

2017 Annual Report



January 2018

Flambeau Mining Company
4700 Daybreak Parkway
South Jordan UT 84095

Flambeau Mining Company
4700 Daybreak Parkway
South Jordan, UT 84095
801-204-2526



January 31, 2018

Mr. Dave Siebert
Bureau Director
Wisconsin Department of Natural Resources
101 South Webster Street, GEF2
Madison, WI 53707-7921

Dear Mr. Siebert:

The Flambeau Mining Company (Flambeau) is submitting 5 copies of the attached 2017 Annual Report pursuant to Part 1-8 of the Flambeau Mine Permit (Docket No. IH-89-14). This submittal also addresses other requirements of the Mining Permit and associated approvals.

Monitoring and evaluations conducted during 2017 continue to document that the Flambeau River remains fully protected and Flambeau remains in full compliance with its permit standards.

If you have any comments or questions regarding this submittal, please contact me at (801) 204-2526 or dave.cline@riotinto.com.

Sincerely,



Dave Cline
President – Flambeau Mining Company

Distribution

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**FLAMBEAU MINING COMPANY
2017 ANNUAL REPORT**

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1 Purpose and Need

This report serves to document the work that was done at the Flambeau Mine site in 2017 and to satisfy the requirements of the Mining Permit (MP).

Mining Permit, Part 1, Condition 8:

In accordance with sec. 144.89, Stats., Flambeau shall submit a report annually to the Department summarizing the activities which took place on the mining site during the year and shall include other additional information specified in this permit and associated plan approvals.

Mining Permit, Part 2, Condition 4:

The annual report required under sec. 144.89, Stats., shall include discussion of all modifications received during the previous year and shall include an inventory of all modifications received subsequent to permit issuance. The annual report shall also discuss deviations from the approved Mining Plan as a result of final engineering refinements of subsequent plan approvals if these deviations do not require modifications, under Part 2, Conditions 2 and 3.

Mining Permit, Part 2, Condition 6:

Flambeau shall keep a log of all incidents, such as spills, pond overflows and embankment failure or leakage, reported to its environmental compliance staff. This log shall, at all reasonable times, be available for inspection by any duly authorized Department employee. A summary of incidents subject to various Department reporting requirements shall be included in the annual report required under sec. 144.89, Stats.

Mining Permit, Part 2, Condition 7 (Excerpt):

The annual report required under sec. 144.89, Stats, shall include a summary of all exploration drilling activities conducted on the mining site during the previous year.

Mining Permit, Part 4, Condition 9:

Monitoring data and results shall be submitted to the Department within 30 days after completion of the required analyses. The annual report required in this permit shall summarize the year's monitoring activities and any observed trends in the monitoring data.

Water Withdrawal Approval, Condition 1 (Excerpt):

Flambeau Mining Company shall maintain records which document the withdrawal. At a minimum, such information shall include the dates and duration of withdrawal, approximate pumping rate and approximate volume of water withdrawn. Monthly summaries shall be submitted to the department for those months in which a withdrawal occurs. This information shall be available for department review in a separate file at the Flambeau Mining Company office and shall also be summarized in the annual report submitted as a condition of the mining permit.

The primary location of the information which fulfills the requirements of the above conditions is referenced in Table 1-1.

Table 1-1 Location Information Key

Condition No.	Location of Information
MP, Part 1-8	Sections 2 and 3
WWA, Condition 1	Section 2.6.2
MP, Part 2-4	Section 2.8
MP, Part 2-6	Section 2.10
MP, Part 2-7	Section 2.11
MP, Part 4-9	Section 4 and Appendices A and B

2 2017 Summary

2.1 Introduction

On January 14, 1991, after an exhaustive permitting process including extensive opportunity for public input, Flambeau Mining Company (Flambeau), wholly owned by Kennecott Minerals Company, received from the Wisconsin Department of Natural Resources (Department) eleven permits to operate an open pit copper mine in Rusk County, Wisconsin. Over the life of the mine (1993 – 1997), 181,000 tons of copper, 3.3 million ounces of silver, and 334,000 ounces of gold were mined.

Backfilling of the open pit began in earnest in early 1997. Waste rock and soils were replaced to their approximate original location in the open pit. Over 30,000 tons of limestone was added to the sulfide-bearing waste rock to neutralize and buffer the groundwater as it resaturated the backfilled materials.

In 1998, the surface reclamation of the mine site began by returning the land surface to its approximate original contour. Stockpiled topsoil was spread across the site where grasslands and woodlands were created. Hydric (wetland) soils had been stockpiled as well and were used to create over ten acres of wetlands. Reclamation activities since 1998 have included seeding, plug planting, tree planting, erosion control, mowing, invasive species control, trail construction, and prescribed burning. During 2001, Flambeau completed the planting plan and submitted the Notice of Completion (NOC) to the Department. Concurrent with the submittal of the NOC, the reclaimed Flambeau Mine nature trails were opened to the public for non-motorized recreational activities. The City of Ladysmith had partnered with Flambeau to develop the four-mile nature trail system.

During 2006, monitoring of the reclaimed mine site documented the continued development of high quality native grassland, woodland and wetland communities. Ecological monitoring has documented that 272 native plant species are established on the site. Fifty-two bird species were found to be using the reclaimed mine site and 33 bird species were recorded as nesting on the site.

During 2007, Flambeau petitioned the Department for Certificate of Completion (COC). The COC process included a preconference hearing, public hearing and contested case hearing. At the contested case hearing, the parties negotiated an agreement and entered into a stipulation which was subsequently accepted by the administrative law judge and resulted in a signed order. The order granted a COC to Flambeau for 149 acres of the Flambeau Mine site that includes the backfilled pit and not including the 32-acre Industrial Outlot. Among the other aspects of the stipulation included in the Order was an agreement by Flambeau to withdraw the COC petition for the Industrial Outlot and that it would not apply for a COC for the Industrial Outlot for at least three years, a reduction of the reclamation bond to 20 percent of the \$11 million bond on file with the Department at that time (maximum reduction allowed by Wisconsin law), and a commitment by Flambeau to conduct further environmental monitoring.

Between 2007 and 2012, Flambeau completed extensive monitoring as required by the 2007 COC stipulation and also supplemental monitoring on a voluntary basis.

In 2012, the former 0.9-acre Biofilter was removed and a series of infiltration basins were installed in the Industrial Outlot area in order to manage stormwater from the Industrial Outlot. In 2013, Flambeau commenced sampling in accordance with the Copper Park Business and Recreation Area Maintenance and Monitoring Plan (MMP). The MMP sampling concluded in 2015.

In 2016, work within the Industrial Outlot continued by improving stormwater management best management practices (BMPs). Monitoring activities within the Industrial Outlot and the site continued in 2017 under the Mining Permit and Individual Chapter 30 permit, IP-NO-2015-55-01907.

Throughout each phase of the project, samples have been collected from numerous monitoring wells and the Flambeau River including water quality, sediments, fish, and macroinvertebrates. Continued protection of the Flambeau River, located 140 feet from the backfilled pit, has been documented throughout the Flambeau project by extensive monitoring.

2.2 Groundwater Quality Assessments

Assessments of the backfill groundwater quality have been routinely performed with the most recent completed during January 2018. Further detail on groundwater quality can be found in Section 4 of this report.

2.3 Notice of Completion/Certificate of Completion

Data obtained during monitoring of the reclaimed vegetation during 2000 documented that Flambeau met the vegetative performance standards for NOC.

During September 2001, Flambeau submitted the NOC to the Department. In a letter dated March 8, 2002, the Department accepted Flambeau's NOC. The four-year monitoring period prior to COC began November 19, 2001. For Flambeau to receive the COC, the performance standards were met during the final year of the four-year monitoring period. The final year of the four-year monitoring period was 2005. All performance standards were met in 2005 and again in 2006 even during extreme regional climatic conditions such as the regional drought experienced in 2005 and 2006. On January 9, 2007, Flambeau Mining Company petitioned the Department for COC.

The COC process included a preconference hearing in April, public hearing in mid-May and contested case hearing in late May 2007. The contested case portion of the process had just started when the parties began negotiating an agreement. At the hearing, the parties entered into a stipulation which was subsequently accepted by the administrative law judge and incorporated into an order. The order was signed by the judge granting a COC to Flambeau for 149 acres of the Flambeau Mine site that includes the backfilled pit and not including the 32-acre Industrial Outlot. Among the other aspects of the Stipulation included in the Order was an agreement by Flambeau to withdraw the COC petition for the Industrial Outlot and that it would not apply for a COC for the Industrial Outlot for at least three years, a reduction of the reclamation bond to 20 percent of the \$11 million bond on file with the Department at that time (maximum reduction allowed by Wisconsin law), and a commitment by Flambeau to conduct further environmental monitoring.

During 2012, Flambeau completed the five-year term of environmental monitoring as agreed to in the Order's Stipulation.

2.4 Industrial Outlot

2.4.1 Reuse of Industrial Outlot Facilities

On January 8, 1998, Flambeau submitted a request for modification of the Mining Permit and Reclamation Plan. The requested modifications included modification of the final land use for 32 acres of the mining site to allow for alternative use of the on-site buildings and related ancillary facilities, railroad spur and a portion of the former Type II waste rock stockpile area by the Ladysmith Community Industrial Development Corporation (LCIDC).

On July 30, 1998, the Department approved the request for modification of the final land use for the 32 acre Industrial Outlot with the following condition: "If the portion of the site covered by the lease agreement with the LCIDC has not been put to an acceptable alternative use by the end of 2004, the site shall be reclaimed in a manner consistent with reclamation of the remainder of the mining site. Any demolition waste resulting from such reclamation shall be disposed of in a properly licensed solid waste facility."

A long-term lease agreement exists between Flambeau and the LCIDC, where the LCIDC leases a 32-acre portion of the former mine site referred as the Industrial Outlot. The 32-acre area includes the former administration building now occupied by the Ladysmith Department of Natural Resources Service Center; the former Water Treatment Plant (WTP) building now occupied by Xcel Energy and the Department; the rail spur for which the LCIDC has installed major improvements and purchased adjacent property outside of the mine project area; an approximate eight-acre area north of the former rail spur in the former Type II stockpile area now occupied by the Copper Park Equestrian Trails Trailhead; and a new wetland area constructed in 2015-2016.

During 2000, the LCIDC completed renovations on the administration building, now serving as the Department's Ladysmith Service Center, and the WTP building, now housing Xcel Energy's line maintenance shop and the Department's equipment storage area. In addition, the LCIDC constructed another building for the Department between the Service Center and the former WTP to house additional Department equipment. The Department and Xcel Energy continue to occupy the former mine buildings.

During 2003, the LCIDC submitted a request to the Department for the retention of the rail spur located east of Highway 27 as part of the communities' on-going efforts to increase industrial development. The LCIDC had committed to remove and reclaim about 200 feet of the rail spur east of Highway 27. In a letter dated June 12, 2003, the Department stated that it "...is satisfied that the portion of the rail spur east of the highway is being used for alternate purposes. Therefore, the rail spur east of Highway 27 will not need to be removed and revegetated..."

During early 2004, the Flambeau Riders, Inc. (Flambeau Riders) approached Flambeau about the possibility of developing non-motorized trails on property owned by Flambeau south of the Industrial Outlot and east and south of the Flambeau River. In addition, the Flambeau Riders inquired about using a portion of the Industrial Outlot as driveway access and as an equestrian trailhead. In documents dated May 19, 2004 and May 28, 2004, Flambeau proposed to the Department an alternate use plan for Flambeau's former rail spur area west of Highway 27 and the eight-acre area north of the west rail spur area within the Industrial Outlot as a driveway and equestrian trailhead.

During 2004, a Community Advisory Group was formed to advise Kennecott Minerals on development of a land use management plan for the 2,177 acres owned by Flambeau as of year-end 2004. The Advisory Group is represented by Rusk County, City of Ladysmith, Town of Grant, Ladysmith Area Trails Association, Flambeau Riders, LCIDC and the Department's Northern Rivers Initiative. During a late December 2004 meeting, the Advisory Group agreed that the expansion of trails south of the reclaimed mine site and using a portion of the Industrial Outlot as an equestrian trailhead were acceptable and beneficial uses of the property. It was agreed to formalize the agreement with 1) a Trail Easement & License between Flambeau and the City of Ladysmith and 2) a Sublease between the LCIDC and the City of Ladysmith. Fully executed documents, Trail Easement & License and Sublease, dated January 1, 2005, are in place.

In a letter to the Department dated December 30, 2004, Flambeau provided notice that the 32-acre Industrial Outlot has met the condition of "acceptable alternative use."

The Department responded in a letter dated February 18, 2005 that the only portion of the Industrial Outlot for which an acceptable alternate use had not been designated was the section lying north of the rail spur in the area of the former Type II waste rock stockpile. The Department conceptually found the proposed use as an equestrian trail head acceptable, but required further details to review and approve the proposed construction plans.

In submittals dated March 1 and July 21, 2005, Flambeau provided to the Department drawings and detail regarding the proposed equestrian trailhead and access via Copper Park Lane. The Department provided approval for the project in a letter dated July 28, 2005.

The construction of the equestrian trailhead initiated on August 11, 2005 and was complete by September 8, 2005. The trails remain open to the public since September 2005.

2.4.2 Industrial Outlot Projects and Improvements

During spring 2003, Flambeau and the LCIDC agreed that the Wisconsin Department of Transportation should remove the rail crossing as part of the renovation of Highway 27 during 2004. In addition, stormwater sampling had measured copper concentrations entering the 0.9-acre Biofilter that may have been associated with the west rail spur area.

During fall 2003, the top two feet of ballast and gravel were excavated from the rail spur area west of Highway 27. Reclamation of the west rail spur area and 200 feet east of Highway 27 was completed during spring 2004.

A submittal, Rail Spur Reclamation Documentation, dated November 10, 2004, was made to the Department and included a topographic drawing showing the east and west reclaimed rail spur areas and details regarding the reclamation of the rail spur areas.

As discussed in Section 2.4.3, during 2006, the remaining gravel parking lot area around the buildings was asphalted and the drainage swale was lined with rocks.

The Flambeau Riders have been making improvements to the equestrian trailhead since 2005. The trailhead improvements include an information kiosk, split rail fence, trees and horse hitching tie lines. During 2011, two concrete manure bunkers were installed by the Flambeau Riders.

Pursuant to discussions with the Department in 2010, the Copper Park Business and Recreation Area Work Plan was submitted to the Department in May 2011. During October and November 2011, Flambeau constructed an infiltration basin in the west portion of the Industrial Outlot. Construction of the North and East Infiltration Basins began in March 2012 and was completed in April 2012. The Copper Park Business and Recreation Area Construction Documentation Report was submitted to the Department on January 31, 2013.

Between spring 2013 and spring of 2015 efforts were undertaken to determine a long-term sustainable stormwater management solution for the Industrial Outlot due to the fact that infiltration basins were not functioning as intended. In May 2015, the Copper Park Business and Recreation Area Work Plan Supplement (Work Plan Supplement) was submitted to the Department and the required permits were applied for at the same time. Construction activities described in the Work Plan Supplement began in the fall of 2015 and were completed in June 2016. Work activities were documented in the Copper Park Business and Recreation Area Supplement Construction Documentation Report submitted to the Department on November 16, 2016. Vegetation requirements were met and erosion control BMPs were removed in September 2016. The project was determined to be complete on September 23, 2016 and tracking for qualifying storm events to complete surface water monitoring commenced. The surface water monitoring plan was defined in the September 24, 2015 WDNR correspondence, Flambeau Mine Surface Water Monitoring Plan, and is being completed under Department permit (IP-NO-2015-55-01907).

2.4.3 Intermittent Stream C

The Flambeau Mine remains committed to the protection of water quality in the Flambeau River. Since final reclamation in 1999, Flambeau has continued its monitoring of water quality in the Flambeau River as well as surface runoff into the Flambeau River. This monitoring indicates that the water quality of the Flambeau River remains fully protected.

Surface water sampling in 2017 proceeded as described in Section 2.4.4 in accordance with the monitoring plan approved by the Department under permit (IP-NO-2015-55-01907).

Also, surface water samples were voluntarily collected and analyzed from the Flambeau River in the spring and fall of 2017. Consistent with previous years' results, the monitoring results document that the Flambeau River remains protected.

2.5 Community Involvement

Flambeau's involvement with the surrounding communities has included promotion of community activities, partnering with community groups, economic development, promoting tourism, enhancing communication, restoration projects, providing educational opportunities, and maintaining an open door policy.

A summary of community activities in 2017 is provided below:

- ♦ Flambeau's partnership with the City of Ladysmith and Flambeau Riders, Inc. allowed continued access to the non-motorized multi-use recreational trails in 2017. These trails, the Copper Park Equestrian Trails and Trailhead, were opened to the public in September 2005.
- ♦ The Reclaimed Flambeau Mine nature recreation trails were open to the public for the 16th year. On September 9, 2017, Flambeau partnered with Kids and Mentors Outdoors (KAMO) to promote and host a guided educational "moonlit hike" of the Reclaimed Flambeau Mine Nature Trails for local youth and families.
- ♦ Flambeau sponsored and hosted a bird species count as part of the statewide Great Wisconsin Birdathon on May 3, 2017. Seventy eight species were observed along the Reclaimed Flambeau Mine Nature Trails, Copper Park Equestrian Trails, and Sisters Farm Trails. Funds raised were donated to eight statewide bird conservation groups.
- ♦ Flambeau partnered with the Rusk Area Art Alliance (RAAA) and the Writer's Exchange to create a calendar showcasing artwork and poetry from local artists and writers. The 2017 calendar was themed "Flora of the Reclaimed Flambeau Mine" and artwork represented plant species that can be found on the mine site. Original pieces were displayed in the Rusk County Library from September through December.
- ♦ Flambeau continued its open-door policy and upon request conducted tours of the mine site in 2017.

2.6 Water Management

2.6.1 Precipitation Runoff

Since 2000, the reclaimed mine site surface remains stabilized by vegetative growth and there is minimal evidence of erosion. Aerial photographs (color and infrared) taken during August 2017 further document the surface of the reclaimed mine site has stabilized.

Flambeau River water quality samples were voluntarily collected upstream and downstream from the reclaimed mine site during 2017. Comparing analytical results, there was no notable difference between downstream and upstream samples and this further confirms that the reclaimed site is stable and functioning as designed. A summary of Flambeau River water quality results is found in Appendix B.

2.6.2 River Water Withdrawal

On May 5, 1998, the Department approved Flambeau's application to withdraw water from the Flambeau River for use on site. The Department's approval requires submittal of monthly summaries for months during which a withdrawal occurs. When the irrigation pump system operates it is powered with a portable generator since electrical supply had been removed during 2001. During 2017, no water was withdrawn from the Flambeau River.

Wetland 1 is located immediately west of the reclaimed mine site. With the backfilling of the open pit being complete in 1997, the hydrogeologic system has equilibrated, and Wetland 1 has been documented to be notably moister with groundwater seeps again flowing.

During 2017, Flambeau continued to monitor the staff gauge within Wetland 1 and maintain the ability to add mitigation water to the wetland. Mitigation water was not added during 2017 as was also the case between 2002 and 2016.

2.7 2017 Milestones

The following is a summary of significant milestones throughout the year:

Table 2-1 2017 Milestones

Milestone	Month
Continuation of the surface water monitoring plan	Spring-Fall 2017

2.8 Modifications & Deviations

Condition 2-4 in the Mine Permit requires an inventory of deviations and modifications to the Permit received subsequent to permit issuance. Activities during 2017 were consistent with permits, approved plans, and modifications received subsequent to permit issuance. During 2017, there were no modifications or deviations to the Permit.

2.9 Construction Reports

During 2017, there were no construction activities.

2.10 Incident Log

Mine Permit Condition 2-6 requires a log of all incidents such as spills, pond overflow, embankment failure or leakage. This log is maintained on-site and is available for inspection. Spills are reported in accordance with Wis. Adm. Code ch. NR 706, CERCLA Reportable Quantities and SARA Section 302 Extremely Hazardous Substances Reportable Quantities.

During 2017, there were no reportable or recordable incidents that occurred on the reclaimed Flambeau Mine site.

2.11 Drill Holes

Mine Permit Condition 2-7 requires a summary of all exploration drilling activities conducted on the mine site during the previous year. No exploration drilling activities were conducted on the reclaimed mine site during 2017.

3 Reclamation Activities

Upon receipt of the COC, on May 31, 2007, for the 149-acre Reclaimed Flambeau Mine Nature Area, Flambeau has met the requirements for reclamation within the nature area.

There were no on site reclamation activities undertaken during 2017, and thus, no reports were submitted.

3.1 Other Activities

Also reported are post-COC management activities during 2017 within the Reclaimed Flambeau Mine Nature Area that included mowing grass trails and routine inspections.

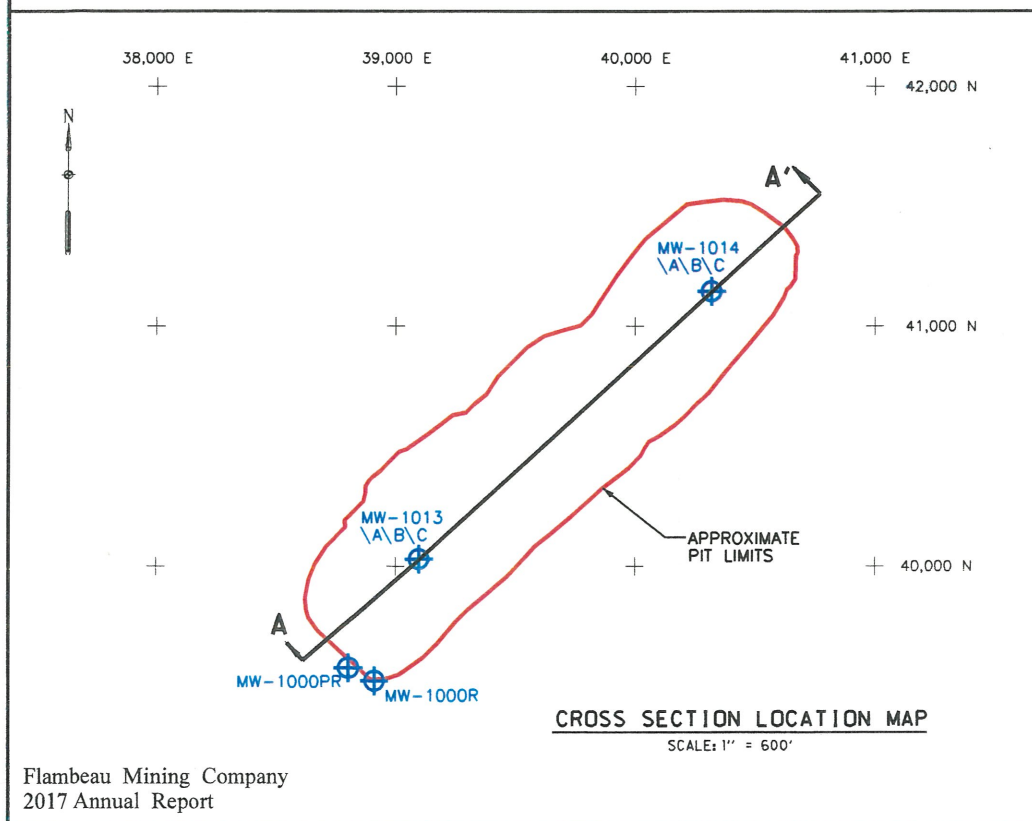
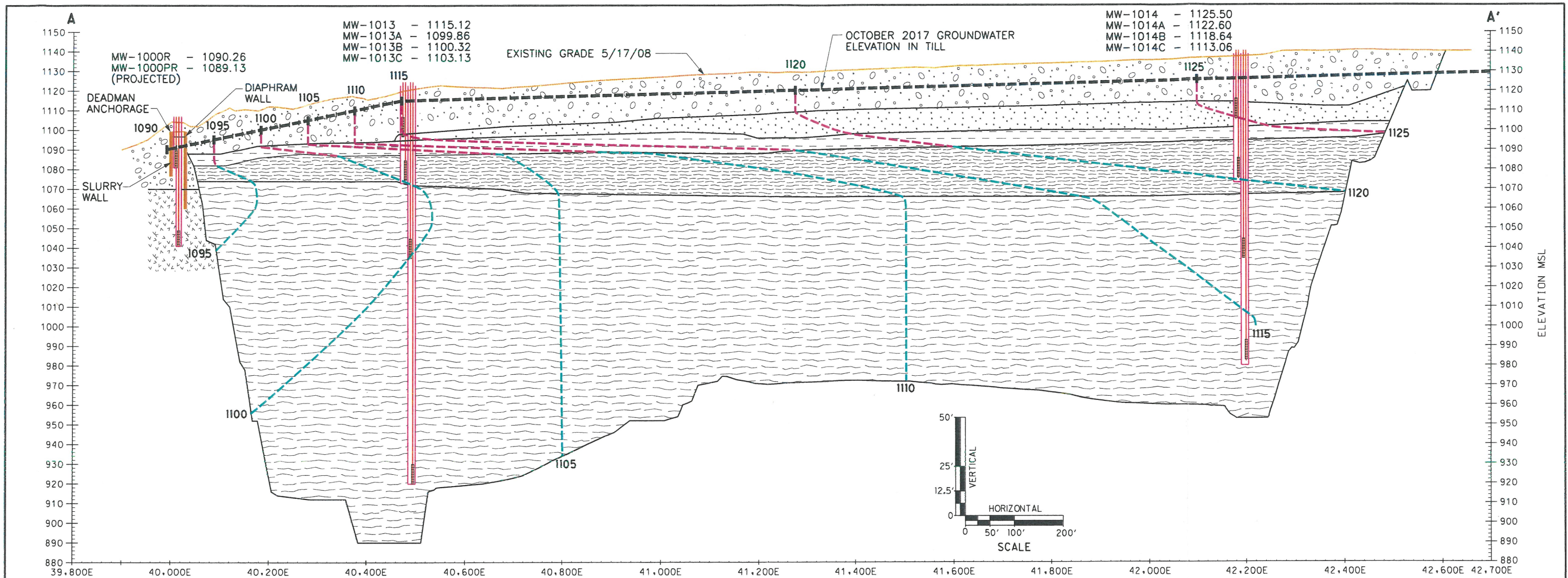
4 Site Monitoring

Environmental monitoring at the Reclaimed Flambeau Mine, during 2017, included assessing the quality of groundwater and backfill pore water. All data obtained during environmental monitoring continues to show that Flambeau remains in compliance with all permit standards and the Flambeau River remains fully protected.

4.1 Groundwater Quality Sampling and Analysis

Quarterly groundwater monitoring was performed in accordance with descriptions provided in the Updated Monitoring Plan (July 1991), the Quality Assurance Project Plan (February 2015), and the Local Agreement. As a result of regulatory changes with respect to arsenic in groundwater, the Department requested that Flambeau consider analyzing groundwater samples for arsenic on a quarterly basis. In a letter dated August 5, 2004, Flambeau notified the Department that arsenic will be included in the quarterly monitoring program. Results of the 2017 monitoring were submitted to the Department Mine Reclamation Unit on May 17, 2017, August 3, 2017, September 19, 2017, and December 11, 2017. Those reports are incorporated by reference.

Figure 4-1 shows the groundwater potentiometric surface using data obtained during 2017. The map was generated using the shallowest measured water levels, and thus represents shallow groundwater flow in the native formations and in the replaced till and sandstone in the backfilled pit footprint. The potentiometric surface shows a direction of regional shallow groundwater flow to the west-northwest toward the Flambeau River. Figure 4-2 shows the potentiometric surface using the lowest water level for nested wells, where available, and the water levels for the B completion in the backfill monitor wells. Beyond the pit footprint, the groundwater levels generally mimic the shallow groundwater conditions. Within the pit backfill, the surface reflects a general direction of groundwater flow in the backfilled Type I and Type II stockpile materials along the axis of the pit toward the Flambeau River. Figure 4-3 shows hydraulic head in cross section along the axis of the pit. The cross section is interpreted to show predominantly horizontal flow in the backfilled Type I and Type II stockpile materials but with a downward hydraulic gradient at the eastern pit area and an upward hydraulic gradient with convergent groundwater flow near the Flambeau River. These observations are consistent with previous, post-mining years.




Flambeau Mining Company
2017 Annual Report

MINE PIT COORDINATES SECTION A - A'

LEGEND

- TILL
- SANDSTONE
- SAPROLITE
- TYPE I MATERIAL
- TYPE II MATERIAL
- PRECAMBRIAN
- WATER TABLE
- GROUNDWATER EQUIPOTENTIAL LINE IN TYPE I AND II BACKFILL
- GROUNDWATER EQUIPOTENTIAL LINE IN SHALLOW FLOW SYSTEM

Foth Infrastructure & Environment, LLC			
REVISED	DATE	BY	DESCRIPTION
CHECKED BY:		SVF	DATE: JAN. '18
APPROVED BY:		MAN	DATE: JAN. '18
APPROVED BY:			DATE:



Foth
Foth Infrastructure & Environment, LLC

FLAMBEAU MINING COMPANY

FIGURE 4-3
MINE PIT CROSS SECTION A - A'
WITH IN-PIT GROUNDWATER
MONITORING WELLS

Scale: SEE BAR SCALE	Date: JANUARY, 2018
Prepared By: JOW	Checked By: SVF
	17F777

4.2 Backfilled Pit Water Quality Assessment

The porewater chemistry of the backfill placed as part of the reclamation at the Flambeau mine has been monitored since February 1999 through sample collection from groundwater wells completed in the backfilled areas. The 2017 evaluation was completed by Foth and is included as Appendix A.

There were no significant changes in porewater chemistry in the backfilled pit during 2017 compared to 2016. The 2017 data show continuation of established trends for most analytes (alkalinity, major cations, major anions, iron, and manganese) and fluctuations in concentrations that are within the ranges observed in previous years of monitoring or no change. Specific observations include:

- ◆ Alkalinity concentrations are stable and within historical ranges.
- ◆ Redox potentials measured for the 2017 samples are generally within or lower than ranges observed in previous years.
- ◆ Manganese concentrations continue to be stable or decreasing slowly at most wells. Some fluctuation in concentrations is observed in the shallower wells in the MW-1014 nest. Stable concentrations for manganese have been reached for the deepest wells (MW-1013C and MW-1014C).
- ◆ Iron concentrations are generally constant and similar to what was reported in previous years.
- ◆ Consistent with previous evaluations, geochemical modeling indicates that conditions of equilibrium or near-equilibrium with respect to calcite and gypsum are prevalent for wells that sample porewater from limestone-amended backfill. Additionally, conditions of near-equilibrium to supersaturation with respect to rhodochrosite also occur for most wells in the limestone-amended backfill except MW-1014A since 2009, which is undersaturated with respect to rhodochrosite.
- ◆ Consistent with previous results, historic decreasing trends for manganese, iron, and sulfate suggest there may be a slow rinse out of easily solubilized constituents by inflow of background groundwater at the upgradient location of the MW-1014 well nest. Concentrations of sulfate, manganese, and iron in the deep wells have been relatively stable over the last few years.
- ◆ The flux, from the backfilled pit to the Flambeau River, was initially presented in Appendix L of the Mining Permit Application for the Flambeau Project (FVD, 1989), then in a memorandum submitted by FMC to the Department on October 17, 2000, entitled Backfilled Pit Water Quality Assessment (FMC, 2000). The flux was calculated to be on the order of 6.3×10^{-4} cubic feet/second. When the flux is considered with the existing backfilled pit concentrations, the potential increase in concentrations in the Flambeau River is immeasurable and there is no impact to the Flambeau River. Additionally, the

results of the annual geochemical modeling continue to show stable conditions and conditions are not expected to change.

4.3 Trend Analysis

A detailed analysis of statistical trends occurring in the groundwater and surface water data was performed. The complete trend memorandum is included in the memorandum in Appendix B.

Statistical tests evaluated long-term trends occurring during the post-mining period (October 1997 to the present) and short-term trends for the most recent five years. Historical trend graphs of the data are also presented.

The majority of the trends with notable concentration changes occur in the quarterly groundwater monitoring parameters. A general discussion of the trend results for each well nest is provided in Section 3 of Appendix B. The changes in the results of the statistical trend tests from the 2016 Annual Report include the following:

- ♦ Alkalinity, hardness, TDS, and conductivity in MW-1002G, and TDS in MW-1002, have small increasing trends since 2013. Concentrations remain within variation levels observed during the pre-mining period.
- ♦ Small decreasing trends of alkalinity, hardness, sulfate, and conductivity have been observed in MW-1004S since the beginning of 2015. Redox potential decreased during 2014 in both MW-1004 and MW-1004S. TDS in MW-1004P had a small increase since 2015, but concentrations remain within variation levels observed during the pre-mining period.
- ♦ Hardness, TDS, and conductivity in MW-1005 were noted in the previous Annual Report as having increasing trends since 2013. These trends continue through 2017, along with an increasing trend of manganese in MW-1005. Also, the annual parameters of barium, calcium, chloride, magnesium, sodium had increased concentration levels during 2016 and 2017 in MW-1005. The increase in these parameters may be due to application of road salt on State Highway 27, which is proximal to the well location. Additional contributing factors may include rising water levels and evaporative concentration effects.

No statistically significant trends were observed in the surface water monitoring results.

4.4 Wetland Monitoring

During 2017, Flambeau monitored wetland surface flows.

In accordance with Section 3.1.4.3 of the Updated Monitoring Plan, Flambeau continued to monitor water level measurements at least three times per year (spring, summer, and fall) in Wetland 1.

4.4.1 Wetland Surface Flows

In May 2001, Flambeau submitted a Wetland Area Hydrographic Assessment, prepared by Foth & Van Dyke, evaluating the wetland water elevations and recommending cessation of monitoring of

wetland surface water elevations, with the exception of Wetland 1, in accordance with the Updated Monitoring Plan. Based upon the Wetland Area Hydrographic Assessment, Flambeau requested the Department's approval of cessation of monitoring wetland surface water elevations for Wetlands 5C, 6C, 7, and 10A. During April 2002, the Department concurred with Flambeau's request to decrease the extent of wetland water level monitoring.

In accordance with Section 3.1.4.3 of the Updated Monitoring Plan, Flambeau monitored water level measurements three times per year (spring, summer, and fall). Water levels in Wetland 1 (Staff Gauge WT-5) were measured three times during 2017: spring, summer, and fall. Standing water at the staff gauge was observed during spring and summer.

Measurements from Wetland 1 are provided in Appendix B. Figure 4-1 shows the staff gauge location. A request to end the required monitoring and reporting in Wetland 1 is being evaluated and will be submitted independently.

4.5 Surface Water Monitoring

Surface water monitoring commenced after completion of the Work Plan Supplement activities on September 23, 2016. Sampling was conducted in accordance with the September 24, 2015 Flambeau Mining Company Surface Water Monitoring Plan. Surface water samples, were collected at two locations (SW-C9, and SW-C1) as shown on Figure 2-1. There were four qualifying storm events during the spring and three qualifying storm events during the fall. Surface water was collected from these locations and was sent to Pace Analytical Service, Inc. (Pace) (Green Bay, WI). Pace is a state-certified laboratory. Samples were analyzed for the following parameters:

- ♦ Hardness, total
- ♦ Copper, total
- ♦ Zinc, total
- ♦ Total Suspended Solids (TSS), total

Surface water sampling results were provided to the Department on June 27, 2017 and December 26, 2017.

AES completed a vegetation analysis in accordance with the September 24, 2015 Flambeau Mining Company Surface Water Monitoring Plan. Vegetative coverage was evaluated in the East area, the North area, the East-West Swale, the West area and Wetland #7. Total estimated coverage was 101% in the East Upland Prairie, 90% in the East Area Bottom, 98% in the North Area Upland Prairie, 86% in the North Area Bottom, 68% in the West Area, and 93% in Wetland #7. The memorandum is included as Appendix C.

4.6 Surface Subsidence

Pursuant to Section 3.1.7 of the Updated Monitoring Plan (July 1991), with 2008 being the tenth year after reclamation activities were performed in the area of the pit, a review of the surface topography in the area of the pit was performed in 2008.

The results of the 2008 subsidence analysis indicated a general increase of 0.6 feet. These results were consistent with the results of the review of the surface topography in the area of the pit completed in 2001 when the general subsidence across the site was less than a half a foot which is within the accuracy of the mapping technique and the largest settlement observed in isolated areas by mapping was 1.5 feet.

Subsequent subsidence surveys are to occur in the twentieth (2018) and fortieth (2038) year after reclamation activities in the area of the pit are completed.

Aerial Photography (Color and Infrared)

In accordance with Section 3.1.6 of the Updated Monitoring Plan (July 1991), aerial and color infrared photography was completed in the late summer for four consecutive years following completion of closure and will continue every five years throughout the long-term care and maintenance period to monitor success of revegetation.

In the November 7, 2002 submittal of the 2002 Aerial and Color Infrared Photography, Flambeau requested a reduction of the area of coverage for the photography based upon the substantial rebound of groundwater around the reclaimed mine site. Flambeau proposed that the photography cover the reclaimed mine site and 500 feet beyond the site's perimeter including the area of Wetland 1. In a letter dated July 9, 2003, the Department authorized Flambeau to reduce the breadth of the aerial and color infrared photography as requested.

Year 2005 was the fourth year of the four consecutive years for aerial and color infrared photography since the submittal of the NOC in 2001. Aerial and color infrared photography was completed on August 3, 2006 for a fifth additional year and these results were presented in the 2006 Annual Reclamation Report.

With the long-term care phase of the Flambeau project beginning with the May 2007 COC, aerial and color infrared photography has been conducted every five years. The first of the long-term care phase aerial and color infrared photography occurred in 2012. The results were presented in the 2012 Annual Report. The second of the long-term care phase aerial and color infrared photography occurred in 2017. The results are presented in Appendix D. Subsequent aerial and color infrared photography will occur in 2022, 2027, 2032, 2037, 2042, and 2047.

4.7 Other Activities

There were no additional monitoring activities in 2017.

REFERENCES

2016 Annual Report	January 2017
Copper Park Business and Recreation Area Supplement Construction Documentation Report	November 2016
2015 Annual Report	January 2016
Copper Park Business and Recreation Area Work Plan Supplement	May 2015
Quality Assurance Project Plan	February 2015
2014 Annual Report	January 2015
2013 Annual Report	January 2014
Copper Park Business and Recreation Area Maintenance and Monitoring Plan	February 2013
2012 Annual Report	January 2013
Copper Park Business and Recreation Area Construction Documentation Report	January 2013
2012 Annual Reclamation Report	November 2012
2011 Annual Report	January 2012
2011 Annual Reclamation Report	November 2011
Copper Park Business and Recreation Area Work Plan	May 2011
2010 Annual Report	January 2011
2010 Annual Reclamation Report	November 2010
2009 Annual Report	February 2010
2009 Annual Reclamation Report	November 2009
2008 Annual Report	January 2009
2008 Annual Reclamation Report	November 2008
2008 Monitoring Results and Copper Park Lane Work Plan	October 2008
2007 Annual Report	January 2008
COC Stipulation Monitoring Work Plan	December 2007
Quality Assurance Project Plan – Stipulation Monitoring Work Plan QAPP for the Flambeau Mine	December 2007
2007 Annual Reclamation Report	November 2007
Stipulation and Order	May 2007
2006 Annual Report	January 2007
Biofilter Management Plan	January 2007
2006 Annual Reclamation Report	November 2006

Construction Documentation Report – Flambeau Industrial Outlot	September 2006
2005 Annual Report	January 2006
2005 Annual Reclamation Report	November 2005
2004 Annual Reclamation Report	November 2004
2001 Annual Reclamation Report	November 2001
2000 Annual Report	January 2001
Revised Mining Permit Quality Assurance/Quality Control Plan	August 1991
Updated Monitoring Plan	July 1991
Mining Permit	January 1991
Operational Phase and Long Term Care Quality Assurance Plan	November 1993
Mine Permit Application	December 1989
Local Agreement	August 1988

SUBMITTALS

DOCUMENT	DATE	SUBMITTEE
Section 2.0 Operating Activities 2016 Annual Report	January 2017	Larry Lynch ⁽²⁾
Section 4.0 Site Monitoring Environmental Monitoring (First Quarter 2017), Groundwater Spring 2017 Surface Water Analytical Report	May 2017 June 2017	Dave Siebert ⁽¹⁾ Dave Siebert ⁽¹⁾
Environmental Monitoring (Second Quarter 2017), Groundwater Environmental Monitoring (Third Quarter 2017), Groundwater Environmental Monitoring (Fourth Quarter 2017), Groundwater	August 2017 September 2017 December 2017	Dave Siebert ⁽¹⁾ Dave Siebert ⁽¹⁾ Dave Siebert ⁽¹⁾
Fall 2017 Surface Water Analytical Report	December 2017	Dave Siebert ⁽¹⁾

1. Wisconsin Department of Natural Resources
Division of External Services
Bureau of Environmental Analysis & Sustainability
2. Wisconsin Department of Natural Resources
Division of Environmental Management
Waste & Materials Management
Hazardous Waste Prevention and Management Section

Appendix A
Backfilled Pit Water Quality Assessment



Green Bay Location

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(920) 497-2500 • Fax: (920) 497-8516
www.foth.com

January 31, 2018

TO: Dave Cline, Flambeau Mining Company

CC: Steve Donohue, Foth Infrastructure & Environment, LLC
Sharon Kozicki, Foth Infrastructure & Environment, LLC

FR: Allison Haus, Foth Infrastructure & Environment, LLC

RE: Flambeau Mine Backfilled Pit – 2017 Monitoring Results
Flambeau Mining Company

1.0 Introduction

1.1 Background

The porewater chemistry of the backfill placed as part of the reclamation at the Flambeau mine has been monitored since February 1999 through sample collection from groundwater wells completed in the backfilled areas. SRK Consulting, Inc. (SRK) reviewed the sampling results annually from 1999 through 2009 to assess geochemical interactions between the groundwater and the backfill (e.g., SRK, 2010). Interralogic, Inc. (Interralogic) conducted the reviews and assessment from 2010 through 2013 (e.g., Interralogic, 2014). Golder Associates Inc. (Golder) was contracted to perform the 2014 and 2015 reviews and assessments from a geochemical perspective. Foth Infrastructure & Environment, LLC (Foth) reviewed and assessed geochemistry in 2016 and 2017.

This technical memorandum summarizes the review and assessment of the backfilled pit monitoring results for 2017. The text and format established in reports for previous reviews and assessments by SRK, Interralogic, and Golder have been retained to the extent possible in order to maintain consistency.

1.2 Summary of Previous Results

The results of the review and assessment for the 2016 monitoring period (Foth, 2017) are summarized here within.

There were no significant changes in porewater chemistry in the backfilled pit during 2016 relative to 2015. The 2016 data show continuation of established trends for most analytes (alkalinity, major cations, major anions, iron, and manganese) or fluctuations in

concentrations that are within the ranges observed in previous years of monitoring or no change. Specific observations made for the 2016 data included:

- ♦ Alkalinity concentrations were above background concentrations, but stable or within historical ranges.
- ♦ Redox potentials measured for the 2016 samples were generally within or lower than ranges observed in previous years.
- ♦ Manganese concentrations continued to be generally stable or decreasing slowly at most wells. Some fluctuation in concentrations were observed in the shallower wells in the MW-1014 nest. Stable concentrations for manganese appear to have been reached for the deepest wells (MW-1013C and MW-1014C).
- ♦ Iron concentrations were generally constant and similar to what was reported in previous years, and less than background at most wells except MW-1013, MW-1013C and MW-1014C. Iron concentrations at MW1013 fluctuate above background. Iron concentrations at MW-1013C have increased slightly over the last few years and remain above background. Iron concentrations at MW-1014C since 2010 have been generally stable above background.
- ♦ Geochemical modeling indicates that conditions of equilibrium or near-equilibrium with respect to calcite and gypsum are prevalent for wells that sample porewater from limestone-amended backfill; conditions of equilibrium to supersaturation with respect to rhodochrosite and siderite also occur.
- ♦ Historically observed decreasing trends for manganese, iron, and sulfate suggest that there may be a slow rinse out of readily solubilized constituents by inflow of background groundwater at the upgradient location of the MW-1014 well nest. Concentrations of sulfate, manganese, and iron in the deep wells have been relatively consistent over the last few years.

2.0 Summary Data Collected in 2017

Quarterly groundwater monitoring was performed in accordance with descriptions provided in the Updated Monitoring Plan (July 1991), the Quality Assurance Project Plan (February 2015), and the Local Agreement. The wells sampled in 2017 for this evaluation include the MW-1013 nest, which includes MW-1013, MW-1013A, MW-1013B, and MW-1013C, and the MW-1014 nest, which includes MW-1014, MW-1014A, MW-1014B, and MW-1014C. The MW-1014 nest is located upgradient of the MW-1013 nest and both nests are completed in backfill materials. The wells in each nest are located at approximately the same location but completed at different depths. The background well MW-1005P, which is located upgradient of the backfill, was also sampled for this evaluation.

The routine monitoring program for the backfill groundwater is given in Table 1. The quarterly sampling events with the reduced list of analyses occurred in March, May,

June, and October 2017. The annual sampling program with the extended analyte list was completed in June 2017. The analytical results of the monitoring program for the wells located in the backfilled pit area (MW-1013 and MW-1014 nests) and the background well (MW-1005P) are provided in Attachment 1.

3.0 Results and Discussion

3.1 Alkalinity Trends

Concentration trends for alkalinity are shown on Figure B-6a for the MW-1013 well nest and on Figure B-7a for the MW-1014 well nest. The alkalinity concentrations measured in 2017 are consistent with the results from previous years for both well nests, indicating overall stable conditions in these wells.

Background conditions are indicated by the data for well MW-1005P (provided on Figure B-6a and Figure B-7a). Alkalinity concentrations in MW-1013A, MW-1013B, and MW-1013C remained elevated above background levels during 2017, as has been observed in previous years (Figure B-6a). Wells MW-1013A, MW-1013B, and MW-1013C sample porewater from limestone-amended backfill material; hence, the high alkalinity values are most likely due to reactions with the limestone. As discussed in Section 3.2, these wells also show elevated CO₂(g) levels relative to ambient atmospheric CO₂(g) values and relative to the groundwater in background well MW-1005P as a result of past limestone dissolution and subsequent trapping of at least a portion of the produced CO₂(g) (Table 2). Well MW-1013, which samples porewater from the replaced till, also has a higher alkalinity concentration than background (MW-1005P) and similar to MW-1013B and MW-1013C (Figure B-6a). These observations for the MW-1013 well nest in 2017 are similar to those made in previous annual monitoring reports.

Alkalinity concentrations in wells MW-1014A, MW-1014B, and MW-1014C, which also sample porewater from limestone-amended waste rock in the backfilled pit, were also higher than background levels during 2017, consistent with concentrations from previous years (Figure B-7a). Alkalinity values in MW-1014A appear to have peaked in 2007 at 560 mg/L as CaCO₃ and have declined slightly since that time and now appear stabilized between approximately 400 to 500 mg/L as CaCO₃. Alkalinity concentrations in MW-1014B have followed a trend similar to MW-1014A, with a peak of 620 mg/L as CaCO₃ in October 2004 and a similar range of stable concentrations as MW-1014A from 2012 to 2017. Alkalinity values in MW-1014C have shown a decreasing trend since 1999 and ranged from 260 to 280 mg/L as CaCO₃ in 2013 and 2014, and results have been near approximately 250 mg/L since 2015. The results for the last three years suggest stabilization at values slightly above or slowly approaching background concentrations. Alkalinity concentrations for MW-1014, which samples porewater from the upper sandstone backfill layer, remained below background concentrations during 2017, also similar to observations in previous years.

3.2 Carbon Dioxide Partial Pressure Trends

Previous annual reports have established that limestone amendments to the waste rock during backfilling neutralized the acidity in the waste rock that may have remained from oxidation processes that occurred when the waste rock was stockpiled above ground during the period of active mining operations. Consistent with these reactions, the neutralization reactions resulted in elevated CO₂(g) levels in the porewater of the backfilled waste rock relative to atmospheric CO₂(g) values and relative to background groundwater (MW-1005P) based on geochemical equilibrium modeling results (Table 2).

The previously observed trends of elevated CO₂(g) in the porewater continued during 2017 for the MW-1013 well nest (Figure A-1), with elevated partial pressures of CO₂(g) calculated in reference to those for the background well (MW-1005P) (Table 2). The CO₂(g) partial pressure remained elevated relative to background at MW-1014A and MW-1014B; at MW-1014, the CO₂(g) partial pressure was equal to that observed at the background well (MW-1005P). The CO₂(g) partial pressure at MW-1014C was slightly below that observed at the background well. The CO₂(g) partial pressures determined for 2017 by PHREEQC calculations are generally within the ranges calculated for past monitoring years.

An upward trend in background partial pressures of CO₂(g) for MW-1005P was observed between 2008 and about 2012. Subsequent calculated CO₂(g) partial pressures exhibit a slight decrease, and 2017 partial pressures are closer to 2006 levels and fall within the historic range (Figure A-1).

The CO₂(g) partial pressures shown on Figure A-1 were calculated with the geochemical model PHREEQC (Parkhurst and Appelo, 1999) using the measured groundwater chemical compositions from the annual (June) samples with the detailed analyte list. In 2017, the geochemical model calculations were conducted with the laboratory-measured alkalinity values and field-measured values for pH, temperature, and redox potential. Consistent with previous modeling, the Wateq4f.dat database provided with PHREEQC was applied. There is a potential for some loss of CO₂(g) by degassing during sample collection and analysis because the samples are collected from the monitoring wells at depth (i.e., under a hydrostatic pressure greater than atmospheric conditions) and then brought to the surface resulting in depressurization. Degassing loss of CO₂(g) during sample collection and analysis would cause the pH to increase, which in turn, would affect the calculation of CO₂(g) partial pressure. The potential for this effect to occur during sampling has been noted in previous monitoring reports (e.g., SRK, 2010).

3.3 pH Trends

The elevated CO₂(g) levels have persisted in the pore water of the waste rock probably due to slow rates of loss through the overlying backfill material and continued dissolution of calcite. Carbon dioxide forms a weak acid; hence porewater samples from

zones with the highest CO₂(g) partial pressures tend to have lower pH values than porewater from zones with comparatively lower CO₂(g) partial pressures (Figure B-6c and Figure B-7c for well nests MW-1013 and MW-1014, respectively). Within the backfilled pit, the elevated CO₂(g) levels relative to that of the background well (MW-1005P) have resulted in pH values generally between 6.0 to 7.0 in the amended backfill (MW-1013 and MW-1014 well nests) compared to a range of 6.6 to 7.4 observed in the background well (MW-1005P) since 1999 where CO₂(g) levels are much lower (Figure B-6c and Figure B-7c).

In general, there were no significant changes in pH values of the monitoring well samples during 2017 compared to previous years. .

3.4 Major Ions

The ionic charge balances of the 2017 annual samples were calculated by spreadsheet from the laboratory results and also checked with the PHREEQC geochemical model. The results of the PHREEQC calculation, which were consistent with the spreadsheet calculation, are shown in Table 3. All nine samples had ionic charge balances within plus or minus 10%. Typically, charge imbalances less than 10% are considered to provide a reliable indication of chemical composition for geochemical modeling and assessment (Alpers and Nordstrom, 1999). Thus, the analytical data for 2017 are considered suitable for use in geochemical modeling and related interpretation of water quality trends for this report.

The classification of the groundwater types based on major cations and anions remain the same as reported in previous annual reports. The chemical composition MW-1005P upgradient of the backfill falls into the Ca-Mg-HCO₃ classification, as does MW-1013. The chemical compositions for MW-1013A and MW-1014 fall into Ca-Mg-HCO₃-SO₄ classification. The chemical compositions for all the other wells (MW-1013B, MW-1013C, MW-1014A, MW-1014B, and MW-1014C) are classified as Ca-Mg-HCO₃-SO₄ waters.

The geochemical model PHREEQC was used as described in Section 3.2 to calculate saturation indices for mineral phases that are potential solubility controlling phases in the porewater of the backfill. The geochemical model calculations were conducted with the laboratory-measured alkalinity values and field-measured values for pH, temperature, and redox potential. The saturation index for a mineral does not indicate the abundance of the mineral nor does it account for any kinetic constraints that may prevent the mineral from forming or dissolving. However, the values of the saturation indices, in combination with information on the backfill mineralogy, provide useful information for determining the potential water-rock reactions most likely to be affecting water chemistry. They are also useful for interpreting causes of trends or changes in water quality trends.

The saturation indices obtained from the PHREEQC calculations are given in Table 4 using the data for the detailed analyte list from the June 2017 samples. Time series charts showing trends in saturation indices for each monitoring well are provided on

Figure A-2 through Figure A-6. Complete sets of input data and results from the PHREEQC model calculations for the 2017 water quality data are included in Attachment 1.

Saturation indices for calcite for porewater in all backfilled areas that were amended with limestone are generally near zero (MW-1013B, MW-1013C, MW-1014A, and MW-1014B), indicating a condition of approximate equilibrium with calcite. This result is consistent with observations in previous years and is due to the presence of limestone, which is comprised primarily of calcite, in the amended waste rock. The results imply that there is a reservoir of acid neutralization capacity in the form of limestone remaining in the waste rock. Dissolution of the calcite is also the most likely reason for the elevated CO₂(g) levels found in the porewater in the limestone-amended portions of the backfilled pit (Section 3.2). The porewater in the till (MW-1013 – Figure A-2) and sandstone (MW-1014 – Figure A-4) layers of the backfilled pit, which were not amended with limestone, are generally also near equilibrium with respect to calcite solubility (saturation index values of -0.8 and -0.7, respectively). Wells MW-1013A and MW-1014C, both of which had lower alkalinity concentrations than other wells in their respective well nests are near-equilibrium with respect to calcite (saturation indices of -0.7 and 0.2 in 2017, respectively, are consistent with previous years). Conditions of calcite solubility equilibrium at these wells were similar to the background well (MW-1005P – Figure A-2), located upgradient of the limestone amended backfill, which had a saturation index of -0.4 in 2017.

Other carbonate minerals indicated to be at near-equilibrium conditions by the geochemical modeling are siderite (iron carbonate – MW-1013, MW-1013C, MW-1014C, and MW-1005P) and rhodochrosite (manganese carbonate – MW-1013, MW-1013A, MW-1013B, MW-1013C, MW-1014, MW-1014B, and MW-1014C)). Variability in the siderite saturation indices are likely due to fluctuations in redox conditions. The rhodochrosite saturation indices are less variable than siderite through time and may partially limit dissolved manganese concentrations; and are discussed further in Section 3.6.

Conditions of near-equilibrium with respect to gypsum solubility continued in 2017 for porewater sampled from selected wells completed in limestone-amended waste rock (MW-1013B, MW-1013C, MW-1014A, and MW-1014B). The gypsum likely formed due to acid neutralization reactions with the calcite in the limestone.

There are no significant changes in major ion chemistry in 2017 compared to previous years. Overall, consistent with the measured pH values and alkalinity concentrations, the conditions of equilibrium with calcite and gypsum indicate that acidity that had previously been present in the backfill has been neutralized and there is excess acid neutralizing capacity in the backfilled waste rock in the form of the limestone amendments. This observation is consistent with conclusions made in previous annual reports.

3.5 Redox

Time trends for measured redox potentials are shown on Figure B-6d and Figure B-7d for the MW-1013 and MW-1014 wells nests, respectively. The values for the background well, MW-1005P, are included in both for comparison. The redox potentials in the MW-1013 and MW-1014 well nests in 2017 were within the ranges reported in previous years.

Redox potentials in 2017 in background well MW-1005P were also consistent with measurements from 2016.

3.6 Manganese and Iron

Time trends for manganese concentrations at the MW-1013 and MW-1014 well nests are shown on Figure B-6b and Figure B-7b, respectively. Annual average concentrations of manganese are provided in Table 5.

For manganese, wells in the MW-1013 well nest (MW-1013, MW-1013A, MW-1013B, and MW-1013C) showed no significant changes in 2017, with concentrations generally within the range of concentrations for previous years (Figure B-7b). The manganese concentrations in these wells appear to be relatively stable. For example at MW-1013B, the average annual manganese concentration was 29,025 $\mu\text{g/L}$ in 2017 (Table 5) and variability throughout the year was similar to that observed in previous years (Figure B-6b).

Manganese concentrations in the MW-1014 nest are shown on Figure B-7b. For MW-1014A, MW-1014B, and MW-1014C, a gradual decreasing trend in manganese concentrations was observed prior to 2010, with relatively consistent manganese concentrations since this time. Concentrations remain highest at MW-1014B, near 11,000 $\mu\text{g/L}$ since 2011.

Saturation indices for rhodochrosite (Table 3 and Figures A-2 through A-6) in 2017 show that conditions of oversaturation to near-equilibrium exist in the wells of the MW-1013 nest, as described in Section 3.4. This result is the same as observed for previous years. More variability is seen in the calculated rhodochrosite saturation indices for the MW-1014 nest than for the MW-1013 nest. Well MW-1014, MW-1014B and MW-1014C are near-equilibrium or even slightly supersaturated, while MW-1014A is slightly undersaturated. The rhodochrosite oversaturation to near-equilibrium conditions in the MW-1013 nest and in MW-1014, MW-1014B, and MW-1014C indicate that rhodochrosite solubility may have a partial limiting effect on manganese concentrations, depending on pH and $\text{CO}_2(\text{g})$ partial pressure.

Time trends for iron concentrations at the MW-1013 and MW-1014 well nests are shown on Figure B-6b and Figure B-7b, respectively. Annual average concentrations of iron are provided in Table 5. Iron concentrations measured in 2017 at MW-1013A and MW-1013B remained at low concentrations ($<0.5 \text{ mg/L}$) that are similar to or are less than the range observed for the background well MW-1005P (Figure B-6b and Figure B-7b). Iron concentrations at MW-1013 and MW-1013C had annual averages of

6.89 and 13.40 mg/L, respectively. The range of concentrations observed in the quarterly samples during 2017 for the MW-1013 well nest are similar to those for previous years (Figure 20).

Iron concentrations for most wells in the MW-1014 nest, with the exception of MW-1014C, measured during 2017 remained lower than those measured for the background well MW-1005P. This is consistent with measurements in previous years (Figure B-7b). Iron concentrations at MW-1014C may have reached stable values following a slow decline in concentrations from 1999 through 2009 (Figure B-7b).

The geochemical modeling results indicate that, under the measured redox conditions, the iron mineral potentially affecting iron concentrations is siderite. Conditions of siderite oversaturation occur at MW-1013C (Figure A-4) and MW-1014C (Figure A-6). Both of these wells also show high partial pressures of CO₂(g) which, depending on the fluctuating iron concentrations and redox conditions, result in conditions of near saturation to oversaturation with respect to siderite solubility. These conditions are similar to those observed in previous years. Near-equilibrium with siderite also is calculated for MW-1013 and at background well MW-1005P (Figure A-2) in 2017. These conditions are also within the range observed in previous years for these wells.

Consistent with previous years (Interralogic, 2014 and Golder, 2016), manganese and iron concentrations in the deep wells of the MW-1014 nest (MW-1014B and MW-1014C) have generally shown a slow downward trend with time (Figure B-6b and Figure B-7b), although the rate of decrease has slowed in recent years and appears to have reached nearly constant values. The rates of decrease in manganese and iron at MW-1014C approximately parallel the rate of decline in sulfate (Figure B-6c and Figure B-7c, respectively). The concentrations of manganese, iron, and sulfate in the upgradient background groundwater in well MW-1005P are much lower than those observed in the wells located in the backfilled pit. The decreasing concentrations of sulfate, manganese, and iron observed for the MW-1014 nest may be caused by a slow process of dilution and displacement of backfill pore water by inflowing natural groundwater. This effect is not seen at the MW-1013 well nest. However, the effects of inflowing groundwater would be expected to be more pronounced and occur earlier at the MW-1014 nest because it is located in an upgradient position relative to the MW-1013 nest and therefore more likely to show an earlier influence from groundwater inflow.

4.0 Conclusions

There were no significant changes in porewater chemistry in the backfilled pit during 2017 compared to 2016. The 2017 data show continuation of established trends and conditions for most analytes (alkalinity, major cations, major anions, iron, and manganese) and fluctuations in concentrations that are within the ranges observed in previous years of monitoring or no change. Specific observations include:

- ♦ Alkalinity concentrations are stable and within historical ranges.

- ♦ Redox potentials measured for the 2017 samples are generally within or lower than ranges observed in previous years.
- ♦ Manganese concentrations continue to be stable or decreasing slowly at most wells. Some fluctuation in concentrations is observed in the shallower wells in the MW-1014 nest. Stable concentrations for manganese have been reached for the deepest wells (MW-1013C and MW-1014C).
- ♦ Iron concentrations are generally constant and similar to what was reported in previous years.
- ♦ Consistent with previous evaluations, geochemical modeling indicates that conditions of equilibrium or near-equilibrium with respect to calcite and gypsum are prevalent for wells that sample porewater from limestone-amended backfill. Additionally, conditions of near-equilibrium to supersaturation with respect to rhodochrosite also occur for most wells in the limestone-amended backfill except MW-1014A since 2009, which is undersaturated with respect to rhodochrosite.
- ♦ Consistent with previous results, historic decreasing trends for manganese, iron, and sulfate suggest there may be a slow rinse out of easily solubilized constituents by inflow of background groundwater at the upgradient location of the MW-1014 well nest. Concentrations of sulfate, manganese, and iron in the deep wells have been relatively stable over the last few years.
- ♦ The flux, from the backfilled pit to the Flambeau River, was initially presented in Appendix L of the Mining Permit Application for the Flambeau Project (FVD, 1989), then in a memorandum submitted by FMC to the Department on October 17, 2000, entitled Backfilled Pit Water Quality Assessment (FMC, 2000). The flux was calculated to be on the order of 6.3×10^{-4} cubic feet/second. When the flux is considered with the existing backfilled pit concentrations, the potential increase in concentrations in the Flambeau River is immeasurable and there is no impact to the Flambeau River. Additionally, the results of the annual geochemical modeling continue to show stable conditions and conditions are not expected to change.

5.0 Recommendations

The porewater in the backfilled pit area appears to have reached a condition of near constant concentrations, particularly for the deeper wells. Continued groundwater monitoring in and around the backfilled pit from the MW-1013 and MW-1014 well nests as well as the background well MW-1005P on an annual basis is recommended. Quarterly samples for the limited suite of water quality parameters can be discontinued given consistent concentration ranges throughout the year and relatively stable concentration trends. An annual sampling program would be sufficient to identify changes in water quality because the historical record provides information that is

sufficient to determine if significant changes are taking place given that there will always be some amount of year-to-year variability. An annual monitoring event was previously recommended by SRK (2010), Interralogic (2011, 2012, 2013, and 2014), Golder (2015, 2016), and Foth (2017). An annual event should include all the parameters in the detailed list that are part of the annual sampling program currently being followed. An annual review of the data should be included in the project's annual report to determine if the conclusions reached in this memorandum and previous reviews remain valid.

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Tables

Table 1
Summary of Routine Groundwater Monitoring Parameters

Parameter	Units	Quarterly Samples	Annual Sample
Alkalinity	mg/L as CaCO ₃	X	X
As	µg/L	X	X
Ba	µg/L		X
Cd	µg/L		X
Ca	mg/L		X
Cl	mg/L		X
Cr	µg/L		X
Cu	mg/L	X	X
Hardness	mg/L	X	X
Fe	mg/L	X	X
Pb	µg/L		X
Mg	mg/L		X
Mn	µg/L	X	X
Hg	µg/L		X
Field pH	s.u.	X	X
Laboratory pH	s.u.	X	X
K	mg/L		X
Se	µg/L		X
Ag	µg/L		X
Na	mg/L		X
TDS	mg/L	X	X
Sulfate	mg/L	X	X
Zn	µg/L		X
Field Conductivity	µmhos/cm	X	X
Redox Potential	mV	X	X
Groundwater Elevation	feet	X	X

Abbreviations:

mg/L = milligrams per liter
 mg/L as CaCO₃ = milligrams per liter as calcium carbonate
 mV = millivolts
 s.u. = standard units
 µg/L = micrograms per liter
 µmhos/cm = micromhos per centimeter

Prepared by: HLH
 Checked by: ASH1

Table 2
Estimates of Carbon Dioxide Gas in Equilibrium with Annual Samples

Well	Sample Date (M-YY)	pH	Alkalinity	Temperature	pCO ₂	Log10 pCO ₂	CO ₂ (g) Over-saturation ¹	CO ₂ (g) Over-saturation ²
			(mg CaCO ₃ /L)	(°C)	(atm)	(atm)	(atm/atm)	(atm/atm)
MW-1013	Jun-17	6.02	580	8.8	0.50	-0.3	1585	21.9
MW-1013A	Jun-17	6.42	364	10.1	0.13	-0.89	407	5.6
MW-1013B	Jun-17	6.17	573	11.1	0.32	-0.49	1023	14.1
MW-1013C	Jun-17	6.37	469	10.1	0.17	-0.78	525	7.2
MW-1014	Jun-17	6.82	166	8.4	0.02	-1.63	74	1.0
MW-1014A	Jun-17	6.78	491	8.9	0.07	-1.16	219	3.0
MW-1014B	Jun-17	6.62	525	9.2	0.10	-0.98	331	4.6
MW-1014C	Jun-17	7.28	279	9.3	0.01	-1.88	42	0.6
MW-1005P	Jun-17	7.03	251	9.6	0.02	-1.64	72	1.0
MW-1013	Jun-16	6.11	589	9.2	0.42	-0.38	1318	21.4
MW-1013A	Jun-16	6.58	358	6.6	0.09	-1.07	269	4.4
MW-1013B	Jun-16	6.16	574	9.7	0.32	-0.49	1023	16.6
MW-1013C	Jun-16	6.41	499	10.1	0.16	-0.79	513	8.3
MW-1014	Jun-16	6.28	162	8.4	0.08	-1.1	251	4.1
MW-1014A	Jun-16	6.51	473	8.9	0.13	-0.9	398	6.5
MW-1014B	Jun-16	6.38	469	8.8	0.16	-0.79	513	8.3
MW-1014C	Jun-16	6.58	272	9.5	0.07	-1.18	209	3.4
MW-1005P	Jun-16	7.08	241	9.8	0.02	-1.71	62	1.0
MW-1013	Jun-15	6.09	610	11.25	0.46	-0.34	1440	24.1
MW-1013A	Jun-15	6.56	340	9.42	0.09	-1.06	274	4.6
MW-1013B	Jun-15	6.2	590	9.61	0.3	-0.52	956	16
MW-1013C	Jun-15	6.38	500	9.61	0.17	-0.77	541	9
MW-1014	Jun-15	6.4	180	11.2	0.07	-1.16	221	3.7
MW-1014A	Jun-15	6.51	450	9.53	0.12	-0.92	379	6.3
MW-1014B	Jun-15	6.28	480	8.99	0.21	-0.68	659	11
MW-1014C	Jun-15	6.57	270	9.77	0.07	-1.17	212	3.6
MW-1005P	Jun-15	7.09	240	9.54	0.02	-1.72	60	1
MW-1013	Jun-14	6.13	660	9.27	0.44	-0.36	1391	22
MW-1013A	Jun-14	6.58	340	10.56	0.08	-1.08	253	4
MW-1013B	Jun-14	6.31	530	10.11	0.21	-0.67	664	10.5
MW-1013C	Jun-14	6.38	510	10.28	0.18	-0.75	569	9
MW-1014	Jun-14	5.97	140	8.32	0.14	-0.85	443	7
MW-1014A	Jun-14	6.42	430	7.4	0.14	-0.86	443	7
MW-1014B	Jun-14	6.21	480	9.68	0.25	-0.6	791	12.5
MW-1014C	Jun-14	6.5	270	35.7	0.11	-0.95	348	5.5
MW-1005P	Jun-14	7.05	230	8.84	0.02	-1.71	63	1
MW-1013	Jun-13	6.11	560	10.2	0.39	-0.41	1233	19.5
MW-1013A	Jun-13	6.64	320	11.9	0.07	-1.16	221	3.5
MW-1013B	Jun-13	6.18	510	11.5	0.28	-0.55	885	14
MW-1013C	Jun-13	6.39	530	14.1	0.19	-0.73	601	9.5
MW-1014	Jun-13	6.49	150	10.1	0.05	-1.33	158	2.5
MW-1014A	Jun-13	6.58	430	10.5	0.1	-1.01	316	5
MW-1014B	Jun-13	6.3	460	10.7	0.19	-0.72	601	9.5
MW-1014C	Jun-13	6.62	270	11.9	0.06	-1.21	190	3
MW-1005P	Jun-13	7.1	220	10.3	0.02	-1.77	63	1
MW-1013	Jun-12	6.1	610	10.8	0.45	-0.35	1413	15
MW-1013A	Jun-12	6.62	340	13.2	0.08	-1.1	251	2.7
MW-1013B	Jun-12	6.17	580	12.6	0.33	-0.48	1047	11
MW-1013C	Jun-12	6.38	560	13.7	0.2	-0.7	631	6.7
MW-1014	Jun-12	6.35	170	10.5	0.07	-1.13	234	2.3
MW-1014A	Jun-12	6.56	500	11.7	0.12	-0.91	389	4
MW-1014B	Jun-12	6.33	470	12	0.19	-0.72	603	6.3
MW-1014C	Jun-12	6.6	290	14.3	0.07	-1.15	224	2.3
MW-1005P	Jun-12	6.97	250	13.1	0.03	-1.57	85	1
MW-1013	Jul-11	6.1	660	15	0.5	-0.3	1593	16.7

Table 2 (continued)

Well	Sample Date (M-YY)	Alkalinity		Temperature	pCO ₂	Log10 pCO ₂	CO ₂ (g) Over-saturation ¹	CO ₂ (g) Over-saturation ²
		pH	(mg CaCO ₃ /L)	(°C)	(atm)	(atm)	(atm/atm)	(atm/atm)
MW-1013A	Jul-11	6.55	350	14.6	0.1	-1.01	307	3.3
MW-1013B	Jul-11	6.14	620	15.6	0.39	-0.41	1237	13
MW-1013C	Jul-11	6.38	520	16.4	0.19	-0.72	605	6.3
MW-1014	Jul-11	6.23	170	11.8	0.1	-1.02	304	3.3
MW-1014A	Jul-11	6.5	500	14.3	0.14	-0.84	455	4.7
MW-1014B	Jul-11	6.33	550	14.8	0.23	-0.64	721	7.7
MW-1014C	Jul-11	6.53	290	14.5	0.08	-1.08	264	2.7
MW-1005P	Jul-11	6.97	250	11.6	0.03	-1.58	84	1
MW-1013	Jun-10	6.18	590	11.2	0.36	-0.44	1139	18
MW-1013A	Jun-10	6.65	350	13.2	0.08	-1.12	241	4
MW-1013B	Jun-10	6.22	690	12.6	0.35	-0.46	1108	17.5
MW-1013C	Jun-10	6.37	620	14.1	0.23	-0.64	728	11.5
MW-1014	Jun-10	6.44	190	12.5	0.07	-1.17	216	3.5
MW-1014A	Jun-10	6.59	510	12.1	0.12	-0.93	370	6
MW-1014B	Jun-10	6.37	550	13.1	0.2	-0.69	645	10
MW-1014C	Jun-10	6.52	310	13.5	0.09	-1.04	287	4.5
MW-1005P	Jun-10	7.01	240	12.7	0.02	-1.62	75	1
MW-1013	Jun-09	6.11	580	11.3	0.084	-1.08	266	4.9
MW-1013A	Jun-09	6.61	320	12.8	0.22	-0.66	696	12.9
MW-1013B	Jun-09	6.17	580	12	0.13	-0.89	411	7.6
MW-1013C	Jun-09	6.35	550	14.2	0.3	-0.52	949	17.6
MW-1014	Jun-09	6.34	170	11.6	0.06	-1.22	190	3.5
MW-1014A	Jun-09	6.54	500	11	0.22	-0.66	696	12.9
MW-1014B	Jun-09	6.33	510	11.2	0.25	-0.6	791	14.7
MW-1014C	Jun-09	6.59	300	13.8	0.13	-0.89	411	7.6
MW-1005P	Jun-09	7.09	240	12.9	0.017	-1.77	54	1
MW-1013	Jun-08	6.2	470	11.9	0.2	-0.7	632	20
MW-1013A	Jun-08	6.6	340	12.6	0.045	-1.35	142	4.5
MW-1013B	Jun-08	6.2	550	12	0.22	-0.66	696	22
MW-1013C	Jun-08	6.4	480	14.3	0.07	-1.15	221	7
MW-1014	Jun-08	6.3	160	11.7	0.051	-1.29	161	5.1
MW-1014A	Jun-08	6.6	530	11.2	0.088	-1.06	278	8.8
MW-1014B	Jun-08	6.4	580	12.6	0.13	-0.89	411	13
MW-1014C	Jun-08	6.5	280	14.9	0.043	-1.37	136	4.3
MW-1005P	Jun-08	7.2	250	11.8	0.01	-2	32	1
MW-1013	Jun-07	6.1	610	11.4	0.23	-0.64	727	20.9
MW-1013A	Jun-07	6.6	360	13.2	0.047	-1.33	149	4.3
MW-1013B	Jun-07	6.2	620	12.4	0.18	-0.74	569	16.4
MW-1013C	Jun-07	6.4	590	14.2	0.11	-0.96	348	10
MW-1014	Jun-07	6.4	180	13.4	0.034	-1.47	108	3.1
MW-1014A	Jun-07	6.5	490	13.1	0.065	-1.19	206	5.9
MW-1014B	Jun-07	6.3	570	ND	0.12	-0.92	379	10.9
MW-1014C	Jun-07	6.6	360	16.5	0.057	-1.24	180	5.2
MW-1005P	Jun-07	7	260	12.1	0.011	-1.96	35	1
MW-1013	Jul-06	6.05	520	13	0.2	-0.7	632	12.5
MW-1013A	Jul-06	6.52	320	13.2	0.057	-1.24	180	3.6
MW-1013B	Jul-06	6.17	610	13.6	0.23	-0.64	727	14.4
MW-1013C	Jul-06	6.09	520	14.7	0.14	-0.85	443	8.8
MW-1014	Jul-06	6.54	170	12.1	0.04	-1.4	126	2.5
MW-1014A	Jul-06	6.62	450	12.8	0.088	-1.06	278	5.5
MW-1014B	Jul-06	6.41	520	13.7	0.17	-0.77	538	10.6
MW-1014C	Jul-06	6.55	350	13	0.072	-1.14	228	4.5
MW-1005P	Jul-06	6.59	240	14.7	0.016	-1.8	51	1
MW-1013B	Jul-05	6.4	640	15.8	0.31	-0.51	980	22.1
MW-1013C	Jul-05	6.6	510	14.1	0.14	-0.85	443	10
MW-1014A	Jul-05	6.8	500	14.1	0.11	-0.96	348	7.9
MW-1014B	Jul-05	6.5	570	15	0.26	-0.59	822	18.6
MW-1014C	Jul-05	6.9	350	15	0.092	-1.04	291	6.6
MW-1005P	Jul-05	7.4	240	13.3	0.014	-1.85	44	1

Table 2 (continued)

Well	Sample Date (M-YY)	pH	Alkalinity (mg CaCO ₃ /L)	Temperature (°C)	pCO ₂ (atm)	Log10 pCO ₂ (atm)	CO ₂ (g)	CO ₂ (g)
							Over-saturation ¹ (atm/atm)	Over-saturation ² (atm/atm)
MW-1013B	Jul-04	6.1	550	13.3	0.16	-0.8	506	16
MW-1013C	Jul-04	6.2	520	14.9	0.14	-0.85	443	14
MW-1014A	Jul-04	6.7	440	17.1	0.073	-1.14	231	7.3
MW-1014B	Jul-04	6.3	450	14.3	0.23	-0.64	727	23
MW-1014C	Jul-04	6.4	300	15.5	0.094	-1.03	297	9.4
MW-1005P	Jul-04	7	240	11.4	0.01	-2	32	1
MW-1013B	Jul-03	6.25	620	14.9	0.16	-0.8	506	16
MW-1013C	Jul-03	6.32	500	14.6	0.14	-0.85	443	14
MW-1014A	Jul-03	6.62	420	13.6	0.073	-1.14	231	7.3
MW-1014B	Jul-03	6.28	530	12.6	0.23	-0.64	727	23
MW-1014C	Jul-03	6.43	340	13	0.094	-1.03	297	9.4
MW-1005P	Jul-03	7.11	240	13.4	0.01	-2	32	1
MW-1013B	Jul-02	6.37	690	16.1	0.11	-0.96	348	11
MW-1013C	Jul-02	6.43	520	16.5	0.079	-1.1	250	7.9
MW-1014A	Jul-02	6.49	460	15.1	0.056	-1.25	177	5.6
MW-1014B	Jul-02	6.25	550	14.1	0.1	-1	316	10
MW-1014C	Jul-02	6.6	350	17.2	0.053	-1.28	168	5.3
MW-1005P	Jul-02	7.19	250	13.6	0.01	-2	32	1
MW-1013B	Apr-01	6	530	14	0.14	-0.85	443	17.5
MW-1013C	Apr-01	6.3	440	13.8	0.092	-1.04	291	11.5
MW-1014A	Apr-01	6.3	430	12.1	0.063	-1.2	199	7.9
MW-1014B	Apr-01	6.1	520	13.5	0.17	-0.77	538	21.3
MW-1014C	Apr-01	6.2	330	12.8	0.077	-1.11	243	9.6
MW-1005P	Apr-01	6.7	240	12.8	0.008	-2.1	25	1
MW-1013B	Apr-00	6.63	520	8.7	0.14	-0.85	443	10.8
MW-1013C	Apr-00	6.73	460	8.5	0.1	-1	316	7.7
MW-1014A	Apr-00	6.87	390	11.2	0.055	-1.26	174	4.2
MW-1014B	Apr-00	6.43	480	14.2	0.21	-0.68	664	16.2
MW-1014C	Apr-00	6.65	320	11.9	0.071	-1.15	225	5.5
MW-1005P	Apr-00	7.27	250	6.4	0.013	-1.89	41	1

Notes:

¹ Oversaturation relative to atmospheric CO₂(g) at 10^{-3.5} atm² Multiple of CO₂(g) for background well MW-1005P

Pre-2014 values are as reported in Interralagic (2014).

2014 and 2015 values are as reported in Golder (2016).

Abbreviations:

°C = degrees Celsius

atm = atmosphere

atm/atm = atmosphere per atmosphere

mg/L as CaCO₃ = milligrams per liter as calcium carbonate

Prepared by: HLH

Checked by: ASHI

Table 3
Charge Balances of June 2017 Annual Samples Calculated in PHREEQC

Sample	Charge Balance (%) ¹
MW-1005P	2.41
MW-1013	2.72
MW-1013A	-3.14
MW-1013B	-6.57
MW-1013C	-3.67
MW-1014	-0.65
MW-1014A	-5.89
MW-1014B	-4.49
MW-1014C	2.13

Prepared by: ASH1
Checked by: HLH

Note:
¹ Charge balance = 100 * (Cations - |Anions|) / (Cations + |Anions|)
Abbreviations:
% = percent

Table 4
Saturation Indices for Secondary Minerals Determined with PHREEQC

Date (M-YY)	Monitoring Well	T (°C)	pH	pE	Calcite/Aragonite	Gypsum	Ferrihydrite	Siderite	Rhodochrosite
June-17	MW-1013	8.8	6.02	0.6471	-0.76/-0.92	-2.07	-4.46	-0.56	0.84
June-17	MW-1013A	10.1	6.42	1.69033	-0.66/-0.82	-1.2	-3.74	-1.88	0.28
June-17	MW-1013B	11.1	6.17	1.95013	-0.27/-0.43	-0.01	-4.41	-2.17	0.85
June-17	MW-1013C	10.1	6.37	0.77739	-0.17/-0.33	-0.02	-2.58	0.35	0.49
June-17	MW-1014	8.4	6.82	1.73072	-0.71/-0.87	-1.43	-2.43	-1.73	0.06
June-17	MW-1014A	8.9	6.78	2.00979	0.08/-0.08	-0.32	-2.51	-1.59	-1.08
June-17	MW-1014B	9.2	6.62	2.28638	0.10/-0.06	-0.07	-2.75	-1.77	0.85
June-17	MW-1014C	9.3	7.28	0.7475	0.20/0.05	-1.05	-0.17	0.80	0.63
June-17	MW-1005P	9.6	7.03	0.05703	-0.42/-0.57	-3.94	-2.01	0.13	-0.97
June-16	MW-1013	9.2	6.11	0.9	-0.67/-0.82	-2.06	-4.00	-0.54	0.89
June-16	MW-1013A	6.6	6.58	0.7	-0.52/-0.67	-1.18	-3.63	-1.14	0.4
June-16	MW-1013B	9.7	6.16	2.4	-0.29/-0.44	-0.03	-4.09	-2.28	0.79
June-16	MW-1013C	10.1	6.41	0.9	-0.11/-0.27	-0.07	-2.42	0.38	0.52
June-16	MW-1014	8.4	6.28	2.2	-1.28/-1.44	-1.52	-4.34	-3.01	-0.53
June-16	MW-1014A	8.9	6.51	2.2	-0.20/-0.36	-0.37	-3.75	-2.50	-1.32
June-16	MW-1014B	8.8	6.38	2.3	-0.21/-0.37	-0.15	-4.15	-2.77	0.48
June-16	MW-1014C	9.5	6.58	0.7	-0.53/-0.69	-1.08	-2.26	0.10	-0.11
June-16	MW-1005P	9.8	7.08	0.5	-0.40/-0.55	-3.35	-1.63	-0.10	-0.92
June-15	MW-1013	11.3	6.09	1.3	-0.61/-0.76	-2.02	-3.61	-0.52	0.97
June-15	MW-1013A	9.4	6.56	1.5	-0.55/-0.70	-1.19	-3.63	-1.85	0.41
June-15	MW-1013B	9.6	6.2	2.2	-0.20/-0.36	-0.03	-3.91	-1.94	0.94
June-15	MW-1013C	9.6	6.38	1	-0.12/-0.27	-0.04	-2.32	0.38	0.57
June-15	MW-1014	11.2	6.4	2.3	-1.10/-1.26	-1.45	-3.59	-2.55	-0.24
June-15	MW-1014A	9.5	6.51	2.5	-0.20/-0.35	-0.35	-2.57	-1.65	-1.52
June-15	MW-1014B	9	6.28	2.7	-0.26/-0.42	-0.11	-3.18	-1.92	0.51
June-15	MW-1014C	9.8	6.57	0.5	-0.53/-0.69	-1.1	-2.48	0.12	-0.05
June-15	MW-1005P	9.5	7.09	0.6	-0.41/-0.56	-3.26	-1.46	0.03	-0.88
June-14	MW-1013	9.3	6.13	0.6	-0.60/-0.75	-1.93	-3.76	0	0.96
June-14	MW-1013A	10.6	6.58	0.7	-0.48/-0.63	-1.15	-4.16	-1.62	0.28
June-14	MW-1013B	10.1	6.31	5.1	-0.14/-0.30	-0.01	-0.48	-1.74	1.04
June-14	MW-1013C	10.3	6.38	2.8	-0.11/-0.26	-0.03	-0.55	0.39	0.54
June-14	MW-1014	8.3	5.97	2.2	-1.66/-1.82	-1.57	-4.97	-3.11	-0.79
June-14	MW-1014A	7.4	6.42	2.2	-0.37/-0.53	-0.37	-3.96	-2.49	-1.89
June-14	MW-1014B	9.7	6.21	2.2	-0.35/-0.50	-0.13	-4.52	-2.67	0.37
June-14	MW-1014C	35.7	6.5	0.6	-0.25/-0.38	-1.16	-2.01	0.44	0.19
June-14	MW-1005P	8.8	7.05	-0.6	-0.45/-0.61	-3.24	-2.83	-0.12	-0.8
June-13	MW-1013	10.2	6.11	0.8	-0.63/-0.79	-2	-3.11	0.42	0.92
June-13	MW-1013A	11.9	6.64	0.8	-0.43/-0.58	-1.14	-3.64	-1.43	0.35
June-13	MW-1013B	11.5	6.18	1.7	-0.27/-0.43	-0.02	-4.51	-2.09	0.62
June-13	MW-1013C	14.1	6.39	1.6	-0.04/-0.19	-0.06	-1.58	0.51	0.62
June-13	MW-1014	10.1	6.49	1	-1.06/-1.21	-1.51	-4.69	-2.65	-0.19
June-13	MW-1014A	10.5	6.58	1.4	-0.16/-0.32	-0.36	-4.25	-2.4	-2.04
June-13	MW-1014B	10.7	6.3	1.6	-0.26/-0.41	-0.12	-4.21	-2	0.57
June-13	MW-1014C	11.9	6.62	1.1	-0.43/-0.58	-1.08	-1.73	0.22	0.03
June-13	MW-1005P	10.3	7.1	1.7	-1.77/-0.39	-3.16	-1.15	-0.81	-0.7
June-12	MW-1013	10.8	6.1	2.5	-0.63/-0.79	-1.9	-2.05	-0.2	0.87
June-12	MW-1013A	13.2	6.62	3	-0.43/-0.58	-1.22	-1.86	-1.79	0.42
June-12	MW-1013B	12.6	6.17	6.1	-0.22/-0.38	-0.03	-0.8	-2.75	0.94
June-12	MW-1013C	13.7	6.38	0.7	-0.04/-0.2	-0.09	-2.65	0.38	0.63
June-12	MW-1014	10.5	6.35	5.3	-1.16/-1.32	-1.5	-0.84	-2.75	-0.48
June-12	MW-1014A	11.7	6.56	5.1	-0.11/-0.26	-0.44	-0.3	-2.04	-0.61
June-12	MW-1014B	12	6.33	2.6	-0.22/-0.37	-0.16	-3.83	-2.62	0.56
June-12	MW-1014C	14.3	6.6	1	-0.41/-0.56	-1.11	-1.86	0.22	0.09
June-12	MW-1005P	13.1	6.97	-0.7	-0.44/-0.6	-3.26	-2.89	0.06	-0.96
July-11	MW-1013	15	6.1	1.7	-0.52/-0.67	-1.85	-2.94	-0.24	0.97
July-11	MW-1013A	14.6	6.55	1.8	-0.45/-0.61	-1.32	-2.6	-1.18	0.3
July-11	MW-1013B	15.6	6.14	4.3	-0.18/-0.33	-0.04	-1.59	-1.65	0.99

Table 4 (continued)

Date (M-YY)	Monitoring Well	T (°C)	pH	pE	Calcite/Aragonite	Gypsum	Ferrihydrite	Siderite	Rhodochrosite
July-11	MW-1013C	16.4	6.38	0.8	-0.02/-0.17	-0.06	-2.48	0.43	0.63
July-11	MW-1014	11.8	6.23	2.9	-1.27/-1.42	-1.5	-3.06	-2.33	-0.5
July-11	MW-1014A	14.3	6.5	2.8	-0.14/-0.29	-0.4	-2.14	-1.47	-1.11
July-11	MW-1014B	14.8	6.33	2.9	-0.11/-0.27	-0.17	-2.5	-1.6	0.65
July-11	MW-1014C	14.5	6.53	1	-0.48/-0.63	-1.09	-1.98	0.18	-0.03
July-11	MW-1005P	11.6	6.97	-0.2	-0.47/-0.63	-3.27	-2.45	0.03	-0.94
June-10	MW-1013	11.2	6.2	1.7	-0.56/-0.71	-1.78	-2.84	-0.32	0.97
June-10	MW-1013A	13.2	6.7	1.8	-0.41/-0.57	-1.29	-2.69	-1.43	0.33
June-10	MW-1013B	12.6	6.2	4.3	-0.08/-0.23	-0.11	-1.93	-2.06	1.1
June-10	MW-1013C	14.1	6.4	0.8	-0.03/-0.18	-0.08	-2.7	0.33	0.64
June-10	MW-1014	12.5	6.4	2.9	-1.01/-1.17	-1.45	-2.39	-2.03	-1.3
June-10	MW-1014A	12.1	6.6	2.8	-0.07/-0.22	-0.37	-2.27	-1.75	-1.04
June-10	MW-1014B	13.1	6.4	2.9	-0.06/-0.21	-0.24	-2.78	-1.94	0.73
June-10	MW-1014C	13.5	6.5	1	-0.5/-0.65	-1.14	-2.06	0.15	-0.02
June-10	MW-1005P	12.7	7	-0.2	-0.5/-0.66	-3.32	-3.11	-0.72	-1.06
June-09	MW-1013	11.3	6.1	1.5	-0.67/-0.83	-1.73	-2.93	0.21	0.85
June-09	MW-1013A	12.8	6.6	1.6	-0.48/-0.63	-1.19	-3.3	0.15	0.25
June-09	MW-1013B	10.7	6.2	3.8	-0.21/-0.37	-0.04	-2.85	-0.04	0.73
June-09	MW-1013C	12.6	6.4	0.6	-0.09/-0.25	-0.05	-2.77	-1.78	0.6
June-09	MW-1014	11.6	6.3	3	-1.22/-1.38	-1.37	-3.04	-2.32	-1.13
June-09	MW-1014A	11	6.3	2.9	-0.41/-0.56	-0.4	-2.74	0.31	-1.15
June-09	MW-1014B	11.2	6.3	3.6	-0.21/-0.36	-0.14	-2.72	-2.4	0.63
June-09	MW-1014C	11.2	6.6	0.9	-0.45/-0.61	-1.01	-2	-1.66	0.01
June-09	MW-1005P	12.9	7.1	-0.1	-0.37/-0.52	-3.3	-1.99	-2.26	-0.85
June-08	MW-1013	11.9	6.2	1.5	-0.5/-0.65	-1.64	-2.4	0.45	1.04
June-08	MW-1013A	12.6	6.6	1.6	-0.14/-0.3	-1	-1.8	0.35	0.61
June-08	MW-1013B	12	6.2	3.7	-0.08/-0.23	-0.02	-1.38	-0.04	0.89
June-08	MW-1013C	14.3	6.4	0.6	0.32/0.17	-0.03	-1.52	-0.69	0.99
June-08	MW-1014	11.7	6.3	2.8	-1.06/-1.21	-1.41	-3.43	-1.2	-0.59
June-08	MW-1014A	11.2	6.6	2.8	0.09/-0.07	-0.39	-1.04	0.71	0.4
June-08	MW-1014B	12.6	6.4	3.4	0.05/-0.10	-0.14	-1.2	-3.1	0.89
June-08	MW-1014C	14.9	6.5	0.9	-0.23/-0.38	-1.07	-1.38	-0.78	0.25
June-08	MW-1005P	11.8	7.2	-0.1	-0.1/-0.26	-3.27	-1.38	-1.03	-0.59
June-07	MW-1013	11.4	6.1	1.5	-0.65/-0.81	-1.64	-2.71	0.2	0.88
June-07	MW-1013A	13.2	6.6	1.8	-0.5/-0.65	-1.28	-2.47	-1.06	-0.05
June-07	MW-1013B	12.4	6.2	3.8	-0.2/-0.35	-0.02	-1.82	-1.49	0.76
June-07	MW-1013C	14.2	6.4	1.3	-0.05/-0.21	-0.02	-2.13	0.36	0.61
June-07	MW-1014	13.4	6.4	3.3	-1.07/-1.23	-1.32	-1.43	-1.47	-1.05
June-07	MW-1014A	13.1	6.5	3.2	-0.19/-0.35	-0.35	-1.45	-1.2	-0.47
June-07	MW-1014B	NA	6.3	3.5	-0.18/-0.34	-0.11	-1.83	-1.4	0.67
June-07	MW-1014C	16.5	6.6	0.9	-0.35/-0.51	-0.96	-1.97	0.31	0.11
June-07	MW-1005P	12.1	7	0.1	-0.45/-0.6	-4.25	2.49	-0.68	-0.93
July-06	MW-1013	13	6.4	2.9	-0.36/-0.51	-1.69	-0.74	0.07	1.13
July-06	MW-1013A	13.2	6.7	2.7	-0.39/-0.54	-1.17	-1.03	-0.8	0.18
July-06	MW-1013B	13.6	6.4	4.2	0.00/-0.15	-0.04	-0.72	-1.12	1.2
July-06	MW-1013C	14.7	6.7	0.9	0.25/0.10	-0.05	-1.69	0.05	0.92
July-06	MW-1014	12.1	6.6	2.9	-0.89/-1.04	-1.32	-1.02	-1.11	-0.37
July-06	MW-1014A	12.8	6.7	3.2	-0.05/-0.2	-0.38	-0.8	-0.88	0.03
July-06	MW-1014B	13.7	6.4	3.8	-0.1/-0.25	-0.16	-0.97	-1.09	0.75
July-06	MW-1014C	13	6.6	1.1	-0.31/-0.46	-1.01	-1.63	0.39	0.18
July-06	MW-1005P	14.7	7.1	0	-0.35/-0.5	-3.3	-2.1	-0.12	-0.7
July-05	MW-1013B	15.8	6.4	4	0.04/-0.11	0.01	-0.76	-1.11	1.24
July-05	MW-1013C	14.1	6.6	0.3	0.08/-0.07	-0.01	-2.47	0.4	0.79
July-05	MW-1014A	14.1	6.8	4.7	0.11/-0.05	-0.35	1.18	-0.76	0.16
July-05	MW-1014B	15	6.5	5.2	0.05/-0.10	-0.06	0.77	-1.05	0.95
July-05	MW-1014C	15	6.9	1	-0.04/-0.19	-0.9	-0.76	0.69	0.46
July-05	MW-1005P	13.3	7.4	-0.02	-0.08/-0.23	-3.23	-1.8	-0.47	-0.53
July-04	MW-1013B	13.3	6.3	3.2	-0.06/-0.21	-0.03	-1.77	-1.18	0.96
July-04	MW-1013C	14.9	6.5	0.8	0.09/-0.06	-0.11	-2.35	0.35	0.76
July-04	MW-1014A	17.1	6.7	2.9	0.04/-0.11	0.39	-0.8	-0.69	0.27
July-04	MW-1014B	14.3	6.4	3.2	-0.11/-0.26	-0.15	-1.52	-1.15	0.79

Table 4 (continued)

Date (M-YY)	Monitoring Well	T (°C)	pH	pE	Calcite/Aragonite	Gypsum	Ferrihydrite	Siderite	Rhodochrosite
July-04	MW-1014C	15.5	6.6	0.5	-0.32/-0.47	-0.92	-2.13	0.42	0.2
July-04	MW-1005P	11.4	7.2	-0.1	-0.25/-0.4	-3.25	-2.11	-0.21	-0.63
July-03	MW-1013B	14.9	6.8	3.5	0.49/0.34	-0.02	0.18	-0.4	1.67
July-03	MW-1013C	14.6	6.5	0.5	0.06/-0.09	-0.03	-2.9	0.07	0.71
July-03	MW-1014A	12	6.6	3.5	-0.1/-0.26	-0.34	-0.46	-0.75	0.53
July-03	MW-1014B	12.6	6.2	4.2	-0.3/-0.45	-0.11	-1.23	-1.4	0.63
July-03	MW-1014C	13	6.6	0.7	-0.26/-0.41	-0.83	-1.94	0.48	0.25
July-03	MW-1005P	13.4	7	-0.1	-0.41/-0.56	-3.25	-2.24	0.02	-0.88
July-02	MW-1013B	16.1	6.4	3.5	0.14/-0.01	-0.08	-1	-0.7	1.32
July-02	MW-1013C	16.5	6.4	0.9	0.05/-0.10	-0.08	-2.68	0.04	0.71
July-02	MW-1014A	15.1	6.5	3.1	-0.07/-0.22	-0.37	-1.2	-0.86	0.6
July-02	MW-1014B	14.1	6.3	4.3	-0.16/-0.31	-0.1	-1.27	-1.59	0.8
July-02	MW-1014C	17.2	6.6	0.8	-0.17/-0.32	-0.84	-1.71	0.61	0.34
July-02	MW-1005P	13.6	7.2	0.5	-0.23/-0.38	-2.97	-2.12	-0.74	-0.71
October-01	MW-1013B	14.4	6.1	3.4	-0.3/-0.45	-0.04	-1.99	-1.1	0.9
October-01	MW-1013C	12.6	6.2	0.4	-0.33/-0.48	-0.05	-4.11	-0.47	0.32
October-01	MW-1014A	14.3	6.3	2.6	-0.38/-0.53	-0.36	-1.76	-0.56	0.33
October-01	MW-1014B	13.4	6.1	3.7	-0.4/-0.55	-0.08	-2.35	-1.178	0.59
October-01	MW-1014C	12.2	6.2	0.9	-0.68/-0.83	-0.75	-2.91	0.13	-0.1
July-01	MW-1005P ⁵	9.9	6.6	0.1	-0.86/-1.01	-2.98	-3.52	-0.59	-1.28
April-01	MW-1013B ¹	8.7	6.6	4.1	0.24/0.08	-0.03	-0.23	-1.01	1.36
April-01	MW-1013C ²	8.5	6.7	3.1	0.15/0.00	-0.01	-0.08	-0.25	0.73
April-01	MW-1014A	11.2	6.9	2.9	0.13/-0.02	-0.36	-0.23	-0.49	0.91
April-01	MW-1014B ³	14.2	6.4	5.1	-0.02/-0.17	-0.07	-0.34	-1.16	0.99
April-01	MW-1014C	11.9	6.7	1.6	-0.02/0.17	-0.64	-0.82	0.76	0.49
April-01	MW-1005P ⁴	15.9	6.9	1.1	-0.37/-0.52	-2.83	-2.66	-1.24	-1

Notes:

¹ April 2000 data with sulfate adjusted upwards to 1500 mg/L to improve ion balance.

