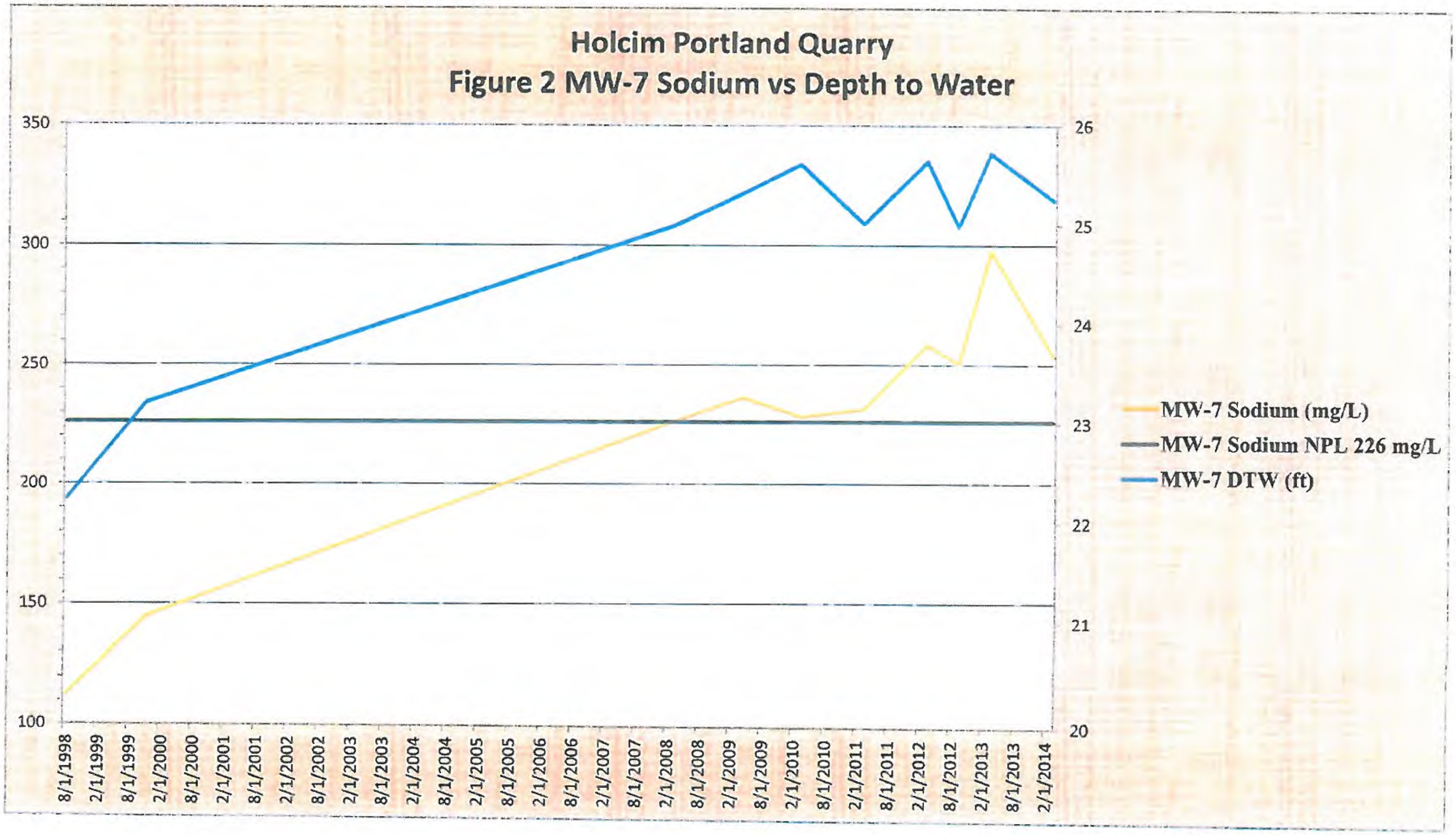
Figures

Figure 1, 2, 3



CITY:(DEN-TECH) DIV/GROUP:(ENV/GIS) DB: GMCKINNEY LD: PIC: PM: TM:
PROJECT: PATH: Z:\GISPROJECTS_ENV\Holcim\GIS\ArcMap_MXD\2014\GroundwaterElevations_2014.mxd


Holcim Portland Quarry
Figure 2 MW-7 Sodium vs Depth to Water
350
300
250
200
150
100
26
25
24
23
22
21
20
8/1/1998
2/1/1999
8/1/1999
2/1/2000
8/1/2000
2/1/2001
8/1/2001
2/1/2002
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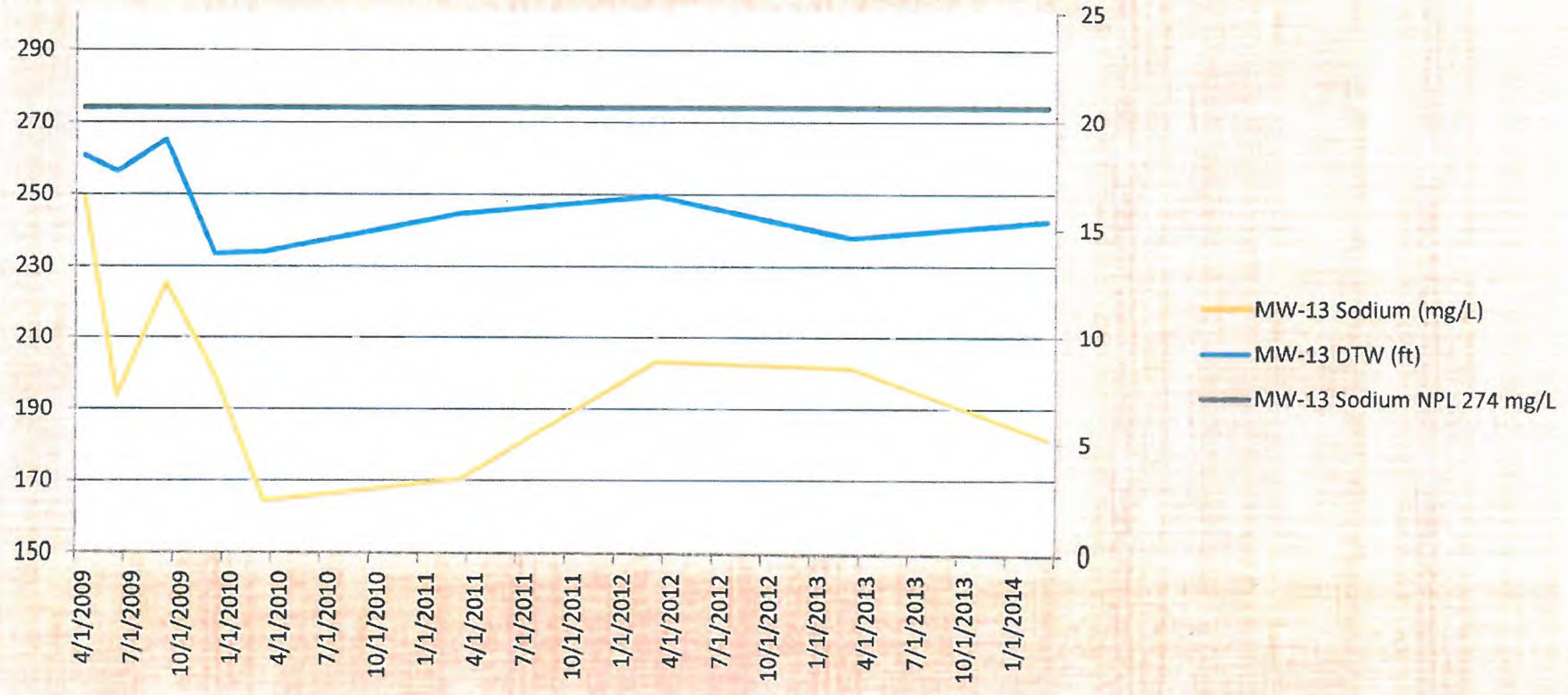
8/1/2009
2/1/2010
8/1/2010
2/1/2011
8/1/2011
2/1/2012
8/1/2012
2/1/2013
8/1/2013
2/1/2014
MW-7 Sodium (mg/L)
MW-7 Sodium NPL 226 mg/L
MW-7 DTW (ft)

Holcim Portland Quarry
Figure 3 MW-13 Sodium vs Depth to Water



ARCADIS

Attachment 1

Letters from DRMS

STATE OF COLORADO

DIVISION OF RECLAMATION, MINING AND SAFETY
Department of Natural Resources

1313 Sherman St., Room 215
Denver, Colorado 80203
Phone: (303) 866-3567
FAX: (303) 832-8106

COLORADO DIVISION OF RECLAMATION MINING & SAFETY

February 24, 2009

Mr. Joel Bolduc
Holcim, (US) Inc
3500 Highway 120
Florence, CO 81226

Re: Proposed Groundwater Monitoring Plan, DRMS Permit # M-1977-344 Portland Cement Plant.

Dear Mr. Joel

To fulfill the requirements of Technical Revision # 6, for permit # M-1977-344, Portland Cement quarry and plant, ground water monitoring plan, the Division sets the following monitoring and compliance wells . The site is located in Fremont County, North side of the Arkansas River. Groundwater flows in the area in a southerly direction towards the river.

Holcim will sample MW-7 WELL Compliance well, annually for the following parameters.

Total Dissolved Solids (TDS)	3,918 MG/L
Sulfate (SO4)	2,080 MG/L
Potassium (K)	17 MG/L
Sodium (Na)	226 MG/L
Iron (Fe)	4.5 MG/L
Manganese (Mn)	0.88 MG/L

In addition Holcium will drill in April 2009, compliance well MW-13 near the entrance to the quarry and will provide five quarters of data, so the Division will determine the appropriate parameters for the well, and set compliance parameters. In addition to MW-7, Holcim will also monitor MW-12, as a background well and provide the same parameters as MW-7 on an annual basis. When two consecutive parameters are exceeded more than 10%, during the reporting year for compliance well MV-7, Holcim will increase the frequency of monitoring to bi-yearly. If the upward trend continues, Holcim will submit an explanation and provide a remedial plan.

If you have questions, please contact me at 302 866-3567 xt 8129.

Sincerely,

Berhan Keffelew

STATE OF COLORADO

DIVISION OF RECLAMATION, MINING AND SAFETY
Department of Natural Resources

1313 Sherman St., Room 215
Denver, Colorado 80203
Phone: (303) 866-3567
FAX: (303) 832-8106

COLORADO DIVISION OF RECLAMATION MINING & SAFETY

John W. Hickenlooper
Governor

Mike King
Executive Director

Loretta E. Pineda
Director

November 27, 2012

Joe Lamanna
Holcim (US), Inc.
3500 Highway 120
Florence, CO 81226

Re: Portland Limestone Quarry, Permit No. M-1977-344, Revised Groundwater Monitoring Plan

Mr. Lamanna:

The Division of Reclamation, Mining and Safety (DRMS) has reviewed your proposed standards for MW-13 (reference Holcim letter to DRMS dated July 7, 2010). The data collected from MW-13 is intended to supplement data collected from MW-7. The DRMS approved numeric protection levels (NPLs) for MW-7 on February 24, 2009.

The DRMS determines NPLs based on the five quarters of monitoring data initially collected from a proposed monitoring well, not from nearby or upgradient wells. The selected NPL is typically the larger of two values: 110 percent of the maximum concentration of a constituent of interest observed during the five quarters of monitoring; or the mean observed concentration of the constituent plus two standard deviations. Based on the five quarters of data provided by Holcim for MW-13, the DRMS has determined the following NPLs are appropriate:

Parameter	NPL for MW-13		Previously Approved NPL for MW-7
Total Dissolved Solids (TDS)	4,026 mg/ℓ	*	3,918 mg/ℓ
Sulfate (SO_4)	2,200 mg/ℓ	*	2,080 mg/ℓ
Potassium (K)	13 mg/ℓ	*‡	17 mg/ℓ
Sodium (Na)	274 mg/ℓ	*	226 mg/ℓ
Iron (Fe – dissolved)	0.13 mg/ℓ	‡	4.5 mg/ℓ
Manganese (Mn - dissolved	0.30 mg/ℓ	‡	0.88 mg/ℓ

* 110% of maximum observed value
‡ Mean observed value plus 2 standard deviations

Holcim will continue to monitor MW-12 (background) and MW-7 (west compliance well), and provide results for the above parameters on an annual basis. When observed parameters in MW-7 and/or MW-13 (east compliance well) exceed the NPL by more than 10 percent, Holcim will increase the monitoring frequency to semi-annually.

Because both MW-7 sodium and iron concentrations were observed above their respective NPLs in March 2012, the DRMS acknowledges that Holcim has committed to sampling MW-7 semi-annually and expects to see results from the second 2012 sampling event as soon as Holcim receives these results.

Sincerely,

Timothy A. Cazier, P.E.
Environmental Protection Specialist

Enclosure

cc: Tom Kaldenbach, DRMS
Berhan Keffelew, DRMS

MW-13 - Compliance Well												
	Apr-09	Jun-09	Sep-09	Dec-09	Mar-10	Mean	Max	110% Max‡	Std Dev	Mean + 2 SD		**Holcim Proposed Std.***
TDS	3660	3620	3630	3470	3300	3536	3660	4026	151.10	3838.2		**4372**
Sulfate	2000	1900	1900	1800	2000	1920	2000	2200	83.67	2087.3		**2585**
Fe	0.04	0.07	0.02	0.02	0.11	0.052	0.11	0.12	0.04	0.13		**12**
Mn (diss)	0.13	0.26	0.113	0.056	0.018	0.1154	0.26	0.29	0.09	0.30		**0.69**
K (diss)	11.9	11.8	10.3	11	9.3	10.86	11.90	13	1.09	13		**17.0**
Na (diss)	249	193	225	199	164	206	249	274	32.37	270.7		**274**
pH	7.99	7.01	6.95	7	7.24	7.238	7.99	8.79	0.44	8.1		?

‡ 110% of Max MW-13 Results (DRMS Std)

* 110% of average background well results from 2009-2010

350 = DRMS NPL

C:\Documents and Settings\tc1\My Documents\Projects_Fremont\M-77-344 Portland Limestone Quarry\GrndWtr Results.xlsx // Sheet1

ARCADIS

Attachment 2

MW-7 log
MW-13 log

FORM NO. GWS-31 10/94

WELL CONSTRUCTION AND TEST REPORT
STATE OF COLORADO, OFFICE OF THE STATE ENGINEER

For Office Use only

1. WELL PERMIT NUMBER MH-35582 (AW-7)

2. OWNER NAME(S) Holnam, Inc.
Mailing Address 3500 Colorado Highway 120
City, St. Zip Florence, CO 81226
Phone (719) 784-6325

3. WELL LOCATION AS DRILLED: SE 1/4 SE 1/4, Sec. 17 Twp. 19 S, Range 68 W
DISTANCES FROM SEC. LINES:
800 ft. from south (north or south) Sec. line, and 750 ft. from east (east or west) Sec. line. OR
SUBDIVISION: ______ LOT ____ BLOCK ____ FILING(UNIT) ____
STREET ADDRESS AT WELL LOCATION: ______

4. GROUND SURFACE ELEVATION 5053.4 ft. DRILLING METHOD air-rotary
DATE COMPLETED 8-22-98. TOTAL DEPTH 70 ft. DEPTH COMPLETED 47 ft.

5. GEOLOGIC LOG:

Depth	Description of Material (Type, Size, Color, Water Location)
0-12'	lt. brn, fine-grained sandstone
12-25'	lt. gray fine-grained cemented sandstone
25-30'	same as above
30-70	gray to blue-gray shale

REMARKS:

6. HOLE DIAM. (in.)

HOLE DIAM. (in.)	From (ft)	To (ft)
8	0	70

7. PLAIN CASING

OD (in)	Kind	Wall Size	From(ft)	To(ft)
4	PVC	sch. 40	0	17
4	PVC	sch. 40	~~47~~	~~70~~
			(sump) 42	47

PERF. CASING: Screen Slot Size: 0.010 in.