² April 2000 data with calcium adjusted upwards to 290 mg/L to improve ion balance.

³ In the April 2000 data, the iron detection limit was anomalously high (0.15 mg/L). In the PHREEQC runs, the iron concentration was set to 0.06 mg/L, as measured in other samples from this well.

⁴ Combination of analytical data from the July 1999 sample with Eh and alkalinity data from the April 2000 sample.

⁵ July 2001 data

Pre-2014 values are as reported in Interrallogic (2014).

2014 and 2015 values are as reported in Golder (2016)

Mineral formulas: Calcite – CaCO₃; Aragonite – CaCO₃; Gypsum – CaSO₄·2H₂O; Ferrihydrite – Fe(OH)₃(am); Siderite – FeCO₃; Rhodochrosite – MnCO₃

Abbreviations

°C = degrees Celcius

mg/L = milligrams per liter

T = temperature

Prepared by: HLH

Checked by: ASH1

Table 5
Summary of Annual Average¹ Dissolved Manganese and Iron Concentrations in the Backfilled Pit Area

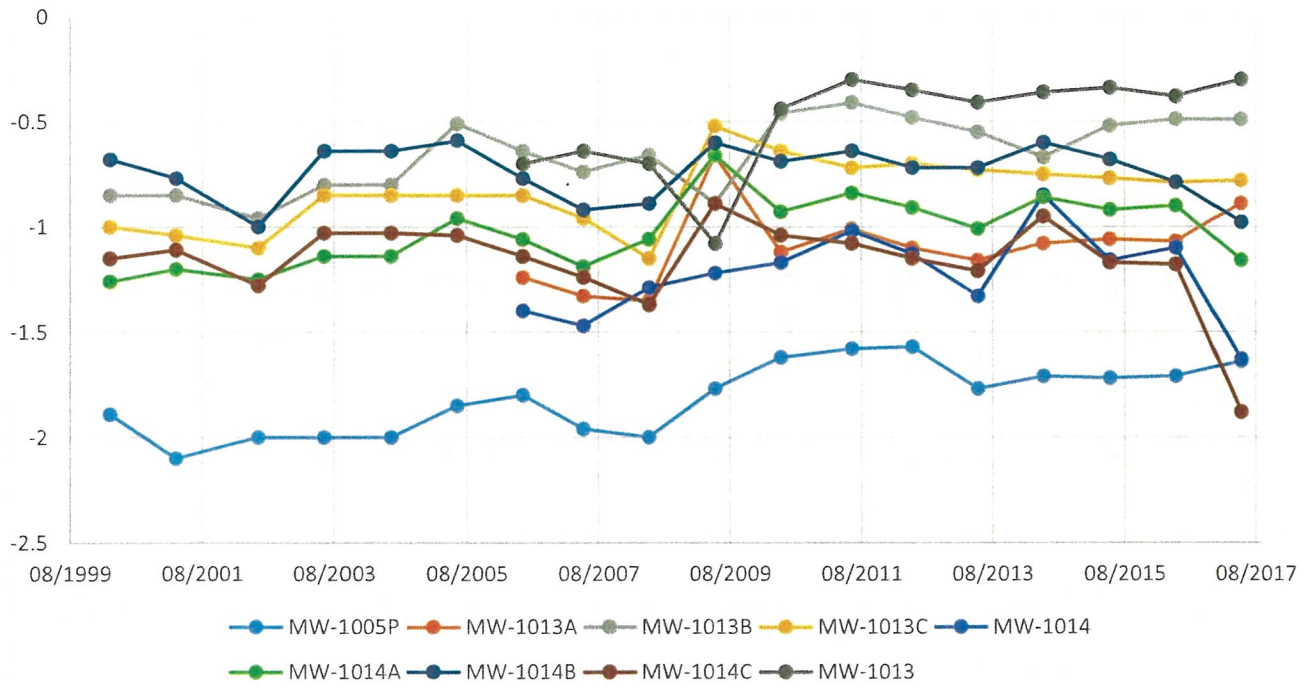
Year	Manganese (µg/L)										Iron (mg/L)									
	MW-1005P	MW-1013	MW-1013A	MW-1013B	MW-1013C	MW-1014	MW-1014A	MW-1014B	MW-1014C	MW-1014D	MW-1005P	MW-1013	MW-1013A	MW-1013B	MW-1013C	MW-1014	MW-1014A	MW-1014B	MW-1014C	MW-1014D
1999	47.25	-	-	28,000	7,450	-	-	23,000	-	-	0.28	-	-	0.33	1.12	-	-	0.04	-	-
2000	60	-	-	32,750	7,925	-	-	21,000	-	-	0.17	-	-	0.47	1.73	-	-	0.23	-	-
2001	41.75	-	-	36,000	8,600	-	-	18,750	-	-	0.1	-	-	0.67	2.65	-	-	0.93	-	-
2002	43.75	-	-	36,250	9,400	-	-	17,750	-	-	0.13	-	-	0.48	4.48	-	-	0.52	-	-
2003	77.25	-	-	32,500	9,625	-	-	17,750	-	-	0.84	-	-	0.56	5.13	-	-	0.54	-	-
2004	60.75	-	-	32,500	9,650	-	-	16,360	-	-	0.35	-	-	0.65	6.25	-	-	0.4	-	-
2005	56.5	-	-	33,750	10,375	-	-	16,000	-	-	0.29	-	-	0.33	8.05	-	-	0.33	-	-
2006	60	21,750	2,725	26,500	10,375	1,030	-	13,750	1,030	-	0.33	0.33	0.3	8.15	0.33	0.33	0.41	0.33	0.33	6.15
2007	62.25	23,750	1,800	26,500	10,750	700	-	14,000	700	-	0.3	0.33	0.33	9.88	0.26	0.33	0.38	0.33	0.33	5.93
2008	65.25	23,250	2,775	28,000	10,250	550	-	13,750	550	-	0.91	0.33	0.33	9.53	0.25	0.33	0.33	0.33	0.33	5.48
2009	67.25	23,000	1,790	22,000	9,725	295	-	12,500	295	-	0.8	0.11	0.11	9.85	0.1	0.14	0.1	0.1	0.1	4.85
2010	63	23,500	2,875	30,750	10,025	238	-	12,500	238	-	0.95	0.18	0.16	10.38	0.16	0.15	0.15	0.15	0.15	4.9
2011	63.5	24,250	3,125	33,500	9,825	1,965	-	11,250	1,965	-	1.25	0.14	0.08	11	0.28	0.05	0.05	0.05	0.05	4.85
2012	62	22,250	2,975	32,500	9,475	1,025	-	10,500	1,025	-	1.33	0.08	0.02	12.25	0.01	0.02	0.01	0.01	0.01	4.8
2013	80.25	26,500	3,000	31,000	9,675	1,110	-	11,750	1,110	-	1.33	0.12	0.06	13.25	0.02	0.01	0.02	0.02	0.02	4.85
2014	66.5	26,250	3,025	36,750	9,775	1,400	-	11,250	1,400	-	1.07	0.07	0.08	13.75	0.04	0.02	0.02	0.02	0.02	5
2015	81.9	27,050	4,033	30,900	10,075	986	-	11,243	986	-	1.07	0.06	0.07	13.68	0.02	0.04	0.04	0.04	0.04	4.84
2016	67.53	26,675	4,490	30,900	9,270	1,460	-	10,468	1,460	-	1.08	0.18	0.05	13.88	0.01	0.01	0.01	0.01	0.01	4.76
2017	75.30	27,000	3,908	29,025	9,633	1,794	-	11,000	1,794	-	1.32	0.10	0.08	13.40	0.05	0.08	0.08	0.08	0.08	4.59

Notes:
 1. Annual averages are calculated from four quarterly samples
 2. Pre-2014 values are as reported in Interlogie (2014).
 3. 2014 and 2015 values are as reported in Golder (2016).
 3. Non-detects have been replaced at the detection limit and values falling between the DL and PQL have been calculated at the given values
 Abbreviations:
 µg/L = micrograms per liter
 mg/L = milligrams per liter

Prepared by: ILLI
 Checked by: ASHI

Figures

Log 10 PCO2



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Figure A-1

Calculated Log 10 PCO2 for Wells in Backfilled Pit Area

Scale: NA

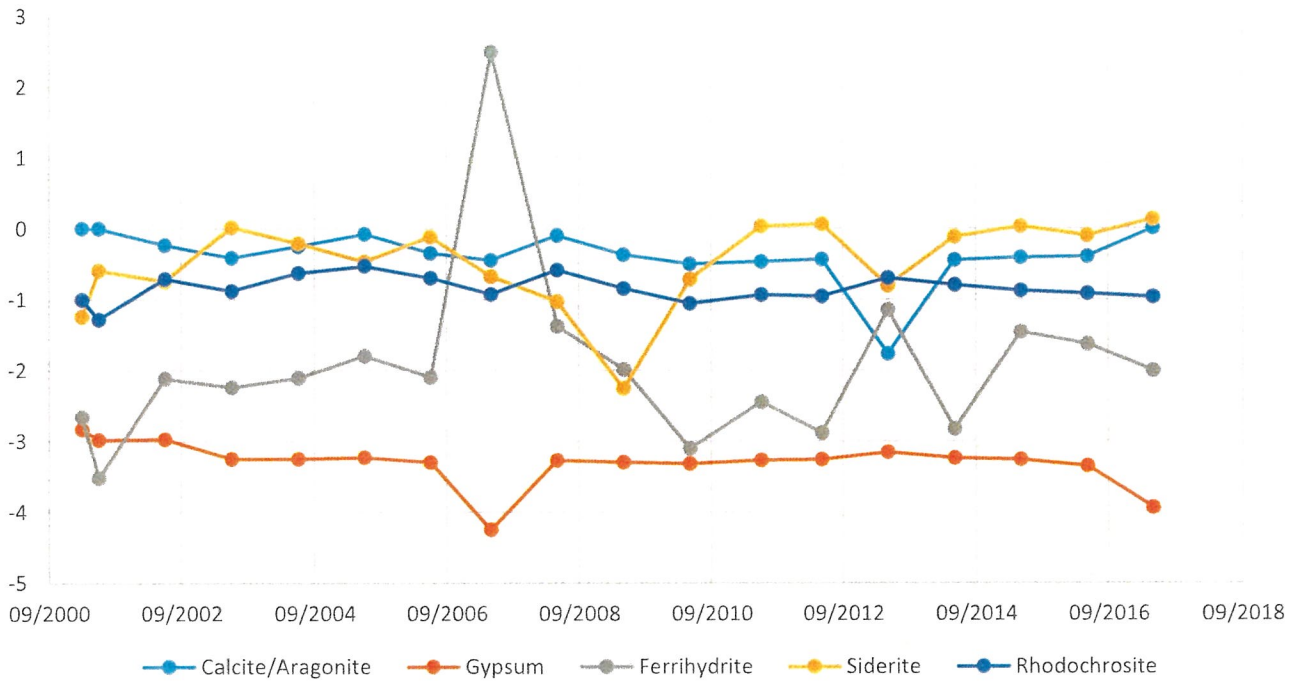
Date: January 2017

Prepared By: HLH

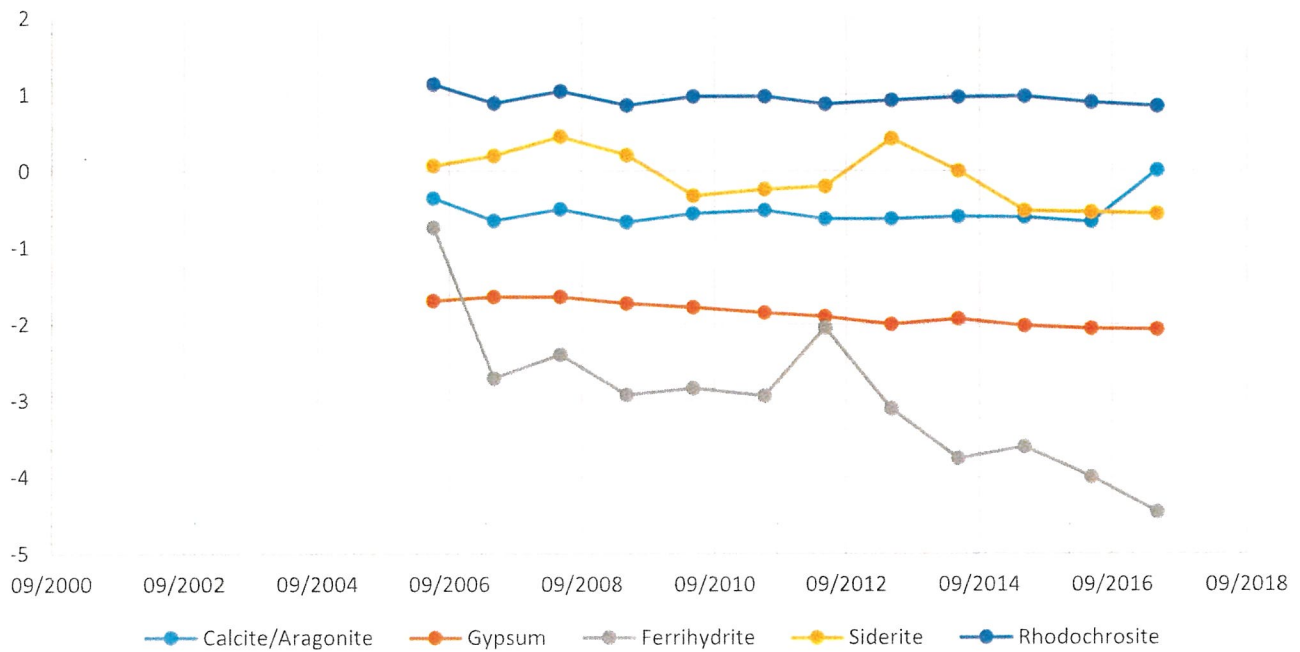
Checked By: SVF

Scope: 17F777-00

MW-1005P



MW-1013



FLAMBEAU MINING COMPANY

Figure A-2

Calculated Saturation Indices for Wells in Backfilled Pit Area
MW-1005P, MW-1013

Scale: NA

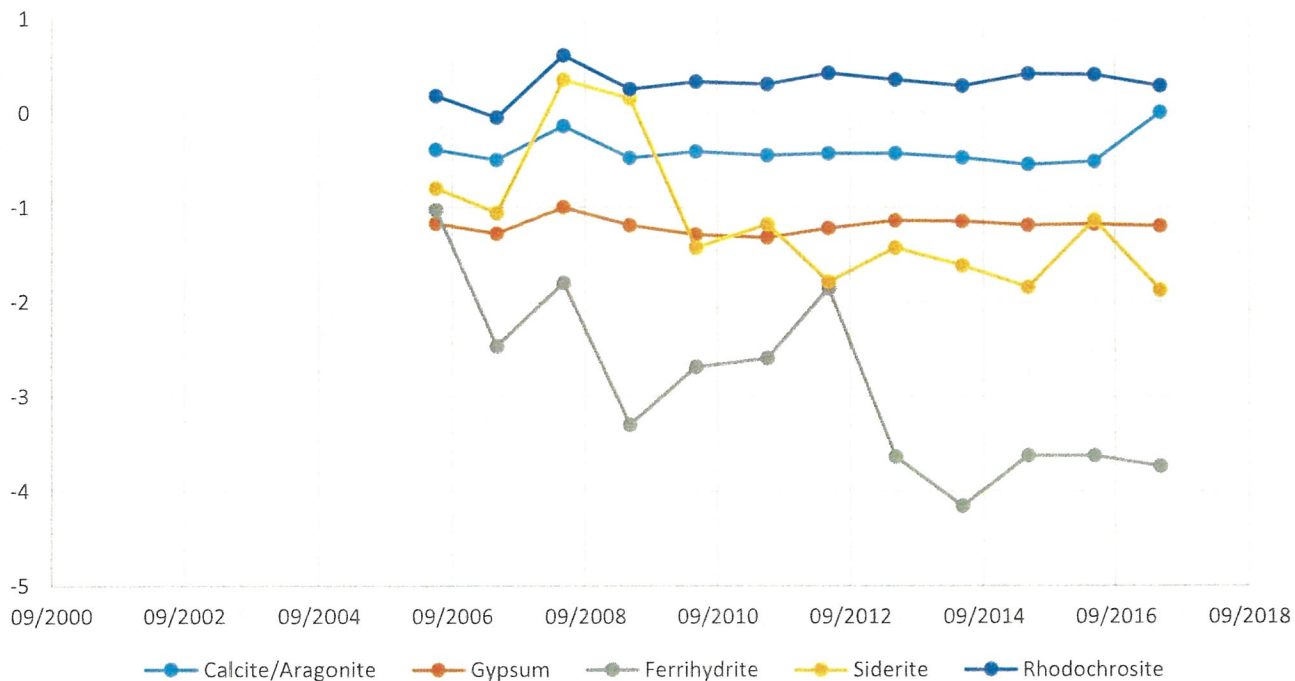
Date: January 2017

Prepared By: HLH

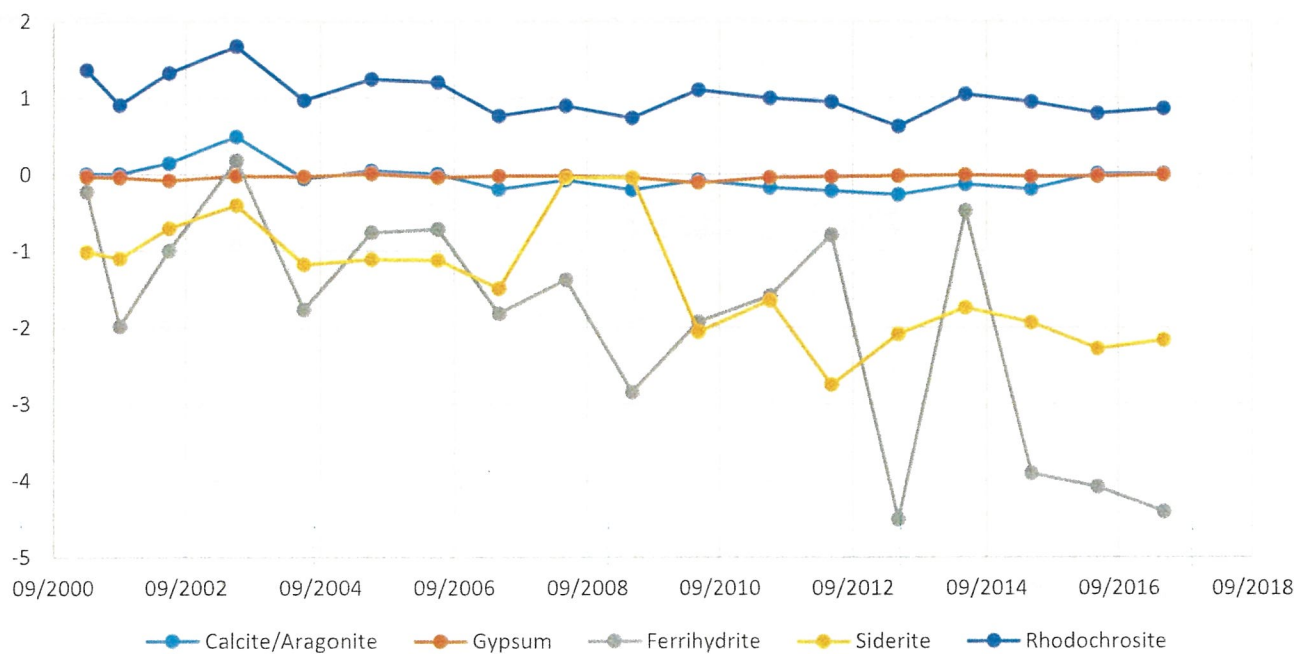
Checked By: SVF

Scope: 17F777-00

MW-1013A



MW-1013B



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Figure A-3

Calculated Saturation Indices for Wells in Backfilled Pit Area
MW-1013A, MW-1013B

Scale: NA

Date: January 2017

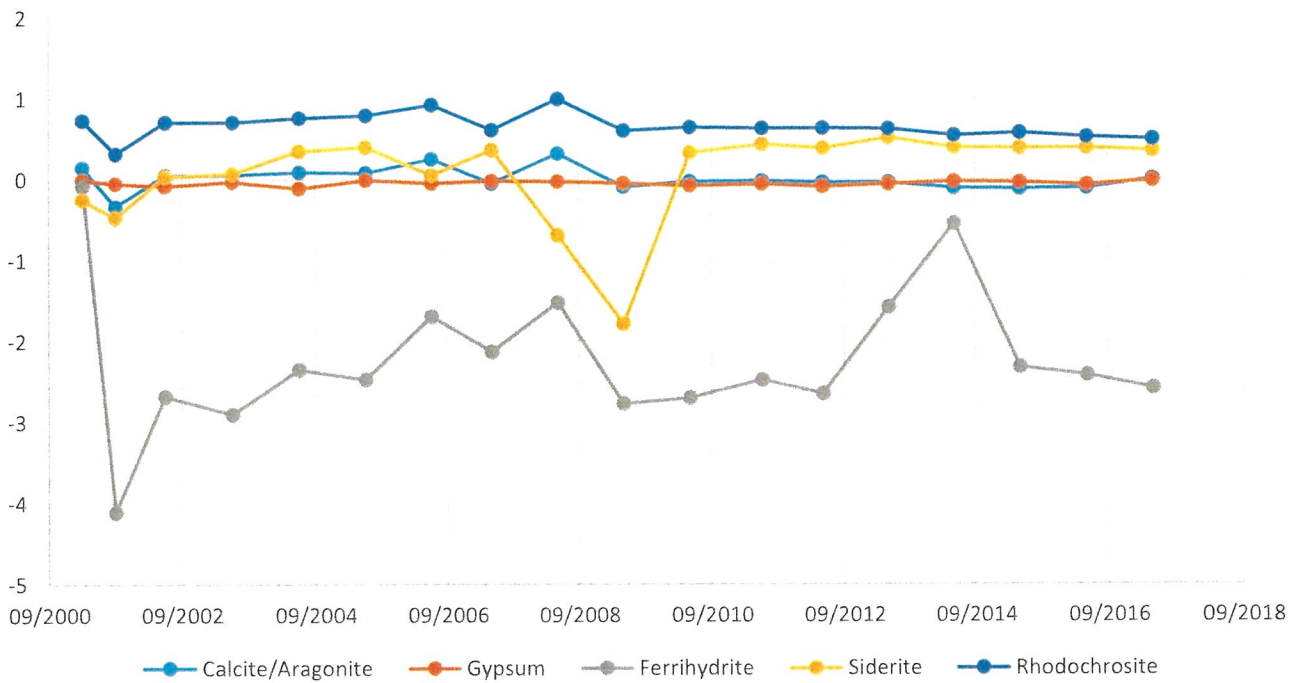
Prepared By: HLH

Checked By: SVF

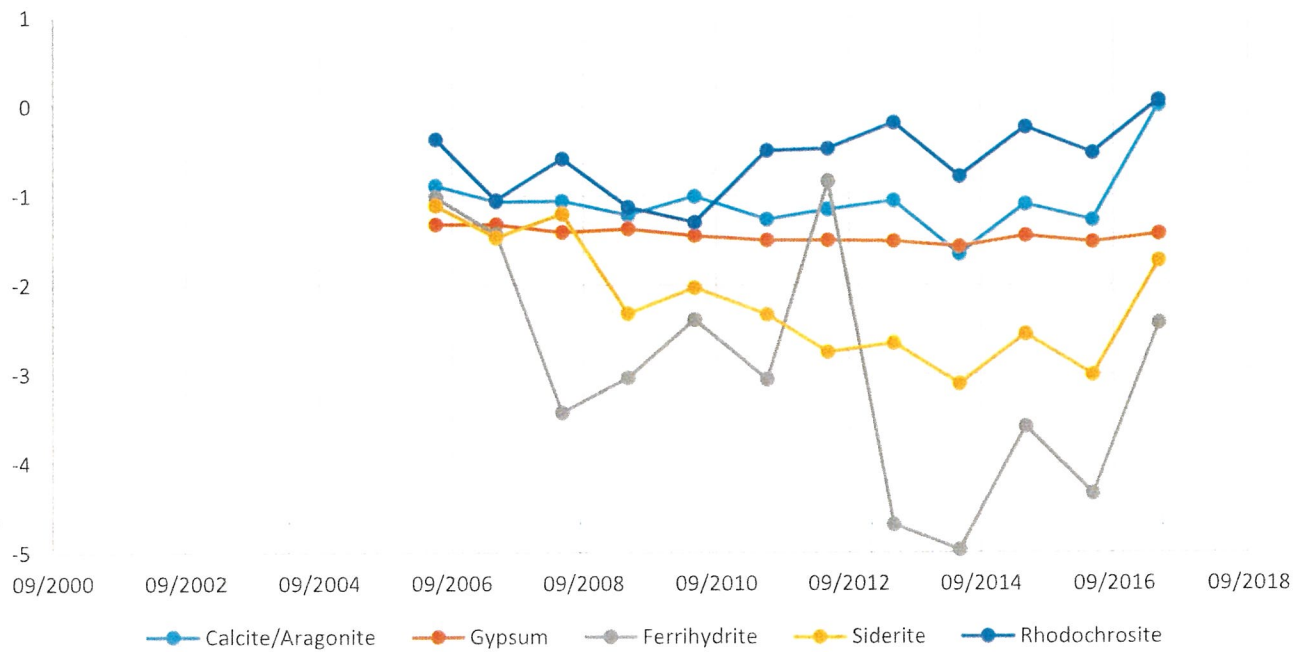
Scope: 17F777-00

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MW-1013C



MW-1014



FORTH INFRASTRUCTURE & ENVIRONMENTAL, L.L.C.

FLAMBEAU MINING COMPANY

Figure A-4

Calculated Saturation Indices for Wells in Backfilled Pit Area
MW-1013C, MW-1014

Scale: NA

Date: January 2017

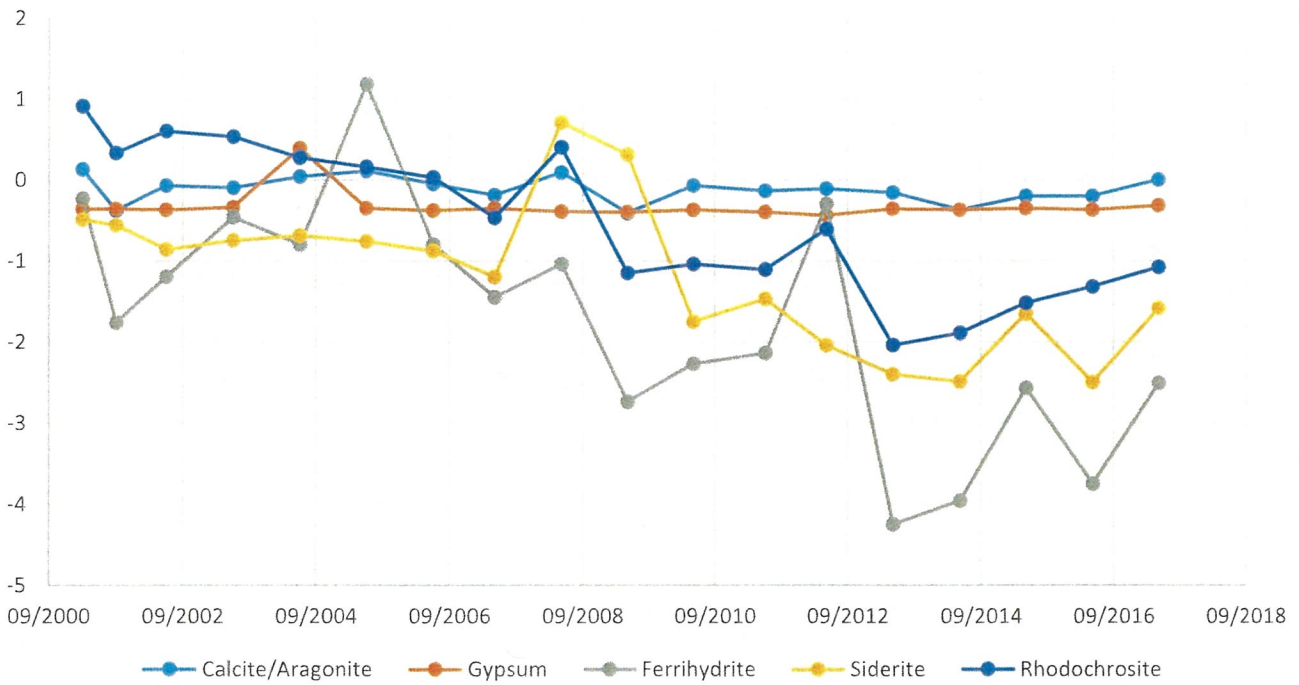
Prepared By: HLH

Checked By: SVF

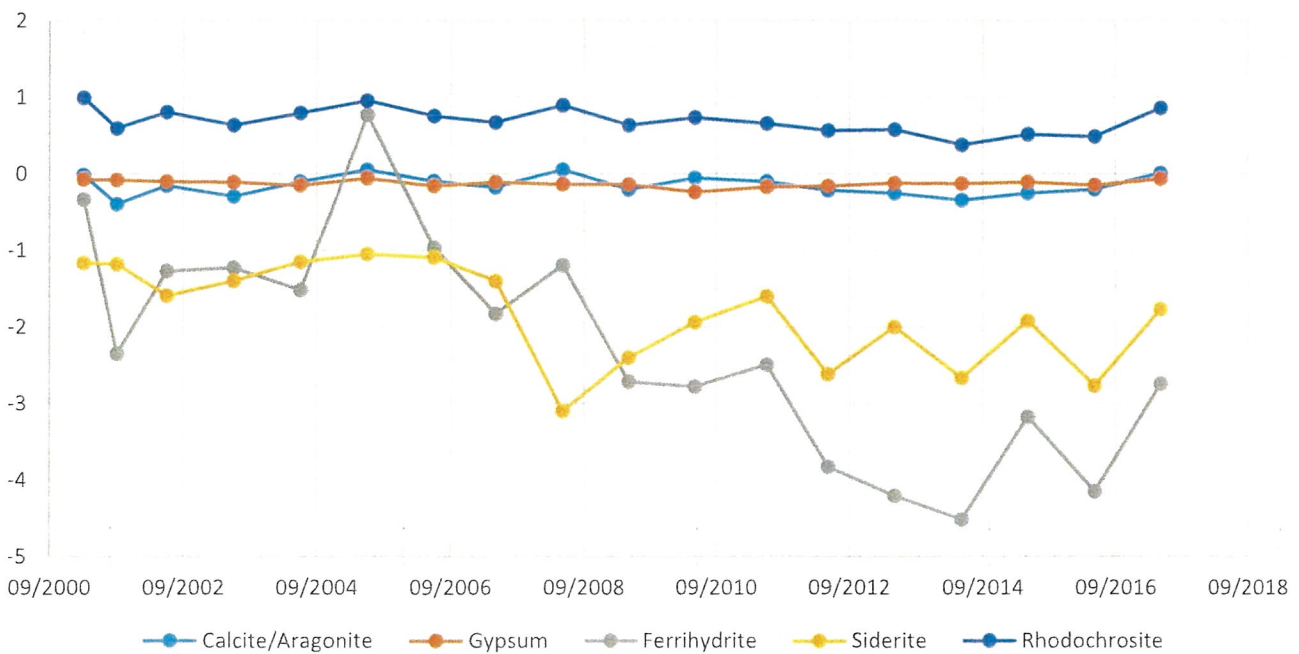
Scope: 17F777-00

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MW-1014A



MW-1014B



FLAMBEAU MINING COMPANY

Figure A-5

Calculated Saturation Indices for Wells in Backfilled Pit Area
MW-1014A, MW-1014B

Scale: NA

Date: January 2017

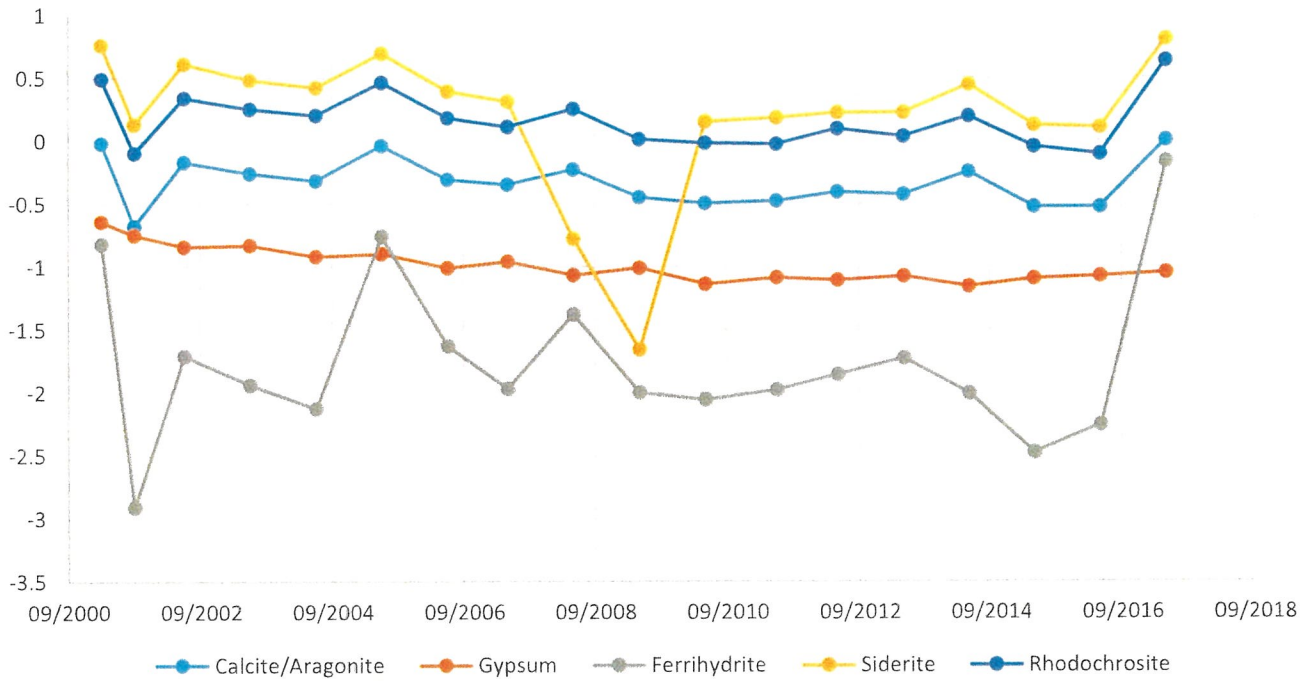
Prepared By: HLH

Checked By: SVF


Scope: 17F777-00

Flambeau Mining Co.
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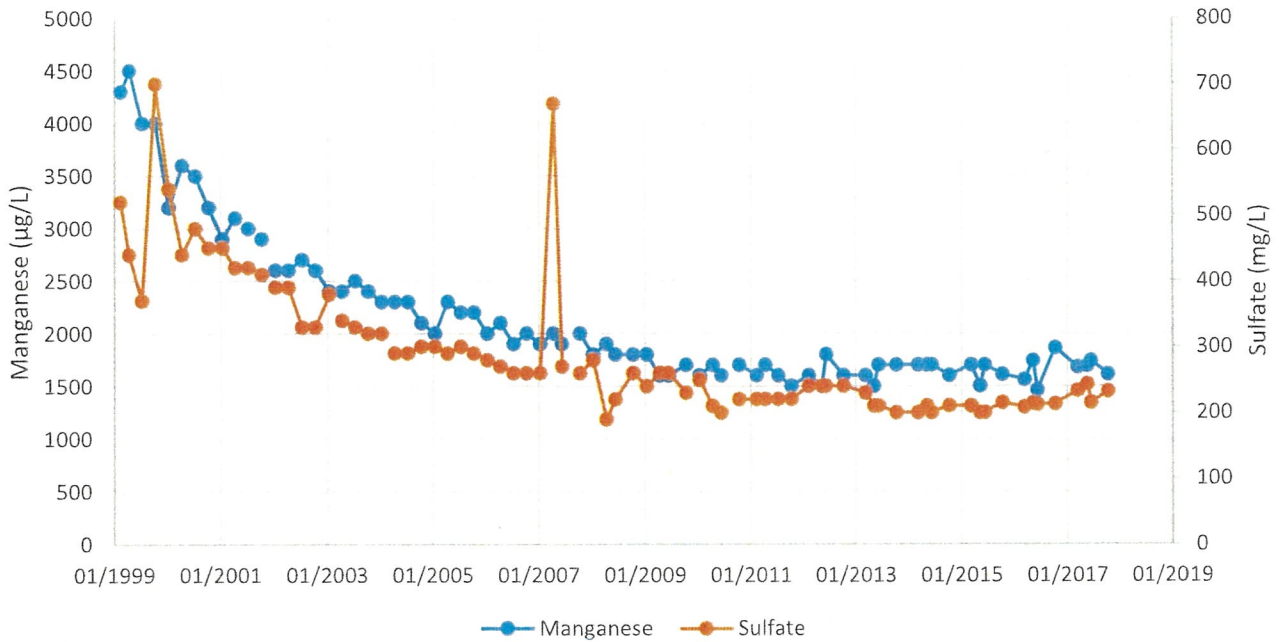
MW-1014C



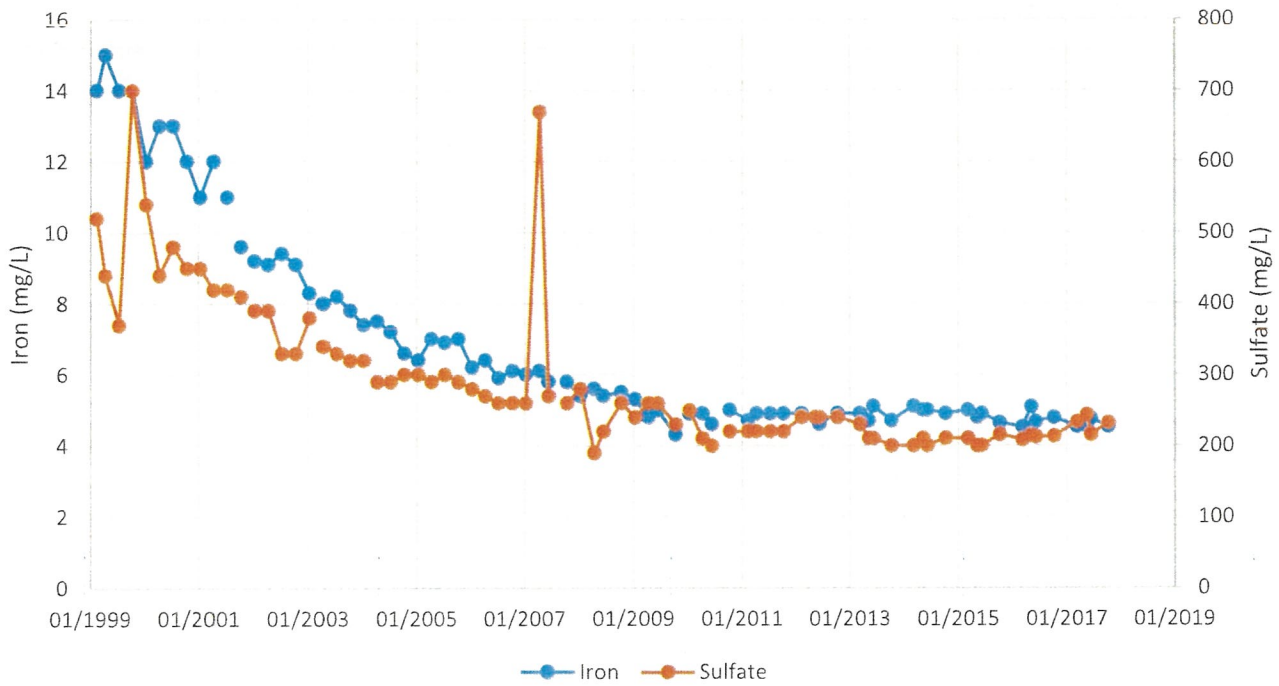
Flambeau Mining Co.
2017 Annual Report

 <small>FOOTH Infrastructure & Environment, LLC</small>		
FLAMBEAU MINING COMPANY		
Figure A-6 Calculated Saturation Indices for Wells in Backfilled Pit Area MW-1014C		
Scale: NA	Date: January 2017	
Prepared By: HLH	Checked By: SVF	Project: 17F777-00

MW-1014C



MW-1014C



FLAMBEAU MINING COMPANY

Figure A-7

Comparison of Decreases in Groundwater Concentrations of Manganese and Iron to Sulfate in MW-1014C

Scale: NA

Date: January 2017

Prepared By: HLH

Checked By: SVF

Project: 17F777-00

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2017 Annual Report

Attachment 1
PHREEQC Calculations

Input file: C:\Users\ash1\Desktop\Flambeau\June_2017_AnnualGWmodel.pqi
 Output file: C:\Users\ash1\Desktop\Flambeau\June_2017_AnnualGWmodel.pqi
 Database file: C:\Test Database Files\wateq4f_TE.DAT

 Reading data base.

SOLUTION_MASTER_SPECIES
 SOLUTION_SPECIES
 PHASES
 EXCHANGE_MASTER_SPECIES
 EXCHANGE_SPECIES
 SURFACE_MASTER_SPECIES
 SURFACE_SPECIES
 RATES
 END

 Reading input data for simulation 1.

DATABASE C:\Test Database Files\wateq4f_TE.DAT
 SOLUTION_SPREAD

units		mg/l		Description		pH	pe		Temp		Alkalinity	
As	Mn	Ba	K	Cd	Ca	Cl	Cu	Fe	Pb			
Mg				Se	Ag	Na	S(6)	Zn				
6/21/2017		MW-1005P		7.03	0.057027931		9.63			251		
0.00014		0.0712		0.00004	56	4.1	0.00055	1.52		0.00010		
23.1	0.0643		9.3	0.0002	0.00005		9.18	0.50	0.0023			
6/21/2017		MW-1013		6.02	0.647096446		8.77			580		
0.00045		0.124		0.00004	148	6.6	0.01570	2.2		0.00010		
45.3	27.4		3.01	0.0005	0.00005		14	21.8	0.0023			
6/21/2017		MW-1013A		6.42	1.690326825		10.08			364		
0.00014		0.0841		0.00004	117	7.2	0.00055	0.0555		0.00010		
41.4	3.97		7.47	0.0002	0.00005		34.3	204	0.0023			
6/21/2017		MW-1013B		6.17	1.950128657		11.11			573		
0.00062		0.0147		0.00080	608	37.9	0.47500	0.0555		0.00010		
141	29.9		5.91	0.0007	0.00005		26.2	1740	0.128			
6/21/2017		MW-1013C		6.37	0.777385657		10.14			469		
0.02190		0.0178		0.00004	594	51.5	0.00055	13.9		0.00010		
132	9.73		24.5	0.0002	0.00005		28.4	1670	0.376			
6/21/2017		MW-1014		6.82	1.730718452		8.42			166		
0.00014		0.0501		0.00004	84.2	46.1	0.00730	0.0555		0.00010		
27.3	1.73		3.42	0.0002	0.00005		14.6	130	0.0156			
6/21/2017		MW-1014A		6.78	2.009792227		8.94			491		
0.00041		0.0145		0.00004	343	11.5	0.00230	0.0555		0.00010		
119	0.0902		10.6	0.0002	0.00005		46.1	1050	0.0078			
6/21/2017		MW-1014B		6.62	2.286376083		9.2			525		
0.00100		0.0226		0.00220	553	45.4	0.50300	0.0555		0.00010		
128	11.7		19	0.0019	0.00005		21.9	1490	1.17			
6/21/2017		MW-1014C		7.28	0.747502499		9.33			279		
0.02520		0.0341		0.00004	161	51.9	0.00055	4.74		0.00010		
37.6	1.74		4.89	0.0002	0.00005		10.7	215	0.29			

 Beginning of initial solution calculations.

Initial solution 1. MW-1005P

-----Solution composition-----

Elements	Molality	Moles
Ag	4.637e-10	4.637e-10
Alkalinity	5.017e-03	5.017e-03
As	1.869e-09	1.869e-09

Ba	5.186e-07	5.186e-07
Ca	1.398e-03	1.398e-03
Cd	3.560e-10	3.560e-10
Cl	1.157e-04	1.157e-04
Cu	8.658e-09	8.658e-09
Fe	2.723e-05	2.723e-05
K	2.379e-04	2.379e-04
Mg	9.505e-04	9.505e-04
Mn	1.171e-06	1.171e-06
Na	3.994e-04	3.994e-04
Pb	4.828e-10	4.828e-10
S (6)	5.207e-06	5.207e-06
Se	2.534e-09	2.534e-09
Zn	3.520e-08	3.520e-08

-----Description of solution-----

pH	=	7.030
pe	=	0.057
Activity of water	=	1.000
Ionic strength (mol/kgw)	=	7.464e-03
Mass of water (kg)	=	1.000e+00
Total carbon (mol/kg)	=	6.244e-03
Total CO2 (mol/kg)	=	6.244e-03
Temperature (°C)	=	9.63
Electrical balance (eq)	=	2.488e-04
Percent error, 100*(Cat- An)/(Cat+ An)	=	2.41
Iterations	=	11
Total H	=	1.110174e+02
Total O	=	5.552374e+01

-----Distribution of species-----

Species	Molality	Activity	Log Molality	Log Activity	Log Gamma	mole V cm ³ /mol
H+	1.010e-07	9.333e-08	-6.996	-7.030	-0.034	0.00
OH-	3.313e-08	3.032e-08	-7.480	-7.518	-0.038	(0)
H2O	5.551e+01	9.998e-01	1.744	-0.000	0.000	18.02
Ag	4.637e-10					
Ag+	3.760e-10	3.442e-10	-9.425	-9.463	-0.038	(0)
AgCl	8.651e-11	8.666e-11	-10.063	-10.062	0.001	(0)
AgCl2-	1.123e-12	1.028e-12	-11.950	-11.988	-0.038	(0)
AgSO4-	1.976e-14	1.808e-14	-13.704	-13.743	-0.038	(0)
AgOH	3.681e-15	3.687e-15	-14.434	-14.433	0.001	(0)
AgCl3-2	1.131e-16	7.935e-17	-15.947	-16.100	-0.154	(0)
Ag(OH)2-	4.316e-20	3.950e-20	-19.365	-19.403	-0.038	(0)
AgCl4-3	3.090e-20	1.393e-20	-19.510	-19.856	-0.346	(0)
As (3)	1.770e-09					
H3AsO3	1.762e-09	1.765e-09	-8.754	-8.753	0.001	(0)
H2AsO3-	7.998e-12	7.320e-12	-11.097	-11.135	-0.038	(0)
H4AsO3+	8.917e-17	8.161e-17	-16.050	-16.088	-0.038	(0)
HAsO3-2	1.109e-19	7.781e-20	-18.955	-19.109	-0.154	(0)
AsO3-3	2.119e-28	9.549e-29	-27.674	-28.020	-0.346	(0)
As (5)	9.925e-11					
H2AsO4-	5.221e-11	4.779e-11	-10.282	-10.321	-0.038	(0)
HAsO4-2	4.704e-11	3.301e-11	-10.328	-10.481	-0.154	(0)
AsO4-3	1.179e-15	5.313e-16	-14.929	-15.275	-0.346	(0)
H3AsO4	7.608e-16	7.621e-16	-15.119	-15.118	0.001	(0)
Ba	5.186e-07					
Ba+2	5.075e-07	3.561e-07	-6.295	-6.448	-0.154	(0)
BaHCO3+	1.038e-08	9.497e-09	-7.984	-8.022	-0.038	(0)
BaSO4	5.504e-10	5.514e-10	-9.259	-9.259	0.001	(0)
BaCO3	2.098e-10	2.102e-10	-9.678	-9.677	0.001	(0)
BaOH+	1.412e-13	1.293e-13	-12.850	-12.888	-0.038	(0)
C (4)	6.244e-03					
HCO3-	4.918e-03	4.513e-03	-2.308	-2.346	-0.037	(0)

CO2	1.232e-03	1.235e-03	-2.909	-2.908	0.001	(0)
CaHCO3+	4.343e-05	3.975e-05	-4.362	-4.401	-0.038	(0)
MgHCO3+	3.598e-05	3.293e-05	-4.444	-4.482	-0.038	(0)
FeHCO3+	6.860e-06	6.279e-06	-5.164	-5.202	-0.038	(0)
CO3-2	2.194e-06	1.556e-06	-5.659	-5.808	-0.149	(0)
CaCO3	2.023e-06	2.027e-06	-5.694	-5.693	0.001	(0)
NaHCO3	9.249e-07	9.265e-07	-6.034	-6.033	0.001	(0)
MgCO3	7.614e-07	7.627e-07	-6.118	-6.118	0.001	(0)
FeCO3	5.183e-07	5.192e-07	-6.285	-6.285	0.001	(0)
MnHCO3+	2.587e-07	2.368e-07	-6.587	-6.626	-0.038	(0)
MnCO3	7.262e-08	7.275e-08	-7.139	-7.138	0.001	(0)
BaHCO3+	1.038e-08	9.497e-09	-7.984	-8.022	-0.038	(0)
ZnHCO3+	9.194e-09	8.415e-09	-8.036	-8.075	-0.038	(0)
NaCO3-	5.103e-09	4.670e-09	-8.292	-8.331	-0.038	(0)
ZnCO3	4.590e-09	4.597e-09	-8.338	-8.337	0.001	(0)
PbCO3	3.983e-10	3.990e-10	-9.400	-9.399	0.001	(0)
Zn(CO3) 2-2	2.179e-10	1.529e-10	-9.662	-9.816	-0.154	(0)
BaCO3	2.098e-10	2.102e-10	-9.678	-9.677	0.001	(0)
CuCO3	1.610e-10	1.613e-10	-9.793	-9.792	0.001	(0)
PbHCO3+	5.781e-11	5.291e-11	-10.238	-10.276	-0.038	(0)
CuHCO3+	4.770e-11	4.366e-11	-10.321	-10.360	-0.038	(0)
CdHCO3+	3.483e-11	3.188e-11	-10.458	-10.496	-0.038	(0)
Pb(CO3) 2-2	2.222e-12	1.559e-12	-11.653	-11.807	-0.154	(0)
Cu(CO3) 2-2	4.501e-13	3.158e-13	-12.347	-12.501	-0.154	(0)
CdCO3	2.756e-13	2.760e-13	-12.560	-12.559	0.001	(0)
Cd(CO3) 2-2	1.935e-15	1.358e-15	-14.713	-14.867	-0.154	(0)
Ca	1.398e-03					
Ca+2	1.352e-03	9.581e-04	-2.869	-3.019	-0.149	(0)
CaHCO3+	4.343e-05	3.975e-05	-4.362	-4.401	-0.038	(0)
CaCO3	2.023e-06	2.027e-06	-5.694	-5.693	0.001	(0)
CaSO4	5.068e-07	5.076e-07	-6.295	-6.294	0.001	(0)
CaOH+	1.861e-09	1.703e-09	-8.730	-8.769	-0.038	(0)
CaHSO4+	2.580e-13	2.362e-13	-12.588	-12.627	-0.038	(0)
Cd	3.560e-10					
Cd+2	3.183e-10	2.234e-10	-9.497	-9.651	-0.154	(0)
CdHCO3+	3.483e-11	3.188e-11	-10.458	-10.496	-0.038	(0)
CdCl+	2.335e-12	2.137e-12	-11.632	-11.670	-0.038	(0)
CdCO3	2.756e-13	2.760e-13	-12.560	-12.559	0.001	(0)
CdSO4	1.799e-13	1.802e-13	-12.745	-12.744	0.001	(0)
CdOH+	6.539e-14	5.985e-14	-13.185	-13.223	-0.038	(0)
CdOHCl	6.683e-15	6.694e-15	-14.175	-14.174	0.001	(0)
Cd(CO3) 2-2	1.935e-15	1.358e-15	-14.713	-14.867	-0.154	(0)
CdCl2	8.859e-16	8.874e-16	-15.053	-15.052	0.001	(0)
Cd(OH) 2	1.143e-16	1.145e-16	-15.942	-15.941	0.001	(0)
Cd(SO4) 2-2	9.607e-18	6.742e-18	-17.017	-17.171	-0.154	(0)
CdCl3-	5.068e-20	4.639e-20	-19.295	-19.334	-0.038	(0)
Cd2OH+3	1.778e-22	8.011e-23	-21.750	-22.096	-0.346	(0)
Cd(OH) 3-	1.504e-22	1.377e-22	-21.823	-21.861	-0.038	(0)
Cd(OH) 4-2	1.873e-29	1.314e-29	-28.727	-28.881	-0.154	(0)
Cl	1.157e-04					
Cl-	1.157e-04	1.057e-04	-3.937	-3.976	-0.039	(0)
FeCl+	2.219e-09	2.031e-09	-8.654	-8.692	-0.038	(0)
MnCl+	2.771e-10	2.536e-10	-9.557	-9.596	-0.038	(0)
AgCl	8.651e-11	8.666e-11	-10.063	-10.062	0.001	(0)
CuCl2-	3.066e-11	2.806e-11	-10.513	-10.552	-0.038	(0)
CdCl+	2.335e-12	2.137e-12	-11.632	-11.670	-0.038	(0)
ZnCl+	2.254e-12	2.063e-12	-11.647	-11.686	-0.038	(0)
AgCl2-	1.123e-12	1.028e-12	-11.950	-11.988	-0.038	(0)
ZnOHCl	5.546e-13	5.556e-13	-12.256	-12.255	0.001	(0)
PbCl+	4.542e-14	4.157e-14	-13.343	-13.381	-0.038	(0)
MnCl2	1.169e-14	1.171e-14	-13.932	-13.932	0.001	(0)
CdOHCl	6.683e-15	6.694e-15	-14.175	-14.174	0.001	(0)
CuCl3-2	6.296e-15	4.418e-15	-14.201	-14.355	-0.154	(0)
CuCl+	2.715e-15	2.484e-15	-14.566	-14.605	-0.038	(0)
CdCl2	8.859e-16	8.874e-16	-15.053	-15.052	0.001	(0)
ZnCl2	2.136e-16	2.140e-16	-15.670	-15.670	0.001	(0)
AgCl3-2	1.131e-16	7.935e-17	-15.947	-16.100	-0.154	(0)

PbCl2	9.414e-18	9.430e-18	-17.026	-17.025	0.001	(0)
MnCl3-	3.725e-19	3.409e-19	-18.429	-18.467	-0.038	(0)
CuCl2	1.182e-19	1.184e-19	-18.927	-18.927	0.001	(0)
CdCl3-	5.068e-20	4.639e-20	-19.295	-19.334	-0.038	(0)
AgCl4-3	3.090e-20	1.393e-20	-19.510	-19.856	-0.346	(0)
ZnCl3-	2.517e-20	2.304e-20	-19.599	-19.638	-0.038	(0)
FeCl+2	1.697e-21	1.191e-21	-20.770	-20.924	-0.154	(0)
PbCl3-	7.831e-22	7.167e-22	-21.106	-21.145	-0.038	(0)
ZnCl4-2	1.530e-24	1.074e-24	-23.815	-23.969	-0.154	(0)
FeCl2+	1.027e-24	9.403e-25	-23.988	-24.027	-0.038	(0)
PbCl4-2	4.563e-26	3.202e-26	-25.341	-25.495	-0.154	(0)
CuCl3-	3.643e-26	3.334e-26	-25.439	-25.477	-0.038	(0)
FeCl3	9.926e-30	9.943e-30	-29.003	-29.002	0.001	(0)
CuCl4-2	1.730e-32	1.214e-32	-31.762	-31.916	-0.154	(0)
Cu (1)	8.373e-09					
Cu+	8.342e-09	7.635e-09	-8.079	-8.117	-0.038	(0)
CuCl2-	3.066e-11	2.806e-11	-10.513	-10.552	-0.038	(0)
CuCl3-2	6.296e-15	4.418e-15	-14.201	-14.355	-0.154	(0)
Cu (2)	2.851e-10					
CuCO3	1.610e-10	1.613e-10	-9.793	-9.792	0.001	(0)
CuHCO3+	4.770e-11	4.366e-11	-10.321	-10.360	-0.038	(0)
Cu (OH) 2	4.621e-11	4.629e-11	-10.335	-10.335	0.001	(0)
Cu+2	2.751e-11	1.930e-11	-10.561	-10.714	-0.154	(0)
CuOH+	2.259e-12	2.068e-12	-11.646	-11.684	-0.038	(0)
Cu (CO3) 2-2	4.501e-13	3.158e-13	-12.347	-12.501	-0.154	(0)
CuSO4	1.087e-14	1.089e-14	-13.964	-13.963	0.001	(0)
CuCl+	2.715e-15	2.484e-15	-14.566	-14.605	-0.038	(0)
Cu (OH) 3-	3.265e-17	2.988e-17	-16.486	-16.525	-0.038	(0)
Cu2 (OH) 2+2	5.336e-19	3.744e-19	-18.273	-18.427	-0.154	(0)
CuCl2	1.182e-19	1.184e-19	-18.927	-18.927	0.001	(0)
Cu (OH) 4-2	9.102e-23	6.387e-23	-22.041	-22.195	-0.154	(0)
CuCl3-	3.643e-26	3.334e-26	-25.439	-25.477	-0.038	(0)
CuCl4-2	1.730e-32	1.214e-32	-31.762	-31.916	-0.154	(0)
Fe (2)	2.723e-05					
Fe+2	1.983e-05	1.391e-05	-4.703	-4.857	-0.154	(0)
FeHCO3+	6.860e-06	6.279e-06	-5.164	-5.202	-0.038	(0)
FeCO3	5.183e-07	5.192e-07	-6.285	-6.285	0.001	(0)
FeOH+	1.534e-08	1.404e-08	-7.814	-7.853	-0.038	(0)
FeSO4	5.673e-09	5.683e-09	-8.246	-8.245	0.001	(0)
FeCl+	2.219e-09	2.031e-09	-8.654	-8.692	-0.038	(0)
Fe (OH) 2	3.122e-13	3.128e-13	-12.506	-12.505	0.001	(0)
FeHSO4+	3.747e-15	3.429e-15	-14.426	-14.465	-0.038	(0)
Fe (OH) 3-	1.160e-16	1.062e-16	-15.936	-15.974	-0.038	(0)
Fe (3)	5.663e-11					
Fe (OH) 2+	3.482e-11	3.187e-11	-10.458	-10.497	-0.038	(0)
Fe (OH) 3	2.167e-11	2.170e-11	-10.664	-10.663	0.001	(0)
Fe (OH) 4-	1.208e-13	1.106e-13	-12.918	-12.956	-0.038	(0)
FeOH+2	2.367e-14	1.661e-14	-13.626	-13.780	-0.154	(0)
Fe+3	1.383e-18	6.234e-19	-17.859	-18.205	-0.346	(0)
FeSO4+	1.612e-20	1.475e-20	-19.793	-19.831	-0.038	(0)
FeCl+2	1.697e-21	1.191e-21	-20.770	-20.924	-0.154	(0)
FeCl2+	1.027e-24	9.403e-25	-23.988	-24.027	-0.038	(0)
Fe (SO4) 2-	1.023e-24	9.360e-25	-23.990	-24.029	-0.038	(0)
Fe2 (OH) 2+4	5.982e-26	1.451e-26	-25.223	-25.838	-0.615	(0)
FeHSO4+2	5.500e-27	3.860e-27	-26.260	-26.413	-0.154	(0)
FeCl3	9.926e-30	9.943e-30	-29.003	-29.002	0.001	(0)
Fe3 (OH) 4+5	3.942e-33	4.308e-34	-32.404	-33.366	-0.961	(0)
H (0)	1.113e-17					
H2	5.563e-18	5.572e-18	-17.255	-17.254	0.001	(0)
K	2.379e-04					
K+	2.379e-04	2.175e-04	-3.624	-3.663	-0.039	(0)
KSO4-	3.888e-09	3.558e-09	-8.410	-8.449	-0.038	(0)
Mg	9.505e-04					
Mg+2	9.134e-04	6.505e-04	-3.039	-3.187	-0.147	(0)
MgHCO3+	3.598e-05	3.293e-05	-4.444	-4.482	-0.038	(0)
MgCO3	7.614e-07	7.627e-07	-6.118	-6.118	0.001	(0)
MgSO4	3.098e-07	3.104e-07	-6.509	-6.508	0.001	(0)

MgOH+	6.399e-09	5.857e-09	-8.194	-8.232	-0.038	(0)
Mn (2)	1.171e-06					
Mn+2	8.389e-07	5.887e-07	-6.076	-6.230	-0.154	(0)
MnHCO3+	2.587e-07	2.368e-07	-6.587	-6.626	-0.038	(0)
MnCO3	7.262e-08	7.275e-08	-7.139	-7.138	0.001	(0)
MnCl+	2.771e-10	2.536e-10	-9.557	-9.596	-0.038	(0)
MnSO4	2.370e-10	2.374e-10	-9.625	-9.624	0.001	(0)
MnOH+	4.727e-11	4.326e-11	-10.325	-10.364	-0.038	(0)
MnCl2	1.169e-14	1.171e-14	-13.932	-13.932	0.001	(0)
MnCl3-	3.725e-19	3.409e-19	-18.429	-18.467	-0.038	(0)
Mn(OH)3-	1.254e-20	1.147e-20	-19.902	-19.940	-0.038	(0)
Mn (3)	4.317e-33					
Mn+3	4.317e-33	1.946e-33	-32.365	-32.711	-0.346	(0)
Mn (6)	0.000e+00					
MnO4-2	0.000e+00	0.000e+00	-74.025	-74.179	-0.154	(0)
Mn (7)	0.000e+00					
MnO4-	0.000e+00	0.000e+00	-84.527	-84.566	-0.038	(0)
Na	3.994e-04					
Na+	3.985e-04	3.651e-04	-3.400	-3.438	-0.038	(0)
NaHCO3	9.249e-07	9.265e-07	-6.034	-6.033	0.001	(0)
NaSO4-	5.573e-09	5.101e-09	-8.254	-8.292	-0.038	(0)
NaCO3-	5.103e-09	4.670e-09	-8.292	-8.331	-0.038	(0)
O (0)	0.000e+00					
O2	0.000e+00	0.000e+00	-63.103	-63.102	0.001	(0)
Pb	4.828e-10					
PbCO3	3.983e-10	3.990e-10	-9.400	-9.399	0.001	(0)
PbHCO3+	5.781e-11	5.291e-11	-10.238	-10.276	-0.038	(0)
Pb+2	2.103e-11	1.476e-11	-10.677	-10.831	-0.154	(0)
PbOH+	3.368e-12	3.083e-12	-11.473	-11.511	-0.038	(0)
Pb(CO3)2-2	2.222e-12	1.559e-12	-11.653	-11.807	-0.154	(0)
PbCl+	4.542e-14	4.157e-14	-13.343	-13.381	-0.038	(0)
PbSO4	2.560e-14	2.564e-14	-13.592	-13.591	0.001	(0)
Pb(OH)2	1.283e-14	1.285e-14	-13.892	-13.891	0.001	(0)
PbCl2	9.414e-18	9.430e-18	-17.026	-17.025	0.001	(0)
Pb(OH)3-	1.727e-18	1.581e-18	-17.763	-17.801	-0.038	(0)
Pb(SO4)2-2	5.924e-19	4.157e-19	-18.227	-18.381	-0.154	(0)
Pb2OH+3	2.260e-21	1.019e-21	-20.646	-20.992	-0.346	(0)
PbCl3-	7.831e-22	7.167e-22	-21.106	-21.145	-0.038	(0)
Pb(OH)4-2	5.528e-23	3.879e-23	-22.257	-22.411	-0.154	(0)
PbCl4-2	4.563e-26	3.202e-26	-25.341	-25.495	-0.154	(0)
Pb3(OH)4+2	6.996e-30	4.910e-30	-29.155	-29.309	-0.154	(0)
S (6)	5.207e-06					
SO4-2	4.374e-06	3.089e-06	-5.359	-5.510	-0.151	(0)
CaSO4	5.068e-07	5.076e-07	-6.295	-6.294	0.001	(0)
MgSO4	3.098e-07	3.104e-07	-6.509	-6.508	0.001	(0)
FeSO4	5.673e-09	5.683e-09	-8.246	-8.245	0.001	(0)
NaSO4-	5.573e-09	5.101e-09	-8.254	-8.292	-0.038	(0)
KSO4-	3.888e-09	3.558e-09	-8.410	-8.449	-0.038	(0)
BaSO4	5.504e-10	5.514e-10	-9.259	-9.259	0.001	(0)
MnSO4	2.370e-10	2.374e-10	-9.625	-9.624	0.001	(0)
HSO4-	2.240e-11	2.050e-11	-10.650	-10.688	-0.038	(0)
ZnSO4	9.452e-12	9.468e-12	-11.024	-11.024	0.001	(0)
CaHSO4+	2.580e-13	2.362e-13	-12.588	-12.627	-0.038	(0)
CdSO4	1.799e-13	1.802e-13	-12.745	-12.744	0.001	(0)
PbSO4	2.560e-14	2.564e-14	-13.592	-13.591	0.001	(0)
AgSO4-	1.976e-14	1.808e-14	-13.704	-13.743	-0.038	(0)
CuSO4	1.087e-14	1.089e-14	-13.964	-13.963	0.001	(0)
FeHSO4+	3.747e-15	3.429e-15	-14.426	-14.465	-0.038	(0)
Zn(SO4)2-2	3.839e-16	2.694e-16	-15.416	-15.570	-0.154	(0)
Cd(SO4)2-2	9.607e-18	6.742e-18	-17.017	-17.171	-0.154	(0)
Pb(SO4)2-2	5.924e-19	4.157e-19	-18.227	-18.381	-0.154	(0)
FeSO4+	1.612e-20	1.475e-20	-19.793	-19.831	-0.038	(0)
Fe(SO4)2-	1.023e-24	9.360e-25	-23.990	-24.029	-0.038	(0)
FeHSO4+2	5.500e-27	3.860e-27	-26.260	-26.413	-0.154	(0)
Se(-2)	7.540e-18					
HSe-	7.534e-18	6.895e-18	-17.123	-17.161	-0.038	(0)
H2Se	6.591e-21	6.603e-21	-20.181	-20.180	0.001	(0)

Se (4)	2.534e-09						
HSeO3-	2.426e-09	2.221e-09	-8.615	-8.653	-0.038	(0)	
SeO3-2	1.072e-10	7.525e-11	-9.970	-10.123	-0.154	(0)	
H2SeO3	1.164e-13	1.166e-13	-12.934	-12.933	0.001	(0)	
Se (6)	8.878e-27						
SeO4-2	8.878e-27	6.230e-27	-26.052	-26.205	-0.154	(0)	
HSeO4-	1.851e-32	1.694e-32	-31.733	-31.771	-0.038	(0)	
Zn	3.520e-08						
Zn+2	2.111e-08	1.481e-08	-7.676	-7.829	-0.154	(0)	
ZnHCO3+	9.194e-09	8.415e-09	-8.036	-8.075	-0.038	(0)	
ZnCO3	4.590e-09	4.597e-09	-8.338	-8.337	0.001	(0)	
Zn (CO3) 2-2	2.179e-10	1.529e-10	-9.662	-9.816	-0.154	(0)	
ZnOH+	5.560e-11	5.089e-11	-10.255	-10.293	-0.038	(0)	
Zn (OH) 2	2.136e-11	2.140e-11	-10.670	-10.670	0.001	(0)	
ZnSO4	9.452e-12	9.468e-12	-11.024	-11.024	0.001	(0)	
ZnCl+	2.254e-12	2.063e-12	-11.647	-11.686	-0.038	(0)	
ZnOHCl	5.546e-13	5.556e-13	-12.256	-12.255	0.001	(0)	
Zn (OH) 3-	7.922e-16	7.251e-16	-15.101	-15.140	-0.038	(0)	
Zn (SO4) 2-2	3.839e-16	2.694e-16	-15.416	-15.570	-0.154	(0)	
ZnCl2	2.136e-16	2.140e-16	-15.670	-15.670	0.001	(0)	
ZnCl3-	2.517e-20	2.304e-20	-19.599	-19.638	-0.038	(0)	
Zn (OH) 4-2	1.754e-21	1.231e-21	-20.756	-20.910	-0.154	(0)	
ZnCl4-2	1.530e-24	1.074e-24	-23.815	-23.969	-0.154	(0)	

-----Saturation indices-----

Phase	SI**	log IAP	log K(282 K,	1 atm)	
Ag2CO3	-13.28	-24.73	-11.45	Ag2CO3	
Ag2O	-17.86	-4.87	13.00	Ag2O	
Ag2SO4	-19.35	-24.44	-5.09	Ag2SO4	
AgMetal	5.00	-9.52	-14.52	Ag	
Anglesite	-8.47	-16.34	-7.88	PbSO4	
Anhydrite	-4.19	-8.53	-4.34	CaSO4	
Antlerite	-17.82	-9.53	8.29	Cu3 (OH) 4SO4	
Aragonite	-0.57	-8.83	-8.25	CaCO3	
Arsenolite	-15.84	-17.51	-1.67	As2O3	
Artinite	-8.87	1.88	10.75	MgCO3:Mg (OH) 2:3H2O	
As2O5 (cr)	-38.76	-30.24	8.53	As2O5	
As_native	-16.39	-30.01	-13.63	As	
Atacamite	-12.40	-4.31	8.08	Cu2 (OH) 3Cl	
Azurite	-13.69	-8.71	4.98	Cu3 (OH) 2 (CO3) 2	
Ba3 (AsO4) 2	0.59	-49.89	-50.49	Ba3 (AsO4) 2	
Barite	-1.71	-11.96	-10.25	BaSO4	
BaSeO3	-10.18	-16.57	-6.39	BaSeO3	
Bianchite	-11.58	-13.34	-1.76	ZnSO4:6H2O	
Birnessite	-21.60	22.00	43.60	MnO2	
Bixbyite	-23.24	-23.24	-0.00	Mn2O3	
Brochantite	-21.53	-6.19	15.34	Cu4 (OH) 6SO4	
Brucite	-7.05	10.87	17.92	Mg (OH) 2	
Ca3 (AsO4) 2:4w	-20.70	-39.61	-18.91	Ca3 (AsO4) 2:4H2O	
Calcite	-0.42	-8.83	-8.41	CaCO3	
CaSeO3	-7.54	-13.14	-5.60	CaSeO3	
Cd (gamma)	-24.08	-9.77	14.31	Cd	
Cd (OH) 2	-9.24	4.41	13.65	Cd (OH) 2	
Cd (OH) 2 (a)	-10.15	4.41	14.56	Cd (OH) 2	
Cd3 (OH) 2 (SO4) 2	-32.62	-25.91	6.71	Cd3 (OH) 2 (SO4) 2	
Cd3 (OH) 4SO4	-28.90	-6.34	22.56	Cd3 (OH) 4SO4	
Cd4 (OH) 6SO4	-30.33	-1.93	28.40	Cd4 (OH) 6SO4	
CdCl2	-17.10	-17.60	-0.50	CdCl2	
CdCl2:2.5H2O	-15.59	-17.60	-2.01	CdCl2:2.5H2O	
CdCl2:H2O	-15.97	-17.60	-1.64	CdCl2:H2O	
CdMetal	-23.97	-9.77	14.21	Cd	
CdOHCl	-10.41	-6.60	3.82	CdOHCl	
CdSO4	-15.65	-15.16	0.49	CdSO4	
CdSO4:2.7H2O	-13.46	-15.16	-1.70	CdSO4:2.67H2O	
CdSO4:H2O	-13.80	-15.16	-1.36	CdSO4:H2O	

Cerargyrite	-3.07	-13.44	-10.37	AgCl
Cerrusite	-3.32	-16.64	-13.32	PbCO3
Chalcanthite	-13.53	-16.22	-2.70	CuSO4:5H2O
Claudetite	-15.90	-17.51	-1.61	As2O3
CO2 (g)	-1.64	-2.91	-1.26	CO2
Cotunnite	-13.79	-18.78	-4.99	PbCl2
Cu(OH)2	-5.90	3.35	9.25	Cu(OH)2
Cu2SO4	-19.98	-21.74	-1.77	Cu2SO4
Cu3(AsO4)2:6w	-27.57	-62.69	-35.12	Cu3(AsO4)2:6H2O
CuCO3	-6.89	-16.52	-9.63	CuCO3
CuMetal	1.27	-8.17	-9.44	Cu
CuOCuSO4	-25.83	-12.88	12.95	CuO:CuSO4
CupricFerrite	1.69	9.11	7.42	CuFe2O4
Cuprite	-0.38	-2.17	-1.80	Cu2O
CuprousFerrite	10.57	1.80	-8.77	CuFeO2
CuSO4	-19.96	-16.22	3.73	CuSO4
Dolomite	-1.11	-17.82	-16.71	CaMg(CO3)2
Dolomite(d)	-1.72	-17.82	-16.10	CaMg(CO3)2
Epsomite	-6.44	-8.70	-2.25	MgSO4:7H2O
Fe(OH)2.7Cl.3	2.62	-0.42	-3.04	Fe(OH)2.7Cl0.3
Fe(OH)3(a)	-2.01	2.88	4.89	Fe(OH)3
Fe2(SeO3)3	-31.35	-66.78	-35.43	Fe2(SeO3)3
Fe3(OH)8	-5.25	14.97	20.22	Fe3(OH)8
FeSe2	-6.43	-25.01	-18.58	FeSe2
Goethite	3.31	2.88	-0.42	FeOOH
Goslarite	-11.25	-13.34	-2.09	ZnSO4:7H2O
Gypsum	-3.94	-8.53	-4.59	CaSO4:2H2O
H2(g)	-14.17	-17.25	-3.08	H2
H2O(g)	-1.93	-0.00	1.93	H2O
Halite	-8.96	-7.41	1.55	NaCl
Hausmannite	-27.38	37.66	65.04	Mn3O4
Hematite	8.55	5.77	-2.78	Fe2O3
Huntite	-6.87	-35.81	-28.94	CaMg3(CO3)4
Hydrocerrusite	-12.59	-30.05	-17.46	Pb(OH)2:2PbCO3
Hydromagnesite	-18.43	-25.11	-6.68	Mg5(CO3)4(OH)2:4H2O
Hydrozincite	-17.91	12.40	30.31	Zn5(OH)6(CO3)2
Hydrozincite_PG	-19.73	12.40	32.14	Zn5(OH)6(CO3)2
Jarosite(ss)	-17.96	-27.79	-9.83	(K0.77Na0.03H0.2)Fe3(SO4)2(OH)6
Jarosite-K	-19.16	-27.12	-7.96	KFe3(SO4)2(OH)6
Jarosite-Na	-23.06	-26.89	-3.84	NaFe3(SO4)2(OH)6
JarositeH	-27.29	-30.49	-3.19	(H3O)Fe3(SO4)2(OH)6
Langite	-24.56	-6.19	18.37	Cu4(OH)6SO4:H2O
Larnakite	-13.09	-13.11	-0.02	PbO:PbSO4
Laurionite	-8.40	-7.78	0.62	PbOHCl
Litharge	-10.14	3.23	13.37	PbO
Maghemite	-0.62	5.77	6.39	Fe2O3
Magnesite	-1.21	-8.99	-7.78	MgCO3
Magnetite	9.23	14.97	5.75	Fe3O4
Malachite	-8.62	-2.68	5.94	Cu2(OH)2CO3
Manganite	-10.42	14.92	25.34	MnOOH
Massicot	-10.35	3.23	13.58	PbO
Melanothallite	-22.89	-18.67	4.22	CuCl2
Melanterite	-7.95	-10.37	-2.42	FeSO4:7H2O
Minium	-53.92	23.86	77.78	Pb3O4
Mirabilite	-10.52	-12.39	-1.87	Na2SO4:10H2O
Mn2(SO4)3	-77.80	-81.95	-4.15	Mn2(SO4)3
Mn3(AsO4)2:8H2O	-20.53	-49.24	-28.71	Mn3(AsO4)2:8H2O
MnCl2:4H2O	-16.20	-14.18	2.02	MnCl2:4H2O
MnSO4	-15.03	-11.74	3.29	MnSO4
Monteponite	-10.35	4.41	14.76	CdO
Nahcolite	-5.09	-5.78	-0.70	NaHCO3
Nantokite	-4.94	-12.09	-7.16	CuCl
Natron	-10.75	-12.68	-1.94	Na2CO3:10H2O
Nesquehonite	-3.60	-8.99	-5.39	MgCO3:3H2O
Nsutite	-20.56	22.00	42.56	MnO2
O2(g)	-60.34	-63.10	-2.76	O2
Otavite	-3.46	-15.46	-12.00	CdCO3

Pb(OH)2	-5.48	3.23	8.71	Pb(OH)2
Pb2(OH)3Cl	-13.34	-4.55	8.79	Pb2(OH)3Cl
Pb2O(OH)2	-19.74	6.46	26.20	PbO:Pb(OH)2
Pb2O3	-40.41	20.63	61.04	Pb2O3
Pb2OCO3	-13.37	-13.41	-0.04	PbO:PbCO3
Pb3(AsO4)2	-27.64	-63.04	-35.40	Pb3(AsO4)2
Pb3O2CO3	-22.25	-10.18	12.07	PbCO3:2PbO
Pb3O2SO4	-21.11	-9.88	11.23	PbSO4:2PbO
Pb4(OH)6SO4	-27.75	-6.65	21.10	Pb4(OH)6SO4
Pb4O3SO4	-30.15	-6.65	23.50	PbSO4:3PbO
PbMetal	-15.20	-10.95	4.25	Pb
PbO:0.3H2O	-9.75	3.23	12.98	PbO:0.33H2O
Phosgenite	-15.61	-35.42	-19.81	PbCl2:PbCO3
Plattnerite	-34.71	17.40	52.12	PbO2
Portlandite	-12.99	11.04	24.04	Ca(OH)2
Pyrochroite	-7.37	7.83	15.20	Mn(OH)2
Pyrolusite	-21.97	22.00	43.97	MnO2
Rhodochrosite	-0.97	-12.04	-11.07	MnCO3
Rhodochrosite(d)	-1.65	-12.04	-10.39	MnCO3
Scorodite	-13.23	-33.48	-20.25	FeAsO4:2H2O
Se(s)	7.30	-10.02	-17.32	Se
SeO2	-15.80	-24.18	-8.38	SeO2
Siderite	0.13	-10.66	-10.79	FeCO3
Siderite(d) (3)	-0.21	-10.66	-10.45	FeCO3
Smithsonite	-3.81	-13.64	-9.83	ZnCO3
Smithsonite_PG	-2.84	-13.64	-10.80	ZnCO3
Tenorite	-4.88	3.35	8.23	CuO
Thenardite	-12.23	-12.39	-0.16	Na2SO4
Thermonatrite	-12.92	-12.68	0.24	Na2CO3:H2O
Trona	-18.39	-18.47	-0.08	NaHCO3:Na2CO3:2H2O
Witherite	-3.62	-12.26	-8.63	BaCO3
Zincite(c)	-5.78	6.23	12.01	ZnO
Zincosite	-17.11	-13.34	3.77	ZnSO4
Zn(OH)2-a	-6.22	6.23	12.45	Zn(OH)2
Zn(OH)2-b	-5.52	6.23	11.75	Zn(OH)2
Zn(OH)2-c	-5.97	6.23	12.20	Zn(OH)2
Zn(OH)2-e	-5.27	6.23	11.50	Zn(OH)2
Zn(OH)2-g	-5.48	6.23	11.71	Zn(OH)2
Zn2(OH)2SO4	-14.61	-7.11	7.50	Zn2(OH)2SO4
Zn2(OH)3Cl	-13.74	1.46	15.20	Zn2(OH)3Cl
Zn3(AsO4)2:2.5w	-26.49	-54.04	-27.55	Zn3(AsO4)2:2.5H2O
Zn3O(SO4)2	-41.94	-20.45	21.49	ZnO:2ZnSO4
Zn4(OH)6SO4	-23.05	5.35	28.40	Zn4(OH)6SO4
Zn5(OH)8Cl2	-29.36	9.14	38.50	Zn5(OH)8Cl2
ZnCl2	-23.51	-15.78	7.73	ZnCl2
ZnCO3:1H2O	-3.38	-13.64	-10.26	ZnCO3:1H2O
ZnCO3:H2O	-3.38	-13.64	-10.26	ZnCO3:H2O
ZnMetal	-35.17	-7.94	27.22	Zn
ZnO(a)	-5.08	6.23	11.31	ZnO
ZnSO4:H2O	-13.19	-13.34	-0.15	ZnSO4:H2O

**For a gas, SI = log10(fugacity). Fugacity = pressure * phi / 1 atm.
For ideal gases, phi = 1.

Initial solution 2. MW-1013

-----Solution composition-----

Elements	Molality	Moles
Ag	4.639e-10	4.639e-10
Alkalinity	1.160e-02	1.160e-02
As	6.011e-09	6.011e-09
Ba	9.036e-07	9.036e-07
Ca	3.696e-03	3.696e-03
Cd	3.562e-10	3.562e-10
Cl	1.863e-04	1.863e-04

Cu	2.473e-07	2.473e-07
Fe	3.943e-05	3.943e-05
K	7.704e-05	7.704e-05
Mg	1.865e-03	1.865e-03
Mn	4.992e-04	4.992e-04
Na	6.095e-04	6.095e-04
Pb	4.831e-10	4.831e-10
S (6)	2.271e-04	2.271e-04
Se	6.338e-09	6.338e-09
Zn	3.521e-08	3.521e-08

-----Description of solution-----

pH	=	6.020
pe	=	0.647
Activity of water	=	0.999
Ionic strength (mol/kgw)	=	1.757e-02
Mass of water (kg)	=	1.000e+00
Total carbon (mol/kg)	=	3.938e-02
Total CO2 (mol/kg)	=	3.938e-02
Temperature (°C)	=	8.77
Electrical balance (eq)	=	6.482e-04
Percent error, 100*(Cat- An)/(Cat+ An)	=	2.72
Iterations	=	10
Total H	=	1.110240e+02
Total O	=	5.559748e+01

-----Distribution of species-----

Species	Molality	Activity	Log Molality	Log Activity	Log Gamma	mole V cm ³ /mol
H+	1.065e-06	9.550e-07	-5.973	-6.020	-0.047	0.00
OH-	3.116e-09	2.742e-09	-8.506	-8.562	-0.056	(0)
H2O	5.551e+01	9.992e-01	1.744	-0.000	0.000	18.02
Ag	4.639e-10					
Ag+	3.424e-10	3.013e-10	-9.465	-9.521	-0.056	(0)
AgCl	1.184e-10	1.189e-10	-9.927	-9.925	0.002	(0)
AgCl2-	2.491e-12	2.192e-12	-11.604	-11.659	-0.056	(0)
AgSO4-	5.980e-13	5.262e-13	-12.223	-12.279	-0.056	(0)
AgCl3-2	4.267e-16	2.558e-16	-15.370	-15.592	-0.222	(0)
AgOH	3.140e-16	3.153e-16	-15.503	-15.501	0.002	(0)
AgCl4-3	2.191e-19	6.933e-20	-18.659	-19.159	-0.500	(0)
Ag(OH)2-	3.749e-22	3.299e-22	-21.426	-21.482	-0.056	(0)
As (3)	6.009e-09					
H3AsO3	6.006e-09	6.031e-09	-8.221	-8.220	0.002	(0)
H2AsO3-	2.680e-12	2.358e-12	-11.572	-11.627	-0.056	(0)
H4AsO3+	3.243e-15	2.853e-15	-14.489	-14.545	-0.056	(0)
HAsO3-2	3.920e-21	2.351e-21	-20.407	-20.629	-0.222	(0)
AsO3-3	8.623e-31	2.728e-31	-30.064	-30.564	-0.500	(0)
As (5)	2.471e-12					
H2AsO4-	2.249e-12	1.979e-12	-11.648	-11.704	-0.056	(0)
HAsO4-2	2.219e-13	1.330e-13	-12.654	-12.876	-0.222	(0)
H3AsO4	3.187e-16	3.200e-16	-15.497	-15.495	0.002	(0)
AsO4-3	6.460e-19	2.044e-19	-18.190	-18.690	-0.500	(0)
Ba	9.036e-07					
Ba+2	8.451e-07	5.067e-07	-6.073	-6.295	-0.222	(0)
BaHCO3+	3.234e-08	2.846e-08	-7.490	-7.546	-0.056	(0)
BaSO4	2.618e-08	2.629e-08	-7.582	-7.580	0.002	(0)
BaCO3	6.036e-11	6.060e-11	-10.219	-10.218	0.002	(0)
BaOH+	2.041e-14	1.796e-14	-13.690	-13.746	-0.056	(0)
C (4)	3.938e-02					
CO2	2.779e-02	2.790e-02	-1.556	-1.554	0.002	(0)
HCO3-	1.104e-02	9.765e-03	-1.957	-2.010	-0.053	(0)
CaHCO3+	2.097e-04	1.845e-04	-3.678	-3.734	-0.056	(0)
MnHCO3+	1.831e-04	1.611e-04	-3.737	-3.793	-0.056	(0)
MgHCO3+	1.318e-04	1.160e-04	-3.880	-3.936	-0.056	(0)