OD (in)	Kind	Wall Size	From(ft)	To(ft)
4	PVC	sch. 40	17	42

8. FILTER PACK:
Material silica sand
Size 10-20
Interval 15-70'

9. PACKER PLACEMENT:
Type ______
Depth ______

10. GROUTING RECORD:

Material	Amount	Density	Interval	Placement
silica sand	5'	second	10-15'	poured
grout	10'	std.	0-10'	"

11. DISINFECTION: Type None Amt. Used ______

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form No. GWS 39 Supplemental Well Test.
TESTING METHOD NA
Static Level 17.85 ft. Date/Time measured 9-11-98, Production Rate ______ gpm.
Pumping level ______ ft. Date/Time measured ______, Test length (hrs.) ______
Remarks ______

13. I have read the statements made herein and know the contents thereof, and that they are true to my knowledge. [Pursuant to Section 24-4-104 (13)(a) C.R.S., the making of false statements herein constitutes perjury in the second degree and is punishable as a class 1 misdemeanor.]

CONTRACTOR Resource Geoscience, Inc. Phone (719) 635-0229 Lic. No. ______
Mailing Address 19 E. Willamette Ave., Colorado Springs, CO 80903
Name/Title (Please type or print) | Signature | Date

FORM NO. GWS-31 04/2005

WELL CONSTRUCTION AND TEST REPORT

STATE OF COLORADO, OFFICE OF THE STATE ENGINEER
1313 Sherman St., Room 818, Denver, CO 80203
Phone – Info (303) 866-3587 Main (303) 866-3581
Fax (303) 866-3589 http://www.water.state.co.us

For Office Use Only

1. WELL PERMIT NUMBER:

2. WELL OWNER INFORMATION

NAME OF WELL OWNER: Holcim, Inc.

MAILING ADDRESS: 3500 Highway 120

CITY: Florence STATE: CO ZIP CODE: 81226

TELEPHONE NUMBER: (719) 784-1118

3. WELL LOCATION AS DRILLED: SE1/4, SW1/4, Sec. 16, Twp. 19 ☐ N or ☒ S, Range 68 ☐ E or ☒ W

DISTANCES FROM SEC. LINES: ______ ft. from ☐ N or ☐ S section line and ______ ft. from ☐ E or ☐ W section line.

SUBDIVISION: NA, LOT NA, BLOCK NA, FILING (UNIT) NA

Optional GPS Location: GPS Unit must use the following settings: Format must be **UTM**, Units must be **meters**, Datum must be **NAD83**, Unit must be set to **true N**, ☐ Zone 12 or ☐ Zone 13

Owner's Well Designation: MW-13

Easting:

Northing:

STREET ADDRESS AT WELL LOCATION: Highway 120

4. GROUND SURFACE ELEVATION ______ feet DRILLING METHOD Air Rotary

DATE COMPLETED 04/03/09 TOTAL DEPTH 32 feet DEPTH COMPLETED 30 feet

5. GEOLOGIC LOG:

Depth	Type	Grain Size	Color	Water Loc.
0-3'	SILT	silt sized	lt bn gray	none
3-18.5'	SANDSTONE	med sand	lt gray	15-17'
18.5-32'	LIMESTONE	silt sized	gray	none

Remarks:

6. HOLE DIAM (in.)

HOLE DIAM (in.)	From (ft)	To (ft)
5	0	32

7. PLAIN CASING:

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2-inch	PVC	sch. 40	0	15

PERFORATED CASING: Screen Slot Size (in): 0.010

OD (in)	Kind	Wall Size (in)	From (ft)	To (ft)
2-inch	PVC	sch. 40	15	30

8. FILTER PACK:

Material sand
Size #10/20
Interval 13-32'

9. PACKER PLACEMENT:

Type NA
Depth NA

10. GROUTING RECORD

Material	Amount	Density	Interval	Placement
b chips	bucket	1/8"	11-13'	poured
grout	10 gal	std.	2-11'	poured

11. DISINFECTION: Type none Amt. Used NA

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form Number GWS 39 Supplemental Well Test.

TESTING METHOD

Static Level 15' ft. Date/Time measured: 04/03/09 / 08:50am, Production Rate NA gpm.

Pumping Level NA ft. Date/Time measured NA, Test Length (hrs) NA.

Remarks:

13. I have read the statements made herein and know the contents thereof, and they are true to my knowledge. This document is signed and certified in accordance with Rule 17.4 of the Water Well Construction Rules, 2 CCR 402-2. [The filing of a document that contains false statements is a violation of section 37-91-108(1)(e), C.R.S., and is punishable by fines up to $5000 and/or revocation of the contracting license.]

Company Name: Phone: ( ) - License Number:

Mailing Address:

Signature: Print Name and Title Date

COLORADO
Division of Reclamation, Mining and Safety
Department of Natural Resources

1313 Sherman Street, Room 215
Denver, CO 80203

October 31, 2014

Mr. Justin Andrews
Holcim (US) Inc.
3500 Highway 120
Florence, CO 81226

**Re: Portland Limestone Quarry, Permit No. M-1977-344;
Technical Revision (TR-10) Preliminary Adequacy Review**

Dear Mr. Andrews:

On October 20, 2014 the Division of Reclamation, Mining and Safety (Division) received a request for a Technical Revision (TR-10) addressing the following:

- *Proposal to remove sodium as groundwater quality parameter.*

The submittal was called complete for the purpose of filing on October 20, 2014. The decision date for TR-10 is November 19, 2014. Please be advised that if you are unable to satisfactorily address any concerns identified in this review before the decision date, **it will be your responsibility to request an extension of the review period**. If there are outstanding issues that have not been adequately addressed prior to the end of the review period, and no extension has been requested, the Division will deny this technical revision.

The Division is not opposed to modifying parameters used to indicate potential impacts to groundwater from buried and/or landfilled cement kiln dust (CKD) at the Portland Limestone Quarry. However, the Division has the following concerns and questions related to the proposal submitted by Arcadis, dated August 4, 2014:

1) Increased depth to water vs. higher sodium concentration: Mr. Peters argues that the observed trend in the increased depth to groundwater means there is less Arkansas River water available in monitoring wells MW-7 and MW-13 for dilution. The Division concurs the lower water level may be a contributing factor, but as stipulated by Mr. Peters on the top of page 2, the correlation exhibited in MW-13 is not as strong. Therefore, it is reasonable to assume there are other contributing factors, that Mr. Peters concedes are "not clear". Further, there is no discussion provided indicating the observed

increased concentrations of sodium are not attributable to impacts from CKD. Please provide some discussion on this point.

2) Literature data: An argument is presented that the data presented in the roughly 350-page Report to Congress on Cement Kiln Dust is from plants similar to the Portland Limestone Quarry. A review of previous Technical Revisions to this permit (e.g., TR-01 & TR-06) indicate bio-solids from the nearby Fremont County Sanitation District wastewater treatment plant are mixed with CKD as part of the backfilling/landfilling disposal process. Sludge samples analyzed for TR-06 suggest the addition of the bio-solids alter the chemistry of that typical for CKD. Please provide some discussion related to the referenced Report to Congress as to whether or not bio-solids are included in the characterization of CKD at similar cement plants.

3) The use of the K:Na ratio: The Division is concerned about this approach. Currently, the observed potassium concentrations are relatively constant (the standard deviation being only 10% of the mean in MW-13), whereas the observed sodium concentrations are less consistent (the standard deviation being 16% of the mean in MW-13) as seen from the July 2014 groundwater monitoring report. Mr. Peters proposes a K:Na ratio of 0.5. The 2009-2010 K:Na ratio for reported values are roughly 0.05, an order of magnitude less. Furthermore, if Na concentrations continue to increase, while K concentrations remain essentially the same, the proposed ratio of 0.5 will be quite easy to achieve. Of greater concern is that both Na and K concentrations could increase over time, but as long as the concentration of Na is at least twice that the K, the proposed standard would be met. Significant increases in either Na or K and Na should be viewed as a concern from the Division's viewpoint. A greater discussion on the K/Na chemistry as it relates to CKD and a more compelling argument for the K:Na ratio needs to be provided to the Division before this approach can be considered.

If you have any questions or need further information, please contact me at (303)866-3567 x8169.

Sincerely,

Timothy A. Cazier, P.E.
Environmental Protection Specialist

ec: Tom Kaldenbach, DRMS
Amy Eschberger, DRMS
DRMS file

ARCADIS
1687 Cole Blvd.
Suite 200
Lakewood
Colorado 80401
Tel 303.231.9115
Fax 303.231.9571
www.arcadis-us.com

Environment

Mr. Timothy A. Cazier, P.E.
Environmental Protection Specialist
Colorado Division of Reclamation, Mining and Safety
Department of Natural Resources
1313 Sherman Street, Room 215
Denver, Colorado 80203

Subject:
Response to DRMS Technical Revision (TR-10) Preliminary Adequacy Review
Holcim (US) Inc. Portland, Colorado Limestone Quarry, Permit No. M-1977-344

Date:
November 19, 2014

Contact:
Chris Peters

Phone:
517.324.5052

Email:
chris.peters@
arcadis-us.com

Our ref:
B0025510

Dear Mr. Cazier:

ARCADIS has prepared this letter on behalf of Holcim (US) Inc. (Holcim) to respond to the Division of Reclamation, Mining and Safety (DRMS) Technical Revision (TR-10) Technical Adequacy Review of the "Proposal to Remove Sodium as a Groundwater Quality Parameter – DRMS Permit No. M-1977-344, Technical Revision No. 6", dated August 4, 2014 and received by DRMS on October 20, 2014. The DRMS responded to the above proposal in a letter to Justin Andrews of Holcim dated October 31, 2014, requesting additional information be provided before they would authorize the removal of sodium as a water quality parameter to evaluate potential impact from leaching of cement kiln dust (CKD).

Presented below is a summary of the DRMS comment from the October 31 letter followed by ARCADIS' response. We believe this information will provide the justification to remove the numeric protection level (NPL) for sodium from the groundwater monitoring program, approved by the DRMS on February 24, 2009 and updated on November 27, 2012. We would propose as a revision to the groundwater monitoring program to continue to analyze groundwater samples for sodium in order to continue to determine the potassium to sodium ratio, which we would propose to replace the sodium NPL as the primary water quality indicator of impact from the CKD landfill.

1) Relationship between depth to water and sodium concentration in monitoring well MW-7:

The DRMS acknowledges that the higher concentrations of sodium observed in MW-7 may be partially attributable to lower water levels in that monitoring well, but commented that ARCADIS should provide further discussion as to why the increased sodium concentrations are <u>not</u> attributable to impacts from CKD.

ARCADIS Response:

As presented below, multiple lines of evidence support the conclusion that increasing concentrations of sodium in groundwater samples collected at MW-7 are not associated with leachate from the CKD landfill.

We have further evaluated the effect of depth to water in monitoring well MW-7 (see **Figure 1** for location) to water quality in that well by preparing concentration versus depth to groundwater graphs for sulfate and potassium, two of the other constituents analyzed as part of the Groundwater Monitoring Plan (GMP) for the site. These graphs are presented in **Figure 2** along with a sodium concentration versus depth to groundwater graph. The graphs demonstrate that while sodium concentration increase with increasing depth to groundwater, sulfate and sodium concentrations are inversely related to depth to groundwater. The correlation between and sulfate and potassium concentrations and depth to water is not as strong when compared to sodium after 2010, as indicated by the two observed “spikes” in concentration (**Figure 2**), particularly for sulfate. However, for both potassium and sulfate, when depth to groundwater decreases, constituent concentrations increase. All three constituents are present in the CKD (see **Table 1**), and potassium and sulfate are present in the CKD at much higher concentrations than sodium (see discussion below) and all three constituents are highly leachable.. It follows that if the observed increases in sodium concentrations were associated with the CKD landfill, then corresponding increases in sulfate and potassium should be observed. The historical data for these two constituents do not exhibit this pattern.

In addition to the observed relationship between depth to water and sodium, sulfate, and potassium concentrations, there are additional lines of evidence that the increase in sodium concentrations are not related to releases from the CKD landfill. The basis for this position is that the concentrations of sodium in the groundwater should reflect its concentration in the CKD as well as its concentration relative to other constituents in the CKD. We present below both compositional and leach test data from the CKD to demonstrate that sodium concentrations in groundwater at MW-7 are not attributable to leaching from CKD.

CKD chemistry indicates high concentrations of potassium and chloride relative to sodium. **Table 1** is a summary of compositional CKD analyses from the Portland plant for 2014 for sodium, potassium, and chloride. Sodium and potassium analyses are presented as oxides of these parameters. The data indicate that the average potassium concentration is greater than sodium by more than a factor of 10 (K:Na > 10). Chloride concentrations in the CKD exceed sodium concentrations in the CKD by nearly factor of 20 (Cl:Na >20). **Table 2** summarizes compositional potassium and sodium concentrations from the Portland plant and eight other Holcim plants in the United States from 2005 and 2006. Potassium concentrations on average exceed sodium concentrations by a factor of approximately 11. Sodium, potassium, and chloride are all highly leachable constituents and behave conservatively in the environment; that is, they are minimally affected by geochemical conditions in the receiving groundwater (for example pH, redox, cation exchange capacity). It therefore follows that concentration of these constituents in the groundwater, if leakage from the landfill was occurring, should mimic the concentrations in the CKD (thus, potassium concentrations should greatly exceed sodium concentrations). Based on several years of groundwater monitoring data from the site this is not the case. While chloride is not part of the GMP, previous analyses of chloride suggest the same conclusion. **Table 3** presents some historical chloride, potassium , and sodium concentrations in MW-7 between 1998 and 2009. Chloride concentrations ranged from approximately 25 to 42 mg/L during that time period, compared to 7 to 17 mg/L for potassium in that well over the same time frame, and 112 to 236 mg/L for sodium. If these concentrations were a result of leaching from the CKD, potassium and chloride concentrations should be much higher than sodium concentrations rather than the opposite. These conclusions are illustrated with graphs of groundwater sodium concentrations versus K:Na and Cl:Na values for groundwater samples (**Figure 3**). As shown in **Figure 3**, groundwater K:Na values are below 0.25 and Cl/Na values are below 0.3, both of which are more than an order of magnitude below the K:Na >10 and Cl:Na >20 values expected for CKD and CKD leachate.

CKD leachate testing data also suggests that the landfill is not the source of sodium in groundwater at MW-7. **Table 4** is a summary of Synthetic Precipitation Leaching Procedure (SPLP) test data for CKD and alkali bypass dust generated from the Portland plant, from 2002 and 1999. While the data set is limited, the results of both tests show that the concentrations of sodium (158 and 159 mg/L) are less than the recent and historical concentrations of sodium in groundwater at MW-7. Based on these results it is not feasible that releases from the landfill could be the cause of the increasing sodium concentrations in groundwater at MW-7. Furthermore, the elevated chloride concentration in the alkali bypass dust from the SPLP test (4,600 mg/L) relative to the sodium concentration (158 mg/L) results in a Cl:Na value of 29, generally consistent with the chloride to sodium ratio values greater than 20 in the CKD composition analysis results (**Table 1**).

Groundwater data were evaluated further to better understand the potential cause of increasing sodium concentrations at MW-7. **Figure 4** demonstrates little relation between sodium and sulfate concentrations for groundwater monitoring locations with the exception of MW-7, which shows a strong inverse relation between sodium and sulfate concentrations. These results suggest that water with different compositional "types" is entering into the MW-7 monitoring well. Trilinear diagrams, also known as Piper diagrams, were developed for select samples that had sufficient data for plotting. As shown in **Figure 5**, most groundwater samples plotted within the calcium plus magnesium, sulfate [Ca+Mg–SO_4] type water field shown in the upper portion of the diamond. However, the MW-7 2008 sample is shifted away from the primary group of samples towards the sodium plus potassium, bicarbonate [Na+K–HCO_3] type water while the MW-7 2009 sample is clearly a Na+K–HCO_3 type water. These shifts in water composition occurred when depth to groundwater increased.

MW-7 is completed within the Codell Sandstone and the underlying Blue Hill Shale. The MW-7 borehole was completed to a total depth of 70 feet below ground surface (ft bgs) with the upper 30 feet in the sandstone and the lower 40 feet in the underlying shale (**Figure 6**). The borehole was backfilled with silica sand to a depth of 42 ft bgs. The borehole was cased and a slotted screen interval was completed from 17 to 42 feet bgs across both the sandstone and shale bedrock. When the depth to groundwater increases at MW-7, the proportion of groundwater that may be contributed from the shale increases and may result in the observed shifts in groundwater quality with increased depth to groundwater. No other site groundwater monitoring wells intersect the Blue Hill Shale and no other site groundwater monitoring wells exhibit the wide variability in constituent concentrations observed at MW-7. The borehole log is included as Attachment 1 to this letter.

2) Literature Data:

The DRMS has requested that ARCADIS provide some discussion related to the referenced Report to Congress as to whether or not bio-solids are included in the characterization of CKD at similar cement plants. The basis for this statement is that they indicated sludge samples analyzed for TR-06 suggest the addition of the bio-solids alter the chemistry of that typical for CKD.

Response:

We are not aware of biosolids being used as an admixture for CKD at other cement plants, and we were not able to obtain any data in that regard. Biosolids were originally used as a dust control measure. However, biosolids have not been used at the Portland facility for at least 10 years and represent a small percentage of the total waste in the facility. As such, it is unlikely that they will have a significant impact on the overall chemistry of the highly leachable constituents, such as potassium, sodium, and chloride present in the CKD and be observed in measurements taken 10 years later.

3) The use of the K/Na ratio:

The DRMS has stated: “The 2009-2010 K:Na ratio for reported values are roughly 0.05, an order of magnitude less. Furthermore, if Na concentrations continue to increase, while K concentrations remain essentially the same, the proposed ratio of 0.5 will be quite easy to achieve. Of greater concern is that both Na and K concentrations could increase over time, but as long as the concentration of Na is at least twice that the K, the proposed standard would be met. Significant increases in either Na or K and Na should be viewed as a concern from the Division’s viewpoint. A greater discussion on the K:Na chemistry as it relates to CKD and a more compelling argument for the K:Na ratio needs to be provided to the Division before this approach can be considered.”

Response:

While we concur that significant increases in sodium or potassium should be closely monitored, the discussion provided in this letter has demonstrated that increases in sodium are not related to releases from CKD. If they were, a correspondingly greater increase in potassium concentration should be observed. This is clearly not the case. As shown in **Figure 3**, K:Na values for all site groundwater samples were less than 0.25 and most were less than 0.15; well below the K:Na value of greater than 10 for CKD. When sodium concentrations increased in groundwater at MW-7, the K:Na value decreased substantially, demonstrating a behavior that is the *opposite* of what would be expected from contributions of CKD leachate.

We believe that we have provided a convincing argument that the ratio of potassium and sodium is a useful indicator of CKD impacts. ARCADIS has successfully used K:Na ratios in other states, particularly Michigan to assess impacts to groundwater from CKD waste areas. A K:Na ratio threshold of 0.5 is a reasonable, and we believe conservative indicator of groundwater impact from CKD leaching.

If the Division has additional questions or concerns about the suggested monitoring approach, we would suggest that a meeting be convened to further discuss this issue. Please let us know a convenient meeting time.

Furthermore , we propose to complete an additional round of groundwater monitoring at the site in December In addition to the current list of parameters included in the GMP, we will analyze groundwater samples for chloride.

We look forward to your response. Please contact me at 517.324 5052 (office) or 517.927.3611 (cell) if you have any questions.

Sincerely,
ARCADIS

Christopher S. Peters, CPG
Vice President

Tables:

Table 1	Compositional Concentrations for Alkali Bypass Dust at Holcim Portland Plant - 2014 (weight percent)
Table 2	Summary of Compositional Potassium and Sodium Concentrations in Cement Kiln Dust/Alkali Bypass Dust
Table 3	Historical Cl, K, and Na Concentrations in Monitoring Well MW-7
Table 4	Synthetic Precipitation Leaching Procedure Test Results

Figures:

Figure 2	Sulfate, Sodium, and Potassium versus Depth to Groundwater
Figure 3	Sodium Concentrations versus Potassium to Sodium and Chloride to Sodium Ratios
Figure 4	Sodium and Sulfate Concentrations
Figure 5	General Geochemistry
Figure 6	MW-7 Well Completion, Depth to Groundwater, and Water Quality

Attachments:

1	Boring Log for Monitoring Well MW-7

Copies:

Justin Andrews, Holcim (US) Inc.
Lauri Yusko, ARCADIS
Julie Sueker, ARCADIS
File

Tables

Table 1. Compositional Concentrations for Alkali Bypass Dust at Holcim Portland Plant - 2014 (weight percent)

	SiO2	Al2O3	Fe2O3	CaO	MgO	SO3	Na2O	K2O	NaEq	Cl
	%	%	%	%	%	%	%	%	%	%
Average	15.4	4.2	1.98	46.89	1.33	4.95	0.43	5.14	3.81	8.1
Median	15.71	4.25	2.03	47.25	1.33	4.46	0.4	4.7	3.6	5.84
Std. Dev.	1.61	0.47	0.22	6.35	0.07	2.24	0.14	2.09	1.5	3.31
Maximum	18.11	5.21	2.43	60.94	1.62	11.25	1.01	12.64	9.14	19.3
Minimum	9.64	2.58	1.18	29.68	1.11	1.37	0.19	1.45	1.14	1.68
N	189	189	189	189	189	190	190	190	190	190

N = sample count

Source: Holcim (US) Inc.

Table 2. Summary of Compositional Potassium and Sodium Concentrations in Cement Kiln Dust/Alkali Bypass Dust Holcim (US) Inc. Plants (weight percent)

Plant	Ada	Devils Slide	Dundee	Midlothian	Portland	Trident	Artesia	Clarksville	Holly Hill	
Year/ Quarter										
2005/1st										**ave.**
Na_2O	0.25	0.62	0.37	0.45	0.56	0.51	0.81	0.17	0.31	0.45
K_2O	2.68	3.82	4.14	3.36	0.95	6.9	6.55	3.18	4.31	3.99
2005/2nd										
Na_2O	0.32	0.56	NA	NA	0.61	0.49	NA	0.3	NA	0.46
K_2O	2.14	3.7	NA	NA	7.17	8.38	NA	3.74	NA	5.03
2005/3rd										
Na_2O	0.21	0.74	0.43	0.47	0.58	0.69	NA	0.24	NA	0.48
K_2O	1.57	9.1	3.95	4.31	6.05	8.21	NA	3.77	NA	5.28
2005/4th										
Na_2O	0.15	0.65	0.4	0.27	0.38	NA	NA	0.14	NA	0.35
K_2O	1.81	8.99	3.7	3.57	7.64	NA	NA	3.84	NA	4.9
2006/1st										
Na_2O	0.18	0.74	0.41	0.11	NA	0.11	1.5	0.19	NA	0.46
K_2O	2.52	8.27	1.72	2.67	NA	3	9.97	2.97	NA	4.4

NA - data not available

Table 3. Historical Cl, K, and Na Concentrations in Monitoring Well MW-7
Holcim (US) Inc. Portland Plant (mg/L)

Date	Cl	K	Na
9/11/1998	32.6	17	112
11/30/1999	26.5	13	144
5/5/2000	29.4	15.6	185
8/11/2000	25.9	16	164
11/7/2000	27.2	12.8	161
2/8/2001	27.6	11.2	177
5/21/2001	28.1	11.1	186
8/7/2003	25.0 J	11	170
3/1/2008	37	10.4	226
4/1/2009	42	7.2	236

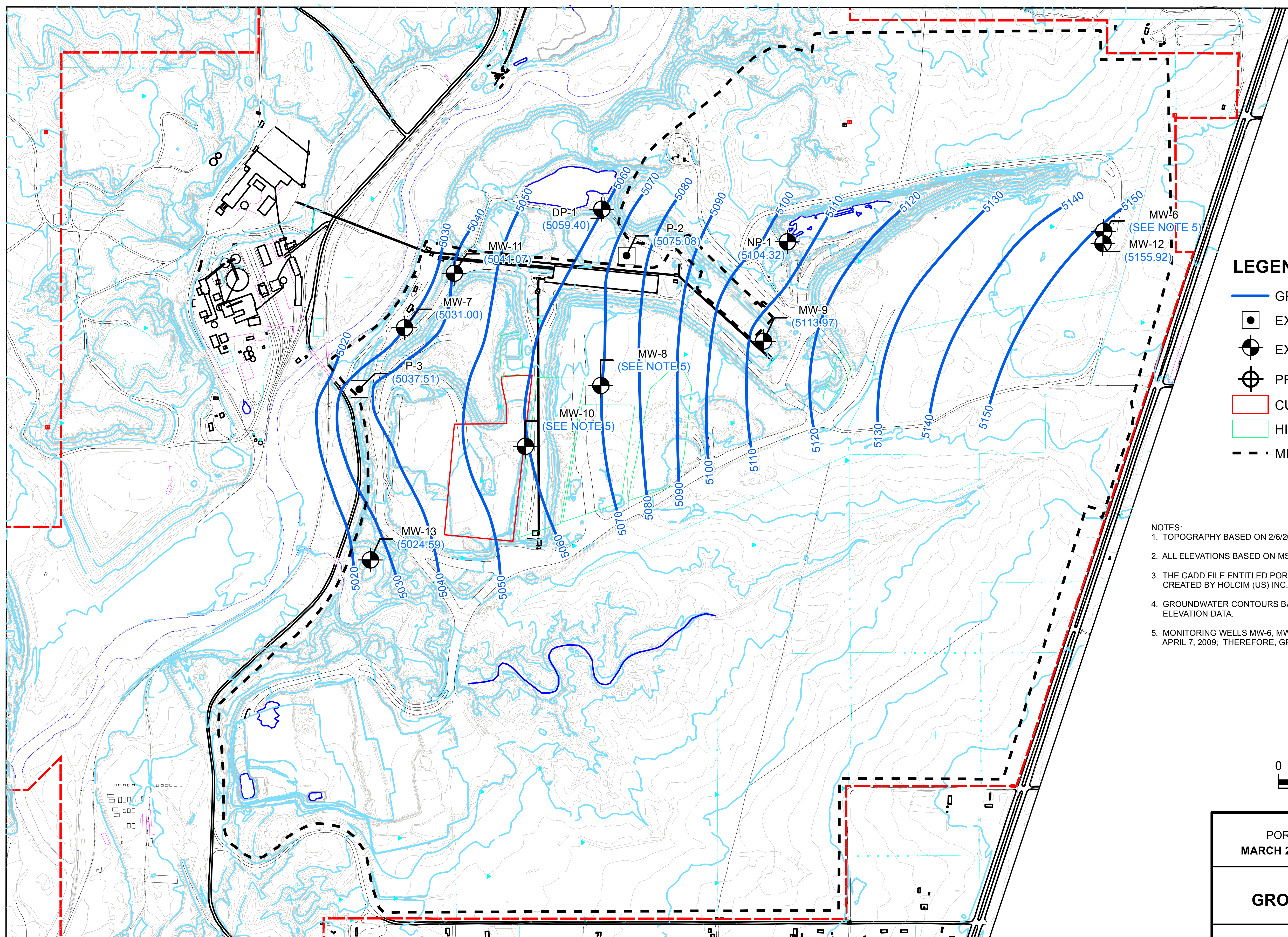
J- concentration below reportable limit but above method detection limit

Table 4. Synthetic Precipitation Leaching Procedure Test Results
Holcim (US) Inc., Portland Plant

Parameter	**Date** / **Material**	**11/14/2002** Alkali Bypass Dust	**1999** Sludge/CKD Mix
Calcium		1680	251
Chloride		4600	77.2
Sodium		158	195
Sulfate		2680	3800
Conductivity (mS/cm)		29900	10600/12300
pH (std. units)		12.4	12.5/12.7

1999 sample from Resource Geoscience, Inc. 1999. Hydrogeologic Assessment Holnam, Inc. Portland, CO. Prepared for Holnam, Inc. January 27, 1999.

Figures



LEGEND:

- GROUNDWATER CONTOUR
- EXISTING PIEZOMETER
- EXISTING WELL
- PROPOSED WELL
- CURRENT BYPASS DUST DISPOSAL AREA
- HISTORIC CKD DISPOSAL AREA
- MINE PERMIT BOUNDARY

NOTES:
1. TOPOGRAPHY BASED ON 2/6/2004 AERIAL PHOTOGRAPH.
2. ALL ELEVATIONS BASED ON MSL.
3. THE CADD FILE ENTITLED PORTLAND 2005 UPDATED 2-21-05.DWG CREATED BY HOLCIM (US) INC. WAS UTILIZED AS THE BASE MAP.
4. GROUNDWATER CONTOURS BASED ON MARCH 2014 GROUNDWATER ELEVATION DATA.
5. MONITORING WELLS MW-6, MW-8, AND MW-10 WERE ABANDONED ON APRIL 7, 2009; THEREFORE, GROUNDWATER LEVELS ARE UNAVAILABLE.

0 1,000 2,000
GRAPHIC SCALE IN FEET

HOLCIM (US) INC.
PORTLAND PLANT, FLORENCE, COLORADO
MARCH 2014 GROUNDWATER MONITORING REPORT

GROUNDWATER CONTOUR MAP

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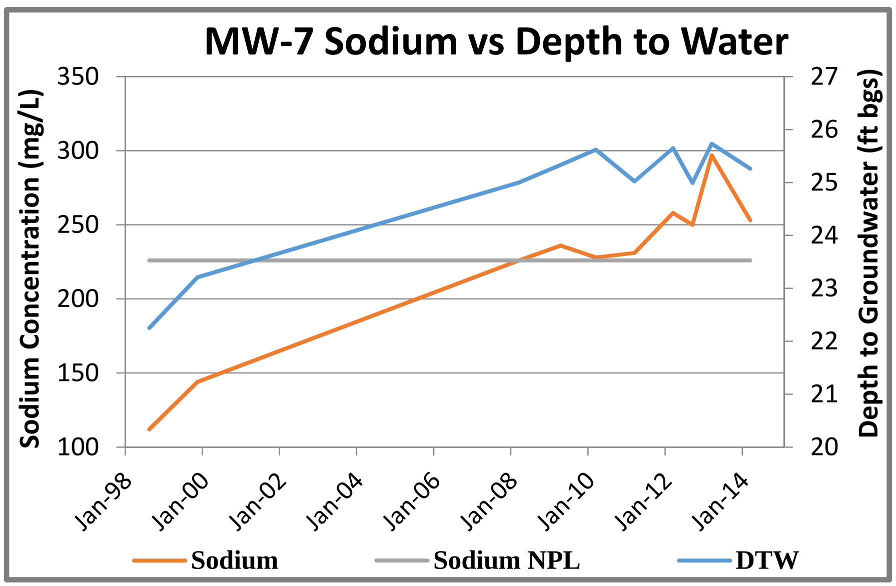
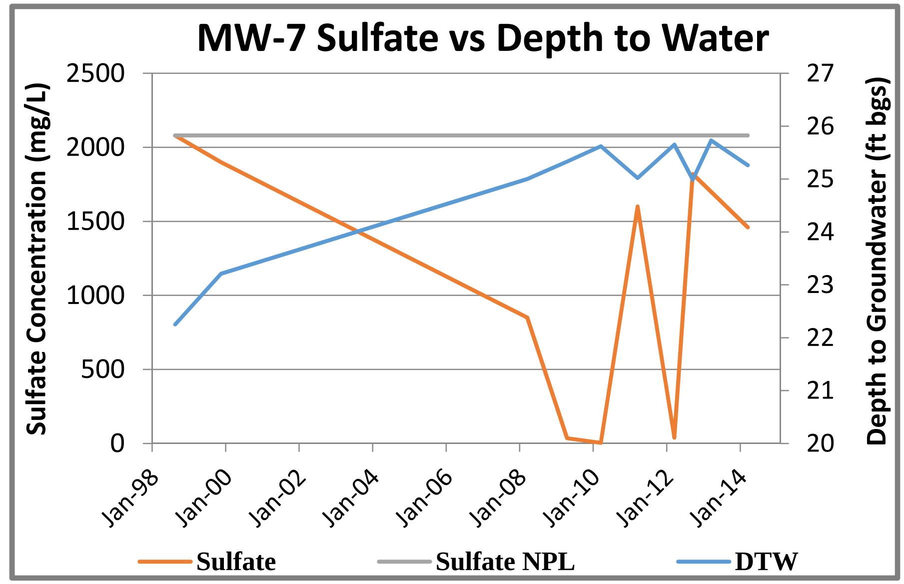
FIGURE
1

CITY:(DEN-TECH) DIV/GROUP:(ENV/GIS) DB: GMCKINNEY LD: PIC: PM: TM:
PROJECT: PATH: Z:\GISPROJECTS_ENV\Holcim\GIS\ArcMap_MXD\2014\GroundwaterElevations_2014.mxd