FeHCO3+	1.563e-05	1.376e-05	-4.806	-4.862	-0.056	(0)
MnCO3	4.697e-06	4.716e-06	-5.328	-5.326	0.002	(0)
NaHCO3	2.923e-06	2.934e-06	-5.534	-5.532	0.002	(0)
CaCO3	9.113e-07	9.150e-07	-6.040	-6.039	0.002	(0)
CO3-2	5.245e-07	3.207e-07	-6.280	-6.494	-0.214	(0)
MgCO3	2.518e-07	2.528e-07	-6.599	-6.597	0.002	(0)
FeCO3	1.079e-07	1.084e-07	-6.967	-6.965	0.002	(0)
BaHCO3+	3.234e-08	2.846e-08	-7.490	-7.546	-0.056	(0)
ZnHCO3+	1.561e-08	1.374e-08	-7.807	-7.862	-0.056	(0)
CuHCO3+	1.105e-08	9.720e-09	-7.957	-8.012	-0.056	(0)
CuCO3	3.407e-09	3.421e-09	-8.468	-8.466	0.002	(0)
NaCO3-	1.526e-09	1.343e-09	-8.816	-8.872	-0.056	(0)
ZnCO3	7.122e-10	7.151e-10	-9.147	-9.146	0.002	(0)
PbHCO3+	2.640e-10	2.323e-10	-9.578	-9.634	-0.056	(0)
PbCO3	1.663e-10	1.669e-10	-9.779	-9.777	0.002	(0)
CdHCO3+	6.060e-11	5.333e-11	-10.218	-10.273	-0.056	(0)
BaCO3	6.036e-11	6.060e-11	-10.219	-10.218	0.002	(0)
Zn (CO3) 2-2	8.178e-12	4.903e-12	-11.087	-11.310	-0.222	(0)
Cu (CO3) 2-2	2.303e-12	1.381e-12	-11.638	-11.860	-0.222	(0)
Pb (CO3) 2-2	2.243e-13	1.345e-13	-12.649	-12.871	-0.222	(0)
CdCO3	4.381e-14	4.399e-14	-13.358	-13.357	0.002	(0)
Cd (CO3) 2-2	7.441e-17	4.461e-17	-16.128	-16.351	-0.222	(0)
Ca	3.696e-03					
Ca+2	3.448e-03	2.108e-03	-2.462	-2.676	-0.214	(0)
CaHCO3+	2.097e-04	1.845e-04	-3.678	-3.734	-0.056	(0)
CaSO4	3.693e-05	3.708e-05	-4.433	-4.431	0.002	(0)
CaCO3	9.113e-07	9.150e-07	-6.040	-6.039	0.002	(0)
CaOH+	4.159e-10	3.660e-10	-9.381	-9.437	-0.056	(0)
CaHSO4+	1.992e-10	1.753e-10	-9.701	-9.756	-0.056	(0)
Cd	3.562e-10					
Cd+2	2.880e-10	1.727e-10	-9.541	-9.763	-0.222	(0)
CdHCO3+	6.060e-11	5.333e-11	-10.218	-10.273	-0.056	(0)
CdSO4	4.623e-12	4.641e-12	-11.335	-11.333	0.002	(0)
CdCl+	2.890e-12	2.543e-12	-11.539	-11.595	-0.056	(0)
CdCO3	4.381e-14	4.399e-14	-13.358	-13.357	0.002	(0)
Cd (SO4) 2-2	9.758e-15	5.851e-15	-14.011	-14.233	-0.222	(0)
CdOH+	4.783e-15	4.208e-15	-14.320	-14.376	-0.056	(0)
CdCl2	1.618e-15	1.625e-15	-14.791	-14.789	0.002	(0)
CdOHCl	7.592e-16	7.623e-16	-15.120	-15.118	0.002	(0)
Cd (CO3) 2-2	7.441e-17	4.461e-17	-16.128	-16.351	-0.222	(0)
Cd (OH) 2	8.410e-19	8.444e-19	-18.075	-18.073	0.002	(0)
CdCl3-	1.469e-19	1.293e-19	-18.833	-18.888	-0.056	(0)
Cd2OH+3	1.393e-23	4.408e-24	-22.856	-23.356	-0.500	(0)
Cd (OH) 3-	1.127e-25	9.914e-26	-24.948	-25.004	-0.056	(0)
Cd (OH) 4-2	1.542e-33	9.245e-34	-32.812	-33.034	-0.222	(0)
Cl	1.863e-04					
Cl-	1.862e-04	1.633e-04	-3.730	-3.787	-0.057	(0)
MnCl+	1.400e-07	1.232e-07	-6.854	-6.910	-0.056	(0)
FeCl+	3.608e-09	3.175e-09	-8.443	-8.498	-0.056	(0)
CuCl2-	1.997e-09	1.758e-09	-8.700	-8.755	-0.056	(0)
AgCl	1.184e-10	1.189e-10	-9.927	-9.925	0.002	(0)
MnCl2	8.743e-12	8.779e-12	-11.058	-11.057	0.002	(0)
CdCl+	2.890e-12	2.543e-12	-11.539	-11.595	-0.056	(0)
ZnCl+	2.618e-12	2.304e-12	-11.582	-11.638	-0.056	(0)
AgCl2-	2.491e-12	2.192e-12	-11.604	-11.659	-0.056	(0)
CuCl3-2	7.101e-13	4.258e-13	-12.149	-12.371	-0.222	(0)
CuCl+	4.280e-13	3.767e-13	-12.369	-12.424	-0.056	(0)
PbCl+	1.446e-13	1.272e-13	-12.840	-12.895	-0.056	(0)
ZnOHCl	6.297e-14	6.322e-14	-13.201	-13.199	0.002	(0)
CdCl2	1.618e-15	1.625e-15	-14.791	-14.789	0.002	(0)
CdOHCl	7.592e-16	7.623e-16	-15.120	-15.118	0.002	(0)
MnCl3-	4.487e-16	3.948e-16	-15.348	-15.404	-0.056	(0)
AgCl3-2	4.267e-16	2.558e-16	-15.370	-15.592	-0.222	(0)
ZnCl2	3.662e-16	3.677e-16	-15.436	-15.435	0.002	(0)
PbCl2	4.519e-17	4.537e-17	-16.345	-16.343	0.002	(0)
CuCl2	2.732e-17	2.744e-17	-16.563	-16.562	0.002	(0)
AgCl4-3	2.191e-19	6.933e-20	-18.659	-19.159	-0.500	(0)

CdCl3-	1.469e-19	1.293e-19	-18.833	-18.888	-0.056	(0)
ZnCl3-	6.907e-20	6.078e-20	-19.161	-19.216	-0.056	(0)
FeCl+2	1.112e-20	6.669e-21	-19.954	-20.176	-0.222	(0)
PbCl3-	6.016e-21	5.294e-21	-20.221	-20.276	-0.056	(0)
CuCl3-	1.333e-23	1.173e-23	-22.875	-22.931	-0.056	(0)
FeCl2+	9.525e-24	8.382e-24	-23.021	-23.077	-0.056	(0)
ZnCl4-2	7.241e-24	4.341e-24	-23.140	-23.362	-0.222	(0)
PbCl4-2	6.046e-25	3.625e-25	-24.219	-24.441	-0.222	(0)
FeCl3	1.363e-28	1.369e-28	-27.865	-27.864	0.002	(0)
CuCl4-2	1.076e-29	6.450e-30	-28.968	-29.190	-0.222	(0)
Cu (1)	2.294e-07					
Cu+	2.274e-07	2.001e-07	-6.643	-6.699	-0.056	(0)
CuCl2-	1.997e-09	1.758e-09	-8.700	-8.755	-0.056	(0)
CuCl3-2	7.101e-13	4.258e-13	-12.149	-12.371	-0.222	(0)
Cu (2)	1.787e-08					
CuHCO3+	1.105e-08	9.720e-09	-7.957	-8.012	-0.056	(0)
CuCO3	3.407e-09	3.421e-09	-8.468	-8.466	0.002	(0)
Cu+2	3.312e-09	1.986e-09	-8.480	-8.702	-0.222	(0)
Cu (OH) 2	4.524e-11	4.543e-11	-10.344	-10.343	0.002	(0)
CuSO4	3.713e-11	3.728e-11	-10.430	-10.429	0.002	(0)
CuOH+	2.361e-11	2.078e-11	-10.627	-10.682	-0.056	(0)
Cu (CO3) 2-2	2.303e-12	1.381e-12	-11.638	-11.860	-0.222	(0)
CuCl+	4.280e-13	3.767e-13	-12.369	-12.424	-0.056	(0)
Cu2 (OH) 2+2	5.733e-17	3.437e-17	-16.242	-16.464	-0.222	(0)
CuCl2	2.732e-17	2.744e-17	-16.563	-16.562	0.002	(0)
Cu (OH) 3-	3.255e-18	2.864e-18	-17.487	-17.543	-0.056	(0)
CuCl3-	1.333e-23	1.173e-23	-22.875	-22.931	-0.056	(0)
Cu (OH) 4-2	9.972e-25	5.979e-25	-24.001	-24.223	-0.222	(0)
CuCl4-2	1.076e-29	6.450e-30	-28.968	-29.190	-0.222	(0)
Fe (2)	3.943e-05					
Fe+2	2.349e-05	1.409e-05	-4.629	-4.851	-0.222	(0)
FeHCO3+	1.563e-05	1.376e-05	-4.806	-4.862	-0.056	(0)
FeSO4	1.887e-07	1.894e-07	-6.724	-6.723	0.002	(0)
FeCO3	1.079e-07	1.084e-07	-6.967	-6.965	0.002	(0)
FeCl+	3.608e-09	3.175e-09	-8.443	-8.498	-0.056	(0)
FeOH+	1.469e-09	1.293e-09	-8.833	-8.889	-0.056	(0)
FeHSO4+	1.331e-12	1.171e-12	-11.876	-11.931	-0.056	(0)
Fe (OH) 2	2.576e-15	2.577e-15	-14.589	-14.587	0.002	(0)
Fe (OH) 3-	9.654e-20	8.496e-20	-19.015	-19.071	-0.056	(0)
Fe (3)	1.252e-12					
Fe (OH) 2+	1.177e-12	1.036e-12	-11.929	-11.985	-0.056	(0)
Fe (OH) 3	6.579e-14	6.605e-14	-13.182	-13.180	0.002	(0)
FeOH+2	9.558e-15	5.731e-15	-14.020	-14.242	-0.222	(0)
Fe (OH) 4-	3.593e-17	3.162e-17	-16.445	-16.500	-0.056	(0)
Fe+3	7.366e-18	2.330e-18	-17.133	-17.633	-0.500	(0)
FeSO4+	2.056e-18	1.809e-18	-17.687	-17.743	-0.056	(0)
FeCl+2	1.112e-20	6.669e-21	-19.954	-20.176	-0.222	(0)
Fe (SO4) 2-	4.353e-21	3.831e-21	-20.361	-20.417	-0.056	(0)
FeCl2+	9.525e-24	8.382e-24	-23.021	-23.077	-0.056	(0)
FeHSO4+2	8.119e-24	4.868e-24	-23.091	-23.313	-0.222	(0)
Fe2 (OH) 2+4	1.390e-26	1.797e-27	-25.857	-26.746	-0.889	(0)
FeCl3	1.363e-28	1.369e-28	-27.865	-27.864	0.002	(0)
Fe3 (OH) 4+5	4.633e-35	1.894e-36	-34.334	-35.723	-1.388	(0)
H (0)	7.750e-17					
H2	3.875e-17	3.891e-17	-16.412	-16.410	0.002	(0)
K	7.704e-05					
K+	7.700e-05	6.754e-05	-4.113	-4.170	-0.057	(0)
KSO4-	4.138e-08	3.641e-08	-7.383	-7.439	-0.056	(0)
Mg	1.865e-03					
Mg+2	1.716e-03	1.060e-03	-2.765	-2.975	-0.209	(0)
MgHCO3+	1.318e-04	1.160e-04	-3.880	-3.936	-0.056	(0)
MgSO4	1.646e-05	1.653e-05	-4.784	-4.782	0.002	(0)
MgCO3	2.518e-07	2.528e-07	-6.599	-6.597	0.002	(0)
MgOH+	9.712e-10	8.546e-10	-9.013	-9.068	-0.056	(0)
Mn (2)	4.992e-04					
Mn+2	3.088e-04	1.851e-04	-3.510	-3.733	-0.222	(0)
MnHCO3+	1.831e-04	1.611e-04	-3.737	-3.793	-0.056	(0)

MnCO3	4.697e-06	4.716e-06	-5.328	-5.326	0.002	(0)
MnSO4	2.446e-06	2.456e-06	-5.611	-5.610	0.002	(0)
MnCl+	1.400e-07	1.232e-07	-6.854	-6.910	-0.056	(0)
MnOH+	1.397e-09	1.229e-09	-8.855	-8.910	-0.056	(0)
MnCl2	8.743e-12	8.779e-12	-11.058	-11.057	0.002	(0)
MnCl3-	4.487e-16	3.948e-16	-15.348	-15.404	-0.056	(0)
Mn(OH) 3-	3.820e-21	3.361e-21	-20.418	-20.474	-0.056	(0)
Mn (3)	6.542e-30					
Mn+3	6.542e-30	2.070e-30	-29.184	-29.684	-0.500	(0)
Mn (6)	0.000e+00					
MnO4-2	0.000e+00	0.000e+00	-77.534	-77.756	-0.222	(0)
Mn (7)	0.000e+00					
MnO4-	0.000e+00	0.000e+00	-87.560	-87.615	-0.056	(0)
Na	6.095e-04					
Na+	6.063e-04	5.344e-04	-3.217	-3.272	-0.055	(0)
NaHCO3	2.923e-06	2.934e-06	-5.534	-5.532	0.002	(0)
NaSO4-	2.825e-07	2.486e-07	-6.549	-6.604	-0.056	(0)
NaCO3-	1.526e-09	1.343e-09	-8.816	-8.872	-0.056	(0)
O (0)	0.000e+00					
O2	0.000e+00	0.000e+00	-65.102	-65.100	0.002	(0)
Pb	4.831e-10					
PbHCO3+	2.640e-10	2.323e-10	-9.578	-9.634	-0.056	(0)
PbCO3	1.663e-10	1.669e-10	-9.779	-9.777	0.002	(0)
Pb+2	4.996e-11	2.995e-11	-10.301	-10.524	-0.222	(0)
PbSO4	1.736e-12	1.744e-12	-11.760	-11.759	0.002	(0)
PbOH+	6.944e-13	6.111e-13	-12.158	-12.214	-0.056	(0)
Pb(CO3) 2-2	2.243e-13	1.345e-13	-12.649	-12.871	-0.222	(0)
PbCl+	1.446e-13	1.272e-13	-12.840	-12.895	-0.056	(0)
Pb(SO4) 2-2	1.580e-15	9.471e-16	-14.801	-15.024	-0.222	(0)
Pb(OH) 2	2.477e-16	2.487e-16	-15.606	-15.604	0.002	(0)
PbCl2	4.519e-17	4.537e-17	-16.345	-16.343	0.002	(0)
PbCl3-	6.016e-21	5.294e-21	-20.221	-20.276	-0.056	(0)
Pb(OH) 3-	3.396e-21	2.988e-21	-20.469	-20.525	-0.056	(0)
Pb2OH+3	1.295e-21	4.098e-22	-20.888	-21.387	-0.500	(0)
PbCl4-2	6.046e-25	3.625e-25	-24.219	-24.441	-0.222	(0)
Pb(OH) 4-2	1.195e-26	7.163e-27	-25.923	-26.145	-0.222	(0)
Pb3(OH) 4+2	5.394e-33	3.234e-33	-32.268	-32.490	-0.222	(0)
S (6)	2.271e-04					
SO4-2	1.707e-04	1.035e-04	-3.768	-3.985	-0.217	(0)
CaSO4	3.693e-05	3.708e-05	-4.433	-4.431	0.002	(0)
MgSO4	1.646e-05	1.653e-05	-4.784	-4.782	0.002	(0)
MnSO4	2.446e-06	2.456e-06	-5.611	-5.610	0.002	(0)
NaSO4-	2.825e-07	2.486e-07	-6.549	-6.604	-0.056	(0)
FeSO4	1.887e-07	1.894e-07	-6.724	-6.723	0.002	(0)
KSO4-	4.138e-08	3.641e-08	-7.383	-7.439	-0.056	(0)
BaSO4	2.618e-08	2.629e-08	-7.582	-7.580	0.002	(0)
HSO4-	7.861e-09	6.917e-09	-8.105	-8.160	-0.056	(0)
ZnSO4	2.366e-10	2.376e-10	-9.626	-9.624	0.002	(0)
CaHSO4+	1.992e-10	1.753e-10	-9.701	-9.756	-0.056	(0)
CuSO4	3.713e-11	3.728e-11	-10.430	-10.429	0.002	(0)
CdSO4	4.623e-12	4.641e-12	-11.335	-11.333	0.002	(0)
PbSO4	1.736e-12	1.744e-12	-11.760	-11.759	0.002	(0)
FeHSO4+	1.331e-12	1.171e-12	-11.876	-11.931	-0.056	(0)
AgSO4-	5.980e-13	5.262e-13	-12.223	-12.279	-0.056	(0)
Zn(SO4) 2-2	3.805e-13	2.281e-13	-12.420	-12.642	-0.222	(0)
Cd(SO4) 2-2	9.758e-15	5.851e-15	-14.011	-14.233	-0.222	(0)
Pb(SO4) 2-2	1.580e-15	9.471e-16	-14.801	-15.024	-0.222	(0)
FeSO4+	2.056e-18	1.809e-18	-17.687	-17.743	-0.056	(0)
Fe(SO4) 2-	4.353e-21	3.831e-21	-20.361	-20.417	-0.056	(0)
FeHSO4+2	8.119e-24	4.868e-24	-23.091	-23.313	-0.222	(0)
Se (-2)	6.545e-15					
HSe-	6.487e-15	5.709e-15	-14.188	-14.243	-0.056	(0)
H2Se	5.733e-17	5.757e-17	-16.242	-16.240	0.002	(0)
Se (4)	6.338e-09					
HSeO3-	6.304e-09	5.547e-09	-8.200	-8.256	-0.056	(0)
SeO3-2	3.064e-11	1.837e-11	-10.514	-10.736	-0.222	(0)
H2SeO3	2.967e-12	2.979e-12	-11.528	-11.526	0.002	(0)

Se (6)	3.665e-28						
SeO4-2	3.665e-28	2.198e-28	-27.436	-27.658	-0.222	(0)	
HSeO4-	6.765e-33	5.953e-33	-32.170	-32.225	-0.056	(0)	
Zn	3.521e-08						
Zn+2	1.864e-08	1.117e-08	-7.730	-7.952	-0.222	(0)	
ZnHCO3+	1.561e-08	1.374e-08	-7.807	-7.862	-0.056	(0)	
ZnCO3	7.122e-10	7.151e-10	-9.147	-9.146	0.002	(0)	
ZnSO4	2.366e-10	2.376e-10	-9.626	-9.624	0.002	(0)	
Zn(CO3)2-2	8.178e-12	4.903e-12	-11.087	-11.310	-0.222	(0)	
ZnOH+	3.963e-12	3.487e-12	-11.402	-11.458	-0.056	(0)	
ZnCl+	2.618e-12	2.304e-12	-11.582	-11.638	-0.056	(0)	
Zn(SO4)2-2	3.805e-13	2.281e-13	-12.420	-12.642	-0.222	(0)	
Zn(OH)2	1.534e-13	1.540e-13	-12.814	-12.812	0.002	(0)	
ZnOHCl	6.297e-14	6.322e-14	-13.201	-13.199	0.002	(0)	
ZnCl2	3.662e-16	3.677e-16	-15.436	-15.435	0.002	(0)	
Zn(OH)3-	5.791e-19	5.096e-19	-18.237	-18.293	-0.056	(0)	
ZnCl3-	6.907e-20	6.078e-20	-19.161	-19.216	-0.056	(0)	
ZnCl4-2	7.241e-24	4.341e-24	-23.140	-23.362	-0.222	(0)	
Zn(OH)4-2	1.409e-25	8.451e-26	-24.851	-25.073	-0.222	(0)	

-----Saturation indices-----

Phase	SI**	log IAP	log K(281 K,	1 atm)	
Ag2CO3	-14.06	-25.54	-11.47	Ag2CO3	
Ag2O	-20.02	-7.00	13.02	Ag2O	
Ag2SO4	-17.93	-23.03	-5.10	Ag2SO4	
AgMetal	4.41	-10.17	-14.57	Ag	
Anglesite	-6.63	-14.51	-7.88	PbSO4	
Anhydrite	-2.32	-6.66	-4.34	CaSO4	
Antlerite	-14.30	-6.01	8.29	Cu3(OH)4SO4	
Aragonite	-0.92	-9.17	-8.25	CaCO3	
Arsenolite	-14.76	-16.44	-1.68	As2O3	
Artinite	-11.22	-0.41	10.81	MgCO3:Mg(OH)2:3H2O	
As2O5(cr)	-39.54	-30.99	8.55	As2O5	
As_native	-14.53	-28.22	-13.69	As	
Atacamite	-11.26	-3.13	8.13	Cu2(OH)3Cl	
Azurite	-11.10	-6.05	5.05	Cu3(OH)2(CO3)2	
Ba3(AsO4)2	-5.75	-56.27	-50.51	Ba3(AsO4)2	
Barite	-0.01	-10.28	-10.27	BaSO4	
BaSeO3	-10.64	-17.03	-6.39	BaSeO3	
Bianchite	-10.18	-11.94	-1.76	ZnSO4:6H2O	
Birnessite	-21.96	21.64	43.60	MnO2	
Bixbyite	-23.28	-23.25	0.03	Mn2O3	
Brochantite	-18.02	-2.68	15.34	Cu4(OH)6SO4	
Brucite	-8.92	9.06	17.98	Mg(OH)2	
Ca3(AsO4)2:4w	-26.50	-45.41	-18.91	Ca3(AsO4)2:4H2O	
Calcite	-0.76	-9.17	-8.41	CaCO3	
CaSeO3	-7.81	-13.41	-5.60	CaSeO3	
Cd(gamma)	-25.41	-11.06	14.36	Cd	
Cd(OH)2	-11.37	2.28	13.65	Cd(OH)2	
Cd(OH)2(a)	-12.33	2.28	14.61	Cd(OH)2	
Cd3(OH)2(SO4)2	-31.93	-25.22	6.71	Cd3(OH)2(SO4)2	
Cd3(OH)4SO4	-31.75	-9.19	22.56	Cd3(OH)4SO4	
Cd4(OH)6SO4	-35.32	-6.92	28.40	Cd4(OH)6SO4	
CdCl2	-16.85	-17.34	-0.49	CdCl2	
CdCl2:2.5H2O	-15.33	-17.34	-2.01	CdCl2:2.5H2O	
CdCl2:H2O	-15.70	-17.34	-1.63	CdCl2:H2O	
CdMetal	-25.31	-11.06	14.25	Cd	
CdOHCl	-11.36	-7.53	3.83	CdOHCl	
CdSO4	-14.27	-13.75	0.52	CdSO4	
CdSO4:2.7H2O	-12.06	-13.75	-1.69	CdSO4:2.67H2O	
CdSO4:H2O	-12.41	-13.75	-1.34	CdSO4:H2O	
Cerargyrite	-2.90	-13.31	-10.41	AgCl	
Cerrusite	-3.68	-17.02	-13.34	PbCO3	
Chalcanthite	-9.99	-12.69	-2.70	CuSO4:5H2O	
Claudetite	-14.81	-16.44	-1.63	As2O3	

CO2 (g)	-0.30	-1.55	-1.25	CO2
Cotunnite	-13.09	-18.10	-5.01	PbCl2
Cu(OH)2	-5.95	3.34	9.28	Cu(OH)2
Cu2SO4	-15.62	-17.38	-1.76	Cu2SO4
Cu3(AsO4)2:6w	-28.36	-63.49	-35.12	Cu3(AsO4)2:6H2O
CuCO3	-5.57	-15.20	-9.63	CuCO3
CuMetal	2.14	-7.35	-9.48	Cu
CuOCuSO4	-22.38	-9.35	13.03	CuO:CuSO4
CupricFerrite	-3.32	4.19	7.51	CuFe2O4
Cuprite	0.46	-1.36	-1.81	Cu2O
CuprousFerrite	8.51	-0.25	-8.76	CuFeO2
CuSO4	-16.46	-12.69	3.78	CuSO4
Dolomite	-1.95	-18.64	-16.69	CaMg(CO3)2
Dolomite(d)	-2.57	-18.64	-16.07	CaMg(CO3)2
Epsomite	-4.70	-6.96	-2.26	MgSO4:7H2O
Fe(OH)2.7Cl.3	0.52	-2.52	-3.04	Fe(OH)2.7Cl0.3
Fe(OH)3(a)	-4.46	0.43	4.89	Fe(OH)3
Fe2(SeO3)3	-32.04	-67.47	-35.43	Fe2(SeO3)3
Fe3(OH)8	-12.18	8.04	20.22	Fe3(OH)8
FeSe2	-1.42	-20.00	-18.58	FeSe2
Goethite	0.82	0.43	-0.39	FeOOH
Goslarite	-9.84	-11.94	-2.10	ZnSO4:7H2O
Gypsum	-2.07	-6.66	-4.59	CaSO4:2H2O
H2(g)	-13.33	-16.41	-3.08	H2
H2O(g)	-1.95	-0.00	1.95	H2O
Halite	-8.60	-7.06	1.54	NaCl
Hausmannite	-27.02	38.26	65.28	Mn3O4
Hematite	3.56	0.85	-2.71	Fe2O3
Huntite	-8.69	-37.58	-28.88	CaMg3(CO3)4
Hydrocerrusite	-15.06	-32.52	-17.46	Pb(OH)2:2PbCO3
Hydromagnesite	-22.25	-28.81	-6.56	Mg5(CO3)4(OH)2:4H2O
Hydrozincite	-25.93	4.38	30.31	Zn5(OH)6(CO3)2
Hydrozincite_PG	-27.92	4.38	32.29	Zn5(OH)6(CO3)2
Jarosite(ss)	-19.43	-29.26	-9.83	(K0.77Na0.03H0.2)Fe3(SO4)2(OH)6
Jarosite-K	-21.03	-28.92	-7.89	KFe3(SO4)2(OH)6
Jarosite-Na	-24.27	-28.02	-3.75	NaFe3(SO4)2(OH)6
JarositeH	-27.71	-30.77	-3.06	(H3O)Fe3(SO4)2(OH)6
Langite	-21.14	-2.68	18.46	Cu4(OH)6SO4:H2O
Larnakite	-12.98	-12.99	-0.01	PbO:PbSO4
Laurionite	-8.91	-8.29	0.62	PbOHCl
Litharge	-11.90	1.52	13.41	PbO
Maghemite	-5.53	0.85	6.39	Fe2O3
Magnesite	-1.70	-9.47	-7.77	MgCO3
Magnetite	2.18	8.04	5.87	Fe3O4
Malachite	-7.34	-1.36	5.98	Cu2(OH)2CO3
Manganite	-10.37	14.97	25.34	MnOOH
Massicot	-12.10	1.52	13.62	PbO
Melanothallite	-20.53	-16.28	4.25	CuCl2
Melanterite	-6.41	-8.84	-2.43	FeSO4:7H2O
Minium	-60.14	17.88	78.03	Pb3O4
Mirabilite	-8.62	-10.53	-1.92	Na2SO4:10H2O
Mn2(SO4)3	-67.26	-71.32	-4.06	Mn2(SO4)3
Mn3(AsO4)2:8H2O	-19.87	-48.58	-28.71	Mn3(AsO4)2:8H2O
MnCl2:4H2O	-13.28	-11.31	1.98	MnCl2:4H2O
MnSO4	-11.04	-7.72	3.32	MnSO4
Monteponite	-12.54	2.28	14.81	CdO
Nahcolite	-4.58	-5.28	-0.70	NaHCO3
Nantokite	-3.30	-10.49	-7.18	CuCl
Natron	-11.07	-13.04	-1.98	Na2CO3:10H2O
Nesquehonite	-4.09	-9.47	-5.38	MgCO3:3H2O
Nsutite	-20.92	21.64	42.56	MnO2
O2(g)	-62.35	-65.10	-2.75	O2
Otavite	-4.26	-16.26	-12.00	CdCO3
Pb(OH)2	-7.22	1.52	8.74	Pb(OH)2
Pb2(OH)3Cl	-15.57	-6.78	8.79	Pb2(OH)3Cl
Pb2O(OH)2	-23.17	3.03	26.20	PbO:Pb(OH)2
Pb2O3	-44.67	16.37	61.04	Pb2O3

Pb2OCO3	-15.48	-15.50	-0.02	PbO:PbCO3
Pb3(AsO4)2	-33.55	-68.95	-35.40	Pb3(AsO4)2
Pb3O2CO3	-26.12	-13.99	12.14	PbCO3:2PbO
Pb3O2SO4	-22.75	-11.48	11.28	PbSO4:2PbO
Pb4(OH)6SO4	-31.06	-9.96	21.10	Pb4(OH)6SO4
Pb4O3SO4	-33.54	-9.96	23.58	PbSO4:3PbO
PbMetal	-16.07	-11.82	4.25	Pb
PbO:0.3H2O	-11.46	1.52	12.98	PbO:0.33H2O
Phosgenite	-15.31	-35.12	-19.81	PbCl2:PbCO3
Plattnerite	-37.43	14.85	52.28	PbO2
Portlandite	-14.74	9.36	24.11	Ca(OH)2
Pyrochroite	-6.89	8.31	15.20	Mn(OH)2
Pyrolusite	-22.49	21.64	44.13	MnO2
Rhodochrosite	0.84	-10.23	-11.07	MnCO3
Rhodochrosite(d)	0.16	-10.23	-10.39	MnCO3
Scorodite	-16.07	-36.32	-20.25	FeAsO4:2H2O
Se(s)	10.39	-6.93	-17.32	Se
SeO2	-14.40	-22.78	-8.38	SeO2
Siderite	-0.56	-11.35	-10.79	FeCO3
Siderite(d)(3)	-0.90	-11.35	-10.45	FeCO3
Smithsonite	-4.63	-14.45	-9.82	ZnCO3
Smithsonite_PG	-3.65	-14.45	-10.79	ZnCO3
Tenorite	-4.93	3.34	8.26	CuO
Thenardite	-10.37	-10.53	-0.15	Na2SO4
Thermonatrite	-13.28	-13.04	0.24	Na2CO3:H2O
Trona	-18.29	-18.32	-0.04	NaHCO3:Na2CO3:2H2O
Witherite	-4.15	-12.79	-8.64	BaCO3
Zincite(c)	-7.97	4.09	12.06	ZnO
Zincosite	-15.76	-11.94	3.82	ZnSO4
Zn(OH)2-a	-8.36	4.09	12.45	Zn(OH)2
Zn(OH)2-b	-7.66	4.09	11.75	Zn(OH)2
Zn(OH)2-c	-8.11	4.09	12.20	Zn(OH)2
Zn(OH)2-e	-7.41	4.09	11.50	Zn(OH)2
Zn(OH)2-g	-7.62	4.09	11.71	Zn(OH)2
Zn2(OH)2SO4	-15.35	-7.85	7.50	Zn2(OH)2SO4
Zn2(OH)3Cl	-16.83	-1.63	15.20	Zn2(OH)3Cl
Zn3(AsO4)2:2.5w	-33.69	-61.24	-27.55	Zn3(AsO4)2:2.5H2O
Zn3O(SO4)2	-41.42	-19.79	21.64	ZnO:2ZnSO4
Zn4(OH)6SO4	-28.07	0.33	28.40	Zn4(OH)6SO4
Zn5(OH)8Cl2	-37.68	0.82	38.50	Zn5(OH)8Cl2
ZnCl2	-23.29	-15.53	7.77	ZnCl2
ZnCO3:1H2O	-4.19	-14.45	-10.26	ZnCO3:1H2O
ZnCO3:H2O	-4.19	-14.45	-10.26	ZnCO3:H2O
ZnMetal	-36.55	-9.25	27.31	Zn
ZnO(a)	-7.22	4.09	11.31	ZnO
ZnSO4:H2O	-11.82	-11.94	-0.12	ZnSO4:H2O

**For a gas, SI = log10(fugacity). Fugacity = pressure * phi / 1 atm.
For ideal gases, phi = 1.

Initial solution 3. MW-1013A

-----Solution composition-----

Elements	Molality	Moles
Ag	4.639e-10	4.639e-10
Alkalinity	7.278e-03	7.278e-03
As	1.870e-09	1.870e-09
Ba	6.128e-07	6.128e-07
Ca	2.921e-03	2.921e-03
Cd	3.561e-10	3.561e-10
Cl	2.032e-04	2.032e-04
Cu	8.662e-09	8.662e-09
Fe	9.946e-07	9.946e-07
K	1.912e-04	1.912e-04
Mg	1.704e-03	1.704e-03

Mn	7.232e-05	7.232e-05
Na	1.493e-03	1.493e-03
Pb	4.830e-10	4.830e-10
S (6)	2.125e-03	2.125e-03
Se	2.535e-09	2.535e-09
Zn	3.521e-08	3.521e-08

-----Description of solution-----

pH	=	6.420
pe	=	1.690
Activity of water	=	1.000
Ionic strength (mol/kgw)	=	1.607e-02
Mass of water (kg)	=	1.000e+00
Total carbon (mol/kg)	=	1.418e-02
Total CO2 (mol/kg)	=	1.418e-02
Temperature (°C)	=	10.08
Electrical balance (eq)	=	-6.487e-04
Percent error, 100*(Cat- An)/(Cat+ An)	=	-3.14
Iterations	=	10
Total H	=	1.110197e+02
Total O	=	5.555035e+01

-----Distribution of species-----

Species	Molality	Activity	Log Molality	Log Activity	Log Gamma	mole V cm ³ /mol
H+	4.227e-07	3.802e-07	-6.374	-6.420	-0.046	0.00
OH-	8.764e-09	7.746e-09	-8.057	-8.111	-0.054	(0)
H2O	5.551e+01	9.996e-01	1.744	-0.000	0.000	18.02
Ag	4.639e-10					
Ag+	3.316e-10	2.931e-10	-9.479	-9.533	-0.054	(0)
AgCl	1.236e-10	1.240e-10	-9.908	-9.906	0.002	(0)
AgSO4-	5.877e-12	5.194e-12	-11.231	-11.284	-0.054	(0)
AgCl2-	2.809e-12	2.483e-12	-11.551	-11.605	-0.054	(0)
AgOH	7.678e-16	7.707e-16	-15.115	-15.113	0.002	(0)
AgCl3-2	5.379e-16	3.283e-16	-15.269	-15.484	-0.214	(0)
AgCl4-3	2.964e-19	9.756e-20	-18.528	-19.011	-0.483	(0)
Ag (OH) 2-	2.293e-21	2.026e-21	-20.640	-20.693	-0.054	(0)
As (3)	8.771e-10					
H3AsO3	8.761e-10	8.793e-10	-9.057	-9.056	0.002	(0)
H2AsO3-	1.032e-12	9.120e-13	-11.986	-12.040	-0.054	(0)
H4AsO3+	1.874e-16	1.656e-16	-15.727	-15.781	-0.054	(0)
HAsO3-2	3.984e-21	2.431e-21	-20.400	-20.614	-0.214	(0)
AsO3-3	2.263e-30	7.451e-31	-29.645	-30.128	-0.483	(0)
As (5)	9.930e-10					
H2AsO4-	7.968e-10	7.043e-10	-9.099	-9.152	-0.054	(0)
HAsO4-2	1.961e-10	1.197e-10	-9.707	-9.922	-0.214	(0)
H3AsO4	4.581e-14	4.598e-14	-13.339	-13.337	0.002	(0)
AsO4-3	1.454e-15	4.787e-16	-14.837	-15.320	-0.483	(0)
Ba	6.128e-07					
Ba+2	4.566e-07	2.786e-07	-6.341	-6.555	-0.214	(0)
BaSO4	1.444e-07	1.449e-07	-6.841	-6.839	0.002	(0)
BaHCO3+	1.186e-08	1.048e-08	-7.926	-7.980	-0.054	(0)
BaCO3	5.720e-11	5.741e-11	-10.243	-10.241	0.002	(0)
BaOH+	2.808e-14	2.482e-14	-13.552	-13.605	-0.054	(0)
C (4)	1.418e-02					
HCO3-	7.070e-03	6.278e-03	-2.151	-2.202	-0.052	(0)
CO2	6.901e-03	6.927e-03	-2.161	-2.159	0.002	(0)
CaHCO3+	1.042e-04	9.209e-05	-3.982	-4.036	-0.054	(0)
MgHCO3+	7.399e-05	6.539e-05	-4.131	-4.184	-0.054	(0)
MnHCO3+	1.868e-05	1.651e-05	-4.729	-4.782	-0.054	(0)
NaHCO3	4.613e-06	4.630e-06	-5.336	-5.334	0.002	(0)
MnCO3	1.257e-06	1.261e-06	-5.901	-5.899	0.002	(0)
CaCO3	1.152e-06	1.156e-06	-5.938	-5.937	0.002	(0)
CO3-2	8.656e-07	5.382e-07	-6.063	-6.269	-0.206	(0)

MgCO3	3.777e-07	3.791e-07	-6.423	-6.421	0.002	(0)
FeHCO3+	2.825e-07	2.497e-07	-6.549	-6.603	-0.054	(0)
BaHCO3+	1.186e-08	1.048e-08	-7.926	-7.980	-0.054	(0)
ZnHCO3+	1.100e-08	9.726e-09	-7.958	-8.012	-0.054	(0)
NaCO3-	6.734e-09	5.952e-09	-8.172	-8.225	-0.054	(0)
FeCO3	5.116e-09	5.135e-09	-8.291	-8.289	0.002	(0)
CuHCO3+	1.622e-09	1.433e-09	-8.790	-8.844	-0.054	(0)
ZnCO3	1.317e-09	1.321e-09	-8.881	-8.879	0.002	(0)
CuCO3	1.312e-09	1.317e-09	-8.882	-8.881	0.002	(0)
PbCO3	2.606e-10	2.616e-10	-9.584	-9.582	0.002	(0)
PbHCO3+	1.578e-10	1.395e-10	-9.802	-9.856	-0.054	(0)
BaCO3	5.720e-11	5.741e-11	-10.243	-10.241	0.002	(0)
CdHCO3+	3.706e-11	3.275e-11	-10.431	-10.485	-0.054	(0)
Zn (CO3) 2-2	2.492e-11	1.521e-11	-10.604	-10.818	-0.214	(0)
Cu (CO3) 2-2	1.462e-12	8.920e-13	-11.835	-12.050	-0.214	(0)
Pb (CO3) 2-2	5.795e-13	3.536e-13	-12.237	-12.451	-0.214	(0)
CdCO3	7.027e-14	7.054e-14	-13.153	-13.152	0.002	(0)
Cd (CO3) 2-2	1.967e-16	1.200e-16	-15.706	-15.921	-0.214	(0)
Ca	2.921e-03					
Ca+2	2.535e-03	1.576e-03	-2.596	-2.803	-0.207	(0)
CaSO4	2.807e-04	2.817e-04	-3.552	-3.550	0.002	(0)
CaHCO3+	1.042e-04	9.209e-05	-3.982	-4.036	-0.054	(0)
CaCO3	1.152e-06	1.156e-06	-5.938	-5.937	0.002	(0)
CaOH+	7.779e-10	6.876e-10	-9.109	-9.163	-0.054	(0)
CaHSO4+	6.063e-10	5.359e-10	-9.217	-9.271	-0.054	(0)
Cd	3.561e-10					
Cd+2	2.704e-10	1.650e-10	-9.568	-9.783	-0.214	(0)
CdSO4	4.469e-11	4.485e-11	-10.350	-10.348	0.002	(0)
CdHCO3+	3.706e-11	3.275e-11	-10.431	-10.485	-0.054	(0)
CdCl+	3.030e-12	2.678e-12	-11.519	-11.572	-0.054	(0)
Cd (SO4) 2-2	9.204e-13	5.617e-13	-12.036	-12.250	-0.214	(0)
CdCO3	7.027e-14	7.054e-14	-13.153	-13.152	0.002	(0)
CdOH+	1.274e-14	1.126e-14	-13.895	-13.949	-0.054	(0)
CdOHC1	2.073e-15	2.081e-15	-14.683	-14.682	0.002	(0)
CdCl2	1.880e-15	1.887e-15	-14.726	-14.724	0.002	(0)
Cd (CO3) 2-2	1.967e-16	1.200e-16	-15.706	-15.921	-0.214	(0)
Cd (OH) 2	5.076e-18	5.095e-18	-17.294	-17.293	0.002	(0)
CdCl3-	1.904e-19	1.683e-19	-18.720	-18.774	-0.054	(0)
Cd2OH+3	3.361e-23	1.106e-23	-22.474	-22.956	-0.483	(0)
Cd (OH) 3-	1.701e-24	1.503e-24	-23.769	-23.823	-0.054	(0)
Cd (OH) 4-2	5.772e-32	3.522e-32	-31.239	-31.453	-0.214	(0)
Cl	2.032e-04					
Cl-	2.032e-04	1.791e-04	-3.692	-3.747	-0.055	(0)
MnCl+	2.435e-08	2.152e-08	-7.613	-7.667	-0.054	(0)
AgCl	1.236e-10	1.240e-10	-9.908	-9.906	0.002	(0)
FeCl+	1.113e-10	9.834e-11	-9.954	-10.007	-0.054	(0)
CuCl2-	5.017e-11	4.434e-11	-10.300	-10.353	-0.054	(0)
ZnCl+	3.358e-12	2.968e-12	-11.474	-11.528	-0.054	(0)
CdCl+	3.030e-12	2.678e-12	-11.519	-11.572	-0.054	(0)
AgCl2-	2.809e-12	2.483e-12	-11.551	-11.605	-0.054	(0)
MnCl2	1.676e-12	1.683e-12	-11.776	-11.774	0.002	(0)
ZnOHC1	1.912e-13	1.919e-13	-12.719	-12.717	0.002	(0)
PbCl+	1.528e-13	1.351e-13	-12.816	-12.869	-0.054	(0)
CuCl+	1.151e-13	1.018e-13	-12.939	-12.992	-0.054	(0)
CuCl3-2	1.941e-14	1.185e-14	-13.712	-13.926	-0.214	(0)
CdOHC1	2.073e-15	2.081e-15	-14.683	-14.682	0.002	(0)
CdCl2	1.880e-15	1.887e-15	-14.726	-14.724	0.002	(0)
AgCl3-2	5.379e-16	3.283e-16	-15.269	-15.484	-0.214	(0)
ZnCl2	5.205e-16	5.225e-16	-15.284	-15.282	0.002	(0)
MnCl3-	9.390e-17	8.299e-17	-16.027	-16.081	-0.054	(0)
PbCl2	5.123e-17	5.142e-17	-16.290	-16.289	0.002	(0)
CuCl2	8.228e-18	8.258e-18	-17.085	-17.083	0.002	(0)
AgCl4-3	2.964e-19	9.756e-20	-18.528	-19.011	-0.483	(0)
CdCl3-	1.904e-19	1.683e-19	-18.720	-18.774	-0.054	(0)
ZnCl3-	1.081e-19	9.554e-20	-18.966	-19.020	-0.054	(0)
PbCl3-	7.511e-21	6.639e-21	-20.124	-20.178	-0.054	(0)
FeCl+2	4.242e-21	2.588e-21	-20.372	-20.587	-0.214	(0)

ZnCl4-2	1.241e-23	7.572e-24	-22.906	-23.121	-0.214	(0)
CuCl3-	4.495e-24	3.973e-24	-23.347	-23.401	-0.054	(0)
FeCl2+	3.854e-24	3.407e-24	-23.414	-23.468	-0.054	(0)
PbCl4-2	8.263e-25	5.043e-25	-24.083	-24.297	-0.214	(0)
FeCl3	6.078e-29	6.101e-29	-28.216	-28.215	0.002	(0)
CuCl4-2	4.062e-30	2.479e-30	-29.391	-29.606	-0.214	(0)
Cu (1)	4.815e-09					
Cu+	4.765e-09	4.212e-09	-8.322	-8.376	-0.054	(0)
CuCl2-	5.017e-11	4.434e-11	-10.300	-10.353	-0.054	(0)
CuCl3-2	1.941e-14	1.185e-14	-13.712	-13.926	-0.214	(0)
Cu (2)	3.847e-09					
CuHCO3+	1.622e-09	1.433e-09	-8.790	-8.844	-0.054	(0)
CuCO3	1.312e-09	1.317e-09	-8.882	-8.881	0.002	(0)
Cu+2	7.464e-10	4.555e-10	-9.127	-9.342	-0.214	(0)
CuSO4	8.626e-11	8.658e-11	-10.064	-10.063	0.002	(0)
Cu (OH) 2	6.555e-11	6.579e-11	-10.183	-10.182	0.002	(0)
CuOH+	1.355e-11	1.198e-11	-10.868	-10.922	-0.054	(0)
Cu (CO3) 2-2	1.462e-12	8.920e-13	-11.835	-12.050	-0.214	(0)
CuCl+	1.151e-13	1.018e-13	-12.939	-12.992	-0.054	(0)
Cu2 (OH) 2+2	2.163e-17	1.320e-17	-16.665	-16.880	-0.214	(0)
Cu (OH) 3-	1.179e-17	1.042e-17	-16.928	-16.982	-0.054	(0)
CuCl2	8.228e-18	8.258e-18	-17.085	-17.083	0.002	(0)
Cu (OH) 4-2	8.960e-24	5.468e-24	-23.048	-23.262	-0.214	(0)
CuCl3-	4.495e-24	3.973e-24	-23.347	-23.401	-0.054	(0)
CuCl4-2	4.062e-30	2.479e-30	-29.391	-29.606	-0.214	(0)
Fe (2)	9.946e-07					
Fe+2	6.518e-07	3.978e-07	-6.186	-6.400	-0.214	(0)
FeHCO3+	2.825e-07	2.497e-07	-6.549	-6.603	-0.054	(0)
FeSO4	5.487e-08	5.507e-08	-7.261	-7.259	0.002	(0)
FeCO3	5.116e-09	5.135e-09	-8.291	-8.289	0.002	(0)
FeOH+	1.157e-10	1.023e-10	-9.937	-9.990	-0.054	(0)
FeCl+	1.113e-10	9.834e-11	-9.954	-10.007	-0.054	(0)
FeHSO4+	1.531e-13	1.353e-13	-12.815	-12.869	-0.054	(0)
Fe (OH) 2	5.818e-16	5.839e-16	-15.235	-15.234	0.002	(0)
Fe (OH) 3-	5.531e-20	4.889e-20	-19.257	-19.311	-0.054	(0)
Fe (3)	3.321e-12					
Fe (OH) 2+	2.879e-12	2.545e-12	-11.541	-11.594	-0.054	(0)
Fe (OH) 3	4.330e-13	4.346e-13	-12.363	-12.362	0.002	(0)
FeOH+2	8.689e-15	5.302e-15	-14.061	-14.276	-0.214	(0)
Fe (OH) 4-	6.272e-16	5.544e-16	-15.203	-15.256	-0.054	(0)
FeSO4+	7.159e-18	6.328e-18	-17.145	-17.199	-0.054	(0)
Fe+3	2.392e-18	7.874e-19	-17.621	-18.104	-0.483	(0)
Fe (SO4) 2-	1.528e-19	1.351e-19	-18.816	-18.869	-0.054	(0)
FeCl+2	4.242e-21	2.588e-21	-20.372	-20.587	-0.214	(0)
FeHSO4+2	1.102e-23	6.727e-24	-22.958	-23.172	-0.214	(0)
FeCl2+	3.854e-24	3.407e-24	-23.414	-23.468	-0.054	(0)
Fe2 (OH) 2+4	1.044e-26	1.448e-27	-25.981	-26.839	-0.858	(0)
FeCl3	6.078e-29	6.101e-29	-28.216	-28.215	0.002	(0)
Fe3 (OH) 4+5	7.183e-35	3.279e-36	-34.144	-35.484	-1.340	(0)
H (0)	9.924e-20					
H2	4.962e-20	4.980e-20	-19.304	-19.303	0.002	(0)
K	1.912e-04					
K+	1.901e-04	1.676e-04	-3.721	-3.776	-0.055	(0)
KSO4-	1.051e-06	9.288e-07	-5.978	-6.032	-0.054	(0)
Mg	1.704e-03					
Mg+2	1.480e-03	9.283e-04	-2.830	-3.032	-0.202	(0)
MgSO4	1.501e-04	1.507e-04	-3.824	-3.822	0.002	(0)
MgHCO3+	7.399e-05	6.539e-05	-4.131	-4.184	-0.054	(0)
MgCO3	3.777e-07	3.791e-07	-6.423	-6.421	0.002	(0)
MgOH+	2.428e-09	2.146e-09	-8.615	-8.668	-0.054	(0)
Mn (2)	7.232e-05					
Mn+2	4.834e-05	2.950e-05	-4.316	-4.530	-0.214	(0)
MnHCO3+	1.868e-05	1.651e-05	-4.729	-4.782	-0.054	(0)
MnSO4	4.019e-06	4.034e-06	-5.396	-5.394	0.002	(0)
MnCO3	1.257e-06	1.261e-06	-5.901	-5.899	0.002	(0)
MnCl+	2.435e-08	2.152e-08	-7.613	-7.667	-0.054	(0)
MnOH+	6.270e-10	5.542e-10	-9.203	-9.256	-0.054	(0)

MnCl2	1.676e-12	1.683e-12	-11.776	-11.774	0.002	(0)
MnCl3-	9.390e-17	8.299e-17	-16.027	-16.081	-0.054	(0)
Mn(OH) 3-	9.616e-21	8.499e-21	-20.017	-20.071	-0.054	(0)
Mn (3)	1.370e-29					
Mn+3	1.370e-29	4.508e-30	-28.863	-29.346	-0.483	(0)
Mn (6)	0.000e+00					
MnO4-2	0.000e+00	0.000e+00	-70.428	-70.642	-0.214	(0)
Mn (7)	0.000e+00					
MnO4-	0.000e+00	0.000e+00	-79.309	-79.363	-0.054	(0)
Na	1.493e-03					
Na+	1.482e-03	1.311e-03	-2.829	-2.882	-0.053	(0)
NaSO4-	6.985e-06	6.173e-06	-5.156	-5.209	-0.054	(0)
NaHCO3	4.613e-06	4.630e-06	-5.336	-5.334	0.002	(0)
NaCO3-	6.734e-09	5.952e-09	-8.172	-8.225	-0.054	(0)
O (0)	0.000e+00					
O2	0.000e+00	0.000e+00	-58.845	-58.844	0.002	(0)
Pb	4.830e-10					
PbCO3	2.606e-10	2.616e-10	-9.584	-9.582	0.002	(0)
PbHCO3+	1.578e-10	1.395e-10	-9.802	-9.856	-0.054	(0)
Pb+2	4.583e-11	2.797e-11	-10.339	-10.553	-0.214	(0)
PbSO4	1.626e-11	1.632e-11	-10.789	-10.787	0.002	(0)
PbOH+	1.622e-12	1.434e-12	-11.790	-11.843	-0.054	(0)
Pb (CO3) 2-2	5.795e-13	3.536e-13	-12.237	-12.451	-0.214	(0)
PbCl+	1.528e-13	1.351e-13	-12.816	-12.869	-0.054	(0)
Pb (SO4) 2-2	1.456e-13	8.886e-14	-12.837	-13.051	-0.214	(0)
Pb (OH) 2	1.461e-15	1.467e-15	-14.835	-14.834	0.002	(0)
PbCl2	5.123e-17	5.142e-17	-16.290	-16.289	0.002	(0)
Pb (OH) 3-	5.010e-20	4.428e-20	-19.300	-19.354	-0.054	(0)
PbCl3-	7.511e-21	6.639e-21	-20.124	-20.178	-0.054	(0)
Pb2OH+3	2.728e-21	8.979e-22	-20.564	-21.047	-0.483	(0)
PbCl4-2	8.263e-25	5.043e-25	-24.083	-24.297	-0.214	(0)
Pb (OH) 4-2	4.370e-25	2.667e-25	-24.359	-24.574	-0.214	(0)
Pb3 (OH) 4+2	2.141e-31	1.307e-31	-30.669	-30.884	-0.214	(0)
S (6)	2.125e-03					
SO4-2	1.682e-03	1.038e-03	-2.774	-2.984	-0.210	(0)
CaSO4	2.807e-04	2.817e-04	-3.552	-3.550	0.002	(0)
MgSO4	1.501e-04	1.507e-04	-3.824	-3.822	0.002	(0)
NaSO4-	6.985e-06	6.173e-06	-5.156	-5.209	-0.054	(0)
MnSO4	4.019e-06	4.034e-06	-5.396	-5.394	0.002	(0)
KSO4-	1.051e-06	9.288e-07	-5.978	-6.032	-0.054	(0)
BaSO4	1.444e-07	1.449e-07	-6.841	-6.839	0.002	(0)
FeSO4	5.487e-08	5.507e-08	-7.261	-7.259	0.002	(0)
HSO4-	3.201e-08	2.829e-08	-7.495	-7.548	-0.054	(0)
ZnSO4	2.643e-09	2.652e-09	-8.578	-8.576	0.002	(0)
CaHSO4+	6.063e-10	5.359e-10	-9.217	-9.271	-0.054	(0)
CuSO4	8.626e-11	8.658e-11	-10.064	-10.063	0.002	(0)
CdSO4	4.469e-11	4.485e-11	-10.350	-10.348	0.002	(0)
Zn (SO4) 2-2	4.137e-11	2.524e-11	-10.383	-10.598	-0.214	(0)
PbSO4	1.626e-11	1.632e-11	-10.789	-10.787	0.002	(0)
AgSO4-	5.877e-12	5.194e-12	-11.231	-11.284	-0.054	(0)
Cd (SO4) 2-2	9.204e-13	5.617e-13	-12.036	-12.250	-0.214	(0)
FeHSO4+	1.531e-13	1.353e-13	-12.815	-12.869	-0.054	(0)
Pb (SO4) 2-2	1.456e-13	8.886e-14	-12.837	-13.051	-0.214	(0)
FeSO4+	7.159e-18	6.328e-18	-17.145	-17.199	-0.054	(0)
Fe (SO4) 2-	1.528e-19	1.351e-19	-18.816	-18.869	-0.054	(0)
FeHSO4+2	1.102e-23	6.727e-24	-22.958	-23.172	-0.214	(0)
Se (-2)	5.658e-24					
HSe-	5.639e-24	4.984e-24	-23.249	-23.302	-0.054	(0)
H2Se	1.908e-26	1.915e-26	-25.719	-25.718	0.002	(0)
Se (4)	2.535e-09					
HSeO3-	2.504e-09	2.213e-09	-8.601	-8.655	-0.054	(0)
SeO3-2	3.017e-11	1.841e-11	-10.520	-10.735	-0.214	(0)
H2SeO3	4.715e-13	4.732e-13	-12.327	-12.325	0.002	(0)
Se (6)	2.780e-25					
SeO4-2	2.780e-25	1.696e-25	-24.556	-24.770	-0.214	(0)
HSeO4-	2.156e-30	1.905e-30	-29.666	-29.720	-0.054	(0)
Zn	3.521e-08					

Zn+2	2.017e-08	1.231e-08	-7.695	-7.910	-0.214	(0)
ZnHCO3+	1.100e-08	9.726e-09	-7.958	-8.012	-0.054	(0)
ZnSO4	2.643e-09	2.652e-09	-8.578	-8.576	0.002	(0)
ZnCO3	1.317e-09	1.321e-09	-8.881	-8.879	0.002	(0)
Zn(SO4)2-2	4.137e-11	2.524e-11	-10.383	-10.598	-0.214	(0)
Zn(CO3)2-2	2.492e-11	1.521e-11	-10.604	-10.818	-0.214	(0)
ZnOH+	1.220e-11	1.078e-11	-10.914	-10.967	-0.054	(0)
ZnCl+	3.358e-12	2.968e-12	-11.474	-11.528	-0.054	(0)
Zn(OH)2	1.067e-12	1.071e-12	-11.972	-11.970	0.002	(0)
ZnOHCl	1.912e-13	1.919e-13	-12.719	-12.717	0.002	(0)
ZnCl2	5.205e-16	5.225e-16	-15.284	-15.282	0.002	(0)
Zn(OH)3-	1.008e-17	8.905e-18	-16.997	-17.050	-0.054	(0)
ZnCl3-	1.081e-19	9.554e-20	-18.966	-19.020	-0.054	(0)
ZnCl4-2	1.241e-23	7.572e-24	-22.906	-23.121	-0.214	(0)
Zn(OH)4-2	6.081e-24	3.711e-24	-23.216	-23.431	-0.214	(0)

-----Saturation indices-----

Phase	SI**	log IAP	log K(283 K, 1 atm)	
Ag2CO3	-13.90	-25.34	-11.44	Ag2CO3
Ag2O	-19.21	-6.23	12.98	Ag2O
Ag2SO4	-16.97	-22.05	-5.08	Ag2SO4
AgMetal	3.26	-11.22	-14.48	Ag
Anglesite	-5.66	-13.54	-7.87	PbSO4
Anhydrite	-1.45	-5.79	-4.34	CaSO4
Antlerite	-13.62	-5.33	8.29	Cu3(OH)4SO4
Aragonite	-0.82	-9.07	-8.26	CaCO3
Arsenolite	-16.45	-18.11	-1.66	As2O3
Artinite	-10.20	0.51	10.71	MgCO3:Mg(OH)2:3H2O
As2O5(cr)	-35.19	-26.67	8.52	As2O5
As_native	-19.79	-33.39	-13.59	As
Atacamite	-11.23	-3.17	8.06	Cu2(OH)3Cl
Azurite	-11.69	-6.75	4.94	Cu3(OH)2(CO3)2
Ba3(AsO4)2	0.17	-50.30	-50.48	Ba3(AsO4)2
Barite	0.70	-9.54	-10.24	BaSO4
BaSeO3	-10.90	-17.29	-6.39	BaSeO3
Bianchite	-9.14	-10.89	-1.76	ZnSO4:6H2O
Birnessite	-19.07	24.53	43.60	MnO2
Bixbyite	-20.15	-20.17	-0.02	Mn2O3
Brochantite	-17.17	-1.83	15.34	Cu4(OH)6SO4
Brucite	-8.08	9.81	17.89	Mg(OH)2
Ca3(AsO4)2:4w	-20.14	-39.05	-18.91	Ca3(AsO4)2:4H2O
Calcite	-0.66	-9.07	-8.41	CaCO3
CaSeO3	-7.94	-13.54	-5.60	CaSeO3
Cd(gamma)	-27.45	-13.16	14.29	Cd
Cd(OH)2	-10.59	3.06	13.65	Cd(OH)2
Cd(OH)2(a)	-11.47	3.06	14.53	Cd(OH)2
Cd3(OH)2(SO4)2	-29.19	-22.48	6.71	Cd3(OH)2(SO4)2
Cd3(OH)4SO4	-29.21	-6.65	22.56	Cd3(OH)4SO4
Cd4(OH)6SO4	-32.00	-3.60	28.40	Cd4(OH)6SO4
CdCl2	-16.77	-17.28	-0.51	CdCl2
CdCl2:2.5H2O	-15.27	-17.28	-2.01	CdCl2:2.5H2O
CdCl2:H2O	-15.64	-17.28	-1.64	CdCl2:H2O
CdMetal	-27.35	-13.16	14.19	Cd
CdOHCl	-10.92	-7.11	3.81	CdOHCl
CdSO4	-13.24	-12.77	0.47	CdSO4
CdSO4:2.7H2O	-11.06	-12.77	-1.71	CdSO4:2.67H2O
CdSO4:H2O	-11.40	-12.77	-1.37	CdSO4:H2O
Cerargyrite	-2.93	-13.28	-10.35	AgCl
Cerrusite	-3.50	-16.82	-13.32	PbCO3
Chalcanthite	-9.63	-12.33	-2.70	CuSO4:5H2O
Claudetite	-16.51	-18.11	-1.60	As2O3
CO2(g)	-0.89	-2.16	-1.27	CO2
Cotunnite	-13.06	-18.05	-4.99	PbCl2
Cu(OH)2	-5.73	3.50	9.23	Cu(OH)2
Cu2SO4	-17.96	-19.74	-1.77	Cu2SO4

Cu3(AsO4)2:6w	-23.54	-58.67	-35.12	Cu3(AsO4)2:6H2O
CuCO3	-5.98	-15.61	-9.63	CuCO3
CuMetal	-0.64	-10.07	-9.42	Cu
CuOCuSO4	-21.73	-8.83	12.90	CuO:CuSO4
CupricFerrite	-1.56	5.81	7.37	CuFe2O4
Cuprite	-2.12	-3.91	-1.79	Cu2O
CuprousFerrite	7.97	-0.80	-8.77	CuFeO2
CuSO4	-16.04	-12.33	3.71	CuSO4
Dolomite	-1.65	-18.37	-16.73	CaMg(CO3)2
Dolomite(d)	-2.26	-18.37	-16.11	CaMg(CO3)2
Epsomite	-3.77	-6.02	-2.25	MgSO4:7H2O
Fe(OH)2.7Cl.3	1.15	-1.89	-3.04	Fe(OH)2.7Cl0.3
Fe(OH)3(a)	-3.74	1.16	4.89	Fe(OH)3
Fe2(SeO3)3	-32.98	-68.41	-35.43	Fe2(SeO3)3
Fe3(OH)8	-11.47	8.75	20.22	Fe3(OH)8
FeSe2	-18.20	-36.78	-18.58	FeSe2
Goethite	1.60	1.16	-0.44	FeOOH
Goslarite	-8.81	-10.90	-2.09	ZnSO4:7H2O
Gypsum	-1.20	-5.79	-4.59	CaSO4:2H2O
H2(g)	-16.22	-19.30	-3.08	H2
H2O(g)	-1.92	-0.00	1.92	H2O
Halite	-8.18	-6.63	1.55	NaCl
Hausmannite	-23.77	41.15	64.92	Mn3O4
Hematite	5.13	2.31	-2.82	Fe2O3
Huntite	-8.00	-36.98	-28.97	CaMg3(CO3)4
Hydrocerussite	-13.90	-31.36	-17.46	Pb(OH)2:2PbCO3
Hydromagnesite	-20.65	-27.40	-6.74	Mg5(CO3)4(OH)2:4H2O
Hydrozincite	-22.90	7.41	30.31	Zn5(OH)6(CO3)2
Hydrozincite_PG	-24.65	7.41	32.05	Zn5(OH)6(CO3)2
Jarosite(ss)	-16.21	-26.04	-9.83	(K0.77Na0.03H0.2)Fe3(SO4)2(OH)6
Jarosite-K	-17.53	-25.54	-8.00	KFe3(SO4)2(OH)6
Jarosite-Na	-20.76	-24.64	-3.88	NaFe3(SO4)2(OH)6
JarositeH	-24.92	-28.18	-3.26	(H3O)Fe3(SO4)2(OH)6
Langite	-20.15	-1.83	18.32	Cu4(OH)6SO4:H2O
Larnakite	-11.22	-11.25	-0.03	PbO:PbSO4
Laurionite	-8.50	-7.88	0.62	PbOHCl
Litharge	-11.07	2.29	13.35	PbO
Maghemite	-4.07	2.31	6.39	Fe2O3
Magnesite	-1.51	-9.30	-7.79	MgCO3
Magnetite	3.07	8.75	5.69	Fe3O4
Malachite	-7.54	-1.63	5.91	Cu2(OH)2CO3
Manganite	-8.92	16.42	25.34	MnOOH
Massicot	-11.27	2.29	13.56	PbO
Melanothallite	-21.04	-16.84	4.21	CuCl2
Melanterite	-6.98	-9.39	-2.41	FeSO4:7H2O
Minium	-54.58	23.08	77.66	Pb3O4
Mirabilite	-6.90	-8.75	-1.85	Na2SO4:10H2O
Mn2(SO4)3	-63.44	-67.64	-4.20	Mn2(SO4)3
Mn3(AsO4)2:8H2O	-15.52	-44.23	-28.71	Mn3(AsO4)2:8H2O
MnCl2:4H2O	-14.06	-12.02	2.04	MnCl2:4H2O
MnSO4	-10.78	-7.51	3.27	MnSO4
Monteponite	-11.67	3.06	14.73	CdO
Nahcolite	-4.39	-5.08	-0.69	NaHCO3
Nantokite	-4.98	-12.12	-7.15	CuCl
Natron	-10.12	-12.04	-1.92	Na2CO3:10H2O
Nesquehonite	-3.90	-9.30	-5.40	MgCO3:3H2O
Nsutite	-18.03	24.53	42.56	MnO2
O2(g)	-56.08	-58.84	-2.77	O2
Otavite	-4.05	-16.05	-12.00	CdCO3
Pb(OH)2	-6.40	2.29	8.69	Pb(OH)2
Pb2(OH)3Cl	-14.39	-5.59	8.79	Pb2(OH)3Cl
Pb2O(OH)2	-21.63	4.57	26.20	PbO:Pb(OH)2
Pb2O3	-40.25	20.79	61.04	Pb2O3
Pb2OCO3	-14.48	-14.54	-0.06	PbO:PbCO3
Pb3(AsO4)2	-26.90	-62.30	-35.40	Pb3(AsO4)2
Pb3O2CO3	-24.29	-12.25	12.04	PbCO3:2PbO
Pb3O2SO4	-20.17	-8.96	11.20	PbSO4:2PbO

Pb4 (OH) 6SO4	-27.78	-6.68	21.10	Pb4 (OH) 6SO4
Pb4O3SO4	-30.13	-6.68	23.45	PbSO4:3PbO
PbMetal	-18.19	-13.93	4.25	Pb
PbO:0.3H2O	-10.69	2.29	12.98	PbO:0.33H2O
Phosgenite	-15.06	-34.87	-19.81	PbCl2:PbCO3
Plattnerite	-33.52	18.51	52.03	PbO2
Portlandite	-13.96	10.04	24.00	Ca (OH) 2
Pyrochroite	-6.89	8.31	15.20	Mn (OH) 2
Pyrolusite	-19.36	24.53	43.89	MnO2
Rhodochrosite	0.28	-10.80	-11.07	MnCO3
Rhodochrosite (d)	-0.41	-10.80	-10.39	MnCO3
Scorodite	-13.18	-33.42	-20.25	FeAsO4:2H2O
Se (s)	3.82	-13.50	-17.32	Se
SeO2	-15.19	-23.57	-8.38	SeO2
Siderite	-1.88	-12.67	-10.79	FeCO3
Siderite (d) (3)	-2.22	-12.67	-10.45	FeCO3
Smithsonite	-4.35	-14.18	-9.83	ZnCO3
Smithsonite_PG	-3.38	-14.18	-10.80	ZnCO3
Tenorite	-4.71	3.50	8.21	CuO
Thenardite	-8.59	-8.75	-0.16	Na2SO4
Thermonatrite	-12.27	-12.03	0.23	Na2CO3:H2O
Trona	-17.02	-17.12	-0.10	NaHCO3:Na2CO3:2H2O
Witherite	-4.19	-12.82	-8.63	BaCO3
Zincite (c)	-7.05	4.93	11.98	ZnO
Zincosite	-14.65	-10.89	3.75	ZnSO4
Zn (OH) 2-a	-7.52	4.93	12.45	Zn (OH) 2
Zn (OH) 2-b	-6.82	4.93	11.75	Zn (OH) 2
Zn (OH) 2-c	-7.27	4.93	12.20	Zn (OH) 2
Zn (OH) 2-e	-6.57	4.93	11.50	Zn (OH) 2
Zn (OH) 2-g	-6.78	4.93	11.71	Zn (OH) 2
Zn2 (OH) 2SO4	-13.46	-5.96	7.50	Zn2 (OH) 2SO4
Zn2 (OH) 3Cl	-15.51	-0.31	15.20	Zn2 (OH) 3Cl
Zn3 (AsO4) 2:2.5w	-26.82	-54.37	-27.55	Zn3 (AsO4) 2:2.5H2O
Zn3O (SO4) 2	-38.27	-16.86	21.41	ZnO:2ZnSO4
Zn4 (OH) 6SO4	-24.50	3.90	28.40	Zn4 (OH) 6SO4
Zn5 (OH) 8Cl2	-34.18	4.32	38.50	Zn5 (OH) 8Cl2
ZnCl2	-23.11	-15.40	7.70	ZnCl2
ZnCO3:1H2O	-3.92	-14.18	-10.26	ZnCO3:1H2O
ZnCO3:H2O	-3.92	-14.18	-10.26	ZnCO3:H2O
ZnMetal	-38.47	-11.29	27.18	Zn
ZnO (a)	-6.38	4.93	11.31	ZnO
ZnSO4:H2O	-10.73	-10.89	-0.16	ZnSO4:H2O

**For a gas, SI = log10(fugacity). Fugacity = pressure * phi / 1 atm.
For ideal gases, phi = 1.

Initial solution 4. MW-1013B

-----Solution composition-----

Elements	Molality	Moles
Ag	4.650e-10	4.650e-10
Alkalinity	1.148e-02	1.148e-02
As	8.302e-09	8.302e-09
Ba	1.074e-07	1.074e-07
Ca	1.522e-02	1.522e-02
Cd	7.140e-09	7.140e-09
Cl	1.072e-03	1.072e-03
Cu	7.499e-06	7.499e-06
Fe	9.969e-07	9.969e-07
K	1.516e-04	1.516e-04
Mg	5.818e-03	5.818e-03
Mn	5.460e-04	5.460e-04
Na	1.143e-03	1.143e-03
Pb	4.842e-10	4.842e-10
S (6)	1.817e-02	1.817e-02

Se 8.893e-09 8.893e-09
 Zn 1.964e-06 1.964e-06

-----Description of solution-----

pH = 6.170
 pe = 1.950
 Activity of water = 0.999
 Ionic strength (mol/kgw) = 6.041e-02
 Mass of water (kg) = 1.000e+00
 Total carbon (mol/kg) = 2.798e-02
 Total CO2 (mol/kg) = 2.798e-02
 Temperature (°C) = 11.11
 Electrical balance (eq) = -4.423e-03
 Percent error, 100*(Cat-|An|)/(Cat+|An|) = -6.57
 Iterations = 11
 Total H = 1.110239e+02
 Total O = 5.564634e+01

-----Distribution of species-----

Species	Molality	Activity	Log Molality	Log Activity	Log Gamma	mole V cm ³ /mol
H+	7.965e-07	6.761e-07	-6.099	-6.170	-0.071	0.00
OH-	5.856e-09	4.767e-09	-8.232	-8.322	-0.089	(0)
H2O	5.551e+01	9.989e-01	1.744	-0.000	0.000	18.02
Ag	4.650e-10					
AgCl	2.584e-10	2.620e-10	-9.588	-9.582	0.006	(0)
Ag+	1.610e-10	1.311e-10	-9.793	-9.883	-0.089	(0)
AgCl2-	3.071e-11	2.500e-11	-10.513	-10.602	-0.089	(0)
AgSO4-	1.489e-11	1.212e-11	-10.827	-10.916	-0.089	(0)
AgCl3-2	3.710e-14	1.629e-14	-13.431	-13.788	-0.357	(0)
AgOH	1.910e-16	1.936e-16	-15.719	-15.713	0.006	(0)
AgCl4-3	1.482e-16	2.327e-17	-15.829	-16.633	-0.804	(0)
Ag(OH) 2-	3.515e-22	2.861e-22	-21.454	-21.543	-0.089	(0)
As (3)	4.542e-09					
H3AsO3	4.539e-09	4.602e-09	-8.343	-8.337	0.006	(0)
H2AsO3-	3.440e-12	2.800e-12	-11.463	-11.553	-0.089	(0)
H4AsO3+	1.894e-15	1.542e-15	-14.723	-14.812	-0.089	(0)
HAsO3-2	1.004e-20	4.410e-21	-19.998	-20.356	-0.357	(0)
AsO3-3	5.033e-30	7.901e-31	-29.298	-30.102	-0.804	(0)
As (5)	3.759e-09					
H2AsO4-	3.191e-09	2.598e-09	-8.496	-8.585	-0.089	(0)
HAsO4-2	5.681e-10	2.495e-10	-9.246	-9.603	-0.357	(0)
H3AsO4	3.006e-13	3.049e-13	-12.522	-12.516	0.006	(0)
AsO4-3	3.676e-15	5.771e-16	-14.435	-15.239	-0.804	(0)
Ba	1.074e-07					
BaSO4	5.700e-08	5.780e-08	-7.244	-7.238	0.006	(0)
Ba+2	4.895e-08	2.149e-08	-7.310	-7.668	-0.357	(0)
BaHCO3+	1.425e-09	1.160e-09	-8.846	-8.935	-0.089	(0)
BaCO3	3.586e-12	3.637e-12	-11.445	-11.439	0.006	(0)
BaOH+	1.322e-15	1.076e-15	-14.879	-14.968	-0.089	(0)
C (4)	2.798e-02					
CO2	1.651e-02	1.674e-02	-1.782	-1.776	0.006	(0)
HCO3-	1.062e-02	8.718e-03	-1.974	-2.060	-0.086	(0)
CaHCO3+	4.859e-04	3.955e-04	-3.313	-3.403	-0.089	(0)
MgHCO3+	2.257e-04	1.837e-04	-3.646	-3.736	-0.089	(0)
MnHCO3+	1.309e-04	1.065e-04	-3.883	-3.973	-0.089	(0)
MnCO3	4.649e-06	4.714e-06	-5.333	-5.327	0.006	(0)
NaHCO3	4.386e-06	4.447e-06	-5.358	-5.352	0.006	(0)
CaCO3	2.778e-06	2.817e-06	-5.556	-5.550	0.006	(0)
CuHCO3+	2.138e-06	1.740e-06	-5.670	-5.759	-0.089	(0)
CO3-2	9.517e-07	4.329e-07	-6.022	-6.364	-0.342	(0)
CuCO3	9.131e-07	9.259e-07	-6.039	-6.033	0.006	(0)
MgCO3	6.173e-07	6.260e-07	-6.209	-6.203	0.006	(0)
ZnHCO3+	5.352e-07	4.357e-07	-6.271	-6.361	-0.089	(0)

FeHCO3+	2.616e-07	2.130e-07	-6.582	-6.672	-0.089	(0)
ZnCO3	3.381e-08	3.428e-08	-7.471	-7.465	0.006	(0)
NaCO3-	4.308e-09	3.507e-09	-8.366	-8.455	-0.089	(0)
FeCO3	2.502e-09	2.537e-09	-8.602	-8.596	0.006	(0)
BaHCO3+	1.425e-09	1.160e-09	-8.846	-8.935	-0.089	(0)
Cu (CO3) 2-2	1.149e-09	5.045e-10	-8.940	-9.297	-0.357	(0)
Zn (CO3) 2-2	7.225e-10	3.173e-10	-9.141	-9.499	-0.357	(0)
CdHCO3+	5.603e-10	4.561e-10	-9.252	-9.341	-0.089	(0)
PbHCO3+	1.920e-10	1.563e-10	-9.717	-9.806	-0.089	(0)
PbCO3	1.674e-10	1.698e-10	-9.776	-9.770	0.006	(0)
BaCO3	3.586e-12	3.637e-12	-11.445	-11.439	0.006	(0)
CdCO3	5.610e-13	5.688e-13	-12.251	-12.245	0.006	(0)
Pb (CO3) 2-2	4.203e-13	1.846e-13	-12.376	-12.734	-0.357	(0)
Cd (CO3) 2-2	1.773e-15	7.786e-16	-14.751	-15.109	-0.357	(0)
Ca	1.522e-02					
Ca+2	1.036e-02	4.737e-03	-1.984	-2.324	-0.340	(0)
CaSO4	4.365e-03	4.426e-03	-2.360	-2.354	0.006	(0)
CaHCO3+	4.859e-04	3.955e-04	-3.313	-3.403	-0.089	(0)
CaCO3	2.778e-06	2.817e-06	-5.556	-5.550	0.006	(0)
CaHSO4+	1.856e-08	1.511e-08	-7.731	-7.821	-0.089	(0)
CaOH+	1.427e-09	1.162e-09	-8.846	-8.935	-0.089	(0)
Cd	7.140e-09					
Cd+2	3.767e-09	1.654e-09	-8.424	-8.781	-0.357	(0)
CdSO4	2.309e-09	2.342e-09	-8.637	-8.630	0.006	(0)
CdHCO3+	5.603e-10	4.561e-10	-9.252	-9.341	-0.089	(0)
Cd (SO4) 2-2	3.429e-10	1.506e-10	-9.465	-9.822	-0.357	(0)
CdCl+	1.591e-10	1.295e-10	-9.798	-9.888	-0.089	(0)
CdCO3	5.610e-13	5.688e-13	-12.251	-12.245	0.006	(0)
CdCl2	4.343e-13	4.404e-13	-12.362	-12.356	0.006	(0)
CdOH+	8.478e-14	6.902e-14	-13.072	-13.161	-0.089	(0)
CdOHC1	5.714e-14	5.794e-14	-13.243	-13.237	0.006	(0)
Cd (CO3) 2-2	1.773e-15	7.786e-16	-14.751	-15.109	-0.357	(0)
CdCl3-	2.359e-16	1.920e-16	-15.627	-15.717	-0.089	(0)
Cd (OH) 2	1.591e-17	1.613e-17	-16.798	-16.792	0.006	(0)
Cd2OH+3	4.271e-21	6.705e-22	-20.369	-21.174	-0.804	(0)
Cd (OH) 3-	3.285e-24	2.674e-24	-23.483	-23.573	-0.089	(0)
Cd (OH) 4-2	8.020e-32	3.522e-32	-31.096	-31.453	-0.357	(0)
Cl	1.072e-03					
Cl-	1.071e-03	8.606e-04	-2.970	-3.065	-0.095	(0)
CuCl2-	6.095e-07	4.962e-07	-6.215	-6.304	-0.089	(0)
MnCl+	5.905e-07	4.807e-07	-6.229	-6.318	-0.089	(0)
CuCl3-2	1.457e-09	6.399e-10	-8.836	-9.194	-0.357	(0)
ZnCl+	5.942e-10	4.837e-10	-9.226	-9.315	-0.089	(0)
CuCl+	5.553e-10	4.521e-10	-9.255	-9.345	-0.089	(0)
FeCl+	3.565e-10	2.902e-10	-9.448	-9.537	-0.089	(0)
AgCl	2.584e-10	2.620e-10	-9.588	-9.582	0.006	(0)
MnCl2	1.781e-10	1.806e-10	-9.749	-9.743	0.006	(0)
CdCl+	1.591e-10	1.295e-10	-9.798	-9.888	-0.089	(0)
AgCl2-	3.071e-11	2.500e-11	-10.513	-10.602	-0.089	(0)
ZnOHC1	1.648e-11	1.671e-11	-10.783	-10.777	0.006	(0)
PbCl+	6.619e-13	5.388e-13	-12.179	-12.269	-0.089	(0)
CdCl2	4.343e-13	4.404e-13	-12.362	-12.356	0.006	(0)
ZnCl2	4.054e-13	4.111e-13	-12.392	-12.386	0.006	(0)
CuCl2	1.760e-13	1.785e-13	-12.754	-12.748	0.006	(0)
CdOHC1	5.714e-14	5.794e-14	-13.243	-13.237	0.006	(0)
MnCl3-	5.258e-14	4.280e-14	-13.279	-13.369	-0.089	(0)
AgCl3-2	3.710e-14	1.629e-14	-13.431	-13.788	-0.357	(0)
PbCl2	9.515e-16	9.648e-16	-15.022	-15.016	0.006	(0)
ZnCl3-	4.469e-16	3.638e-16	-15.350	-15.439	-0.089	(0)
CdCl3-	2.359e-16	1.920e-16	-15.627	-15.717	-0.089	(0)
AgCl4-3	1.482e-16	2.327e-17	-15.829	-16.633	-0.804	(0)
PbCl3-	7.406e-19	6.029e-19	-18.130	-18.220	-0.089	(0)
CuCl3-	5.172e-19	4.211e-19	-18.286	-18.376	-0.089	(0)
ZnCl4-2	3.183e-19	1.398e-19	-18.497	-18.855	-0.357	(0)
FeCl+2	3.491e-20	1.533e-20	-19.457	-19.814	-0.357	(0)
PbCl4-2	5.055e-22	2.220e-22	-21.296	-21.654	-0.357	(0)
FeCl2+	1.149e-22	9.354e-23	-21.940	-22.029	-0.089	(0)

CuCl4-2	2.952e-24	1.296e-24	-23.530	-23.887	-0.357	(0)
FeCl3	7.939e-27	8.050e-27	-26.100	-26.094	0.006	(0)
Cu (1)	3.125e-06					
Cu+	2.514e-06	2.046e-06	-5.600	-5.689	-0.089	(0)
CuCl2-	6.095e-07	4.962e-07	-6.215	-6.304	-0.089	(0)
CuCl3-2	1.457e-09	6.399e-10	-8.836	-9.194	-0.357	(0)
Cu (2)	4.374e-06					
CuHCO3+	2.138e-06	1.740e-06	-5.670	-5.759	-0.089	(0)
CuCO3	9.131e-07	9.259e-07	-6.039	-6.033	0.006	(0)
Cu+2	9.070e-07	3.983e-07	-6.042	-6.400	-0.357	(0)
CuSO4	3.891e-07	3.945e-07	-6.410	-6.404	0.006	(0)
Cu (OH) 2	1.791e-08	1.817e-08	-7.747	-7.741	0.006	(0)
CuOH+	7.229e-09	5.885e-09	-8.141	-8.230	-0.089	(0)
Cu (CO3) 2-2	1.149e-09	5.045e-10	-8.940	-9.297	-0.357	(0)
CuCl+	5.553e-10	4.521e-10	-9.255	-9.345	-0.089	(0)
Cu2 (OH) 2+2	8.123e-12	3.567e-12	-11.090	-11.448	-0.357	(0)
CuCl2	1.760e-13	1.785e-13	-12.754	-12.748	0.006	(0)
Cu (OH) 3-	1.987e-15	1.617e-15	-14.702	-14.791	-0.089	(0)
CuCl3-	5.172e-19	4.211e-19	-18.286	-18.376	-0.089	(0)
Cu (OH) 4-2	1.086e-21	4.768e-22	-20.964	-21.322	-0.357	(0)
CuCl4-2	2.952e-24	1.296e-24	-23.530	-23.887	-0.357	(0)
Fe (2)	9.969e-07					
Fe+2	5.563e-07	2.443e-07	-6.255	-6.612	-0.357	(0)
FeHCO3+	2.616e-07	2.130e-07	-6.582	-6.672	-0.089	(0)
FeSO4	1.761e-07	1.786e-07	-6.754	-6.748	0.006	(0)
FeCO3	2.502e-09	2.537e-09	-8.602	-8.596	0.006	(0)
FeCl+	3.565e-10	2.902e-10	-9.448	-9.537	-0.089	(0)
FeOH+	4.721e-11	3.843e-11	-10.326	-10.415	-0.089	(0)
FeHSO4+	9.570e-13	7.790e-13	-12.019	-12.108	-0.089	(0)
Fe (OH) 2	1.342e-16	1.361e-16	-15.872	-15.866	0.006	(0)
Fe (OH) 3-	7.955e-21	6.475e-21	-20.099	-20.189	-0.089	(0)
Fe (3)	1.425e-12					
Fe (OH) 2+	1.310e-12	1.066e-12	-11.883	-11.972	-0.089	(0)
Fe (OH) 3	1.061e-13	1.076e-13	-12.974	-12.968	0.006	(0)
FeOH+2	8.625e-15	3.788e-15	-14.064	-14.422	-0.357	(0)
Fe (OH) 4-	9.915e-17	8.071e-17	-16.004	-16.093	-0.089	(0)
FeSO4+	4.900e-17	3.989e-17	-16.310	-16.399	-0.089	(0)
Fe+3	5.964e-18	9.361e-19	-17.224	-18.029	-0.804	(0)
Fe (SO4) 2-	5.433e-18	4.423e-18	-17.265	-17.354	-0.089	(0)
FeCl+2	3.491e-20	1.533e-20	-19.457	-19.814	-0.357	(0)
FeHSO4+2	1.708e-22	7.499e-23	-21.768	-22.125	-0.357	(0)
FeCl2+	1.149e-22	9.354e-23	-21.940	-22.029	-0.089	(0)
Fe2 (OH) 2+4	1.896e-26	7.050e-28	-25.722	-27.152	-1.430	(0)
FeCl3	7.939e-27	8.050e-27	-26.100	-26.094	0.006	(0)
Fe3 (OH) 4+5	1.032e-34	6.025e-37	-33.986	-36.220	-2.234	(0)
H (0)	9.284e-20					
H2	4.642e-20	4.707e-20	-19.333	-19.327	0.006	(0)
K	1.516e-04					
K+	1.474e-04	1.185e-04	-3.832	-3.926	-0.095	(0)
KSO4-	4.255e-06	3.463e-06	-5.371	-5.460	-0.089	(0)
Mg	5.818e-03					
Mg+2	3.993e-03	1.876e-03	-2.399	-2.727	-0.328	(0)
MgSO4	1.599e-03	1.621e-03	-2.796	-2.790	0.006	(0)
MgHCO3+	2.257e-04	1.837e-04	-3.646	-3.736	-0.089	(0)
MgCO3	6.173e-07	6.260e-07	-6.209	-6.203	0.006	(0)
MgOH+	3.317e-09	2.700e-09	-8.479	-8.569	-0.089	(0)
Mn (2)	5.460e-04					
Mn+2	3.122e-04	1.371e-04	-3.506	-3.863	-0.357	(0)
MnHCO3+	1.309e-04	1.065e-04	-3.883	-3.973	-0.089	(0)
MnSO4	9.769e-05	9.906e-05	-4.010	-4.004	0.006	(0)
MnCO3	4.649e-06	4.714e-06	-5.333	-5.327	0.006	(0)
MnCl+	5.905e-07	4.807e-07	-6.229	-6.318	-0.089	(0)
MnOH+	1.950e-09	1.588e-09	-8.710	-8.799	-0.089	(0)
MnCl2	1.781e-10	1.806e-10	-9.749	-9.743	0.006	(0)
MnCl3-	5.258e-14	4.280e-14	-13.279	-13.369	-0.089	(0)
Mn (OH) 3-	8.609e-21	7.008e-21	-20.065	-20.154	-0.089	(0)
Mn (3)	2.866e-28					

Mn+3	2.866e-28	4.499e-29	-27.543	-28.347	-0.804	(0)
Mn (6)	0.000e+00					
MnO4-2	0.000e+00	0.000e+00	-70.160	-70.518	-0.357	(0)
Mn (7)	0.000e+00					
MnO4-	0.000e+00	0.000e+00	-78.815	-78.904	-0.089	(0)
Na	1.143e-03					
Na+	1.112e-03	9.071e-04	-2.954	-3.042	-0.088	(0)
NaSO4-	2.732e-05	2.224e-05	-4.564	-4.653	-0.089	(0)
NaHCO3	4.386e-06	4.447e-06	-5.358	-5.352	0.006	(0)
NaCO3-	4.308e-09	3.507e-09	-8.366	-8.455	-0.089	(0)
O (0)	0.000e+00					
O2	0.000e+00	0.000e+00	-58.434	-58.428	0.006	(0)
Pb	4.842e-10					
PbHCO3+	1.920e-10	1.563e-10	-9.717	-9.806	-0.089	(0)
PbCO3	1.674e-10	1.698e-10	-9.776	-9.770	0.006	(0)
PbSO4	6.714e-11	6.808e-11	-10.173	-10.167	0.006	(0)
Pb+2	5.139e-11	2.257e-11	-10.289	-10.647	-0.357	(0)
Pb (SO4) 2-2	4.365e-12	1.917e-12	-11.360	-11.717	-0.357	(0)
PbOH+	7.987e-13	6.501e-13	-12.098	-12.187	-0.089	(0)
PbCl+	6.619e-13	5.388e-13	-12.179	-12.269	-0.089	(0)
Pb (CO3) 2-2	4.203e-13	1.846e-13	-12.376	-12.734	-0.357	(0)
PbCl2	9.515e-16	9.648e-16	-15.022	-15.016	0.006	(0)
Pb (OH) 2	3.686e-16	3.737e-16	-15.434	-15.427	0.006	(0)
PbCl3-	7.406e-19	6.029e-19	-18.130	-18.220	-0.089	(0)
Pb (OH) 3-	7.788e-21	6.340e-21	-20.109	-20.198	-0.089	(0)
Pb2OH+3	2.092e-21	3.285e-22	-20.679	-21.484	-0.804	(0)
PbCl4-2	5.055e-22	2.220e-22	-21.296	-21.654	-0.357	(0)
Pb (OH) 4-2	4.887e-26	2.146e-26	-25.311	-25.668	-0.357	(0)
Pb3 (OH) 4+2	1.849e-32	8.118e-33	-31.733	-32.091	-0.357	(0)
S (6)	1.817e-02					
SO4-2	1.208e-02	5.365e-03	-1.918	-2.270	-0.352	(0)
CaSO4	4.365e-03	4.426e-03	-2.360	-2.354	0.006	(0)
MgSO4	1.599e-03	1.621e-03	-2.796	-2.790	0.006	(0)
MnSO4	9.769e-05	9.906e-05	-4.010	-4.004	0.006	(0)
NaSO4-	2.732e-05	2.224e-05	-4.564	-4.653	-0.089	(0)
KSO4-	4.255e-06	3.463e-06	-5.371	-5.460	-0.089	(0)
ZnSO4	4.401e-07	4.463e-07	-6.356	-6.350	0.006	(0)
CuSO4	3.891e-07	3.945e-07	-6.410	-6.404	0.006	(0)
HSO4-	3.258e-07	2.653e-07	-6.487	-6.576	-0.089	(0)
FeSO4	1.761e-07	1.786e-07	-6.754	-6.748	0.006	(0)
BaSO4	5.700e-08	5.780e-08	-7.244	-7.238	0.006	(0)
Zn (SO4) 2-2	4.958e-08	2.177e-08	-7.305	-7.662	-0.357	(0)
CaHSO4+	1.856e-08	1.511e-08	-7.731	-7.821	-0.089	(0)
CdSO4	2.309e-09	2.342e-09	-8.637	-8.630	0.006	(0)
Cd (SO4) 2-2	3.429e-10	1.506e-10	-9.465	-9.822	-0.357	(0)
PbSO4	6.714e-11	6.808e-11	-10.173	-10.167	0.006	(0)
AgSO4-	1.489e-11	1.212e-11	-10.827	-10.916	-0.089	(0)
Pb (SO4) 2-2	4.365e-12	1.917e-12	-11.360	-11.717	-0.357	(0)
FeHSO4+	9.570e-13	7.790e-13	-12.019	-12.108	-0.089	(0)
FeSO4+	4.900e-17	3.989e-17	-16.310	-16.399	-0.089	(0)
Fe (SO4) 2-	5.433e-18	4.423e-18	-17.265	-17.354	-0.089	(0)
FeHSO4+2	1.708e-22	7.499e-23	-21.768	-22.125	-0.357	(0)
Se (-2)	1.746e-23					
HSe-	1.737e-23	1.414e-23	-22.760	-22.850	-0.089	(0)
H2Se	9.210e-26	9.339e-26	-25.036	-25.030	0.006	(0)
Se (4)	8.893e-09					
HSeO3-	8.814e-09	7.175e-09	-8.055	-8.144	-0.089	(0)
SeO3-2	7.643e-11	3.356e-11	-10.117	-10.474	-0.357	(0)
H2SeO3	2.690e-12	2.728e-12	-11.570	-11.564	0.006	(0)
Se (6)	7.363e-25					
SeO4-2	7.363e-25	3.233e-25	-24.133	-24.490	-0.357	(0)
HSeO4-	8.187e-30	6.664e-30	-29.087	-29.176	-0.089	(0)
Zn	1.964e-06					
Zn+2	9.040e-07	3.970e-07	-6.044	-6.401	-0.357	(0)
ZnHCO3+	5.352e-07	4.357e-07	-6.271	-6.361	-0.089	(0)
ZnSO4	4.401e-07	4.463e-07	-6.356	-6.350	0.006	(0)
Zn (SO4) 2-2	4.958e-08	2.177e-08	-7.305	-7.662	-0.357	(0)

ZnCO3	3.381e-08	3.428e-08	-7.471	-7.465	0.006	(0)
Zn(CO3) 2-2	7.225e-10	3.173e-10	-9.141	-9.499	-0.357	(0)
ZnCl+	5.942e-10	4.837e-10	-9.226	-9.315	-0.089	(0)
ZnOH+	2.616e-10	2.130e-10	-9.582	-9.672	-0.089	(0)
ZnOHC1	1.648e-11	1.671e-11	-10.783	-10.777	0.006	(0)
Zn(OH) 2	1.076e-11	1.091e-11	-10.968	-10.962	0.006	(0)
ZnCl2	4.054e-13	4.111e-13	-12.392	-12.386	0.006	(0)
ZnCl3-	4.469e-16	3.638e-16	-15.350	-15.439	-0.089	(0)
Zn(OH) 3-	6.262e-17	5.097e-17	-16.203	-16.293	-0.089	(0)
ZnCl4-2	3.183e-19	1.398e-19	-18.497	-18.855	-0.357	(0)
Zn(OH) 4-2	2.718e-23	1.194e-23	-22.566	-22.923	-0.357	(0)