Figure 2. Sulfate, Sodium, and Potassium versus Depth to Groundwater

- Sodium concentrations increase with increasing depth to groundwater
- Sulfate and potassium concentrations are inversely related to depth to groundwater





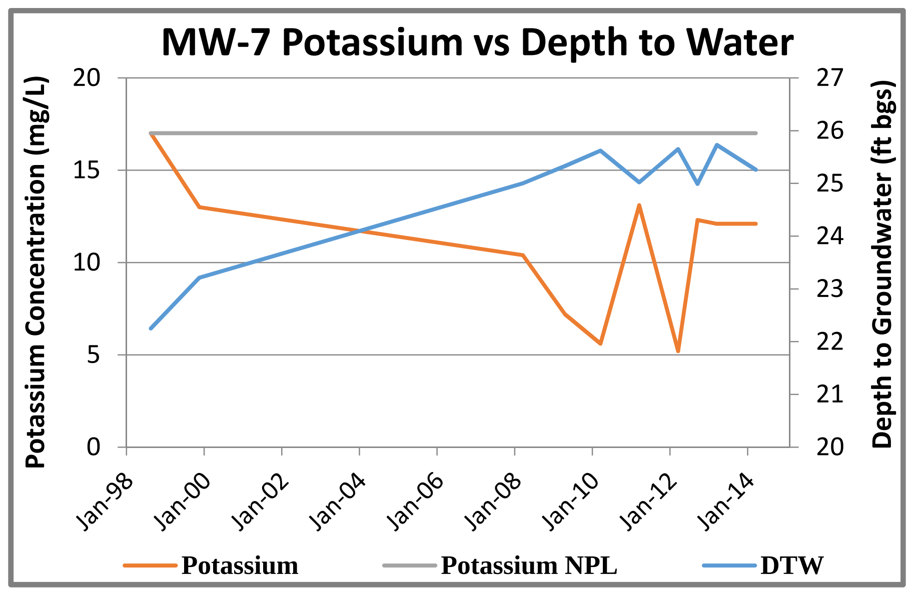
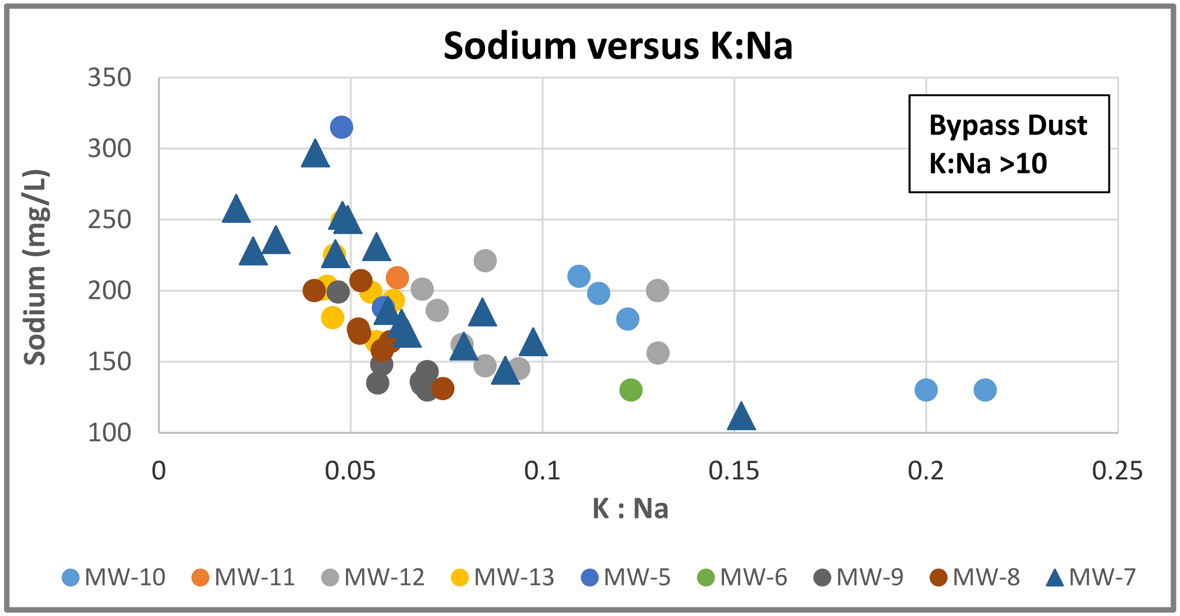


Figure 3. Sodium Concentrations versus Potassium to Sodium and Chloride to Sodium Ratios

- Bypass Dust K:Na values typically > 10
- Groundwater K:Na values <0.25
- MW-7 K:Na decreases with increasing Na concentration
- MW-7 K:Na values not consistent with Bypass Dust source of Na



- Bypass Dust Cl:Na values typically > 20
- Groundwater K:Na values <0.3
- MW-7 no relation between sodium concentration and Cl:Na
- MW-7 Cl:Na values not consistent with Bypass Dust source of Na

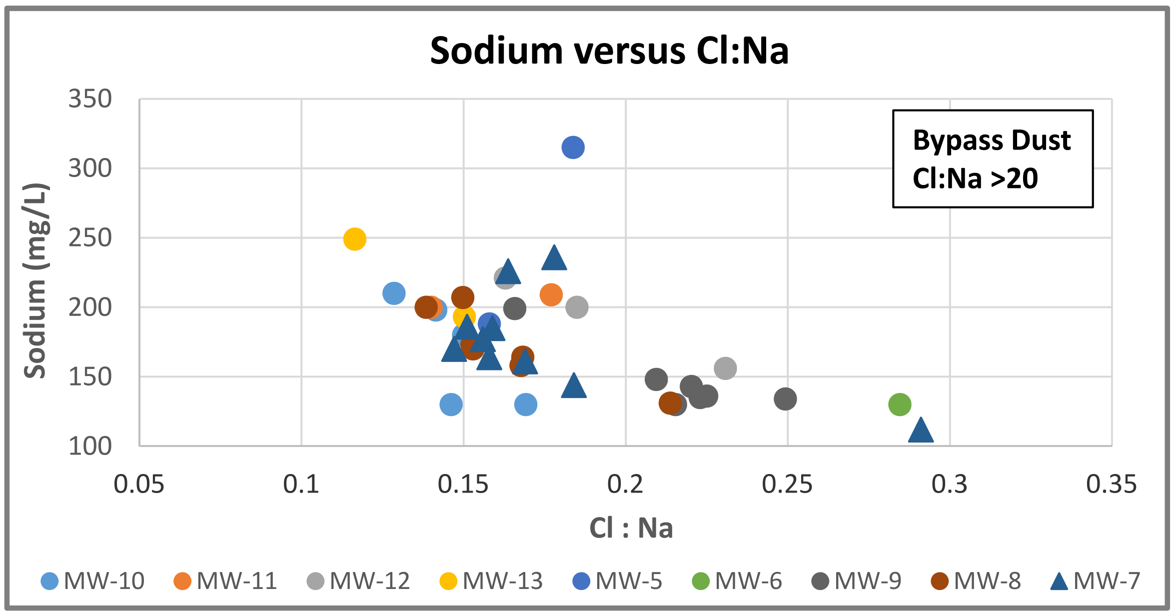


Figure 4. Sodium and Sulfate Concentrations

- Most groundwater monitoring locations have no relation between sodium and sulfate concentrations
- MW-7 samples exhibit strong inverse relation between sodium and sulfate concentrations

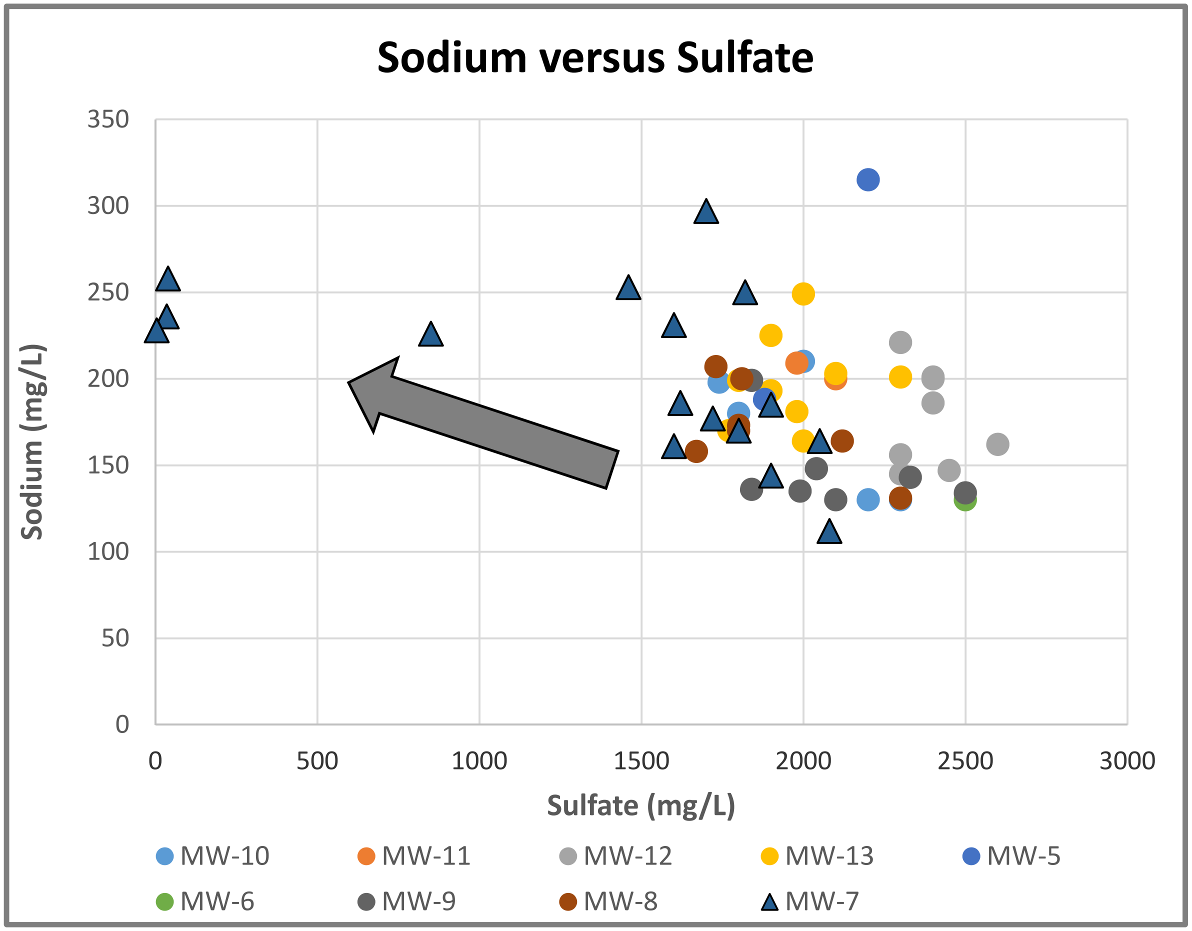
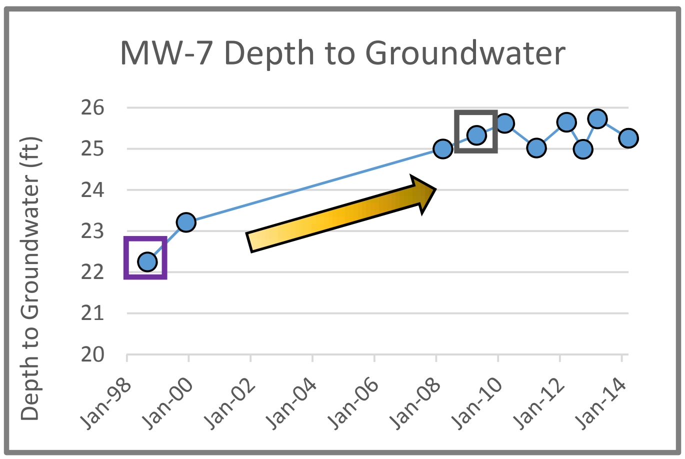


Figure 5. General Geochemistry

- Most samples plot within the Ca,Mg–SO_4 water type
- MW-7 shift to Na–HCO_3 type water with increasing depth to water
- Contributions of water to MW-7 from different geologic strata



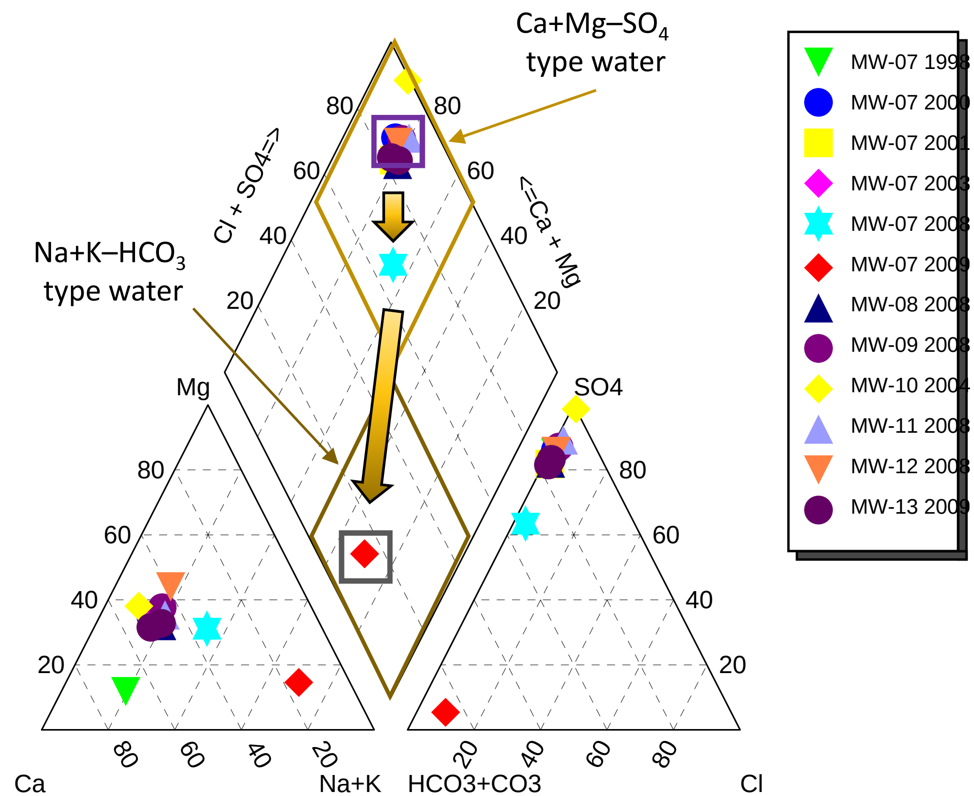
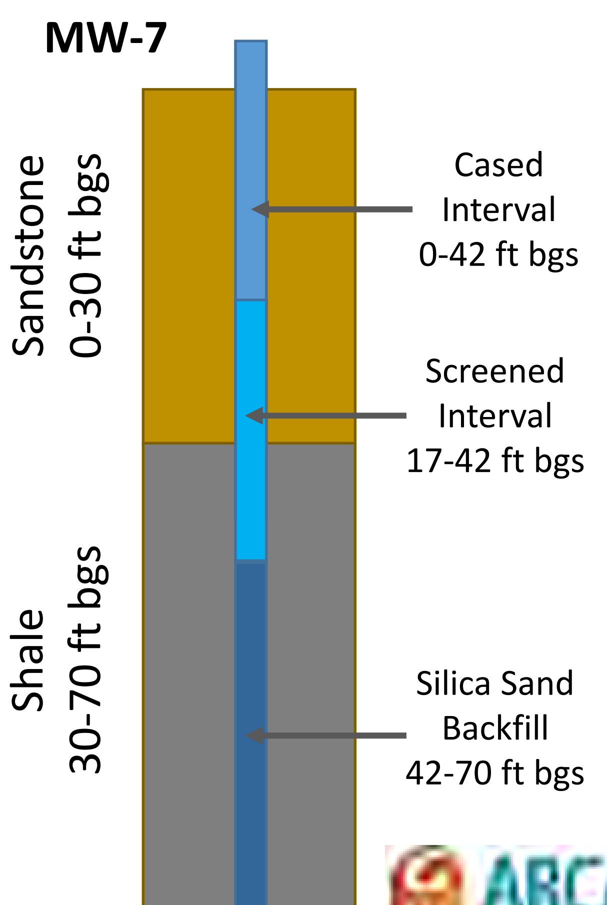
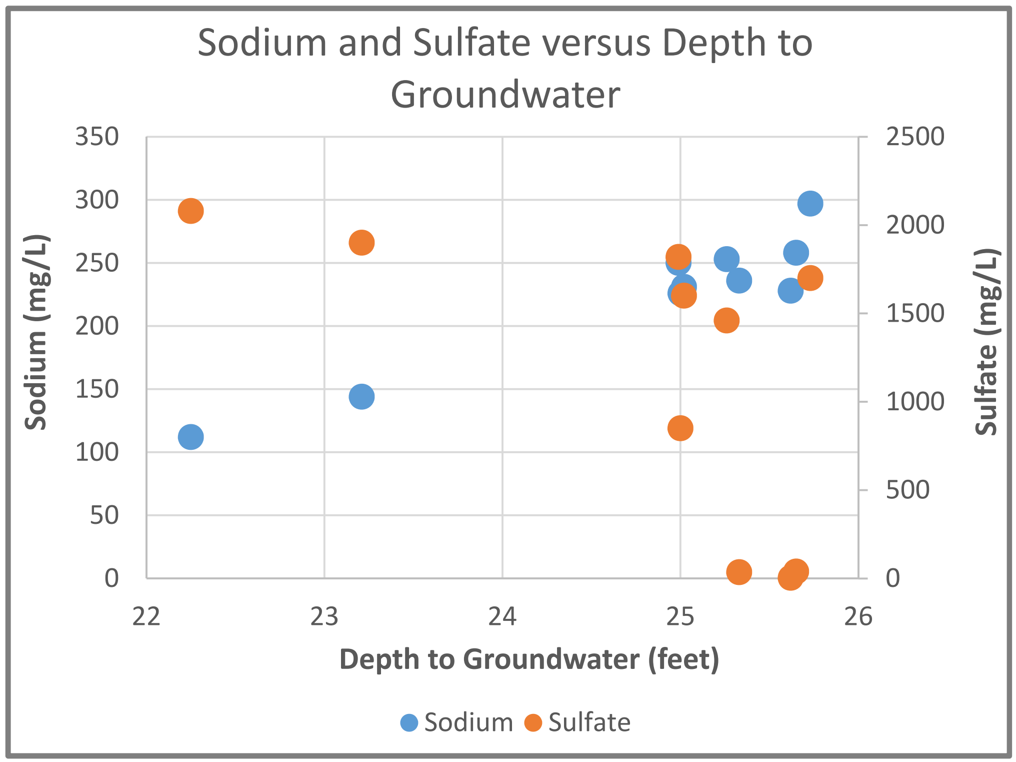


Figure 6. MW-7 Well Completion, Depth to Groundwater, and Water Quality

- MW-7 completed within sandstone and shale bedrock
- Greater contribution of water from shale with greater depth to groundwater
- Groundwater in shale may have different composition than in overlying sandstone





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Attachments

Boring Log for Monitoring Well MW-7

FORM NO. GWS-31 10/94

WELL CONSTRUCTION AND TEST REPORT
STATE OF COLORADO, OFFICE OF THE STATE ENGINEER

For Office Use only

1. WELL PERMIT NUMBER MH-35582 (MW-7)

2. OWNER NAME(S) Holnam, Inc.
Mailing Address 3500 Colorado Highway 120
City, St. Zip Florence, CO 81226
Phone (719) 784-6325

3. WELL LOCATION AS DRILLED: SE 1/4 SE 1/4, Sec. 17 Twp. 19 S, Range 68 W
DISTANCES FROM SEC. LINES:
800 ft. from south (north or south) Sec. line. and 750 ft. from east (east or west) Sec. line. OR
SUBDIVISION: ______ LOT ____ BLOCK ____ FILING(UNIT) ____
STREET ADDRESS AT WELL LOCATION:

4. GROUND SURFACE ELEVATION 5053.4 ft. DRILLING METHOD air-rotary.
DATE COMPLETED 8-22-98. TOTAL DEPTH 70 ft. DEPTH COMPLETED 47 ft.

5. GEOLOGIC LOG:

Depth	Description of Material (Type, Size, Color, Water Location)
0-12'	lt. brn., fine-grained sandstone
12-25'	lt. gray, fine-grained cemented sandstone
25-30'	same as above
30-70	gray to blue-gray shale

REMARKS:

6. HOLE DIAM. (in.)

HOLE DIAM. (in.)	From (ft)	To (ft)
8	0	70

7. PLAIN CASING

OD (in)	Kind	Wall Size	From(ft)	To(ft)
4	PVC	sch 40	0	17
4	PVC	sch. 40	~~47~~	~~70~~
			RSI 42	47

PERF. CASING: Screen Slot Size: 0.010 in.

OD (in)	Kind	Wall Size	From(ft)	To(ft)
4	PVC	sch. 40	17	42

8. FILTER PACK:
Material silica sand
Size 10-20
Interval 15-70'

9. PACKER PLACEMENT:
Type
Depth

10. GROUTING RECORD:

Material	Amount	Density	Interval	Placement
silica sand	5'	loosed	10-15'	poured
grout	10'	std.	0-10'	"

11. DISINFECTION: Type None Amt. Used

12. WELL TEST DATA: ☐ Check box if Test Data is submitted on Form No. GWS 39 Supplemental Well Test.
TESTING METHOD NA
Static Level 19.85 ft. Date/Time measured 9-11-98, Production Rate ______ gpm.
Pumping level ______ ft. Date/Time measured ______, Test length (hrs.) ______.
Remarks

13. I have read the statements made herein and know the contents thereof, and that they are true to my knowledge. [Pursuant to Section 24-4-104 (13)(a) C.R.S., the making of false statements herein constitutes perjury in the second degree and is punishable as a class 1 misdemeanor.]

CONTRACTOR Resource Geoscience, Inc. Phone (719) 635-0229 Lic. No. ______
Mailing Address 19 E. Willamette Ave., Colorado Springs, CO 80903

Name/Title (Please type or print)	Signature	Date

COLORADO
Division of Reclamation, Mining and Safety
Department of Natural Resources

1313 Sherman Street, Room 215
Denver, CO 80203

February 25, 2015

Mr. Joe Lamanna
Holcim (US) Inc.
3500 Highway 120
Florence, CO 81226

**Re: Portland Limestone Quarry, Permit No. M-1977-344;
Technical Revision Approval, Revision No. TR-10**

Dear Mr. Lamanna:

On February 25, 2015 the Division of Reclamation, Mining and Safety approved the Technical Revision application submitted to the Division on October 20, 2014, addressing the following:

> *Proposal to remove sodium as groundwater quality parameter and replace with a K:Na ratio using 0.5 as a numeric protection limit.*

The terms of the Technical Revision No. 10 approved by the Division are hereby incorporated into Permit No. M-1977-344. All other conditions and requirements of Permit No. M-1977-344 remain in full force and effect.

The Division has reviewed this change for impacts to the financial warranty and has determined that this change does not require an increase to the current reclamation liability.

If you have any questions or need further information, please contact me at (303)866-3567 x8169.

Sincerely,

Timothy A. Cazier, P.E.
Environmental Protection Specialist

ec: Tom Kaldenbach, DRMS
Amy Eschberger, DRMS
DRMS file
Chris Peters, ARCADIS

Appendix C

Groundwater Sampling Forms

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GROUNDWATER SAMPLING FORM

Page ___ of ___

Project No. 30113015   Well ID MW-7   Date 3/24/22

Project Name/Location HOLCIM   Weather SUNNY, 60°F

Measuring Pt. Description TOC   Screen Setting (ft-bmp) ___   Casing Diameter (in.) 4   Well Material X PVC ___ SS

Static Water Level (ft-bmp) 27.28   Total Depth (ft-bmp) 50.30   Water Column/Gallons in Well 23.02/15

MP Elevation ___   Pump Intake (ft-bmp) ___   Purge Method: bladder / Centrifugal / Submersible / Other ___   Sample Method BAILER

Pump On/Off ___   Volumes Purged ___

Sample Time: Label 12:35 Start ___ End ___   Replicate/Code No. ___   Sampled by DJ RUDER

Time	Minutes Elapsed	Rate (gpm) (mL/min)	Depth to Water (ft)	Gallons Purged	pH	Cond. (umhos) (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temp. (°C) (°F)	SALINITY ppt	Appearance Color	Appearance Odor	SP COND µS/cm
9:15	0	—	27.28	0	7.53	1116	LOW	3.92	14.54	0.70	TAN	NONE	1395
9:23	8	—	—	8	7.85	1068	"	1.32	14.71	0.67	"	"	1329
9:29	14	—	—	16	7.89	1067	"	1.28	14.73	0.67	"	"	1327
9:36	20	—	—	24	7.84	1072	MED	1.10	14.69	0.71	GRY	"	1330
9:38	23	—	—	27	7.81	1394	HIGH	1.06	14.85	1.07	GRY	"	1874
— DRY —													
12:35			36.44	* SAMPLE									

3/24/22

Constituents Sampled	Container	Number	Preservative

Well Casing Volumes

Gallons/Foot 1" = 0.04 1.25" = 0.06 1.5" = 0.09 2" = 0.16 2.5" = 0.26 3" = 0.37 3.5" = 0.50 4" = 0.65 6" = 1.47

Well Information

Well Location: ___   Well Locked at Arrival: Yes / No

Condition of Well: ___   Well Locked at Departure: Yes / No

Well Completion: Flush Mount / Slick Up   Key Number To Well: ___

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GROUNDWATER SAMPLING FORM

Page ___ of ___

Project No. 30113015 Well ID MW-12 Date 3/24/22

Project Name/Location HOLCIM Weather SUNNY, 60°F

Measuring Pt. Description TOC Screen Setting (ft-bmp) ______ Casing Diameter (in.) 2 Well Material X PVC ___ SS

Static Water Level (ft-bmp) 100.06 Total Depth (ft-bmp) 150.30 Water Column/ Gallons in Well 50.24/8

MP Elevation ______ Pump Intake (ft-bmp) ______ Purge Method: bladder ______ Centrifugal ______ Submersible ______ Other ______ Sample Method BAILER

Pump On/Off ______ Volumes Purged ______

Sample Time: Label 11:27 Start ______ End ______ Replicate/ Code No. (DUPLICATE-1) Sampled by DJ RUDER

Time	Minutes Elapsed	Rate (gpm) (mL/min)	Depth to Water (ft)	Gallons Purged	pH	Cond. (µMhos) (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temp. (°C) (°F)	SALINITY PPT	Appearance Color	Appearance Odor	SP COND Ms/cm
11:00	Ø	—	100.06	Ø	7.01	2952	LOW	1.60	14.62	1.95	CLEAR	NONE	3678
11:06	6	—	—	8	6.92	2976	"	1.49	14.67	1.97	"	"	3708
11:14	14	—	—	16	6.90	2972	"	1.47	14.58	1.98	"	"	3713
11:24	24	—	—	24	6.88	2970	"	1.44	14.56	1.99	"	"	3716

DJR 3/24/22

Constituents Sampled	Container	Number	Preservative

Well Casing Volumes

Gallons/Foot 1" = 0.04 1.25" = 0.06 1.5" = 0.09 2" = 0.16 2.5" = 0.26 3" = 0.37 3.5" = 0.50 4" = 0.65 6" = 1.47

Well Information

Well Location: ______ Well Locked at Arrival: Yes / No

Condition of Well: ______ Well Locked at Departure: Yes / No

Well Completion: Flush Mount / Stick Up Key Number To Well: ______

GW Sample Form

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GROUNDWATER SAMPLING FORM

Project No. HOLCIM 30113015 Well ID MW-13 Page ___ of ___

Project Name/Location 30113015 HOLCIM Date 3/24/22

Weather SUNNY, 60°F

Measuring Pt. Description TOC Screen Setting (ft-bmp) ___ Casing Diameter (in.) 2 Well Material X PVC ___ SS

Static Water Level (ft-bmp) 13.95 Total Depth (ft-bmp) 31.95 Water Column/ Gallons in Well 18.00/ 3

MP Elevation ___ Pump Intake (ft-bmp) ___ Purge Method: bladder ___ Centrifugal ___ Submersible ___ Other ___ Sample Method BAILER

Pump On/Off ___ Volumes Purged ___

Sample Time: Label 12:05 Start ___ End ___ Replicate/ Code No. ___ Sampled by DJ RUDER

Time	Minutes Elapsed	Rate (gpm) (mL/min)	Depth to Water (ft)	Gallons Purged	pH	Cond. (umhos) (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Temp. (°C) (°F)	SALINITY ppt	Appearance Color	Appearance Odor	SP COND Ms/cm
11:50	Ø	—	13.95	Ø	7.81	2771	LOW	7.62	14.55	1.84	CLEAR	NONE	3482
11:54	4	—	—	3	7.37	2839	"	3.33	14.30	1.87	"	"	3581
11:58	8	—	—	6	7.33	2848	"	3.22	14.24	1.89	TAN	"	3589
12:02	12	—	—	9	7.34	2852	"	3.17	14.21	1.90	"	"	3591

DJR 3/24/22

Constituents Sampled	Container	Number	Preservative

Well Casing Volumes

Gallons/Foot 1" = 0.04 1.25" = 0.06 1.5" = 0.09 2" = 0.16 2.5" = 0.26 3" = 0.37 3.5" = 0.50 4" = 0.65 6" = 1.47

Well Information

Well Location: ___ Well Locked at Arrival: Yes / No

Condition of Well: ___ Well Locked at Departure: Yes / No

Well Completion: Flush Mount / Stick Up Key Number To Well: ___

Appendix D

Laboratory Analytical Results Report

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Analytical Report

April 12, 2022

Report to:
Treck Hohman
Arcadis
630 Plaza Drive
Suite 100
Highlands Ranch, CO 80129

cc: DJ Ruder

Bill to:
Accounts Payable
ARCADIS
630 Plaza Drive, Suite 100

Highlands Ranch, CO 80129

Project ID: 30113015
ACZ Project ID: L72196

Treck Hohman:

Enclosed are the analytical results for sample(s) submitted to ACZ Laboratories, Inc. (ACZ) on March 25, 2022. This project has been assigned to ACZ's project number, L72196. Please reference this number in all future inquiries.

All analyses were performed according to ACZ's Quality Assurance Plan. The enclosed results relate only to the samples received under L72196. Each section of this report has been reviewed and approved by the appropriate Laboratory Supervisor, or a qualified substitute.

Except as noted, the test results for the methods and parameters listed on ACZ's current NELAC certificate letter (#ACZ) meet all requirements of NELAC.

This report shall be used or copied only in its entirety. ACZ is not responsible for the consequences arising from the use of a partial report.

All samples and sub-samples associated with this project will be disposed of after October 09, 2022. If the samples are determined to be hazardous, additional charges apply for disposal (typically $11/sample). If you would like the samples to be held longer than ACZ's stated policy or to be returned, please contact your Project Manager or Customer Service Representative for further details and associated costs. ACZ retains analytical raw data reports for ten years.

If you have any questions or other needs, please contact your Project Manager.