-----Saturation indices-----

Phase	SI**	log IAP	log K(284 K,	1 atm)	
Ag2CO3	-14.72	-26.13	-11.41	Ag2CO3	
Ag2O	-20.38	-7.43	12.95	Ag2O	
Ag2SO4	-16.96	-22.04	-5.07	Ag2SO4	
AgMetal	2.58	-11.83	-14.41	Ag	
Anglesite	-5.05	-12.92	-7.87	PbSO4	
Anhydrite	-0.26	-4.59	-4.33	CaSO4	
Antlerite	-5.08	3.21	8.29	Cu3(OH) 4SO4	
Aragonite	-0.43	-8.69	-8.26	CaCO3	
Arsenolite	-15.04	-16.67	-1.64	As2O3	
Artinite	-10.11	0.52	10.63	MgCO3:Mg(OH) 2:3H2O	
As2O5(cr)	-33.53	-25.03	8.50	As2O5	
As_native	-19.18	-32.70	-13.52	As	
Atacamite	-5.37	2.64	8.01	Cu2(OH) 3Cl	
Azurite	-3.50	1.36	4.86	Cu3(OH) 2(CO3) 2	
Ba3(AsO4) 2	-3.03	-53.48	-50.45	Ba3(AsO4) 2	
Barite	0.28	-9.94	-10.22	BaSO4	
BaSeO3	-11.75	-18.14	-6.39	BaSeO3	
Bianchite	-6.92	-8.67	-1.76	ZnSO4:6H2O	
Birnessite	-18.88	24.72	43.60	MnO2	
Bixbyite	-19.61	-19.68	-0.06	Mn2O3	
Brochantite	-6.19	9.15	15.34	Cu4(OH) 6SO4	
Brucite	-8.20	9.61	17.81	Mg(OH) 2	
Ca3(AsO4) 2:4w	-18.55	-37.45	-18.91	Ca3(AsO4) 2:4H2O	
Calcite	-0.27	-8.69	-8.41	CaCO3	
CaSeO3	-7.20	-12.80	-5.60	CaSeO3	
Cd(gamma)	-26.92	-12.68	14.24	Cd	
Cd(OH) 2	-10.09	3.56	13.65	Cd(OH) 2	
Cd(OH) 2(a)	-10.92	3.56	14.47	Cd(OH) 2	
Cd3(OH) 2(SO4) 2	-25.26	-18.55	6.71	Cd3(OH) 2(SO4) 2	
Cd3(OH) 4SO4	-26.50	-3.94	22.56	Cd3(OH) 4SO4	
Cd4(OH) 6SO4	-28.78	-0.38	28.40	Cd4(OH) 6SO4	
CdCl2	-14.39	-14.91	-0.52	CdCl2	
CdCl2:2.5H2O	-12.91	-14.91	-2.00	CdCl2:2.5H2O	
CdCl2:H2O	-13.27	-14.91	-1.64	CdCl2:H2O	
CdMetal	-26.82	-12.68	14.13	Cd	
CdOHC1	-9.46	-5.68	3.79	CdOHC1	
CdSO4	-11.48	-11.05	0.43	CdSO4	
CdSO4:2.7H2O	-9.33	-11.05	-1.72	CdSO4:2.67H2O	
CdSO4:H2O	-9.66	-11.05	-1.39	CdSO4:H2O	
Cerargyrite	-2.64	-12.95	-10.31	AgCl	
Cerrusite	-3.71	-17.01	-13.30	PbCO3	
Chalcanthite	-5.98	-8.67	-2.69	CuSO4:5H2O	
Claudetite	-15.09	-16.67	-1.58	As2O3	
CO2(g)	-0.49	-1.78	-1.29	CO2	
Cotunnite	-11.81	-16.78	-4.97	PbCl2	
Cu(OH) 2	-3.25	5.94	9.19	Cu(OH) 2	
Cu2SO4	-11.86	-13.65	-1.79	Cu2SO4	
Cu3(AsO4) 2:6w	-14.56	-49.68	-35.12	Cu3(AsO4) 2:6H2O	
CuCO3	-3.13	-12.76	-9.63	CuCO3	
CuMetal	1.73	-7.64	-9.37	Cu	
CuOCuSO4	-15.53	-2.73	12.80	CuO:CuSO4	

CupricFerrite	-0.36	6.90	7.27	CuFe2O4
Cuprite	2.74	0.96	-1.77	Cu2O
CuprousFerrite	9.75	0.96	-8.78	CuFeO2
CuSO4	-12.33	-8.67	3.66	CuSO4
Dolomite	-1.03	-17.78	-16.75	CaMg (CO3) 2
Dolomite (d)	-1.64	-17.78	-16.14	CaMg (CO3) 2
Epsomite	-2.76	-5.00	-2.24	MgSO4:7H2O
Fe (OH) 2.7Cl.3	0.75	-2.29	-3.04	Fe (OH) 2.7Cl0.3
Fe (OH) 3 (a)	-4.41	0.48	4.89	Fe (OH) 3
Fe2 (SeO3) 3	-32.05	-67.48	-35.43	Fe2 (SeO3) 3
Fe3 (OH) 8	-13.54	6.69	20.22	Fe3 (OH) 8
FeSe2	-17.49	-36.07	-18.58	FeSe2
Goethite	0.96	0.48	-0.48	FeOOH
Goslarite	-6.60	-8.67	-2.08	ZnSO4:7H2O
Gypsum	-0.01	-4.60	-4.59	CaSO4:2H2O
H2 (g)	-16.24	-19.33	-3.09	H2
H2O (g)	-1.89	-0.00	1.89	H2O
Halite	-7.66	-6.11	1.55	NaCl
Hausmannite	-22.97	41.67	64.63	Mn3O4
Hematite	3.86	0.96	-2.90	Fe2O3
Huntite	-6.91	-35.96	-29.05	CaMg3 (CO3) 4
Hydrocerrusite	-14.87	-32.33	-17.46	Pb (OH) 2:2PbCO3
Hydromagnesite	-19.86	-26.75	-6.89	Mg5 (CO3) 4 (OH) 2:4H2O
Hydrozincite	-17.08	13.23	30.31	Zn5 (OH) 6 (CO3) 2
Hydrozincite_PG	-18.63	13.23	31.86	Zn5 (OH) 6 (CO3) 2
Jarosite (ss)	-16.13	-25.96	-9.83	(K0.77Na0.03H0.2) Fe3 (SO4) 2 (OH) 6
Jarosite-K	-17.45	-25.54	-8.09	KFe3 (SO4) 2 (OH) 6
Jarosite-Na	-20.67	-24.65	-3.98	NaFe3 (SO4) 2 (OH) 6
JarositeH	-24.37	-27.78	-3.41	(H3O) Fe3 (SO4) 2 (OH) 6
Langite	-9.06	9.15	18.21	Cu4 (OH) 6SO4:H2O
Larnakite	-11.17	-11.22	-0.05	PbO:PbSO4
Laurionite	-8.17	-7.54	0.62	PbOHCl
Litharge	-11.61	1.69	13.31	PbO
Maghemite	-5.42	0.96	6.39	Fe2O3
Magnesite	-1.28	-9.09	-7.81	MgCO3
Magnetite	1.14	6.69	5.54	Fe3O4
Malachite	-2.21	3.65	5.86	Cu2 (OH) 2CO3
Manganite	-8.74	16.60	25.34	MnOOH
Massicot	-11.82	1.69	13.51	PbO
Melanothallite	-16.70	-12.53	4.17	CuCl2
Melanterite	-6.49	-8.89	-2.39	FeSO4:7H2O
Minium	-56.05	21.32	77.37	Pb3O4
Mirabilite	-6.57	-8.36	-1.79	Na2SO4:10H2O
Mn2 (SO4) 3	-59.19	-63.51	-4.31	Mn2 (SO4) 3
Mn3 (AsO4) 2:8H2O	-13.36	-42.07	-28.71	Mn3 (AsO4) 2:8H2O
MnCl2:4H2O	-12.08	-10.00	2.09	MnCl2:4H2O
MnSO4	-9.36	-6.13	3.22	MnSO4
Monteponite	-11.10	3.56	14.66	CdO
Nahcolite	-4.42	-5.10	-0.68	NaHCO3
Nantokite	-1.64	-8.75	-7.12	CuCl
Natron	-10.58	-12.45	-1.87	Na2CO3:10H2O
Nesquehonite	-3.68	-9.09	-5.41	MgCO3:3H2O
Nsutite	-17.85	24.72	42.56	MnO2
O2 (g)	-55.65	-58.43	-2.78	O2
Otavite	-3.14	-15.15	-12.00	CdCO3
Pb (OH) 2	-6.96	1.69	8.65	Pb (OH) 2
Pb2 (OH) 3Cl	-14.64	-5.85	8.79	Pb2 (OH) 3Cl
Pb2O (OH) 2	-22.81	3.39	26.20	PbO:Pb (OH) 2
Pb2O3	-41.41	19.63	61.04	Pb2O3
Pb2OCO3	-15.23	-15.32	-0.09	PbO:PbCO3
Pb3 (AsO4) 2	-27.01	-62.42	-35.40	Pb3 (AsO4) 2
Pb3O2CO3	-25.59	-13.62	11.97	PbCO3:2PbO
Pb3O2SO4	-20.67	-9.53	11.14	PbSO4:2PbO
Pb4 (OH) 6SO4	-28.94	-7.84	21.10	Pb4 (OH) 6SO4
Pb4O3SO4	-31.19	-7.84	23.36	PbSO4:3PbO
PbMetal	-18.80	-14.55	4.26	Pb
PbO:0.3H2O	-11.29	1.69	12.98	PbO:0.33H2O

Phosgenite	-13.98	-33.79	-19.81	PbCl2:PbCO3
Plattnerite	-33.90	17.93	51.83	PbO2
Portlandite	-13.90	10.01	23.91	Ca(OH)2
Pyrochroite	-6.72	8.48	15.20	Mn(OH)2
Pyrolusite	-19.00	24.72	43.71	MnO2
Rhodochrosite	0.85	-10.23	-11.08	MnCO3
Rhodochrosite(d)	0.16	-10.23	-10.39	MnCO3
Scorodite	-13.02	-33.27	-20.25	FeAsO4:2H2O
Se(s)	4.54	-12.78	-17.32	Se
SeO2	-14.43	-22.81	-8.38	SeO2
Siderite	-2.17	-12.98	-10.80	FeCO3
Siderite(d) (3)	-2.53	-12.98	-10.45	FeCO3
Smithsonite	-2.92	-12.76	-9.84	ZnCO3
Smithsonite_PG	-1.96	-12.76	-10.81	ZnCO3
Tenorite	-2.23	5.94	8.17	CuO
Thenardite	-8.20	-8.36	-0.16	Na2SO4
Thermonatrite	-12.67	-12.45	0.23	Na2CO3:H2O
Trona	-17.40	-17.55	-0.15	NaHCO3:Na2CO3:2H2O
Witherite	-5.41	-14.03	-8.62	BaCO3
Zincite(c)	-5.98	5.94	11.92	ZnO
Zincosite	-12.37	-8.67	3.70	ZnSO4
Zn(OH)2-a	-6.51	5.94	12.45	Zn(OH)2
Zn(OH)2-b	-5.81	5.94	11.75	Zn(OH)2
Zn(OH)2-c	-6.26	5.94	12.20	Zn(OH)2
Zn(OH)2-e	-5.56	5.94	11.50	Zn(OH)2
Zn(OH)2-g	-5.77	5.94	11.71	Zn(OH)2
Zn2(OH)2SO4	-10.23	-2.73	7.50	Zn2(OH)2SO4
Zn2(OH)3Cl	-12.56	2.64	15.20	Zn2(OH)3Cl
Zn3(AsO4)2:2.5w	-22.14	-49.68	-27.55	Zn3(AsO4)2:2.5H2O
Zn3O(SO4)2	-32.65	-11.41	21.24	ZnO:2ZnSO4
Zn4(OH)6SO4	-19.26	9.14	28.40	Zn4(OH)6SO4
Zn5(OH)8Cl2	-27.28	11.22	38.50	Zn5(OH)8Cl2
ZnCl2	-20.19	-12.53	7.66	ZnCl2
ZnCO3:1H2O	-2.51	-12.77	-10.26	ZnCO3:1H2O
ZnCO3:H2O	-2.51	-12.77	-10.26	ZnCO3:H2O
ZnMetal	-37.38	-10.30	27.07	Zn
ZnO(a)	-5.37	5.94	11.31	ZnO
ZnSO4:H2O	-8.48	-8.67	-0.19	ZnSO4:H2O

**For a gas, SI = log10(fugacity). Fugacity = pressure * phi / 1 atm.
For ideal gases, phi = 1.

Initial solution 5. MW-1013C

-----Solution composition-----

Elements	Molality	Moles
Ag	4.649e-10	4.649e-10
Alkalinity	9.399e-03	9.399e-03
As	2.932e-07	2.932e-07
Ba	1.300e-07	1.300e-07
Ca	1.486e-02	1.486e-02
Cd	3.569e-10	3.569e-10
Cl	1.457e-03	1.457e-03
Cu	8.681e-09	8.681e-09
Fe	2.496e-04	2.496e-04
K	6.284e-04	6.284e-04
Mg	5.446e-03	5.446e-03
Mn	1.776e-04	1.776e-04
Na	1.239e-03	1.239e-03
Pb	4.841e-10	4.841e-10
S(6)	1.744e-02	1.744e-02
Se	2.541e-09	2.541e-09
Zn	5.769e-06	5.769e-06

-----Description of solution-----

pH = 6.370
 pe = 0.777
 Activity of water = 0.999
 Ionic strength (mol/kgw) = 5.826e-02
 Mass of water (kg) = 1.000e+00
 Total carbon (mol/kg) = 1.815e-02
 Total CO2 (mol/kg) = 1.815e-02
 Temperature (°C) = 10.14
 Electrical balance (eq) = -2.374e-03
 Percent error, 100*(Cat-|An|)/(Cat+|An|) = -3.67
 Iterations = 11
 Total H = 1.110218e+02
 Total O = 5.562166e+01

-----Distribution of species-----

Species	Molality	Activity	Log Molality	Log Activity	Log Gamma	mole V cm ³ /mol
H+	5.016e-07	4.266e-07	-6.300	-6.370	-0.070	0.00
OH-	8.498e-09	6.937e-09	-8.071	-8.159	-0.088	(0)
H2O	5.551e+01	9.991e-01	1.744	-0.000	0.000	18.02
Ag	4.649e-10					
AgCl	2.816e-10	2.854e-10	-9.550	-9.544	0.006	(0)
Ag+	1.261e-10	1.029e-10	-9.899	-9.988	-0.088	(0)
AgCl2-	4.588e-11	3.746e-11	-10.338	-10.426	-0.088	(0)
AgSO4-	1.127e-11	9.198e-12	-10.948	-11.036	-0.088	(0)
AgCl3-2	7.327e-14	3.254e-14	-13.135	-13.488	-0.352	(0)
AgCl4-3	3.940e-16	6.344e-17	-15.405	-16.198	-0.793	(0)
AgOH	2.378e-16	2.410e-16	-15.624	-15.618	0.006	(0)
Ag (OH) 2-	6.915e-22	5.645e-22	-21.160	-21.248	-0.088	(0)
As (3)	2.893e-07					
H3AsO3	2.889e-07	2.928e-07	-6.539	-6.533	0.006	(0)
H2AsO3-	3.324e-10	2.714e-10	-9.478	-9.566	-0.088	(0)
H4AsO3+	7.581e-14	6.189e-14	-13.120	-13.208	-0.088	(0)
HAsO3-2	1.456e-18	6.467e-19	-17.837	-18.189	-0.352	(0)
AsO3-3	1.099e-27	1.770e-28	-26.959	-27.752	-0.793	(0)
As (5)	3.922e-09					
H2AsO4-	3.068e-09	2.504e-09	-8.513	-8.601	-0.088	(0)
HAsO4-2	8.543e-10	3.794e-10	-9.068	-9.421	-0.352	(0)
H3AsO4	1.811e-13	1.836e-13	-12.742	-12.736	0.006	(0)
AsO4-3	8.414e-15	1.355e-15	-14.075	-14.868	-0.793	(0)
Ba	1.300e-07					
BaSO4	6.874e-08	6.967e-08	-7.163	-7.157	0.006	(0)
Ba+2	5.985e-08	2.658e-08	-7.223	-7.575	-0.352	(0)
BaHCO3+	1.403e-09	1.146e-09	-8.853	-8.941	-0.088	(0)
BaCO3	5.523e-12	5.597e-12	-11.258	-11.252	0.006	(0)
BaOH+	2.584e-15	2.109e-15	-14.588	-14.676	-0.088	(0)
C (4)	1.815e-02					
CO2	8.761e-03	8.879e-03	-2.057	-2.052	0.006	(0)
HCO3-	8.716e-03	7.178e-03	-2.060	-2.144	-0.084	(0)
CaHCO3+	3.885e-04	3.172e-04	-3.411	-3.499	-0.088	(0)
MgHCO3+	1.782e-04	1.455e-04	-3.749	-3.837	-0.088	(0)
FeHCO3+	5.723e-05	4.672e-05	-4.242	-4.331	-0.088	(0)
MnHCO3+	3.697e-05	3.018e-05	-4.432	-4.520	-0.088	(0)
NaHCO3	3.932e-06	3.985e-06	-5.405	-5.400	0.006	(0)
CaCO3	3.504e-06	3.551e-06	-5.455	-5.450	0.006	(0)
MnCO3	2.031e-06	2.059e-06	-5.692	-5.686	0.006	(0)
ZnHCO3+	1.370e-06	1.118e-06	-5.863	-5.952	-0.088	(0)
CO3-2	1.195e-06	5.494e-07	-5.923	-6.260	-0.337	(0)
FeCO3	8.463e-07	8.577e-07	-6.072	-6.067	0.006	(0)
MgCO3	7.435e-07	7.535e-07	-6.129	-6.123	0.006	(0)
ZnCO3	1.338e-07	1.356e-07	-6.873	-6.868	0.006	(0)
NaCO3-	5.622e-09	4.589e-09	-8.250	-8.338	-0.088	(0)
Zn (CO3) 2-2	3.587e-09	1.593e-09	-8.445	-8.798	-0.352	(0)
BaHCO3+	1.403e-09	1.146e-09	-8.853	-8.941	-0.088	(0)

CuHCO3+	2.628e-10	2.145e-10	-9.580	-9.668	-0.088	(0)
PbCO3	2.086e-10	2.114e-10	-9.681	-9.675	0.006	(0)
CuCO3	1.736e-10	1.760e-10	-9.760	-9.755	0.006	(0)
PbHCO3+	1.546e-10	1.262e-10	-9.811	-9.899	-0.088	(0)
CdHCO3+	2.358e-11	1.925e-11	-10.627	-10.716	-0.088	(0)
BaCO3	5.523e-12	5.597e-12	-11.258	-11.252	0.006	(0)
Pb(CO3) 2-2	6.568e-13	2.917e-13	-12.183	-12.535	-0.352	(0)
Cu(CO3) 2-2	2.740e-13	1.217e-13	-12.562	-12.915	-0.352	(0)
CdCO3	3.652e-14	3.701e-14	-13.437	-13.432	0.006	(0)
Cd(CO3) 2-2	1.448e-16	6.430e-17	-15.839	-16.192	-0.352	(0)
Ca	1.486e-02					
Ca+2	1.026e-02	4.739e-03	-1.989	-2.324	-0.335	(0)
CaSO4	4.216e-03	4.273e-03	-2.375	-2.369	0.006	(0)
CaHCO3+	3.885e-04	3.172e-04	-3.411	-3.499	-0.088	(0)
CaCO3	3.504e-06	3.551e-06	-5.455	-5.450	0.006	(0)
CaHSO4+	1.118e-08	9.125e-09	-7.952	-8.040	-0.088	(0)
CaOH+	2.256e-09	1.842e-09	-8.647	-8.735	-0.088	(0)
Cd	3.569e-10					
Cd+2	1.910e-10	8.482e-11	-9.719	-10.072	-0.352	(0)
CdSO4	1.147e-10	1.163e-10	-9.940	-9.935	0.006	(0)
CdHCO3+	2.358e-11	1.925e-11	-10.627	-10.716	-0.088	(0)
Cd(SO4) 2-2	1.652e-11	7.336e-12	-10.782	-11.135	-0.352	(0)
CdCl+	1.106e-11	9.032e-12	-10.956	-11.044	-0.088	(0)
CdCl2	4.120e-14	4.176e-14	-13.385	-13.379	0.006	(0)
CdCO3	3.652e-14	3.701e-14	-13.437	-13.432	0.006	(0)
CdOH+	6.346e-15	5.181e-15	-14.197	-14.286	-0.088	(0)
CdOHCl	6.177e-15	6.261e-15	-14.209	-14.203	0.006	(0)
Cd(CO3) 2-2	1.448e-16	6.430e-17	-15.839	-16.192	-0.352	(0)
CdCl3-	2.996e-17	2.446e-17	-16.523	-16.612	-0.088	(0)
Cd(OH) 2	2.051e-18	2.078e-18	-17.688	-17.682	0.006	(0)
Cd2OH+3	1.624e-23	2.615e-24	-22.789	-23.583	-0.793	(0)
Cd(OH) 3-	6.690e-25	5.461e-25	-24.175	-24.263	-0.088	(0)
Cd(OH) 4-2	2.567e-32	1.140e-32	-31.591	-31.943	-0.352	(0)
Cl	1.457e-03					
Cl-	1.457e-03	1.175e-03	-2.837	-2.930	-0.093	(0)
MnCl+	2.766e-07	2.258e-07	-6.558	-6.646	-0.088	(0)
FeCl+	1.293e-07	1.056e-07	-6.888	-6.977	-0.088	(0)
CuCl2-	2.506e-09	2.046e-09	-8.601	-8.689	-0.088	(0)
ZnCl+	2.405e-09	1.963e-09	-8.619	-8.707	-0.088	(0)
AgCl	2.816e-10	2.854e-10	-9.550	-9.544	0.006	(0)
MnCl2	1.143e-10	1.158e-10	-9.942	-9.936	0.006	(0)
ZnOHCl	1.112e-10	1.127e-10	-9.954	-9.948	0.006	(0)
AgCl2-	4.588e-11	3.746e-11	-10.338	-10.426	-0.088	(0)
CdCl+	1.106e-11	9.032e-12	-10.956	-11.044	-0.088	(0)
CuCl3-2	8.075e-12	3.586e-12	-11.093	-11.445	-0.352	(0)
ZnCl2	2.238e-12	2.268e-12	-11.650	-11.644	0.006	(0)
PbCl+	8.608e-13	7.027e-13	-12.065	-12.153	-0.088	(0)
CuCl+	1.074e-13	8.769e-14	-12.969	-13.057	-0.088	(0)
AgCl3-2	7.327e-14	3.254e-14	-13.135	-13.488	-0.352	(0)
MnCl3-	4.590e-14	3.747e-14	-13.338	-13.426	-0.088	(0)
CdCl2	4.120e-14	4.176e-14	-13.385	-13.379	0.006	(0)
CdOHCl	6.177e-15	6.261e-15	-14.209	-14.203	0.006	(0)
ZnCl3-	3.334e-15	2.722e-15	-14.477	-14.565	-0.088	(0)
PbCl2	1.729e-15	1.752e-15	-14.762	-14.756	0.006	(0)
AgCl4-3	3.940e-16	6.344e-17	-15.405	-16.198	-0.793	(0)
CuCl2	4.609e-17	4.672e-17	-16.336	-16.331	0.006	(0)
CdCl3-	2.996e-17	2.446e-17	-16.523	-16.612	-0.088	(0)
ZnCl4-2	3.188e-18	1.416e-18	-17.497	-17.849	-0.352	(0)
PbCl3-	1.819e-18	1.485e-18	-17.740	-17.828	-0.088	(0)
FeCl+2	7.689e-19	3.415e-19	-18.114	-18.467	-0.352	(0)
FeCl2+	3.604e-21	2.942e-21	-20.443	-20.531	-0.088	(0)
PbCl4-2	1.667e-21	7.403e-22	-20.778	-21.131	-0.352	(0)
CuCl3-	1.808e-22	1.476e-22	-21.743	-21.831	-0.088	(0)
FeCl3	3.410e-25	3.456e-25	-24.467	-24.461	0.006	(0)
CuCl4-2	1.362e-27	6.051e-28	-26.866	-27.218	-0.352	(0)
Cu(1)	8.045e-09					
Cu+	5.531e-09	4.516e-09	-8.257	-8.345	-0.088	(0)

CuCl2-	2.506e-09	2.046e-09	-8.601	-8.689	-0.088	(0)
CuCl3-2	8.075e-12	3.586e-12	-11.093	-11.445	-0.352	(0)
Cu (2)	6.360e-10					
CuHCO3+	2.628e-10	2.145e-10	-9.580	-9.668	-0.088	(0)
CuCO3	1.736e-10	1.760e-10	-9.760	-9.755	0.006	(0)
Cu+2	1.343e-10	5.964e-11	-9.872	-10.224	-0.352	(0)
CuSO4	5.640e-11	5.716e-11	-10.249	-10.243	0.006	(0)
Cu (OH) 2	6.744e-12	6.835e-12	-11.171	-11.165	0.006	(0)
CuOH+	1.711e-12	1.397e-12	-11.767	-11.855	-0.088	(0)
Cu (CO3) 2-2	2.740e-13	1.217e-13	-12.562	-12.915	-0.352	(0)
CuCl+	1.074e-13	8.769e-14	-12.969	-13.057	-0.088	(0)
CuCl2	4.609e-17	4.672e-17	-16.336	-16.331	0.006	(0)
Cu (OH) 3-	1.182e-18	9.646e-19	-17.928	-18.016	-0.088	(0)
Cu2 (OH) 2+2	4.069e-19	1.807e-19	-18.391	-18.743	-0.352	(0)
CuCl3-	1.808e-22	1.476e-22	-21.743	-21.831	-0.088	(0)
Cu (OH) 4-2	1.015e-24	4.508e-25	-23.994	-24.346	-0.352	(0)
CuCl4-2	1.362e-27	6.051e-28	-26.866	-27.218	-0.352	(0)
Fe (2)	2.496e-04					
Fe+2	1.465e-04	6.509e-05	-3.834	-4.187	-0.352	(0)
FeHCO3+	5.723e-05	4.672e-05	-4.242	-4.331	-0.088	(0)
FeSO4	4.487e-05	4.548e-05	-4.348	-4.342	0.006	(0)
FeCO3	8.463e-07	8.577e-07	-6.072	-6.067	0.006	(0)
FeCl+	1.293e-07	1.056e-07	-6.888	-6.977	-0.088	(0)
FeOH+	1.835e-08	1.498e-08	-7.736	-7.824	-0.088	(0)
FeHSO4+	1.535e-10	1.253e-10	-9.814	-9.902	-0.088	(0)
Fe (OH) 2	7.561e-14	7.663e-14	-13.121	-13.116	0.006	(0)
Fe (OH) 3-	7.005e-18	5.719e-18	-17.155	-17.243	-0.088	(0)
Fe (3)	5.632e-11					
Fe (OH) 2+	4.995e-11	4.078e-11	-10.301	-10.390	-0.088	(0)
Fe (OH) 3	6.140e-12	6.223e-12	-11.212	-11.206	0.006	(0)
FeOH+2	2.143e-13	9.515e-14	-12.669	-13.022	-0.352	(0)
Fe (OH) 4-	8.684e-15	7.089e-15	-14.061	-14.149	-0.088	(0)
FeSO4+	7.852e-16	6.410e-16	-15.105	-15.193	-0.088	(0)
Fe+3	9.813e-17	1.580e-17	-16.008	-16.801	-0.793	(0)
Fe (SO4) 2-	8.452e-17	6.900e-17	-16.073	-16.161	-0.088	(0)
FeCl+2	7.689e-19	3.415e-19	-18.114	-18.467	-0.352	(0)
FeCl2+	3.604e-21	2.942e-21	-20.443	-20.531	-0.088	(0)
FeHSO4+2	1.721e-21	7.643e-22	-20.764	-21.117	-0.352	(0)
Fe2 (OH) 2+4	1.195e-23	4.651e-25	-22.922	-24.332	-1.410	(0)
FeCl3	3.410e-25	3.456e-25	-24.467	-24.461	0.006	(0)
Fe3 (OH) 4+5	2.678e-30	1.678e-32	-29.572	-31.775	-2.203	(0)
H (0)	8.281e-18					
H2	4.140e-18	4.196e-18	-17.383	-17.377	0.006	(0)
K	6.284e-04					
K+	6.115e-04	4.933e-04	-3.214	-3.307	-0.093	(0)
KSO4-	1.690e-05	1.380e-05	-4.772	-4.860	-0.088	(0)
Mg	5.446e-03					
Mg+2	3.807e-03	1.806e-03	-2.419	-2.743	-0.324	(0)
MgSO4	1.460e-03	1.480e-03	-2.836	-2.830	0.006	(0)
MgHCO3+	1.782e-04	1.455e-04	-3.749	-3.837	-0.088	(0)
MgCO3	7.435e-07	7.535e-07	-6.129	-6.123	0.006	(0)
MgOH+	4.582e-09	3.741e-09	-8.339	-8.427	-0.088	(0)
Mn (2)	1.776e-04					
Mn+2	1.062e-04	4.718e-05	-3.974	-4.326	-0.352	(0)
MnHCO3+	3.697e-05	3.018e-05	-4.432	-4.520	-0.088	(0)
MnSO4	3.213e-05	3.256e-05	-4.493	-4.487	0.006	(0)
MnCO3	2.031e-06	2.059e-06	-5.692	-5.686	0.006	(0)
MnCl+	2.766e-07	2.258e-07	-6.558	-6.646	-0.088	(0)
MnOH+	9.724e-10	7.938e-10	-9.012	-9.100	-0.088	(0)
MnCl2	1.143e-10	1.158e-10	-9.942	-9.936	0.006	(0)
MnCl3-	4.590e-14	3.747e-14	-13.338	-13.426	-0.088	(0)
Mn (OH) 3-	1.177e-20	9.607e-21	-19.929	-20.017	-0.088	(0)
Mn (3)	5.524e-30					
Mn+3	5.524e-30	8.896e-31	-29.258	-30.051	-0.793	(0)
Mn (6)	0.000e+00					
MnO4-2	0.000e+00	0.000e+00	-74.114	-74.466	-0.352	(0)
Mn (7)	0.000e+00					

MnO4-	0.000e+00	0.000e+00	-84.008	-84.096	-0.088	(0)
Na	1.239e-03					
Na+	1.206e-03	9.873e-04	-2.919	-3.006	-0.087	(0)
NaSO4-	2.871e-05	2.344e-05	-4.542	-4.630	-0.088	(0)
NaHCO3	3.932e-06	3.985e-06	-5.405	-5.400	0.006	(0)
NaCO3-	5.622e-09	4.589e-09	-8.250	-8.338	-0.088	(0)
O(0)	0.000e+00					
O2	0.000e+00	0.000e+00	-62.680	-62.674	0.006	(0)
Pb	4.841e-10					
PbCO3	2.086e-10	2.114e-10	-9.681	-9.675	0.006	(0)
PbHCO3+	1.546e-10	1.262e-10	-9.811	-9.899	-0.088	(0)
PbSO4	6.425e-11	6.512e-11	-10.192	-10.186	0.006	(0)
Pb+2	4.985e-11	2.214e-11	-10.302	-10.655	-0.352	(0)
Pb(SO4) 2-2	4.024e-12	1.787e-12	-11.395	-11.748	-0.352	(0)
PbOH+	1.239e-12	1.011e-12	-11.907	-11.995	-0.088	(0)
PbCl+	8.608e-13	7.027e-13	-12.065	-12.153	-0.088	(0)
Pb(CO3) 2-2	6.568e-13	2.917e-13	-12.183	-12.535	-0.352	(0)
PbCl2	1.729e-15	1.752e-15	-14.762	-14.756	0.006	(0)
Pb(OH) 2	9.091e-16	9.213e-16	-15.041	-15.036	0.006	(0)
PbCl3-	1.819e-18	1.485e-18	-17.740	-17.828	-0.088	(0)
Pb(OH) 3-	3.035e-20	2.478e-20	-19.518	-19.606	-0.088	(0)
Pb2OH+3	3.113e-21	5.012e-22	-20.507	-21.300	-0.793	(0)
PbCl4-2	1.667e-21	7.403e-22	-20.778	-21.131	-0.352	(0)
Pb(OH) 4-2	2.993e-25	1.329e-25	-24.524	-24.876	-0.352	(0)
Pb3(OH) 4+2	9.282e-32	4.122e-32	-31.032	-31.385	-0.352	(0)
S(6)	1.744e-02					
SO4-2	1.164e-02	5.230e-03	-1.934	-2.282	-0.347	(0)
CaSO4	4.216e-03	4.273e-03	-2.375	-2.369	0.006	(0)
MgSO4	1.460e-03	1.480e-03	-2.836	-2.830	0.006	(0)
FeSO4	4.487e-05	4.548e-05	-4.348	-4.342	0.006	(0)
MnSO4	3.213e-05	3.256e-05	-4.493	-4.487	0.006	(0)
NaSO4-	2.871e-05	2.344e-05	-4.542	-4.630	-0.088	(0)
KSO4-	1.690e-05	1.380e-05	-4.772	-4.860	-0.088	(0)
ZnSO4	1.327e-06	1.345e-06	-5.877	-5.871	0.006	(0)
HSO4-	1.962e-07	1.602e-07	-6.707	-6.795	-0.088	(0)
Zn(SO4) 2-2	1.452e-07	6.449e-08	-6.838	-7.191	-0.352	(0)
BaSO4	6.874e-08	6.967e-08	-7.163	-7.157	0.006	(0)
CaHSO4+	1.118e-08	9.125e-09	-7.952	-8.040	-0.088	(0)
FeHSO4+	1.535e-10	1.253e-10	-9.814	-9.902	-0.088	(0)
CdSO4	1.147e-10	1.163e-10	-9.940	-9.935	0.006	(0)
PbSO4	6.425e-11	6.512e-11	-10.192	-10.186	0.006	(0)
CuSO4	5.640e-11	5.716e-11	-10.249	-10.243	0.006	(0)
Cd(SO4) 2-2	1.652e-11	7.336e-12	-10.782	-11.135	-0.352	(0)
AgSO4-	1.127e-11	9.198e-12	-10.948	-11.036	-0.088	(0)
Pb(SO4) 2-2	4.024e-12	1.787e-12	-11.395	-11.748	-0.352	(0)
FeSO4+	7.852e-16	6.410e-16	-15.105	-15.193	-0.088	(0)
Fe(SO4) 2-	8.452e-17	6.900e-17	-16.073	-16.161	-0.088	(0)
FeHSO4+2	1.721e-21	7.643e-22	-20.764	-21.117	-0.352	(0)
Se(-2)	3.399e-18					
HSe-	3.387e-18	2.765e-18	-17.470	-17.558	-0.088	(0)
H2Se	1.174e-20	1.190e-20	-19.930	-19.925	0.006	(0)
Se(4)	2.541e-09					
HSeO3-	2.506e-09	2.046e-09	-8.601	-8.689	-0.088	(0)
SeO3-2	3.415e-11	1.516e-11	-10.467	-10.819	-0.352	(0)
H2SeO3	4.842e-13	4.907e-13	-12.315	-12.309	0.006	(0)
Se(6)	3.730e-27					
SeO4-2	3.730e-27	1.657e-27	-26.428	-26.781	-0.352	(0)
HSeO4-	2.562e-32	2.091e-32	-31.591	-31.680	-0.088	(0)
Zn	5.769e-06					
Zn+2	2.786e-06	1.237e-06	-5.555	-5.908	-0.352	(0)
ZnHCO3+	1.370e-06	1.118e-06	-5.863	-5.952	-0.088	(0)
ZnSO4	1.327e-06	1.345e-06	-5.877	-5.871	0.006	(0)
Zn(SO4) 2-2	1.452e-07	6.449e-08	-6.838	-7.191	-0.352	(0)
ZnCO3	1.338e-07	1.356e-07	-6.873	-6.868	0.006	(0)
Zn(CO3) 2-2	3.587e-09	1.593e-09	-8.445	-8.798	-0.352	(0)
ZnCl+	2.405e-09	1.963e-09	-8.619	-8.707	-0.088	(0)
ZnOH+	1.189e-09	9.703e-10	-8.925	-9.013	-0.088	(0)

ZnOHC1	1.112e-10	1.127e-10	-9.954	-9.948	0.006	(0)
Zn(OH)2	8.431e-11	8.545e-11	-10.074	-10.068	0.006	(0)
ZnCl2	2.238e-12	2.268e-12	-11.650	-11.644	0.006	(0)
ZnCl3-	3.334e-15	2.722e-15	-14.477	-14.565	-0.088	(0)
Zn(OH)3-	7.753e-16	6.329e-16	-15.111	-15.199	-0.088	(0)
ZnCl4-2	3.188e-18	1.416e-18	-17.497	-17.849	-0.352	(0)
Zn(OH)4-2	5.290e-22	2.349e-22	-21.277	-21.629	-0.352	(0)

-----Saturation indices-----

Phase	SI**	log IAP	log K(283 K,	1 atm)		
Ag2CO3	-14.80	-26.24	-11.44	Ag2CO3		
Ag2O	-20.22	-7.24	12.98	Ag2O		
Ag2SO4	-17.17	-22.26	-5.08	Ag2SO4		
AgMetal	3.72	-10.76	-14.48	Ag		
Anglesite	-5.06	-12.94	-7.87	PbSO4		
Anhydrite	-0.27	-4.61	-4.34	CaSO4		
Antlerite	-15.77	-7.48	8.29	Cu3(OH)4SO4		
Aragonite	-0.33	-8.58	-8.26	CaCO3		
Arsenolite	-11.41	-13.07	-1.66	As2O3		
Artinite	-9.71	0.99	10.71	MgCO3:Mg(OH)2:3H2O		
As2O5(cr)	-33.99	-25.47	8.52	As2O5		
As_native	-14.38	-27.97	-13.59	As		
Atacamite	-12.33	-4.27	8.06	Cu2(OH)3Cl		
Azurite	-14.42	-9.48	4.94	Cu3(OH)2(CO3)2		
Ba3(AsO4)2	-1.99	-52.46	-50.48	Ba3(AsO4)2		
Barite	0.39	-9.86	-10.24	BaSO4		
BaSeO3	-12.00	-18.39	-6.39	BaSeO3		
Bianchite	-6.43	-8.19	-1.76	ZnSO4:6H2O		
Birnessite	-20.89	22.71	43.60	MnO2		
Bixbyite	-21.86	-21.88	-0.02	Mn2O3		
Brochantite	-20.30	-4.96	15.34	Cu4(OH)6SO4		
Brucite	-7.89	10.00	17.88	Mg(OH)2		
Ca3(AsO4)2:4w	-17.81	-36.71	-18.91	Ca3(AsO4)2:4H2O		
Calcite	-0.17	-8.58	-8.41	CaCO3		
CaSeO3	-7.54	-13.14	-5.60	CaSeO3		
Cd(gamma)	-25.91	-11.63	14.29	Cd		
Cd(OH)2	-10.98	2.67	13.65	Cd(OH)2		
Cd(OH)2(a)	-11.86	2.67	14.53	Cd(OH)2		
Cd3(OH)2(SO4)2	-28.75	-22.04	6.71	Cd3(OH)2(SO4)2		
Cd3(OH)4SO4	-29.58	-7.02	22.56	Cd3(OH)4SO4		
Cd4(OH)6SO4	-32.75	-4.35	28.40	Cd4(OH)6SO4		
CdCl2	-15.42	-15.93	-0.51	CdCl2		
CdCl2:2.5H2O	-13.93	-15.93	-2.01	CdCl2:2.5H2O		
CdCl2:H2O	-14.29	-15.93	-1.64	CdCl2:H2O		
CdMetal	-25.81	-11.63	14.18	Cd		
CdOHC1	-10.44	-6.63	3.80	CdOHC1		
CdSO4	-12.82	-12.35	0.47	CdSO4		
CdSO4:2.7H2O	-10.65	-12.35	-1.71	CdSO4:2.67H2O		
CdSO4:H2O	-10.99	-12.35	-1.37	CdSO4:H2O		
Cerargyrite	-2.57	-12.92	-10.35	AgCl		
Cerrusite	-3.60	-16.91	-13.32	PbCO3		
Chalcanthite	-9.81	-12.51	-2.70	CuSO4:5H2O		
Claudetite	-11.46	-13.07	-1.60	As2O3		
CO2(g)	-0.78	-2.05	-1.27	CO2		
Cotunnite	-11.53	-16.51	-4.99	PbCl2		
Cu(OH)2	-6.71	2.51	9.23	Cu(OH)2		
Cu2SO4	-17.20	-18.97	-1.77	Cu2SO4		
Cu3(AsO4)2:6w	-25.29	-60.41	-35.12	Cu3(AsO4)2:6H2O		
CuCO3	-6.85	-16.48	-9.63	CuCO3		
CuMetal	0.30	-9.12	-9.42	Cu		
CuOCuSO4	-22.89	-9.99	12.90	CuO:CuSO4		
CupricFerrite	-0.24	7.13	7.37	CuFe2O4		
Cuprite	-2.16	-3.95	-1.79	Cu2O		
CuprousFerrite	9.11	0.33	-8.77	CuFeO2		
CuSO4	-16.21	-12.51	3.71	CuSO4		

Dolomite	-0.86	-17.59	-16.73	CaMg (CO3) 2
Dolomite(d)	-1.47	-17.59	-16.11	CaMg (CO3) 2
Epsomite	-2.78	-5.03	-2.25	MgSO4:7H2O
Fe(OH) 2.7Cl.3	2.56	-0.48	-3.04	Fe (OH) 2.7Cl0.3
Fe(OH) 3(a)	-2.58	2.31	4.89	Fe (OH) 3
Fe2(SeO3) 3	-30.63	-66.06	-35.43	Fe2 (SeO3) 3
Fe3(OH) 8	-7.05	13.17	20.22	Fe3 (OH) 8
FeSe2	-6.43	-25.01	-18.58	FeSe2
Goethite	2.75	2.31	-0.44	FeOOH
Goslarite	-6.10	-8.19	-2.09	ZnSO4:7H2O
Gypsum	-0.02	-4.61	-4.59	CaSO4:2H2O
H2(g)	-14.29	-17.38	-3.08	H2
H2O(g)	-1.92	-0.00	1.91	H2O
Halite	-7.48	-5.94	1.55	NaCl
Hausmannite	-25.36	39.53	64.90	Mn3O4
Hematite	7.44	4.62	-2.82	Fe2O3
Huntite	-6.62	-35.59	-28.98	CaMg3 (CO3) 4
Hydrocerussite	-14.29	-31.75	-17.46	Pb (OH) 2:2PbCO3
Hydromagnesite	-19.27	-26.02	-6.75	Mg5 (CO3) 4 (OH) 2:4H2O
Hydrozincite	-13.18	17.13	30.31	Zn5 (OH) 6 (CO3) 2
Hydrozincite_PG	-14.91	17.13	32.04	Zn5 (OH) 6 (CO3) 2
Jarosite(ss)	-10.83	-20.66	-9.83	(K0.77Na0.03H0.2) Fe3 (SO4) 2 (OH) 6
Jarosite-K	-12.05	-20.06	-8.01	KFe3 (SO4) 2 (OH) 6
Jarosite-Na	-15.87	-19.75	-3.89	NaFe3 (SO4) 2 (OH) 6
JarositeH	-19.85	-23.12	-3.27	(H3O) Fe3 (SO4) 2 (OH) 6
Langite	-23.28	-4.96	18.31	Cu4 (OH) 6SO4:H2O
Larnakite	-10.82	-10.85	-0.03	PbO:PbSO4
Laurionite	-7.84	-7.22	0.62	PbOHCl
Litharge	-11.26	2.08	13.35	PbO
Maghemite	-1.77	4.62	6.39	Fe2O3
Magnesite	-1.21	-9.00	-7.79	MgCO3
Magnetite	7.49	13.17	5.68	Fe3O4
Malachite	-9.39	-3.48	5.91	Cu2 (OH) 2CO3
Manganite	-9.78	15.56	25.34	MnOOH
Massicot	-11.47	2.08	13.56	PbO
Melanothallite	-20.29	-16.08	4.20	CuCl2
Melanterite	-4.06	-6.47	-2.41	FeSO4:7H2O
Minium	-57.09	20.55	77.64	Pb3O4
Mirabilite	-6.45	-8.30	-1.84	Na2SO4:10H2O
Mn2(SO4) 3	-62.74	-66.95	-4.21	Mn2 (SO4) 3
Mn3(AsO4) 2:8H2O	-14.01	-42.72	-28.71	Mn3 (AsO4) 2:8H2O
MnCl2:4H2O	-12.23	-10.19	2.04	MnCl2:4H2O
MnSO4	-9.87	-6.61	3.26	MnSO4
Monteponite	-12.05	2.67	14.72	CdO
Nahcolite	-4.46	-5.15	-0.69	NaHCO3
Nantokite	-4.13	-11.28	-7.14	CuCl
Natron	-10.36	-12.28	-1.92	Na2CO3:10H2O
Nesquehonite	-3.61	-9.00	-5.40	MgCO3:3H2O
Nsutite	-19.86	22.71	42.56	MnO2
O2(g)	-59.91	-62.67	-2.77	O2
Otavite	-4.33	-16.33	-12.00	CdCO3
Pb(OH) 2	-6.60	2.08	8.69	Pb (OH) 2
Pb2 (OH) 3Cl	-13.92	-5.13	8.79	Pb2 (OH) 3Cl
Pb2O(OH) 2	-22.03	4.17	26.20	PbO:Pb (OH) 2
Pb2O3	-42.58	18.46	61.04	Pb2O3
Pb2OCO3	-14.77	-14.83	-0.06	PbO:PbCO3
Pb3(AsO4) 2	-26.30	-61.70	-35.40	Pb3 (AsO4) 2
Pb3O2CO3	-24.78	-12.75	12.04	PbCO3:2PbO
Pb3O2SO4	-19.96	-8.77	11.20	PbSO4:2PbO
Pb4 (OH) 6SO4	-27.78	-6.68	21.10	Pb4 (OH) 6SO4
Pb4O3SO4	-30.13	-6.68	23.45	PbSO4:3PbO
PbMetal	-16.46	-12.21	4.25	Pb
PbO:0.3H2O	-10.90	2.08	12.98	PbO:0.33H2O
Phosgenite	-13.62	-33.43	-19.81	PbCl2:PbCO3
Plattnerite	-35.64	16.38	52.02	PbO2
Portlandite	-13.58	10.41	23.99	Ca (OH) 2
Pyrochroite	-6.79	8.41	15.20	Mn (OH) 2

Pyrolusite	-21.18	22.71	43.88	MnO2
Rhodochrosite	0.49	-10.59	-11.08	MnCO3
Rhodochrosite (d)	-0.20	-10.59	-10.39	MnCO3
Scorodite	-11.42	-31.67	-20.25	FeAsO4:2H2O
Se(s)	7.69	-9.63	-17.32	Se
SeO2	-15.18	-23.56	-8.38	SeO2
Siderite	0.35	-10.45	-10.79	FeCO3
Siderite (d) (3)	0.00	-10.45	-10.45	FeCO3
Smithsonite	-2.34	-12.17	-9.83	ZnCO3
Smithsonite_PG	-1.36	-12.17	-10.80	ZnCO3
Tenorite	-5.69	2.52	8.21	CuO
Thenardite	-8.14	-8.29	-0.16	Na2SO4
Thermonatrite	-12.50	-12.27	0.23	Na2CO3:H2O
Trona	-17.32	-17.42	-0.10	NaHCO3:Na2CO3:2H2O
Witherite	-5.20	-13.84	-8.63	BaCO3
Zincite (c)	-5.15	6.83	11.98	ZnO
Zincosite	-11.94	-8.19	3.75	ZnSO4
Zn(OH)2-a	-5.62	6.83	12.45	Zn(OH)2
Zn(OH)2-b	-4.92	6.83	11.75	Zn(OH)2
Zn(OH)2-c	-5.37	6.83	12.20	Zn(OH)2
Zn(OH)2-e	-4.67	6.83	11.50	Zn(OH)2
Zn(OH)2-g	-4.88	6.83	11.71	Zn(OH)2
Zn2(OH)2SO4	-8.86	-1.36	7.50	Zn2(OH)2SO4
Zn2(OH)3Cl	-10.84	4.36	15.20	Zn2(OH)3Cl
Zn3(AsO4)2:2.5w	-19.91	-47.46	-27.55	Zn3(AsO4)2:2.5H2O
Zn3O(SO4)2	-30.95	-9.55	21.40	ZnO:2ZnSO4
Zn4(OH)6SO4	-16.09	12.31	28.40	Zn4(OH)6SO4
Zn5(OH)8Cl2	-22.94	15.56	38.50	Zn5(OH)8Cl2
ZnCl2	-19.47	-11.77	7.70	ZnCl2
ZnCO3:1H2O	-1.91	-12.17	-10.26	ZnCO3:1H2O
ZnCO3:H2O	-1.91	-12.17	-10.26	ZnCO3:H2O
ZnMetal	-34.63	-7.46	27.17	Zn
ZnO (a)	-4.48	6.83	11.31	ZnO
ZnSO4:H2O	-8.03	-8.19	-0.16	ZnSO4:H2O

**For a gas, SI = log10(fugacity). Fugacity = pressure * phi / 1 atm.
For ideal gases, phi = 1.

Initial solution 6. MW-1014

-----Solution composition-----

Elements	Molality	Moles
Ag	4.637e-10	4.637e-10
Alkalinity	3.318e-03	3.318e-03
As	1.870e-09	1.870e-09
Ba	3.650e-07	3.650e-07
Ca	2.102e-03	2.102e-03
Cd	3.560e-10	3.560e-10
Cl	1.301e-03	1.301e-03
Cu	1.149e-07	1.149e-07
Fe	9.943e-07	9.943e-07
K	8.750e-05	8.750e-05
Mg	1.123e-03	1.123e-03
Mn	3.150e-05	3.150e-05
Na	6.354e-04	6.354e-04
Pb	4.829e-10	4.829e-10
S(6)	1.354e-03	1.354e-03
Se	2.534e-09	2.534e-09
Zn	2.388e-07	2.388e-07

-----Description of solution-----

pH = 6.820
pe = 1.731
Activity of water = 1.000

Ionic strength (mol/kgw) = 1.080e-02
 Mass of water (kg) = 1.000e+00
 Total carbon (mol/kg) = 4.651e-03
 Total CO2 (mol/kg) = 4.651e-03
 Temperature (°C) = 8.42
 Electrical balance (eq) = -8.738e-05
 Percent error, 100*(Cat-|An|)/(Cat+|An|) = -0.65
 Iterations = 10
 Total H = 1.110157e+02
 Total O = 5.552425e+01

-----Distribution of species-----

Species	Molality	Activity	Log Molality	Log Activity	Log Gamma	mole V cm ³ /mol
H+	1.658e-07	1.514e-07	-6.780	-6.820	-0.040	0.00
OH-	1.861e-08	1.677e-08	-7.730	-7.775	-0.045	(0)
H2O	5.551e+01	9.998e-01	1.744	-0.000	0.000	18.02
Ag	4.637e-10					
AgCl	3.004e-10	3.012e-10	-9.522	-9.521	0.001	(0)
Ag+	1.175e-10	1.059e-10	-9.930	-9.975	-0.045	(0)
AgCl2-	4.428e-11	3.990e-11	-10.354	-10.399	-0.045	(0)
AgSO4-	1.465e-12	1.320e-12	-11.834	-11.879	-0.045	(0)
AgCl3-2	5.014e-14	3.308e-14	-13.300	-13.480	-0.181	(0)
AgOH	6.979e-16	6.996e-16	-15.156	-15.155	0.001	(0)
AgCl4-3	1.638e-16	6.424e-17	-15.786	-16.192	-0.406	(0)
Ag (OH) 2-	5.128e-21	4.622e-21	-20.290	-20.335	-0.045	(0)
As (3)	8.928e-11					
H3AsO3	8.904e-11	8.926e-11	-10.050	-10.049	0.001	(0)
H2AsO3-	2.408e-13	2.171e-13	-12.618	-12.663	-0.045	(0)
H4AsO3+	7.427e-18	6.694e-18	-17.129	-17.174	-0.045	(0)
HAsO3-2	2.034e-21	1.342e-21	-20.692	-20.872	-0.181	(0)
AsO3-3	2.472e-30	9.696e-31	-29.607	-30.013	-0.406	(0)
As (5)	1.780e-09					
H2AsO4-	1.128e-09	1.016e-09	-8.948	-8.993	-0.045	(0)
HAsO4-2	6.524e-10	4.304e-10	-9.186	-9.366	-0.181	(0)
H3AsO4	2.589e-14	2.595e-14	-13.587	-13.586	0.001	(0)
AsO4-3	1.053e-14	4.132e-15	-13.977	-14.384	-0.406	(0)
Ba	3.650e-07					
Ba+2	2.904e-07	1.916e-07	-6.537	-6.718	-0.181	(0)
BaSO4	7.101e-08	7.118e-08	-7.149	-7.148	0.001	(0)
BaHCO3+	3.548e-09	3.198e-09	-8.450	-8.495	-0.045	(0)
BaCO3	4.258e-11	4.269e-11	-10.371	-10.370	0.001	(0)
BaOH+	4.758e-14	4.288e-14	-13.323	-13.368	-0.045	(0)
C (4)	4.651e-03					
HCO3-	3.245e-03	2.934e-03	-2.489	-2.532	-0.044	(0)
CO2	1.335e-03	1.339e-03	-2.874	-2.873	0.001	(0)
CaHCO3+	3.679e-05	3.315e-05	-4.434	-4.479	-0.045	(0)
MgHCO3+	2.510e-05	2.262e-05	-4.600	-4.645	-0.045	(0)
MnHCO3+	4.681e-06	4.219e-06	-5.330	-5.375	-0.045	(0)
CaCO3	1.033e-06	1.035e-06	-5.986	-5.985	0.001	(0)
NaHCO3	9.391e-07	9.414e-07	-6.027	-6.026	0.001	(0)
CO3-2	8.994e-07	6.017e-07	-6.046	-6.221	-0.175	(0)
MnCO3	7.691e-07	7.710e-07	-6.114	-6.113	0.001	(0)
MgCO3	3.055e-07	3.062e-07	-6.515	-6.514	0.001	(0)
FeHCO3+	1.657e-07	1.493e-07	-6.781	-6.826	-0.045	(0)
ZnHCO3+	4.438e-08	3.999e-08	-7.353	-7.398	-0.045	(0)
CuCO3	1.778e-08	1.782e-08	-7.750	-7.749	0.001	(0)
ZnCO3	1.297e-08	1.300e-08	-7.887	-7.886	0.001	(0)
CuHCO3+	9.000e-09	8.111e-09	-8.046	-8.091	-0.045	(0)
FeCO3	7.328e-09	7.346e-09	-8.135	-8.134	0.001	(0)
BaHCO3+	3.548e-09	3.198e-09	-8.450	-8.495	-0.045	(0)
NaCO3-	2.926e-09	2.637e-09	-8.534	-8.579	-0.045	(0)
PbCO3	3.324e-10	3.333e-10	-9.478	-9.477	0.001	(0)
Zn (CO3) 2-2	2.535e-10	1.672e-10	-9.596	-9.777	-0.181	(0)
PbHCO3+	8.242e-11	7.428e-11	-10.084	-10.129	-0.045	(0)

BaCO3	4.258e-11	4.269e-11	-10.371	-10.370	0.001	(0)
Cu (CO3) 2-2	2.046e-11	1.350e-11	-10.689	-10.870	-0.181	(0)
CdHCO3+	1.898e-11	1.711e-11	-10.722	-10.767	-0.045	(0)
Pb (CO3) 2-2	7.635e-13	5.037e-13	-12.117	-12.298	-0.181	(0)
CdCO3	8.790e-14	8.812e-14	-13.056	-13.055	0.001	(0)
Cd (CO3) 2-2	2.542e-16	1.677e-16	-15.595	-15.776	-0.181	(0)
Ca	2.102e-03					
Ca+2	1.904e-03	1.273e-03	-2.720	-2.895	-0.175	(0)
CaSO4	1.595e-04	1.599e-04	-3.797	-3.796	0.001	(0)
CaHCO3+	3.679e-05	3.315e-05	-4.434	-4.479	-0.045	(0)
CaCO3	1.033e-06	1.035e-06	-5.986	-5.985	0.001	(0)
CaOH+	1.549e-09	1.396e-09	-8.810	-8.855	-0.045	(0)
CaHSO4+	1.325e-10	1.194e-10	-9.878	-9.923	-0.045	(0)
Cd	3.560e-10					
Cd+2	2.794e-10	1.844e-10	-9.554	-9.734	-0.181	(0)
CdSO4	3.532e-11	3.541e-11	-10.452	-10.451	0.001	(0)
CdCl+	2.156e-11	1.943e-11	-10.666	-10.712	-0.045	(0)
CdHCO3+	1.898e-11	1.711e-11	-10.722	-10.767	-0.045	(0)
Cd (SO4) 2-2	4.857e-13	3.205e-13	-12.314	-12.494	-0.181	(0)
CdCl2	8.862e-14	8.884e-14	-13.052	-13.051	0.001	(0)
CdCO3	8.790e-14	8.812e-14	-13.056	-13.055	0.001	(0)
CdOHC1	3.637e-14	3.646e-14	-13.439	-13.438	0.001	(0)
CdOH+	3.057e-14	2.755e-14	-13.515	-13.560	-0.045	(0)
Cd (CO3) 2-2	2.542e-16	1.677e-16	-15.595	-15.776	-0.181	(0)
CdCl3-	5.587e-17	5.035e-17	-16.253	-16.298	-0.045	(0)
Cd (OH) 2	3.585e-17	3.594e-17	-16.446	-16.444	0.001	(0)
Cd2OH+3	7.893e-23	3.096e-23	-22.103	-22.509	-0.406	(0)
Cd (OH) 3-	2.955e-23	2.663e-23	-22.529	-22.575	-0.045	(0)
Cd (OH) 4-2	2.377e-30	1.568e-30	-29.624	-29.805	-0.181	(0)
Cl	1.301e-03					
Cl-	1.301e-03	1.170e-03	-2.886	-2.932	-0.046	(0)
MnCl+	8.532e-08	7.689e-08	-7.069	-7.114	-0.045	(0)
CuCl2-	2.288e-08	2.062e-08	-7.641	-7.686	-0.045	(0)
FeCl+	9.121e-10	8.220e-10	-9.040	-9.085	-0.045	(0)
AgCl	3.004e-10	3.012e-10	-9.522	-9.521	0.001	(0)
ZnCl+	1.744e-10	1.572e-10	-9.758	-9.804	-0.045	(0)
CuCl3-2	5.416e-11	3.573e-11	-10.266	-10.447	-0.181	(0)
AgCl2-	4.428e-11	3.990e-11	-10.354	-10.399	-0.045	(0)
MnCl2	3.918e-11	3.927e-11	-10.407	-10.406	0.001	(0)
ZnOHC1	2.764e-11	2.771e-11	-10.558	-10.557	0.001	(0)
CdCl+	2.156e-11	1.943e-11	-10.666	-10.712	-0.045	(0)
CuCl+	8.159e-12	7.353e-12	-11.088	-11.134	-0.045	(0)
PbCl+	1.066e-12	9.606e-13	-11.972	-12.017	-0.045	(0)
ZnCl2	1.791e-13	1.795e-13	-12.747	-12.746	0.001	(0)
CdCl2	8.862e-14	8.884e-14	-13.052	-13.051	0.001	(0)
AgCl3-2	5.014e-14	3.308e-14	-13.300	-13.480	-0.181	(0)
CdOHC1	3.637e-14	3.646e-14	-13.439	-13.438	0.001	(0)
MnCl3-	1.404e-14	1.266e-14	-13.853	-13.898	-0.045	(0)
CuCl2	3.812e-15	3.822e-15	-14.419	-14.418	0.001	(0)
PbCl2	2.467e-15	2.473e-15	-14.608	-14.607	0.001	(0)
ZnCl3-	2.353e-16	2.121e-16	-15.628	-15.673	-0.045	(0)
AgCl4-3	1.638e-16	6.424e-17	-15.786	-16.192	-0.406	(0)
CdCl3-	5.587e-17	5.035e-17	-16.253	-16.298	-0.045	(0)
PbCl3-	2.288e-18	2.062e-18	-17.640	-17.686	-0.045	(0)
ZnCl4-2	1.640e-19	1.082e-19	-18.785	-18.966	-0.181	(0)
FeCl+2	3.067e-20	2.024e-20	-19.513	-19.694	-0.181	(0)
CuCl3-	1.290e-20	1.162e-20	-19.889	-19.935	-0.045	(0)
PbCl4-2	1.529e-21	1.009e-21	-20.815	-20.996	-0.181	(0)
FeCl2+	2.047e-22	1.845e-22	-21.689	-21.734	-0.045	(0)
CuCl4-2	6.881e-26	4.540e-26	-25.162	-25.343	-0.181	(0)
FeCl3	2.154e-26	2.159e-26	-25.667	-25.666	0.001	(0)
Cu (1)	7.361e-08					
Cu+	5.068e-08	4.567e-08	-7.295	-7.340	-0.045	(0)
CuCl2-	2.288e-08	2.062e-08	-7.641	-7.686	-0.045	(0)
CuCl3-2	5.416e-11	3.573e-11	-10.266	-10.447	-0.181	(0)
Cu (2)	4.133e-08					
CuCO3	1.778e-08	1.782e-08	-7.750	-7.749	0.001	(0)

CuHCO3+	9.000e-09	8.111e-09	-8.046	-8.091	-0.045	(0)
Cu+2	8.360e-09	5.516e-09	-8.078	-8.258	-0.181	(0)
Cu(OH)2	5.016e-09	5.028e-09	-8.300	-8.299	0.001	(0)
CuSO4	7.377e-10	7.396e-10	-9.132	-9.131	0.001	(0)
CuOH+	4.043e-10	3.643e-10	-9.393	-9.438	-0.045	(0)
Cu(CO3)2-2	2.046e-11	1.350e-11	-10.689	-10.870	-0.181	(0)
CuCl+	8.159e-12	7.353e-12	-11.088	-11.134	-0.045	(0)
Cu2(OH)2+2	1.541e-14	1.016e-14	-13.812	-13.993	-0.181	(0)
CuCl2	3.812e-15	3.822e-15	-14.419	-14.418	0.001	(0)
Cu(OH)3-	2.221e-15	2.001e-15	-14.654	-14.699	-0.045	(0)
CuCl3-	1.290e-20	1.162e-20	-19.889	-19.935	-0.045	(0)
Cu(OH)4-2	3.998e-21	2.638e-21	-20.398	-20.579	-0.181	(0)
CuCl4-2	6.881e-26	4.540e-26	-25.162	-25.343	-0.181	(0)
Fe(2)	9.942e-07					
Fe+2	7.714e-07	5.089e-07	-6.113	-6.293	-0.181	(0)
FeHCO3+	1.657e-07	1.493e-07	-6.781	-6.826	-0.045	(0)
FeSO4	4.855e-08	4.867e-08	-7.314	-7.313	0.001	(0)
FeCO3	7.328e-09	7.346e-09	-8.135	-8.134	0.001	(0)
FeCl+	9.121e-10	8.220e-10	-9.040	-9.085	-0.045	(0)
FeOH+	3.177e-10	2.863e-10	-9.498	-9.543	-0.045	(0)
FeHSO4+	5.297e-14	4.774e-14	-13.276	-13.321	-0.045	(0)
Fe(OH)2	3.488e-15	3.496e-15	-14.457	-14.456	0.001	(0)
Fe(OH)3-	8.013e-19	7.222e-19	-18.096	-18.141	-0.045	(0)
Fe(3)	2.568e-11					
Fe(OH)2+	1.890e-11	1.704e-11	-10.723	-10.769	-0.045	(0)
Fe(OH)3	6.728e-12	6.745e-12	-11.172	-11.171	0.001	(0)
FeOH+2	2.297e-14	1.516e-14	-13.639	-13.819	-0.181	(0)
Fe(OH)4-	2.226e-14	2.006e-14	-13.652	-13.698	-0.045	(0)
FeSO4+	6.110e-18	5.506e-18	-17.214	-17.259	-0.045	(0)
Fe+3	2.547e-18	9.991e-19	-17.594	-18.000	-0.406	(0)
Fe(SO4)2-	9.253e-20	8.339e-20	-19.034	-19.079	-0.045	(0)
FeCl+2	3.067e-20	2.024e-20	-19.513	-19.694	-0.181	(0)
FeCl2+	2.047e-22	1.845e-22	-21.689	-21.734	-0.045	(0)
FeHSO4+2	3.568e-24	2.354e-24	-23.448	-23.628	-0.181	(0)
Fe2(OH)2+4	6.742e-26	1.277e-26	-25.171	-25.894	-0.722	(0)
FeCl3	2.154e-26	2.159e-26	-25.667	-25.666	0.001	(0)
Fe3(OH)4+5	3.091e-33	2.297e-34	-32.510	-33.639	-1.129	(0)
H(0)	1.332e-20					
H2	6.659e-21	6.675e-21	-20.177	-20.176	0.001	(0)
K	8.750e-05					
K+	8.717e-05	7.841e-05	-4.060	-4.106	-0.046	(0)
KSO4-	3.336e-07	3.007e-07	-6.477	-6.522	-0.045	(0)
Mg	1.123e-03					
Mg+2	1.022e-03	6.880e-04	-2.990	-3.162	-0.172	(0)
MgSO4	7.589e-05	7.608e-05	-4.120	-4.119	0.001	(0)
MgHCO3+	2.510e-05	2.262e-05	-4.600	-4.645	-0.045	(0)
MgCO3	3.055e-07	3.062e-07	-6.515	-6.514	0.001	(0)
MgOH+	3.751e-09	3.381e-09	-8.426	-8.471	-0.045	(0)
Mn(2)	3.150e-05					
Mn+2	2.445e-05	1.613e-05	-4.612	-4.792	-0.181	(0)
MnHCO3+	4.681e-06	4.219e-06	-5.330	-5.375	-0.045	(0)
MnSO4	1.518e-06	1.521e-06	-5.819	-5.818	0.001	(0)
MnCO3	7.691e-07	7.710e-07	-6.114	-6.113	0.001	(0)
MnCl+	8.532e-08	7.689e-08	-7.069	-7.114	-0.045	(0)
MnOH+	7.265e-10	6.548e-10	-9.139	-9.184	-0.045	(0)
MnCl2	3.918e-11	3.927e-11	-10.407	-10.406	0.001	(0)
MnCl3-	1.404e-14	1.266e-14	-13.853	-13.898	-0.045	(0)
Mn(OH)3-	8.177e-20	7.369e-20	-19.087	-19.133	-0.045	(0)
Mn(3)	5.263e-30					
Mn+3	5.263e-30	2.065e-30	-29.279	-29.685	-0.406	(0)
Mn(6)	0.000e+00					
MnO4-2	0.000e+00	0.000e+00	-68.044	-68.225	-0.181	(0)
Mn(7)	0.000e+00					
MnO4-	0.000e+00	0.000e+00	-76.981	-77.026	-0.045	(0)
Na	6.354e-04					
Na+	6.323e-04	5.705e-04	-3.199	-3.244	-0.045	(0)
NaSO4-	2.104e-06	1.897e-06	-5.677	-5.722	-0.045	(0)

NaHCO3	9.391e-07	9.414e-07	-6.027	-6.026	0.001	(0)
NaCO3-	2.926e-09	2.637e-09	-8.534	-8.579	-0.045	(0)
O (0)	0.000e+00					
O2	0.000e+00	0.000e+00	-57.696	-57.695	0.001	(0)
Pb	4.829e-10					
PbCO3	3.324e-10	3.333e-10	-9.478	-9.477	0.001	(0)
PbHCO3+	8.242e-11	7.428e-11	-10.084	-10.129	-0.045	(0)
Pb+2	4.830e-11	3.187e-11	-10.316	-10.497	-0.181	(0)
PbSO4	1.325e-11	1.329e-11	-10.878	-10.877	0.001	(0)
PbOH+	4.555e-12	4.105e-12	-11.342	-11.387	-0.045	(0)
PbCl+	1.066e-12	9.606e-13	-11.972	-12.017	-0.045	(0)
Pb (CO3) 2-2	7.635e-13	5.037e-13	-12.117	-12.298	-0.181	(0)
Pb (SO4) 2-2	7.836e-14	5.170e-14	-13.106	-13.287	-0.181	(0)
Pb (OH) 2	1.052e-14	1.055e-14	-13.978	-13.977	0.001	(0)
PbCl2	2.467e-15	2.473e-15	-14.608	-14.607	0.001	(0)
PbCl3-	2.288e-18	2.062e-18	-17.640	-17.686	-0.045	(0)
Pb (OH) 3-	8.877e-19	8.001e-19	-18.052	-18.097	-0.045	(0)
Pb2OH+3	7.465e-21	2.929e-21	-20.127	-20.533	-0.406	(0)
PbCl4-2	1.529e-21	1.009e-21	-20.815	-20.996	-0.181	(0)
Pb (OH) 4-2	1.835e-23	1.211e-23	-22.736	-22.917	-0.181	(0)
Pb3 (OH) 4+2	8.844e-30	5.835e-30	-29.053	-29.234	-0.181	(0)
S (6)	1.354e-03					
SO4-2	1.114e-03	7.414e-04	-2.953	-3.130	-0.177	(0)
CaSO4	1.595e-04	1.599e-04	-3.797	-3.796	0.001	(0)
MgSO4	7.589e-05	7.608e-05	-4.120	-4.119	0.001	(0)
NaSO4-	2.104e-06	1.897e-06	-5.677	-5.722	-0.045	(0)
MnSO4	1.518e-06	1.521e-06	-5.819	-5.818	0.001	(0)
KSO4-	3.336e-07	3.007e-07	-6.477	-6.522	-0.045	(0)
BaSO4	7.101e-08	7.118e-08	-7.149	-7.148	0.001	(0)
FeSO4	4.855e-08	4.867e-08	-7.314	-7.313	0.001	(0)
ZnSO4	1.640e-08	1.644e-08	-7.785	-7.784	0.001	(0)
HSO4-	8.656e-09	7.801e-09	-8.063	-8.108	-0.045	(0)
CuSO4	7.377e-10	7.396e-10	-9.132	-9.131	0.001	(0)
Zn (SO4) 2-2	1.719e-10	1.134e-10	-9.765	-9.945	-0.181	(0)
CaHSO4+	1.325e-10	1.194e-10	-9.878	-9.923	-0.045	(0)
CdSO4	3.532e-11	3.541e-11	-10.452	-10.451	0.001	(0)
PbSO4	1.325e-11	1.329e-11	-10.878	-10.877	0.001	(0)
AgSO4-	1.465e-12	1.320e-12	-11.834	-11.879	-0.045	(0)
Cd (SO4) 2-2	4.857e-13	3.205e-13	-12.314	-12.494	-0.181	(0)
Pb (SO4) 2-2	7.836e-14	5.170e-14	-13.106	-13.287	-0.181	(0)
FeHSO4+	5.297e-14	4.774e-14	-13.276	-13.321	-0.045	(0)
FeSO4+	6.110e-18	5.506e-18	-17.214	-17.259	-0.045	(0)
Fe (SO4) 2-	9.253e-20	8.339e-20	-19.034	-19.079	-0.045	(0)
FeHSO4+2	3.568e-24	2.354e-24	-23.448	-23.628	-0.181	(0)
Se (-2)	1.265e-26					
HSe-	1.263e-26	1.139e-26	-25.898	-25.944	-0.045	(0)
H2Se	1.837e-29	1.841e-29	-28.736	-28.735	0.001	(0)
Se (4)	2.534e-09					
HSeO3-	2.464e-09	2.220e-09	-8.608	-8.654	-0.045	(0)
SeO3-2	7.031e-11	4.639e-11	-10.153	-10.334	-0.181	(0)
H2SeO3	1.885e-13	1.890e-13	-12.725	-12.724	0.001	(0)
Se (6)	4.925e-24					
SeO4-2	4.925e-24	3.249e-24	-23.308	-23.488	-0.181	(0)
HSeO4-	1.531e-29	1.380e-29	-28.815	-28.860	-0.045	(0)
Zn	2.388e-07					
Zn+2	1.641e-07	1.083e-07	-6.785	-6.966	-0.181	(0)
ZnHCO3+	4.438e-08	3.999e-08	-7.353	-7.398	-0.045	(0)
ZnSO4	1.640e-08	1.644e-08	-7.785	-7.784	0.001	(0)
ZnCO3	1.297e-08	1.300e-08	-7.887	-7.886	0.001	(0)
Zn (CO3) 2-2	2.535e-10	1.672e-10	-9.596	-9.777	-0.181	(0)
ZnOH+	2.297e-10	2.070e-10	-9.639	-9.684	-0.045	(0)
ZnCl+	1.744e-10	1.572e-10	-9.758	-9.804	-0.045	(0)
Zn (SO4) 2-2	1.719e-10	1.134e-10	-9.765	-9.945	-0.181	(0)
Zn (OH) 2	5.933e-11	5.947e-11	-10.227	-10.226	0.001	(0)
ZnOHCl	2.764e-11	2.771e-11	-10.558	-10.557	0.001	(0)
ZnCl2	1.791e-13	1.795e-13	-12.747	-12.746	0.001	(0)
Zn (OH) 3-	1.378e-15	1.242e-15	-14.861	-14.906	-0.045	(0)

ZnCl3-	2.353e-16	2.121e-16	-15.628	-15.673	-0.045	(0)
ZnCl4-2	1.640e-19	1.082e-19	-18.785	-18.966	-0.181	(0)
Zn(OH)4-2	1.971e-21	1.301e-21	-20.705	-20.886	-0.181	(0)

-----Saturation indices-----

Phase	SI**	log IAP	log K(281 K, 1 atm)	
Ag2CO3	-14.69	-26.17	-11.48	Ag2CO3
Ag2O	-19.34	-6.31	13.03	Ag2O
Ag2SO4	-17.98	-23.08	-5.10	Ag2SO4
AgMetal	2.89	-11.71	-14.60	Ag
Anglesite	-5.74	-13.63	-7.88	PbSO4
Anhydrite	-1.69	-6.02	-4.34	CaSO4
Antlerite	-8.92	-0.63	8.29	Cu3(OH)4SO4
Aragonite	-0.87	-9.12	-8.25	CaCO3
Arsenolite	-18.41	-20.10	-1.69	As2O3
Artinite	-9.75	1.09	10.84	MgCO3:Mg(OH)2:3H2O
As2O5(cr)	-35.73	-27.17	8.55	As2O5
As_native	-21.98	-35.70	-13.72	As
Atacamite	-7.14	1.01	8.15	Cu2(OH)3Cl
Azurite	-7.64	-2.56	5.08	Cu3(OH)2(CO3)2
Ba3(AsO4)2	1.60	-48.92	-50.52	Ba3(AsO4)2
Barite	0.43	-9.85	-10.28	BaSO4
BaSeO3	-10.66	-17.05	-6.39	BaSeO3
Bianchite	-8.34	-10.10	-1.76	ZnSO4:6H2O
Birnessite	-17.65	25.95	43.60	MnO2
Bixbyite	-18.50	-18.45	0.05	Mn2O3
Brochantite	-10.58	4.76	15.34	Cu4(OH)6SO4
Brucite	-7.53	10.48	18.01	Mg(OH)2
Ca3(AsO4)2:4w	-18.55	-37.45	-18.91	Ca3(AsO4)2:4H2O
Calcite	-0.71	-9.12	-8.40	CaCO3
CaSeO3	-7.63	-13.23	-5.60	CaSeO3
Cd(gamma)	-27.57	-13.20	14.37	Cd
Cd(OH)2	-9.74	3.91	13.65	Cd(OH)2
Cd(OH)2(a)	-10.72	3.91	14.63	Cd(OH)2
Cd3(OH)2(SO4)2	-28.53	-21.82	6.71	Cd3(OH)2(SO4)2
Cd3(OH)4SO4	-27.61	-5.05	22.56	Cd3(OH)4SO4
Cd4(OH)6SO4	-29.55	-1.15	28.40	Cd4(OH)6SO4
CdCl2	-15.11	-15.60	-0.49	CdCl2
CdCl2:2.5H2O	-13.58	-15.60	-2.01	CdCl2:2.5H2O
CdCl2:H2O	-13.97	-15.60	-1.63	CdCl2:H2O
CdMetal	-27.46	-13.20	14.27	Cd
CdOHC1	-9.69	-5.85	3.84	CdOHC1
CdSO4	-13.40	-12.86	0.54	CdSO4
CdSO4:2.7H2O	-11.18	-12.86	-1.69	CdSO4:2.67H2O
CdSO4:H2O	-11.53	-12.86	-1.33	CdSO4:H2O
Cerargyrite	-2.48	-12.91	-10.43	AgCl
Cerrussite	-3.38	-16.72	-13.34	PbCO3
Chalcanthite	-8.69	-11.39	-2.70	CuSO4:5H2O
Claudetite	-18.47	-20.10	-1.63	As2O3
CO2(g)	-1.63	-2.87	-1.25	CO2
Cotunnite	-11.35	-16.36	-5.01	PbCl2
Cu(OH)2	-3.92	5.38	9.30	Cu(OH)2
Cu2SO4	-16.06	-17.81	-1.75	Cu2SO4
Cu3(AsO4)2:6w	-18.42	-53.54	-35.12	Cu3(AsO4)2:6H2O
CuCO3	-4.85	-14.48	-9.63	CuCO3
CuMetal	0.43	-9.07	-9.50	Cu
CuOCuSO4	-19.07	-6.01	13.07	CuO:CuSO4
CupricFerrite	2.75	10.30	7.55	CuFe2O4
Cuprite	0.78	-1.04	-1.82	Cu2O
CuprousFerrite	10.70	1.94	-8.76	CuFeO2
CuSO4	-15.18	-11.39	3.79	CuSO4
Dolomite	-1.82	-18.50	-16.68	CaMg(CO3)2
Dolomite(d)	-2.44	-18.50	-16.06	CaMg(CO3)2
Epsomite	-4.03	-6.29	-2.26	MgSO4:7H2O
Fe(OH)2.7Cl.3	2.57	-0.47	-3.04	Fe(OH)2.7Cl0.3

Fe(OH) 3(a)	-2.43	2.46	4.89	Fe(OH) 3
Fe2(SeO3) 3	-31.57	-67.00	-35.43	Fe2(SeO3) 3
Fe3(OH) 8	-7.96	12.27	20.22	Fe3(OH) 8
FeSe2	-22.50	-41.08	-18.58	FeSe2
Goethite	2.83	2.46	-0.38	FeOOH
Goslarite	-7.99	-10.10	-2.10	ZnSO4:7H2O
Gypsum	-1.43	-6.03	-4.59	CaSO4:2H2O
H2(g)	-17.10	-20.18	-3.07	H2
H2O(g)	-1.96	-0.00	1.96	H2O
Halite	-7.72	-6.18	1.54	NaCl
Hausmannite	-21.73	43.64	65.37	Mn3O4
Hematite	7.60	4.92	-2.68	Fe2O3
Huntite	-8.41	-37.26	-28.86	CaMg3(CO3) 4
Hydrocerrusite	-12.83	-30.29	-17.46	Pb(OH) 2:2PbCO3
Hydromagnesite	-20.55	-27.05	-6.51	Mg5(CO3) 4(OH) 2:4H2O
Hydrozincite	-15.64	14.67	30.31	Zn5(OH) 6(CO3) 2
Hydrozincite_PG	-17.69	14.67	32.36	Zn5(OH) 6(CO3) 2
Jarosite(ss)	-14.13	-23.96	-9.83	(K0.77Na0.03H0.2) Fe3(SO4) 2(OH) 6
Jarosite-K	-15.59	-23.45	-7.86	KFe3(SO4) 2(OH) 6
Jarosite-Na	-18.87	-22.59	-3.72	NaFe3(SO4) 2(OH) 6
JarositeH	-23.15	-26.16	-3.01	(H3O) Fe3(SO4) 2(OH) 6
Langite	-13.74	4.76	18.50	Cu4(OH) 6SO4:H2O
Larnakite	-10.48	-10.48	-0.00	PbO:PbSO4
Laurionite	-7.23	-6.61	0.62	PbOHCl
Litharge	-10.28	3.14	13.43	PbO
Maghemite	-1.47	4.92	6.39	Fe2O3
Magnesite	-1.62	-9.38	-7.76	MgCO3
Magnetite	6.35	12.27	5.91	Fe3O4
Malachite	-4.59	1.41	6.00	Cu2(OH) 2CO3
Manganite	-7.94	17.40	25.34	MnOOH
Massicot	-10.49	3.14	13.63	PbO
Melanothallite	-18.38	-14.12	4.26	CuCl2
Melanterite	-6.99	-9.42	-2.43	FeSO4:7H2O
Minium	-51.59	26.53	78.13	Pb3O4
Mirabilite	-7.68	-9.62	-1.93	Na2SO4:10H2O
Mn2(SO4) 3	-64.74	-68.76	-4.03	Mn2(SO4) 3
Mn3(AsO4) 2:8H2O	-14.44	-43.15	-28.71	Mn3(AsO4) 2:8H2O
MnCl2:4H2O	-12.62	-10.66	1.96	MnCl2:4H2O
MnSO4	-11.26	-7.92	3.34	MnSO4
Monteponite	-10.93	3.91	14.84	CdO
Nahcolite	-5.07	-5.78	-0.71	NaHCO3
Nantokite	-3.08	-10.27	-7.19	CuCl
Natron	-10.72	-12.71	-1.99	Na2CO3:10H2O
Nesquehonite	-4.01	-9.38	-5.37	MgCO3:3H2O
Nsutite	-16.62	25.95	42.56	MnO2
O2(g)	-54.94	-57.69	-2.75	O2
Otavite	-3.95	-15.95	-12.00	CdCO3
Pb(OH) 2	-5.61	3.14	8.75	Pb(OH) 2
Pb2(OH) 3Cl	-12.26	-3.47	8.79	Pb2(OH) 3Cl
Pb2O(OH) 2	-19.91	6.29	26.20	PbO:Pb(OH) 2
Pb2O3	-37.65	23.39	61.04	Pb2O3
Pb2OCO3	-13.57	-13.57	-0.01	PbO:PbCO3
Pb3(AsO4) 2	-24.85	-60.26	-35.40	Pb3(AsO4) 2
Pb3O2CO3	-22.59	-10.43	12.16	PbCO3:2PbO
Pb3O2SO4	-18.64	-7.34	11.30	PbSO4:2PbO
Pb4(OH) 6SO4	-25.30	-4.20	21.10	Pb4(OH) 6SO4
Pb4O3SO4	-27.81	-4.20	23.61	PbSO4:3PbO
PbMetal	-18.21	-13.96	4.25	Pb
PbO:0.3H2O	-9.84	3.14	12.98	PbO:0.33H2O
Phosgenite	-13.27	-33.08	-19.81	PbCl2:PbCO3
Plattnerite	-32.11	20.24	52.35	PbO2
Portlandite	-13.39	10.74	24.14	Ca(OH) 2
Pyrochroite	-6.35	8.85	15.20	Mn(OH) 2
Pyrolusite	-18.24	25.95	44.19	MnO2
Rhodochrosite	0.06	-11.01	-11.07	MnCO3
Rhodochrosite(d)	-0.62	-11.01	-10.39	MnCO3
Scorodite	-12.14	-32.38	-20.25	FeAsO4:2H2O

Se(s)	1.66	-15.66	-17.32	Se
SeO2	-15.59	-23.97	-8.38	SeO2
Siderite	-1.73	-12.51	-10.78	FeCO3
Siderite(d) (3)	-2.06	-12.51	-10.45	FeCO3
Smithsonite	-3.37	-13.19	-9.81	ZnCO3
Smithsonite_PG	-2.40	-13.19	-10.79	ZnCO3
Tenorite	-2.90	5.38	8.28	CuO
Thenardite	-9.46	-9.62	-0.15	Na2SO4
Thermonatrite	-12.95	-12.71	0.25	Na2CO3:H2O
Trona	-18.47	-18.48	-0.02	NaHCO3:Na2CO3:2H2O
Witherite	-4.29	-12.94	-8.65	BaCO3
Zincite(c)	-5.41	6.67	12.08	ZnO
Zincosite	-13.93	-10.10	3.84	ZnSO4
Zn(OH)2-a	-5.78	6.67	12.45	Zn(OH)2
Zn(OH)2-b	-5.08	6.67	11.75	Zn(OH)2
Zn(OH)2-c	-5.53	6.67	12.20	Zn(OH)2
Zn(OH)2-e	-4.83	6.67	11.50	Zn(OH)2
Zn(OH)2-g	-5.04	6.67	11.71	Zn(OH)2
Zn2(OH)2SO4	-10.92	-3.42	7.50	Zn2(OH)2SO4
Zn2(OH)3Cl	-11.60	3.60	15.20	Zn2(OH)3Cl
Zn3(AsO4)2:2.5w	-22.12	-49.66	-27.55	Zn3(AsO4)2:2.5H2O
Zn3O(SO4)2	-35.21	-13.52	21.70	ZnO:2ZnSO4
Zn4(OH)6SO4	-18.47	9.93	28.40	Zn4(OH)6SO4
Zn5(OH)8Cl2	-24.63	13.87	38.50	Zn5(OH)8Cl2
ZnCl2	-20.61	-12.83	7.78	ZnCl2
ZnCO3:1H2O	-2.93	-13.19	-10.26	ZnCO3:1H2O
ZnCO3:H2O	-2.93	-13.19	-10.26	ZnCO3:H2O
ZnMetal	-37.77	-10.43	27.34	Zn
ZnO(a)	-4.64	6.67	11.31	ZnO
ZnSO4:H2O	-9.98	-10.10	-0.11	ZnSO4:H2O

**For a gas, SI = log10(fugacity). Fugacity = pressure * phi / 1 atm.
For ideal gases, phi = 1.

Initial solution 7. MW-1014A

-----Solution composition-----

Elements	Molality	Moles
Ag	4.645e-10	4.645e-10
Alkalinity	9.831e-03	9.831e-03
As	5.484e-09	5.484e-09
Ba	1.058e-07	1.058e-07
Ca	8.576e-03	8.576e-03
Cd	3.566e-10	3.566e-10
Cl	3.250e-04	3.250e-04
Cu	3.627e-08	3.627e-08
Fe	9.958e-07	9.958e-07
K	2.716e-04	2.716e-04
Mg	4.905e-03	4.905e-03
Mn	1.645e-06	1.645e-06
Na	2.009e-03	2.009e-03
Pb	4.837e-10	4.837e-10
S(6)	1.095e-02	1.095e-02
Se	2.538e-09	2.538e-09
Zn	1.196e-07	1.196e-07

-----Description of solution-----

pH	=	6.780
pe	=	2.010
Activity of water	=	0.999
Ionic strength (mol/kgw)	=	4.155e-02
Mass of water (kg)	=	1.000e+00
Total carbon (mol/kg)	=	1.367e-02
Total CO2 (mol/kg)	=	1.367e-02

Temperature (°C) = 8.94
 Electrical balance (eq) = -2.814e-03
 Percent error, 100*(Cat-|An|)/(Cat+|An|) = -5.89
 Iterations = 10
 Total H = 1.110222e+02
 Total O = 5.558719e+01

-----Distribution of species-----

Species	Molality	Activity	Log Molality	Log Activity	Log Gamma	mole V cm ³ /mol
H+	1.920e-07	1.660e-07	-6.717	-6.780	-0.063	0.00
OH-	1.917e-08	1.602e-08	-7.717	-7.795	-0.078	(0)
H2O	5.551e+01	9.994e-01	1.744	-0.000	0.000	18.02
Ag	4.645e-10					
Ag+	2.864e-10	2.393e-10	-9.543	-9.621	-0.078	(0)
AgCl	1.538e-10	1.553e-10	-9.813	-9.809	0.004	(0)
AgSO4-	1.863e-11	1.557e-11	-10.730	-10.808	-0.078	(0)
AgCl2-	5.645e-12	4.717e-12	-11.248	-11.326	-0.078	(0)
AgCl3-2	1.870e-15	9.122e-16	-14.728	-15.040	-0.312	(0)
AgOH	1.427e-15	1.441e-15	-14.845	-14.841	0.004	(0)
AgCl4-3	2.052e-18	4.078e-19	-17.688	-18.390	-0.702	(0)
Ag(OH)2-	1.038e-20	8.678e-21	-19.984	-20.062	-0.078	(0)
As (3)	7.874e-11					
H3AsO3	7.852e-11	7.928e-11	-10.105	-10.101	0.004	(0)
H2AsO3-	2.150e-13	1.797e-13	-12.668	-12.746	-0.078	(0)
H4AsO3+	7.801e-18	6.519e-18	-17.108	-17.186	-0.078	(0)
HAsO3-2	2.131e-21	1.039e-21	-20.672	-20.983	-0.312	(0)
AsO3-3	3.514e-30	6.984e-31	-29.454	-30.156	-0.702	(0)
As (5)	5.405e-09					
H2AsO4-	3.249e-09	2.715e-09	-8.488	-8.566	-0.078	(0)
HAsO4-2	2.156e-09	1.051e-09	-8.666	-8.978	-0.312	(0)
H3AsO4	7.572e-14	7.644e-14	-13.121	-13.117	0.004	(0)
AsO4-3	4.698e-14	9.336e-15	-13.328	-14.030	-0.702	(0)
Ba	1.058e-07					
Ba+2	5.401e-08	2.634e-08	-7.268	-7.579	-0.312	(0)
BaSO4	5.034e-08	5.083e-08	-7.298	-7.294	0.004	(0)
BaHCO3+	1.433e-09	1.197e-09	-8.844	-8.922	-0.078	(0)
BaCO3	1.458e-11	1.472e-11	-10.836	-10.832	0.004	(0)
BaOH+	6.431e-15	5.374e-15	-14.192	-14.270	-0.078	(0)
C (4)	1.367e-02					
HCO3-	9.336e-03	7.863e-03	-2.030	-2.104	-0.075	(0)
CO2	3.851e-03	3.888e-03	-2.414	-2.410	0.004	(0)
CaHCO3+	2.674e-04	2.234e-04	-3.573	-3.651	-0.078	(0)
MgHCO3+	1.969e-04	1.646e-04	-3.706	-3.784	-0.078	(0)
NaHCO3	7.220e-06	7.289e-06	-5.141	-5.137	0.004	(0)
CaCO3	6.320e-06	6.381e-06	-5.199	-5.195	0.004	(0)
CO3-2	2.968e-06	1.493e-06	-5.528	-5.826	-0.298	(0)
MgCO3	2.059e-06	2.079e-06	-5.686	-5.682	0.004	(0)
MnHCO3+	3.944e-07	3.295e-07	-6.404	-6.482	-0.078	(0)
FeHCO3+	2.658e-07	2.221e-07	-6.575	-6.653	-0.078	(0)
MnCO3	5.526e-08	5.579e-08	-7.258	-7.253	0.004	(0)
ZnHCO3+	3.222e-08	2.693e-08	-7.492	-7.570	-0.078	(0)
NaCO3-	2.330e-08	1.947e-08	-7.633	-7.711	-0.078	(0)
CuCO3	1.333e-08	1.345e-08	-7.875	-7.871	0.004	(0)
FeCO3	1.002e-08	1.012e-08	-7.999	-7.995	0.004	(0)
ZnCO3	8.029e-09	8.106e-09	-8.095	-8.091	0.004	(0)
CuHCO3+	7.910e-09	6.610e-09	-8.102	-8.180	-0.078	(0)
BaHCO3+	1.433e-09	1.197e-09	-8.844	-8.922	-0.078	(0)
Zn (CO3) 2-2	5.308e-10	2.588e-10	-9.275	-9.587	-0.312	(0)
PbCO3	3.288e-10	3.320e-10	-9.483	-9.479	0.004	(0)
PbHCO3+	9.559e-11	7.988e-11	-10.020	-10.098	-0.078	(0)
Cu (CO3) 2-2	5.187e-11	2.530e-11	-10.285	-10.597	-0.312	(0)
CdHCO3+	3.061e-11	2.558e-11	-10.514	-10.592	-0.078	(0)
BaCO3	1.458e-11	1.472e-11	-10.836	-10.832	0.004	(0)
Pb (CO3) 2-2	2.554e-12	1.245e-12	-11.593	-11.905	-0.312	(0)