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Inorganic Analytical Results

ARCADIS
Project ID: 30113015
Sample ID: MW-7

ACZ Sample ID: ***L72196-01***
Date Sampled: *03/24/22 12:35*
Date Received: *03/25/22*
Sample Matrix: *Groundwater*

Inorganic Prep

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Lab Filtration (0.45um) & Acidification	M200.7/200.8/3005A								03/30/22 7:00	mlh
Total Hot Plate Digestion	M200.2 ICP				*				04/02/22 15:43	aeh

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Iron, dissolved	M200.7 ICP	1	0.077	J		mg/L	0.06	0.15	04/05/22 1:18	jlw
Iron, total	M200.7 ICP	2	8.85		*	mg/L	0.12	0.3	04/05/22 2:46	jlw
Manganese, dissolved	M200.7 ICP	1	0.030	J		mg/L	0.01	0.05	04/05/22 1:18	jlw
Potassium, dissolved	M200.7 ICP	1	6.60			mg/L	0.2	1	04/05/22 1:18	jlw
Sodium, dissolved	M200.7 ICP	1	264			mg/L	0.2	1	04/05/22 1:18	jlw

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Lab Filtration (0.45um filter)	SOPWC050	1							03/31/22 12:00	emk
Residue, Filterable (TDS) @180C	SM2540C	2	944			mg/L	40	80	03/28/22 14:11	anc
Residue, Non-Filterable (TSS) @105C	SM2540D	1	184		*	mg/L	5	20	03/29/22 20:23	jck
Sulfate	D516-02/-07/-11 - TURBIDIMETRIC	5	108			mg/L	5	25	04/08/22 17:19	mjj1

** Please refer to Qualifier Reports for details.*

ACZ Laboratories, Inc.
2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Inorganic Analytical Results

ARCADIS

Project ID:	30113015	ACZ Sample ID:	***L72196-02***
Sample ID:	MW-12	Date Sampled:	*03/24/22 11:27*
		Date Received:	*03/25/22*
		Sample Matrix:	*Groundwater*

Inorganic Prep

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Lab Filtration (0.45um) & Acidification	M200.7/200.8/3005A								03/30/22 7:00	mlh
Total Hot Plate Digestion	M200.2 ICP								04/02/22 16:27	aeh

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Iron, dissolved	M200.7 ICP	2	0.248	J		mg/L	0.12	0.3	04/05/22 1:21	jlw
Iron, total	M200.7 ICP	2	6.26		*	mg/L	0.12	0.3	04/05/22 2:55	jlw
Manganese, dissolved	M200.7 ICP	2	0.599			mg/L	0.02	0.1	04/05/22 1:21	jlw
Potassium, dissolved	M200.7 ICP	2	12.7			mg/L	0.4	2	04/05/22 1:21	jlw
Sodium, dissolved	M200.7 ICP	2	144			mg/L	0.4	2	04/05/22 1:21	jlw

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Lab Filtration (0.45um filter)	SOPWC050	1							03/31/22 12:04	emk
Residue, Filterable (TDS) @180C	SM2540C	2	3740			mg/L	40	80	03/28/22 14:14	anc
Residue, Non-Filterable (TSS) @105C	SM2540D	1	157		*	mg/L	5	20	03/29/22 20:25	jck
Sulfate	D516-02/-07/-11 - TURBIDIMETRIC	120	2550			mg/L	120	600	04/08/22 17:34	mjj1

Inorganic Analytical Results

ARCADIS

Project ID: 30113015
Sample ID: MW-13

ACZ Sample ID: ***L72196-03***
Date Sampled: *03/24/22 12:05*
Date Received: *03/25/22*
Sample Matrix: *Groundwater*

Inorganic Prep

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Lab Filtration (0.45um) & Acidification	M200.7/200.8/3005A								03/30/22 7:00	mlh
Total Hot Plate Digestion	M200.2 ICP								04/02/22 16:42	aeh

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Iron, dissolved	M200.7 ICP	2	<0.12	U		mg/L	0.12	0.3	04/05/22 1:24	jlw
Iron, total	M200.7 ICP	2	1.12		*	mg/L	0.12	0.3	04/05/22 2:59	jlw
Manganese, dissolved	M200.7 ICP	2	<0.02	U		mg/L	0.02	0.1	04/05/22 1:24	jlw
Potassium, dissolved	M200.7 ICP	2	7.94			mg/L	0.4	2	04/05/22 1:24	jlw
Sodium, dissolved	M200.7 ICP	2	280			mg/L	0.4	2	04/05/22 1:24	jlw

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Lab Filtration (0.45um filter)	SOPWC050	1							03/31/22 12:08	emk
Residue, Filterable (TDS) @180C	SM2540C	2	3580			mg/L	40	80	03/28/22 14:16	anc
Residue, Non-Filterable (TSS) @105C	SM2540D	1	36.0		*	mg/L	5	20	03/29/22 20:27	jck
Sulfate	D516-02/-07/-11 - TURBIDIMETRIC	120	2420		*	mg/L	120	600	04/08/22 17:34	mjj1

** Please refer to Qualifier Reports for details.*

Inorganic Analytical Results

ARCADIS

Project ID: 30113015
Sample ID: DUPLICATE-1

ACZ Sample ID: ***L72196-04***
Date Sampled: *03/24/22 00:00*
Date Received: *03/25/22*
Sample Matrix: *Groundwater*

Inorganic Prep

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Lab Filtration (0.45um) & Acidification	M200.7/200.8/3005A								03/30/22 7:00	mlh
Total Hot Plate Digestion	M200.2 ICP								04/02/22 16:57	aeh

Metals Analysis

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Iron, dissolved	M200.7 ICP	2	0.220	J		mg/L	0.12	0.3	04/05/22 1:28	jlw
Iron, total	M200.7 ICP	2	5.11		*	mg/L	0.12	0.3	04/05/22 3:02	jlw
Manganese, dissolved	M200.7 ICP	2	0.552			mg/L	0.02	0.1	04/05/22 1:28	jlw
Potassium, dissolved	M200.7 ICP	2	12.8			mg/L	0.4	2	04/05/22 1:28	jlw
Sodium, dissolved	M200.7 ICP	2	143			mg/L	0.4	2	04/05/22 1:28	jlw

Wet Chemistry

Parameter	EPA Method	Dilution	Result	Qual	XQ	Units	MDL	PQL	Date	Analyst
Lab Filtration (0.45um filter)	SOPWC050	1							04/01/22 14:36	scd
Residue, Filterable (TDS) @180C	SM2540C	2	3710			mg/L	40	80	03/28/22 14:19	anc
Residue, Non-Filterable (TSS) @105C	SM2540D	1	102		*	mg/L	5	20	03/29/22 20:29	jck
Sulfate	D516-02/-07/-11 - TURBIDIMETRIC	120	2500		*	mg/L	120	600	04/08/22 17:41	mjj1

** Please refer to Qualifier Reports for details.*

Report Header Explanations

Batch	A distinct set of samples analyzed at a specific time
Found	Value of the QC Type of interest
Limit	Upper limit for RPD, in %.
Lower	Lower Recovery Limit, in % (except for LCSS, mg/Kg)
MDL	Method Detection Limit. Same as Minimum Reporting Limit unless omitted or equal to the PQL (see comment #5). Allows for instrument and annual fluctuations.
PCN/SCN	A number assigned to reagents/standards to trace to the manufacturer's certificate of analysis
PQL	Practical Quantitation Limit. Synonymous with the EPA term "minimum level".
QC	True Value of the Control Sample or the amount added to the Spike
Rec	Recovered amount of the true value or spike added, in % (except for LCSS, mg/Kg)
RPD	Relative Percent Difference, calculation used for Duplicate QC Types
Upper	Upper Recovery Limit, in % (except for LCSS, mg/Kg)
Sample	Value of the Sample of interest

QC Sample Types

AS	Analytical Spike (Post Digestion)	*LCSWD*	Laboratory Control Sample - Water Duplicate
ASD	Analytical Spike (Post Digestion) Duplicate	*LFB*	Laboratory Fortified Blank
CCB	Continuing Calibration Blank	*LFM*	Laboratory Fortified Matrix
CCV	Continuing Calibration Verification standard	*LFMD*	Laboratory Fortified Matrix Duplicate
DUP	Sample Duplicate	*LRB*	Laboratory Reagent Blank
ICB	Initial Calibration Blank	*MS*	Matrix Spike
ICV	Initial Calibration Verification standard	*MSD*	Matrix Spike Duplicate
ICSAB	Inter-element Correction Standard - A plus B solutions	*PBS*	Prep Blank - Soil
LCSS	Laboratory Control Sample - Soil	*PBW*	Prep Blank - Water
LCSSD	Laboratory Control Sample - Soil Duplicate	*PQV*	Practical Quantitation Verification standard
LCSW	Laboratory Control Sample - Water	*SDL*	Serial Dilution

QC Sample Type Explanations

Blanks	Verifies that there is no or minimal contamination in the prep method or calibration procedure.
Control Samples	Verifies the accuracy of the method, including the prep procedure.
Duplicates	Verifies the precision of the instrument and/or method.
Spikes/Fortified Matrix	Determines sample matrix interferences, if any.
Standard	Verifies the validity of the calibration.

ACZ Qualifiers (Qual)

B	Analyte concentration detected at a value between MDL and PQL. The associated value is an estimated quantity.
H	Analysis exceeded method hold time. pH is a field test with an immediate hold time.
L	Target analyte response was below the laboratory defined negative threshold.
U	The material was analyzed for, but was not detected above the level of the associated value. The associated value is either the sample quantitation limit or the sample detection limit.

Method References

(1) EPA 600/4-83-020. Methods for Chemical Analysis of Water and Wastes, March 1983.
(2) EPA 600/R-93-100. Methods for the Determination of Inorganic Substances in Environmental Samples, August 1993.
(3) EPA 600/R-94-111. Methods for the Determination of Metals in Environmental Samples - Supplement I, May 1994.
(4) EPA SW-846. Test Methods for Evaluating Solid Waste.
(5) Standard Methods for the Examination of Water and Wastewater.

Comments

(1) QC results calculated from raw data. Results may vary slightly if the rounded values are used in the calculations.
(2) Soil, Sludge, and Plant matrices for Inorganic analyses are reported on a dry weight basis.
(3) Animal matrices for Inorganic analyses are reported on an "as received" basis.
(4) An asterisk in the "XQ" column indicates there is an extended qualifier and/or certification qualifier associated with the result.
(5) If the MDL equals the PQL or the MDL column is omitted, the PQL is the reporting limit.

For a complete list of ACZ's Extended Qualifiers, please click:
https://acz.com/wp-content/uploads/2019/04/Ext-Qual-List.pdf

REP001.03.15.02

ARCADIS

ACZ Project ID: ***L72196***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Iron, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG539569													
WG539569ICV	ICV	04/05/22 0:04	II220401-2	2		1.988	mg/L	99	95	105			
WG539569ICB	ICB	04/05/22 0:10				U	mg/L		-0.18	0.18			
WG539569LFB	LFB	04/05/22 0:23	II220330-3	1.0001		1.071	mg/L	107	85	115			
L72199-01AS	AS	04/05/22 1:44	II220330-3	1.0001	U	1.063	mg/L	106	85	115			
L72199-01ASD	ASD	04/05/22 1:47	II220330-3	1.0001	U	1.066	mg/L	107	85	115	0	20	

Iron, total M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG539590													
WG539590ICV	ICV	04/05/22 2:17	II220315-6	2		2.02	mg/L	101	95	105			
WG539590ICB	ICB	04/05/22 2:23				U	mg/L		-0.18	0.18			
WG539517LRB	LRB	04/05/22 2:36				U	mg/L		-0.132	0.132			
WG539517LFB	LFB	04/05/22 2:39	II220330-3	1.0001		1.072	mg/L	107	85	115			
L72196-01LFM	LFM	04/05/22 2:49	II2XWATER	2.0022	8.85	13.844	mg/L	249	70	130			M3
L72196-01LFMD	LFMD	04/05/22 2:52	II2XWATER	2.0022	8.85	13.468	mg/L	231	70	130	3	20	M3

Manganese, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG539569													
WG539569ICV	ICV	04/05/22 0:04	II220401-2	2		1.961	mg/L	98	95	105			
WG539569ICB	ICB	04/05/22 0:10				U	mg/L		-0.03	0.03			
WG539569LFB	LFB	04/05/22 0:23	II220330-3	.499		.529	mg/L	106	85	115			
L72199-01AS	AS	04/05/22 1:44	II220330-3	.499	.068	.585	mg/L	104	85	115			
L72199-01ASD	ASD	04/05/22 1:47	II220330-3	.499	.068	.584	mg/L	103	85	115	0	20	

Potassium, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG539569													
WG539569ICV	ICV	04/05/22 0:04	II220401-2	20		19.49	mg/L	97	95	105			
WG539569ICB	ICB	04/05/22 0:10				U	mg/L		-0.6	0.6			
WG539569LFB	LFB	04/05/22 0:23	II220330-3	99.95169		103.4	mg/L	103	85	115			
L72199-01AS	AS	04/05/22 1:44	II220330-3	99.95169	52	155.1	mg/L	103	85	115			
L72199-01ASD	ASD	04/05/22 1:47	II220330-3	99.95169	52	153.5	mg/L	102	85	115	1	20	

Residue, Filterable (TDS) @180C SM2540C

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG539126													
WG539126PBW	PBW	03/28/22 13:48				U	mg/L		-20	20			
WG539126LCSW	LCSW	03/28/22 13:50	PCN65061	1000		990	mg/L	99	80	120			
L72196-04DUP	DUP	03/28/22 14:22			3710	3720	mg/L				0	10	

Residue, Non-Filterable (TSS) @105C SM2540D

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG539241													
WG539241PBW	PBW	03/29/22 20:10				U	mg/L		-5	5			
WG539241LCSW	LCSW	03/29/22 20:12	PCN65061	100		103	mg/L	103	80	120			
L72203-02DUP	DUP	03/29/22 20:36			U	U	mg/L				0	10	RA

ARCADIS

ACZ Project ID: ***L72196***

NOTE: If the Rec% column is null, the high/low limits are in the same units as the result. If the Rec% column is not null, then the high/low limits are in % Rec.

Sodium, dissolved M200.7 ICP

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG539569													
WG539569ICV	ICV	04/05/22 0:04	II220401-2	100		98.2	mg/L	98	95	105			
WG539569ICB	ICB	04/05/22 0:10				U	mg/L		-0.6	0.6			
WG539569LFB	LFB	04/05/22 0:23	II220330-3	100.0039		103.7	mg/L	104	85	115			
L72199-01AS	AS	04/05/22 1:44	II220330-3	100.0039	25.9	131	mg/L	105	85	115			
L72199-01ASD	ASD	04/05/22 1:47	II220330-3	100.0039	25.9	129.2	mg/L	103	85	115	1	20	

Sulfate D516-02/-07/-11 - TURBIDIMETRIC

ACZ ID	Type	Analyzed	PCN/SCN	QC	Sample	Found	Units	Rec%	Lower	Upper	RPD	Limit	Qual
WG539981													
WG539981ICB	ICB	04/08/22 8:15				U	mg/L		-3	3			
WG539981ICV	ICV	04/08/22 8:15	WI220331-10	20.46		20.1	mg/L	98	90	110			
WG539981LFB	LFB	04/08/22 16:22	WI211230-5	9.95		10.1	mg/L	102	90	110			
L72071-01DUP	DUP	04/08/22 16:22			30.3	29.9	mg/L				1	20	
L72071-02AS	AS	04/08/22 16:22	WI211230-5	9.95	29.2	39.4	mg/L	103	90	110			
L72204-01AS	AS	04/08/22 17:31	SO4TURB25X	10	461	476.6	mg/L	156	90	110			M3
L72196-04DUP	DUP	04/08/22 17:41			2500	2521.8	mg/L				1	20	

Inorganic Extended Qualifier Report

ARCADIS

ACZ Project ID: ***L72196***

ACZ ID	WORKNUM	PARAMETER	METHOD	QUAL	DESCRIPTION
L72196-01	WG539590	Iron, total	M200.7 ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
	WG539241	Residue, Non-Filterable (TSS) @105C	SM2540D	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG539517	Total Hot Plate Digestion	M200.2 ICP	DD	Sample required dilution due to matrix color or odor.
			M200.2 ICP	DF	Sample required dilution due to high sediment.
L72196-02	WG539590	Iron, total	M200.7 ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
	WG539241	Residue, Non-Filterable (TSS) @105C	SM2540D	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
L72196-03	WG539590	Iron, total	M200.7 ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
	WG539241	Residue, Non-Filterable (TSS) @105C	SM2540D	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG539981	Sulfate	D516-02/-07/-11 - TURBIDIMETRIC	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
L72196-04	WG539590	Iron, total	M200.7 ICP	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.
	WG539241	Residue, Non-Filterable (TSS) @105C	SM2540D	RA	Relative Percent Difference (RPD) was not used for data validation because the concentration of the duplicated sample is too low for accurate evaluation (< 10x MDL).
	WG539981	Sulfate	D516-02/-07/-11 - TURBIDIMETRIC	M3	The spike recovery value is unusable since the analyte concentration in the sample is disproportionate to the spike level. The recovery of the associated control sample (LCS or LFB) was acceptable.

No certification qualifiers associated with this analysis

ACZ Laboratories, Inc.