	CdCO3	1.209e-13	1.220e-13	-12.918	-12.913	0.004	(0)
	Cd (CO3) 2-2	1.182e-15	5.764e-16	-14.927	-15.239	-0.312	(0)
Ca	8.576e-03						
	Ca+2	6.254e-03	3.154e-03	-2.204	-2.501	-0.297	(0)
	CaSO4	2.048e-03	2.068e-03	-2.689	-2.685	0.004	(0)
	CaHCO3+	2.674e-04	2.234e-04	-3.573	-3.651	-0.078	(0)
	CaCO3	6.320e-06	6.381e-06	-5.199	-5.195	0.004	(0)
	CaOH+	3.771e-09	3.152e-09	-8.423	-8.501	-0.078	(0)
	CaHSO4+	2.035e-09	1.701e-09	-8.691	-8.769	-0.078	(0)
Cd	3.566e-10						
	Cd+2	2.110e-10	1.029e-10	-9.676	-9.988	-0.312	(0)
	CdSO4	1.020e-10	1.030e-10	-9.991	-9.987	0.004	(0)
	CdHCO3+	3.061e-11	2.558e-11	-10.514	-10.592	-0.078	(0)
	Cd (SO4) 2-2	9.891e-12	4.823e-12	-11.005	-11.317	-0.312	(0)
	CdCl+	2.993e-12	2.501e-12	-11.524	-11.602	-0.078	(0)
	CdCO3	1.209e-13	1.220e-13	-12.918	-12.913	0.004	(0)
	CdOH+	1.751e-14	1.463e-14	-13.757	-13.835	-0.078	(0)
	CdOHCl	4.291e-15	4.332e-15	-14.367	-14.363	0.004	(0)
	CdCl2	2.613e-15	2.638e-15	-14.583	-14.579	0.004	(0)
	Cd (CO3) 2-2	1.182e-15	5.764e-16	-14.927	-15.239	-0.312	(0)
	Cd (OH) 2	1.651e-17	1.666e-17	-16.782	-16.778	0.004	(0)
	CdCl3-	4.156e-19	3.473e-19	-18.381	-18.459	-0.078	(0)
	Cd2OH+3	4.584e-23	9.110e-24	-22.339	-23.040	-0.702	(0)
	Cd (OH) 3-	1.347e-23	1.126e-23	-22.871	-22.948	-0.078	(0)
	Cd (OH) 4-2	1.239e-30	6.043e-31	-29.907	-30.219	-0.312	(0)
Cl	3.250e-04						
	Cl-	3.250e-04	2.694e-04	-3.488	-3.570	-0.082	(0)
	MnCl+	6.175e-10	5.161e-10	-9.209	-9.287	-0.078	(0)
	CuCl2-	2.100e-10	1.755e-10	-9.678	-9.756	-0.078	(0)
	AgCl	1.538e-10	1.553e-10	-9.813	-9.809	0.004	(0)
	FeCl+	1.257e-10	1.050e-10	-9.901	-9.979	-0.078	(0)
	ZnCl+	1.117e-11	9.331e-12	-10.952	-11.030	-0.078	(0)
	AgCl2-	5.645e-12	4.717e-12	-11.248	-11.326	-0.078	(0)
	CdCl+	2.993e-12	2.501e-12	-11.524	-11.602	-0.078	(0)
	ZnOHCl	1.447e-12	1.461e-12	-11.839	-11.835	0.004	(0)
	CuCl+	6.339e-13	5.297e-13	-12.198	-12.276	-0.078	(0)
	CuCl3-2	1.439e-13	7.018e-14	-12.842	-13.154	-0.312	(0)
	PbCl+	1.078e-13	9.004e-14	-12.968	-13.046	-0.078	(0)
	MnCl2	6.010e-14	6.068e-14	-13.221	-13.217	0.004	(0)
	CdOHCl	4.291e-15	4.332e-15	-14.367	-14.363	0.004	(0)
	CdCl2	2.613e-15	2.638e-15	-14.583	-14.579	0.004	(0)
	ZnCl2	2.435e-15	2.458e-15	-14.614	-14.609	0.004	(0)
	AgCl3-2	1.870e-15	9.122e-16	-14.728	-15.040	-0.312	(0)
	CuCl2	6.317e-17	6.378e-17	-16.199	-16.195	0.004	(0)
	PbCl2	5.228e-17	5.279e-17	-16.282	-16.277	0.004	(0)
	MnCl3-	5.388e-18	4.502e-18	-17.269	-17.347	-0.078	(0)
	AgCl4-3	2.052e-18	4.078e-19	-17.688	-18.390	-0.702	(0)
	ZnCl3-	8.031e-19	6.711e-19	-18.095	-18.173	-0.078	(0)
	CdCl3-	4.156e-19	3.473e-19	-18.381	-18.459	-0.078	(0)
	PbCl3-	1.217e-20	1.017e-20	-19.915	-19.993	-0.078	(0)
	FeCl+2	1.060e-20	5.170e-21	-19.975	-20.286	-0.312	(0)
	ZnCl4-2	1.624e-22	7.920e-23	-21.789	-22.101	-0.312	(0)
	CuCl3-	5.400e-23	4.513e-23	-22.268	-22.346	-0.078	(0)
	FeCl2+	1.275e-23	1.066e-23	-22.894	-22.972	-0.078	(0)
	PbCl4-2	2.360e-24	1.151e-24	-23.627	-23.939	-0.312	(0)
	FeCl3	2.843e-28	2.870e-28	-27.546	-27.542	0.004	(0)
	CuCl4-2	8.434e-29	4.113e-29	-28.074	-28.386	-0.312	(0)
Cu (1)	9.000e-09						
	Cu+	8.790e-09	7.345e-09	-8.056	-8.134	-0.078	(0)
	CuCl2-	2.100e-10	1.755e-10	-9.678	-9.756	-0.078	(0)
	CuCl3-2	1.439e-13	7.018e-14	-12.842	-13.154	-0.312	(0)
Cu (2)	2.727e-08						
	CuCO3	1.333e-08	1.345e-08	-7.875	-7.871	0.004	(0)
	CuHCO3+	7.910e-09	6.610e-09	-8.102	-8.180	-0.078	(0)
	Cu+2	3.440e-09	1.677e-09	-8.463	-8.775	-0.312	(0)
	Cu (OH) 2	1.259e-09	1.271e-09	-8.900	-8.896	0.004	(0)
	CuSO4	1.162e-09	1.173e-09	-8.935	-8.931	0.004	(0)

CuOH+	1.209e-10	1.010e-10	-9.918	-9.996	-0.078	(0)
Cu (CO3) 2-2	5.187e-11	2.530e-11	-10.285	-10.597	-0.312	(0)
CuCl+	6.339e-13	5.297e-13	-12.198	-12.276	-0.078	(0)
Cu2 (OH) 2+2	1.697e-15	8.277e-16	-14.770	-15.082	-0.312	(0)
Cu (OH) 3-	5.518e-16	4.611e-16	-15.258	-15.336	-0.078	(0)
CuCl2	6.317e-17	6.378e-17	-16.199	-16.195	0.004	(0)
Cu (OH) 4-2	1.136e-21	5.541e-22	-20.945	-21.256	-0.312	(0)
CuCl3-	5.400e-23	4.513e-23	-22.268	-22.346	-0.078	(0)
CuCl4-2	8.434e-29	4.113e-29	-28.074	-28.386	-0.312	(0)
Fe (2)	9.958e-07					
Fe+2	5.792e-07	2.825e-07	-6.237	-6.549	-0.312	(0)
FeHCO3+	2.658e-07	2.221e-07	-6.575	-6.653	-0.078	(0)
FeSO4	1.405e-07	1.418e-07	-6.852	-6.848	0.004	(0)
FeCO3	1.002e-08	1.012e-08	-7.999	-7.995	0.004	(0)
FeOH+	1.811e-10	1.513e-10	-9.742	-9.820	-0.078	(0)
FeCl+	1.257e-10	1.050e-10	-9.901	-9.979	-0.078	(0)
FeHSO4+	1.823e-13	1.523e-13	-12.739	-12.817	-0.078	(0)
Fe (OH) 2	1.755e-15	1.772e-15	-14.756	-14.752	0.004	(0)
Fe (OH) 3-	4.015e-19	3.355e-19	-18.396	-18.474	-0.078	(0)
Fe (3)	2.556e-11					
Fe (OH) 2+	1.953e-11	1.632e-11	-10.709	-10.787	-0.078	(0)
Fe (OH) 3	5.983e-12	6.041e-12	-11.223	-11.219	0.004	(0)
FeOH+2	3.195e-14	1.558e-14	-13.496	-13.807	-0.312	(0)
Fe (OH) 4-	2.007e-14	1.677e-14	-13.697	-13.775	-0.078	(0)
FeSO4+	3.777e-17	3.156e-17	-16.423	-16.501	-0.078	(0)
Fe+3	5.477e-18	1.088e-18	-17.261	-17.963	-0.702	(0)
Fe (SO4) 2-	2.978e-18	2.488e-18	-17.526	-17.604	-0.078	(0)
FeCl+2	1.060e-20	5.170e-21	-19.975	-20.286	-0.312	(0)
FeHSO4+2	3.024e-23	1.475e-23	-22.519	-22.831	-0.312	(0)
FeCl2+	1.275e-23	1.066e-23	-22.894	-22.972	-0.078	(0)
Fe2 (OH) 2+4	2.329e-25	1.317e-26	-24.633	-25.880	-1.248	(0)
FeCl3	2.843e-28	2.870e-28	-27.546	-27.542	0.004	(0)
Fe3 (OH) 4+5	1.914e-32	2.151e-34	-31.718	-33.667	-1.949	(0)
H (0)	4.372e-21					
H2	2.186e-21	2.207e-21	-20.660	-20.656	0.004	(0)
K	2.716e-04					
K+	2.663e-04	2.207e-04	-3.575	-3.656	-0.082	(0)
KSO4-	5.314e-06	4.441e-06	-5.275	-5.353	-0.078	(0)
Mg	4.905e-03					
Mg+2	3.628e-03	1.867e-03	-2.440	-2.729	-0.289	(0)
MgSO4	1.078e-03	1.088e-03	-2.967	-2.963	0.004	(0)
MgHCO3+	1.969e-04	1.646e-04	-3.706	-3.784	-0.078	(0)
MgCO3	2.059e-06	2.079e-06	-5.686	-5.682	0.004	(0)
MgOH+	1.055e-08	8.814e-09	-7.977	-8.055	-0.078	(0)
Mn (2)	1.645e-06					
Mn+2	9.643e-07	4.703e-07	-6.016	-6.328	-0.312	(0)
MnHCO3+	3.944e-07	3.295e-07	-6.404	-6.482	-0.078	(0)
MnSO4	2.307e-07	2.329e-07	-6.637	-6.633	0.004	(0)
MnCO3	5.526e-08	5.579e-08	-7.258	-7.253	0.004	(0)
MnCl+	6.175e-10	5.161e-10	-9.209	-9.287	-0.078	(0)
MnOH+	2.183e-11	1.825e-11	-10.661	-10.739	-0.078	(0)
MnCl2	6.010e-14	6.068e-14	-13.221	-13.217	0.004	(0)
MnCl3-	5.388e-18	4.502e-18	-17.269	-17.347	-0.078	(0)
Mn (OH) 3-	1.948e-21	1.627e-21	-20.711	-20.788	-0.078	(0)
Mn (3)	6.269e-31					
Mn+3	6.269e-31	1.246e-31	-30.203	-30.905	-0.702	(0)
Mn (6)	0.000e+00					
MnO4-2	0.000e+00	0.000e+00	-68.438	-68.750	-0.312	(0)
Mn (7)	0.000e+00					
MnO4-	0.000e+00	0.000e+00	-77.156	-77.234	-0.078	(0)
Na	2.009e-03					
Na+	1.968e-03	1.649e-03	-2.706	-2.783	-0.077	(0)
NaSO4-	3.418e-05	2.857e-05	-4.466	-4.544	-0.078	(0)
NaHCO3	7.220e-06	7.289e-06	-5.141	-5.137	0.004	(0)
NaCO3-	2.330e-08	1.947e-08	-7.633	-7.711	-0.078	(0)
O (0)	0.000e+00					
O2	0.000e+00	0.000e+00	-56.550	-56.546	0.004	(0)

Pb	4.837e-10					
PbCO3	3.288e-10	3.320e-10	-9.483	-9.479	0.004	(0)
PbHCO3+	9.559e-11	7.988e-11	-10.020	-10.098	-0.078	(0)
PbSO4	2.743e-11	2.769e-11	-10.562	-10.558	0.004	(0)
Pb+2	2.623e-11	1.279e-11	-10.581	-10.893	-0.312	(0)
Pb(CO3) 2-2	2.554e-12	1.245e-12	-11.593	-11.905	-0.312	(0)
PbOH+	1.797e-12	1.502e-12	-11.745	-11.823	-0.078	(0)
Pb(SO4) 2-2	1.148e-12	5.596e-13	-11.940	-12.252	-0.312	(0)
PbCl+	1.078e-13	9.004e-14	-12.968	-13.046	-0.078	(0)
Pb(OH) 2	3.485e-15	3.518e-15	-14.458	-14.454	0.004	(0)
PbCl2	5.228e-17	5.279e-17	-16.282	-16.277	0.004	(0)
Pb(OH) 3-	2.911e-19	2.432e-19	-18.536	-18.614	-0.078	(0)
PbCl3-	1.217e-20	1.017e-20	-19.915	-19.993	-0.078	(0)
Pb2OH+3	2.164e-21	4.300e-22	-20.665	-21.367	-0.702	(0)
Pb(OH) 4-2	6.881e-24	3.356e-24	-23.162	-23.474	-0.312	(0)
PbCl4-2	2.360e-24	1.151e-24	-23.627	-23.939	-0.312	(0)
Pb3(OH) 4+2	5.828e-31	2.842e-31	-30.234	-30.546	-0.312	(0)
S(6)	1.095e-02					
SO4-2	7.787e-03	3.850e-03	-2.109	-2.414	-0.306	(0)
CaSO4	2.048e-03	2.068e-03	-2.689	-2.685	0.004	(0)
MgSO4	1.078e-03	1.088e-03	-2.967	-2.963	0.004	(0)
NaSO4-	3.418e-05	2.857e-05	-4.466	-4.544	-0.078	(0)
KSO4-	5.314e-06	4.441e-06	-5.275	-5.353	-0.078	(0)
MnSO4	2.307e-07	2.329e-07	-6.637	-6.633	0.004	(0)
FeSO4	1.405e-07	1.418e-07	-6.852	-6.848	0.004	(0)
HSO4-	5.368e-08	4.486e-08	-7.270	-7.348	-0.078	(0)
BaSO4	5.034e-08	5.083e-08	-7.298	-7.294	0.004	(0)
ZnSO4	2.134e-08	2.155e-08	-7.671	-7.667	0.004	(0)
CaHSO4+	2.035e-09	1.701e-09	-8.691	-8.769	-0.078	(0)
Zn(SO4) 2-2	1.576e-09	7.685e-10	-8.802	-9.114	-0.312	(0)
CuSO4	1.162e-09	1.173e-09	-8.935	-8.931	0.004	(0)
CdSO4	1.020e-10	1.030e-10	-9.991	-9.987	0.004	(0)
PbSO4	2.743e-11	2.769e-11	-10.562	-10.558	0.004	(0)
AgSO4-	1.863e-11	1.557e-11	-10.730	-10.808	-0.078	(0)
Cd(SO4) 2-2	9.891e-12	4.823e-12	-11.005	-11.317	-0.312	(0)
Pb(SO4) 2-2	1.148e-12	5.596e-13	-11.940	-12.252	-0.312	(0)
FeHSO4+	1.823e-13	1.523e-13	-12.739	-12.817	-0.078	(0)
FeSO4+	3.777e-17	3.156e-17	-16.423	-16.501	-0.078	(0)
Fe(SO4) 2-	2.978e-18	2.488e-18	-17.526	-17.604	-0.078	(0)
FeHSO4+2	3.024e-23	1.475e-23	-22.519	-22.831	-0.312	(0)
Se(-2)	4.648e-28					
HSe-	4.641e-28	3.878e-28	-27.333	-27.411	-0.078	(0)
H2Se	6.693e-31	6.758e-31	-30.174	-30.170	0.004	(0)
Se(4)	2.538e-09					
HSeO3-	2.458e-09	2.054e-09	-8.609	-8.687	-0.078	(0)
SeO3-2	8.025e-11	3.914e-11	-10.096	-10.407	-0.312	(0)
H2SeO3	1.899e-13	1.917e-13	-12.722	-12.717	0.004	(0)
Se(6)	1.689e-23					
SeO4-2	1.689e-23	8.239e-24	-22.772	-23.084	-0.312	(0)
HSeO4-	4.666e-29	3.899e-29	-28.331	-28.409	-0.078	(0)
Zn	1.196e-07					
Zn+2	5.578e-08	2.720e-08	-7.253	-7.565	-0.312	(0)
ZnHCO3+	3.222e-08	2.693e-08	-7.492	-7.570	-0.078	(0)
ZnSO4	2.134e-08	2.155e-08	-7.671	-7.667	0.004	(0)
ZnCO3	8.029e-09	8.106e-09	-8.095	-8.091	0.004	(0)
Zn(SO4) 2-2	1.576e-09	7.685e-10	-8.802	-9.114	-0.312	(0)
Zn(CO3) 2-2	5.308e-10	2.588e-10	-9.275	-9.587	-0.312	(0)
ZnOH+	5.931e-11	4.956e-11	-10.227	-10.305	-0.078	(0)
Zn(OH) 2	1.230e-11	1.242e-11	-10.910	-10.906	0.004	(0)
ZnCl+	1.117e-11	9.331e-12	-10.952	-11.030	-0.078	(0)
ZnOHCl	1.447e-12	1.461e-12	-11.839	-11.835	0.004	(0)
ZnCl2	2.435e-15	2.458e-15	-14.614	-14.609	0.004	(0)
Zn(OH) 3-	2.830e-16	2.365e-16	-15.548	-15.626	-0.078	(0)
ZnCl3-	8.031e-19	6.711e-19	-18.095	-18.173	-0.078	(0)
Zn(OH) 4-2	4.628e-22	2.257e-22	-21.335	-21.646	-0.312	(0)
ZnCl4-2	1.624e-22	7.920e-23	-21.789	-22.101	-0.312	(0)

-----Saturation indices-----

Phase	SI**	log IAP	log K(282 K,	1 atm)
Ag2CO3	-13.60	-25.07	-11.47	Ag2CO3
Ag2O	-18.70	-5.68	13.02	Ag2O
Ag2SO4	-16.56	-21.66	-5.10	Ag2SO4
AgMetal	2.93	-11.63	-14.56	Ag
Anglesite	-5.43	-13.31	-7.88	PbSO4
Anhydrite	-0.58	-4.92	-4.34	CaSO4
Antlerite	-9.91	-1.62	8.29	Cu3 (OH) 4SO4
Aragonite	-0.08	-8.33	-8.25	CaCO3
Arsenolite	-18.52	-20.20	-1.68	As2O3
Artinite	-8.52	2.28	10.80	MgCO3:Mg (OH) 2:3H2O
As2O5 (cr)	-34.78	-26.23	8.54	As2O5
As_native	-22.79	-36.47	-13.68	As
Atacamite	-8.90	-0.78	8.12	Cu2 (OH) 3Cl
Azurite	-8.45	-3.42	5.04	Cu3 (OH) 2 (CO3) 2
Ba3 (AsO4) 2	-0.29	-50.80	-50.51	Ba3 (AsO4) 2
Barite	0.27	-9.99	-10.27	BaSO4
BaSeO3	-11.60	-17.99	-6.39	BaSeO3
Bianchite	-8.22	-9.98	-1.76	ZnSO4:6H2O
Birnessite	-18.79	24.81	43.60	MnO2
Bixbyite	-21.16	-21.13	0.03	Mn2O3
Brochantite	-12.18	3.16	15.34	Cu4 (OH) 6SO4
Brucite	-7.14	10.83	17.97	Mg (OH) 2
Ca3 (AsO4) 2:4w	-16.66	-35.56	-18.91	Ca3 (AsO4) 2:4H2O
Calcite	0.08	-8.33	-8.41	CaCO3
CaSeO3	-7.31	-12.91	-5.60	CaSeO3
Cd (gamma)	-28.35	-14.01	14.35	Cd
Cd(OH) 2	-10.08	3.57	13.65	Cd(OH) 2
Cd(OH) 2 (a)	-11.02	3.57	14.60	Cd(OH) 2
Cd3 (OH) 2 (SO4) 2	-27.94	-21.23	6.71	Cd3 (OH) 2 (SO4) 2
Cd3 (OH) 4SO4	-27.82	-5.26	22.56	Cd3 (OH) 4SO4
Cd4 (OH) 6SO4	-30.09	-1.69	28.40	Cd4 (OH) 6SO4
CdCl2	-16.63	-17.13	-0.49	CdCl2
CdCl2:2.5H2O	-15.12	-17.13	-2.01	CdCl2:2.5H2O
CdCl2:H2O	-15.49	-17.13	-1.63	CdCl2:H2O
CdMetal	-28.25	-14.01	14.24	Cd
CdOHCl	-10.61	-6.78	3.83	CdOHCl
CdSO4	-12.92	-12.40	0.52	CdSO4
CdSO4:2.7H2O	-10.71	-12.40	-1.69	CdSO4:2.67H2O
CdSO4:H2O	-11.06	-12.40	-1.34	CdSO4:H2O
Cerargyrite	-2.79	-13.19	-10.40	AgCl
Cerrusite	-3.39	-16.72	-13.33	PbCO3
Chalcanthite	-8.49	-11.19	-2.70	CuSO4:5H2O
Claudetite	-18.58	-20.20	-1.62	As2O3
CO2 (g)	-1.16	-2.41	-1.25	CO2
Cotunnite	-13.03	-18.03	-5.00	PbCl2
Cu (OH) 2	-4.49	4.78	9.28	Cu (OH) 2
Cu2SO4	-16.92	-18.68	-1.76	Cu2SO4
Cu3 (AsO4) 2:6w	-19.26	-54.39	-35.12	Cu3 (AsO4) 2:6H2O
CuCO3	-4.97	-14.60	-9.63	CuCO3
CuMetal	-0.67	-10.14	-9.47	Cu
CuOCuSO4	-19.42	-6.41	13.01	CuO:CuSO4
CupricFerrite	2.04	9.54	7.49	CuFe2O4
Cuprite	-0.90	-2.71	-1.81	Cu2O
CuprousFerrite	9.78	1.02	-8.76	CuFeO2
CuSO4	-14.96	-11.19	3.77	CuSO4
Dolomite	-0.19	-16.88	-16.70	CaMg (CO3) 2
Dolomite (d)	-0.80	-16.88	-16.08	CaMg (CO3) 2
Epsomite	-2.89	-5.15	-2.26	MgSO4:7H2O
Fe (OH) 2.7Cl.3	2.31	-0.73	-3.04	Fe (OH) 2.7Cl0.3
Fe (OH) 3 (a)	-2.51	2.38	4.89	Fe (OH) 3
Fe2 (SeO3) 3	-31.72	-67.15	-35.43	Fe2 (SeO3) 3
Fe3 (OH) 8	-8.46	11.76	20.22	Fe3 (OH) 8
FeSe2	-25.21	-43.79	-18.58	FeSe2

Goethite	2.77	2.38	-0.40	FeOOH
Goslarite	-7.88	-9.98	-2.10	ZnSO4:7H2O
Gypsum	-0.32	-4.92	-4.59	CaSO4:2H2O
H2(g)	-17.58	-20.66	-3.08	H2
H2O(g)	-1.95	-0.00	1.95	H2O
Halite	-7.90	-6.35	1.54	NaCl
Hausmannite	-25.95	39.28	65.23	Mn3O4
Hematite	7.47	4.75	-2.72	Fe2O3
Huntite	-5.10	-33.99	-28.89	CaMg3(CO3)4
Hydrocerussite	-13.31	-30.77	-17.46	Pb(OH)2:2PbCO3
Hydromagnesite	-16.81	-23.39	-6.58	Mg5(CO3)4(OH)2:4H2O
Hydrozincite	-18.10	12.20	30.31	Zn5(OH)6(CO3)2
Hydrozincite_PG	-20.06	12.20	32.26	Zn5(OH)6(CO3)2
Jarosite(ss)	-12.46	-22.29	-9.83	(K0.77Na0.03H0.2)Fe3(SO4)2(OH)6
Jarosite-K	-13.79	-21.70	-7.90	KFe3(SO4)2(OH)6
Jarosite-Na	-17.05	-20.82	-3.77	NaFe3(SO4)2(OH)6
JarositeH	-21.73	-24.82	-3.09	(H3O)Fe3(SO4)2(OH)6
Langite	-15.28	3.16	18.44	Cu4(OH)6SO4:H2O
Larnakite	-10.63	-10.64	-0.01	PbO:PbSO4
Laurionite	-8.31	-7.68	0.62	PbOHCl
Litharge	-10.74	2.67	13.40	PbO
Maghemite	-1.63	4.75	6.39	Fe2O3
Magnesite	-0.78	-8.55	-7.77	MgCO3
Magnetite	5.92	11.76	5.84	Fe3O4
Malachite	-5.29	0.68	5.97	Cu2(OH)2CO3
Manganite	-9.32	16.02	25.34	MnOOH
Massicot	-10.94	2.67	13.61	PbO
Melanothallite	-20.16	-15.91	4.24	CuCl2
Melanterite	-6.54	-8.97	-2.43	FeSO4:7H2O
Minium	-52.40	25.58	77.98	Pb3O4
Mirabilite	-6.08	-7.98	-1.91	Na2SO4:10H2O
Mn2(SO4)3	-64.97	-69.05	-4.08	Mn2(SO4)3
Mn3(AsO4)2:8H2O	-18.34	-47.04	-28.71	Mn3(AsO4)2:8H2O
MnCl2:4H2O	-15.45	-13.47	1.98	MnCl2:4H2O
MnSO4	-12.06	-8.74	3.31	MnSO4
Monteponite	-11.23	3.57	14.80	CdO
Nahcolite	-4.18	-4.89	-0.70	NaHCO3
Nantokite	-4.53	-11.70	-7.18	CuCl
Natron	-9.43	-11.39	-1.97	Na2CO3:10H2O
Nesquehonite	-3.18	-8.56	-5.38	MgCO3:3H2O
Nsutite	-17.75	24.81	42.56	MnO2
O2(g)	-53.79	-56.55	-2.76	O2
Otavite	-3.81	-15.81	-12.00	CdCO3
Pb(OH)2	-6.07	2.67	8.73	Pb(OH)2
Pb2(OH)3Cl	-13.81	-5.02	8.79	Pb2(OH)3Cl
Pb2O(OH)2	-20.87	5.33	26.20	PbO:Pb(OH)2
Pb2O3	-38.13	22.91	61.04	Pb2O3
Pb2OCO3	-14.03	-14.05	-0.02	PbO:PbCO3
Pb3(AsO4)2	-25.34	-60.74	-35.40	Pb3(AsO4)2
Pb3O2CO3	-23.51	-11.39	12.12	PbCO3:2PbO
Pb3O2SO4	-19.24	-7.97	11.27	PbSO4:2PbO
Pb4(OH)6SO4	-26.41	-5.31	21.10	Pb4(OH)6SO4
Pb4O3SO4	-28.87	-5.31	23.56	PbSO4:3PbO
PbMetal	-19.17	-14.91	4.25	Pb
PbO:0.33H2O	-10.31	2.67	12.98	PbO:0.33H2O
Phosgenite	-14.94	-34.75	-19.81	PbCl2:PbCO3
Plattnerite	-32.01	20.25	52.25	PbO2
Portlandite	-13.04	11.06	24.09	Ca(OH)2
Pyrochroite	-7.97	7.23	15.20	Mn(OH)2
Pyrolusite	-19.29	24.81	44.10	MnO2
Rhodochrosite	-1.08	-12.15	-11.07	MnCO3
Rhodochrosite(d)	-1.76	-12.15	-10.39	MnCO3
Scorodite	-11.74	-31.99	-20.25	FeAsO4:2H2O
Se(s)	0.71	-16.61	-17.32	Se
SeO2	-15.59	-23.97	-8.38	SeO2
Siderite	-1.59	-12.37	-10.79	FeCO3
Siderite(d)(3)	-1.92	-12.37	-10.45	FeCO3

Smithsonite	-3.57	-13.39	-9.82	ZnCO3
Smithsonite_PG	-2.60	-13.39	-10.79	ZnCO3
Tenorite	-3.47	4.78	8.26	CuO
Thenardite	-7.83	-7.98	-0.16	Na2SO4
Thermonatrite	-11.63	-11.39	0.24	Na2CO3:H2O
Trona	-16.24	-16.28	-0.04	NaHCO3:Na2CO3:2H2O
Witherite	-4.76	-13.41	-8.64	BaCO3
Zincite (c)	-6.06	5.99	12.05	ZnO
Zincosite	-13.79	-9.98	3.81	ZnSO4
Zn(OH)2-a	-6.46	5.99	12.45	Zn(OH)2
Zn(OH)2-b	-5.76	5.99	11.75	Zn(OH)2
Zn(OH)2-c	-6.21	5.99	12.20	Zn(OH)2
Zn(OH)2-e	-5.51	5.99	11.50	Zn(OH)2
Zn(OH)2-g	-5.72	5.99	11.71	Zn(OH)2
Zn2(OH)2SO4	-11.49	-3.99	7.50	Zn2(OH)2SO4
Zn2(OH)3Cl	-13.56	1.64	15.20	Zn2(OH)3Cl
Zn3(AsO4)2:2.5w	-23.21	-50.76	-27.55	Zn3(AsO4)2:2.5H2O
Zn3O(SO4)2	-35.57	-13.97	21.61	ZnO:2ZnSO4
Zn4(OH)6SO4	-20.40	8.00	28.40	Zn4(OH)6SO4
Zn5(OH)8Cl2	-29.23	9.27	38.50	Zn5(OH)8Cl2
ZnCl2	-22.46	-14.70	7.76	ZnCl2
ZnCO3:1H2O	-3.13	-13.39	-10.26	ZnCO3:1H2O
ZnCO3:H2O	-3.13	-13.39	-10.26	ZnCO3:H2O
ZnMetal	-38.88	-11.58	27.29	Zn
ZnO (a)	-5.32	5.99	11.31	ZnO
ZnSO4:H2O	-9.85	-9.98	-0.13	ZnSO4:H2O

**For a gas, SI = log10(fugacity). Fugacity = pressure * phi / 1 atm.
For ideal gases, phi = 1.

Initial solution 8. MW-1014B

-----Solution composition-----

Elements	Molality	Moles
Ag	4.648e-10	4.648e-10
Alkalinity	1.052e-02	1.052e-02
As	1.338e-08	1.338e-08
Ba	1.650e-07	1.650e-07
Ca	1.384e-02	1.384e-02
Cd	1.963e-08	1.963e-08
Cl	1.284e-03	1.284e-03
Cu	7.938e-06	7.938e-06
Fe	9.966e-07	9.966e-07
K	4.873e-04	4.873e-04
Mg	5.280e-03	5.280e-03
Mn	2.136e-04	2.136e-04
Na	9.553e-04	9.553e-04
Pb	4.840e-10	4.840e-10
S (6)	1.555e-02	1.555e-02
Se	2.413e-08	2.413e-08
Zn	1.795e-05	1.795e-05

-----Description of solution-----

pH	=	6.620
pe	=	2.286
Activity of water	=	0.999
Ionic strength (mol/kgw)	=	5.481e-02
Mass of water (kg)	=	1.000e+00
Total carbon (mol/kg)	=	1.619e-02
Total CO2 (mol/kg)	=	1.619e-02
Temperature (°C)	=	9.20
Electrical balance (eq)	=	-2.758e-03
Percent error, 100*(Cat- An)/(Cat+ An)	=	-4.49
Iterations	=	11

Total H = 1.110229e+02

Total O = 5.561132e+01

-----Distribution of species-----

Species	Molality	Activity	Log Molality	Log Activity	Log Gamma	mole V cm ³ /mol
H+	2.812e-07	2.399e-07	-6.551	-6.620	-0.069	0.00
OH-	1.383e-08	1.135e-08	-7.859	-7.945	-0.086	(0)
H2O	5.551e+01	9.992e-01	1.744	-0.000	0.000	18.02
Ag	4.648e-10					
AgCl	2.767e-10	2.802e-10	-9.558	-9.553	0.005	(0)
Ag+	1.369e-10	1.123e-10	-9.863	-9.950	-0.086	(0)
AgCl2-	4.000e-11	3.280e-11	-10.398	-10.484	-0.086	(0)
AgSO4-	1.113e-11	9.125e-12	-10.954	-11.040	-0.086	(0)
AgCl3-2	5.451e-14	2.465e-14	-13.263	-13.608	-0.345	(0)
AgOH	4.619e-16	4.678e-16	-15.335	-15.330	0.005	(0)
AgCl4-3	2.538e-16	4.257e-17	-15.596	-16.371	-0.775	(0)
Ag (OH) 2-	2.376e-21	1.948e-21	-20.624	-20.710	-0.086	(0)
As (3)	1.700e-10					
H3AsO3	1.696e-10	1.718e-10	-9.771	-9.765	0.005	(0)
H2AsO3-	3.320e-13	2.723e-13	-12.479	-12.565	-0.086	(0)
H4AsO3+	2.490e-17	2.042e-17	-16.604	-16.690	-0.086	(0)
HAsO3-2	2.439e-21	1.103e-21	-20.613	-20.957	-0.345	(0)
AsO3-3	3.088e-30	5.180e-31	-29.510	-30.286	-0.775	(0)
As (5)	1.321e-08					
H2AsO4-	8.891e-09	7.291e-09	-8.051	-8.137	-0.086	(0)
HAsO4-2	4.324e-09	1.955e-09	-8.364	-8.709	-0.345	(0)
H3AsO4	2.938e-13	2.975e-13	-12.532	-12.526	0.005	(0)
AsO4-3	7.214e-14	1.210e-14	-13.142	-13.917	-0.775	(0)
Ba	1.650e-07					
BaSO4	8.437e-08	8.544e-08	-7.074	-7.068	0.005	(0)
Ba+2	7.858e-08	3.554e-08	-7.105	-7.449	-0.345	(0)
BaHCO3+	2.050e-09	1.681e-09	-8.688	-8.774	-0.086	(0)
BaCO3	1.418e-11	1.436e-11	-10.848	-10.843	0.005	(0)
BaOH+	6.116e-15	5.016e-15	-14.213	-14.300	-0.086	(0)
C (4)	1.619e-02					
HCO3-	9.810e-03	8.114e-03	-2.008	-2.091	-0.082	(0)
CO2	5.693e-03	5.765e-03	-2.245	-2.239	0.005	(0)
CaHCO3+	4.104e-04	3.366e-04	-3.387	-3.473	-0.086	(0)
MgHCO3+	2.013e-04	1.651e-04	-3.696	-3.782	-0.086	(0)
MnHCO3+	4.962e-05	4.069e-05	-4.304	-4.390	-0.086	(0)
CaCO3	6.577e-06	6.660e-06	-5.182	-5.177	0.005	(0)
MnCO3	4.743e-06	4.803e-06	-5.324	-5.319	0.005	(0)
ZnHCO3+	4.700e-06	3.855e-06	-5.328	-5.414	-0.086	(0)
NaHCO3	3.451e-06	3.495e-06	-5.462	-5.457	0.005	(0)
CuCO3	2.513e-06	2.544e-06	-5.600	-5.594	0.005	(0)
CO3-2	2.296e-06	1.074e-06	-5.639	-5.969	-0.330	(0)
CuHCO3+	2.187e-06	1.793e-06	-5.660	-5.746	-0.086	(0)
MgCO3	1.441e-06	1.460e-06	-5.841	-5.836	0.005	(0)
ZnCO3	7.988e-07	8.090e-07	-6.098	-6.092	0.005	(0)
FeHCO3+	2.562e-07	2.101e-07	-6.591	-6.678	-0.086	(0)
Zn (CO3) 2-2	4.109e-08	1.858e-08	-7.386	-7.731	-0.345	(0)
NaCO3-	8.055e-09	6.605e-09	-8.094	-8.180	-0.086	(0)
Cu (CO3) 2-2	7.611e-09	3.442e-09	-8.119	-8.463	-0.345	(0)
FeCO3	6.590e-09	6.673e-09	-8.181	-8.176	0.005	(0)
BaHCO3+	2.050e-09	1.681e-09	-8.688	-8.774	-0.086	(0)
CdHCO3+	1.522e-09	1.248e-09	-8.818	-8.904	-0.086	(0)
PbCO3	2.827e-10	2.863e-10	-9.549	-9.543	0.005	(0)
PbHCO3+	1.205e-10	9.882e-11	-9.919	-10.005	-0.086	(0)
BaCO3	1.418e-11	1.436e-11	-10.848	-10.843	0.005	(0)
CdCO3	4.100e-12	4.152e-12	-11.387	-11.382	0.005	(0)
Pb (CO3) 2-2	1.709e-12	7.727e-13	-11.767	-12.112	-0.345	(0)
Cd (CO3) 2-2	3.119e-14	1.411e-14	-13.506	-13.851	-0.345	(0)
Ca	1.384e-02					
Ca+2	9.724e-03	4.569e-03	-2.012	-2.340	-0.328	(0)

CaSO4	3.695e-03	3.742e-03	-2.432	-2.427	0.005	(0)
CaHCO3+	4.104e-04	3.366e-04	-3.387	-3.473	-0.086	(0)
CaCO3	6.577e-06	6.660e-06	-5.182	-5.177	0.005	(0)
CaHSO4+	5.437e-09	4.459e-09	-8.265	-8.351	-0.086	(0)
CaOH+	3.852e-09	3.159e-09	-8.414	-8.501	-0.086	(0)
Cd	1.963e-08					
Cd+2	1.076e-08	4.865e-09	-7.968	-8.313	-0.345	(0)
CdSO4	6.001e-09	6.078e-09	-8.222	-8.216	0.005	(0)
CdHCO3+	1.522e-09	1.248e-09	-8.818	-8.904	-0.086	(0)
Cd(SO4) 2-2	7.828e-10	3.540e-10	-9.106	-9.451	-0.345	(0)
CdCl+	5.574e-10	4.571e-10	-9.254	-9.340	-0.086	(0)
CdCO3	4.100e-12	4.152e-12	-11.387	-11.382	0.005	(0)
CdCl2	1.841e-12	1.864e-12	-11.735	-11.729	0.005	(0)
CdOH+	5.964e-13	4.891e-13	-12.224	-12.311	-0.086	(0)
CdOHC1	5.442e-13	5.511e-13	-12.264	-12.259	0.005	(0)
Cd(CO3) 2-2	3.119e-14	1.411e-14	-13.506	-13.851	-0.345	(0)
CdCl3-	1.161e-15	9.519e-16	-14.935	-15.021	-0.086	(0)
Cd(OH) 2	3.723e-16	3.770e-16	-15.429	-15.424	0.005	(0)
Cd2OH+3	8.552e-20	1.434e-20	-19.068	-19.843	-0.775	(0)
Cd(OH) 3-	2.149e-22	1.762e-22	-21.668	-21.754	-0.086	(0)
Cd(OH) 4-2	1.446e-29	6.541e-30	-28.840	-29.184	-0.345	(0)
Cl	1.284e-03					
Cl-	1.283e-03	1.040e-03	-2.892	-2.983	-0.091	(0)
CuCl2-	4.447e-07	3.647e-07	-6.352	-6.438	-0.086	(0)
MnCl+	2.908e-07	2.385e-07	-6.536	-6.623	-0.086	(0)
ZnCl+	6.174e-09	5.063e-09	-8.209	-8.296	-0.086	(0)
CuCl3-2	1.247e-09	5.639e-10	-8.904	-9.249	-0.345	(0)
CuCl+	6.652e-10	5.455e-10	-9.177	-9.263	-0.086	(0)
CdCl+	5.574e-10	4.571e-10	-9.254	-9.340	-0.086	(0)
ZnOHC1	5.346e-10	5.414e-10	-9.272	-9.266	0.005	(0)
FeCl+	4.534e-10	3.718e-10	-9.344	-9.430	-0.086	(0)
AgCl	2.767e-10	2.802e-10	-9.558	-9.553	0.005	(0)
MnCl2	1.069e-10	1.083e-10	-9.971	-9.965	0.005	(0)
AgCl2-	4.000e-11	3.280e-11	-10.398	-10.484	-0.086	(0)
ZnCl2	5.093e-12	5.157e-12	-11.293	-11.288	0.005	(0)
CdCl2	1.841e-12	1.864e-12	-11.735	-11.729	0.005	(0)
CdOHC1	5.442e-13	5.511e-13	-12.264	-12.259	0.005	(0)
PbCl+	5.120e-13	4.199e-13	-12.291	-12.377	-0.086	(0)
CuCl2	2.513e-13	2.544e-13	-12.600	-12.594	0.005	(0)
AgCl3-2	5.451e-14	2.465e-14	-13.263	-13.608	-0.345	(0)
MnCl3-	3.784e-14	3.103e-14	-13.422	-13.508	-0.086	(0)
ZnCl3-	6.641e-15	5.446e-15	-14.178	-14.264	-0.086	(0)
CdCl3-	1.161e-15	9.519e-16	-14.935	-15.021	-0.086	(0)
PbCl2	9.336e-16	9.455e-16	-15.030	-15.024	0.005	(0)
AgCl4-3	2.538e-16	4.257e-17	-15.596	-16.371	-0.775	(0)
ZnCl4-2	5.501e-18	2.488e-18	-17.260	-17.604	-0.345	(0)
PbCl3-	8.595e-19	7.049e-19	-18.066	-18.152	-0.086	(0)
CuCl3-	8.522e-19	6.988e-19	-18.069	-18.156	-0.086	(0)
FeCl+2	7.844e-20	3.548e-20	-19.105	-19.450	-0.345	(0)
PbCl4-2	6.825e-22	3.087e-22	-21.166	-21.511	-0.345	(0)
FeCl2+	3.412e-22	2.798e-22	-21.467	-21.553	-0.086	(0)
CuCl4-2	5.475e-24	2.476e-24	-23.262	-23.606	-0.345	(0)
FeCl3	2.874e-26	2.910e-26	-25.542	-25.536	0.005	(0)
Cu (1)	1.695e-06					
Cu+	1.249e-06	1.024e-06	-5.903	-5.990	-0.086	(0)
CuCl2-	4.447e-07	3.647e-07	-6.352	-6.438	-0.086	(0)
CuCl3-2	1.247e-09	5.639e-10	-8.904	-9.249	-0.345	(0)
Cu (2)	6.243e-06					
CuCO3	2.513e-06	2.544e-06	-5.600	-5.594	0.005	(0)
CuHCO3+	2.187e-06	1.793e-06	-5.660	-5.746	-0.086	(0)
Cu+2	9.750e-07	4.410e-07	-6.011	-6.356	-0.345	(0)
CuSO4	3.801e-07	3.849e-07	-6.420	-6.415	0.005	(0)
Cu(OH) 2	1.578e-07	1.598e-07	-6.802	-6.796	0.005	(0)
CuOH+	2.240e-08	1.837e-08	-7.650	-7.736	-0.086	(0)
Cu(CO3) 2-2	7.611e-09	3.442e-09	-8.119	-8.463	-0.345	(0)
CuCl+	6.652e-10	5.455e-10	-9.177	-9.263	-0.086	(0)
Cu2(OH) 2+2	6.228e-11	2.817e-11	-10.206	-10.550	-0.345	(0)

CuCl2	2.513e-13	2.544e-13	-12.600	-12.594	0.005	(0)
Cu (OH) 3-	4.892e-14	4.012e-14	-13.311	-13.397	-0.086	(0)
CuCl3-	8.522e-19	6.988e-19	-18.069	-18.156	-0.086	(0)
Cu (OH) 4-2	7.372e-20	3.334e-20	-19.132	-19.477	-0.345	(0)
CuCl4-2	5.475e-24	2.476e-24	-23.262	-23.606	-0.345	(0)
Fe (2)	9.966e-07					
Fe+2	5.725e-07	2.589e-07	-6.242	-6.587	-0.345	(0)
FeHCO3+	2.562e-07	2.101e-07	-6.591	-6.678	-0.086	(0)
FeSO4	1.607e-07	1.628e-07	-6.794	-6.788	0.005	(0)
FeCO3	6.590e-09	6.673e-09	-8.181	-8.176	0.005	(0)
FeCl+	4.534e-10	3.718e-10	-9.344	-9.430	-0.086	(0)
FeOH+	1.195e-10	9.803e-11	-9.922	-10.009	-0.086	(0)
FeHSO4+	3.081e-13	2.527e-13	-12.511	-12.597	-0.086	(0)
Fe (OH) 2	8.041e-16	8.143e-16	-15.095	-15.089	0.005	(0)
Fe (OH) 3-	1.304e-19	1.070e-19	-18.885	-18.971	-0.086	(0)
Fe (3)	2.091e-11					
Fe (OH) 2+	1.724e-11	1.414e-11	-10.763	-10.850	-0.086	(0)
Fe (OH) 3	3.620e-12	3.666e-12	-11.441	-11.436	0.005	(0)
FeOH+2	4.267e-14	1.930e-14	-13.370	-13.714	-0.345	(0)
Fe (OH) 4-	8.685e-15	7.122e-15	-14.061	-14.147	-0.086	(0)
FeSO4+	8.496e-17	6.967e-17	-16.071	-16.157	-0.086	(0)
Fe+3	1.143e-17	1.916e-18	-16.942	-17.718	-0.775	(0)
Fe (SO4) 2-	8.354e-18	6.851e-18	-17.078	-17.164	-0.086	(0)
FeCl+2	7.844e-20	3.548e-20	-19.105	-19.450	-0.345	(0)
FeCl2+	3.412e-22	2.798e-22	-21.467	-21.553	-0.086	(0)
FeHSO4+2	1.039e-22	4.697e-23	-21.984	-22.328	-0.345	(0)
Fe2 (OH) 2+4	4.775e-25	1.998e-26	-24.321	-25.700	-1.378	(0)
FeCl3	2.874e-26	2.910e-26	-25.542	-25.536	0.005	(0)
Fe3 (OH) 4+5	3.920e-32	2.751e-34	-31.407	-33.561	-2.154	(0)
H (0)	2.541e-21					
H2	1.270e-21	1.286e-21	-20.896	-20.891	0.005	(0)
K	4.873e-04					
K+	4.754e-04	3.855e-04	-3.323	-3.414	-0.091	(0)
KSO4-	1.184e-05	9.712e-06	-4.927	-5.013	-0.086	(0)
Mg	5.280e-03					
Mg+2	3.766e-03	1.815e-03	-2.424	-2.741	-0.317	(0)
MgSO4	1.311e-03	1.328e-03	-2.882	-2.877	0.005	(0)
MgHCO3+	2.013e-04	1.651e-04	-3.696	-3.782	-0.086	(0)
MgCO3	1.441e-06	1.460e-06	-5.841	-5.836	0.005	(0)
MgOH+	7.419e-09	6.084e-09	-8.130	-8.216	-0.086	(0)
Mn (2)	2.136e-04					
Mn+2	1.244e-04	5.627e-05	-3.905	-4.250	-0.345	(0)
MnHCO3+	4.962e-05	4.069e-05	-4.304	-4.390	-0.086	(0)
MnSO4	3.448e-05	3.492e-05	-4.462	-4.457	0.005	(0)
MnCO3	4.743e-06	4.803e-06	-5.324	-5.319	0.005	(0)
MnCl+	2.908e-07	2.385e-07	-6.536	-6.623	-0.086	(0)
MnOH+	1.886e-09	1.546e-09	-8.725	-8.811	-0.086	(0)
MnCl2	1.069e-10	1.083e-10	-9.971	-9.965	0.005	(0)
MnCl3-	3.784e-14	3.103e-14	-13.422	-13.508	-0.086	(0)
Mn (OH) 3-	7.859e-20	6.445e-20	-19.105	-19.191	-0.086	(0)
Mn (3)	1.753e-28					
Mn+3	1.753e-28	2.941e-29	-27.756	-28.532	-0.775	(0)
Mn (6)	0.000e+00					
MnO4-2	0.000e+00	0.000e+00	-66.394	-66.739	-0.345	(0)
Mn (7)	0.000e+00					
MnO4-	0.000e+00	0.000e+00	-74.842	-74.928	-0.086	(0)
Na	9.553e-04					
Na+	9.316e-04	7.659e-04	-3.031	-3.116	-0.085	(0)
NaSO4-	2.020e-05	1.656e-05	-4.695	-4.781	-0.086	(0)
NaHCO3	3.451e-06	3.495e-06	-5.462	-5.457	0.005	(0)
NaCO3-	8.055e-09	6.605e-09	-8.094	-8.180	-0.086	(0)
O (0)	0.000e+00					
O2	0.000e+00	0.000e+00	-55.989	-55.984	0.005	(0)
Pb	4.840e-10					
PbCO3	2.827e-10	2.863e-10	-9.549	-9.543	0.005	(0)
PbHCO3+	1.205e-10	9.882e-11	-9.919	-10.005	-0.086	(0)
PbSO4	4.084e-11	4.136e-11	-10.389	-10.383	0.005	(0)

Pb+2	3.390e-11	1.533e-11	-10.470	-10.814	-0.345	(0)
Pb (SO4) 2-2	2.302e-12	1.041e-12	-11.638	-11.982	-0.345	(0)
Pb (CO3) 2-2	1.709e-12	7.727e-13	-11.767	-12.112	-0.345	(0)
PbOH+	1.519e-12	1.245e-12	-11.819	-11.905	-0.086	(0)
PbCl+	5.120e-13	4.199e-13	-12.291	-12.377	-0.086	(0)
Pb (OH) 2	1.993e-15	2.018e-15	-14.701	-14.695	0.005	(0)
PbCl2	9.336e-16	9.455e-16	-15.030	-15.024	0.005	(0)
PbCl3-	8.595e-19	7.049e-19	-18.066	-18.152	-0.086	(0)
Pb (OH) 3-	1.177e-19	9.651e-20	-18.929	-19.015	-0.086	(0)
Pb2OH+3	2.548e-21	4.274e-22	-20.594	-21.369	-0.775	(0)
PbCl4-2	6.825e-22	3.087e-22	-21.166	-21.511	-0.345	(0)
Pb (OH) 4-2	2.036e-24	9.209e-25	-23.691	-24.036	-0.345	(0)
Pb3 (OH) 4+2	2.589e-31	1.171e-31	-30.587	-30.932	-0.345	(0)
S (6)	1.555e-02					
SO4-2	1.048e-02	4.797e-03	-1.980	-2.319	-0.339	(0)
CaSO4	3.695e-03	3.742e-03	-2.432	-2.427	0.005	(0)
MgSO4	1.311e-03	1.328e-03	-2.882	-2.877	0.005	(0)
MnSO4	3.448e-05	3.492e-05	-4.462	-4.457	0.005	(0)
NaSO4-	2.020e-05	1.656e-05	-4.695	-4.781	-0.086	(0)
KSO4-	1.184e-05	9.712e-06	-4.927	-5.013	-0.086	(0)
ZnSO4	3.685e-06	3.732e-06	-5.434	-5.428	0.005	(0)
CuSO4	3.801e-07	3.849e-07	-6.420	-6.415	0.005	(0)
Zn (SO4) 2-2	3.658e-07	1.655e-07	-6.437	-6.781	-0.345	(0)
FeSO4	1.607e-07	1.628e-07	-6.794	-6.788	0.005	(0)
HSO4-	9.898e-08	8.117e-08	-7.004	-7.091	-0.086	(0)
BaSO4	8.437e-08	8.544e-08	-7.074	-7.068	0.005	(0)
CdSO4	6.001e-09	6.078e-09	-8.222	-8.216	0.005	(0)
CaHSO4+	5.437e-09	4.459e-09	-8.265	-8.351	-0.086	(0)
Cd (SO4) 2-2	7.828e-10	3.540e-10	-9.106	-9.451	-0.345	(0)
PbSO4	4.084e-11	4.136e-11	-10.389	-10.383	0.005	(0)
AgSO4-	1.113e-11	9.125e-12	-10.954	-11.040	-0.086	(0)
Pb (SO4) 2-2	2.302e-12	1.041e-12	-11.638	-11.982	-0.345	(0)
FeHSO4+	3.081e-13	2.527e-13	-12.511	-12.597	-0.086	(0)
FeSO4+	8.496e-17	6.967e-17	-16.071	-16.157	-0.086	(0)
Fe (SO4) 2-	8.354e-18	6.851e-18	-17.078	-17.164	-0.086	(0)
FeHSO4+2	1.039e-22	4.697e-23	-21.984	-22.328	-0.345	(0)
Se (-2)	8.911e-28					
HSe-	8.893e-28	7.293e-28	-27.051	-27.137	-0.086	(0)
H2Se	1.798e-30	1.821e-30	-29.745	-29.740	0.005	(0)
Se (4)	2.413e-08					
HSeO3-	2.356e-08	1.932e-08	-7.628	-7.714	-0.086	(0)
SeO3-2	5.633e-10	2.547e-10	-9.249	-9.594	-0.345	(0)
H2SeO3	2.574e-12	2.607e-12	-11.589	-11.584	0.005	(0)
Se (6)	2.028e-22					
SeO4-2	2.028e-22	9.173e-23	-21.693	-22.038	-0.345	(0)
HSeO4-	7.714e-28	6.326e-28	-27.113	-27.199	-0.086	(0)
Zn	1.795e-05					
Zn+2	8.344e-06	3.773e-06	-5.079	-5.423	-0.345	(0)
ZnHCO3+	4.700e-06	3.855e-06	-5.328	-5.414	-0.086	(0)
ZnSO4	3.685e-06	3.732e-06	-5.434	-5.428	0.005	(0)
ZnCO3	7.988e-07	8.090e-07	-6.098	-6.092	0.005	(0)
Zn (SO4) 2-2	3.658e-07	1.655e-07	-6.437	-6.781	-0.345	(0)
Zn (CO3) 2-2	4.109e-08	1.858e-08	-7.386	-7.731	-0.345	(0)
ZnCl+	6.174e-09	5.063e-09	-8.209	-8.296	-0.086	(0)
ZnOH+	5.928e-09	4.861e-09	-8.227	-8.313	-0.086	(0)
Zn (OH) 2	8.139e-10	8.242e-10	-9.089	-9.084	0.005	(0)
ZnOHCl	5.346e-10	5.414e-10	-9.272	-9.266	0.005	(0)
ZnCl2	5.093e-12	5.157e-12	-11.293	-11.288	0.005	(0)
Zn (OH) 3-	1.324e-14	1.086e-14	-13.878	-13.964	-0.086	(0)
ZnCl3-	6.641e-15	5.446e-15	-14.178	-14.264	-0.086	(0)
ZnCl4-2	5.501e-18	2.488e-18	-17.260	-17.604	-0.345	(0)
Zn (OH) 4-2	1.585e-20	7.167e-21	-19.800	-20.145	-0.345	(0)

-----Saturation indices-----

Phase SI** log IAP log K(282 K, 1 atm)

Ag2CO3	-14.41	-25.87	-11.46	Ag2CO3
Ag2O	-19.67	-6.66	13.01	Ag2O
Ag2SO4	-17.12	-22.22	-5.09	Ag2SO4
AgMetal	2.31	-12.24	-14.55	Ag
Anglesite	-5.26	-13.13	-7.88	PbSO4
Anhydrite	-0.32	-4.66	-4.34	CaSO4
Antlerite	-3.20	5.09	8.29	Cu3(OH)4SO4
Aragonite	-0.06	-8.31	-8.25	CaCO3
Arsenolite	-17.85	-19.53	-1.67	As2O3
Artinite	-8.99	1.79	10.78	MgCO3:Mg(OH)2:3H2O
As2O5(cr)	-33.59	-25.05	8.54	As2O5
As_native	-22.82	-36.48	-13.66	As
Atacamite	-3.94	4.16	8.11	Cu2(OH)3Cl
Azurite	-1.79	3.23	5.02	Cu3(OH)2(CO3)2
Ba3(AsO4)2	0.32	-50.18	-50.50	Ba3(AsO4)2
Barite	0.49	-9.77	-10.26	BaSO4
BaSeO3	-10.65	-17.04	-6.39	BaSeO3
Bianchite	-5.99	-7.74	-1.76	ZnSO4:6H2O
Birnessite	-16.80	26.80	43.60	MnO2
Bixbyite	-17.36	-17.34	0.01	Mn2O3
Brochantite	-3.36	11.98	15.34	Cu4(OH)6SO4
Brucite	-7.45	10.50	17.95	Mg(OH)2
Ca3(AsO4)2:4w	-15.95	-34.86	-18.91	Ca3(AsO4)2:4H2O
Calcite	0.10	-8.31	-8.41	CaCO3
CaSeO3	-6.33	-11.93	-5.60	CaSeO3
Cd(gamma)	-27.22	-12.89	14.33	Cd
Cd(OH)2	-8.72	4.93	13.65	Cd(OH)2
Cd(OH)2(a)	-9.66	4.93	14.58	Cd(OH)2
Cd3(OH)2(SO4)2	-23.05	-16.34	6.71	Cd3(OH)2(SO4)2
Cd3(OH)4SO4	-23.34	-0.78	22.56	Cd3(OH)4SO4
Cd4(OH)6SO4	-24.25	4.15	28.40	Cd4(OH)6SO4
CdCl2	-13.78	-14.28	-0.50	CdCl2
CdCl2:2.5H2O	-12.27	-14.28	-2.01	CdCl2:2.5H2O
CdCl2:H2O	-12.64	-14.28	-1.64	CdCl2:H2O
CdMetal	-27.11	-12.89	14.23	Cd
CdOHC1	-8.50	-4.68	3.82	CdOHC1
CdSO4	-11.14	-10.63	0.50	CdSO4
CdSO4:2.7H2O	-8.94	-10.63	-1.70	CdSO4:2.67H2O
CdSO4:H2O	-9.28	-10.63	-1.35	CdSO4:H2O
Cerargyrite	-2.54	-12.93	-10.39	AgCl
Cerrusite	-3.45	-16.78	-13.33	PbCO3
Chalcanthite	-5.98	-8.68	-2.70	CuSO4:5H2O
Claudetite	-17.91	-19.53	-1.62	As2O3
CO2(g)	-0.98	-2.24	-1.26	CO2
Cotunnite	-11.78	-16.78	-5.00	PbCl2
Cu(OH)2	-2.38	6.88	9.27	Cu(OH)2
Cu2SO4	-12.54	-14.30	-1.76	Cu2SO4
Cu3(AsO4)2:6w	-11.78	-46.90	-35.12	Cu3(AsO4)2:6H2O
CuCO3	-2.69	-12.32	-9.63	CuCO3
CuMetal	1.19	-8.28	-9.46	Cu
CuOCuSO4	-14.78	-1.79	12.99	CuO:CuSO4
CupricFerrite	3.70	11.17	7.47	CuFe2O4
Cuprite	3.07	1.26	-1.81	Cu2O
CuprousFerrite	11.54	2.77	-8.76	CuFeO2
CuSO4	-12.43	-8.67	3.75	CuSO4
Dolomite	-0.32	-17.02	-16.70	CaMg(CO3)2
Dolomite(d)	-0.93	-17.02	-16.09	CaMg(CO3)2
Epsomite	-2.81	-5.06	-2.26	MgSO4:7H2O
Fe(OH)2.7Cl.3	2.30	-0.74	-3.04	Fe(OH)2.7Cl0.3
Fe(OH)3(a)	-2.75	2.14	4.89	Fe(OH)3
Fe2(SeO3)3	-28.79	-64.22	-35.43	Fe2(SeO3)3
Fe3(OH)8	-9.29	10.94	20.22	Fe3(OH)8
FeSe2	-24.47	-43.05	-18.58	FeSe2
Goethite	2.55	2.14	-0.41	FeOOH
Goslarite	-5.65	-7.74	-2.10	ZnSO4:7H2O
Gypsum	-0.07	-4.66	-4.59	CaSO4:2H2O
H2(g)	-17.81	-20.89	-3.08	H2

H2O(g)	-1.94	-0.00	1.94	H2O
Halite	-7.64	-6.10	1.54	NaCl
Hausmannite	-20.38	44.78	65.16	Mn3O4
Hematite	7.03	4.28	-2.74	Fe2O3
Huntite	-5.53	-34.44	-28.91	CaMg3(CO3)4
Hydrocerrusite	-13.68	-31.14	-17.46	Pb(OH)2:2PbCO3
Hydromagnesite	-17.72	-24.34	-6.62	Mg5(CO3)4(OH)2:4H2O
Hydrozincite	-8.65	21.66	30.31	Zn5(OH)6(CO3)2
Hydrozincite_PG	-10.55	21.66	32.21	Zn5(OH)6(CO3)2
Jarosite(ss)	-12.29	-22.12	-9.83	(K0.77Na0.03H0.2)Fe3(SO4)2(OH)6
Jarosite-K	-13.56	-21.49	-7.93	KFe3(SO4)2(OH)6
Jarosite-Na	-17.39	-21.19	-3.80	NaFe3(SO4)2(OH)6
JarositeH	-21.57	-24.69	-3.13	(H3O)Fe3(SO4)2(OH)6
Langite	-6.44	11.98	18.41	Cu4(OH)6SO4:H2O
Larnakite	-10.69	-10.71	-0.02	PbO:PbSO4
Laurionite	-7.80	-7.18	0.62	PbOHCl
Litharge	-10.97	2.43	13.39	PbO
Maghemite	-2.10	4.28	6.39	Fe2O3
Magnesite	-0.93	-8.71	-7.78	MgCO3
Magnetite	5.13	10.94	5.81	Fe3O4
Malachite	-0.90	5.06	5.96	Cu2(OH)2CO3
Manganite	-7.44	17.90	25.34	MnOOH
Massicot	-11.17	2.43	13.60	PbO
Melanothallite	-16.56	-12.32	4.24	CuCl2
Melanterite	-6.49	-8.91	-2.42	FeSO4:7H2O
Minium	-52.82	25.09	77.90	Pb3O4
Mirabilite	-6.66	-8.55	-1.89	Na2SO4:10H2O
Mn2(SO4)3	-59.91	-64.02	-4.11	Mn2(SO4)3
Mn3(AsO4)2:8H2O	-11.88	-40.59	-28.71	Mn3(AsO4)2:8H2O
MnCl2:4H2O	-12.21	-10.22	2.00	MnCl2:4H2O
MnSO4	-9.87	-6.57	3.30	MnSO4
Monteponite	-9.86	4.93	14.79	CdO
Nahcolite	-4.51	-5.21	-0.70	NaHCO3
Nantokite	-1.80	-8.97	-7.17	CuCl
Natron	-10.25	-12.20	-1.96	Na2CO3:10H2O
Nesquehonite	-3.33	-8.71	-5.38	MgCO3:3H2O
Nsutite	-15.76	26.80	42.56	MnO2
O2(g)	-53.23	-55.98	-2.76	O2
Otavite	-2.28	-14.28	-12.00	CdCO3
Pb(OH)2	-6.30	2.42	8.72	Pb(OH)2
Pb2(OH)3Cl	-13.55	-4.75	8.79	Pb2(OH)3Cl
Pb2O(OH)2	-21.35	4.85	26.20	PbO:Pb(OH)2
Pb2O3	-38.38	22.66	61.04	Pb2O3
Pb2OCO3	-14.33	-14.36	-0.03	PbO:PbCO3
Pb3(AsO4)2	-24.87	-60.28	-35.40	Pb3(AsO4)2
Pb3O2CO3	-24.04	-11.93	12.10	PbCO3:2PbO
Pb3O2SO4	-19.53	-8.28	11.25	PbSO4:2PbO
Pb4(OH)6SO4	-26.96	-5.86	21.10	Pb4(OH)6SO4
Pb4O3SO4	-29.40	-5.86	23.54	PbSO4:3PbO
PbMetal	-19.64	-15.39	4.25	Pb
PbO:0.3H2O	-10.55	2.43	12.98	PbO:0.33H2O
Phosgenite	-13.75	-33.56	-19.81	PbCl2:PbCO3
Plattnerite	-31.96	20.24	52.20	PbO2
Portlandite	-13.17	10.90	24.07	Ca(OH)2
Pyrochroite	-6.21	8.99	15.20	Mn(OH)2
Pyrolusite	-17.25	26.80	44.05	MnO2
Rhodochrosite	0.85	-10.22	-11.07	MnCO3
Rhodochrosite(d)	0.17	-10.22	-10.39	MnCO3
Scorodite	-11.39	-31.64	-20.25	FeAsO4:2H2O
Se(s)	1.38	-15.94	-17.32	Se
SeO2	-14.45	-22.83	-8.38	SeO2
Siderite	-1.77	-12.56	-10.79	FeCO3
Siderite(d)(3)	-2.11	-12.56	-10.45	FeCO3
Smithsonite	-1.57	-11.39	-9.82	ZnCO3
Smithsonite_PG	-0.60	-11.39	-10.80	ZnCO3
Tenorite	-1.36	6.88	8.25	CuO
Thenardite	-8.40	-8.55	-0.16	Na2SO4

Thermonatrite	-12.44	-12.20	0.24	Na2CO3:H2O
Trona	-17.35	-17.41	-0.06	NaHCO3:Na2CO3:2H2O
Witherite	-4.78	-13.42	-8.64	BaCO3
Zincite(c)	-4.22	7.82	12.04	ZnO
Zincosite	-11.54	-7.74	3.80	ZnSO4
Zn(OH)2-a	-4.63	7.82	12.45	Zn(OH)2
Zn(OH)2-b	-3.93	7.82	11.75	Zn(OH)2
Zn(OH)2-c	-4.38	7.82	12.20	Zn(OH)2
Zn(OH)2-e	-3.68	7.82	11.50	Zn(OH)2
Zn(OH)2-g	-3.89	7.82	11.71	Zn(OH)2
Zn2(OH)2SO4	-7.43	0.07	7.50	Zn2(OH)2SO4
Zn2(OH)3Cl	-9.17	6.03	15.20	Zn2(OH)3Cl
Zn3(AsO4)2:2.5w	-16.56	-44.11	-27.55	Zn3(AsO4)2:2.5H2O
Zn3O(SO4)2	-29.23	-7.67	21.56	ZnO:2ZnSO4
Zn4(OH)6SO4	-12.69	15.71	28.40	Zn4(OH)6SO4
Zn5(OH)8Cl2	-18.62	19.88	38.50	Zn5(OH)8Cl2
ZnCl2	-19.14	-11.39	7.75	ZnCl2
ZnCO3:1H2O	-1.13	-11.39	-10.26	ZnCO3:1H2O
ZnCO3:H2O	-1.13	-11.39	-10.26	ZnCO3:H2O
ZnMetal	-37.26	-10.00	27.27	Zn
ZnO(a)	-3.49	7.82	11.31	ZnO
ZnSO4:H2O	-7.61	-7.74	-0.13	ZnSO4:H2O

**For a gas, SI = log10(fugacity). Fugacity = pressure * phi / 1 atm.
For ideal gases, phi = 1.

Initial solution 9. MW-1014C

-----Solution composition-----

Elements	Molality	Moles
Ag	4.639e-10	4.639e-10
Alkalinity	5.579e-03	5.579e-03
As	3.366e-07	3.366e-07
Ba	2.485e-07	2.485e-07
Ca	4.020e-03	4.020e-03
Cd	3.561e-10	3.561e-10
Cl	1.465e-03	1.465e-03
Cu	8.662e-09	8.662e-09
Fe	8.494e-05	8.494e-05
K	1.252e-04	1.252e-04
Mg	1.548e-03	1.548e-03
Mn	3.170e-05	3.170e-05
Na	4.658e-04	4.658e-04
Pb	4.830e-10	4.830e-10
S(6)	2.240e-03	2.240e-03
Se	2.535e-09	2.535e-09
Zn	4.440e-06	4.440e-06

-----Description of solution-----

pH	=	7.280
pe	=	0.748
Activity of water	=	1.000
Ionic strength (mol/kgw)	=	1.716e-02
Mass of water (kg)	=	1.000e+00
Total carbon (mol/kg)	=	6.288e-03
Total CO2 (mol/kg)	=	6.288e-03
Temperature (°C)	=	9.33
Electrical balance (eq)	=	4.454e-04
Percent error, 100*(Cat- An)/(Cat+ An)	=	2.13
Iterations	=	10
Total H	=	1.110180e+02
Total O	=	5.553331e+01

-----Distribution of species-----

Species	Molality	Activity	Log Molality	Log Activity	Log Gamma	mole V cm ³ /mol
OH-	5.959e-08	5.249e-08	-7.225	-7.280	-0.055	(0)
H+	5.849e-08	5.248e-08	-7.233	-7.280	-0.047	0.00
H2O	5.551e+01	9.997e-01	1.744	-0.000	0.000	18.02
Ag	4.639e-10					
AgCl	3.009e-10	3.021e-10	-9.522	-9.520	0.002	(0)
Ag+	1.114e-10	9.812e-11	-9.953	-10.008	-0.055	(0)
AgCl2-	4.959e-11	4.368e-11	-10.305	-10.360	-0.055	(0)
AgSO4-	1.969e-12	1.735e-12	-11.706	-11.761	-0.055	(0)
AgCl3-2	6.762e-14	4.073e-14	-13.170	-13.390	-0.220	(0)
AgOH	1.862e-15	1.869e-15	-14.730	-14.728	0.002	(0)
AgCl4-3	2.721e-16	8.695e-17	-15.565	-16.061	-0.495	(0)
Ag (OH) 2-	4.042e-20	3.561e-20	-19.393	-19.448	-0.055	(0)
As (3)	2.815e-08					
H3AsO3	2.792e-08	2.803e-08	-7.554	-7.552	0.002	(0)
H2AsO3-	2.317e-10	2.041e-10	-9.635	-9.690	-0.055	(0)
H4AsO3+	8.272e-16	7.287e-16	-15.082	-15.137	-0.055	(0)
HAsO3-2	6.315e-18	3.804e-18	-17.200	-17.420	-0.220	(0)
AsO3-3	2.568e-26	8.206e-27	-25.590	-26.086	-0.495	(0)
As (5)	3.085e-07					
HAsO4-2	1.981e-07	1.193e-07	-6.703	-6.923	-0.220	(0)
H2AsO4-	1.104e-07	9.725e-08	-6.957	-7.012	-0.055	(0)
AsO4-3	1.060e-11	3.386e-12	-10.975	-11.470	-0.495	(0)
H3AsO4	8.660e-13	8.694e-13	-12.062	-12.061	0.002	(0)
Ba	2.485e-07					
Ba+2	1.864e-07	1.123e-07	-6.730	-6.950	-0.220	(0)
BaSO4	5.843e-08	5.866e-08	-7.233	-7.232	0.002	(0)
BaHCO3+	3.534e-09	3.114e-09	-8.452	-8.507	-0.055	(0)
BaCO3	1.214e-10	1.219e-10	-9.916	-9.914	0.002	(0)
BaOH+	8.226e-14	7.247e-14	-13.085	-13.140	-0.055	(0)
C (4)	6.288e-03					
HCO3-	5.352e-03	4.738e-03	-2.271	-2.324	-0.053	(0)
CO2	7.310e-04	7.339e-04	-3.136	-3.134	0.002	(0)
CaHCO3+	1.060e-04	9.335e-05	-3.975	-4.030	-0.055	(0)
MgHCO3+	5.089e-05	4.483e-05	-4.293	-4.348	-0.055	(0)
FeHCO3+	1.898e-05	1.672e-05	-4.722	-4.777	-0.055	(0)
CaCO3	8.416e-06	8.449e-06	-5.075	-5.073	0.002	(0)
MnHCO3+	6.057e-06	5.336e-06	-5.218	-5.273	-0.055	(0)
CO3-2	4.688e-06	2.879e-06	-5.329	-5.541	-0.212	(0)
MnCO3	2.878e-06	2.890e-06	-5.541	-5.539	0.002	(0)
FeCO3	2.427e-06	2.437e-06	-5.615	-5.613	0.002	(0)
MgCO3	1.815e-06	1.822e-06	-5.741	-5.739	0.002	(0)
NaHCO3	1.083e-06	1.087e-06	-5.965	-5.964	0.002	(0)
ZnHCO3+	9.394e-07	8.275e-07	-6.027	-6.082	-0.055	(0)
ZnCO3	7.938e-07	7.969e-07	-6.100	-6.099	0.002	(0)
Zn (CO3) 2-2	8.144e-08	4.905e-08	-7.089	-7.309	-0.220	(0)
NaCO3-	1.078e-08	9.499e-09	-7.967	-8.022	-0.055	(0)
BaHCO3+	3.534e-09	3.114e-09	-8.452	-8.507	-0.055	(0)
CuCO3	7.896e-10	7.927e-10	-9.103	-9.101	0.002	(0)
PbCO3	4.192e-10	4.209e-10	-9.378	-9.376	0.002	(0)
CuHCO3+	1.382e-10	1.218e-10	-9.859	-9.915	-0.055	(0)
BaCO3	1.214e-10	1.219e-10	-9.916	-9.914	0.002	(0)
PbHCO3+	3.594e-11	3.166e-11	-10.444	-10.499	-0.055	(0)
CdHCO3+	2.701e-11	2.379e-11	-10.569	-10.624	-0.055	(0)
Pb (CO3) 2-2	5.053e-12	3.043e-12	-11.296	-11.517	-0.220	(0)
Cu (CO3) 2-2	4.770e-12	2.873e-12	-11.322	-11.542	-0.220	(0)
CdCO3	3.617e-13	3.631e-13	-12.442	-12.440	0.002	(0)
Cd (CO3) 2-2	5.488e-15	3.306e-15	-14.261	-14.481	-0.220	(0)
Ca	4.020e-03					
Ca+2	3.522e-03	2.162e-03	-2.453	-2.665	-0.212	(0)
CaSO4	3.838e-04	3.854e-04	-3.416	-3.414	0.002	(0)
CaHCO3+	1.060e-04	9.335e-05	-3.975	-4.030	-0.055	(0)
CaCO3	8.416e-06	8.449e-06	-5.075	-5.073	0.002	(0)
CaOH+	7.759e-09	6.835e-09	-8.110	-8.165	-0.055	(0)

	CaHSO4+	1.142e-10	1.006e-10	-9.943	-9.998	-0.055	(0)
Cd		3.561e-10					
	Cd+2	2.636e-10	1.588e-10	-9.579	-9.799	-0.220	(0)
	CdSO4	4.299e-11	4.316e-11	-10.367	-10.365	0.002	(0)
	CdHCO3+	2.701e-11	2.379e-11	-10.569	-10.624	-0.055	(0)
	CdCl+	2.095e-11	1.846e-11	-10.679	-10.734	-0.055	(0)
	Cd(SO4) 2-2	9.062e-13	5.458e-13	-12.043	-12.263	-0.220	(0)
	CdCO3	3.617e-13	3.631e-13	-12.442	-12.440	0.002	(0)
	CdOHC1	1.017e-13	1.021e-13	-12.993	-12.991	0.002	(0)
	CdCl2	9.278e-14	9.315e-14	-13.033	-13.031	0.002	(0)
	CdOH+	8.378e-14	7.380e-14	-13.077	-13.132	-0.055	(0)
	Cd(CO3) 2-2	5.488e-15	3.306e-15	-14.261	-14.481	-0.220	(0)
	Cd(OH) 2	2.564e-16	2.574e-16	-15.591	-15.589	0.002	(0)
	CdCl3-	6.690e-17	5.894e-17	-16.175	-16.230	-0.055	(0)
	Cd(OH) 3-	6.245e-22	5.502e-22	-21.204	-21.260	-0.055	(0)
	Cd2OH+3	2.207e-22	7.053e-23	-21.656	-22.152	-0.495	(0)
	Cd(OH) 4-2	1.551e-28	9.341e-29	-27.809	-28.030	-0.220	(0)
Cl		1.465e-03					
	Cl-	1.465e-03	1.286e-03	-2.834	-2.891	-0.056	(0)
	MnCl+	7.518e-08	6.623e-08	-7.124	-7.179	-0.055	(0)
	FeCl+	7.112e-08	6.265e-08	-7.148	-7.203	-0.055	(0)
	ZnCl+	2.630e-09	2.317e-09	-8.580	-8.635	-0.055	(0)
	CuCl2-	2.548e-09	2.245e-09	-8.594	-8.649	-0.055	(0)
	ZnOHC1	1.121e-09	1.126e-09	-8.950	-8.949	0.002	(0)
	AgCl	3.009e-10	3.021e-10	-9.522	-9.520	0.002	(0)
	AgCl2-	4.959e-11	4.368e-11	-10.305	-10.360	-0.055	(0)
	MnCl2	3.704e-11	3.719e-11	-10.431	-10.430	0.002	(0)
	CdCl+	2.095e-11	1.846e-11	-10.679	-10.734	-0.055	(0)
	CuCl3-2	7.129e-12	4.294e-12	-11.147	-11.367	-0.220	(0)
	ZnCl2	2.908e-12	2.920e-12	-11.536	-11.535	0.002	(0)
	PbCl+	3.245e-13	2.859e-13	-12.489	-12.544	-0.055	(0)
	CdOHC1	1.017e-13	1.021e-13	-12.993	-12.991	0.002	(0)
	CdCl2	9.278e-14	9.315e-14	-13.033	-13.031	0.002	(0)
	CuCl+	8.966e-14	7.899e-14	-13.047	-13.102	-0.055	(0)
	AgCl3-2	6.762e-14	4.073e-14	-13.170	-13.390	-0.220	(0)
	MnCl3-	1.496e-14	1.318e-14	-13.825	-13.880	-0.055	(0)
	ZnCl3-	4.332e-15	3.816e-15	-14.363	-14.418	-0.055	(0)
	PbCl2	7.908e-16	7.939e-16	-15.102	-15.100	0.002	(0)
	AgCl4-3	2.721e-16	8.695e-17	-15.565	-16.061	-0.495	(0)
	CdCl3-	6.690e-17	5.894e-17	-16.175	-16.230	-0.055	(0)
	CuCl2	4.545e-17	4.563e-17	-16.342	-16.341	0.002	(0)
	ZnCl4-2	3.583e-18	2.158e-18	-17.446	-17.666	-0.220	(0)
	PbCl3-	8.315e-19	7.326e-19	-18.080	-18.135	-0.055	(0)
	FeCl+2	2.906e-19	1.750e-19	-18.537	-18.757	-0.220	(0)
	FeCl2+	1.929e-21	1.699e-21	-20.715	-20.770	-0.055	(0)
	PbCl4-2	6.593e-22	3.971e-22	-21.181	-21.401	-0.220	(0)
	CuCl3-	1.764e-22	1.554e-22	-21.754	-21.809	-0.055	(0)
	FeCl3	2.177e-25	2.186e-25	-24.662	-24.660	0.002	(0)
	CuCl4-2	1.134e-27	6.831e-28	-26.945	-27.166	-0.220	(0)
Cu (1)		7.236e-09					
	Cu+	4.681e-09	4.124e-09	-8.330	-8.385	-0.055	(0)
	CuCl2-	2.548e-09	2.245e-09	-8.594	-8.649	-0.055	(0)
	CuCl3-2	7.129e-12	4.294e-12	-11.147	-11.367	-0.220	(0)
Cu (2)		1.426e-09					
	CuCO3	7.896e-10	7.927e-10	-9.103	-9.101	0.002	(0)
	Cu(OH) 2	3.872e-10	3.887e-10	-9.412	-9.410	0.002	(0)
	CuHCO3+	1.382e-10	1.218e-10	-9.859	-9.915	-0.055	(0)
	Cu+2	8.513e-11	5.127e-11	-10.070	-10.290	-0.220	(0)
	CuOH+	1.109e-11	9.767e-12	-10.955	-11.010	-0.055	(0)
	CuSO4	9.698e-12	9.736e-12	-11.013	-11.012	0.002	(0)
	Cu(CO3) 2-2	4.770e-12	2.873e-12	-11.322	-11.542	-0.220	(0)
	CuCl+	8.966e-14	7.899e-14	-13.047	-13.102	-0.055	(0)
	Cu(OH) 3-	5.065e-16	4.462e-16	-15.295	-15.350	-0.055	(0)
	CuCl2	4.545e-17	4.563e-17	-16.342	-16.341	0.002	(0)
	Cu2(OH) 2+2	1.342e-17	8.081e-18	-16.872	-17.093	-0.220	(0)
	Cu(OH) 4-2	2.816e-21	1.696e-21	-20.550	-20.771	-0.220	(0)
	CuCl3-	1.764e-22	1.554e-22	-21.754	-21.809	-0.055	(0)

CuCl4-2	1.134e-27	6.831e-28	-26.945	-27.166	-0.220	(0)
Fe (2)	8.494e-05					
Fe+2	5.858e-05	3.528e-05	-4.232	-4.452	-0.220	(0)
FeHCO3+	1.898e-05	1.672e-05	-4.722	-4.777	-0.055	(0)
FeSO4	4.815e-06	4.834e-06	-5.317	-5.316	0.002	(0)
FeCO3	2.427e-06	2.437e-06	-5.615	-5.613	0.002	(0)
FeCl+	7.112e-08	6.265e-08	-7.148	-7.203	-0.055	(0)
FeOH+	7.011e-08	6.176e-08	-7.154	-7.209	-0.055	(0)
Fe (OH) 2	2.367e-12	2.376e-12	-11.626	-11.624	0.002	(0)
FeHSO4+	1.863e-12	1.641e-12	-11.730	-11.785	-0.055	(0)
Fe (OH) 3-	1.623e-15	1.430e-15	-14.790	-14.845	-0.055	(0)
Fe (3)	2.783e-09					
Fe (OH) 3	1.416e-09	1.421e-09	-8.849	-8.847	0.002	(0)
Fe (OH) 2+	1.352e-09	1.191e-09	-8.869	-8.924	-0.055	(0)
Fe (OH) 4-	1.442e-11	1.270e-11	-10.841	-10.896	-0.055	(0)
FeOH+2	5.870e-13	3.536e-13	-12.231	-12.452	-0.220	(0)
FeSO4+	6.849e-17	6.034e-17	-16.164	-16.219	-0.055	(0)
Fe+3	2.382e-17	7.611e-18	-16.623	-17.119	-0.495	(0)
Fe (SO4) 2-	1.464e-18	1.290e-18	-17.834	-17.889	-0.055	(0)
FeCl+2	2.906e-19	1.750e-19	-18.537	-18.757	-0.220	(0)
FeCl2+	1.929e-21	1.699e-21	-20.715	-20.770	-0.055	(0)
Fe2 (OH) 2+4	5.064e-23	6.665e-24	-22.296	-23.176	-0.881	(0)
FeHSO4+2	1.476e-23	8.893e-24	-22.831	-23.051	-0.220	(0)
FeCl3	2.177e-25	2.186e-25	-24.662	-24.660	0.002	(0)
Fe3 (OH) 4+5	1.814e-28	7.629e-30	-27.741	-29.118	-1.376	(0)
H (0)	1.465e-19					
H2	7.325e-20	7.354e-20	-19.135	-19.133	0.002	(0)
K	1.252e-04					
K+	1.245e-04	1.093e-04	-3.905	-3.961	-0.056	(0)
KSO4-	6.811e-07	6.000e-07	-6.167	-6.222	-0.055	(0)
Mg	1.548e-03					
Mg+2	1.361e-03	8.438e-04	-2.866	-3.074	-0.208	(0)
MgSO4	1.342e-04	1.347e-04	-3.872	-3.871	0.002	(0)
MgHCO3+	5.089e-05	4.483e-05	-4.293	-4.348	-0.055	(0)
MgCO3	1.815e-06	1.822e-06	-5.741	-5.739	0.002	(0)
MgOH+	1.488e-08	1.311e-08	-7.827	-7.883	-0.055	(0)
Mn (2)	3.170e-05					
Mn+2	2.098e-05	1.264e-05	-4.678	-4.898	-0.220	(0)
MnHCO3+	6.057e-06	5.336e-06	-5.218	-5.273	-0.055	(0)
MnCO3	2.878e-06	2.890e-06	-5.541	-5.539	0.002	(0)
MnSO4	1.702e-06	1.709e-06	-5.769	-5.767	0.002	(0)
MnCl+	7.518e-08	6.623e-08	-7.124	-7.179	-0.055	(0)
MnOH+	1.824e-09	1.607e-09	-8.739	-8.794	-0.055	(0)
MnCl2	3.704e-11	3.719e-11	-10.431	-10.430	0.002	(0)
MnCl3-	1.496e-14	1.318e-14	-13.825	-13.880	-0.055	(0)
Mn (OH) 3-	1.572e-18	1.385e-18	-17.804	-17.859	-0.055	(0)
Mn (3)	6.103e-31					
Mn+3	6.103e-31	1.950e-31	-30.214	-30.710	-0.495	(0)
Mn (6)	0.000e+00					
MnO4-2	0.000e+00	0.000e+00	-67.989	-68.209	-0.220	(0)
Mn (7)	0.000e+00					
MnO4-	0.000e+00	0.000e+00	-77.872	-77.927	-0.055	(0)
Na	4.658e-04					
Na+	4.625e-04	4.081e-04	-3.335	-3.389	-0.054	(0)
NaSO4-	2.180e-06	1.920e-06	-5.662	-5.717	-0.055	(0)
NaHCO3	1.083e-06	1.087e-06	-5.965	-5.964	0.002	(0)
NaCO3-	1.078e-08	9.499e-09	-7.967	-8.022	-0.055	(0)
O (0)	0.000e+00					
O2	0.000e+00	0.000e+00	-59.453	-59.451	0.002	(0)
Pb	4.830e-10					
PbCO3	4.192e-10	4.209e-10	-9.378	-9.376	0.002	(0)
PbHCO3+	3.594e-11	3.166e-11	-10.444	-10.499	-0.055	(0)
Pb+2	1.397e-11	8.413e-12	-10.855	-11.075	-0.220	(0)
Pb (CO3) 2-2	5.053e-12	3.043e-12	-11.296	-11.517	-0.220	(0)
PbSO4	4.913e-12	4.932e-12	-11.309	-11.307	0.002	(0)
PbOH+	3.547e-12	3.125e-12	-11.450	-11.505	-0.055	(0)
PbCl+	3.245e-13	2.859e-13	-12.489	-12.544	-0.055	(0)

Pb(SO4) 2-2	4.480e-14	2.699e-14	-13.349	-13.569	-0.220	(0)
Pb(OH) 2	2.307e-14	2.316e-14	-13.637	-13.635	0.002	(0)
PbCl2	7.908e-16	7.939e-16	-15.102	-15.100	0.002	(0)
Pb(OH) 3-	5.750e-18	5.065e-18	-17.240	-17.295	-0.055	(0)
PbCl3-	8.315e-19	7.326e-19	-18.080	-18.135	-0.055	(0)
Pb2OH+3	1.841e-21	5.885e-22	-20.735	-21.230	-0.495	(0)
PbCl4-2	6.593e-22	3.971e-22	-21.181	-21.401	-0.220	(0)
Pb(OH) 4-2	3.670e-22	2.210e-22	-21.435	-21.656	-0.220	(0)
Pb3(OH) 4+2	1.436e-29	8.646e-30	-28.843	-29.063	-0.220	(0)
S(6)	2.240e-03					
SO4-2	1.712e-03	1.043e-03	-2.766	-2.982	-0.215	(0)
CaSO4	3.838e-04	3.854e-04	-3.416	-3.414	0.002	(0)
MgSO4	1.342e-04	1.347e-04	-3.872	-3.871	0.002	(0)
FeSO4	4.815e-06	4.834e-06	-5.317	-5.316	0.002	(0)
NaSO4-	2.180e-06	1.920e-06	-5.662	-5.717	-0.055	(0)
MnSO4	1.702e-06	1.709e-06	-5.769	-5.767	0.002	(0)
KSO4-	6.811e-07	6.000e-07	-6.167	-6.222	-0.055	(0)
ZnSO4	2.974e-07	2.985e-07	-6.527	-6.525	0.002	(0)
BaSO4	5.843e-08	5.866e-08	-7.233	-7.232	0.002	(0)
Zn(SO4) 2-2	4.771e-09	2.874e-09	-8.321	-8.542	-0.220	(0)
HSO4-	4.392e-09	3.869e-09	-8.357	-8.412	-0.055	(0)
CaHSO4+	1.142e-10	1.006e-10	-9.943	-9.998	-0.055	(0)
CdSO4	4.299e-11	4.316e-11	-10.367	-10.365	0.002	(0)
CuSO4	9.698e-12	9.736e-12	-11.013	-11.012	0.002	(0)
PbSO4	4.913e-12	4.932e-12	-11.309	-11.307	0.002	(0)
AgSO4-	1.969e-12	1.735e-12	-11.706	-11.761	-0.055	(0)
FeHSO4+	1.863e-12	1.641e-12	-11.730	-11.785	-0.055	(0)
Cd(SO4) 2-2	9.062e-13	5.458e-13	-12.043	-12.263	-0.220	(0)
Pb(SO4) 2-2	4.480e-14	2.699e-14	-13.349	-13.569	-0.220	(0)
FeSO4+	6.849e-17	6.034e-17	-16.164	-16.219	-0.055	(0)
Fe(SO4) 2-	1.464e-18	1.290e-18	-17.834	-17.889	-0.055	(0)
FeHSO4+2	1.476e-23	8.893e-24	-22.831	-23.051	-0.220	(0)
Se(-2)	1.647e-23					
HSe-	1.647e-23	1.451e-23	-22.783	-22.838	-0.055	(0)
H2Se	7.858e-27	7.890e-27	-26.105	-26.103	0.002	(0)
Se(4)	2.535e-09					
HSeO3-	2.330e-09	2.052e-09	-8.633	-8.688	-0.055	(0)
SeO3-2	2.053e-10	1.237e-10	-9.688	-9.908	-0.220	(0)
H2SeO3	6.033e-14	6.056e-14	-13.219	-13.218	0.002	(0)
Se(6)	1.292e-24					
SeO4-2	1.292e-24	7.782e-25	-23.889	-24.109	-0.220	(0)
HSeO4-	1.338e-30	1.179e-30	-29.873	-29.929	-0.055	(0)
Zn	4.440e-06					
Zn+2	2.304e-06	1.387e-06	-5.638	-5.858	-0.220	(0)
ZnHCO3+	9.394e-07	8.275e-07	-6.027	-6.082	-0.055	(0)
ZnCO3	7.938e-07	7.969e-07	-6.100	-6.099	0.002	(0)
ZnSO4	2.974e-07	2.985e-07	-6.527	-6.525	0.002	(0)
Zn(CO3) 2-2	8.144e-08	4.905e-08	-7.089	-7.309	-0.220	(0)
ZnOH+	9.382e-09	8.265e-09	-8.028	-8.083	-0.055	(0)
Zn(OH) 2	6.313e-09	6.338e-09	-8.200	-8.198	0.002	(0)
Zn(SO4) 2-2	4.771e-09	2.874e-09	-8.321	-8.542	-0.220	(0)
ZnCl+	2.630e-09	2.317e-09	-8.580	-8.635	-0.055	(0)
ZnOHC1	1.121e-09	1.126e-09	-8.950	-8.949	0.002	(0)
ZnCl2	2.908e-12	2.920e-12	-11.536	-11.535	0.002	(0)
Zn(OH) 3-	4.334e-13	3.818e-13	-12.363	-12.418	-0.055	(0)
ZnCl3-	4.332e-15	3.816e-15	-14.363	-14.418	-0.055	(0)
ZnCl4-2	3.583e-18	2.158e-18	-17.446	-17.666	-0.220	(0)
Zn(OH) 4-2	1.914e-18	1.153e-18	-17.718	-17.938	-0.220	(0)

-----Saturation indices-----

Phase	SI**	log IAP	log K(282 K,	1 atm)
Ag2CO3	-14.10	-25.56	-11.46	Ag2CO3
Ag2O	-18.46	-5.46	13.00	Ag2O
Ag2SO4	-17.91	-23.00	-5.09	Ag2SO4
AgMetal	3.78	-10.76	-14.54	Ag

Anglesite	-6.18	-14.06	-7.88	PbSO4
Anhydrite	-1.31	-5.65	-4.34	CaSO4
Antlerite	-13.02	-4.73	8.29	Cu3(OH)4SO4
Aragonite	0.05	-8.21	-8.25	CaCO3
Arsenolite	-13.43	-15.10	-1.67	As2O3
Artinite	-7.90	2.87	10.77	MgCO3:Mg(OH)2:3H2O
As2O5(cr)	-32.66	-24.12	8.54	As2O5
As_native	-17.98	-31.63	-13.65	As
Atacamite	-9.73	-1.63	8.10	Cu2(OH)3Cl
Azurite	-11.40	-6.40	5.01	Cu3(OH)2(CO3)2
Ba3(AsO4)2	6.71	-43.79	-50.50	Ba3(AsO4)2
Barite	0.33	-9.93	-10.26	BaSO4
BaSeO3	-10.47	-16.86	-6.39	BaSeO3
Bianchite	-7.08	-8.84	-1.76	ZnSO4:6H2O
Birnessite	-17.88	25.72	43.60	MnO2
Bixbyite	-17.75	-17.74	0.01	Mn2O3
Brochantite	-15.80	-0.46	15.34	Cu4(OH)6SO4
Brucite	-6.46	11.49	17.94	Mg(OH)2
Ca3(AsO4)2:4w	-12.03	-30.94	-18.91	Ca3(AsO4)2:4H2O
Calcite	0.20	-8.21	-8.41	CaCO3
CaSeO3	-6.97	-12.57	-5.60	CaSeO3
Cd(gamma)	-25.62	-11.29	14.33	Cd
Cd(OH)2	-8.89	4.76	13.65	Cd(OH)2
Cd(OH)2(a)	-9.81	4.76	14.57	Cd(OH)2
Cd3(OH)2(SO4)2	-27.51	-20.80	6.71	Cd3(OH)2(SO4)2
Cd3(OH)4SO4	-25.82	-3.26	22.56	Cd3(OH)4SO4
Cd4(OH)6SO4	-26.90	1.50	28.40	Cd4(OH)6SO4
CdCl2	-15.08	-15.58	-0.50	CdCl2
CdCl2:2.5H2O	-13.57	-15.58	-2.01	CdCl2:2.5H2O
CdCl2:H2O	-13.94	-15.58	-1.64	CdCl2:H2O
CdMetal	-25.52	-11.29	14.22	Cd
CdOHCl	-9.23	-5.41	3.82	CdOHCl
CdSO4	-13.28	-12.78	0.50	CdSO4
CdSO4:2.7H2O	-11.08	-12.78	-1.70	CdSO4:2.67H2O
CdSO4:H2O	-11.43	-12.78	-1.35	CdSO4:H2O
Cerargyrite	-2.51	-12.90	-10.39	AgCl
Cerrusite	-3.29	-16.62	-13.33	PbCO3
Chalcanthite	-10.57	-13.27	-2.70	CuSO4:5H2O
Claudetite	-13.49	-15.10	-1.62	As2O3
CO2(g)	-1.88	-3.13	-1.26	CO2
Cotunnite	-11.86	-16.86	-5.00	PbCl2
Cu(OH)2	-4.99	4.27	9.26	Cu(OH)2
Cu2SO4	-17.99	-19.75	-1.76	Cu2SO4
Cu3(AsO4)2:6w	-18.69	-53.81	-35.12	Cu3(AsO4)2:6H2O
CuCO3	-6.20	-15.83	-9.63	CuCO3
CuMetal	0.32	-9.13	-9.46	Cu
CuOCuSO4	-21.98	-9.00	12.98	CuO:CuSO4
CupricFerrite	6.26	13.71	7.45	CuFe2O4
Cuprite	-0.41	-2.21	-1.80	Cu2O
CuprousFerrite	12.38	3.62	-8.77	CuFeO2
CuSO4	-17.02	-13.27	3.75	CuSO4
Dolomite	-0.11	-16.82	-16.71	CaMg(CO3)2
Dolomite(d)	-0.73	-16.82	-16.09	CaMg(CO3)2
Epsomite	-3.80	-6.06	-2.25	MgSO4:7H2O
Fe(OH)2.7Cl.3	4.71	1.67	-3.04	Fe(OH)2.7Cl0.3
Fe(OH)3(a)	-0.17	4.72	4.89	Fe(OH)3
Fe2(SeO3)3	-28.53	-63.96	-35.43	Fe2(SeO3)3
Fe3(OH)8	-0.67	19.55	20.22	Fe3(OH)8
FeSe2	-15.49	-34.07	-18.58	FeSe2
Goethite	5.13	4.72	-0.41	FeOOH
Goslarite	-6.75	-8.84	-2.09	ZnSO4:7H2O
Gypsum	-1.05	-5.65	-4.59	CaSO4:2H2O
H2(g)	-16.06	-19.13	-3.08	H2
H2O(g)	-1.94	-0.00	1.94	H2O
Halite	-7.82	-6.28	1.54	NaCl
Hausmannite	-20.08	45.04	65.12	Mn3O4
Hematite	12.20	9.44	-2.75	Fe2O3

Huntite	-5.13	-34.05	-28.92	CaMg ₃ (CO ₃) ₄
Hydrocerrusite	-12.29	-29.75	-17.46	Pb(OH) ₂ :2PbCO ₃
Hydromagnesite	-16.34	-22.97	-6.64	Mg ₅ (CO ₃) ₄ (OH) ₂ :4H ₂ O
Hydrozincite	-6.01	24.30	30.31	Zn ₅ (OH) ₆ (CO ₃) ₂
Hydrozincite_PG	-7.89	24.30	32.19	Zn ₅ (OH) ₆ (CO ₃) ₂
Jarosite(ss)	-8.42	-18.25	-9.83	(K _{0.77} Na _{0.03} H _{0.2})Fe ₃ (SO ₄) ₂ (OH) ₆
Jarosite-K	-9.66	-17.60	-7.94	KFe ₃ (SO ₄) ₂ (OH) ₆
Jarosite-Na	-13.22	-17.03	-3.81	NaFe ₃ (SO ₄) ₂ (OH) ₆
JarositeH	-17.77	-20.92	-3.15	(H ₃ O)Fe ₃ (SO ₄) ₂ (OH) ₆
Langite	-18.86	-0.46	18.40	Cu ₄ (OH) ₆ SO ₄ :H ₂ O
Larnakite	-10.55	-10.57	-0.02	PbO:PbSO ₄
Laurionite	-7.31	-6.69	0.62	PbOHCl
Litharge	-9.90	3.48	13.39	PbO
Maghemite	3.06	9.44	6.39	Fe ₂ O ₃
Magnesite	-0.84	-8.61	-7.78	MgCO ₃
Magnetite	13.76	19.55	5.79	Fe ₃ O ₄
Malachite	-7.02	-1.06	5.95	Cu ₂ (OH) ₂ CO ₃
Manganite	-7.65	17.69	25.34	MnOOH
Massicot	-10.11	3.48	13.59	PbO
Melanothallite	-20.30	-16.07	4.23	CuCl ₂
Melanterite	-5.02	-7.44	-2.42	FeSO ₄ :7H ₂ O
Minium	-51.36	26.51	77.87	Pb ₃ O ₄
Mirabilite	-7.88	-9.76	-1.89	Na ₂ SO ₄ :10H ₂ O
Mn ₂ (SO ₄) ₃	-66.24	-70.37	-4.12	Mn ₂ (SO ₄) ₃
Mn ₃ (AsO ₄) ₂ :8H ₂ O	-8.93	-37.64	-28.71	Mn ₃ (AsO ₄) ₂ :8H ₂ O
MnCl ₂ :4H ₂ O	-12.68	-10.68	2.00	MnCl ₂ :4H ₂ O
MnSO ₄	-11.18	-7.88	3.30	MnSO ₄
Monteponite	-10.02	4.76	14.78	CdO
Nahcolite	-5.01	-5.71	-0.70	NaHCO ₃
Nantokite	-4.11	-11.28	-7.17	CuCl
Natron	-10.37	-12.32	-1.95	Na ₂ CO ₃ :10H ₂ O
Nesquehonite	-3.23	-8.61	-5.39	MgCO ₃ :3H ₂ O
Nsutite	-16.85	25.72	42.56	MnO ₂
O ₂ (g)	-56.69	-59.45	-2.76	O ₂
Otavite	-3.34	-15.34	-12.00	CdCO ₃
Pb(OH) ₂	-5.23	3.48	8.72	Pb(OH) ₂
Pb ₂ (OH) ₃ Cl	-11.99	-3.20	8.79	Pb ₂ (OH) ₃ Cl
Pb ₂ O(OH) ₂	-19.23	6.97	26.20	PbO:Pb(OH) ₂
Pb ₂ O ₃	-38.02	23.02	61.04	Pb ₂ O ₃
Pb ₂ O ₃ CO ₃	-13.10	-13.13	-0.03	PbO:PbCO ₃
Pb ₃ (AsO ₄) ₂	-20.76	-56.17	-35.40	Pb ₃ (AsO ₄) ₂
Pb ₃ O ₂ CO ₃	-21.74	-9.65	12.09	PbCO ₃ :2PbO
Pb ₃ O ₂ SO ₄	-18.33	-7.09	11.24	PbSO ₄ :2PbO
Pb ₄ (OH) ₆ SO ₄	-24.70	-3.60	21.10	Pb ₄ (OH) ₆ SO ₄
Pb ₄ O ₃ SO ₄	-27.13	-3.60	23.53	PbSO ₄ :3PbO
PbMetal	-16.82	-12.57	4.25	Pb
PbO:0.3H ₂ O	-9.50	3.48	12.98	PbO:0.33H ₂ O
Phosgenite	-13.66	-33.47	-19.81	PbCl ₂ :PbCO ₃
Plattnerite	-32.64	19.54	52.18	PbO ₂
Portlandite	-12.17	11.89	24.06	Ca(OH) ₂
Pyrochroite	-5.54	9.66	15.20	Mn(OH) ₂
Pyrolusite	-18.31	25.72	44.03	MnO ₂
Rhodochrosite	0.63	-10.44	-11.07	MnCO ₃
Rhodochrosite(d)	-0.05	-10.44	-10.39	MnCO ₃
Scorodite	-8.34	-28.59	-20.25	FeAsO ₄ :2H ₂ O
Se(s)	3.26	-14.06	-17.32	Se
SeO ₂	-16.09	-24.47	-8.38	SeO ₂
Siderite	0.80	-9.99	-10.79	FeCO ₃
Siderite(d)(3)	0.46	-9.99	-10.45	FeCO ₃
Smithsonite	-1.58	-11.40	-9.82	ZnCO ₃
Smithsonite_PG	-0.60	-11.40	-10.80	ZnCO ₃
Tenorite	-3.97	4.27	8.24	CuO
Thenardite	-9.60	-9.76	-0.16	Na ₂ SO ₄
Thermonatrite	-12.56	-12.32	0.24	Na ₂ CO ₃ :H ₂ O
Trona	-17.97	-18.03	-0.06	NaHCO ₃ :Na ₂ CO ₃ :2H ₂ O
Witherite	-3.85	-12.49	-8.64	BaCO ₃
Zincite(c)	-3.33	8.70	12.03	ZnO

Zincosite	-12.63	-8.84	3.79	ZnSO4
Zn(OH)2-a	-3.75	8.70	12.45	Zn(OH)2
Zn(OH)2-b	-3.05	8.70	11.75	Zn(OH)2
Zn(OH)2-c	-3.50	8.70	12.20	Zn(OH)2
Zn(OH)2-e	-2.80	8.70	11.50	Zn(OH)2
Zn(OH)2-g	-3.01	8.70	11.71	Zn(OH)2
Zn2(OH)2SO4	-7.64	-0.14	7.50	Zn2(OH)2SO4
Zn2(OH)3Cl	-7.97	7.23	15.20	Zn2(OH)3Cl
Zn3(AsO4)2:2.5w	-12.97	-40.51	-27.55	Zn3(AsO4)2:2.5H2O
Zn3O(SO4)2	-30.52	-8.98	21.54	ZnO:2ZnSO4
Zn4(OH)6SO4	-11.13	17.27	28.40	Zn4(OH)6SO4
Zn5(OH)8Cl2	-15.33	23.17	38.50	Zn5(OH)8Cl2
ZnCl2	-19.38	-11.64	7.74	ZnCl2
ZnCO3:1H2O	-1.14	-11.40	-10.26	ZnCO3:1H2O
ZnCO3:H2O	-1.14	-11.40	-10.26	ZnCO3:H2O
ZnMetal	-34.61	-7.35	27.25	Zn
ZnO(a)	-2.61	8.70	11.31	ZnO
ZnSO4:H2O	-8.70	-8.84	-0.14	ZnSO4:H2O

**For a gas, SI = log10(fugacity). Fugacity = pressure * phi / 1 atm.
For ideal gases, phi = 1.

End of simulation.

Reading input data for simulation 2.

End of Run after 0.234 Seconds.

Appendix B

Groundwater Quality & Elevation/Surface Water Quality Trends



Memorandum

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January 31, 2018

TO: Dave Cline, Flambeau Mining Company

CC: Steve Donohue, Foth Infrastructure & Environment, LLC
Sharon Kozicki, P.G., Foth Infrastructure & Environment, LLC

FR: Stephen Lehrke, Ph.D., Foth Infrastructure & Environment, LLC
Allison Haus, Ph.D., Foth Infrastructure & Environment, LLC

RE: 2017 Annual Report Groundwater and Surface Water Trends

1. Background

Groundwater and surface water sample results collected for the 2017 monitoring programs were added to the analytical monitoring historical database. These results were statistically tested and graphically displayed to determine whether any significant increasing or decreasing trends are occurring in the groundwater or surface water chemistry. This is done to satisfy the requirements of Part 4, Condition 9 of the Mine Permit to summarize the monitoring activities and any observed trends. The 2017 surface water samples in the Flambeau River were not required but taken voluntarily by Flambeau Mining Company (Flambeau).

Groundwater quality results, trend graphs, and statistical test results are included as Attachment 1 for the quarterly monitoring parameters and Attachment 2 for the annual monitoring parameters. Surface water quality results, trend graphs, and statistical test results are included as Attachment 3. Hydrographs are included as Attachment 4.

Intervention boundary wells included in the trend analyses are MW-1000PR, MW-1002, MW-1002G, MW-1004P, MW-1004S, MW-1005, MW-1005P, MW-1005S, and MW-1010P. The in-pit wells included in the trend analyses are MW-1013, MW-1013A, MW-1013B, MW-1013C, MW-1014, MW-1014A, MW-1014B, and MW-1014C. Wells MW-1015A and MW-1015B (also included in the analyses) were constructed in January 2001 approximately 1,000 feet northwest of the backfilled pit and adjacent to the compliance boundary.

2. Statistical Methods

Groundwater and surface water trends over time were assessed using the non-parametric Mann-Kendall test. This test indicates whether any general increasing or decreasing trends have occurred over the time periods evaluated. Two data sets (utilizing two distinct start dates) were assessed: "short-term" trends encompassing the results of 2013 through 2017, i.e., the last five

years, and “long-term” trends encompassing the results from October 1997, when the post-mining period began, through the end of 2017.

Note that annual monitoring, and thus long-term trend analyses, did not begin until July 1999 for barium, cadmium, calcium, chloride, chromium, lead, magnesium, mercury, potassium, selenium, silver, sodium, and zinc. Also note that the long-term trend analyses begin with February 1999 for the in-pit wells MW-1013B, MW-1013C, MW-1014A, MW-1014B, and MW-1014C, and with April 2001 for wells MW-1015A and MW-1015B, which is when monitoring was initiated for these wells. Trend analyses are also included for wells MW-1013, MW-1013A, and MW-1014 beginning with October 2005, and for MW-1000R and MW-1004 beginning with October 2010, at which time sufficient groundwater recovery occurred to collect samples.

The statistical results of the non-parametric Mann-Kendall test for trend are used in conjunction with the trend graphs of Attachments 1, 2, and 3 to properly evaluate trend conditions in the context of the broader site hydrology. It should be noted that a statistically increasing or decreasing trend as determined through the Mann-Kendall test does not necessarily indicate a substantial increase or decrease in actual parameter concentrations. There are situations where variation in the data is small, allowing slight consecutive concentration changes to be detected as a statistically significant trend. Although these minor trends may occur, they should not be construed as an indication of a broader impact on water quality.

The procedure for the Mann-Kendall test is given in Gilbert (1987)¹ and USEPA (2009)². The Type I error for each test was set to 0.01 (two-tailed), with the exception of the 5-year trend tests for the annual parameters. To counteract the decrease in power due to small sample sizes in those cases, the type I error (two-tailed) was set to 0.05 to increase the statistical power (power of detecting existing trends). All non-detected values were replaced with a common value below the lowest detected value.

In the trend test results of Attachments 1, 2, and 3, a “+” indicates a statistically increasing trend and a “-” indicates a statistically decreasing trend. If neither a “+” or “-” is given, no statistically significant trend is present.

3. Trend Results

The majority of trends, increasing, and/or decreasing, were exhibited in the groundwater results for the quarterly parameters of alkalinity, copper, hardness, iron, manganese, sulfate, total dissolved solids (TDS), conductivity, and redox. Many are similar to those noted in the previous annual reports.

¹Gilbert, R.O., 1987. *Statistical Methods for Environmental Pollution Monitoring*, Van Nostrand Reinhold, New York.

²USEPA, 2009. *Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities – Unified Guidance*. EPA 530-R-09-007. Office of Resource Conservation and Recovery, Program Implementation and Information Division, Washington, D.C.

Statistical trend results at each well are summarized below. Historical trend graphs from Attachment 1 (quarterly parameters), Attachment 2 (annual parameters), Attachment 3 (surface water) and Attachment 4 (hydrographs) aid in interpretation. The results are organized by well nest or well location groupings.

As previously noted, the Mann-Kendall test may at times indicate that a statistical trend exists due to slight but consecutive concentration changes (either increasing or decreasing). The discussion below is limited to those instances which show at least a modest change in relative concentration level.

3.1. Quarterly Parameters (Attachment 1)

3.1.1. Intervention Boundary Wells

- ♦ **MW-1000R/MW-1000PR/MW-1010P (Figures B-1a to B-1d):** These three wells are located near the immediate southwest boundary and hydraulically downgradient of the reclaimed mine pit.

Changes in Reported Trends from Previous Annual Report:

Arsenic in MW-1000PR, which previously had been increasing since 2013, and copper in MW-1000PR, which had been decreasing since that time, stabilized during 2017.

Continuing Trends from Previous Annual Report:

Alkalinity in MW-1000R significantly decreased in 2014, with concentrations remaining consistent since then. Long-term decreasing trends in MW-1000PR continue to be noted for hardness, manganese, sulfate, TDS, and conductivity. These decreasing trends have been occurring since an initial concentration increase was observed at the onset of the post-mining period.

- ♦ **MW-1002/MW-1002G (Figures B-2a to B-2d):** This well nest is located approximately 1,800 feet to the northwest and hydraulically sidegradient of the former mine pit.

Changes in Reported Trends from Previous Annual Report:

Alkalinity, hardness, TDS, and conductivity in MW-1002G, and TDS in MW-1002, have small increasing trends since 2013. Concentrations remain within variation levels observed during the pre-mining period.

- ♦ **MW-1004/MW-1004S/MW-1004P (Figures B-3a to B-3d):** This well nest is located near the immediate northwest boundary, and is hydraulically downgradient of the former mine pit.

Changes in Reported Trends from Previous Annual Report:

MW-1004S has had small decreasing trends of alkalinity, hardness, sulfate, and conductivity since the beginning of 2015, while TDS had a small increase in MW-1004P at that time. Redox potential decreased during 2014 in both MW-1004 and

MW-1004S, and has remained consistent since then. Note that TDS concentrations in MW-1004P remain within variation levels observed during the pre-mining period.

- ♦ **MW-1005/MW-1005S/MW-1005P (Figures B-4a to B-4d)**: This well nest is located approximately 1,000 feet to the southeast and hydraulically upgradient of the former mine pit.

Continuing Trends from Previous Annual Report:

Hardness, manganese, TDS, and conductivity in MW-1005 have increasing trends since 2013. Historical maximums were observed during the last two years for manganese, TDS, and conductivity within this well. The increase in these parameters may be due to application of road salt on State Highway 27, which is proximal to the well location. Additional contributing factors may include rising water levels and evaporative concentration effects.

- ♦ **MW-1015A/MW-1015B (Figures B-5a to B-5d)**: This well nest is located approximately 1000 feet to the west and hydraulically downgradient of the former mine pit.

Continuing Trends from Previous Annual Report:

Following concentration increases of iron and manganese in the boundary well MW-1015B during 2002 and 2003, subsequently decreasing trends occurred through 2013. Concentrations have remained consistent since then.

3.1.2. In-Pit Wells

- ♦ **MW-1013/MW-1013A/MW-1013B/MW-1013C (Figures B-6a to B-6d)**: This well nest is located within the former mine pit on the southwest side.

Continuing Trends from Previous Annual Report:

Copper concentrations in MW-1013B and iron concentrations in MA-1013C followed increasing trends from 2001 through 2011. At that time, the increasing trends ceased, with concentration levels remaining fairly consistent since. Water levels in all four wells (MW-1013, MW-1013A, MW-1013B, and MW-1013C) have increased since 2010. Redox potential in MW-1013B decreased from 2013 through 2015 and has remained consistent since then.

- ♦ **MW-1014/MW-1014A/MW-1014B/MW-1014C (Figures B-7a to B-7d)**: This well nest is located within the former mine pit on the northeast side.

Continuing Trends from Previous Annual Report:

The in-pit wells MW-1014A, MW-1014B, and MW-1014C have decreasing trends for manganese beginning in 1999 and continuing through 2010. Hardness, sulfate, TDS, and conductivity in MW-1014B and MW-1014C, and iron in MW-1014C, also followed a significantly decreasing trend over this time. Concentrations of these parameters have since remained at consistent levels.

3.2. Annual Parameters (Attachment 2)

Similar to past trend results, the annual groundwater parameters of barium, cadmium, calcium, chloride, chromium, lead, magnesium, mercury, potassium, selenium, silver, sodium, and zinc illustrated few statistically significant trends, and of those that are noted, most generally reflect relatively small consecutive concentration changes. The following summary is limited to those trends which show at least a modest change in recent concentrations:

- ◆ Calcium, magnesium, and zinc in MW-1000PR have followed decreasing trends since 1999.
- ◆ Calcium, chloride, magnesium, and sodium had small increases during 2011 in MW-1002 and MW-1002G, but have generally remained constant since then.
- ◆ Barium, calcium, chloride, magnesium, and sodium also had small increases in concentrations during 2011 in MW-1005 which remained consistent through 2015. Concentrations of these parameters, however, rose again during 2016 and 2017. The increase in these parameters may potentially be due to application of road salt on State Highway 27, which is proximal to the well location. Additional contributing factors may include rising water levels and evaporative concentration effects.
- ◆ Calcium, magnesium, and sodium also had small increases in MW-1015B during 2013, but have generally remained constant since then.

Historical trend charts for the annual parameters are illustrated on Figures B-8a through B-14e of Attachment 2.

3.3. Surface Water (Attachment 3)

Flambeau voluntarily continued surface water sampling of the Flambeau River in 2017. Parameters currently included in the surface water monitoring are copper, hardness, iron, manganese, total suspended solids, pH, conductivity, dissolved oxygen, and redox potential. Concentrations were stable and no statistical trends increasing or decreasing were noted in the surface water results.

3.4. Hydrographs (Attachment 4)

As observed in the hydrographs (Figures B-16a through B-16p), water levels have stabilized in all wells that showed significant drawdown during the production period of 1993 to 1997.

Groundwater elevations increased steadily from 1999 through 2002 for the in-pit wells of MW-1013A, MW-1013B, MW-1013C, MW-1014, MW-1014A, MW-1014B, and MW-1014C, but stabilized after 2003. Elevations for MW-1013 rose through 2004, but appear to have stabilized during 2005.

Generally higher groundwater elevations are noted for all wells during 2010 and 2011, reflecting the increased precipitation observed in those years. Elevations dropped in 2012, but

rebounded again during the summer of 2013. An increase in water levels was observed from 2014 through 2017 for both intervention boundary and in-pit wells.

4. WT-5 Water Levels

Data collected from the Wetland 1 (WT-5) water level staff gauge is tabulated and presented in Attachment 5.

5. Conclusions

A detailed analysis of statistical trends occurring in the groundwater and surface water data was performed. Statistical tests evaluated long-term trends occurring during the post-mining period (October 1997 to the present) and short-term trends for the most recent five years. Historical trend graphs of the data are also presented.

The majority of the trends with notable concentration changes occur in the quarterly groundwater monitoring parameters. A general discussion of the trend results for each well nest is provided in Section 3 above. The changes in the results of the statistical trend tests from the 2016 Annual Report include the following:

- ♦ Alkalinity, hardness, TDS, and conductivity in MW-1002G, and TDS in MW-1002, have small increasing trends since 2013. Concentrations remain within variation levels observed during the pre-mining period.
- ♦ Small decreasing trends of alkalinity, hardness, sulfate, and conductivity have been observed in MW-1004S since the beginning of 2015. Redox potential decreased during 2014 in both MW-1004 and MW-1004S. TDS in MW-1004P had a small increase since 2015, but concentrations remain within variation levels observed during the pre-mining period.
- ♦ Hardness, TDS, and conductivity in MW-1005 were noted in the previous Annual Report as having increasing trends since 2013. These trends continue through 2017, along with an increasing trend of manganese in MW-1005. Also, the annual parameters of barium, calcium, chloride, magnesium, sodium had increased concentration levels during 2016 and 2017 in MW-1005. The increase in these parameters may be due to application of road salt on State Highway 27, which is proximal to the well location. Additional contributing factors may include rising water levels and evaporative concentration effects.

No statistically significant trends were observed in the surface water monitoring results.

Attachment 1

Statistical Results

Trend Graphs

Historical Data

(Groundwater - Quarterly Parameters)

**Trend Analysis Results - Groundwater (Quarterly Parameters)
Year Ending 2017**

	Alkalinity	Arsenic	Copper	Hardness	Iron	Manganese	Sulfate	TDS	Field pH (su)	Cond (umhos /cm)	Redox (mV)	Grd Water El (Feet)
MW-1000PR												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	18	20
Mann-Kendall S	5	72	-57	-82	-11	-8	-116	-67	-2	-98	13	44
p-Level	0.898	0.020	0.069	0.008	0.749	0.822	0.000	0.031	0.974	0.002	0.654	0.164
Trend				-			-			-		
Trend Results for All Data Since Oct. 1997												
Sample Size	81	62	81	81	81	81	81	81	81	81	65	81
Mann-Kendall S	1685	805	-779	-2210	-505	-1880	-2477	-2134	795	-2348	-596	898
p-Level	0.000	0.000	0.001	0.000	0.040	0.000	0.000	0.000	0.001	0.000	0.001	0.000
Trend	+	+	-	-		-	-	-	+	-	-	+
MW-1000R												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	19	1090.84
Mann-Kendall S	-66	32	-24	-78	-17	-8	6	-67	-34	-100	1	58
p-Level	0.034	0.318	0.46	0.012	0.608	0.822	0.872	0.031	0.288	0	1	0.064
Trend										-		
Trend Results for All Data Since Oct. 1997												
Sample Size	29	29	29	29	29	29	29	29	29	29	28	80
Mann-Kendall S	-177	45	-104	-166	-55	-59	1	-157	-90	-166	-48	963
p-Level	0	0.413	0.052	0.002	0.315	0.28	0.993	0.003	0.096	0.002	0.356	0.000
Trend	-			-				-		-		+
MW-1010P												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	19	20
Mann-Kendall S	107	32	58	44	-22	34	82	83	18	54	-47	42
p-Level	0.000	0.318	0.064	0.164	0.500	0.288	0.008	0.007	0.586	0.086	0.108	0.186
Trend	+						+	+				
Trend Results for All Data Since Oct. 1997												
Sample Size	81	62	81	81	81	81	81	81	81	81	66	81
Mann-Kendall S	812	772	-748	2254	-875	-433	2405	642	668	2071	808	712
p-Level	0.000	0.000	0.000	0.000	0.000	0.078	0.000	0.009	0.006	0.000	0.000	0.004
Trend	+	+	-	+	-		+	+	+	+	+	+
MW-1002												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	16	20
Mann-Kendall S	77	-1	19	11	-23	41	-63	100	-10	13	-34	36
p-Level	0.013	0.987	0.564	0.749	0.480	0.197	0.043	0.000	0.774	0.701	0.140	0.260
Trend								+				
Trend Results for All Data Since Oct. 1997												
Sample Size	81	59	81	81	81	81	81	81	81	81	16	81
Mann-Kendall S	1103	6	10	1117	-480	-166	-978	-129	-369	873	-34	611
p-Level	0.000	0.940	0.960	0.000	0.015	0.319	0.000	0.601	0.133	0.000	0.140	0.013
Trend	+			+			-			+		
MW-1002G												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	16	20
Mann-Kendall S	159	0	19	114	46	36	85	128	-33	105	-18	36
p-Level	0.000	1.000	0.564	0.000	0.146	0.260	0.005	0.000	0.303	0.000	0.450	0.260
Trend	+			+			+	+		+		
Trend Results for All Data Since Oct. 1997												
Sample Size	81	59	81	81	81	81	81	81	81	81	16	81
Mann-Kendall S	844	-85	268	1842	-112	276	-1065	629	-640	1660	-18	579
p-Level	0.001	0.079	0.045	0.000	0.556	0.097	0.000	0.010	0.009	0.000	0.450	0.018
Trend	+			+			-	+	-	+		

**Trend Analysis Results - Groundwater (Quarterly Parameters)
Year Ending 2017**

	Alkalinity	Arsenic	Copper	Hardness	Iron	Manganese	Sulfate	TDS	Field pH (su)	Cond (umhos /cm)	Redox (mV)	Grd Water El (Feet)
MW-1004												
Trend Results for Most Recent 5 Years												
Sample Size	19	19	19	19	19	19	19	19	19	19	18	19
Mann-Kendall S	-27	8	7	-26	15	54	-24	53	-29	-28	-33	11
p-Level	0.368	0.809	0.836	0.387	0.628	0.063	0.426	0.068	0.332	0.35	0.23	0.73
Trend												
Trend Results for All Data Since Oct. 1997												
Sample Size	28	28	28	28	28	28	28	28	28	28	27	68
Mann-Kendall S	-125	3	185	-100	66	95	-52	76	-87	-83	-146	476
p-Level	0.013	0.969	0	0.05	0.202	0.063	0.316	0.14	0.09	0.106	0.002	0.012
Trend			+								-	
MW-1004S												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	19	20
Mann-Kendall S	-94	3	-20	-116	-3	100	-93	-36	-21	-111	-47	32
p-Level	0.002	0.949	0.542	0.000	0.949	0.000	0.002	0.260	0.521	0.000	0.108	0.318
Trend	-			-		+	-			-		
Trend Results for All Data Since Oct. 1997												
Sample Size	81	61	81	81	81	81	81	81	81	81	66	81
Mann-Kendall S	341	-3	650	814	-516	-14	1548	-337	-49	441	-360	1053
p-Level	0.165	0.973	0.004	0.001	0.005	0.949	0.000	0.168	0.845	0.073	0.047	0.000
Trend			+	+	-		+					+
MW-1004P												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	17	20
Mann-Kendall S	85	54	-7	69	28	40	32	92	46	74	-6	53
p-Level	0.005	0.086	0.847	0.026	0.386	0.208	0.318	0.002	0.146	0.016	0.840	0.092
Trend	+							+				
Trend Results for All Data Since Oct. 1997												
Sample Size	82	62	82	82	82	82	82	82	82	82	62	82
Mann-Kendall S	557	327	-736	1000	1743	1728	62	-271	527	1166	-654	1213
p-Level	0.008	0.007	0.000	0.000	0.000	0.000	0.777	0.277	0.035	0.000	0.000	0.000
Trend	+	+	-	+	+	+				+	-	+
MW-1005												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	16	20
Mann-Kendall S	49	21	-108	121	59	112	76	108	-32	120	-9	123
p-Level	0.120	0.521	0.000	0.000	0.059	0.000	0.014	0.000	0.318	0.000	0.723	0.000
Trend			-	+		+		+		+		+
Trend Results for All Data Since Oct. 1997												
Sample Size	81	59	81	81	81	81	81	81	81	81	16	80
Mann-Kendall S	-1215	-305	709	1089	-179	234	674	1085	-765	1241	-9	861
p-Level	0.000	0.043	0.000	0.000	0.466	0.341	0.005	0.000	0.002	0.000	0.723	0.000
Trend	-		+	+			+	+	-	+		+
MW-1005S												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	16	20
Mann-Kendall S	-66	25	5	-87	-82	-84	88	-1	60	-86	6	124
p-Level	0.034	0.441	0.898	0.004	0.008	0.006	0.004	0.987	0.054	0.004	0.824	0.000
Trend				-	-	-	+			-		+
Trend Results for All Data Since Oct. 1997												
Sample Size	81	59	81	81	81	81	81	81	81	81	16	81
Mann-Kendall S	737	-20	11	854	239	689	-637	-431	259	799	6	920
p-Level	0.002	0.901	0.901	0.000	0.328	0.004	0.003	0.078	0.292	0.001	0.824	0.000
Trend	+			+		+	-			+		+

**Trend Analysis Results - Groundwater (Quarterly Parameters)
Year Ending 2017**

	Alkalinity	Arsenic	Copper	Hardness	Iron	Manganese	Sulfate	TDS	Field pH (su)	Cond (umhos /cm)	Redox (mV)	Grd Water El (Feet)
MW-1005P												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	19	20
Mann-Kendall S	112	37	27	50	53	-16	-38	11	26	-64	3	126
p-Level	0.000	0.247	0.404	0.112	0.092	0.630	0.234	0.749	0.422	0.040	0.946	0.000
Trend	+											
Trend Results for All Data Since Oct. 1997												
Sample Size	81	59	81	81	81	81	81	81	81	81	68	81
Mann-Kendall S	259	111	57	539	1636	553	-349	-354	-196	870	-101	721
p-Level	0.273	0.270	0.711	0.023	0.000	0.024	0.026	0.148	0.426	0.000	0.596	0.003
Trend	+											
MW-1015A												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	19	20
Mann-Kendall S	61	0	13	35	12	33	-90	106	-13	60	-41	39
p-Level	0.050	1.000	0.701	0.274	0.724	0.303	0.004	0.000	0.701	0.054	0.164	0.221
Trend	-											
Trend Results for All Data Since Oct. 1997												
Sample Size	75	68	75	75	76	76	75	75	76	76	52	76
Mann-Kendall S	556	-119	309	640	59	-1249	77	-194	366	1572	-56	302
p-Level	0.010	0.078	0.022	0.003	0.670	0.000	0.728	0.375	0.101	0.000	0.664	0.177
Trend	+											
MW-1015B												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	19	20
Mann-Kendall S	92	19	-15	29	39	-42	39	40	-14	47	16	36
p-Level	0.002	0.564	0.654	0.369	0.221	0.186	0.221	0.208	0.678	0.137	0.604	0.260
Trend	+											
Trend Results for All Data Since Oct. 1997												
Sample Size	75	68	75	75	76	76	75	75	76	76	53	76
Mann-Kendall S	60	160	55	1119	32	-829	150	60	476	1467	826	355
p-Level	0.740	0.131	0.375	0.000	0.889	0.000	0.202	0.787	0.033	0.000	0.000	0.112
Trend	+											
MW-1013												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	19	20
Mann-Kendall S	15	-3	38	-31	-68	27	-109	-62	22	-97	-39	120
p-Level	0.654	0.949	0.234	0.335	0.028	0.404	0.000	0.046	0.500	0.002	0.186	0.000
Trend	-											
Trend Results for All Data Since Oct. 1997												
Sample Size	49	49	49	49	49	49	49	49	49	49	49	76
Mann-Kendall S	267	-77	386	-109	-189	567	-904	63	-200	-328	-236	2035
p-Level	0.021	0.485	0.001	0.350	0.105	0.000	0.000	0.592	0.085	0.005	0.043	0.000
Trend	+											
MW-1013A												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	18	20
Mann-Kendall S	122	43	-51	18	-43	75	32	45	-8	45	-23	136
p-Level	0.000	0.175	0.105	0.586	0.175	0.015	0.318	0.155	0.822	0.155	0.410	0.000
Trend	+											
Trend Results for All Data Since Oct. 1997												
Sample Size	49	49	49	49	49	49	49	49	49	49	48	76
Mann-Kendall S	186	6	127	-23	443	525	-111	195	-137	-21	-297	1430
p-Level	0.108	0.956	0.215	0.849	0.000	0.000	0.340	0.094	0.240	0.863	0.009	0.000
Trend	+											

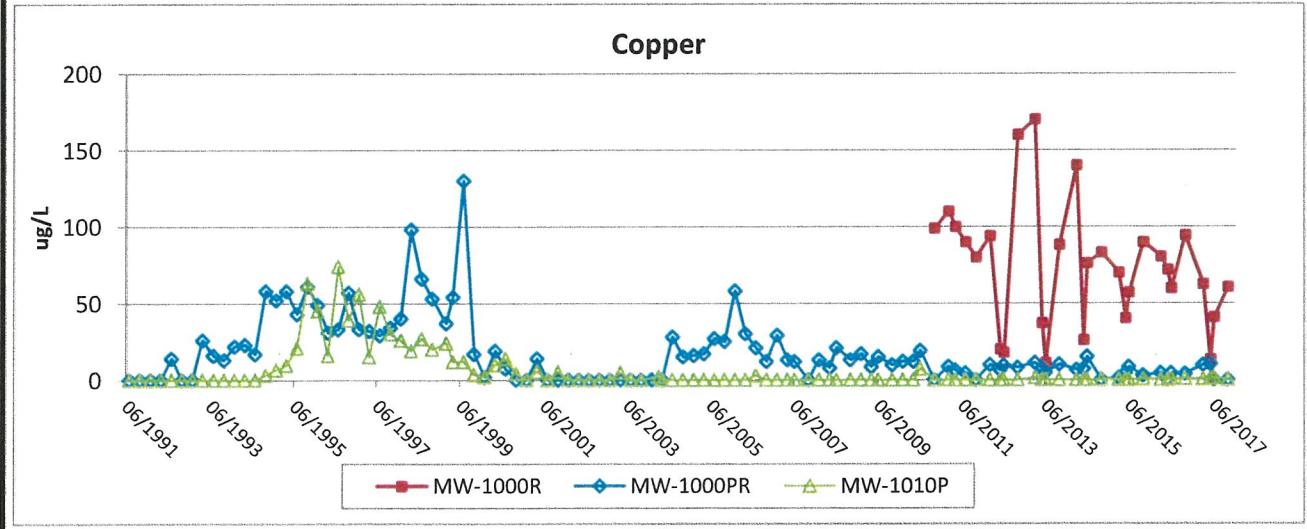
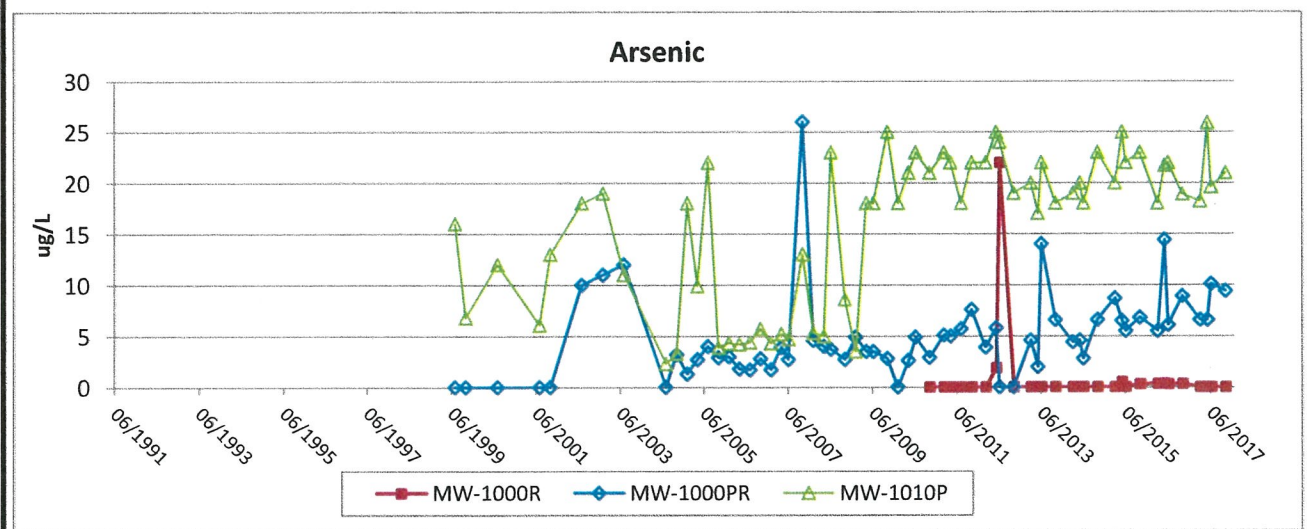
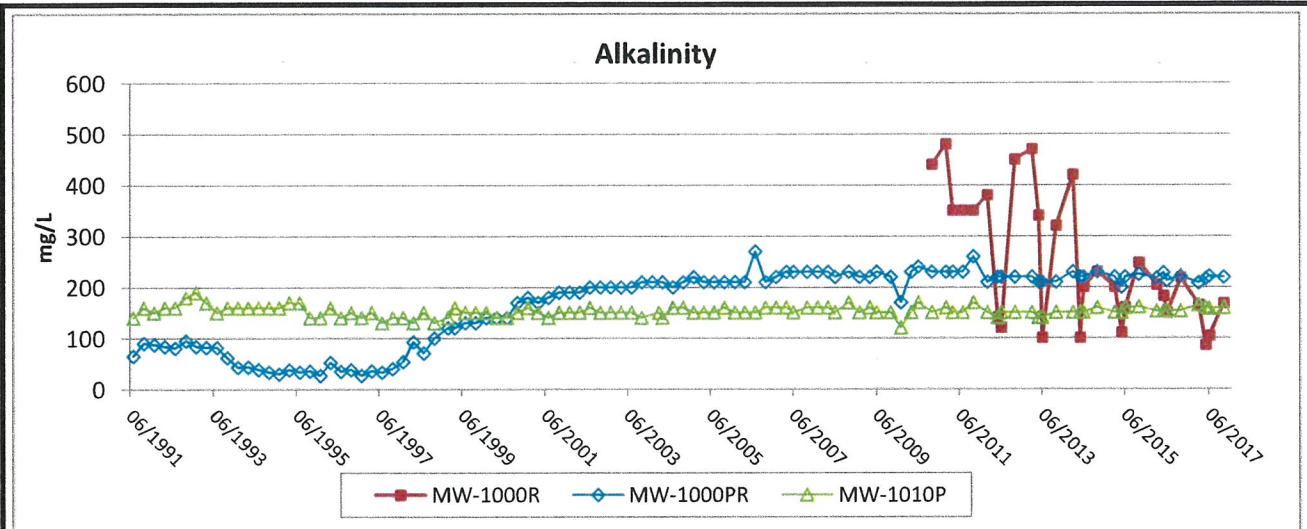
**Trend Analysis Results - Groundwater (Quarterly Parameters)
Year Ending 2017**

	Alkalinity	Arsenic	Copper	Hardness	Iron	Manganese	Sulfate	TDS	Field pH (su)	Cond (umhos /cm)	Redox (mV)	Grd Water El (Feet)
MW-1013B												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	19	20
Mann-Kendall S	41	78	-56	-19	-42	-54	75	-28	13	-35	-75	129
p-Level	0.197	0.012	0.074	0.564	0.186	0.086	0.015	0.386	0.701	0.274	0.008	0.000
Trend											-	+
Trend Results for All Data Since Oct. 1997												
Sample Size	76	64	76	76	76	76	76	76	76	76	68	76
Mann-Kendall S	-404	-193	1772	-537	-384	-189	473	-721	-359	-650	-76	1463
p-Level	0.070	0.223	0.000	0.012	0.064	0.398	0.025	0.001	0.107	0.004	0.691	0.000
Trend			+					-		-		+
MW-1013C												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	19	20
Mann-Kendall S	-66	53	-48	-83	-1	-24	11	-76	55	-57	17	134
p-Level	0.034	0.092	0.128	0.007	0.987	0.460	0.749	0.014	0.080	0.069	0.580	0.000
Trend				-								+
Trend Results for All Data Since Oct. 1997												
Sample Size	76	64	76	76	76	76	76	76	76	75	68	76
Mann-Kendall S	141	916	-20	-1024	2421	628	-560	-1251	156	-1015	402	1444
p-Level	0.529	0.000	0.909	0.000	0.000	0.005	0.009	0.000	0.486	0.000	0.034	0.000
Trend		+		-	+	+	-	-		-		+
MW-1014												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	19	20
Mann-Kendall S	40	24	-32	71	-10	39	64	98	16	36	-33	162
p-Level	0.208	0.460	0.318	0.022	0.774	0.221	0.040	0.002	0.630	0.260	0.266	0.000
Trend								+				+
Trend Results for All Data Since Oct. 1997												
Sample Size	49	49	49	49	49	49	49	49	49	49	49	73
Mann-Kendall S	41	-17	-38	-162	66	302	-661	-94	-184	-259	-371	1472
p-Level	0.725	0.830	0.748	0.162	0.382	0.009	0.000	0.421	0.114	0.026	0.001	0.000
Trend						+	-				-	+
MW-1014A												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	19	20
Mann-Kendall S	72	95	-40	70	6	56	31	-14	28	8	-35	166
p-Level	0.020	0.002	0.208	0.024	0.872	0.074	0.335	0.678	0.386	0.822	0.238	0.000
Trend		+										+
Trend Results for All Data Since Oct. 1997												
Sample Size	71	61	71	71	71	71	71	71	71	71	68	76
Mann-Kendall S	515	-2	785	-234	-761	-1724	-133	-432	-330	-691	-223	1659
p-Level	0.010	0.994	0.000	0.208	0.000	0.000	0.509	0.025	0.101	0.001	0.240	0.000
Trend			+		-	-				-		+
MW-1014B												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	19	20
Mann-Kendall S	46	65	-32	-34	22	-35	28	-34	49	-32	-67	158
p-Level	0.146	0.037	0.318	0.288	0.500	0.274	0.386	0.288	0.120	0.318	0.020	0.000
Trend												+
Trend Results for All Data Since Oct. 1997												
Sample Size	76	64	76	76	76	76	76	76	77	77	68	77
Mann-Kendall S	-474	-153	-677	-1273	10	-2203	-875	-1372	184	-1375	-1055	1535
p-Level	0.033	0.357	0.002	0.000	0.947	0.000	0.000	0.000	0.419	0.000	0.000	0.000
Trend			-	-		-	-	-		-	-	+

**Trend Analysis Results - Groundwater (Quarterly Parameters)
Year Ending 2017**


	Alkalinity	Arsenic	Copper	Hardness	Iron	Manganese	Sulfate	TDS	Field pH (su)	Cond (umhos /cm)	Redox (mV)	Grd Water El (Feet)
MW-1014C												
Trend Results for Most Recent 5 Years												
Sample Size	20	20	20	20	20	20	20	20	20	20	19	20
Mann-Kendall S	46	108	-56	59	-79	13	73	15	41	-3	15	150
p-Level	0.146	0.000	0.074	0.059	0.011	0.701	0.018	0.654	0.197	0.949	0.628	0.000
Trend		+										+
Trend Results for All Data Since Oct. 1997												
Sample Size	76	64	76	76	76	76	76	76	76	76	68	76
Mann-Kendall S	-1849	1104	308	-1972	-2286	-2087	-2063	-1782	726	-2130	172	1421
p-Level	0.000	0.000	0.053	0.000	0.000	0.000	0.000	0.000	0.001	0.000	0.365	0.000
Trend	-	+		-	-	-	-	-	+	-		+

Notes: Overall increasing trend denoted by "+".
Overall decreasing trend denoted by "-".
All trend tests performed at a Type I (two-tailed) error rate of 0.01.



Note: Fourth quarter 2010 was the first time MW-1000R had sufficient water recovery for sampling.

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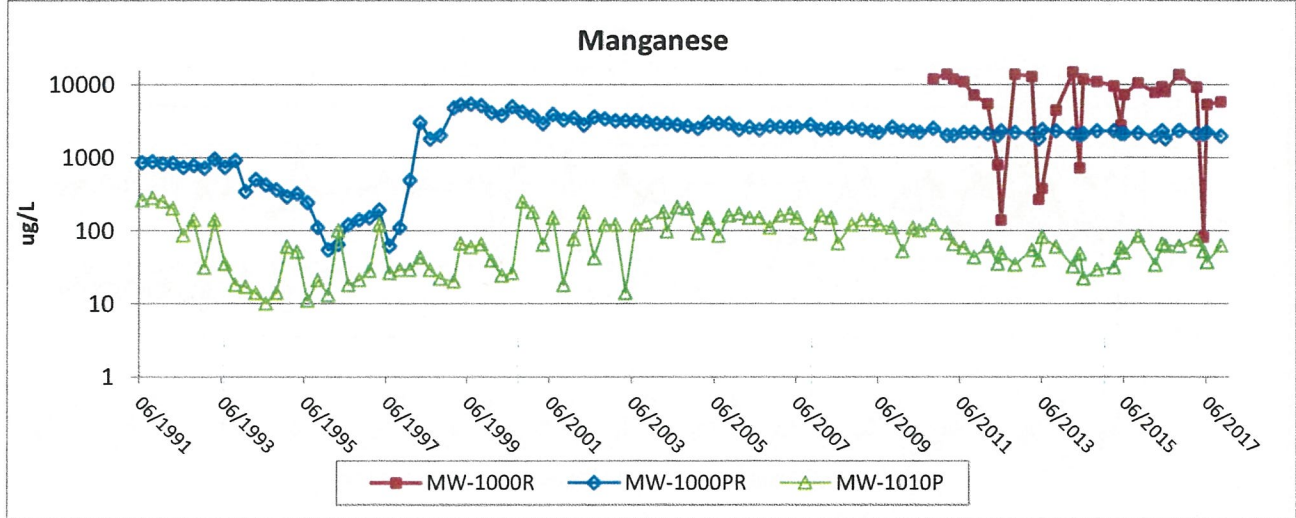
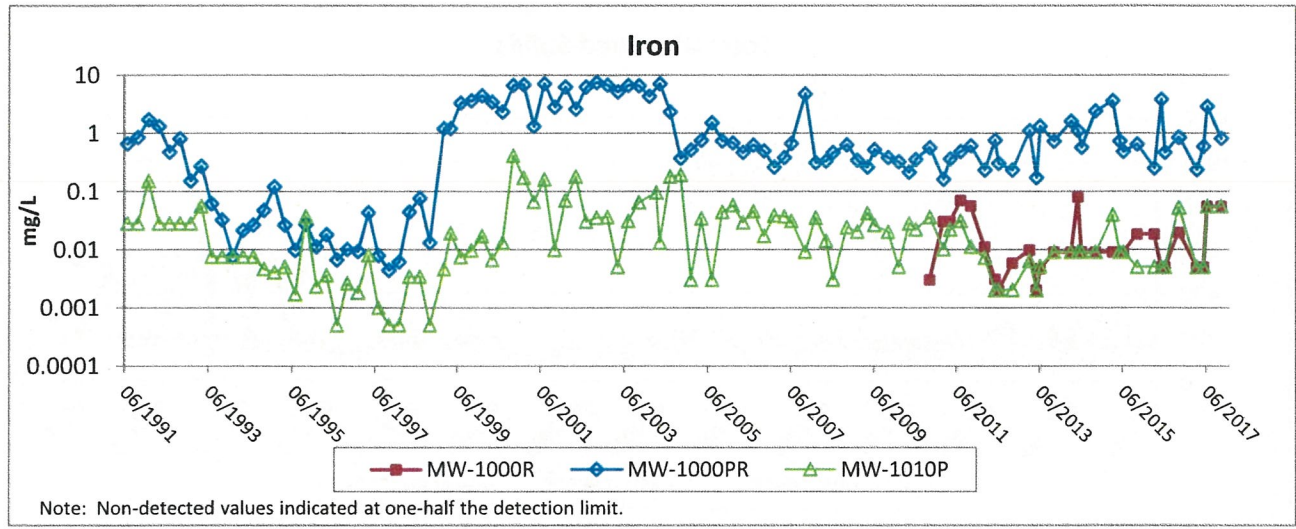
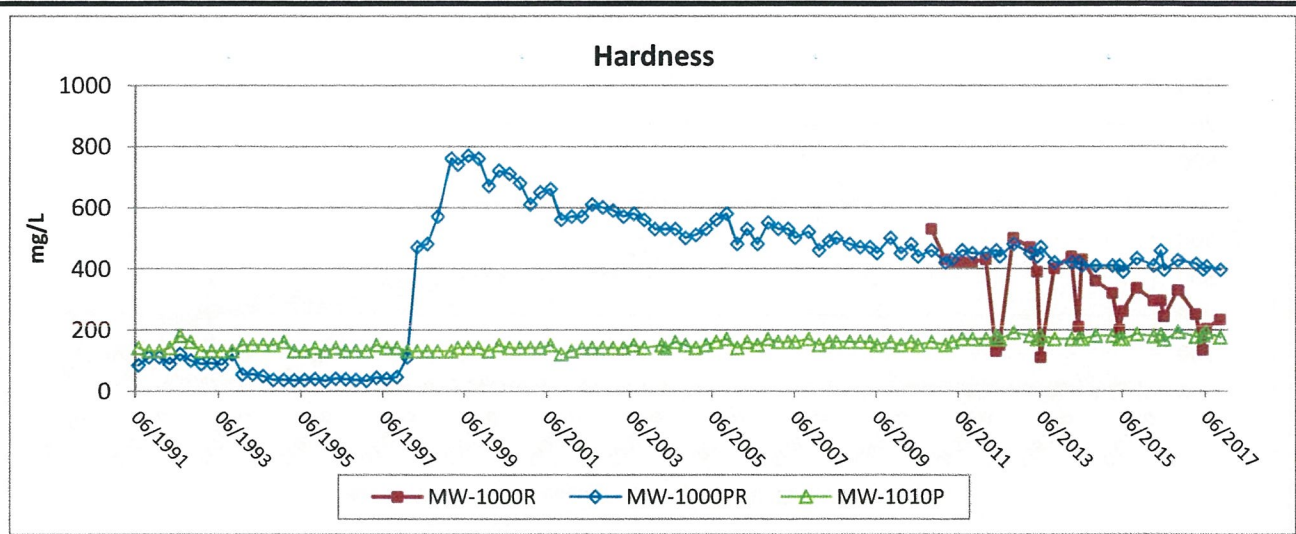
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Figure B-1a

Groundwater Trend Graphs - Quarterly Results


MW-1000R/MW-1000PR/MW-1010P

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	



Note: Iron trend graphs are displayed on a logarithmic scale so the trend patterns of MW-1000R, MW-1000PR and MW-1010P are visible at different concentration scales.

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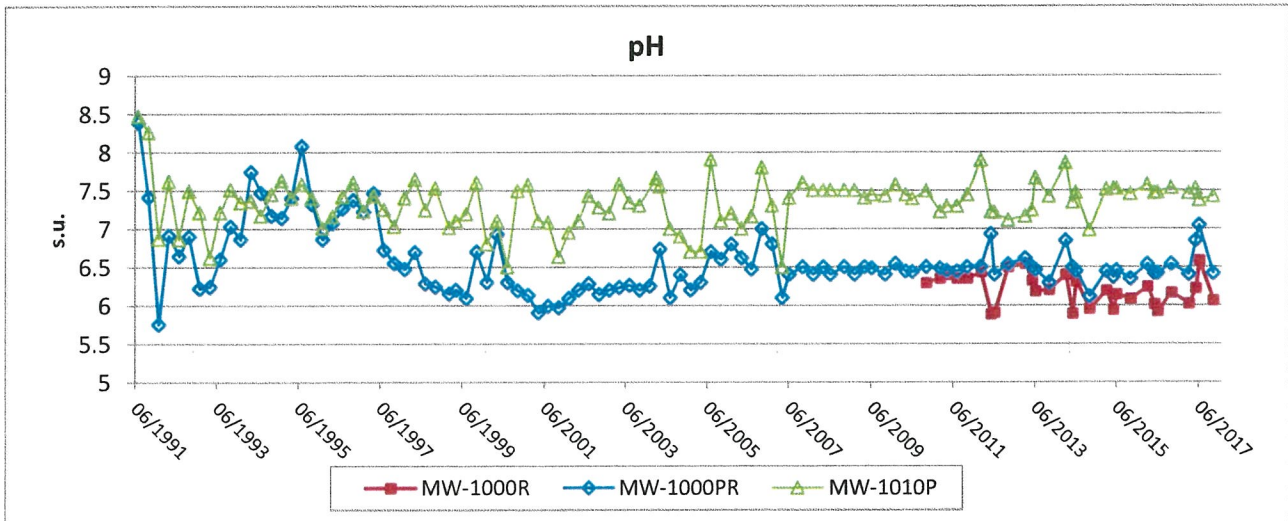
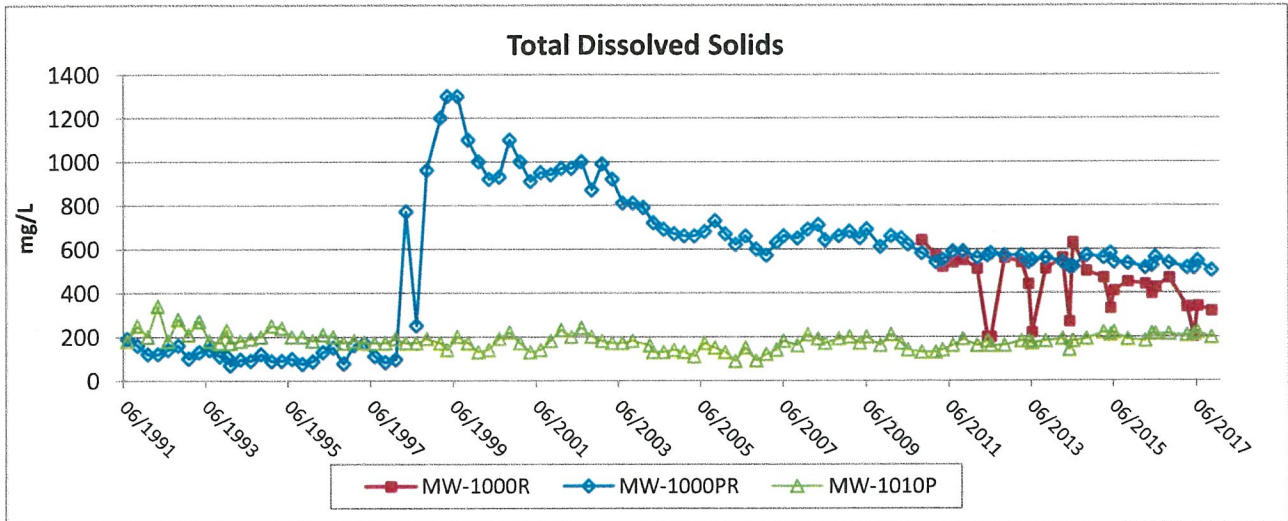
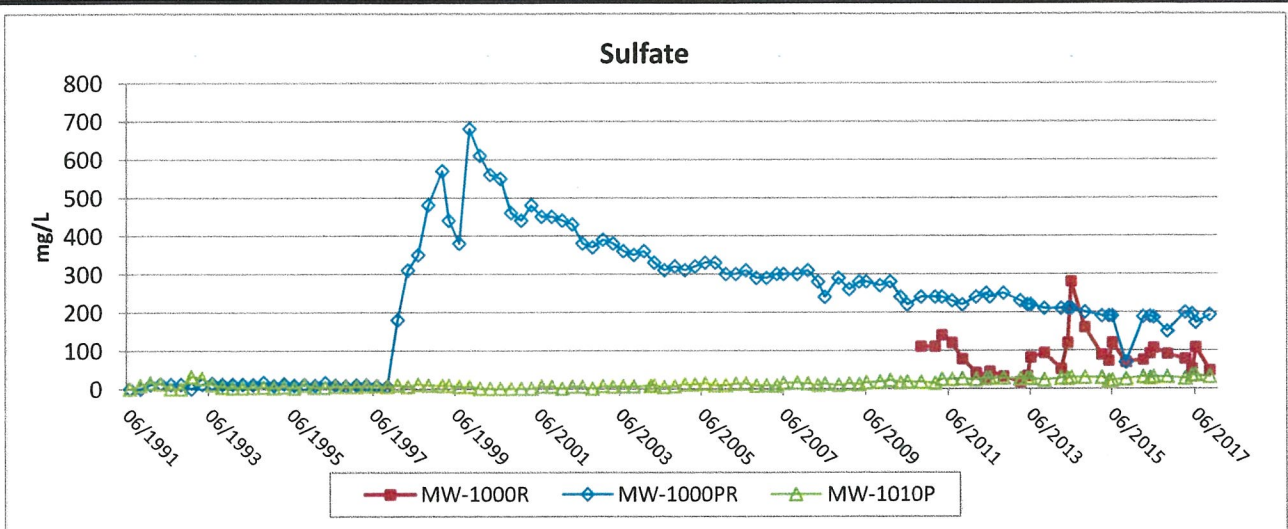
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Figure B-1b

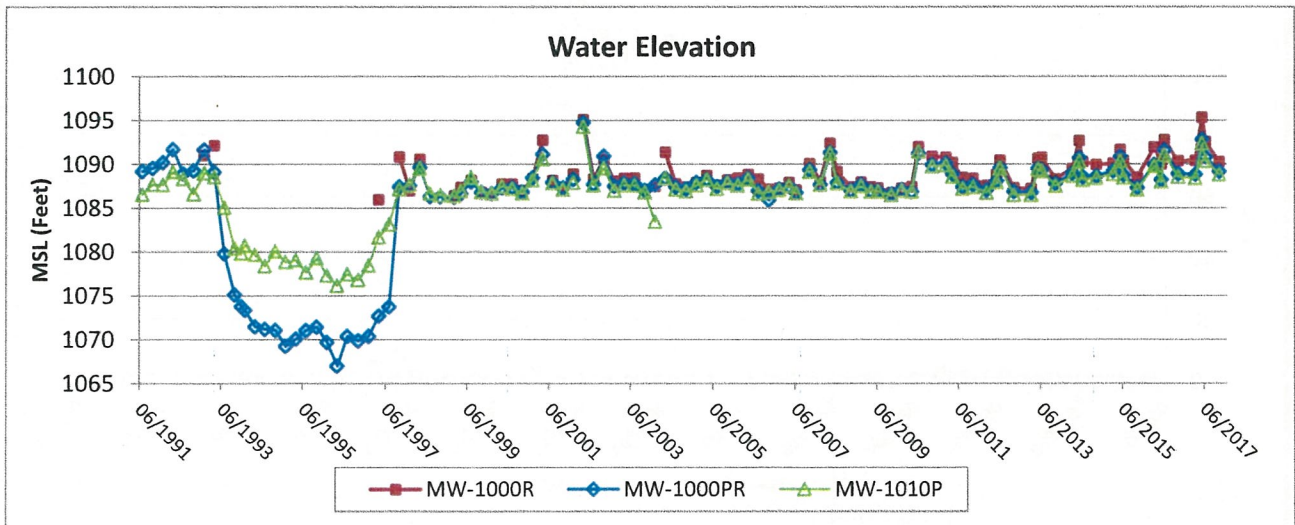
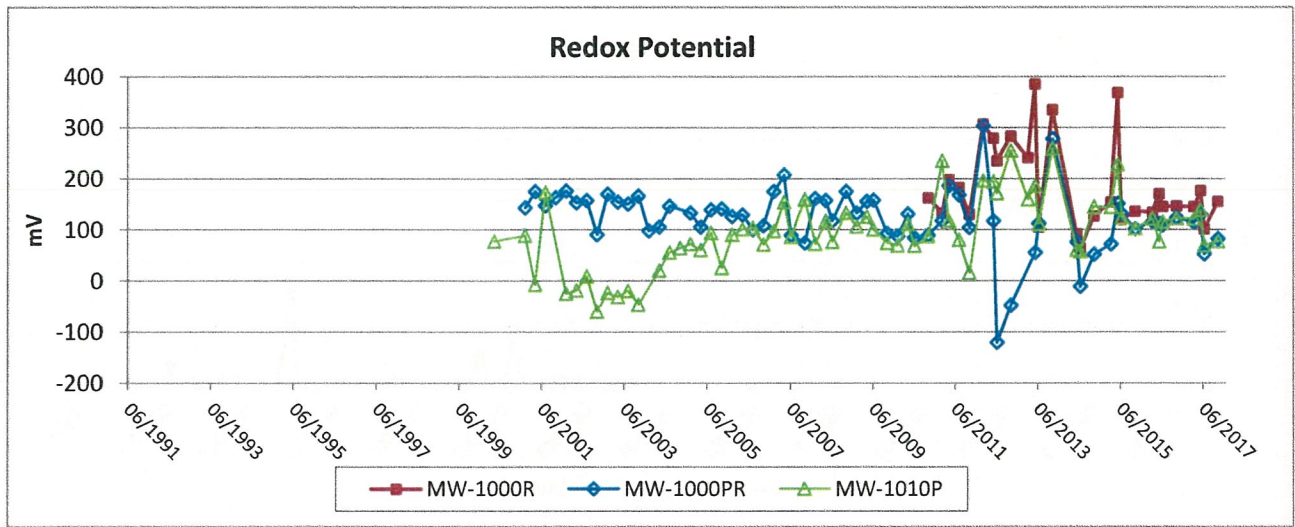
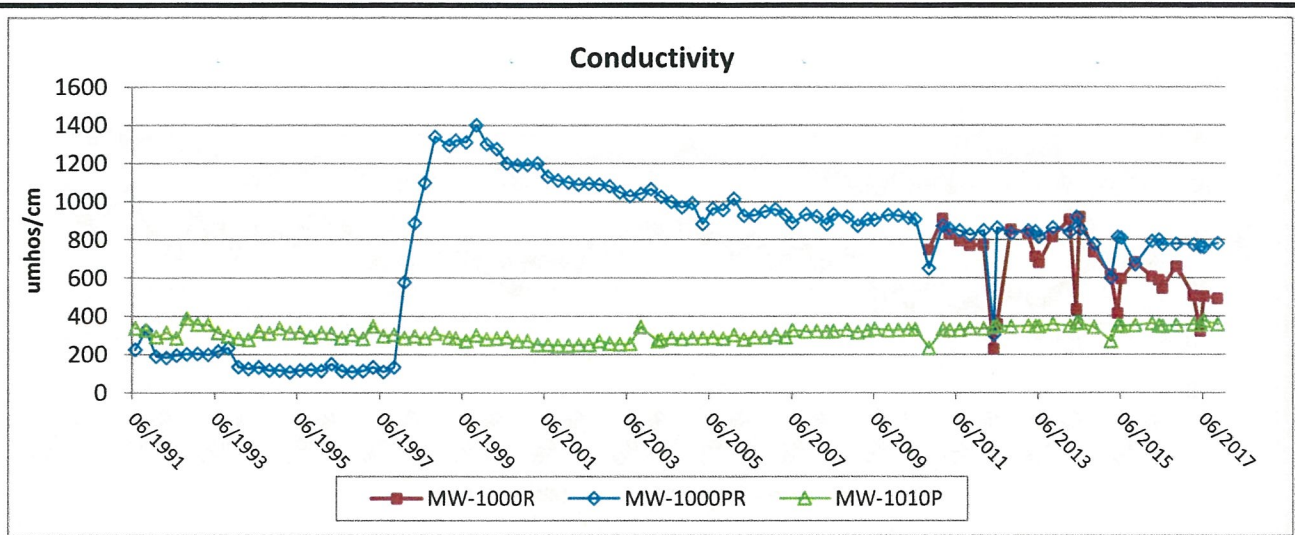
Groundwater Trend Graphs - Quarterly Results

MW-1000R/MW-1000PR/MW-1010P

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	



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Figure B-1c		
Groundwater Trend Graphs - Quarterly Results		
MW-1000R/MW-1000PR/MW-1010P		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00



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Figure B-1d

Groundwater Trend Graphs - Quarterly Results

MW-1000R/MW-1000PR/MW-1010P

Scale: NA

Date: January 2018

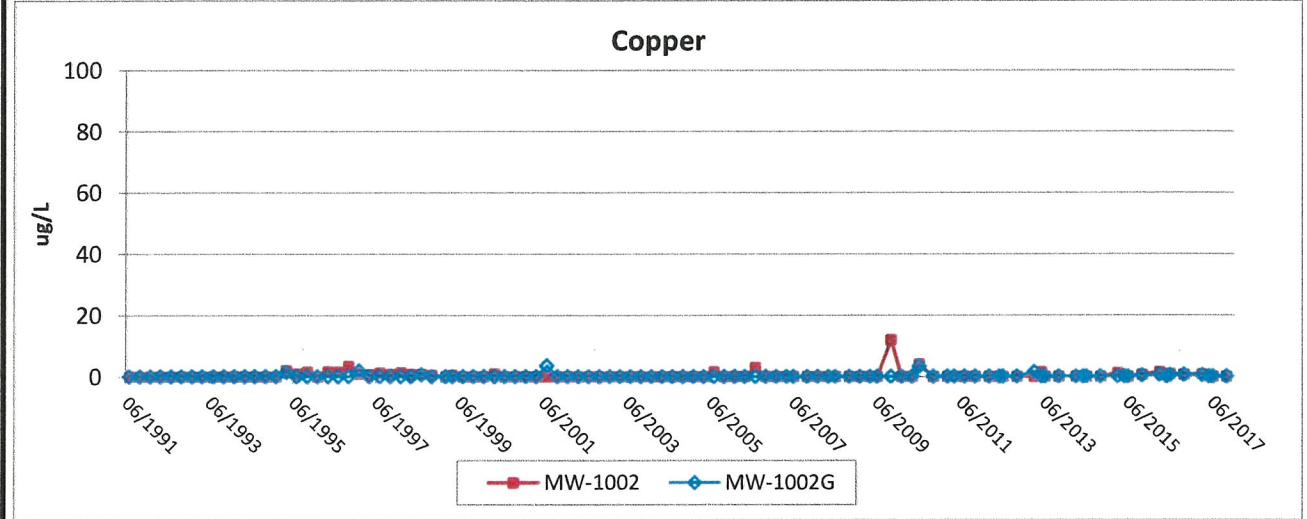
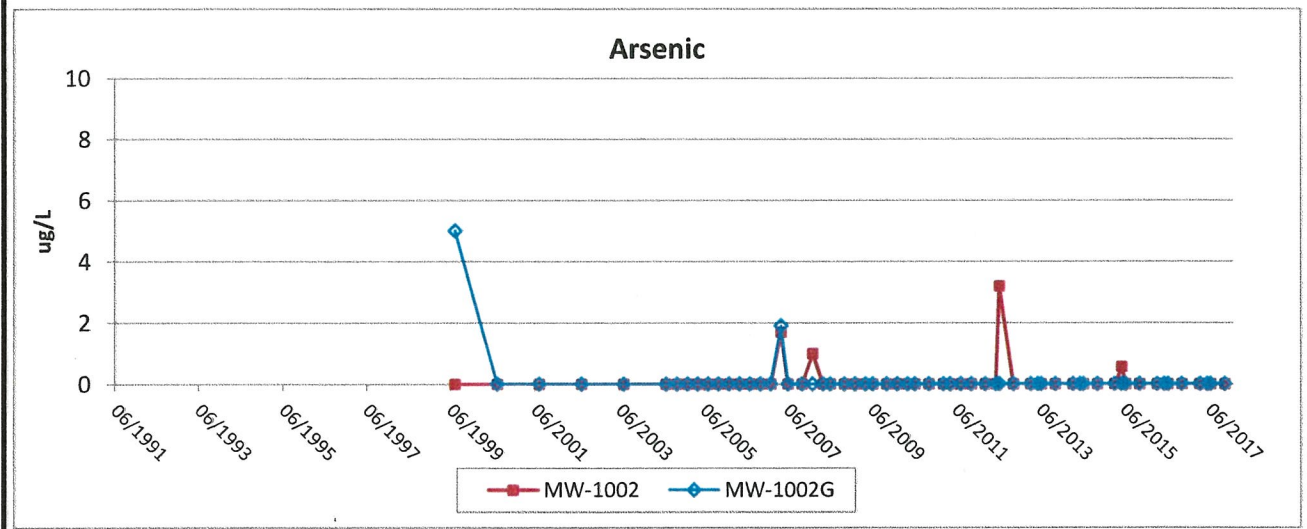
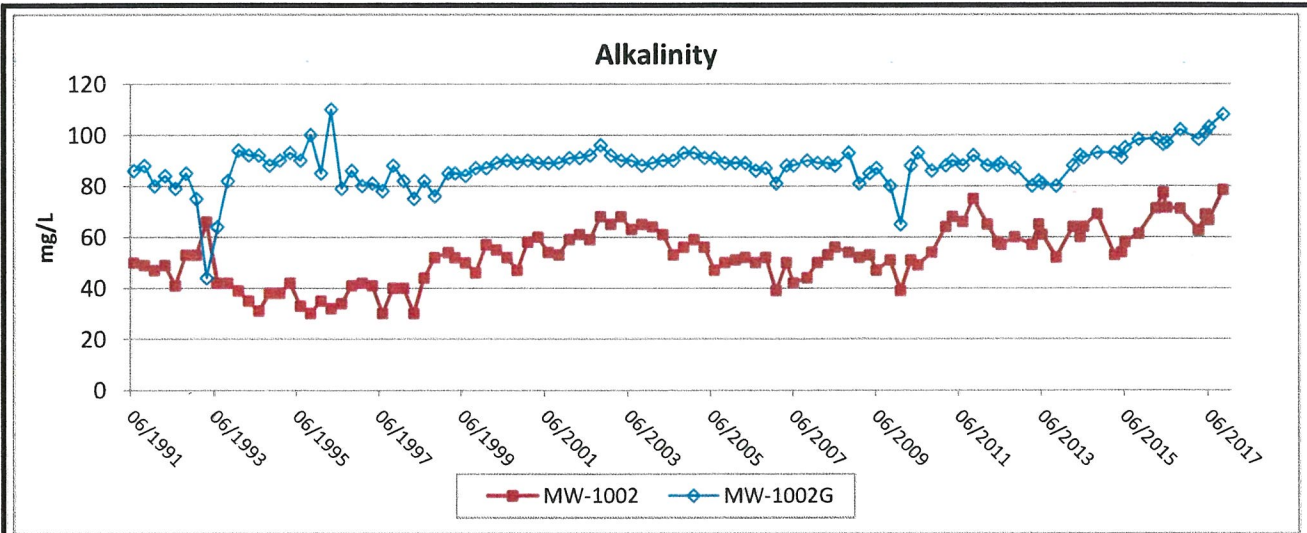
Prepared By: SGL


Checked By: SVF

Scope: 17F777-00

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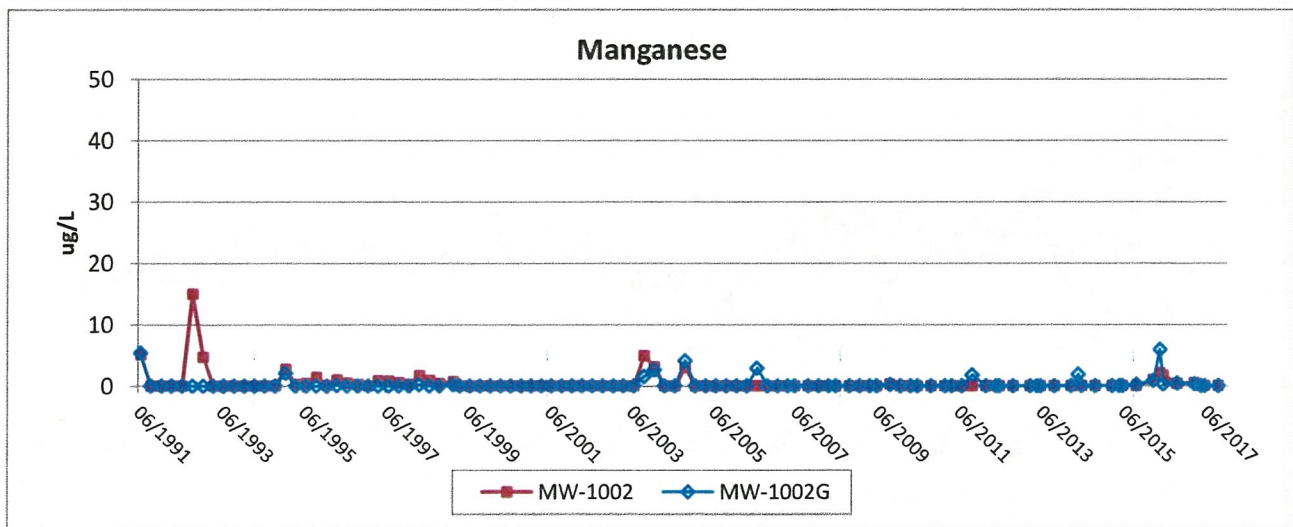
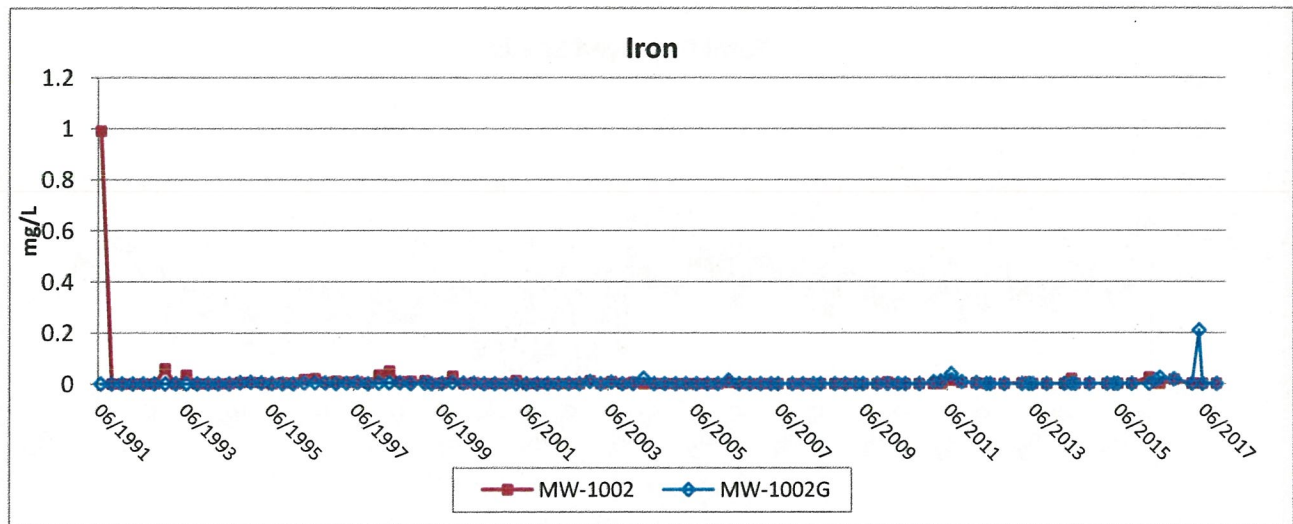
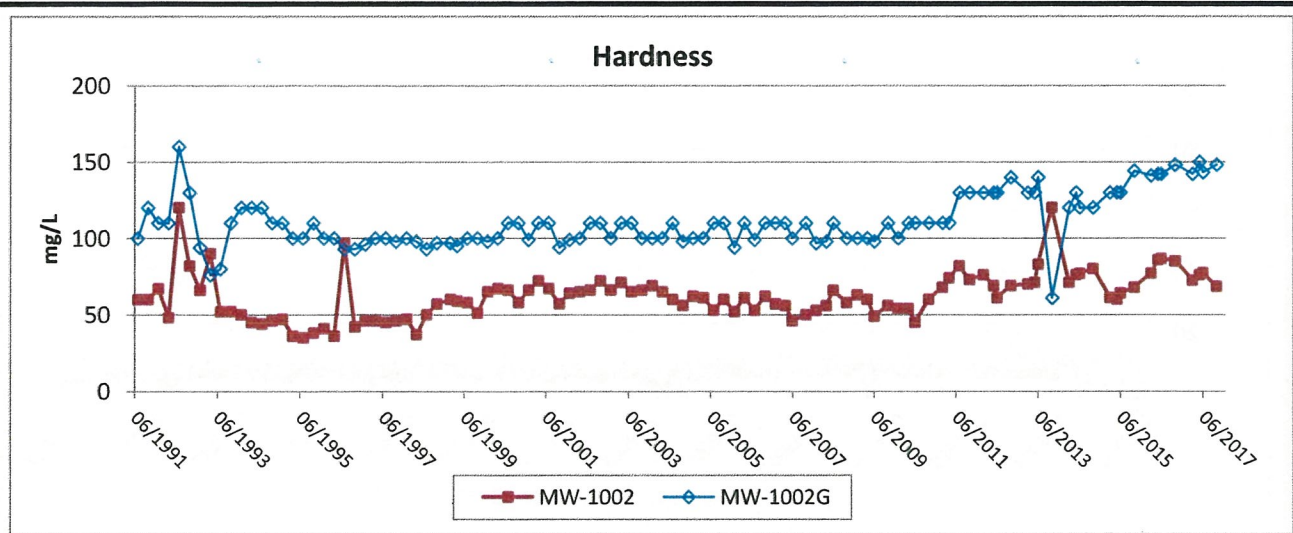
Figure B-2a

Groundwater Trend Graphs - Quarterly Results

MW-1002/MW-1002G

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	

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Figure B-2b

Groundwater Trend Graphs - Quarterly Results

MW-1002/MW-1002G

Scale: NA

Date: January 2018

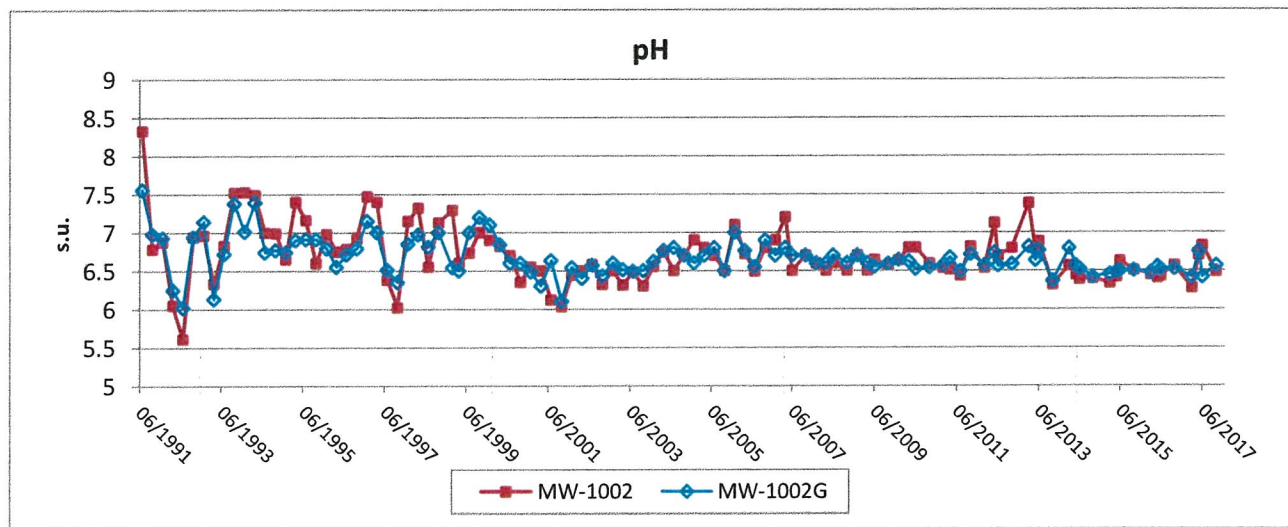
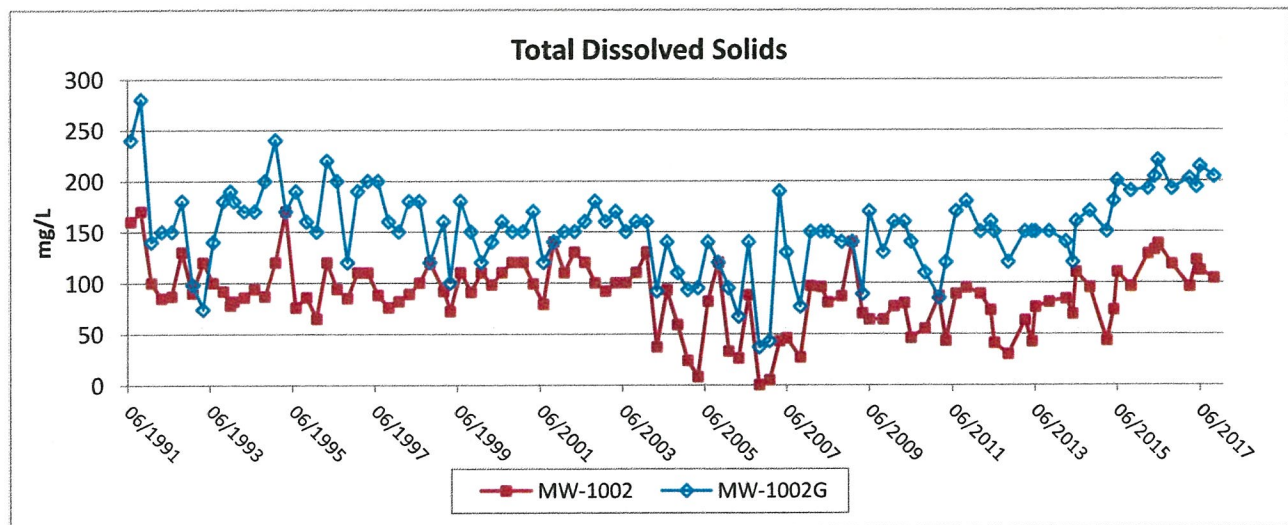
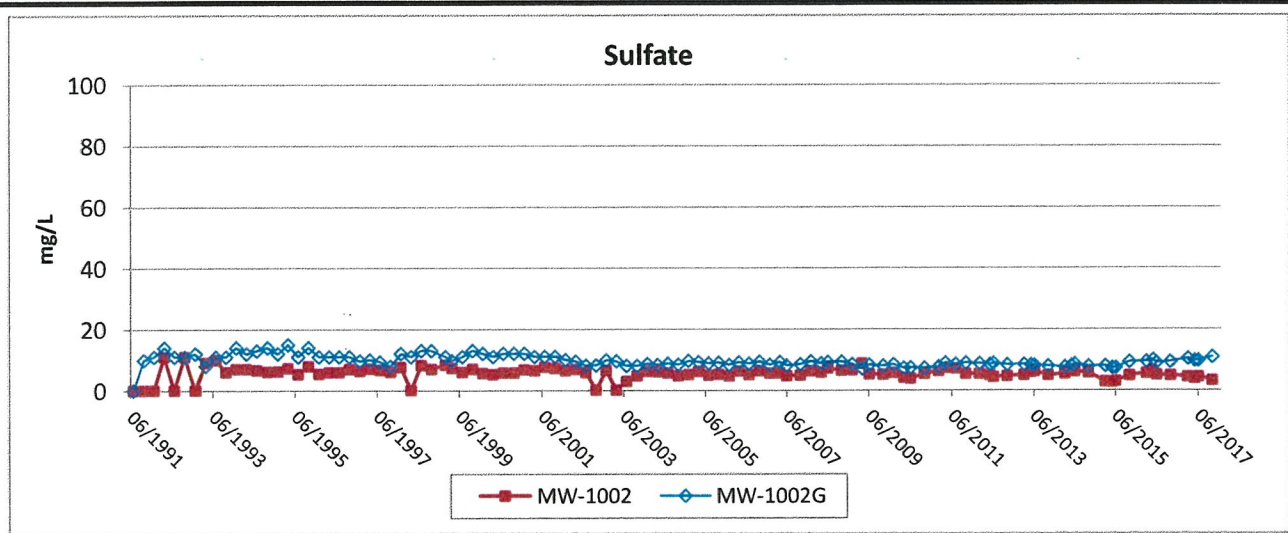
Prepared By: SGL

Checked By: SVF

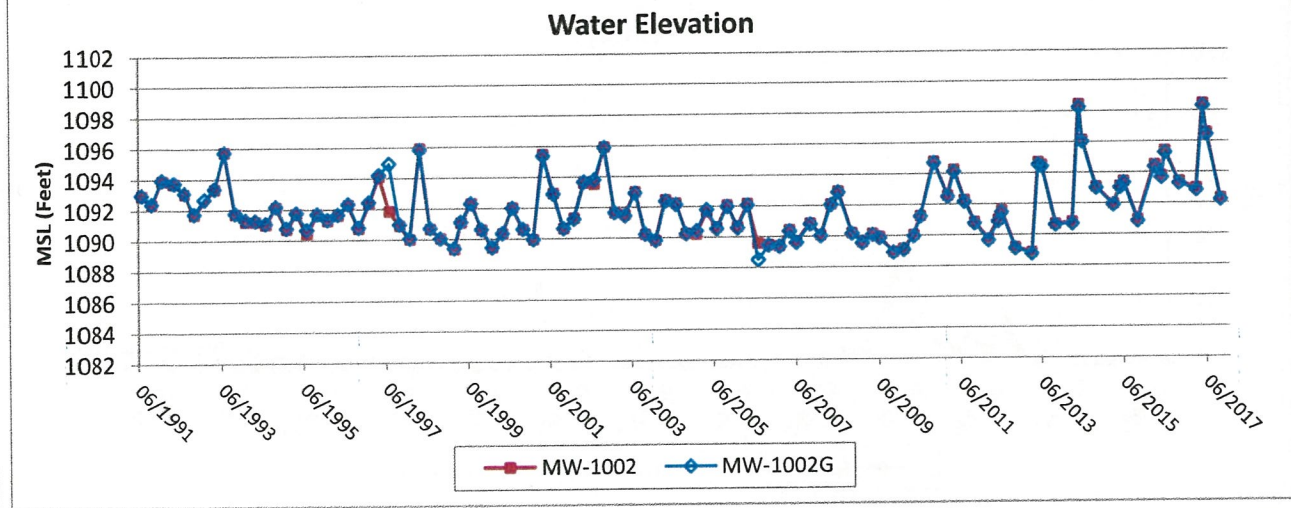
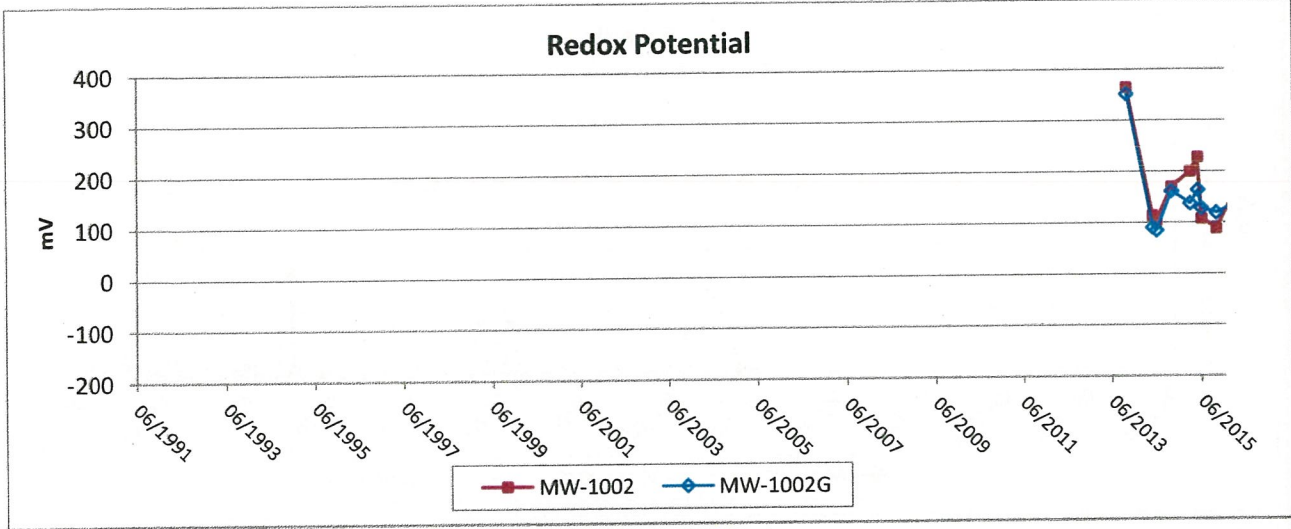
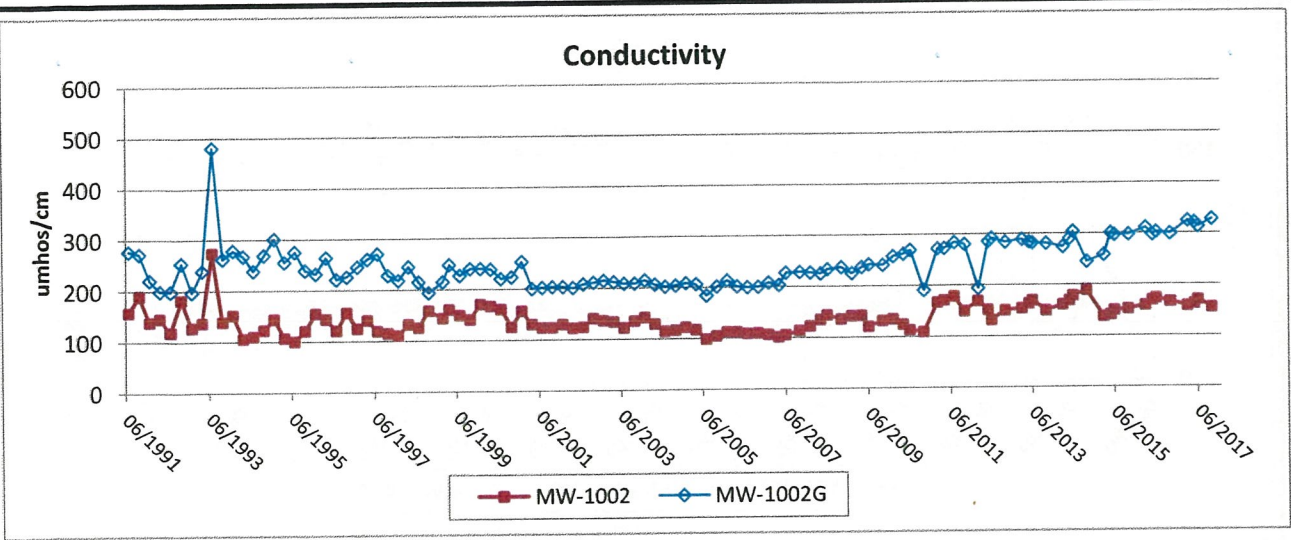
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Figure B-2c		
Groundwater Trend Graphs - Quarterly Results		
MW-1002/MW-1002G		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00