2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Sample Receipt

ARCADIS
30113015

ACZ Project ID:	L72196
Date Received:	03/25/2022 10:38
Received By:	
Date Printed:	3/28/2022

Receipt Verification

	YES	NO	NA
1) Is a foreign soil permit included for applicable samples?			X
2) Is the Chain of Custody form or other directive shipping papers present?	X		
3) Does this project require special handling procedures such as CLP protocol?		X	
4) Are any samples NRC licensable material?			X
5) If samples are received past hold time, proceed with requested short hold time analyses?		X	
6) Is the Chain of Custody form complete and accurate?	X		
7) Were any changes made to the Chain of Custody form prior to ACZ receiving the samples?		X	

Samples/Containers

	YES	NO	NA
8) Are all containers intact and with no leaks?	X		
9) Are all labels on containers and are they intact and legible?	X		
10) Do the sample labels and Chain of Custody form match for Sample ID, Date, and Time?	X		
11) For preserved bottle types, was the pH checked and within limits? [1]	X		
12) Is there sufficient sample volume to perform all requested work?	X		
13) Is the custody seal intact on all containers?			X
14) Are samples that require zero headspace acceptable?			X
15) Are all sample containers appropriate for analytical requirements?	X		
16) Is there an Hg-1631 trip blank present?			X
17) Is there a VOA trip blank present?			X
18) Were all samples received within hold time?	X		

NA indicates Not Applicable

Chain of Custody Related Remarks

Client Contact Remarks

Shipping Containers

Cooler Id	Temp(°C)	Temp Criteria(°C)	Rad(µR/Hr)	Custody Seal Intact?
7029	0.6	<=6.0	15	Yes

Was ice present in the shipment container(s)?

Yes - Wet ice was present in the shipment container(s).

Client must contact an ACZ Project Manager if analysis should not proceed for samples received outside of their thermal preservation acceptance criteria.

Sample Receipt

ARCADIS
30113015

ACZ Project ID: L72196
Date Received: 03/25/2022 10:38
Received By:
Date Printed: 3/28/2022

[1] The preservation of the following bottle types is not checked at sample receipt: Orange (oil and grease), Purple (total cyanide), Pink (dissolved cyanide), Brown (arsenic speciation), Sterile (fecal coliform), EDTA (sulfite), HCl preserved vial (organics), Na2S2O3 preserved vial (organics), and HG-1631 (total/dissolved mercury by method 1631).

ACZ LABORATORIES | Accredited Environmental Testing | 2773 Downhill Drive Steamboat Springs, CO 80487 (970) 879-6590 | L72196

CHAIN of CUSTODY

Report to:

Name: TRECK HOHMAN
Company: ARCADIS
E-mail: TRECK.HOHMAN@ARCADIS.COM
Address: 630 PLAZA DR SUITE 200 HIGHLANDS RANCH, CO 80129
Telephone: (720) 344-3500

Copy of Report to:

Name: DJ RUDER
Company: ARCADIS
E-mail: DJ.RUDER@ARCADIS.COM
Telephone: (720) 344-3500

Invoice to:

Name: ACCOUNTS PAYABLE
Company: ARCADIS
E-mail:
Address: 630 PLAZA DR. SUITE 200 HIGHLANDS RANCH, CO 80129
Telephone: (720) 344-3500

Copy of Invoice to:

Name: TRECK HOHMAN
Company: ARCADIS
E-mail:
Address: (SAME)
Telephone:

If sample(s) received past holding time (HT), or if insufficient HT remains to complete analysis before expiration, shall ACZ proceed with requested short HT analyses? PLEASE CONTACT TRECK HOHMAN YES [ ] NO [X]

If "NO" then ACZ will contact client for further instruction. If neither "YES" nor "NO" is indicated, ACZ will proceed with the requested analyses, even if HT is expired, and data will be qualified

Are samples for SDWA Compliance Monitoring? Yes [ ] No [X]
If yes, please include state forms. Results will be reported to PQL for Colorado.

Sampler's Name: DJ RUDER Sampler's Site Information State CO Zip code 81226 Time Zone MTN
*Sampler's Signature: DJ Rud

*I attest to the authenticity and validity of this sample. I understand that intentionally mislabeling the time/date/location or tampering with the sample in anyway, is considered fraud and punishable by State Law.

PROJECT INFORMATION

Quote #: ANNUAL-GW-2022
PO#: 30113015
Reporting state for compliance testing: COLORADO
Check box if samples include NRC licensed material? [ ]

ANALYSES REQUESTED (attach list or use quote number)

SAMPLE IDENTIFICATION	DATE:TIME	Matrix	# of Containers	ANNUAL-GW-2022							
MW-7	3/24/22 12:35	GW	4	X							
MW-12	3/24/22 11:27	GW	4	X							
MW-13	3/24/22 12:05	GW	4	X							
DUPLICATE-1	3/24/22 —	GW	4	X							

DJ Rud 3/24/22

Matrix: SW (Surface Water) · GW (Ground Water) · WW (Waste Water) · DW (Drinking Water) · SL (Sludge) · SO (Soil) · OL (Oil) · Other (Specify)

REMARKS

ALL NECESSARY FILTERING AND PRESERVATIVES DONE BY ACZ

Please refer to ACZ's terms & conditions located on the reverse side of this COC.

RELINQUISHED BY:	DATE:TIME	RECEIVED BY:	DATE:TIME
DJ Rud	3/24/22 16:00	[illegible]	3/25/22 11:06

L72196 Chain of Custod

ACZ Laboratories, Inc.

2773 Downhill Drive Steamboat Springs, CO 80487 (800) 334-5493

Bottle Order Packing List

Account: ARCADIS/ARCADIS
Bottle Order: BO49177
Internal Note:

Bill to Account: Bill to ACZ
Ship Date Requested: 03/22/2022
Request Placed at: 03/21/2022 14:43
Service Requested: UPS Ground

Sampling supplies

PACK	Qty	ACZ ID	Type	Description
☐		TRIP HG		
☐	2	COC	Chain of Custody	Chain of Custody, 1 for 10 samples.
☐	2	SEAL	Custody Seal	Custody seals for cooler, two for each cooler.
☐	1	RETURN	Return Address	Return Address label, one for each cooler.
☐	16	LABELS	Sample Labels	ACZ supplied labels for sample containers

ACZ Coolers

PACK	Qty	ACZ ID	Size	Weight	UPS Tracking Number
☐	1	7029	Large	29	

Quote number: ANNUAL-GW-2022 — Holcim 2021 Annual Groundwater Monitoring
Sample Quantity: 4 ☐

FILT products in quote. A FILT sticker affixed to a sample container indicates the laboratory will perform filtration.

PACK	Qty	Type	Size	Filter/Raw/Preserve	Instructions
☐	1	RAW	500 ML	Raw	Wet Chemistry (analyses that do not require preservative or filtration) - Completely fill container.
☐	1	WHITE	250 ML	Filtered	Wet chemistry (dissolved) - Filter sample with .45 micron filter. Completely fill container.
☐	1	RED	250 ML	Raw/Nitric	Metals (total except ICPMS) - Do not overfill as there is Nitric Acid in the bottle.
☐	1	GREEN	125 ML	Filtered/Nitric	Metals (dissolved except ICPMS) - Filter sample with .45 micron filter. Do not overfill as there is Nitric Acid in the bottle.

Prepared By/Date: ____________________

sh

Appendix E

Historical Groundwater Monitoring Data (Tables E-1 through E-4)

Table E-1
Historical Groundwater Analytical Results from 1998 to 2001
2022 Groundwater Monitoring Report
Holcim (US) Inc.
Florence, Colorado

Analyte	9/11/1998		11/30/1999		5/5/2000			8/11/2000			11/7/2000			2/8/2001			5/21/2001			
Field Parameters	**MW-5**	**MW-7**	**MW-5**	**MW-7**	**MW-7**	**MW-8**	**MW-9**	**MW-7**	**MW-8**	**MW-9**	**MW-7**	**MW-8**	**MW-9**	**MW-7**	**MW-8**	**MW-9**	**MW-7**	**MW-8**	**MW-9**	**MW-10**
pH(pH units)	6.93	6.94	7.09	6.65	7.26	7.4	7.34	6.7	6.69	6.68	6.65	6.78	6.74	6.95	6.98	6.94	6.72	6.86	6.84	6.77
Conductivity (umhos)	1450	1520	3500	4170	3030	2850	3010	3310	3340	3840	3040	3320	3690	3290	3480	2420	3180	3580	3650	3740
Temperature (°F)	60	62	59	59	65.4	62	62.3	65.1	68.3	76.3	58.8	58.5	62	59	54.9	55.2	63.7	57.4	63.2	58.5
Laboratory Results																				
pH(pH units)	6.98	7	7.61	7.31	7.45	7.8	7.7	6.9	7.1	7	6.9	7	6.9	7	7.2	7.2	7.1	7	7.1	7
Conductivity (umhos)	3120	2750	4080	3390	3490	3380	3680	3330	3290	3520	3090	3110	3360	3310	3260	3490	3270	3170	3470	3380
Total Dissolved Solids	3229	3918	3660	3230	3220	3200	3560	3320	3310	3630	3110	3120	3480	3180	3320	3640	3290	3310	3630	3460
Chloride	29.7	32.6	57.9	26.5	29.4	28	33.4	25.9	27.6	31.5	27.2	26.5	30.6	27.6	27.7	31	28.1	26.4	30.1	28
Sulfate	1880	2080	2200	1900	1900	2300	2500	2050	2120	2330	1600 c	1670 c	1840 c	1720 c	1810 c	2040 c	1620 c	1800 c	1990 c	1740 c
Alkalinity	334	268	440	310	3280 b	2400 b	2840 b	312	221	256	333	224	254	331	288	259	337	270	268	399
Carbonate	0	0	1 U	1 U	1 U	1 U	1 U	5 U	5 U	5 U	5	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5 U
Bicarbonate	419	326	537	378	4000 b	2930 b	3460 b	312	221	256	333	224	254	331	288	259	337	270	268	399
Fluoride	1.4	1.6	0.9	0.8	0.8	1.1	1.1	0.98	1.2	1.4	0.83	1	1.3	0.8	0.95	1.2	0.91	1.2	1.3	0.89
Ammonia-N	0.05 U	0.05 U	0.88	0.52	1.17	0.44	0.67	0.9	0.45	0.64	0.72	0.53	0.71	0.36	0.57	0.14	0.6	0.49	0.35	0.7
Nitrate	2.3	0.4	2.24	0.05 U	0.05 U	0.05 U	0.05 U	0.1 U	0.2	0.1 U	0.1 U	0.2	0.15	0.1 U	0.1 U	0.12	0.1 U	0.1 U	0.13	12.5 Q
Potassium	11	17	15	13	15.6	9.7	9.2	16	9.9	10	12.8	9.2	9.3	11.2	8.1	8.6	11.1	9	7.7	22.7
Sodium	188	112	315	144	185	131	134	164	164	143	161	158	136	177	200	148	186	173	135	198
Arsenic	0.005 U	0.005 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.1 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Antimony	0.2 U	0.2 U	0.06 U	0.06 U	0.06 U	0.06 U	0.06 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Barium	0.1 U	0.1 U	0.44	0.05	0.02	0.03	0.02	0.018	0.028	0.022	0.023	0.021	0.018	0.02	0.028	0.017	0.021	0.02	0.013	0.019
Beryllium	0.01 U	0.01 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Cadmium	0.01 U	0.01 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U
Hexavalent Chromium	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Lead	0.005 U	0.005 U	0.05 U	0.05 U	0.05 U	0.05 U	0.05 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U	0.003 U
Mercury	0.005 U	0.005 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	0.019	0.036	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U	0.04 U
Selenium	0.005 U	0.005 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.005 U	0.019	0.005 U	0.0052	0.012	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.077
Silver	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Thallium	0.1 U	0.1 U	0.1 U	0.1 U	0.12	0.14	0.1 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Aluminum	0.53	0.56	6.52	1.6	0.54	0.05	0.05 U	0.1 U	0.1 U	0.1 U	0.18	0.1 U	0.1 U	0.1 U	0.2	0.1 U	0.14	0.1 U	0.1 U	0.1 U
Iron	0.05 U	0.05 U	5.45	2.14	1.69	0.03	0.36	3.6	0.69	1.2	1.5	1.7	0.9	1.1	1.6	0.54	2.9	2.3	0.67	2.7
Manganese	0.01 U	0.01 U	0.11	0.35	0.67	0.21	0.5	0.88	0.9	0.9	0.45	0.47	0.65	0.42	0.54	0.62	0.47	0.41	0.66	0.32
Magnesium	26.3	39.6	276	177	185	178	225	210	192	242	193	186	244	180	170	234	187	176	224	199
Calcium	198	379	333	457	456	495	517	491	480	503	467	490	538	417	422	491	437	455	477	436

Table E-2
Groundwater Quality Data for Monitoring Wells MW-6 through MW-12 - 2003 through 2004
2022 Groundwater Monitoring Report
Holcim (US) Inc.
Florence, Colorado

ARCADIS

Analyte		8/7/2003 - 8/8/2003							1/16/2004	4/9/2004	7/9/2004
Field Parameters	**MCL**	**MW-6**	**MW-7**	**MW-8**	**MW-9**	**MW-10**	**MW-11**	**MW-12**	**MW-10**	**MW-10**	**MW-10**
pH (std. units)	6.5-8.5[b]	6.9	7.2	7.1	7.4	7.4	7.5	7.2	6.6	7.7	6.7
Conductivity (µs/cm)	NA	3430	2260	2470	2620	2950	3070	3450	4650	4000	3530
Temperature (°C)	NA	21	18	18	18	21	23	22	11	13	22
Laboratory Results											
pH (std. units)	6.5-8.5[b]	6.8	7.0	7.2	7.1	7.1	7.2	7.0	6.8	6.8	7.1
Conductivity (µs/cm)	NA	3900 J	3200 J	3100 J	3400 J	3200 J	3300 J	3800 J	3800 J	4200	3900 J
Total Dissolved Solids	1.5 x bkg	4400	3200	3300	3600	3300	3500	4200	4000	3800 J	3400
Chloride	250[b]	37.0 J	25 J	26.0 J	28.0	27 J	28 J	37 J	22 J	19 J	27 J
Sulfate	250[b]	**2500** J,Q	**1800** J,Q	**1800** J,Q	**2100** J,Q	**1800** J,Q	**2100** J,Q	**2400** J,Q	**2300** J,Q	**2200** Q	**2000** J,Q
Alkalinity	NA	5 U	5 U	5 U	5 U	5 U	5 U	5 U	5.0 U	5.0 U	5.0 U
Hardness, as $CaCO_3$	NA	2800	1900	1900	2300	1900	1900	2500	2800	2400	2000
Fluoride	2.0[c]	0.57 J	0.89 J	1.2 J	1.5 J	0.9 J	1.1 J	**4.4** J	0.73	0.68 J	0.74 J
Ammonia	NA	0.1 U	0.31	0.74	0.60	0.56	0.37	0.28	0.10 U	0.10 U	0.10
Nitrate as N	10.0[a]	2.9	0.1 U	0.005 B	0.015 B	6.8	0.063	0.002 U	**100**	**84**	28 Q
Nitrite	3.3[e]	NA	NA	NA	NA	NA	NA	NA	0.15	0.58 Q	0.041
Potassium	NA	16	11	8.9	9.1	22	26	26	28	26	23
Sodium	NA	130	170	170	130	180	200	200	130 J	130	210 J
Arsenic	0.05[a]	0.006	0.0017 B	0.0016 B	0.005 U	0.0048 B	0.0035 B	0.0035 B	0.016	0.013	0.0028 B
Antimony	0.006[a]	0.002 U	0.00005 B	0.0012 B	0.00063 B	0.000097 B	0.0011 B	0.0029	0.00037 B, J	0.00033 B	0.00021 B
Barium	2.0[a]	0.011 J	0.034 J	0.024 J	0.017 J	0.02 J	0.048 J	0.099 J	0.028	0.026 J	0.016
Beryllium	0.004[a]	*0.005* U	*0.005* U	*0.005* U	*0.005* U	*0.005* U	*0.005* U	*0.005* U	*0.0050* U	*0.0050* U	*0.00066* B
Cadmium	0.005[a]	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.00036 B	0.0050 U	0.0050 U	0.0050 U
Chromium	0.01[c]	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	**0.012**	**0.017**	0.010 U	0.010 U	0.010 U
Lead	0.05[a]	0.0002 B	0.0012	0.00043 B	0.00018 B	0.00041 B	0.0015	0.0052	0.00099 B	0.00031 B	0.00013 B
Mercury	0.002[a]	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U	0.0002 U
Nickel	0.1[a]	0.054	0.04 U	0.019 B	0.013 B	0.013 B	0.032 B	0.071	0.017 B	0.010 B	0.018 B
Selenium	0.02[c]	**0.32**	0.0015 B	0.0055	0.002 B	**0.21**	**0.021**	0.0086	**0.77**	**0.76**	**0.20**
Silver	0.05[a]	0.001 U	0.000019 B	0.001 U	0.001 U	0.001 U	0.00003 B	0.000078 B	0.000020 B	0.000036 B	0.0010 U
Thallium	0.002[a]	0.00032 B,J	0.001	0.000076 B,J	0.000032 B,J	0.000074 B,J	0.000088 B,J	0.00015 B,J	0.00016 B	0.00016 BJ	0.00017 B
Vanadium	0.1[c]	0.005 U	0.003 B	0.005 U	0.005 U	0.005 U	0.003 B	0.011	0.0022 B	0.0050 U	0.0050 U
Zinc	2.0[c]	0.027	0.0087 B	0.0083 B	0.0058 B	0.007300 B	0.016	0.027	0.016	0.011	0.0065 B,J
Aluminum	5.0[c]	0.17 J	1.1 J	0.2 J	0.078 B,J	0.25 J	2.6 J	**11** J	0.21 J	0.12	0.046 B,J
Iron	0.3[b]	0.061 B	**4.5**	**1.7**	**0.32**	**1.0**	**2.1**	**8.50**	**0.35**	0.19	0.021 B
Manganese	0.05[b]	0.0046 B	**0.31**	**0.29**	**0.61**	**0.18**	**0.2**	**1.1**	**0.082**	**0.053**	**0.12**
Magnesium	NA	400	190	180	250	210	200	330	290	260	210
Calcium	NA	480	440	450	500	430	430	470	650	540 L	450 J

Notes:

U - indicates that the analyte was analyzed for but not detected. Detection limit is numeric value shown.