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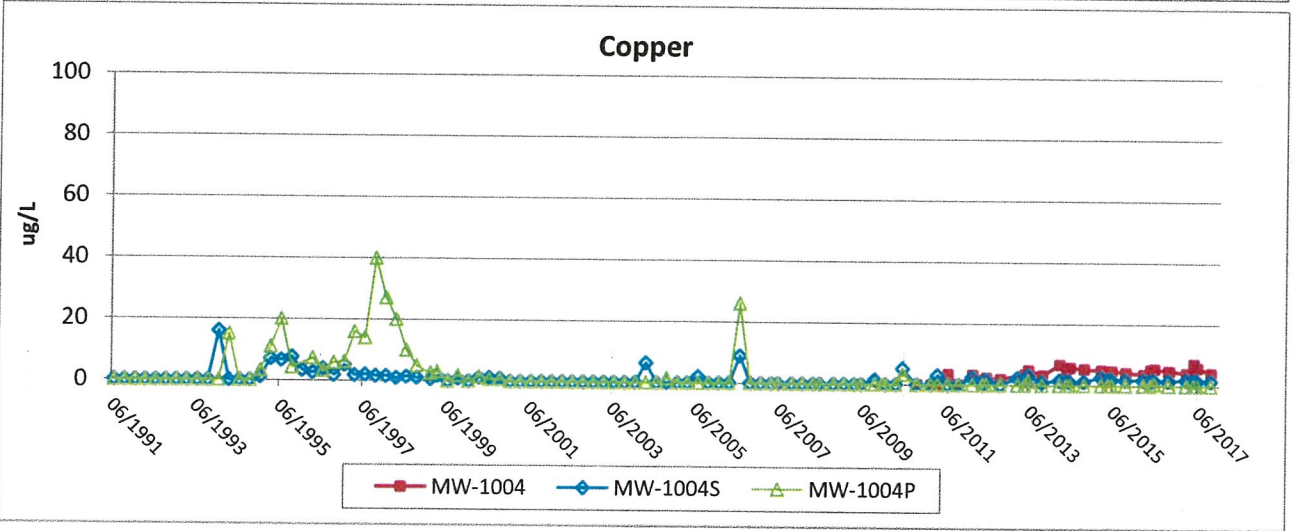
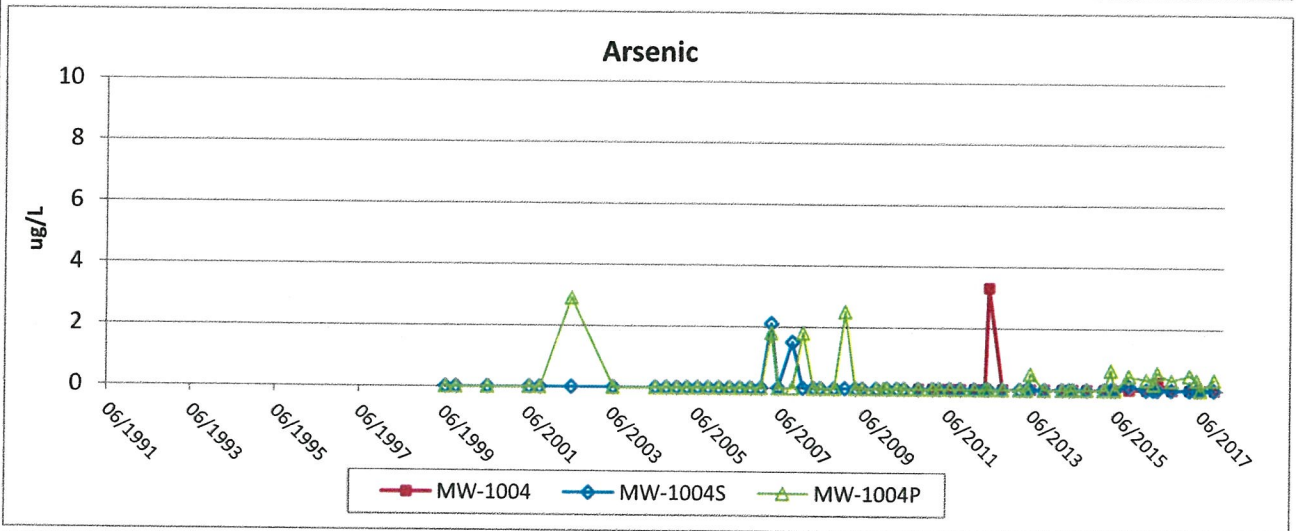
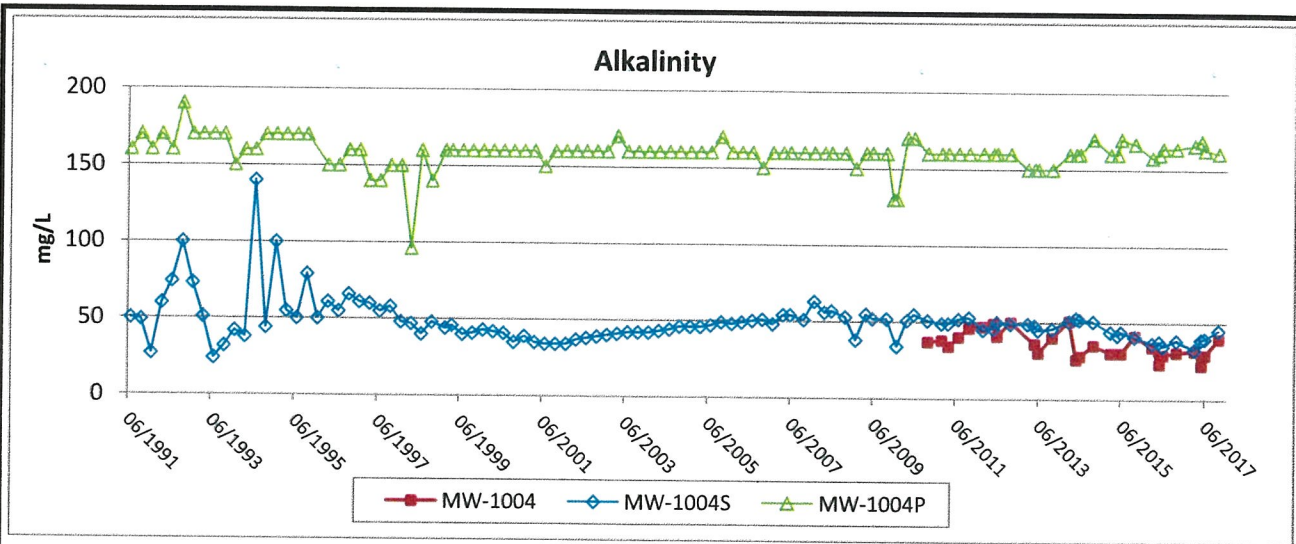
Figure B-2d

Groundwater Trend Graphs - Quarterly Results

MW-1002/MW-1002G


Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	

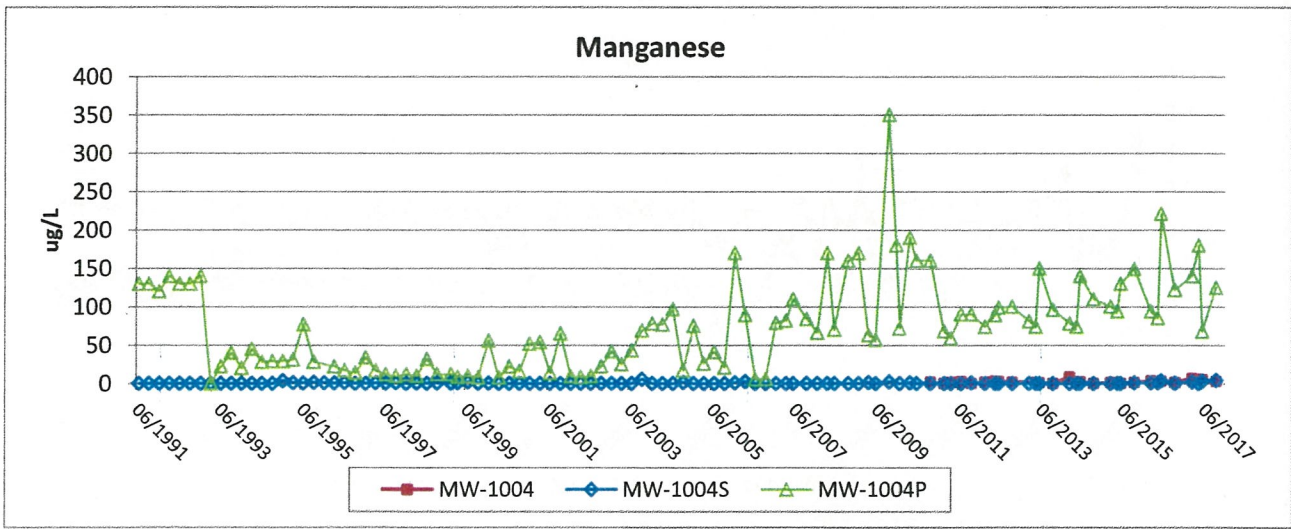
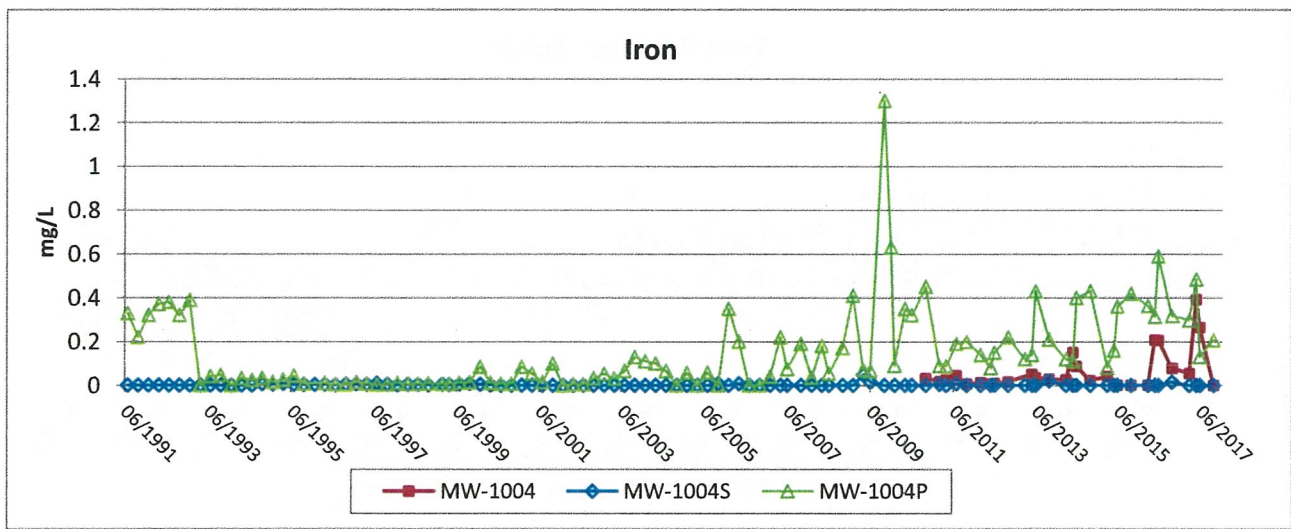
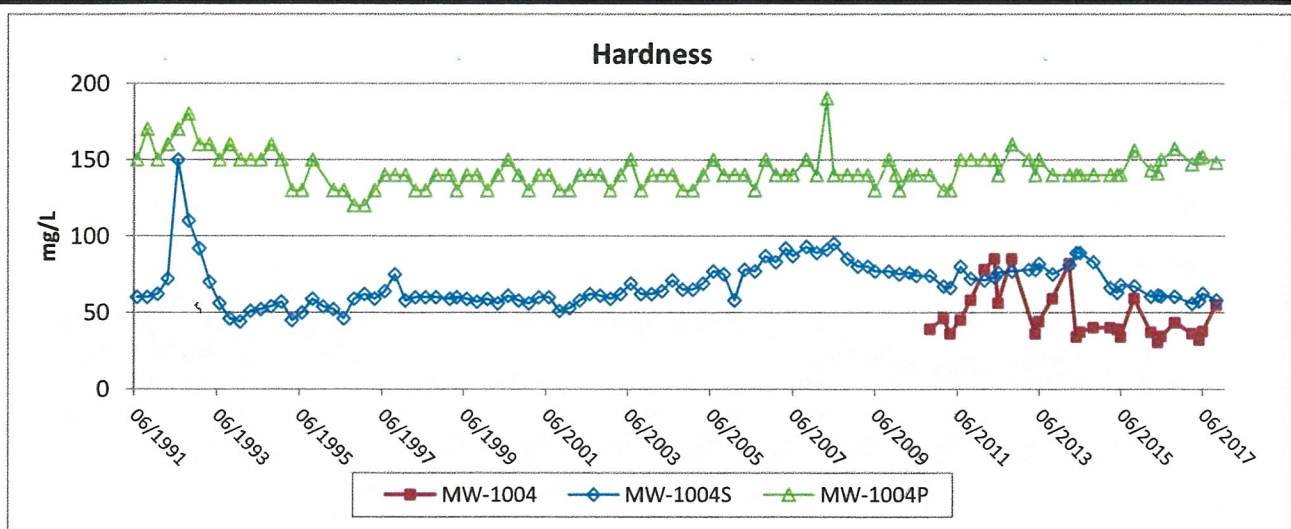
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Note: Fourth quarter 2010 was the first time MW-1004 had sufficient water recovery for sampling.

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Figure B-3a		
Groundwater Trend Graphs - Quarterly Results MW-1004/MW-1004S/MW-1004P		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00



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Figure B-3b

Groundwater Trend Graphs - Quarterly Results
MW-1004/MW-1004S/MW-1004P

Scale: NA

Date: January 2018

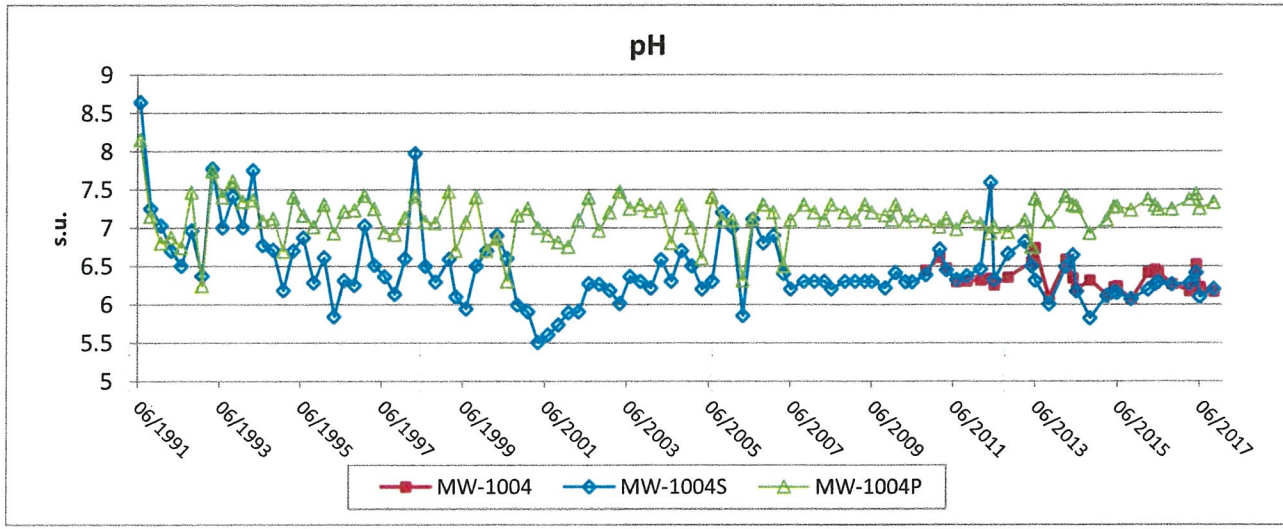
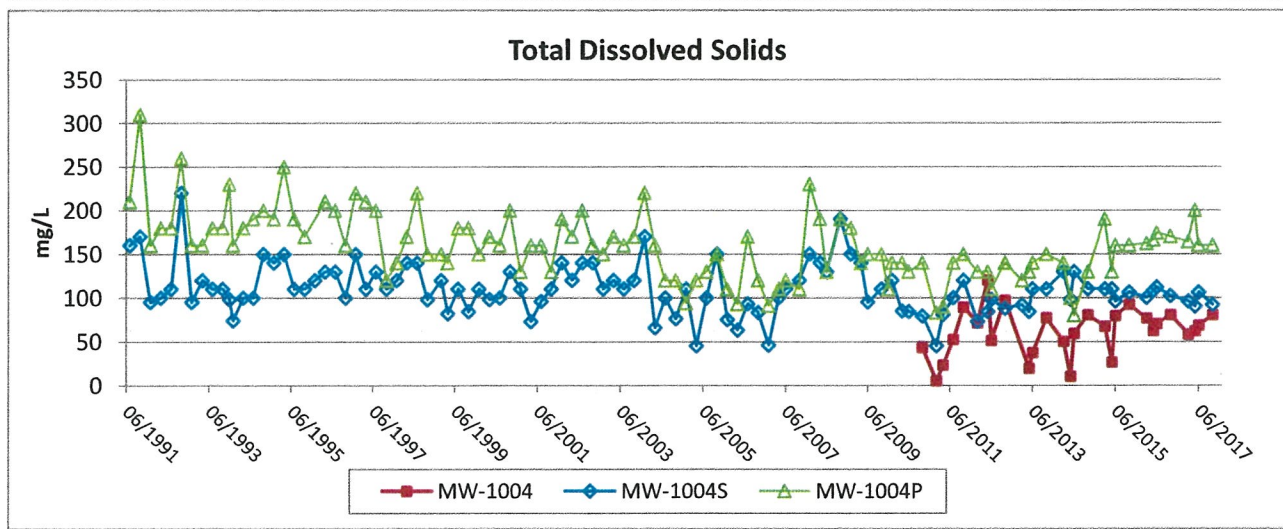
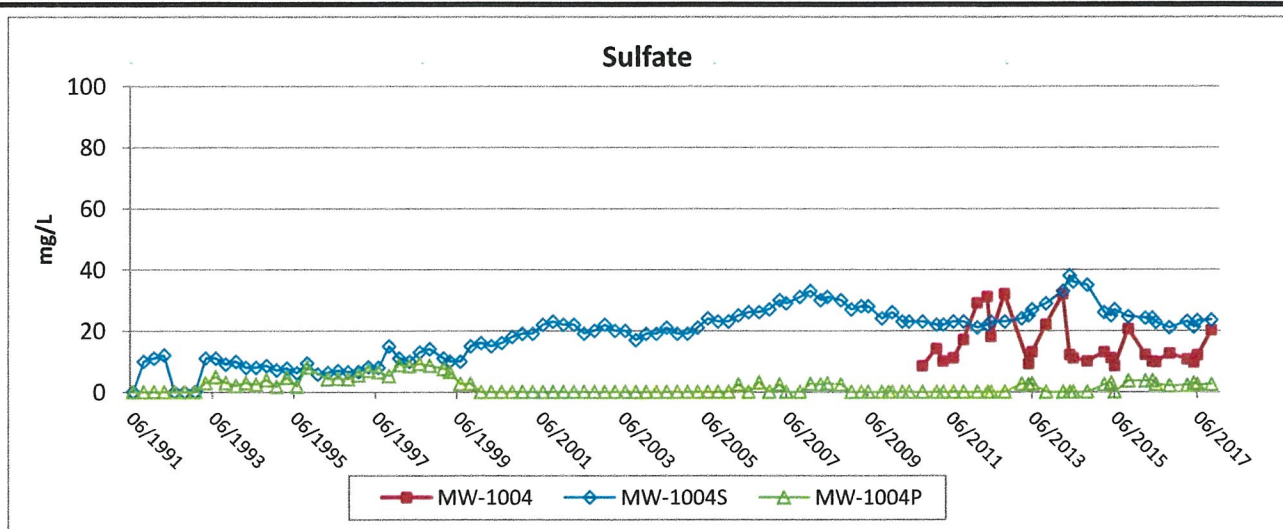
Prepared By: SGL


Checked By: SVF

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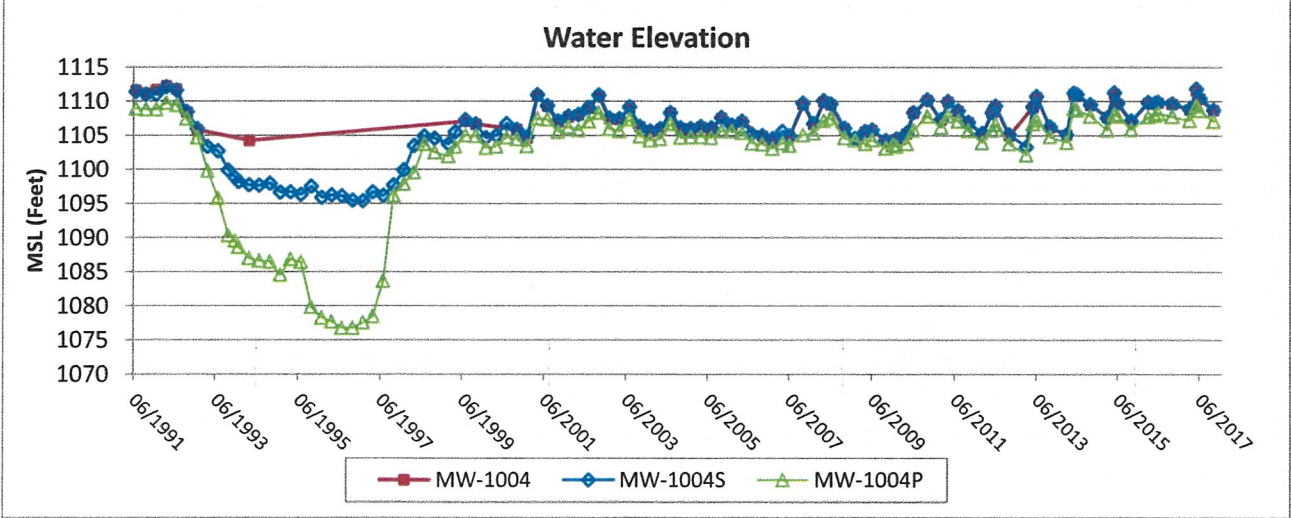
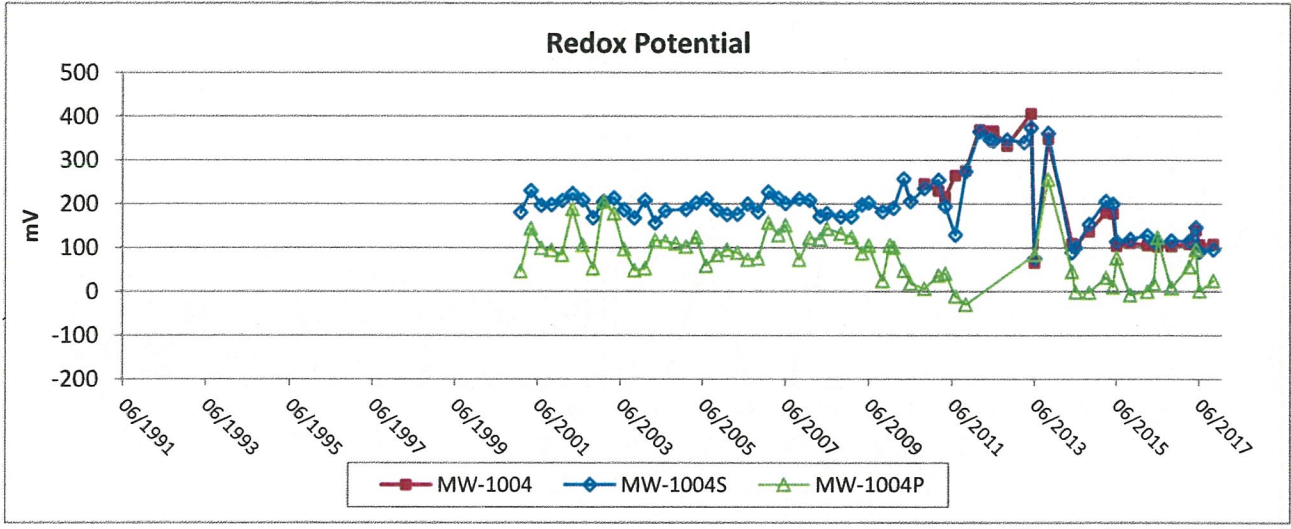
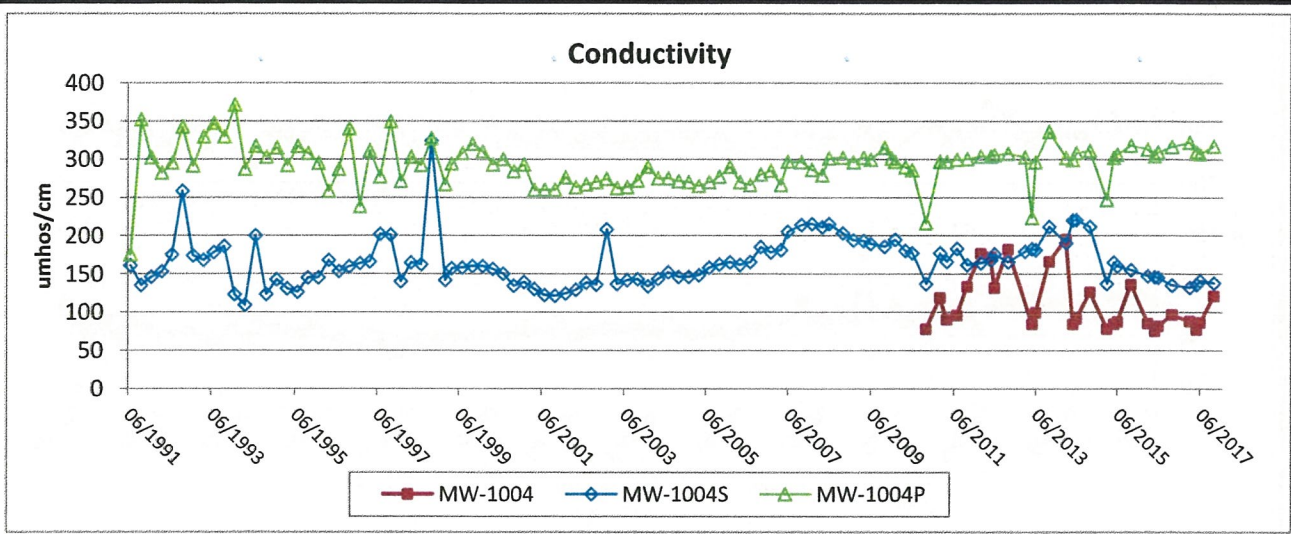
Figure B-3c

Groundwater Trend Graphs - Quarterly Results

MW-1004/MW-1004S/MW-1004P

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
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Figure B-3d

Groundwater Trend Graphs - Quarterly Results
MW-1004/MW-1004S/MW-1004P

Scale: NA

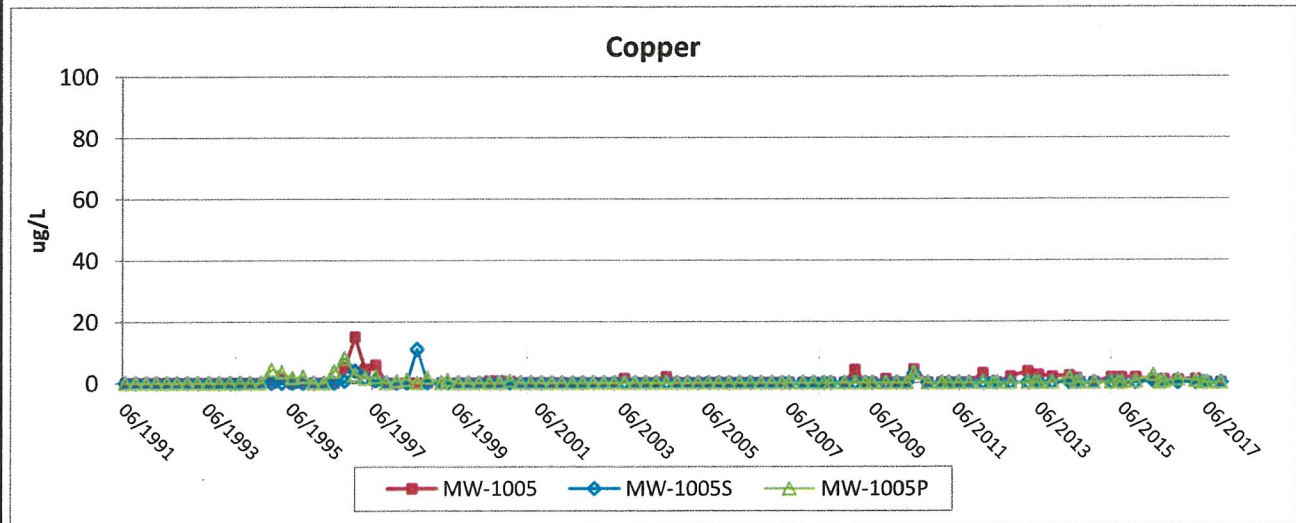
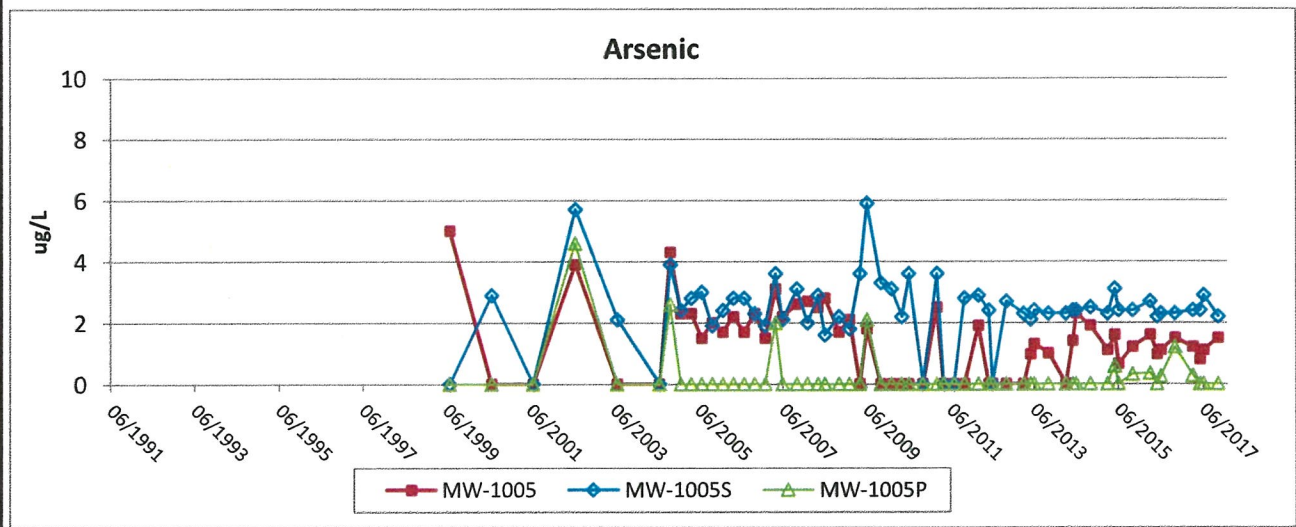
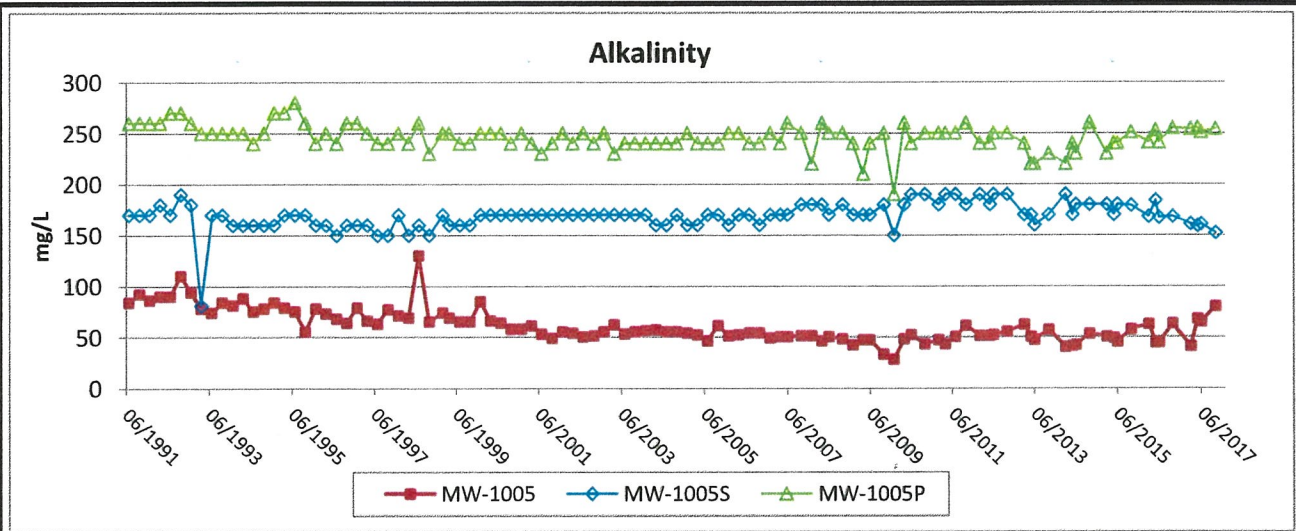
Date: January 2018

Prepared By: SGL

Checked By: SVF

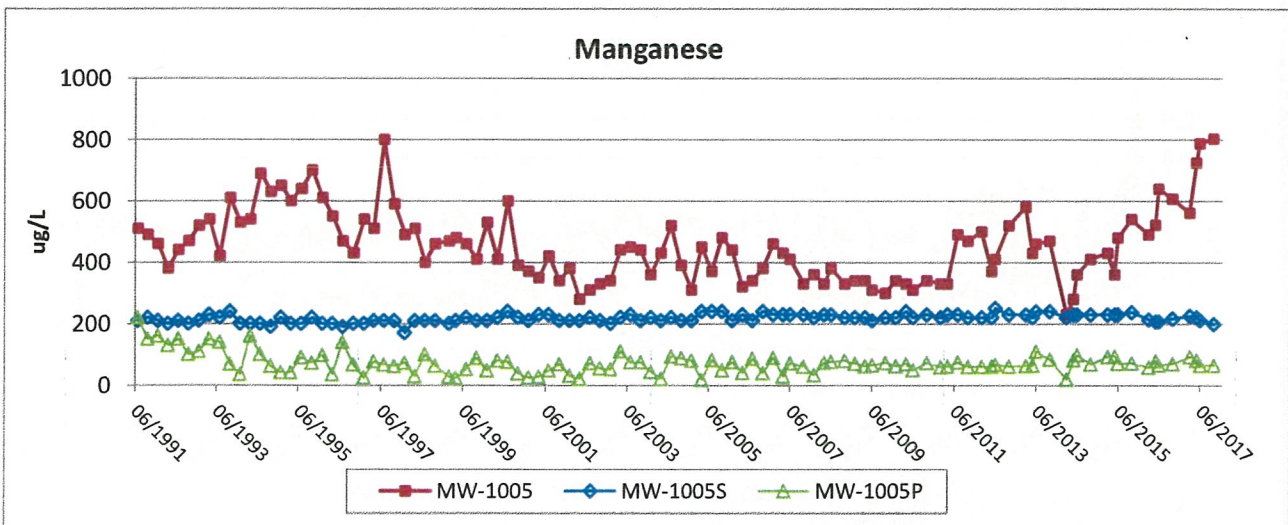
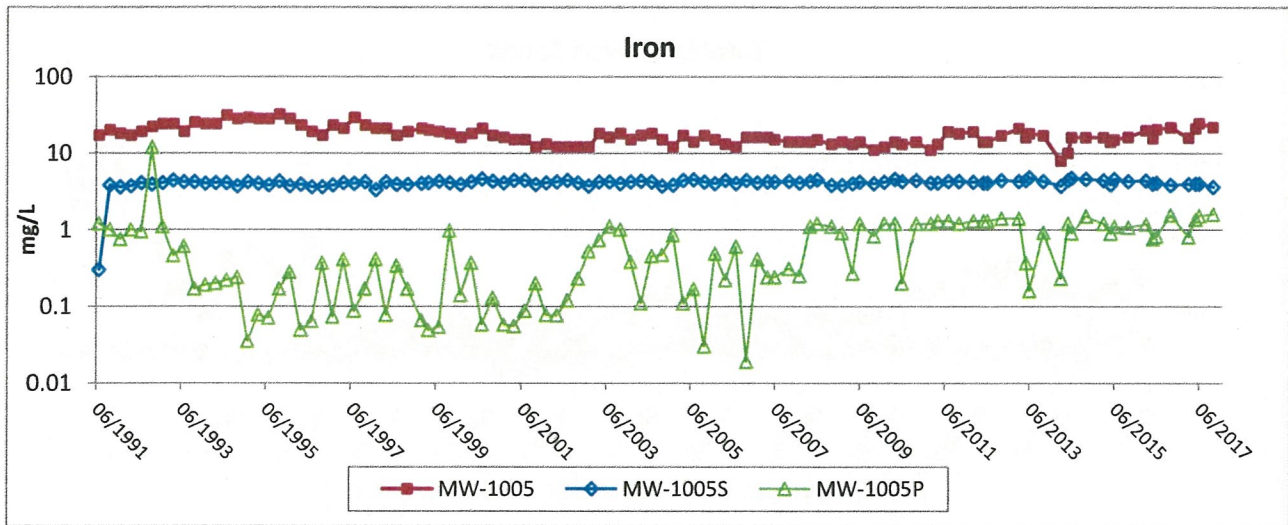
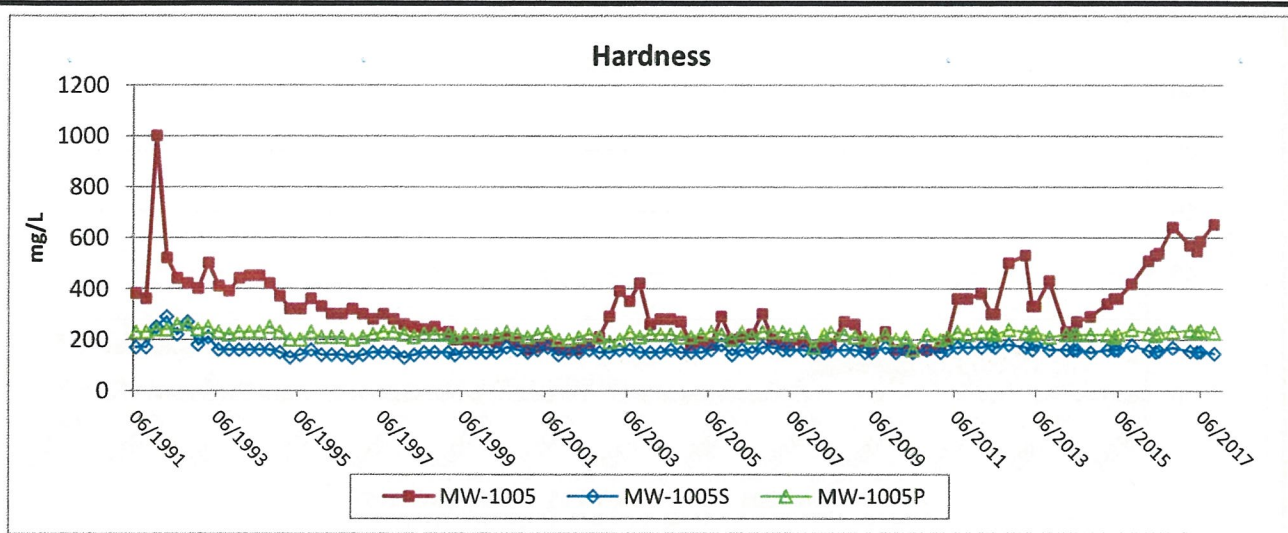
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Figure B-4a		
Groundwater Trend Graphs - Quarterly Results		
MW-1005/MW-1005S/MW-1005P		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00

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Note: Iron trend graphs are displayed on a logarithmic scale so the trend patterns of MW-1005, MW-1005S and MW-1005P are visible at different concentration scales.

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Figure B-4b

Groundwater Trend Graphs - Quarterly Results

MW-1005/MW-1005S/MW-1005P

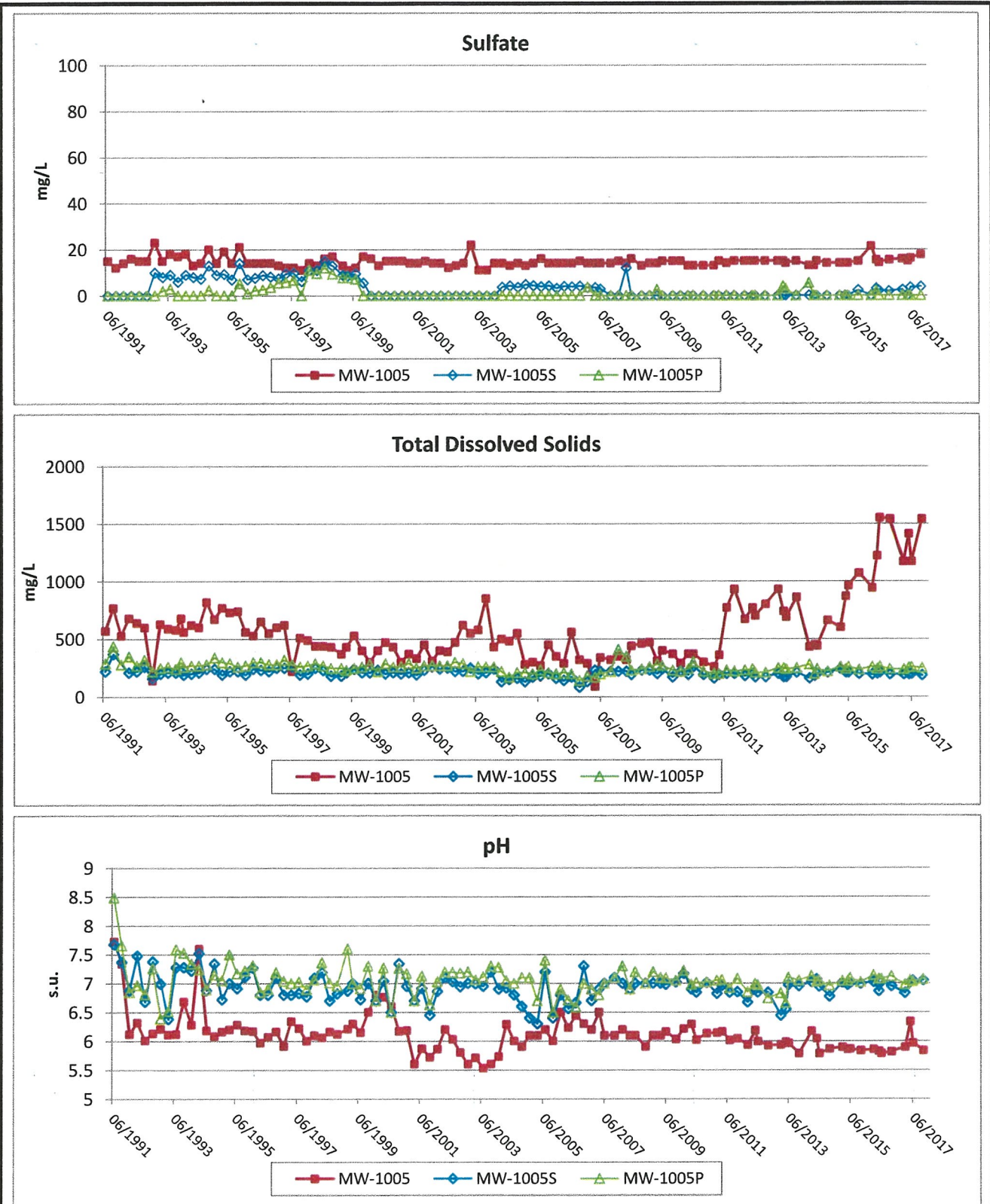
Scale: NA

Date: January 2018

Prepared By: SGL

Checked By: SVF

Scope: 17F777-00



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Figure B-4c

Groundwater Trend Graphs - Quarterly Results

MW-1005/MW-1005S/MW-1005P

Scale: NA

Date: January 2018

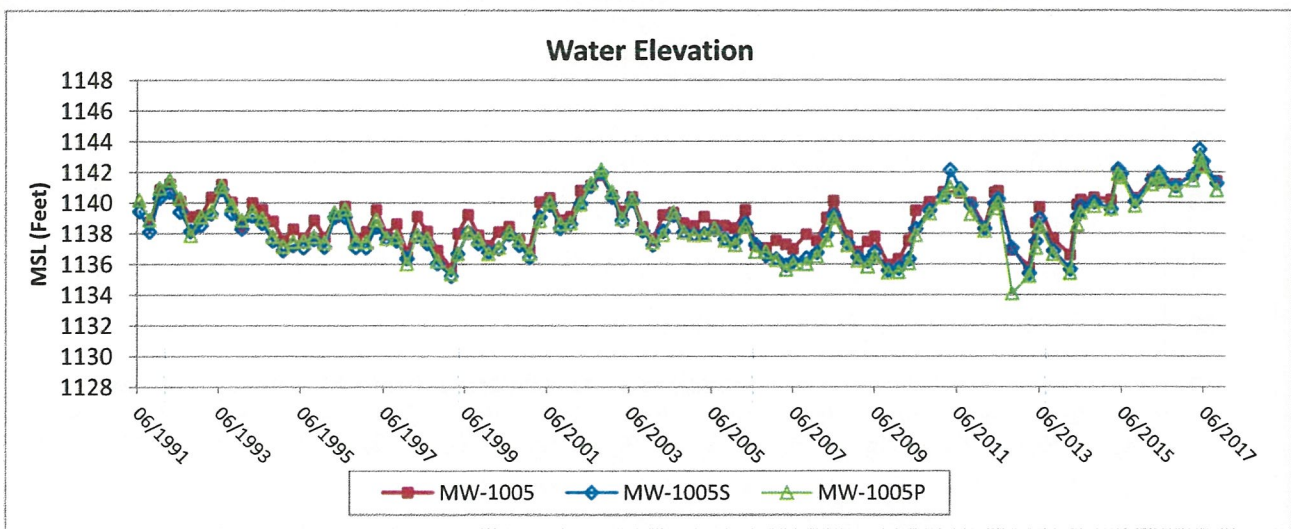
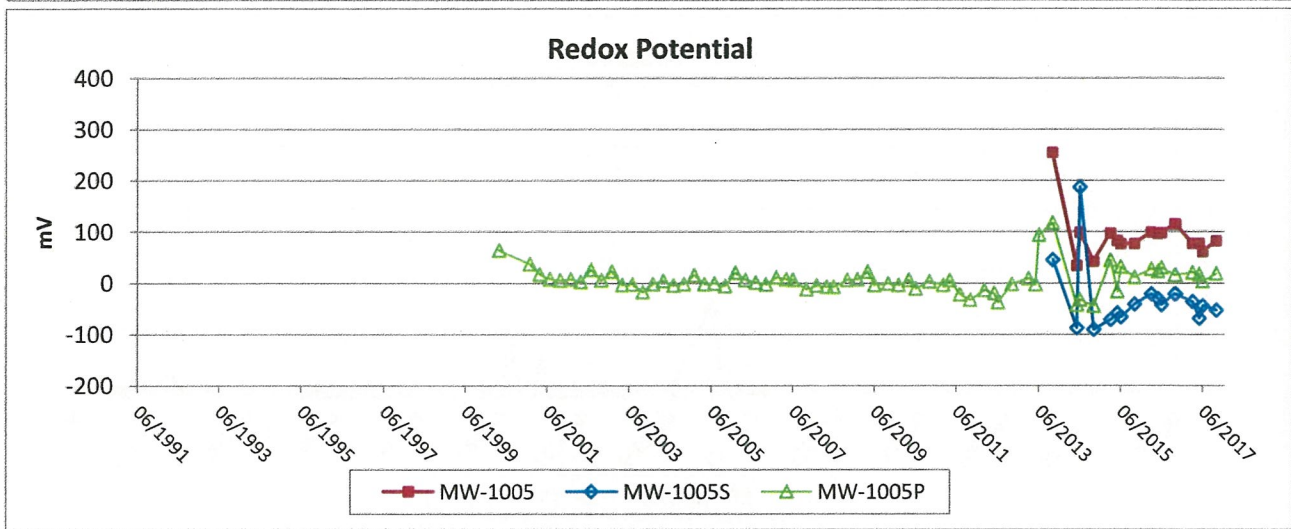
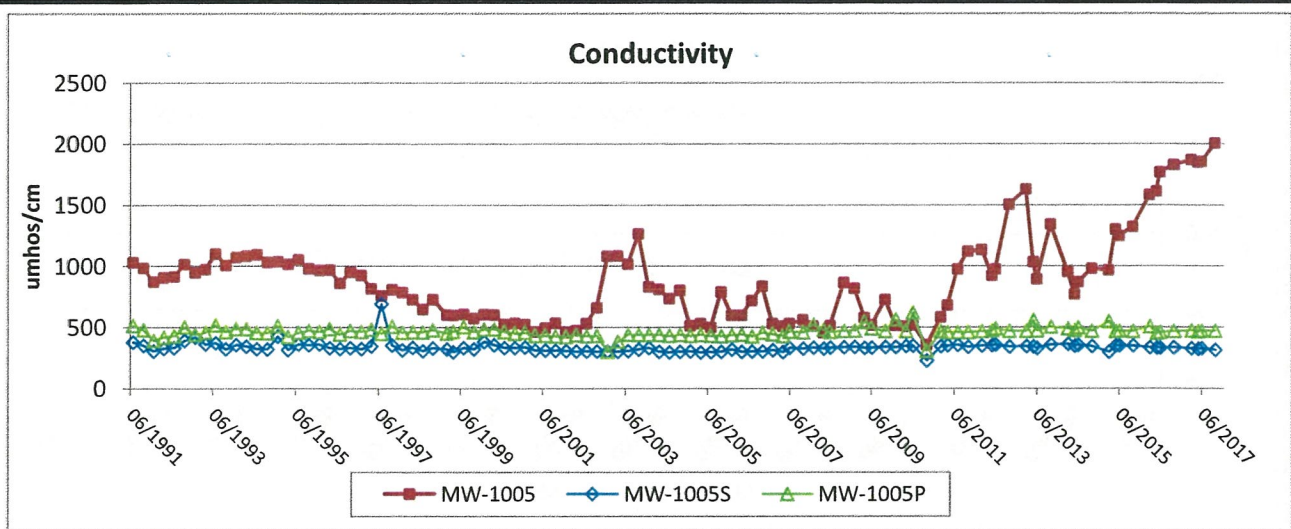
Prepared By: SGL

Checked By: SVF

Scope: 17F777-00

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Figure B-4d

Groundwater Trend Graphs - Quarterly Results

MW-1005/MW-1005S/MW-1005P

Scale: NA

Date: January 2018

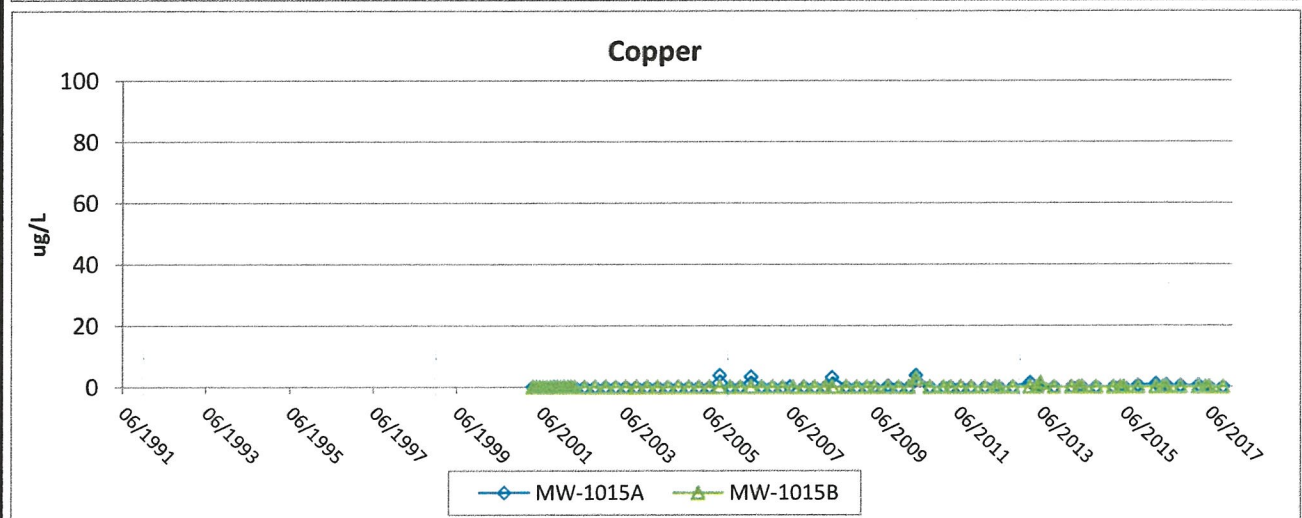
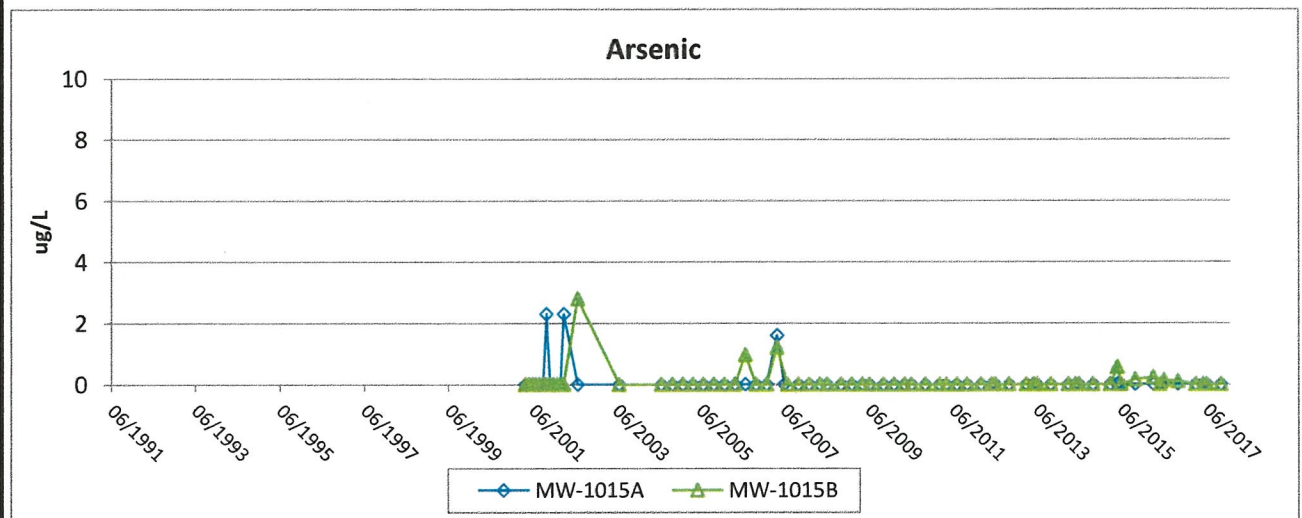
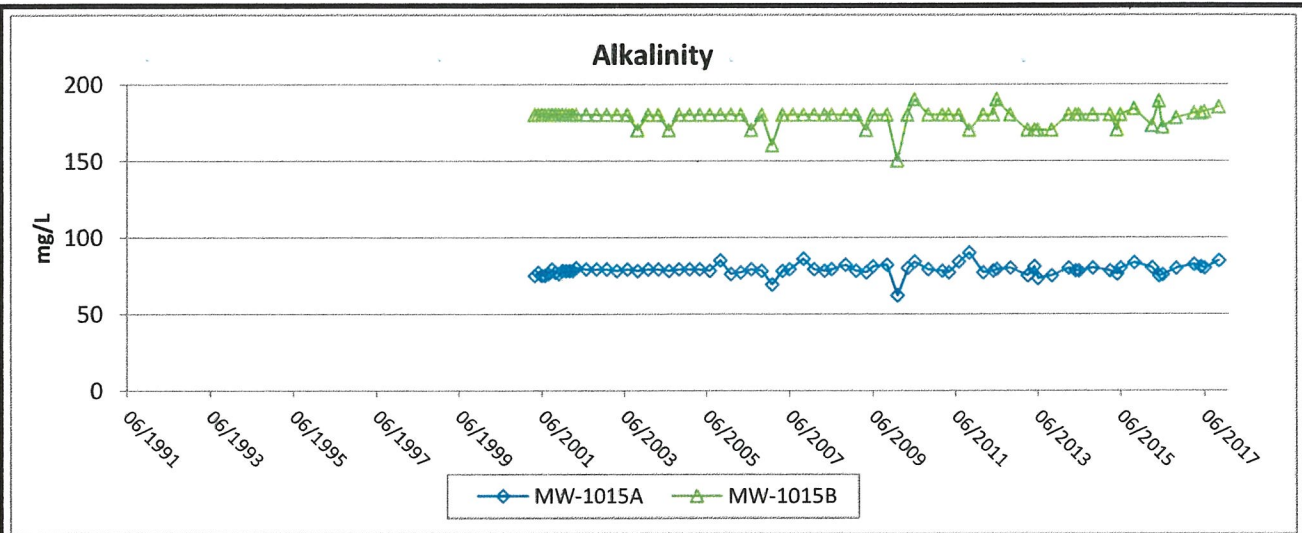
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Checked By: SVF

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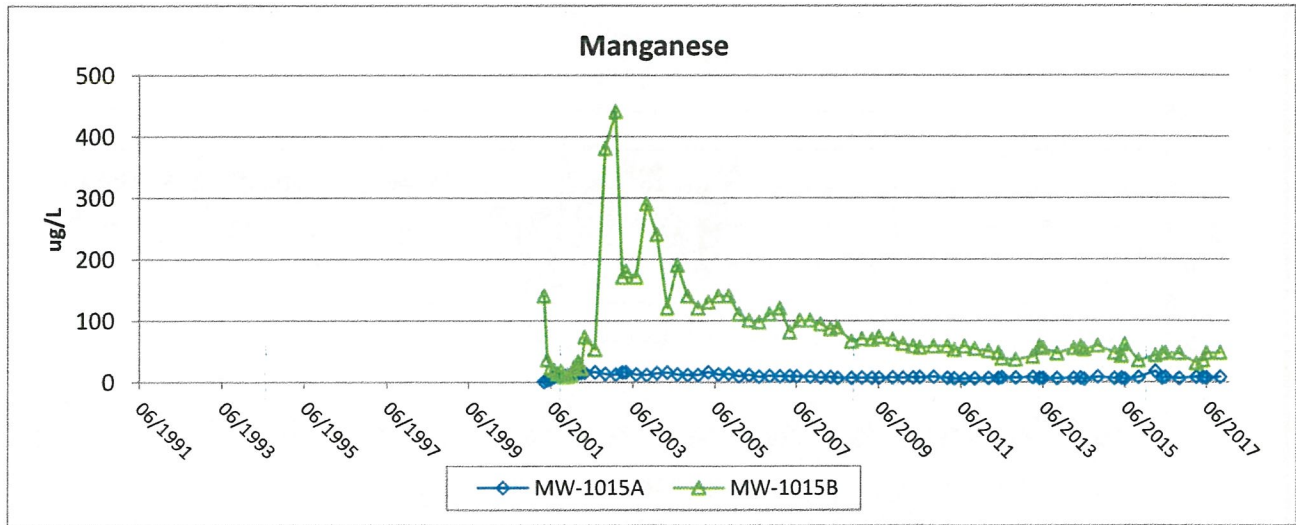
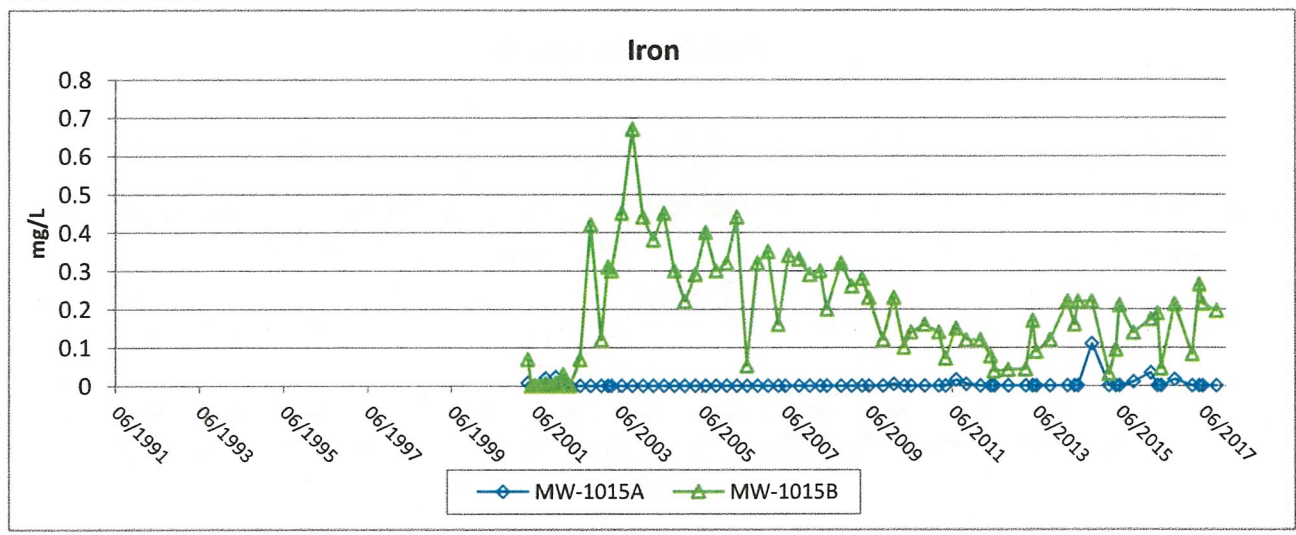
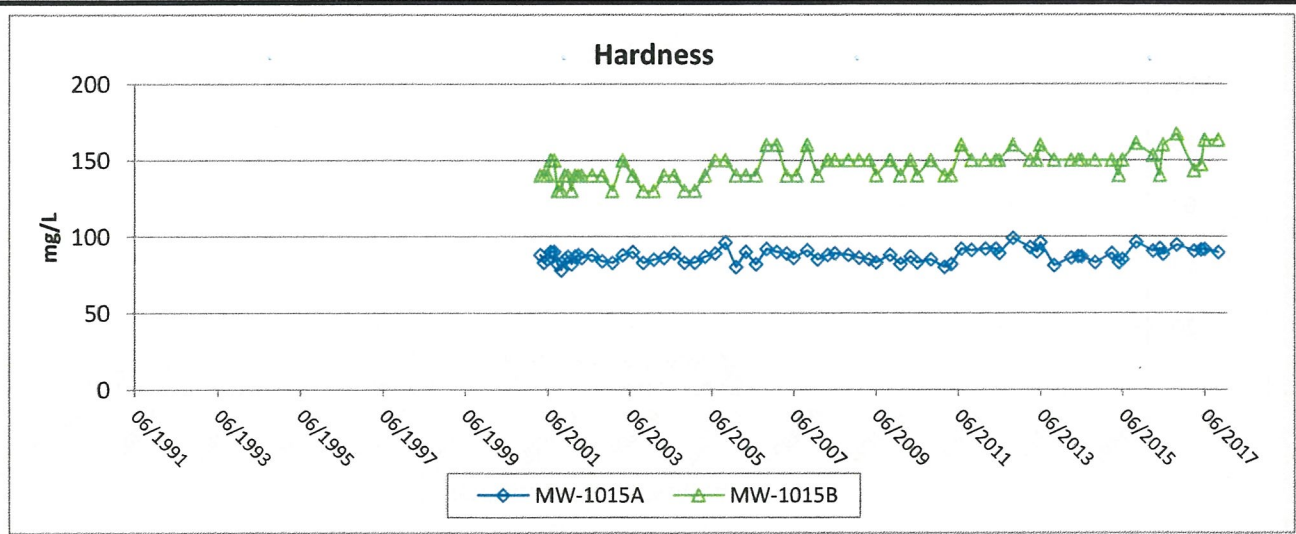
Figure B-5a


Groundwater Trend Graphs - Quarterly Results

MW-1015A/MW-1015B

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	

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Figure B-5b

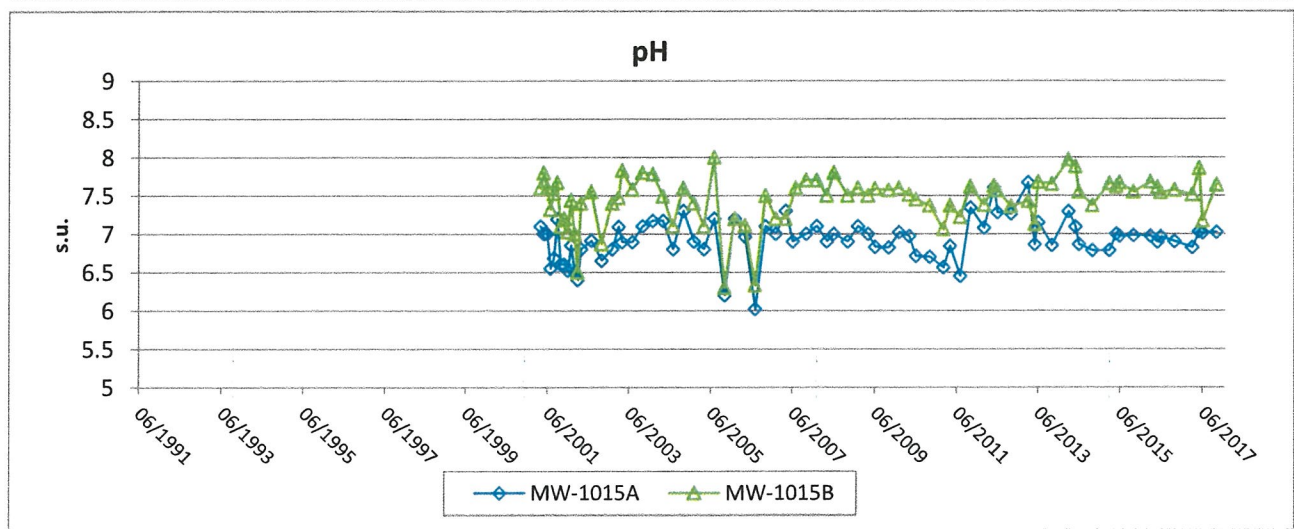
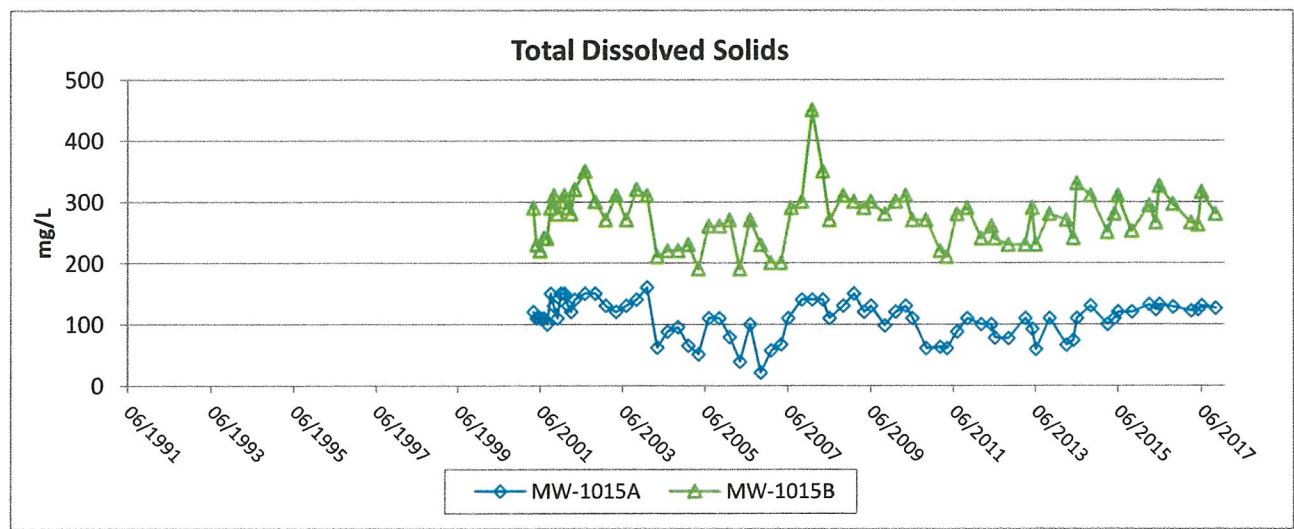
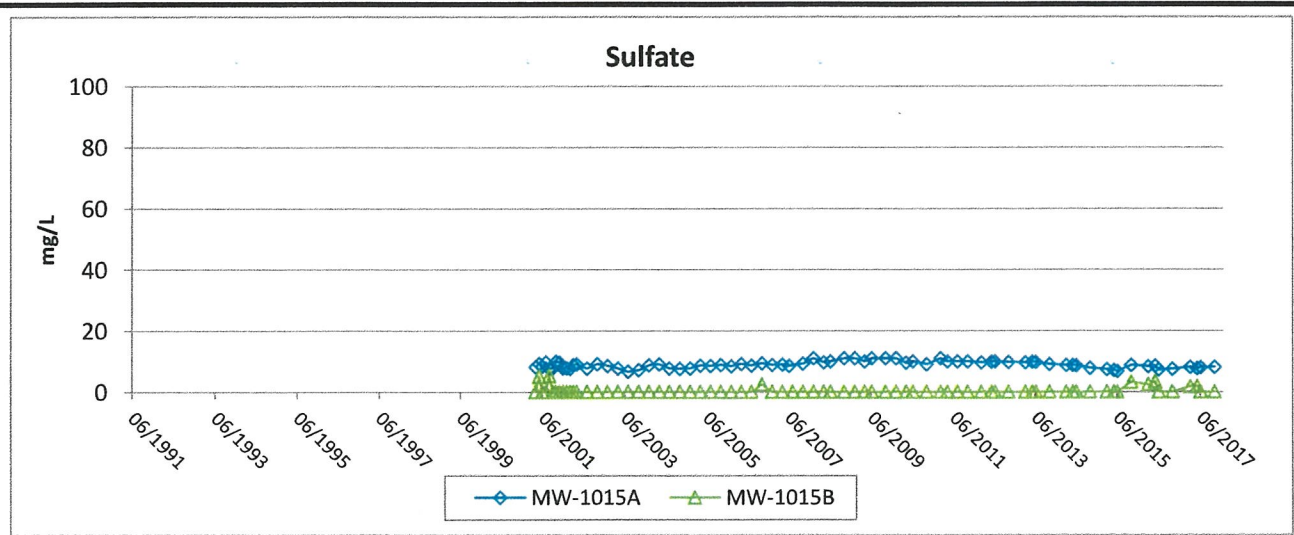
Groundwater Trend Graphs - Quarterly Results


MW-1015A/MW-1015B

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	

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Figure B-5c

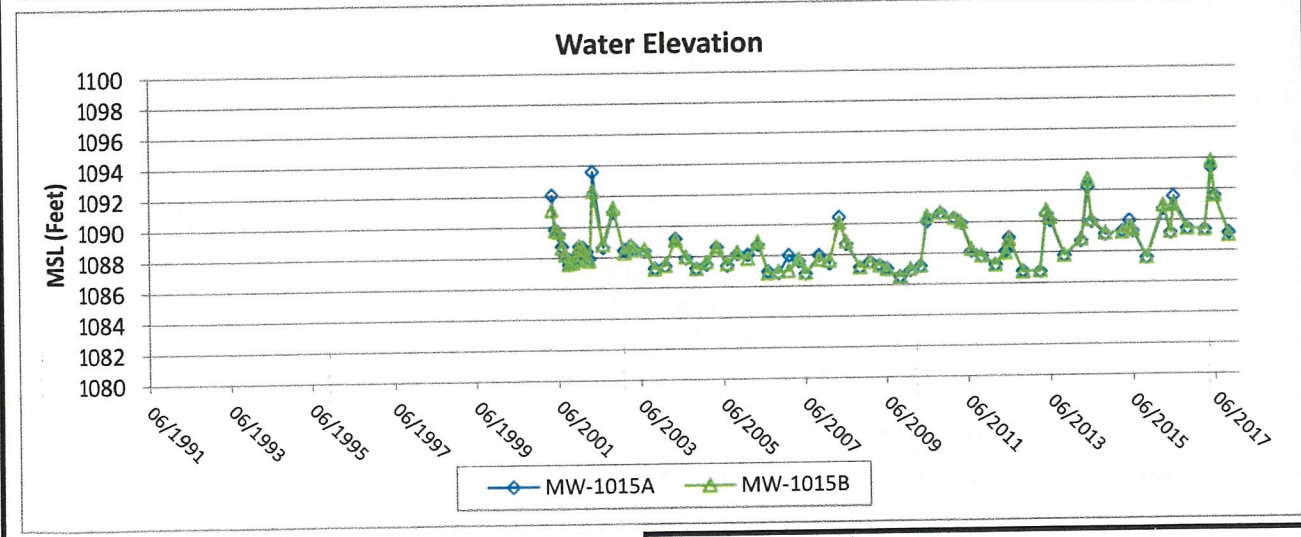
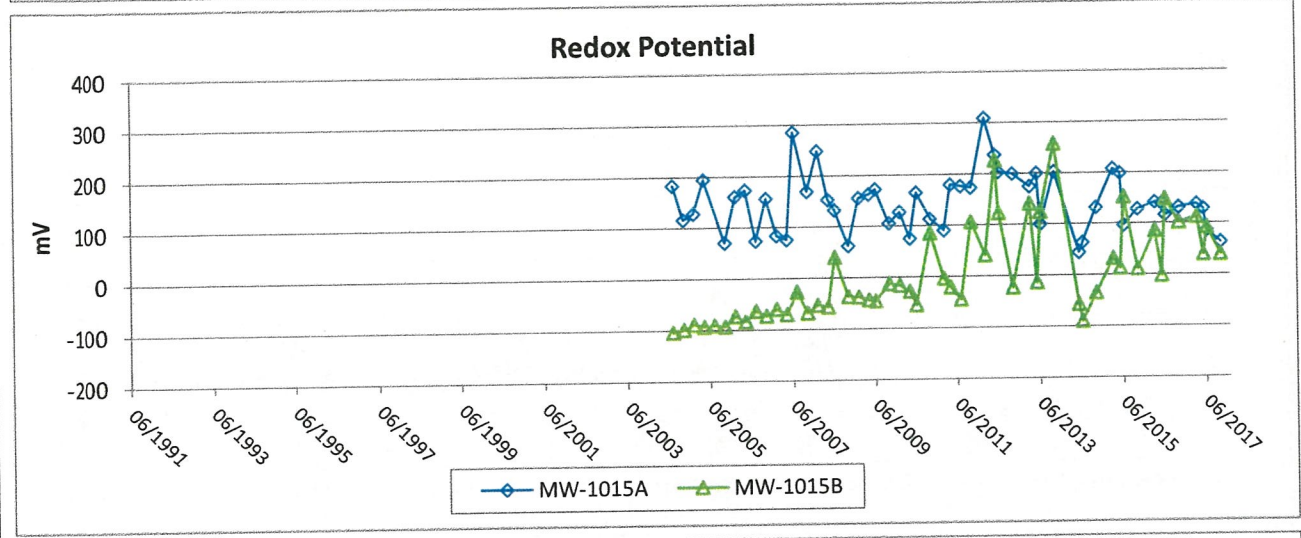
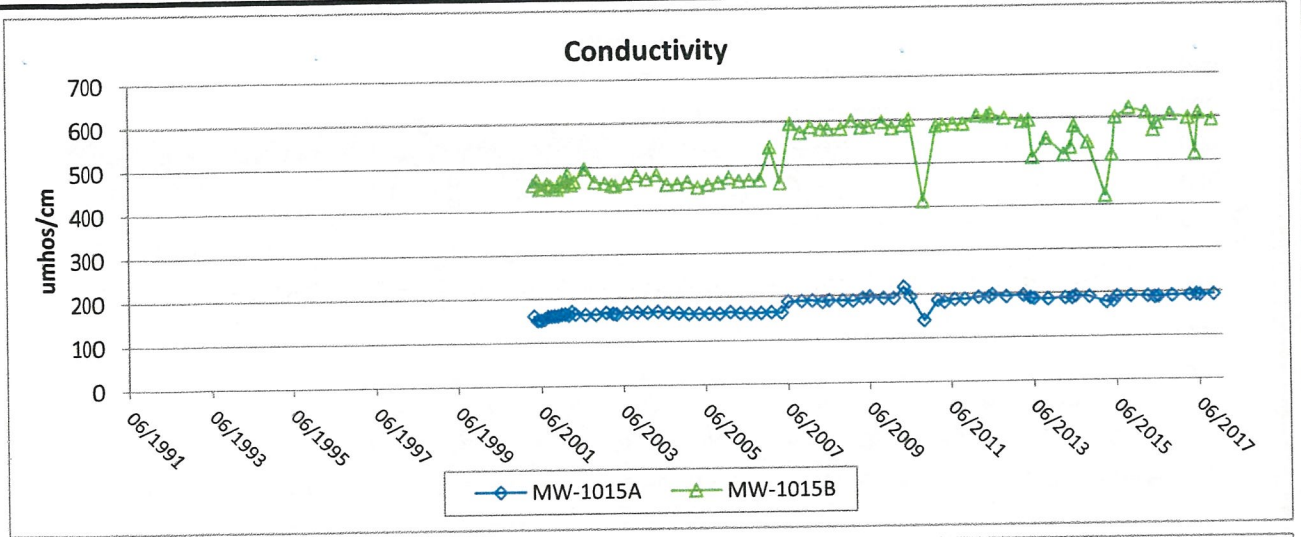
Groundwater Trend Graphs - Quarterly Results

MW-1015A/MW-1015B

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	

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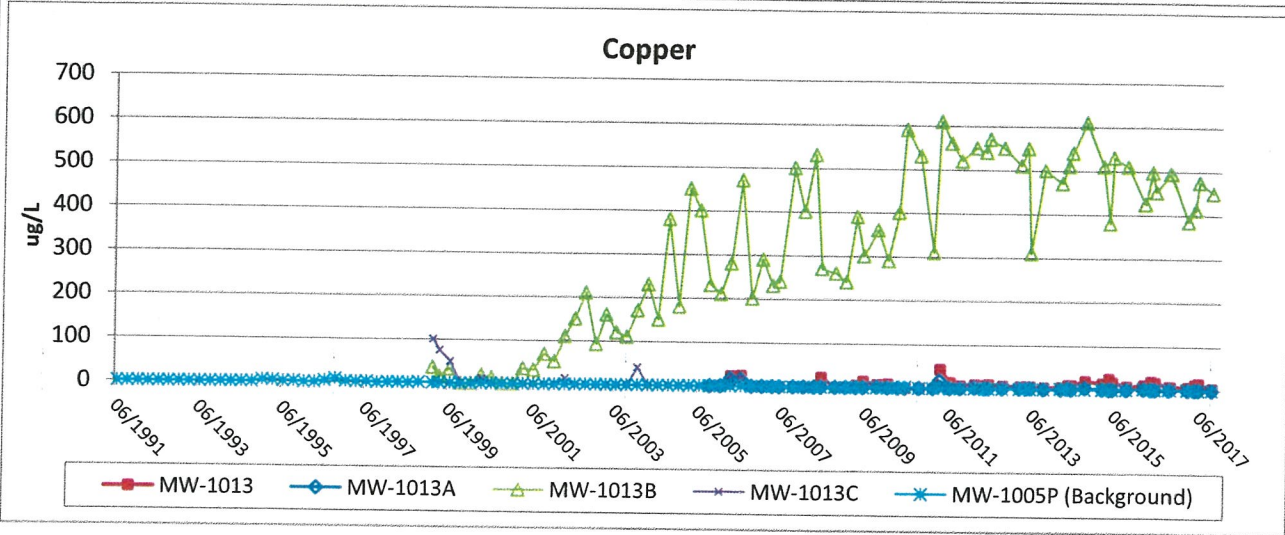
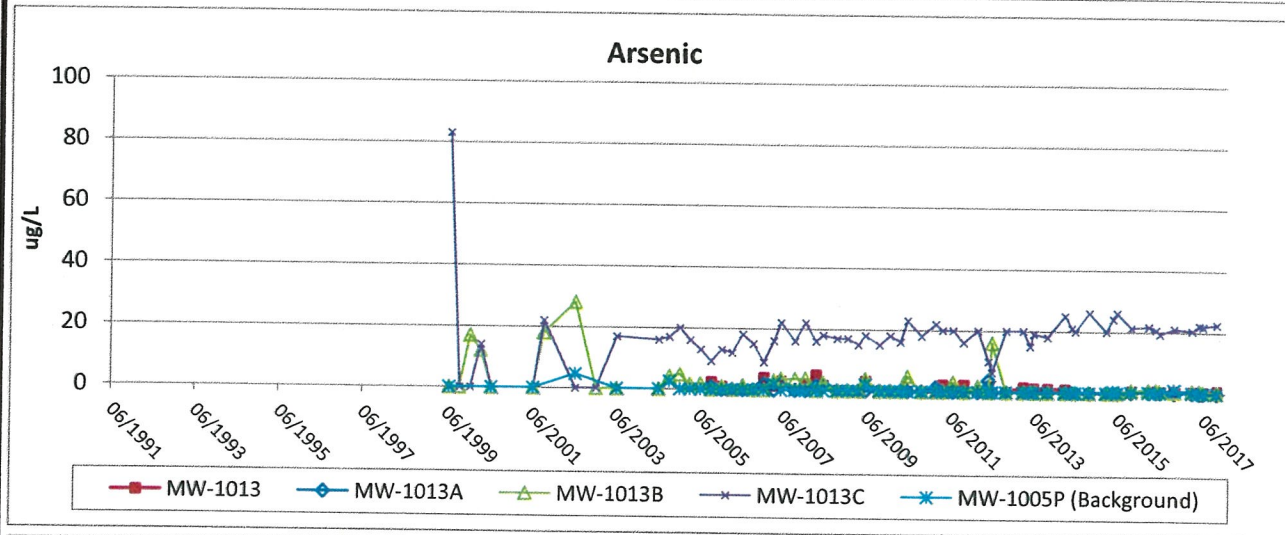
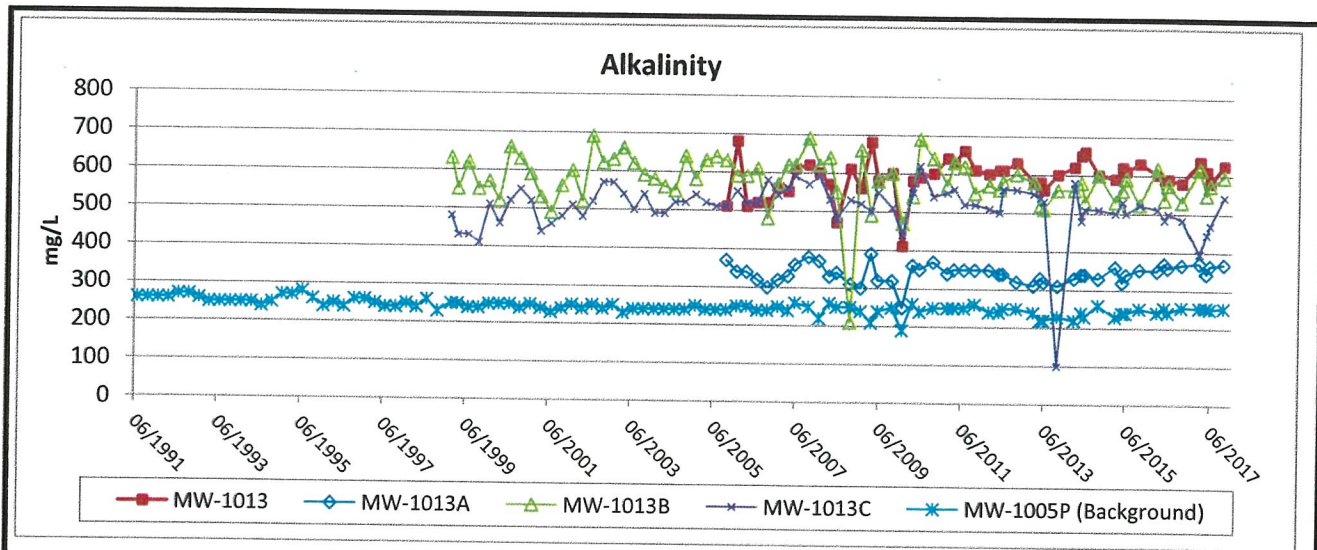
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Figure B-5d		
Groundwater Trend Graphs - Quarterly Results		
MW-1015A/MW-1015B		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00

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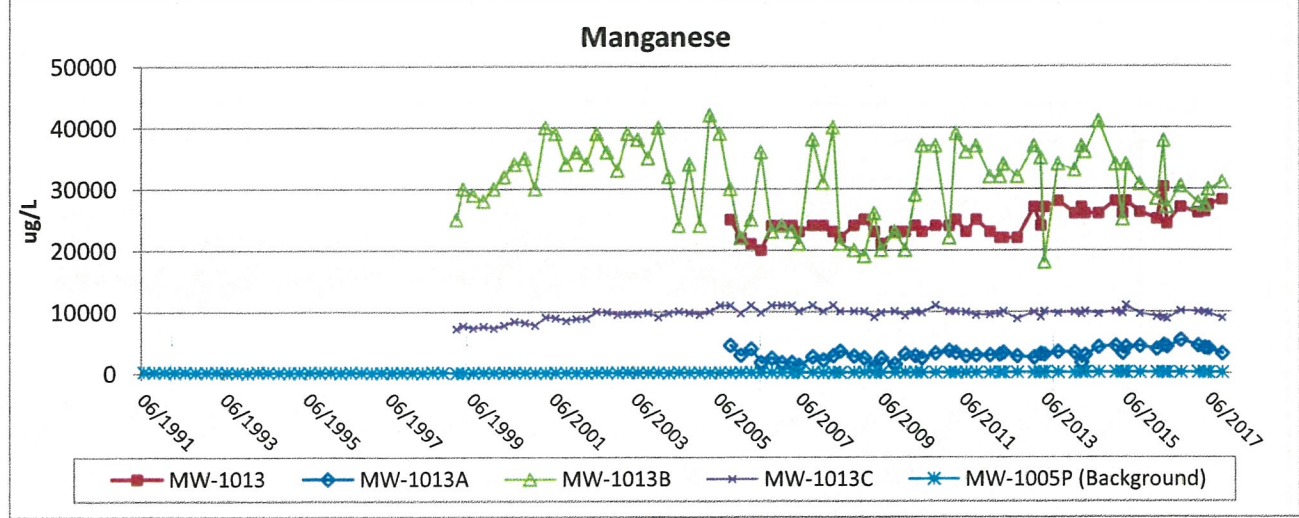
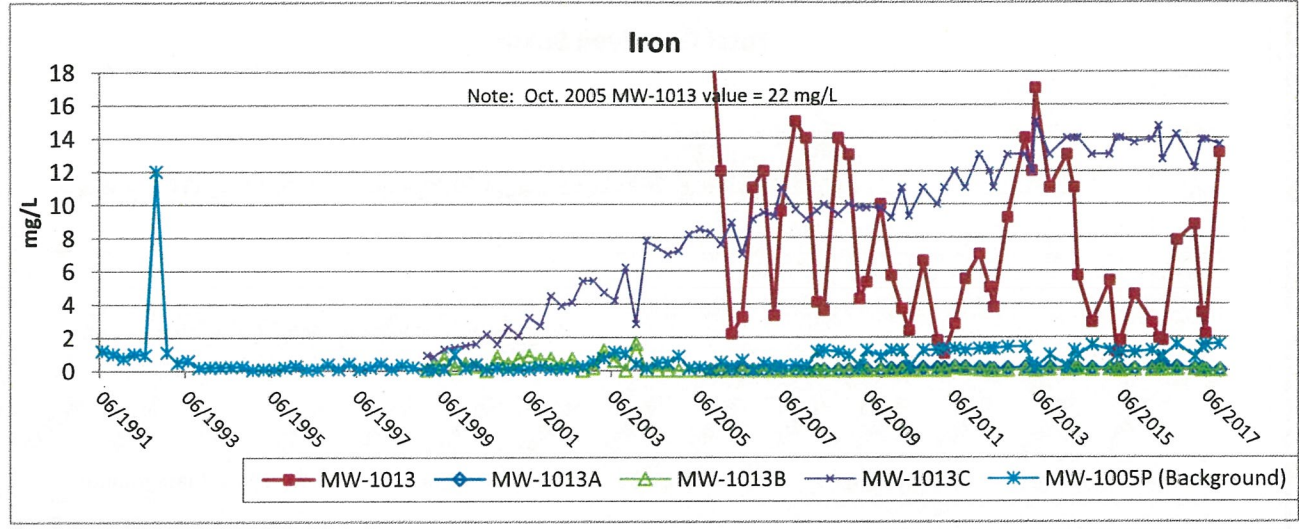
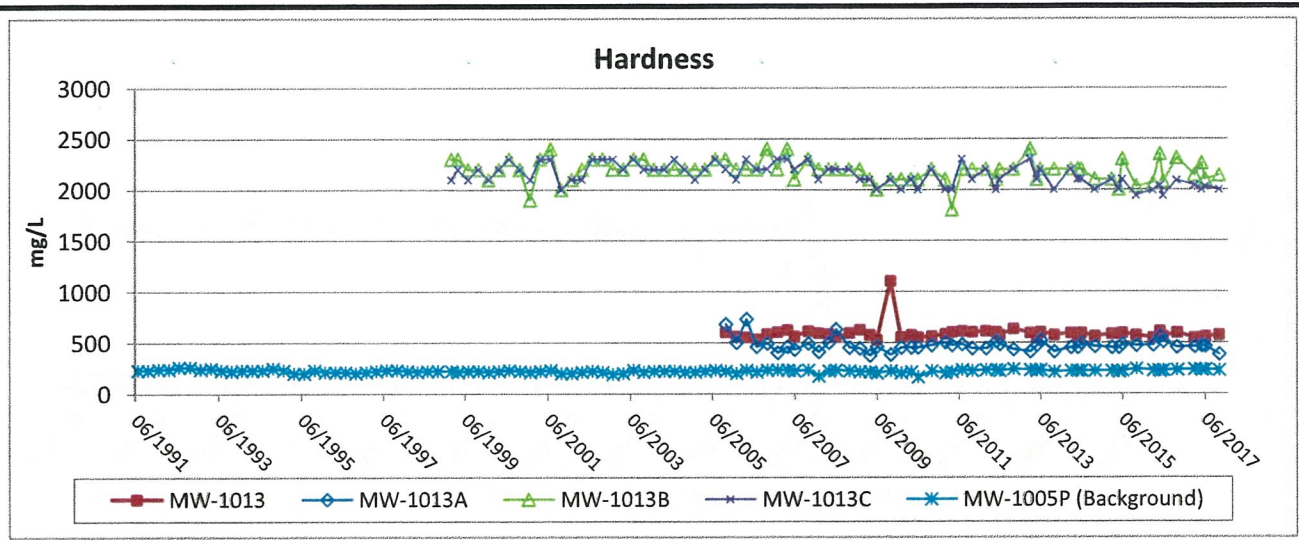


Note: Fourth quarter 2005 was the first time MW-1013 had sufficient water recovery for sampling.