Q - indicates elevated reporting limit due to high analyte level.

All units are in mg/L unless noted otherwise.

NA indicates not available.

Bolded values=MCL exceeded, italicized values=reporting limit greater than MCL.

B - Estimated result. Result is less than the reporting limit.

a) MCL source: Table 1 Human Health Standards, Regulation 41.

b) MCL source: Table 2 Secondary Drinking Water Standards, Regulation 41.

c) MCL source: Table 3 Agricultural Standards for Groundwater, Regulation 41.

d) MCL for nitrate is 10.0 mg/L as N

e) MCL for nitrite is 1.0 mg/L as N

J - Method blank contamination. The associated method blank contains the target analyte at a reportable level.

Analyte		March 2008						April 2009			June 2009		September 2009	December 2009	March 2010		
Field Parameters	**MCL**	**MW-7**	**MW-8**	**MW-9**	**MW-11**	**MW-12**	**MW-7 Compliance Standards**	**MW-7**	**MW-12**	**MW-13**	**MW-13**	**MW-13 DUP**	**MW-13**	**MW-13**	**MW-7**	**MW-12**	**MW-13**
pH (std. units)	6.5-8.5[b]	7.95	6.97	6.96	7.11	6.93	6.5-8.5[a]	**9.21**	7.63	7.99	7.01	NA	6.95	7.00	8.41	7.12	7.24
Conductivity (mS/cm)	NA	2.058	3.095	3.361	3.204	3.764	NA	1.109	3.231	2.900	3.215	NA	2.934	2.7	1.309	3.974	3.300
Temperature (°C)	NA	17.63	15.61	17.33	18.80	18.72	NA	17.3	20.9	14.3	16.9	NA	13.1	13.90	16.4	15.8	13.2
Laboratory Results																	
Alkalinity	NA	458	352	239	198	348	NA	581	331	379	409	410	--	--	--	--	--
Chloride	250[b]	37	31	33	37	36	NA	42	36	29	29	30	--	--	--	--	--
Fluoride	2.0[c]	0.80	0.9	1.1	0.7	**3.4**	NA	1.1	**3.6**	0.8	0.9	0.9	--	--	--	--	--
Hardness, as $CaCO_3$	NA	961	1830	2110	1960	2540	NA	148	2620	2140	2140	2130	--	--	--	--	--
Nitrate as N	10.0[a]	0.03 B	0.04 B	0.16	0.24	0.06 B	NA	0.05 B	0.05 B	0.08 B	0.08 B	0.03 B	--	--	--	--	--
Nitrogen, ammonia	NA	0.98	0.75	0.15 B	0.31 B	0.74	NA	1.23	0.27 B	0.28 B	<0.05	0.06 B	--	--	--	--	--
Total Dissolved Solids	1.5 x bkg	1940	3190	3570	3410	4030	3918	720	3990	3660	3620	3590	3,630	3,470	720	3960	3300
Sulfate	250[b]	**850**	**1730**	**1840**	**1980**	**2300**	2080	35	**2300**	**2000**	**1900**	**2000**	**1,900**	**1,800**	4 B	2400	2000
Aluminum (total)	5.0[c]	**5.97**	0.17 B	1.17	3.11	**21.70**	NA	**9.26**	**23.1**	**7.36**	**9.85**	**11.8**	--	--	--	--	--
Arsenic (total)	0.05[a]	0.0027	0.0010 B	0.001 U	0.0009 B	0.0033	NA	0.0027	0.006	0.005	0.003 B	0.004 B	--	--	--	--	--
Calcium (dissolved)	NA	202	438	458	439	477	NA	24.2	488	492	491	487	--	--	--	--	--
Calcium (total)	NA	206	444	458	439	474	NA	46.1	525	539	524	523	--	--	--	--	--
Iron	0.3[b]	**4.18**	**0.54**	**1.85**	**3.17**	**14.40**	4.5	0.02 U	0.08	0.04 B	0.07	0.22	<0.02	<0.02	0.78	0.25	0.11
Magnesium (dissolved)	NA	111	178	235	209	329	NA	21.4	341	222	221	223	--	--	--	--	--
Magnesium (total)	NA	112	180	232	208	323	NA	26.5	726	225	195	197	--	--	--	--	--
Manganese (total)	0.05[b]	**0.085**	**0.196**	**0.317**	**0.324**	**0.623**	0.88	0.105	**0.673**	**0.13**	**0.26**	**0.24**	**0.113**	**0.056**	0.019 B	0.586	0.018 B
Potassium (total)	NA	10.4	10.9	9.3	13.0	18.8	17	7.2	20.3	11.9	11.8	12.4	10.3	11.0	5.6	13.5	9.3
Selenium (total)	0.02[c]	0.0005	0.0007	0.0005 B	0.0030	0.0023	0.02[d]	0.0008	0.0027	**0.139**	**0.0335**	**0.0406**	--	--	--	--	--
Sodium (total)	NA	226	207	199	209	221	226	**236**	156	249	193	198	225	199	**228**	186	164

Notes:

All units are in mg/L unless noted otherwise.

Bolded values - Screening level exceeded.

B - Analyte concentration detected at a value between Method Detection Limit and Practical Quantitation Limit.

bkg - Background.

MCL - Maximum concentration limit.

NA - Not available.

U - The analyte was analyzed for, but not detected. Detection limit is numeric value shown.

Multiple screening levels present in some instances due to proposed background standards for MW-7.

[a]DRMS-approved Numeric Protection Levels for MW-7.

[b]MCL source: Table 1 Human Health Standards, Regulation 41.

[c]MCL source: Table 2 Secondary Drinking Water Standards, Regulation 41.

[d]MCL source: Table 3 Agricultural Standards for Groundwater, Regulation 41.

[e]MCL source: Table 4 TDS Water Quality Standards, Regulation 41.

Table E-4
Groundwater Quality Data for Monitoring Wells MW-7, MW-12, and MW-13 2011 through 2022
2022 Groundwater Monitoring Report
Holcim (US) Inc.
Florence, Colorado

Analyte		March 2011 Analytical Results				March 2012 Analytical Results				Sept-2012	March 2013 Analytical Results				March 2014 Analytical Results				March 2015 Analytical Results				
Field Parameters	**MW-7 NPLs[a]**	**MW-7**	**MW-7 DUP**	**MW-12**	**MW-13**	**MW-7**	**MW-12**	**MW-12 DUP**	**MW-13**	**MW-7**	**MW-7**	**MW-12**	**MW-12 DUP**	**MW-13**	**MW-7**	**MW-12**	**MW-12 DUP**	**MW-13**	**MW-7**	**MW-12**	**MW-12 DUP**	**MW-13**	**MW-13 NPLs[b]**
pH (std. units)	6.5-8.5	7.98	--	6.87	7.03	7.60	6.81	--	6.95	7.31	7.57	6.80	--	7.07	7.55	6.74	--	7.02	7.63	6.74	--	6.98	NA
Specific Conductivity (mS/cm)	NA	1.427	--	3.686	3.287	1.7	4.0	--	3.7	3.3	3.280	3.899	--	3.559	2.792	3.946	--	3.673	2.672	3.893	--	3.714	NA
Temperature (°C)	NA	14.00	--	15.80	14.60	14.19	13.96	--	14.01	14.70	14.24	13.96	--	14.17	14.00	13.60	--	14.00	14.20	14.10	--	14.10	NA
Laboratory Results																							
Total dissolved solids	3918	2760	2740	3970	3180	810	3910	3920	3500	3270	2780	3870	3850	3480	2620	3940	3890	3420	2010	3910	3870	3540	4026
Sulfate	2080	1600	1500	2400	1770	39	2300	2300	2100	1820	1700	2600	2600	**2300**	1460	2450	2410	1980	1020	2390	2340	2030	2200
Iron (total)	4.5	4.28	**5.13**	Nan	Nan	**13.8**	Nan	Nan	Nan	**9.9**	4.26	Nan	Nan	Nan	3.45	Nan	Nan	Nan	2.37	Nan	Nan	Nan	NA
Iron (dissolved)	NA	U	0.07	0.99	U	U	0.19	0.10	0.04 B	0.09 B	0.10	0.34	0.32	U	0.04 B	1.14	1.20	U	<0.04 U	0.74	0.54	<0.04 U	0.13
Manganese (dissolved)	0.88	0.147	0.146	0.551	U	U	0.54	0.54	U	0.165	0.03 B	0.50	0.49	U	0.059	0.532	0.549	U	<0.01 U	0.550	0.550	<0.01 U	0.3
Potassium (dissolved)	17	13.1	13.1	13.8	8.9	5.2	13.6	13.5	8.9	12.3	12.1	12.8	12.0	8.6	12.1	12.5	13	8.2	11	12.6	12.6	8.4	13
Sodium (dissolved) [1]	NA	231	232	201	170	258	145	143	203	250	297	162	154	201	253	147	152	181	247	131	130	156	NA
Potassium to Sodium ratio	0.5	0.06		0.07	0.05	0.02	0.09		0.04	0.05	0.04	0.08		0.04	0.05	0.09		0.05	0.04	0.10	0.10	0.05	0.5

Analyte		April 2016 Analytical Results				March 2017 Analytical Results				March 2018 Analytical Results				March 2019 Analytical Results				March 2020 Analytical Results				
Field Parameters	**MW-7 NPLs[a]**	**MW-7**	**MW-12**	**MW-12 DUP**	**MW-13**	**MW-7**	**MW-12**	**MW-12 DUP**	**MW-13**	**MW-7**	**MW-12**	**MW-12 DUP**	**MW-13**	**MW-7**	**MW-12**	**MW-12 DUP**	**MW-13**	**MW-7**	**MW-12**	**MW-12 DUP**	**MW-13**	**MW-13 NPLs[b]**
pH (std. units)	6.5-8.5	7.08	6.36	--	6.54	7.32	6.45	--	6.86	7.38	6.58	--	6.85	7.86	6.86	--	7.01	7.86	6.81	--	7.07	NA
Specific Conductivity (mS/cm)	NA	2.277	3.849	--	3.744	1.257	3.854	--	3.288	2.051	3.879	--	3.742	2.077	3.872	--	4.016	1.324	3.046	--	3.355	NA
Temperature (°C)	NA	14.94	14.46	--	14.05	14.82	14.44	--	14.63	14.29	13.88	--	13.94	14.60	14.20	--	14.30	14.70	14.50	--	14.10	NA
Laboratory Results																						
Total dissolved solids	3918	994	3940	3940	3800	1120	3730	3790	3170	984	3860	3850	3580	948	3820	3780	3900	944	3830	3830	3300	4026
Sulfate	2080	231	2320	2320	2130	326	2430	2390	1980	121	2300	2320	2070	95	2020	2020	2000	99.9	2140	2170	1920	2200
Iron (total)	4.5	**8.05**	4.9	7.15	8.54	**6.05**	6.63	4.65	1.53	**4.65**	7.91	7.4	7.98	**9.03**	5.55	7.4	12	**10.1**	10.1	16.1	5.1	NA
Iron (dissolved)	NA	0.12	0.39	0.44	0.08 B	0.13	0.43	0.35	0.09 J	<0.02 U	0.08 J	0.64	<0.04 U	0.05	0.22	0.26	0.05 J	0.08 U	0.1 J	0.07 J	0.20 U	0.13
Manganese (dissolved)	0.88	0.005 B	0.53	0.53	<0.01 U	0.009 J	0.52	0.51	0.01 J	<0.005 U	0.53	0.54	<0.01 U	0.03 U	0.56	0.55	0.05 U	0.05 U	0.53	0.53	0.1 U	0.3
Potassium (dissolved)	17	7.2	13	13.1	8.7	7.4	12.3	12.1	7.5	7.3	12.5	12.6	8	6.7	13	13.0	8.7	6.5	13	13.1	8.4	13
Sodium (dissolved) [1]	NA	230	133	134	186	233	124	122	135	260	128	128	178	259	150	150	242	266	140	141	163	NA
Potassium to Sodium ratio	0.5	0.03	0.10	0.10	0.05	0.032	0.099	0.099	0.056	0.028	0.098	0.098	0.045	0.02587	0.0867	0.087	0.036	0.02	0.09	0.090	0.05	0.5

Analyte		March 2021 Analytical Results				March 2022 Analytical Results				
Field Parameters	**MW-7 NPLs[a]**	**MW-7**	**MW-12**	**MW-12 DUP**	**MW-13**	**MW-7**	**MW-12**	**MW-12 DUP**	**MW-13**	**MW-13 NPLs[b]**
pH (std. units)	6.5-8.5	7.86	6.92	--	7.20	7.81	6.88	--	7.34	NA
Specific Conductivity (mS/cm)	NA	1.544	3.870	--	3.533	1.874	3.716	--	3.591	NA
Temperature (°C)	NA	14.3	14.1	--	13.8	14.9	14.6	--	14.2	NA
Laboratory Results										
Total dissolved solids	3918	976	3960	3710	3350	944	3740	3710	3580	4026
Total suspended solids	--	906	299	219	144	157	157	102	36	--
Sulfate	2080	55.7	2490	2470	2170	108	2550	2500	**2420**	2200
Iron (total)	4.5	**19.6**	8.7	8.86	4.6	**8.9**	6.26	5.11	1.1	NA
Iron (dissolved)	NA	0.06 U	0.146	0.158	0.06 U	0.08 J	0.248 J	0.220 J	0.12 U	0.13
Manganese (dissolved)	0.88	0.01 U	0.489	0.511	0.01 U	0.03 J	0.599	0.552	0.02 U	0.3
Potassium (dissolved)	17	5.6	12.1	12.5	7.84	6.6	12.7	12.8	7.94	13
Sodium (dissolved) [1]	NA	236	141	146	215	264	144	143	280	NA
Potassium to Sodium ratio	0.5	0.02	0.09	0.09	0.04	0.03	0.09	0.09	0.03	0.5

Notes:
All units are in mg/L unless noted otherwise.
Bolded values - Screening level exceeded.
[1] - Sodium removed from list of compliance standards in 2015 per Division of Reclamation, Mining and Safety approval letter dated February 25, 2015.
B - Analyte concentration detected at a value between Method Detection Limit and Practical Quantitation Limit.
bkg - Background.
MCL - Maximum concentration limit.
NA - Not applicable
Nan - Not Analyzed
NPLs - numeric protection levels issued by Division of Reclamation, Mining and Safety
U - The analyte was analyzed for, but not detected. Detection limit is numeric value shown.
Multiple screening levels present in some instances due to proposed background standards for MW-7.
[a]DRMS-approved Numeric Protection Levels for MW-7.
[b]DRMS-approved Numeric Protection Levels for MW-13.

Arcadis U.S., Inc.
630 Plaza Drive, Suite 200
Highlands Ranch
Colorado 80129
Phone: 720 344 3500
Fax: 303 470 2989
www.arcadis.com