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Figure B-6a		
Groundwater Trend Graphs - Quarterly Results (In-Pit Wells)		
MW-1013/MW-1013A/MW-1013B/MW-1013C		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00

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Figure B-6b

Groundwater Trend Graphs - Quarterly Results (In-Pit Wells)
MW-1013/MW-1013A/MW-1013B/MW-1013C

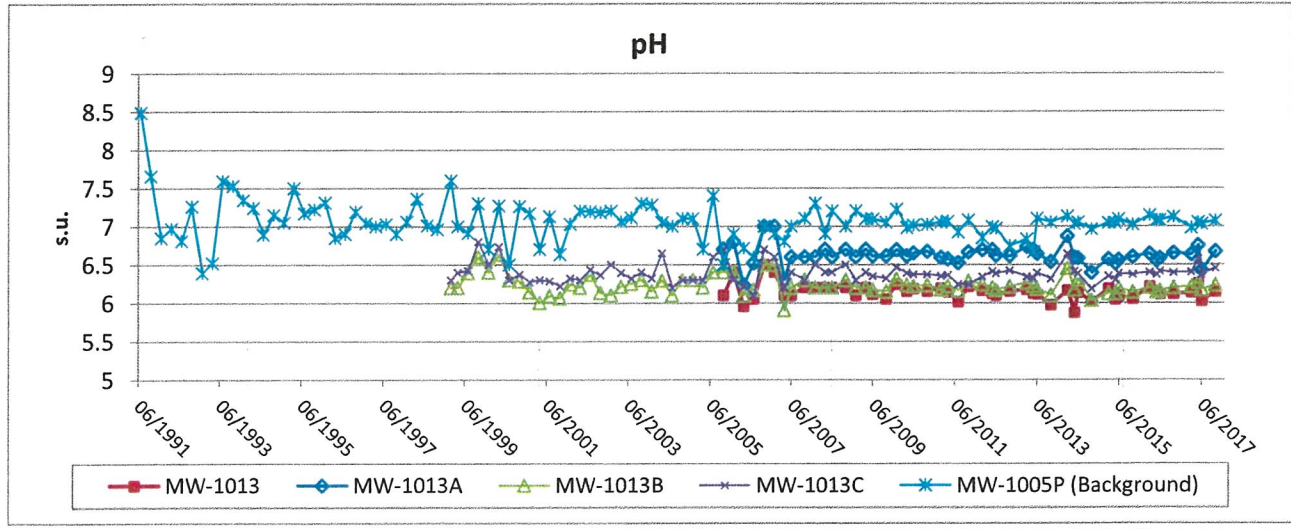
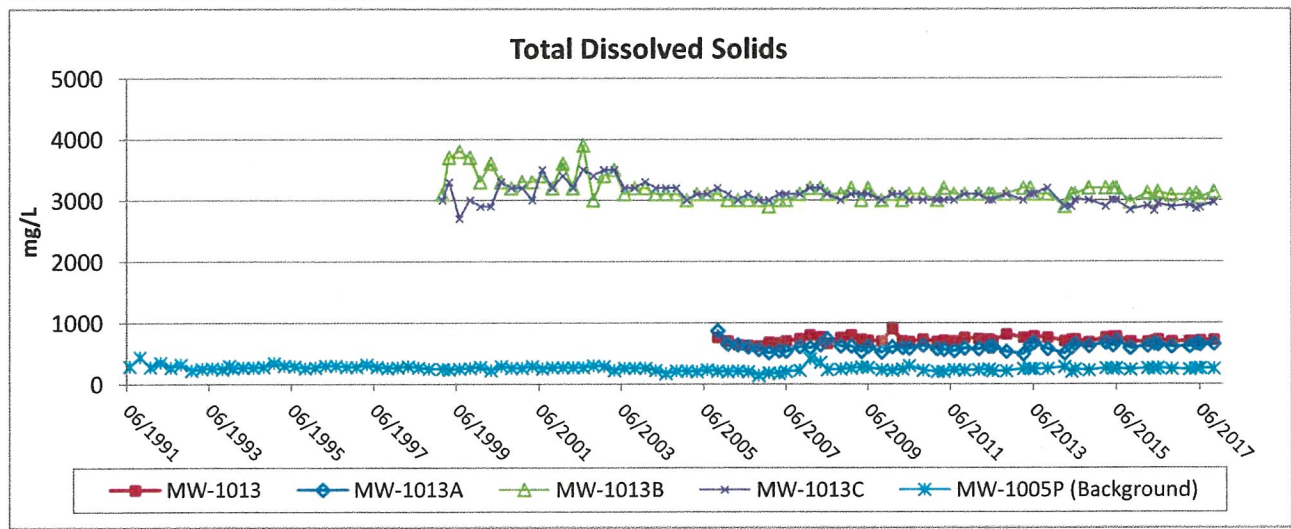
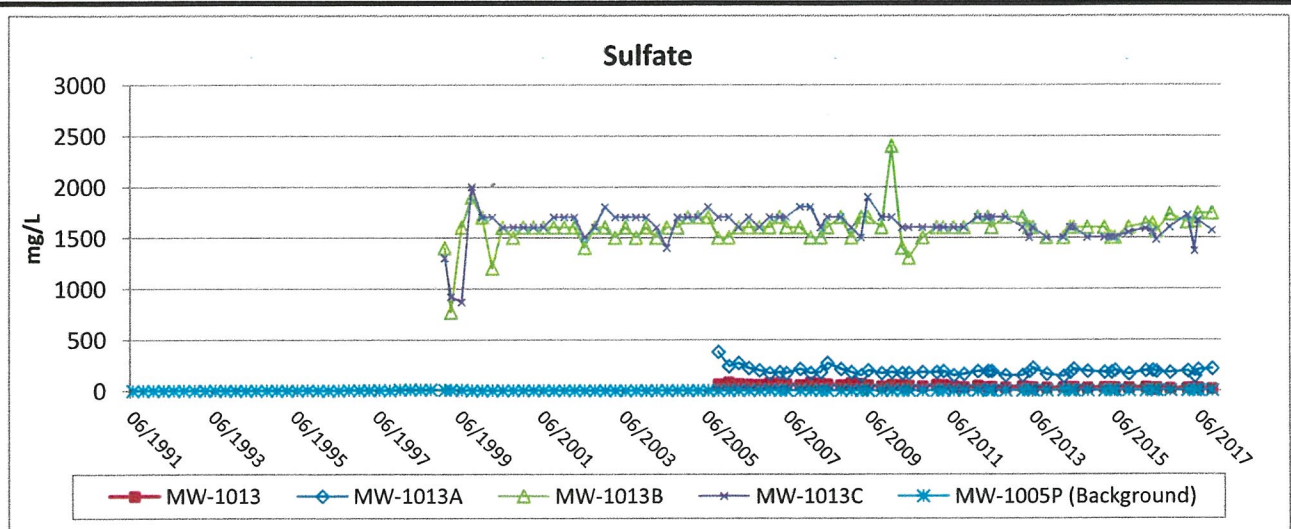
Scale: NA


Date: January 2018

Prepared By: SGL

Checked By: SVF

Scope: 17F777-00





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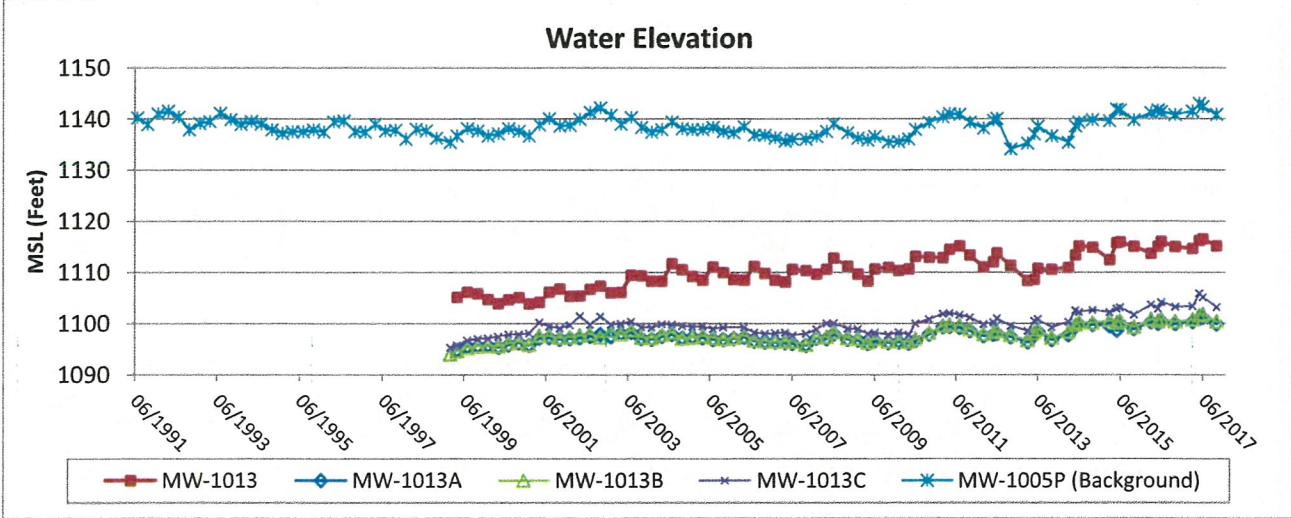
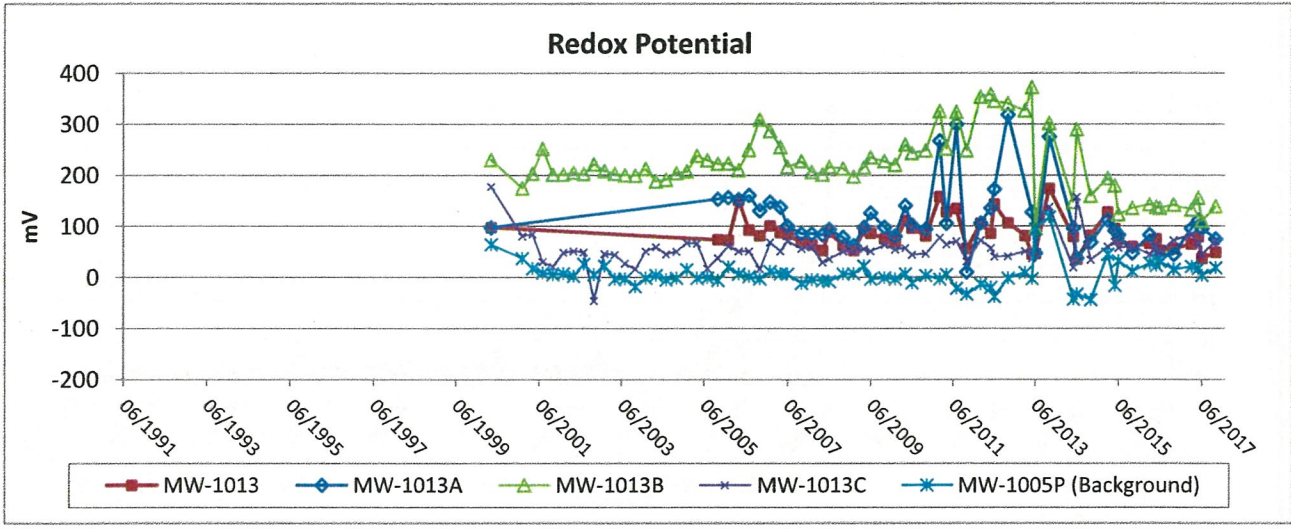
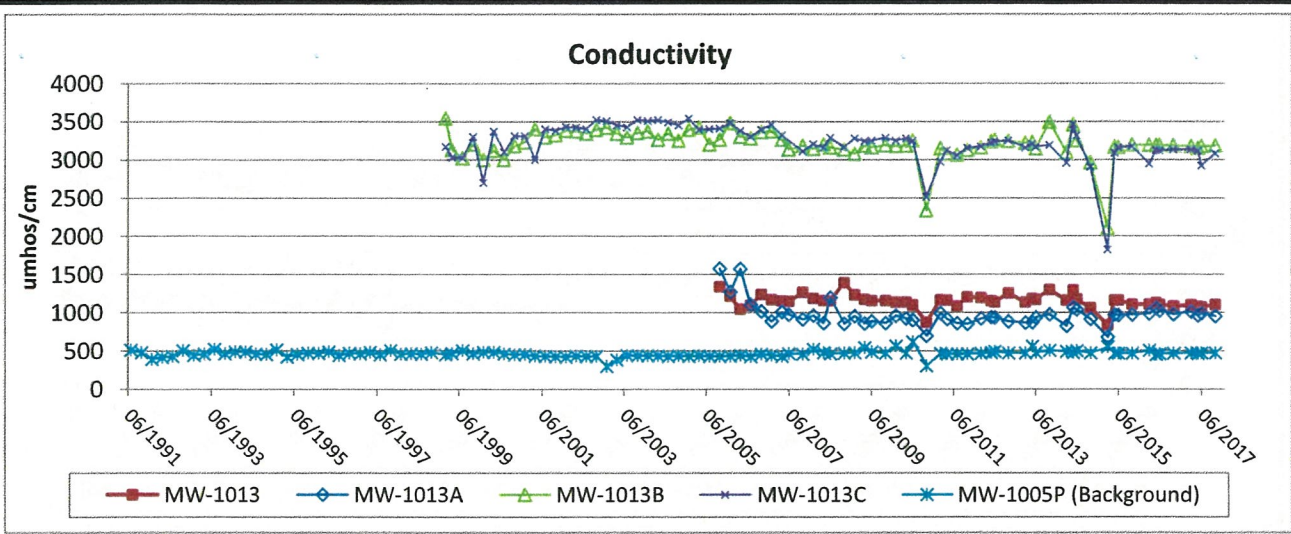
Figure B-6c


Groundwater Trend Graphs - Quarterly Results (In-Pit Wells)

MW-1013/MW-1013A/MW-1013B/MW-1013C

Scale: NA	Date: January 2018
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Figure B-6d

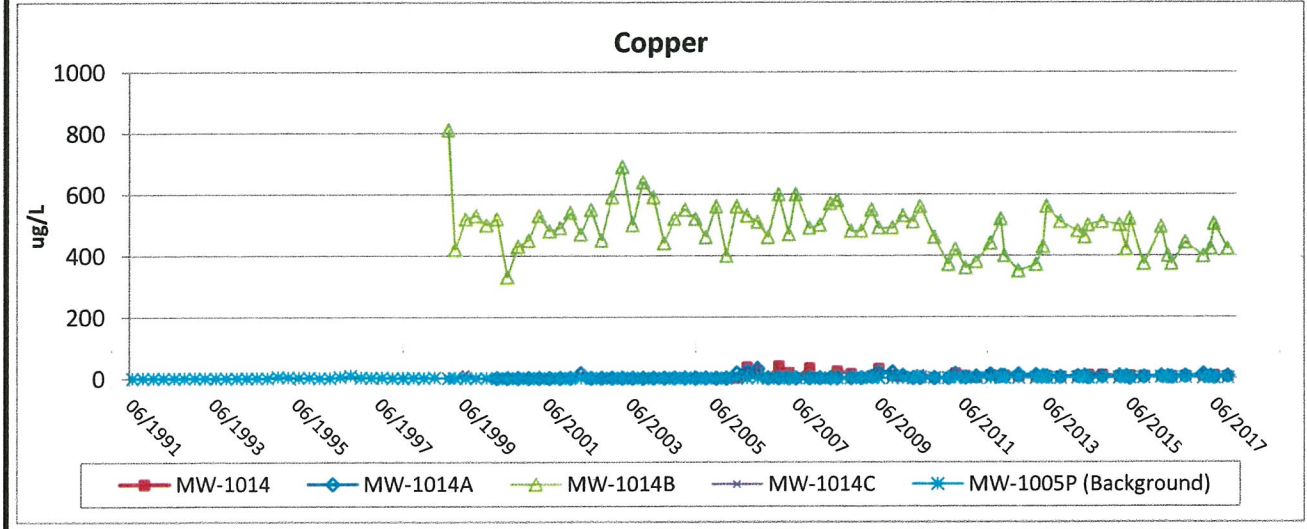
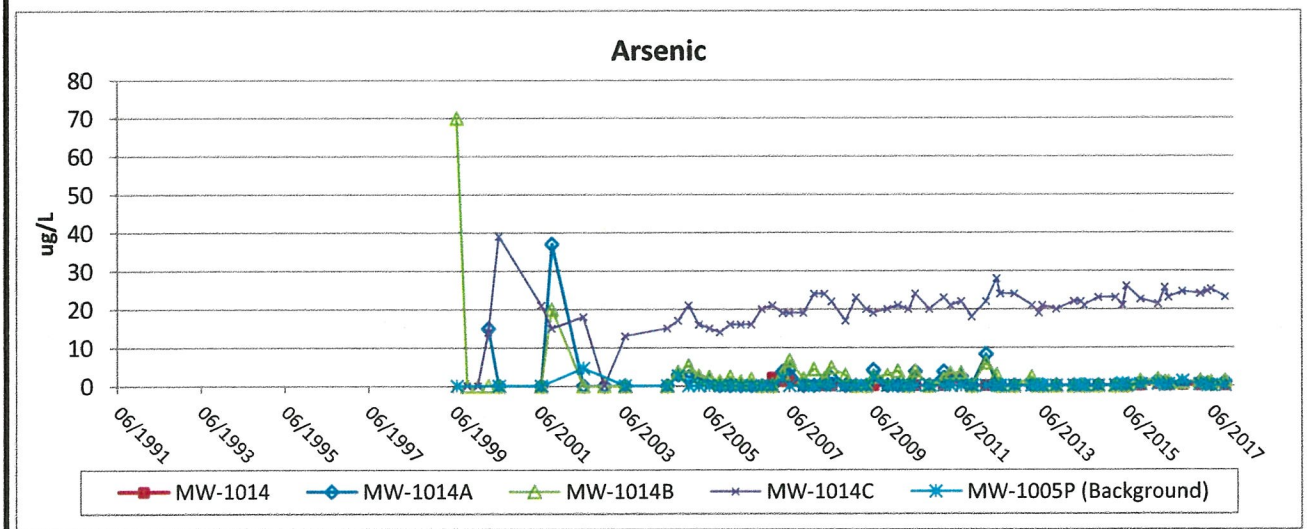
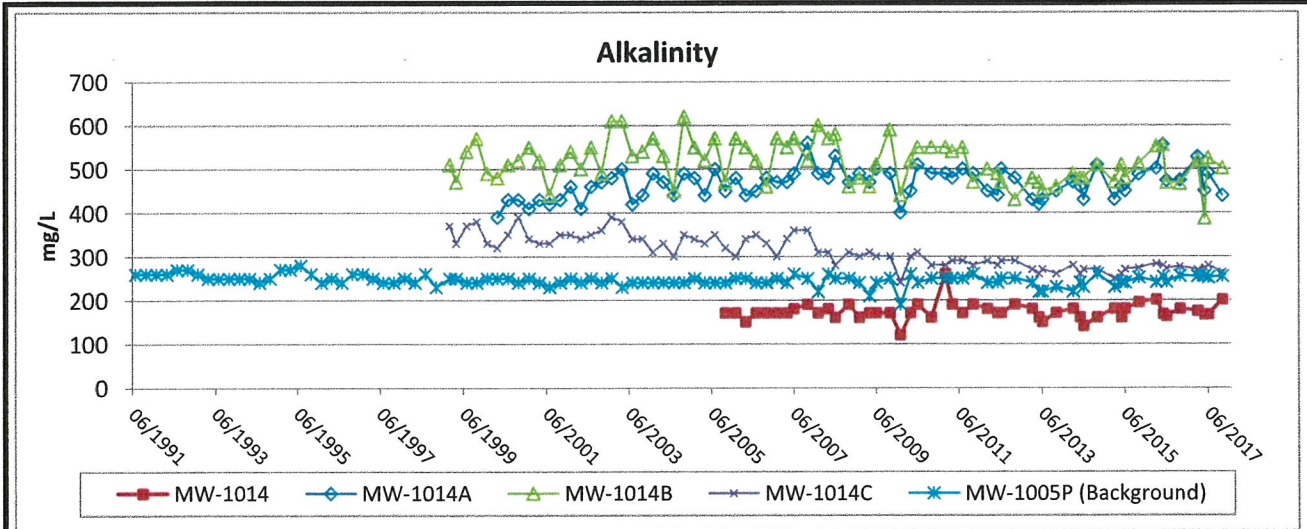
Groundwater Trend Graphs - Quarterly Results (In-Pit Wells)


MW-1013/MW-1013A/MW-1013B/MW-1013C

Scale: NA Date: January 2018

Prepared By: SGL Checked By: SVF Scope: 17F777-00

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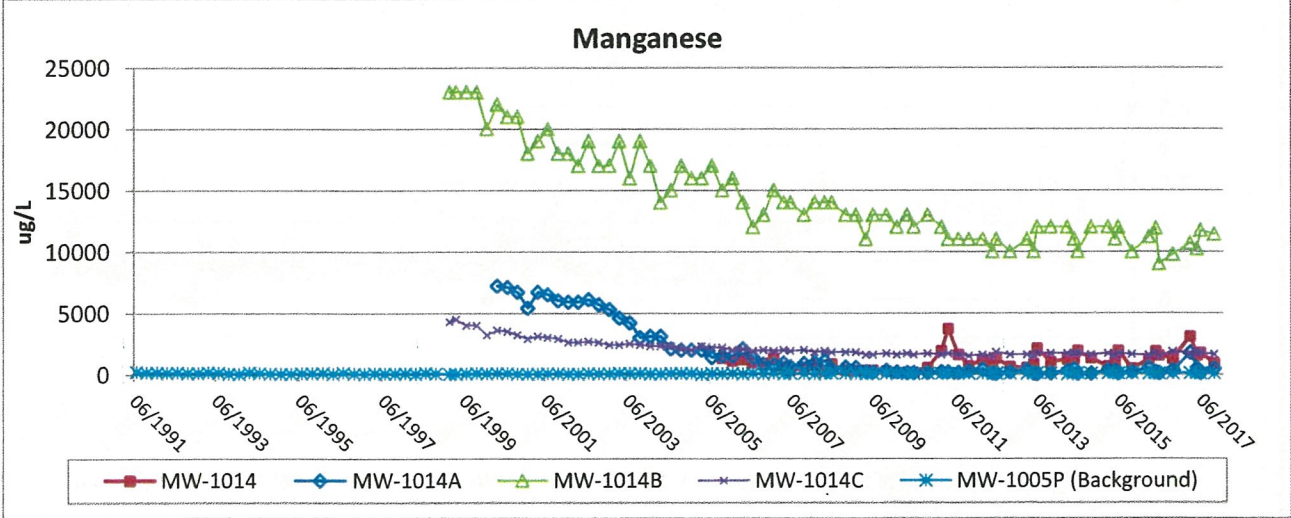
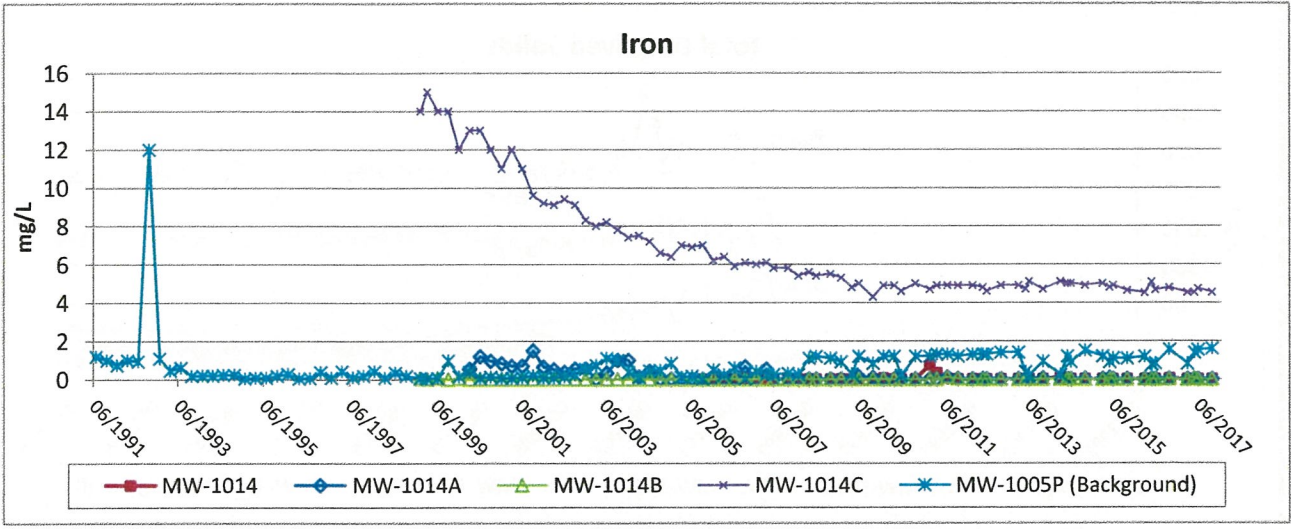
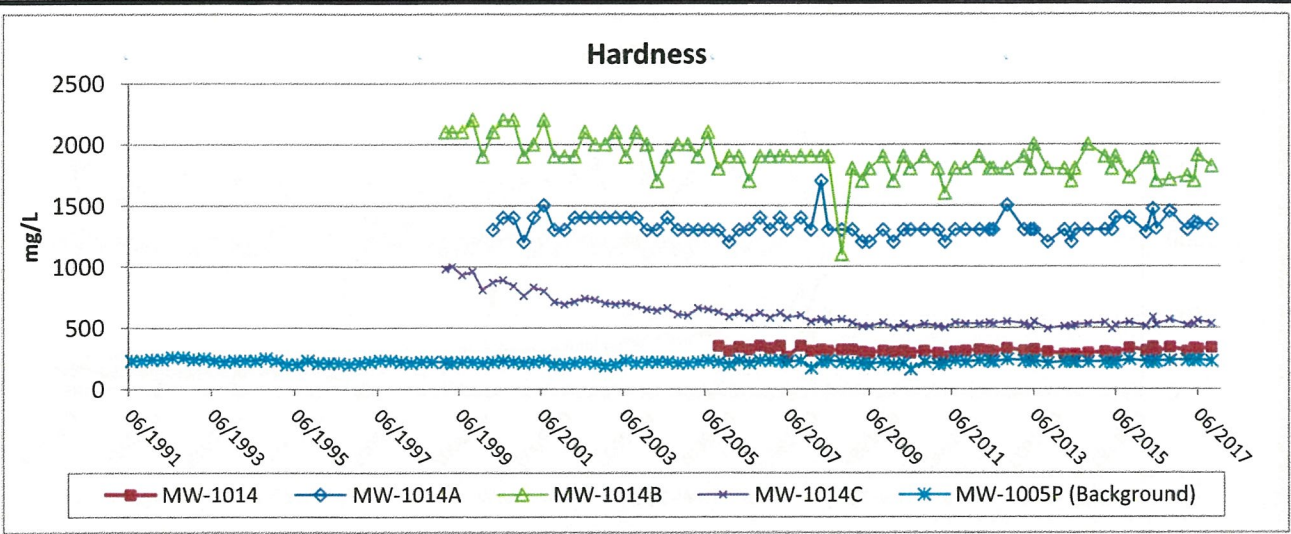
Figure B-7a

Groundwater Trend Graphs - Quarterly Results (In-Pit Wells)

MW-1014/MW-1014A/MW-1014B/MW-1014C

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	

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Figure B-7b

Groundwater Trend Graphs - Quarterly Results (In-Pit Wells)
 MW-1014/MW-1014A/MW-1014B/MW-1014C

Scale: NA

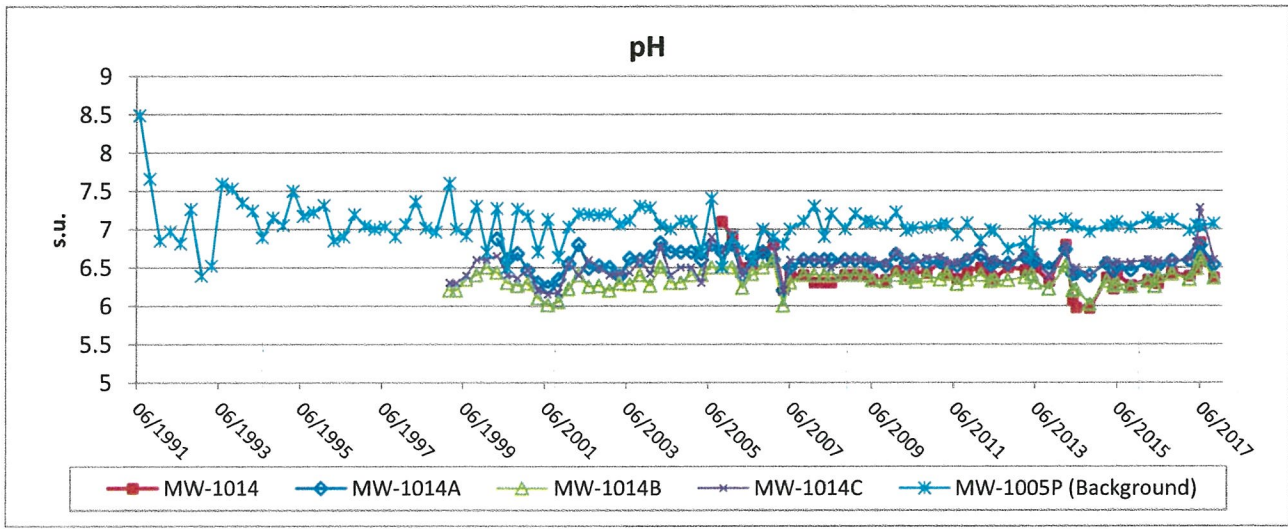
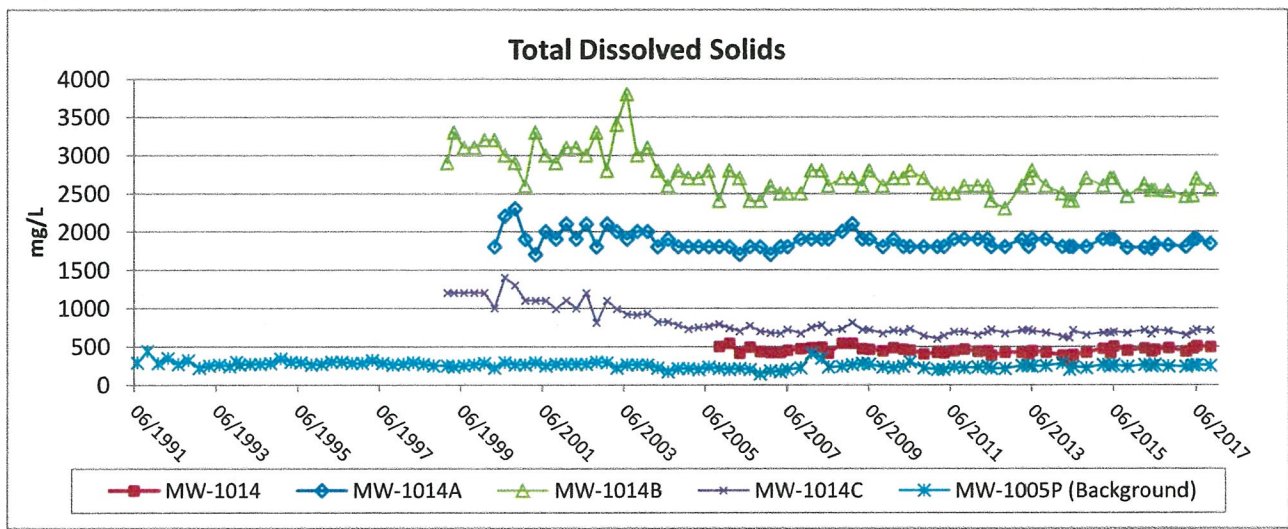
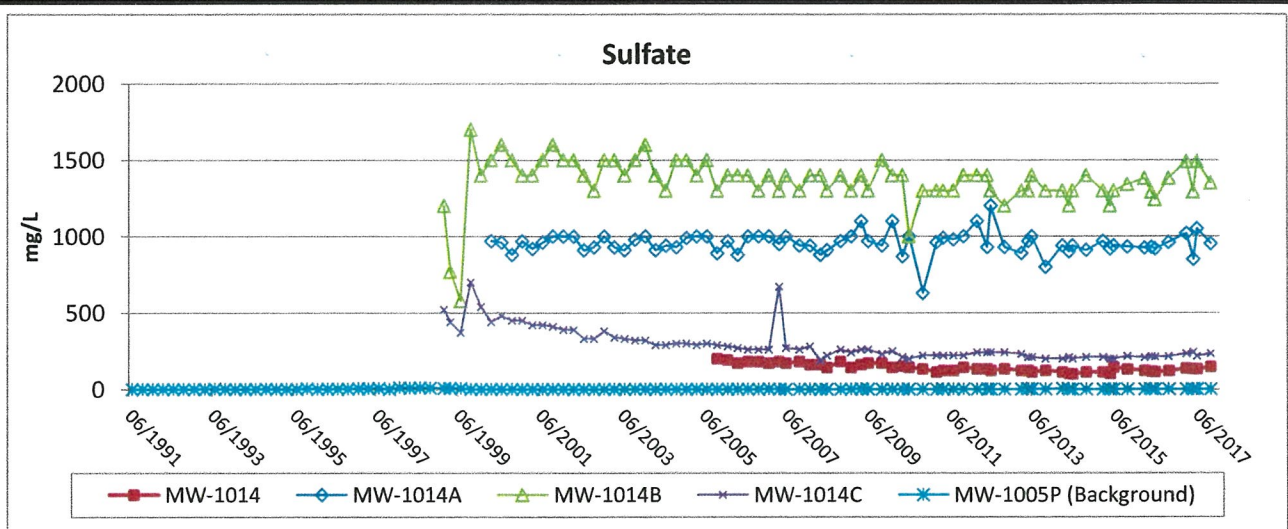
Date: January 2018


Prepared By: SGL

Checked By: SVF

Scope: 17F777-00

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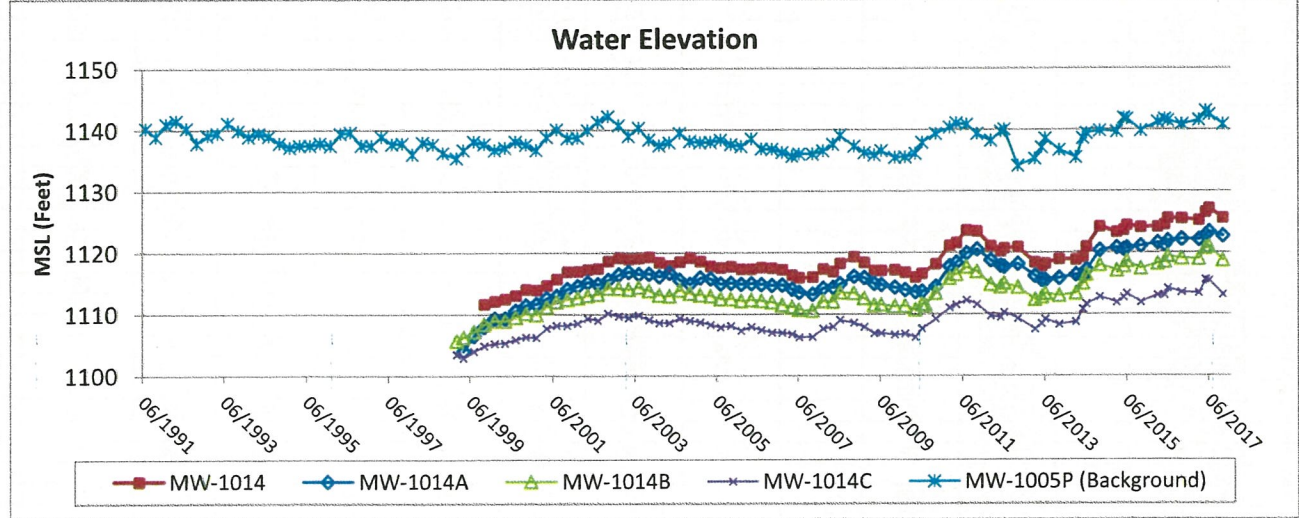
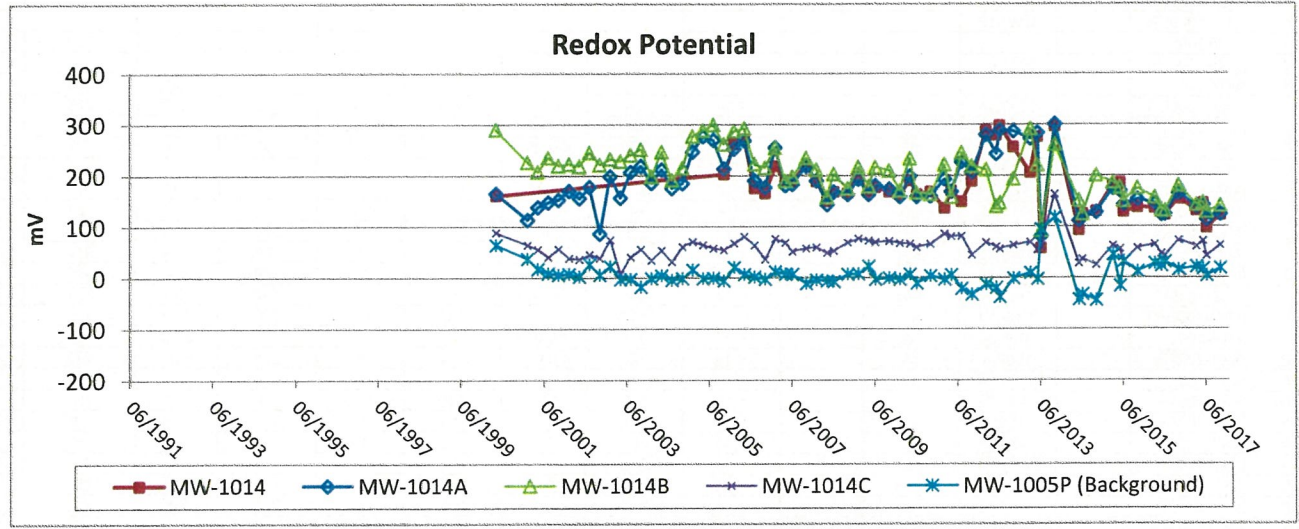
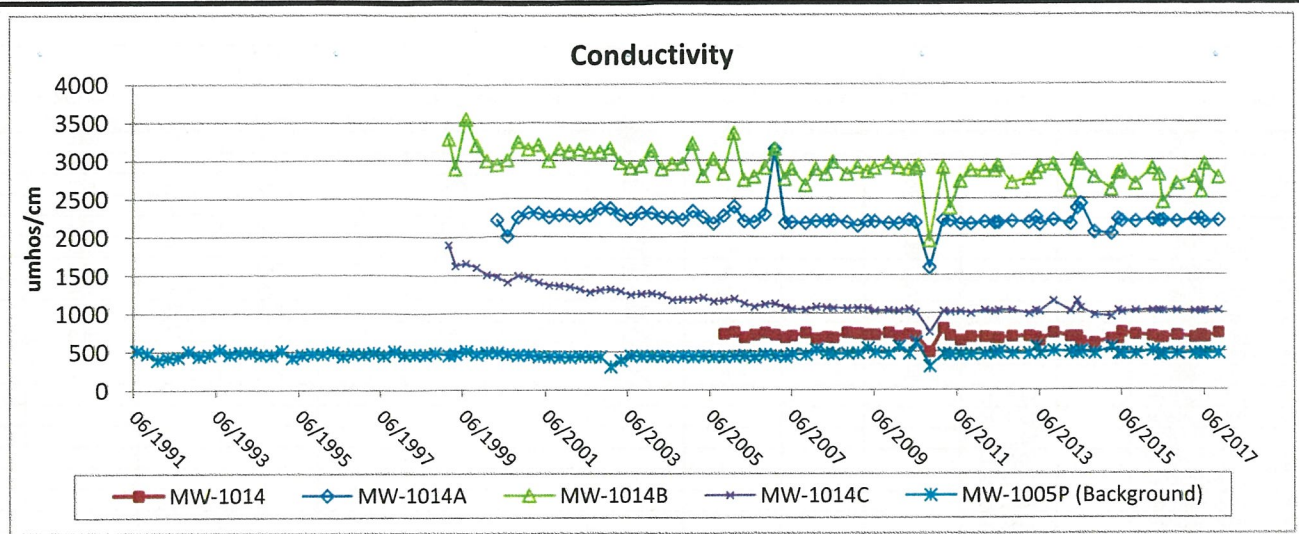
Figure B-7c


Groundwater Trend Graphs - Quarterly Results (In-Pit Wells)

MW-1014/MW-1014A/MW-1014B/MW-1014C

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
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Figure B-7d

Groundwater Trend Graphs - Quarterly Results (In-Pit Wells)

MW-1014/MW-1014A/MW-1014B/MW-1014C

Scale: NA Date: January 2018

Prepared By: SGL Checked By: SVF Scope: 17F777-00

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Historical Groundwater Results - Quarterly Parameters

Sample Date	Location	Water Elevation ft	Alkalinity as		Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
			CaCO3 mg/l	Arsenic ug/l									
1987-10	MW-1005		64		< 5	370	7.2	1400	16	640	5.5	844	
1987-11	MW-1005		74		< 5	380	6.1	1100	16	610	5.6	816	
1987-12	MW-1005		64		< 5	380	13	750	17	650	5.79	822	
1988-01	MW-1005		70		< 6	380	12	650	8	640	5.6	787	
1988-02	MW-1005		80		5	390	12	750	22	550	5.51	867	
1988-03	MW-1005		60		16	390	7.9	710	20	630	5.25	880	
1988-04	MW-1005		60		18	360	3.5	630	17	580	5.91	868	
1988-05	MW-1005		72		< 10	400	15	560	18	730	5.96	954	
1988-06	MW-1005		81		< 10	350	21	620	9	770	6.05	924	
1988-07	MW-1005		81		25	340	19	640	17	650	7.01	468	
1988-08	MW-1005		60		15	330	1.1	450	20	1000	6.1	825	
1988-09	MW-1005		93		< 10	380	12	560	< 25	690	5.58	842	
1989-01	MW-1000PR	1088.83											
1989-04	MW-1000PR	1088.75											
1989-07	MW-1000PR	1090.13											
1989-11	MW-1000PR	1088.04											
1990-01	MW-1000PR	1087.46											
1990-04	MW-1000PR	1088.19											
1990-08	MW-1000PR	1087.94											
1990-10	MW-1000PR	1090.73											
1991-01	MW-1000PR	1089.12											
1991-01	MW-1005										7.82	733	
1991-04	MW-1000PR	1091.83											
1991-04	MW-1005										6.58	842	
1991-07	MW-1000PR	1089.14	65		< 14	84	0.65	850	< 10	190	8.39	225	
1991-07	MW-1002	1092.94	50		< 14	60	0.99	5.1	< 10	160	8.33	157	
1991-07	MW-1002G	1092.97	86		< 14	100	< 0.055	5.4	< 10	240	7.56	277	
1991-07	MW-1004	1111.57											
1991-07	MW-1004P	1108.93	160		< 14	150	0.33	130	< 10	210	8.15	175	
1991-07	MW-1004S	1111.39	50		< 14	60	< 0.055	< 4	< 10	160	8.64	161	
1991-07	MW-1005		84		< 14	380	17	510	15	570	7.73	1028	
1991-07	MW-1005P	1140.19	260		< 14	230	1.2	220	< 10	290	8.49	512	
1991-07	MW-1005S	1139.43	170		< 14	170	0.3	210	< 10	220	7.68	377	
1991-07	MW-1010P	1086.5	140		< 14	140	< 0.055	260	< 10	180	8.47	337	
1991-10	MW-1000PR	1089.51	90		< 14	110	0.84	880	< 10	160	7.41	327	
1991-10	MW-1002	1092.36	49		< 14	60	< 0.055	< 4	< 10	170	6.78	189	
1991-10	MW-1002G	1092.4	88		< 14	120	< 0.055	< 4	10	280	6.98	272	
1991-10	MW-1004	1111.14											
1991-10	MW-1004P	1108.79	170		< 14	170	0.22	130	< 10	310	7.15	352	
1991-10	MW-1004S	1111	49		< 14	60	< 0.055	< 4	10	170	7.25	135	
1991-10	MW-1005	1138.75	92		< 14	360	20	490	12	770	7.34	981	
1991-10	MW-1005P	1138.88	260		< 14	230	1	150	< 10	440	7.66	479	
1991-10	MW-1005S	1138.1	170		< 14	170	3.8	220	< 10	370	7.37	351	
1991-10	MW-1010P	1087.62	160		< 14	130	< 0.055	280	10	250	8.26	326	
1992-01	MW-1000PR	1090.15	88		< 14	110	1.7	820	11	120	5.75	190	
1992-01	MW-1002	1093.9	47		< 14	67	< 0.055	< 4	< 10	100	6.88	138	
1992-01	MW-1002G	1093.93	80		< 14	110	< 0.055	< 4	11	140	6.93	221	
1992-01	MW-1004	1111.65											
1992-01	MW-1004P	1108.79	160		< 14	150	0.32	120	< 10	160	6.8	302	
1992-01	MW-1004S	1111	27		< 14	62	< 0.055	< 4	11	95	7.03	146	
1992-01	MW-1005	1140.86	86		< 14	1000	18	460	14	530	6.12	870	
1992-01	MW-1005P	1140.95	260		< 14	240	0.75	160	< 10	280	6.85	391	
1992-01	MW-1005S	1140.32	170		< 14	250	3.6	210	< 10		6.88	303	
1992-01	MW-1010P	1087.6	150		< 14	130	0.15	250	16	200	6.87	292	
1992-04	MW-1000PR	1091.67	84		< 14	88	1.3	830	14	120	6.91	183.2	
1992-04	MW-1002	1093.7	49		< 14	48	< 0.055	< 4	11	85	6.05	145	
1992-04	MW-1002G	1093.75	84		< 14	110	< 0.055	< 4	14	150	6.25	199	
1992-04	MW-1004	1112.19											
1992-04	MW-1004P	1109.72	170		< 14	160	0.37	140	< 10	180	6.88	282	
1992-04	MW-1004S	1112.05	60		< 14	72	< 0.055	< 4	12	100	6.7	153	
1992-04	MW-1005	1141.23	90		< 14	520	17	380	16	680	6.32	905	
1992-04	MW-1005P	1141.48	260		< 14	240	1	130	< 10	350	6.97	417	
1992-04	MW-1005S	1140.71	180		< 14	290	3.7	200	< 10	210	7.48	324	
1992-04	MW-1010P	1089.08	160		< 14	140	< 0.055	200	14	340	7.62	314	
1992-07	MW-1000PR	1088.87	81		14	120	0.47	730	12	140	6.64	194	
1992-07	MW-1002	1093.04	41		< 14	120	< 0.055	< 4	< 10	87	5.61	118	
1992-07	MW-1002G	1093.09	79		< 14	160	< 0.055	< 4	11	150	6.02	198	
1992-07	MW-1004	1111.73											
1992-07	MW-1004P	1109.39	160		< 14	170	0.38	130	< 10	180	6.74	295	
1992-07	MW-1004S	1111.58	74		< 14	150	< 0.055	< 4	< 10	110	6.5	175	
1992-07	MW-1005	1140.11	90		< 14	440	19	440	15	640	6.01	912	
1992-07	MW-1005P	1140.29	270		< 14	260	0.95	150	< 10	270	6.81	426	
1992-07	MW-1005S	1139.4	170		< 14	220	4.1	210	< 10	220	6.88	331	
1992-07	MW-1010P	1088.28	160		< 14	180	< 0.055	86	< 10	180	6.86	285	
1992-10	MW-1000PR	1089.22	95		< 14	100	0.8	780	12	160	6.9	201	
1992-10	MW-1002	1091.69	53		< 14	82	< 0.055	15	11	130	6.94	181	
1992-10	MW-1002G	1091.73	85		< 14	130	< 0.055	< 4	11	180	6.94	254	
1992-10	MW-1004	1108.33											
1992-10	MW-1004P	1107.39	190		< 14	180	0.32	130	< 10	260	7.46	342	

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Historical Groundwater Results - Quarterly Parameters

Sample Date (yyyy-mm)	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
1992-10	MW-1004S	1108.44	100		< 14	110	< 0.055	< 4	< 10	220	6.96	258	
1992-10	MW-1005	1139.07	110		< 14	420	22	470	15	600	6.13	1013	
1992-10	MW-1005P	1137.84	270		< 14	260	12	100	< 10	320	7.26	501	
1992-10	MW-1005S	1138.13	190		< 14	270	3.9	200	< 10	260	7.38	391	
1992-10	MW-1010P	1086.55	180		< 14	160	< 0.055	140	< 10	280	7.49	389	
1993-01	MW-1000PR	1091.62	84		< 14	88	0.15	710	< 10	100	6.22	203	
1993-01	MW-1000R	1091.01											
1993-01	MW-1002		53		< 14	66	0.059	4.7	< 10	90	6.96	127	
1993-01	MW-1002G	1092.69	75		< 14	94	< 0.055	< 4	12	98	7.14	197	
1993-01	MW-1004	1105.8											
1993-01	MW-1004P	1104.64	170		< 14	160	0.39	140	< 10	160	6.24	291	
1993-01	MW-1004S	1105.97	73		< 14	92	< 0.055	< 4	< 10	95	6.37	174	
1993-01	MW-1005	1139.18	94		< 14	400	24	520	23	140	6.21	945	
1993-01	MW-1005P	1139.08	260		< 14	240	1.1	110	< 10	220	6.39	440	
1993-01	MW-1005S	1138.52	180		< 14	180	4.1	210	10	160	6.99	418	
1993-01	MW-1010P	1088.95	190		< 14	130	< 0.055	31	32	210	7.21	357	
1993-04	MW-1000PR	1089.06	82		26	90	0.27	950	12	130	6.24	198	
1993-04	MW-1000R	1092.11											
1993-04	MW-1002	1093.34	66		< 12	90	< 0.015	< 4	9	120	6.33	136	
1993-04	MW-1002G	1093.38	44		< 12	76	< 0.015	< 4	8	74	6.13	239	
1993-04	MW-1004P	1099.76	170		< 12	160	< 0.015	< 4	3	160	7.74	329	
1993-04	MW-1004S	1103.31	51		< 12	70	< 0.015	< 4	11	120	7.77	168	
1993-04	MW-1005	1140.35	78		< 12	500	24	540	15	630	6.11	971	
1993-04	MW-1005P	1139.42	250		< 12	250	0.46	150	2	250	6.52	458	
1993-04	MW-1005S	1139.26	81		< 12	210	4.4	230	8	200	6.38	360	
1993-04	MW-1010P	1088.51	170		< 14	130	0.055	140	28	270	6.62	357	
1993-07	MW-1000PR	1079.77	82		16	86	0.061	730	15	140	6.6	217	
1993-07	MW-1002	1095.73	42		< 12	52	0.034	< 4	10	100	6.83	273	
1993-07	MW-1002G	1095.72	64		< 12	80	< 0.015	< 4	11	140	6.72	480	
1993-07	MW-1004P	1095.77	170		< 12	150	0.042	22	5	180	7.4	347	
1993-07	MW-1004S	1102.69	24		< 12	56	< 0.015	< 4	11	110	7	178	
1993-07	MW-1005	1141.19	74		< 12	410	19	420	18	590	6.12	1100	
1993-07	MW-1005P	1141.08	250		< 12	230	0.61	140	3	260	7.59	519	
1993-07	MW-1005S	1140.88	170		< 12	160	4.2	220	9	210	7.28	372	
1993-07	MW-1010P	1085.01	150		< 12	130	< 0.015	35	11	180	7.21	313	
1993-08	MW-1000PR	1077.59 1079.23 1078.63 1077.13											
1993-08	MW-1000R	1084.61											
1993-08	MW-1004												
1993-08	MW-1004P	1094.63 1094.34 1094.03 1093.16											
1993-08	MW-1004S	1101.99 1101.73 1101.57 1101.29											
1993-08	MW-1010P	1083.01 1081.55 1081.58 1080.71											
1993-09	MW-1000PR	1076.89 1076.75 1077.04 1076.2 1075.12											
1993-09	MW-1000R												
1993-09	MW-1004												
1993-09	MW-1004P	1092.64 1092.45 1092.34 1092.2 1091.84											
1993-09	MW-1004S	1101.04 1100.85 1100.65 1100.49 1100.33											
1993-09	MW-1010P	1081.61 1081.22 1081.84 1081.13 1080.95											

Historical Groundwater Results - Quarterly Parameters

Sample Date (yyyy-mm)	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
1993-10	MW-1000PR	1074.73 1075.31 1074.86 1075.56 1074.99	62		13	120	0.032	910	12	110	7.03	233	
1993-10	MW-1000R												
1993-10	MW-1002	1091.71	42		< 12	52	< 0.015	< 4	6	92	7.52	138	
1993-10	MW-1002G	1091.77	82		< 12	110	< 0.015	< 4	11	180	7.38	262	
1993-10	MW-1004												
1993-10	MW-1004P	1091.04 1090.18 1090.27 1090.09 1089.84	170		< 12	160	0.048	40	3	180	7.61	329	
1993-10	MW-1004S	1100.18 1099.98 1099.82 1099.78 1099.61	32		< 12	46	< 0.015	< 4	9	110	7.41	186	
1993-10	MW-1005	1140.03	84		< 12	390	25	610	17	580	6.68	1005	
1993-10	MW-1005P	1139.85	250		< 12	220	0.17	69	< 2	240	7.53	462	
1993-10	MW-1005S	1139.29	170		< 12	160	4.2	240	6	210	7.28	321	
1993-10	MW-1010P	1080.02 1081.25 1080.16 1080.01	160		< 12	130	< 0.015	18	5	170	7.51	294	
1993-11	MW-1000PR	1075.95 1075.09 1074.87 1074.21											
1993-11	MW-1000R												
1993-11	MW-1004												
1993-11	MW-1004P	1090.03 1089.94 1088.84 1089.75											
1993-11	MW-1004S	1099.45 1099.27 1099.18 1099.06											
1993-11	MW-1010P	1079.89 1079.71 1080.55 1079.91											
1993-12	MW-1000PR	1074.1 1073.61 1073.49								110			
1993-12	MW-1000R												
1993-12	MW-1002									78			
1993-12	MW-1002G									190			
1993-12	MW-1004												
1993-12	MW-1004P	1089.76 1089.54 1089.27								230			
1993-12	MW-1004S	1098.95 1098.78 1098.67								98			
1993-12	MW-1005									680			
1993-12	MW-1005P									300			
1993-12	MW-1005S									220			
1993-12	MW-1010P	1079.57 1079.91 1079.9								230			
1994-01	MW-1000PR	1073.55 1072.7 1073.75	43		22	54	< 0.015	340	12	70	6.86	135	
1994-01	MW-1000R												
1994-01	MW-1002	1091.21	39		< 12	50	< 0.015	< 4	7	82	7.53	151	
1994-01	MW-1002G	1091.31	94		< 12	120	< 0.015	< 4	14	180	7.01	278	
1994-01	MW-1004												
1994-01	MW-1004P	1088.81 1088.52 1088.4	150		< 12	150	< 0.015	20	2	160	7.34	371	
1994-01	MW-1004S	1098.3 1098.18 1097.96	42		16	44	< 0.015	< 4	10	74	7	123	
1994-01	MW-1005	1138.39	81		< 12	440	24	530	18	560	6.28	1072	

Historical Groundwater Results - Quarterly Parameters

Sample Date	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
1994-01	MW-1005P	1138.88	250		< 12	230	0.19	35	< 2	260	7.34	487	
1994-01	MW-1005S	1138.29	160		< 12	160	4	200	9	190	7.22	357	
1994-01	MW-1010P	1080.83 1080.25 1081.09	160		< 12	150	< 0.015	17	3	170	7.34	283	
1994-02	MW-1000PR	1073.23 1071.99 1071.66 1071.64											
1994-02	MW-1000R												
1994-02	MW-1004												
1994-02	MW-1004P	1088.45 1088.32 1088.13 1088.24											
1994-02	MW-1004S	1097.82 1097.74 1097.67 1097.97											
1994-02	MW-1010P	1080.99 1080.89 1080.51 1080.58											
1994-03	MW-1000PR	1071.26 1070.68 1070.41 1070.71											
1994-03	MW-1000R												
1994-03	MW-1004												
1994-03	MW-1004P	1088.11 1087.64 1087.56 1087.15											
1994-03	MW-1004S	1097.71 1097.77 1097.74 1097.76											
1994-03	MW-1010P	1080.62 1079.5 1078.94 1079.52											
1994-04	MW-1000PR	1070.66 1071.16 1071.91 1071.98	44		23	54	0.021	500	12	95	7.74	124	
1994-04	MW-1000R												
1994-04	MW-1002	1091.21	35		< 12	45	< 0.015	< 4	7	86	7.49	105	
1994-04	MW-1002G	1091.27	92		< 12	120	< 0.015	< 4	12	170	7.39	267	
1994-04	MW-1004	1104.19 1104.19											
1994-04	MW-1004P	1086.88 1087 1086.91 1087.03	160		15	150	0.033	45	3	180	7.36	287	
1994-04	MW-1004S	1097.73 1097.66 1097.6 1097.72	38		< 12	51	< 0.015	< 4	8	100	7.75	109	
1994-04	MW-1005	1140	88		< 12	450	24	540	13	620	7.6	1082	
1994-04	MW-1005P	1139.44	250		< 12	230	0.2	160	< 2	270	7.24	487	
1994-04	MW-1005S	1139.14	160		< 12	160	4.1	200	8	200	7.52	344	
1994-04	MW-1010P	1079.25 1079.25 1080.02 1080	160		< 12	150	< 0.015	14	3	180	7.36	276	
1994-05	MW-1000PR	1071.59 1071.21 1070.96 1071.22											
1994-05	MW-1000R												
1994-05	MW-1004												
1994-05	MW-1004P	1087.18 1086.87 1086.65 1086.66											

Historical Groundwater Results - Quarterly Parameters

Sample Date (yyyy-mm)	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
1994-05	MW-1004S	1098.23 1098.42 1098.41 1098.31											
1994-05	MW-1010P	1079.94 1079 1078.84 1078.33											
1994-06	MW-1000PR	1071.93 1071.71 1071.45 1071.41 1071.18											
1994-06	MW-1000R												
1994-06	MW-1004												
1994-06	MW-1004P	1086.57 1086.58 1086.57 1086.47 1086.48											
1994-06	MW-1004S	1098.12 1098 1097.88 1097.77 1097.67											
1994-06	MW-1010P	1079.45 1078.94 1078.43 1078.37 1078.25											
1994-07	MW-1000PR	1071.28 1071.01 1071.19 1071.1	39		17	49	0.026	420	11	90	7.47	132.6	
1994-07	MW-1000R												
1994-07	MW-1002	1091.02	31		< 12	44	< 0.015	< 4	6.6	94	7	109.4	
1994-07	MW-1002G	1091.07	92		< 12	120	< 0.015	< 4	13	170	6.74	238	
1994-07	MW-1004												
1994-07	MW-1004P	1086.56 1086.74 1086.64 1086.39	160		< 12	150	0.024	28	2.5	190	7.09	317	
1994-07	MW-1004S	1097.7 1097.66 1097.59 1097.56	140		< 12	52	< 0.015	< 4	8	100	6.77	200	
1994-07	MW-1005	1139.53	75		< 12	450	31	690	14	600	6.18	1093	
1994-07	MW-1005P	1138.96	240		< 12	230	0.22	100	< 2	270	6.89	456	
1994-07	MW-1005S	1138.65	160		< 12	160	4.1	200	7.3	210	6.88	322	
1994-07	MW-1010P	1078.46 1078.27 1078.24 1078.37	160		< 12	150	< 0.015	10	3.4	190	7.17	322	
1994-08	MW-1000PR	1071.07 1070.87 1070.55 1070.75											
1994-08	MW-1000R												
1994-08	MW-1004												
1994-08	MW-1004P	1086.12 1086.01 1085.86 1085.8											
1994-08	MW-1004S	1097.49 1097.43 1097.33 1097.27											
1994-08	MW-1010P	1078.31 1078.05 1077.91 1078.76											
1994-09	MW-1000PR	1070.91 1070.71											
1994-09	MW-1000R												
1994-09	MW-1004												
1994-09	MW-1004P	1085.86 1085.92 1086.6											

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Historical Groundwater Results - Quarterly Parameters

Sample Date (yyyy-mm)	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
1994-09	MW-1004S	1097.16 1097.08 1097.87											
1994-09	MW-1010P	1078.59 1078.55 1086.68 1085.52 1084.29 1083.36 1082.6 1081.25 1080.72 1080.87											
1994-10	MW-1000PR	1071.03	34		58	36	0.047	360	17	120	7.17	115.9	
1994-10	MW-1000R												
1994-10	MW-1002	1092.12	38		< 1.6	46	0.0056	< 0.47	6.1	87	6.99	122	
1994-10	MW-1002G	1092.18	88		< 1.6	110	0.0054	< 0.47	14	200	6.77	269	
1994-10	MW-1004												
1994-10	MW-1004P	1086.47 1086.45 1086.4 1086.36 1086.46	170		< 1.6	160	0.035	29	3.9	200	7.12	303	
1994-10	MW-1004S	1098.1 1097.99 1097.84 1097.75 1097.97	44		< 1.6	54	0.0064	< 0.47	8.6	150	6.71	123.5	
1994-10	MW-1005	1138.79	78		< 1.6	420	28	630	20	820	6.08	1028	
1994-10	MW-1005P	1137.79	250		< 1.6	250	0.24	62	2.5	280	7.15	452	
1994-10	MW-1005S	1137.49	160		< 1.6	160	3.7	190	13	240	7.34	320	
1994-10	MW-1010P	1079.81 1079.8 1080.6 1080.17 1079.92	160		3.2	150	0.0046	14	4.5	200	7.45	309	
1994-11	MW-1000PR	1070.27 1070.28 1070.23											
1994-11	MW-1000R												
1994-11	MW-1004												
1994-11	MW-1004P	1086.24 1086.14 1086.1											
1994-11	MW-1004S	1097.63 1097.53 1097.35											
1994-11	MW-1010P	1079.07 1078.85 1079.29											
1994-12	MW-1000PR	1069.65 1069.28 1069.24 1068.91											
1994-12	MW-1000R												
1994-12	MW-1004												
1994-12	MW-1004P	1086.29 1086.07 1085.93 1085.84											
1994-12	MW-1004S	1097.24 1097.14 1097.03 1096.95											
1994-12	MW-1010P	1078.61 1078.12 1078.66 1078.33											
1995-01	MW-1000PR	1069.57 1069.2 1068.79 1069.18	30		52	36	0.12	290	9	88	7.14	115.6	
1995-01	MW-1000R												
1995-01	MW-1002	1090.71	38		< 0.47	47	0.0073	2.7	6.2	120	6.65	143.2	
1995-01	MW-1002G	1090.77	90		< 0.47	110	0.0072	2.1	12	240	6.74	301	
1995-01	MW-1004												

Historical Groundwater Results - Quarterly Parameters

Sample Date (yyyy-mm)	Location	Water Elevation ft	Alkalinity as		Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
			CaCO3 mg/l	Arsenic ug/l									
1995-01	MW-1004P	1080.64 1085.72 1085.81 1085.79	170		3.3	150	0.015	29	1.7	190	6.69	315	
1995-01	MW-1004S	1096.75 1096.65 1096.59 1096.47	100		1.1	57	0.0049	3.4	7.1	140	6.18	142.4	
1995-01	MW-1005	1137.52	84		< 0.47	370	29	650	14	670	6.16	1035	
1995-01	MW-1005P	1137.14	270		4.4	230	0.035	41	< 0.56	340	7.05	511	
1995-01	MW-1005S	1136.86	160		< 0.47	150	4.2	220	8.9	240	6.72	425	
1995-01	MW-1010P	1079.52 1078.76 1078.26 1078.61	160		6.7	160	0.004	60	3.3	250	7.63	337	
1995-02	MW-1000PR	1069.14 1069.19 1069.09 1069.68											
1995-02	MW-1000R												
1995-02	MW-1004												
1995-02	MW-1004P	1085.73 1085.63 1085.56 1085.6											
1995-02	MW-1004S	1096.39 1096.31 1096.24 1096.16											
1995-02	MW-1010P	1078.21 1078.37 1078.32 1078.49											
1995-04	MW-1000PR	1070	38		58	35	0.026	320	14	90	7.4	106	
1995-04	MW-1000R												
1995-04	MW-1002	1091.7	42		2	36	0.0039	0.27	7.3	170	7.4	106	
1995-04	MW-1002G	1091.77	93		1.4	100	0.0044	< 0.086	15	170	6.9	255	
1995-04	MW-1002G	Dup.	93		< 0.68	100	0.0061	< 0.086	15	160			
1995-04	MW-1004												
1995-04	MW-1004P	1086.8	170		11	130	0.025	31	4.7	250	7.4	292	
1995-04	MW-1004S	1096.68	55		7	45	0.0087	0.87	7.8	150	6.7	131	
1995-04	MW-1005	1138.27	79		1.3	320	28	600	19	770	6.2	1014	
1995-04	MW-1005P	1137.45	270		3.7	200	0.078	41	< 0.56	300	7.5	420	
1995-04	MW-1005S	1137.2	170		< 0.68	130	4	200	9.3	190	7	315	
1995-04	MW-1010P	1079.01	170		9.7	130	0.005	51	5.1	240	7.4	311	
1995-05	MW-1000PR												
1995-05	MW-1005	1138.55											
1995-05	MW-1005P	1137.9											
1995-05	MW-1005S	1137.55											
1995-07	MW-1000PR	1070.99	34		43	36	0.0096	240	10	99	8.08	115.7	
1995-07	MW-1000R												
1995-07	MW-1002	1090.41	33		0.97	35	< 0.0017	0.42	5.3	76	7.16	99	
1995-07	MW-1002G	1090.65	90		< 0.68	100	0.0019	< 0.086	11	190	6.91	275	
1995-07	MW-1002G	Dup.	97		< 0.68	100	0.005	0.28	11	190			
1995-07	MW-1004												
1995-07	MW-1004P	1086.38	170		20	130	0.044	77	1.8	190	7.16	317	
1995-07	MW-1004S	1096.28	50		6.6	50	0.0031	0.5	6.2	110	6.87	126.3	
1995-07	MW-1005	1137.69	75		< 0.68	320	28	640	14	730	6.28	1049	
1995-07	MW-1005P	1137.47	280		1.8	200	0.071	90	< 0.56	290	7.17	454	
1995-07	MW-1005S	1137.06	170		< 0.68	140	3.8	200	6.9	220	6.91	358	
1995-07	MW-1010P	1077.61	170		21	130	0.0017	11	2.4	200	7.58	315	
1995-10	MW-1000PR	1071.39	36		61	39	0.027	110	11	75	7.32	118.8	
1995-10	MW-1000PR	Dup.	34		60	39	0.036	140	9.2	71			
1995-10	MW-1000R												
1995-10	MW-1002	1091.61	30		1.6	38	0.004	1.4	7.9	86	6.6	120	
1995-10	MW-1002G	1091.68	100		< 0.68	110	< 0.0017	< 0.086	14	160	6.91	239	
1995-10	MW-1004												
1995-10	MW-1004P	1079.81	170		4.3	150	0.0086	28	8.1	170	7.01	308	
1995-10	MW-1004S	1097.49	79		7.6	59	0.004	1.3	9.4	110	6.28	144.9	
1995-10	MW-1005	1138.86	55		< 0.68	360	32	700	21	740	6.18	976	
1995-10	MW-1005P	1137.79	260		2.1	230	0.17	72	5.3	260	7.22	470	
1995-10	MW-1005S	1137.6	170		< 0.68	160	4.3	220	14	220	7.11	354	
1995-10	MW-1010P	1079.23	140		63	140	0.037	21	9.6	200	7.4	291	
1996-01	MW-1000PR	1069.64	27		49	33	0.011	54	8.5	87	6.86	112.4	
1996-01	MW-1000R												
1996-01	MW-1002	1091.25	35		< 0.68	41	0.0031	0.12	5.4	65	6.98	153.7	
1996-01	MW-1002G	1091.31	85		< 0.68	100	< 0.0017	< 0.086	11	150	6.79	232	
1996-01	MW-1002G	Dup.	82		< 0.68	100	0.0049	< 0.086	11	160			

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Historical Groundwater Results - Quarterly Parameters

Sample Date	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
1996-01	MW-1004												
1996-01	MW-1004P	1078.22									7.3	295	
1996-01	MW-1004S	1095.89	50		3.4	54	0.0038	1.1	5.8	120	6.61	144.9	
1996-01	MW-1005	1137.72	78		< 0.68	330	28	610	14	560	6.17	983	
1996-01	MW-1005P	1137.39	240		< 0.68	210	0.28	97	0.93	270	7.31	464	
1996-01	MW-1005S	1137.09	160		< 0.68	140	3.7	200	7	190	7.27	360	
1996-01	MW-1010P	1077.28	140		45	130	0.0023	13	3.4	180	7.01	313	
1996-04	MW-1000PR	1066.96	53		31	40	0.018	64	16	130	7.07	149.4	
1996-04	MW-1000R												
1996-04	MW-1002	1091.57	32		1.7	36	0.017	0.98	5.9	120	6.75	142.2	
1996-04	MW-1002	Dup.	32		2.2	35	0.015	0.71	5.9	85			
1996-04	MW-1002G	1091.63	110		< 0.68	100	0.0039	0.14	11	220	6.55	264	
1996-04	MW-1004												
1996-04	MW-1004P	1077.65	150		7.3	130	0.011	22	4.2	210	6.93	258	
1996-04	MW-1004S	1096.23	61		2.6	52	0.0048	0.32	6.3	130	5.84	168.2	
1996-04	MW-1005	1139.05	73		< 0.68	300	23	550	14	530	5.97	967	
1996-04	MW-1005P	1139.37	250		< 0.68	210	0.049	35	2.2	300	6.85	486	
1996-04	MW-1005S	1139.04	160		< 0.68	140	3.9	200	7.7	240	6.8	329	
1996-04	MW-1010P	1076.11	160		16	140	0.0036	100	3.8	210	7.16	309	
1996-07	MW-1000PR	1070.33	35		33	38	0.0066	120	9.3	150	7.26	113.5	
1996-07	MW-1000R												
1996-07	MW-1002	1092.26	34		1.6	97	0.021	0.5	5.9	94	6.78	119.6	
1996-07	MW-1002G	1092.33	79		< 0.54	93	0.0038	< 0.18	11	200	6.71	221	
1996-07	MW-1004												
1996-07	MW-1004P	1076.74	150		3.3	130	0.0047	17	4.3	200	7.21	287	
1996-07	MW-1004S	1096.12	55		3.9	46	0.0023	0.72	6.9	130	6.31	153.5	
1996-07	MW-1004S	Dup.	54		3.7	46	0.0033	0.54	7	140			
1996-07	MW-1005	1139.74	68		< 0.54	300	19	470	14	650	6.07	858	
1996-07	MW-1005P	1139.57	240		3.9	210	0.064	140	2.6	300	6.9	441	
1996-07	MW-1005S	1139.05	150		< 0.54	140	3.6	190	8.8	230	6.8	323	
1996-07	MW-1010P	1077.43	140		74	130	< 0.001	18	5.9	200	7.42	285	
1996-10	MW-1000PR	1069.84	38		57	36	0.010	140	7.1	76	7.37	108.5	
1996-10	MW-1000R												
1996-10	MW-1002	1090.73	41		3.5	42	0.0063	0.2	6.9	85	6.92	155.1	
1996-10	MW-1002G	1090.78	86		< 0.54	93	0.0039	< 0.18	11	120	6.79	226	
1996-10	MW-1004												
1996-10	MW-1004P	1076.74	160		5.9	120	0.0042	14	4.2	160	7.23	340	
1996-10	MW-1004S	1095.43	66		1.8	59	0.0049	0.29	6.5	100	6.25	159.5	
1996-10	MW-1004S	Dup.	61		2.1	60	0.0069	0.5	7.1	100			
1996-10	MW-1005	1137.6	64		5	320	17	430	14	550	6.16	948	
1996-10	MW-1005P	1137.46	260		8.2	200	0.37	67	3.6	280	7.19	471	
1996-10	MW-1005S	1137.07	160		0.63	130	3.6	200	8.2	220	7.09	329	
1996-10	MW-1010P	1076.75	150		39	130	0.0026	21	5.8	170	7.6	302	
1997-01	MW-1000PR	1070.35	27		33	33	0.0093	150	9.9	160	7.22	112.4	
1997-01	MW-1000R												
1997-01	MW-1002	1092.32	42		0.99	46	0.011	< 0.18	6.3	110	7.47	123.8	
1997-01	MW-1002G	1092.43	80		1.9	96	0.0024	< 0.18	9.6	190	7.15	245	
1997-01	MW-1004												
1997-01	MW-1004P	1077.5	160		6.2	120	0.015	34	5.5	220	7.42	238	
1997-01	MW-1004S	1095.33	61		5.1	62	0.0061	0.25	6.6	150	7.03	163.7	
1997-01	MW-1005	1138.1	79		15	300	23	540	13	600	5.91	921	
1997-01	MW-1005P	1137.41	260		2.7	210	0.073	24	5.5	280	7.04	462	
1997-01	MW-1005S	1137.05	160		4	140	3.8	200	7.4	250	6.8	321	
1997-01	MW-1005S	Dup.	160		1.6	140	3.8	200	6.9	210			
1997-01	MW-1010P	1078.4	140		56	130	0.0018	28	5.8	180	7.23	282	
1997-04	MW-1000PR	1072.62	36		32	43	0.043	190	9.9	170	7.46	132.9	
1997-04	MW-1000R	1085.95											
1997-04	MW-1002	1094.09	41		0.79	46	0.007	0.87	7	110	7.4	140	
1997-04	MW-1002	Dup.	42		1.1	46	0.0058	0.37	7.3	130			
1997-04	MW-1002G	1094.21	81		< 0.54	100	0.0029	< 0.18	10	200	7	260	
1997-04	MW-1004												
1997-04	MW-1004P	1078.42	140		16	130	0.008	17	6.9	210	7.25	311	
1997-04	MW-1004S	1096.67	60		1.8	59	0.0049	0.72	8.2	110	6.51	165.8	
1997-04	MW-1005	1139.51	66		4.5	280	21	510	12	620	6.34	812	
1997-04	MW-1005P	1138.85	250		1.6	220	0.41	77	5.8	320	7	480	
1997-04	MW-1005S	1138.4	160		1.6	150	4.1	210	9.5	250	6.8	344	
1997-04	MW-1010P	1081.61	150		15	150	0.008	120	6.7	170	7.43	346	
1997-07	MW-1000PR	1073.7	33		29	39	0.0079	61	7.8	110	6.72	107.1	
1997-07	MW-1000R												
1997-07	MW-1002	1091.83	30		1.3	45	0.0087	0.8	6.6	88	6.38	118.4	
1997-07	MW-1002G	1094.93	78		< 0.54	100	0.0051	< 0.18	9.3	200	6.51	271	
1997-07	MW-1004												
1997-07	MW-1004P	1083.61	140		14	140	0.0035	12	6.5	200	6.94	277	
1997-07	MW-1004P	Dup.	140		13	140	0.0042	12	6.4	130			
1997-07	MW-1004S	1096.13	55		2	64	0.0091	0.38	8	130	6.36	202	
1997-07	MW-1005	1137.92	63		5.9	300	29	800	12	220	6.22	755	
1997-07	MW-1005P	1137.66	240		2	230	0.087	66	6.7	280	7.03	448	
1997-07	MW-1005S	1137.65	150		0.71	150	4	210	9.8	260	6.83	689	

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Historical Groundwater Results - Quarterly Parameters

Sample Date (yyyy-mm)	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
1997-07	MW-1010P	1083.07	130		48	140	0.001	26	7.1	170	7.25	295	
1997-10	MW-1000PR	1087.37	40		34	45	0.0044	110	5.9	82	6.55	132	
1997-10	MW-1000R	1090.84											
1997-10	MW-1002	1090.89	40		0.86	46	0.003	0.52	6	76	6.02	114	
1997-10	MW-1002G	1090.97	88		< 0.54	98	< 0.001	< 0.18	7.9	160	6.35	228	
1997-10	MW-1004												
1997-10	MW-1004P	1096.14	150		40	140	0.0047	10	5.3	120	6.91	349	
1997-10	MW-1004S	1097.72	58		1.6	75	0.0057	0.93	15	110	6.13	201	
1997-10	MW-1005	1138.61	77		< 0.54	280	23	590	11	510	6	804	
1997-10	MW-1005P	1137.77	240		< 0.54	230	0.17	62	< 5	260	6.9	505	
1997-10	MW-1005S	1137.49	150		< 0.54	150	4.2	210	6.2	190	6.77	351	
1997-10	MW-1010P	1087.13	140		30	140	< 0.001	29	5.1	170	7.03	303	
1997-10	MW-1010P	Dup.	130		31	140	0.0039	28	6.2	140			
1998-01	MW-1000PR	1087.51	54		40	110	0.0061	490	180	96	6.47	576	
1998-01	MW-1000PR	Dup.	61		42	120	0.0071	520	260	200			
1998-01	MW-1000R	1086.97											
1998-01	MW-1002	1090	40		1.4	47	0.034	0.26	7.6	82	7.15	109.8	
1998-01	MW-1002G	1090.06	82		< 0.54	100	0.0034	< 0.18	12	150	6.85	218	
1998-01	MW-1004												
1998-01	MW-1004P	1097.86	150		27	140	0.012	12	8.8	140	7.13	271	
1998-01	MW-1004S	1099.89	48		1.6	58	0.0027	0.3	11	120	6.6	140.1	
1998-01	MW-1005	1136.65	71		< 0.54	260	21	490	14	490	6.1	782	
1998-01	MW-1005P	1136	250		0.73	220	0.41	72	11	270	7.06	456	
1998-01	MW-1005S	1136.35	170		< 0.54	130	3.3	170	11	200	7.09	313	
1998-01	MW-1010P	1087.61	140		26	130	< 0.001	29	9.2	190	7.4	284	
1998-04	MW-1000PR	1089.61	93		98	470	0.044	3000	310	770	6.69	888	
1998-04	MW-1000PR	Dup.	94		95	470	0.0054	3000	320	790			
1998-04	MW-1000R	1090.61											
1998-04	MW-1002	1095.91	30		0.86	37	0.05	1.7	< 5	89	7.32	131.7	
1998-04	MW-1002G	1095.83	75		< 0.54	98	0.0047	0.21	11	180	6.97	245	
1998-04	MW-1004												
1998-04	MW-1004P	1099.54	96		20	130	0.0064	9.9	8.5	170	7.41	303	
1998-04	MW-1004S	1103.49	47		0.92	60	0.0049	0.52	10	140	7.97	164.6	
1998-04	MW-1005	1139.07	69		< 0.54	250	21	510	13	440	6.06	725	
1998-04	MW-1005P	1137.92	240		1.1	210	0.077	29	9.6	290	7.36	461	
1998-04	MW-1005S	1137.81	150		< 0.54	140	4.2	210	11	250	7.19	332	
1998-04	MW-1010P	1089.49	130		19	130	0.0034	43	5.6	170	7.64	294	
1998-07	MW-1000PR	1086.3	71		66	480	0.076	1800	350	250	6.28	1097	
1998-07	MW-1000PR	Dup.	99		160	640	0.58	3600	440	330			
1998-07	MW-1000R												
1998-07	MW-1002	1090.67	44		0.9	50	0.0077	0.92	8.2	100	6.55	124.8	
1998-07	MW-1002G	1090.72	82		0.69	93	0.0038	< 0.18	13	180	6.81	215	
1998-07	MW-1004												
1998-07	MW-1004P	1103.72	160		10	130	0.0077	32	9.2	220	7.08	292	
1998-07	MW-1004S	1104.88	40		1.4	60	0.0054	0.29	13	140	6.5	162.3	
1998-07	MW-1005	1138.11	130		< 0.54	240	17	400	16	440	6.16	644	
1998-07	MW-1005P	1137.63	260		< 0.54	220	0.34	100	12	270	7.01	458	
1998-07	MW-1005S	1137.32	160		11	150	3.9	210	15	230	6.7	305	
1998-07	MW-1010P	1086.64	150		27	130	0.0034	29	11	170	7.24	284	
1998-10	MW-1000PR	1086.24	100		53	570	0.013	2000	480	960	6.24	1338	
1998-10	MW-1000PR	Dup.	100		40	650	0.017	3300	460	1100			
1998-10	MW-1000R												
1998-10	MW-1002	1090.03	52		0.56	57	0.0096	0.4	6.9	120	7.13	158	
1998-10	MW-1002G	1090.04	76		< 0.54	97	< 0.001	< 0.18	13	120	7	194	
1998-10	MW-1004												
1998-10	MW-1004P	1102.48	140		5	140	0.0094	12	8.6	150	7.06	327	
1998-10	MW-1004S	1104.56	48		1.1	60	0.0029	0.45	14	98	6.29	324	
1998-10	MW-1005	1136.87	65		< 0.54	250	19	460	17	430	6.12	724	
1998-10	MW-1005P	1136.19	230		1.9	220	0.17	63	9.4	250	6.96	477	
1998-10	MW-1005S	1136.02	150		< 0.54	150	3.9	210	13	180	6.82	327	
1998-10	MW-1010P	1086.42	130		20	130	< 0.001	22	8.6	190	7.53	309	
1999-02	MW-1000PR	1086.21	120		37	760	1.2	4800	570	1200	6.15	1293	
1999-02	MW-1000R	1086.44											
1999-02	MW-1002	1089.33	54		< 0.54	60	0.012	0.71	8.3	92	7.29	142.9	
1999-02	MW-1002G	1089.39	85		< 0.54	97	0.0035	0.24	11	160	6.54	215	
1999-02	MW-1004												
1999-02	MW-1004P	1101.9	160		2.6	140	0.007	12	7.6	150	7.47	267	
1999-02	MW-1004P	Dup.	160		2.8	140	0.0069	12	7.6	170			
1999-02	MW-1004S	1103.7	44		0.6	59	0.005	0.63	11	120	6.59	141.8	
1999-02	MW-1005	1135.69	74		< 0.54	230	21	470	13	370	6.21	598	
1999-02	MW-1005P	1135.35	250		< 0.54	220	0.066	27	7.8	250	7.6	449	
1999-02	MW-1005S	1135.21	170		< 0.54	150	4	200	8.9	180	6.87	319	
1999-02	MW-1010P	1086.37	140		24	130	0.0046	20	8.3	170	7.01	288	
1999-02	MW-1013												
1999-02	MW-1013A												
1999-02	MW-1013B	1093.95	630		36	2300	0.045	25000	1400	3100	6.2	3540	
1999-02	MW-1013C	1095.27	480		100	2100	0.92	7200	1300	3000	6.3	3170	
1999-02	MW-1014												

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Flambeau Mining Company
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Historical Groundwater Results - Quarterly Parameters

Sample Date	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
1999-02	MW-1014A												
1999-02	MW-1014B	1105.62	510		810	2100	0.062	23000	1200	2900	6.2	3280	
1999-02	MW-1014C	1103.39	370		< 4.7	980	14	4300	520	1200	6.3	1900	
1999-04	MW-1000PR	1086.61	120		54	740	1.2	5300	440	1300	6.2	1319	
1999-04	MW-1000PR	Dup.	120		55	770	1.3	5300	340	1200			
1999-04	MW-1000R	1087.39											
1999-04	MW-1002	1091.06	52		0.51	59	0.0018	< 0.41	7.3	72	6.6	160	
1999-04	MW-1002G	1091.1	85		< 0.47	95	< 0.001	< 0.41	9.8	100	6.5	248	
1999-04	MW-1004												
1999-04	MW-1004P	1103.29	160		3.2	130	0.0066	9	6.6	140	6.7	294	
1999-04	MW-1004S	1105.49	46		1.7	60	0.0037	0.87	10	82	6.1	157	
1999-04	MW-1005	1137.97	69		< 0.47	200	20	480	11	430	6.3	596	
1999-04	MW-1005P	1136.65	250		1.1	210	0.049	23	7.8	230	7	464	
1999-04	MW-1005S	1136.65	160		< 0.47	140	4.1	210	8.6	210	7	297	
1999-04	MW-1010P	1086.95	160		12	140	0.019	67	7.6	140	7.1	284	
1999-04	MW-1013	1105.11											
1999-04	MW-1013A	1094.73											
1999-04	MW-1013B	1094.58	550		16	2300	0.33	30000	770	3700	6.2	3130	
1999-04	MW-1013C	1095.73	430		75	2200	0.84	7700	920	3300	6.4	3030	
1999-04	MW-1014												
1999-04	MW-1014A	1103.93											
1999-04	MW-1014B	1106.23	470		420	2100	0.033	23000	770	3300	6.2	2890	
1999-04	MW-1014C	1102.83	330		< 4.7	1000	15	4500	440	1200	6.3	1623	
1999-06	MW-1000R	1087.69											
1999-06	MW-1013	1105.34											
1999-06	MW-1013A	1094.82											
1999-06	MW-1014												
1999-06	MW-1014A	1105.19											
1999-07	MW-1000PR	1087.96	130	< 42	130	770	3.3	5400	380	1300	6.09	1310	
1999-07	MW-1000PR	Dup.	130	< 42	97	770	3.2	5600	350	1300			
1999-07	MW-1000R	1088.18											
1999-07	MW-1002	1092.31	50	< 4.2	< 4.7	58	0.0027	< 0.41	5.9	110	6.73	148.6	
1999-07	MW-1002G	1092.3	84	5	< 4.7	100	0.0022	< 0.41	11	180	7	227	
1999-07	MW-1004	1107.06											
1999-07	MW-1004P	1104.96	160	< 4.2	< 6.9	140	0.014	10	2.7	180	7.07	308	
1999-07	MW-1004S	1107.29	40	< 4.2	< 6.9	59	0.0068	2.3	10	110	5.94	157.9	
1999-07	MW-1005	1139.21	65	5	< 4.7	200	19	460	12	530	6.15	603	
1999-07	MW-1005P	1138.09	240	< 4.2	< 4.7	220	0.054	51	7.3	250	6.91	501	
1999-07	MW-1005S	1138.05	160	< 4.2	< 4.7	150	4.3	220	9.5	240	6.72	331	
1999-07	MW-1010P	1088.46	150	16	12	140	0.0074	59	5.5	200	7.19	269	
1999-07	MW-1013	1106.07											
1999-07	MW-1013A	1095.38											
1999-07	MW-1013B	1095.2	620	< 42	33	2200	0.76	29000	1600	3800	6.39	3020	
1999-07	MW-1013C	1096.67	430	83	50	2100	1.3	7300	870	2700	6.42	3020	
1999-07	MW-1014												
1999-07	MW-1014A	1106.42											
1999-07	MW-1014B	1107.13	540	70	520	2100	0.072	23000	580	3100	6.34	3540	
1999-07	MW-1014C	1103.9	370	< 42	16	930	14	4000	370	1200	6.39	1657	
1999-10	MW-1000PR	1086.75	130	< 8.4	17	760	3.6	5200	680	1100	6.7	1400	
1999-10	MW-1000R	1086.8											
1999-10	MW-1002	1090.59	46		< 0.47	51	0.029	< 0.41	6.9	91	7	140	
1999-10	MW-1002G	1090.62	87		< 0.47	100	0.0061	< 0.41	13	150	7.2	240	
1999-10	MW-1004	1106.62											
1999-10	MW-1004P	1104.88	160	< 4.2	1.9	140	0.014	8.1	2.8	180	7.4	320	
1999-10	MW-1004S	1106.68	41	< 4.2	0.83	57	0.0089	0.63	15	84	6.5	160	
1999-10	MW-1005	1137.86	65		< 0.47	190	18	410	17	400	6.5	570	
1999-10	MW-1005P	1137.64	240		< 0.47	220	0.97	88	< 1.5	260	7.3	460	
1999-10	MW-1005S	1137.32	160		< 0.47	150	4.1	210	5.6	210	7	320	
1999-10	MW-1010P	1086.81	150	6.8	3.5	140	0.0096	65	5.3	170	7.6	300	
1999-10	MW-1010P	Dup.	140	13	0.84	140	0.011	130	5.2	170			
1999-10	MW-1013	1105.8											
1999-10	MW-1013A	1095.51											
1999-10	MW-1013B	1095.49	550	< 42	< 9.4	2200	0.17	28000	1900	3700	6.6	3200	
1999-10	MW-1013C	1096.97	410	< 42	< 9.4	2200	1.4	7600	2000	3000	6.8	3300	
1999-10	MW-1014	1111.6											
1999-10	MW-1014A	1107.87											
1999-10	MW-1014B	1108.33	570	< 42	530	2200	< 0.010	23000	1700	3100	6.4	3200	
1999-10	MW-1014C	1104.81	380	< 42	< 9.4	960	14	4000	700	1200	6.6	1600	
2000-01	MW-1000PR	1086.61	140		1.9	670	4.4	4100	610	1000	6.3	1300	
2000-01	MW-1000R	1086.58											
2000-01	MW-1002	1089.42	57		< 0.47	65	< 0.001	< 0.41	5.6	110	6.9	170	
2000-01	MW-1002G	1089.43	87		< 0.47	98	0.0031	< 0.41	12	120	7.1	240	
2000-01	MW-1004												
2000-01	MW-1004P	1103.16	160		< 0.47	130	0.085	56	< 5	150	6.7	310	
2000-01	MW-1004S	1104.64	43		< 0.47	59	0.0051	0.65	16	110	6.7	160	
2000-01	MW-1005	1137.18	85		< 0.47	200	16	530	16	300	6.8	600	
2000-01	MW-1005P	1136.65	250		< 0.47	210	0.14	47	< 5	280	6.7	480	
2000-01	MW-1005S	1136.76	170		< 0.47	150	3.9	210	< 5	210	6.7	380	

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Historical Groundwater Results - Quarterly Parameters

Sample Date (yyyy-mm)	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
2000-01	MW-1010P	1086.65	150		2.2	130	0.017	39	< 5	130	6.8	280	
2000-01	MW-1013	1104.64											
2000-01	MW-1013A	1095.62											
2000-01	MW-1013B	1095.59	570	17	< 4.7	2100	0.41	30000	1700	3300	6.4	3000	
2000-01	MW-1013C	1097.1	510	< 15	< 4.7	2100	1.5	7300	1700	2900	6.5	2700	
2000-01	MW-1014	1112.07											
2000-01	MW-1014A	1109.22											
2000-01	MW-1014B	1108.88	490	< 15	500	1900	0.055	20000	1400	3200	6.5	3000	
2000-01	MW-1014C	1105.18	330	< 15	< 0.47	810	12	3200	540	1200	6.6	1500	
2000-01	MW-1014C	Dup.	310	< 15	< 0.47	820	11	3100	560	1300			
2000-04	MW-1000PR	1087.26	140		19	720	3.4	3800	560	920	6.93	1274	
2000-04	MW-1000PR	Dup.	150		18	700	4.3	4000	550	1000			
2000-04	MW-1000R	1087.73											
2000-04	MW-1002	1090.33	55		0.91	67	0.0039	< 0.41	5.2	98	6.82	166	
2000-04	MW-1002G	1090.34	89		< 0.6	100	0.0027	< 0.41	11	140	6.84	239	
2000-04	MW-1004												
2000-04	MW-1004P	1103.32	160		1.7	140	0.012	7.9	< 5	170	6.86	293	
2000-04	MW-1004S	1104.96	42		1.3	56	0.0027	< 0.41	15	98	6.9	156.3	
2000-04	MW-1005	1138.07	66		0.67	190	18	410	13	400	6.76	598	
2000-04	MW-1005P	1137.05	250		< 0.6	220	0.37	80	< 5	220	7.27	483	64
2000-04	MW-1005S	1136.99	170		< 0.6	150	4.2	220	< 5	230	7.04	354	
2000-04	MW-1010P	1087.46	140		9.9	150	0.0066	24	< 5	140	7.1	283	77
2000-04	MW-1013	1103.87											97
2000-04	MW-1013A	1095.36											97
2000-04	MW-1013B	1095.54	520	12	19	2200	0.27	32000	1200	3600	6.63	3120	230
2000-04	MW-1013C	1097.39	460	14	11	2200	1.6	7800	1700	2900	6.73	3370	177
2000-04	MW-1014	1112.41											160
2000-04	MW-1014A	1109.24	390	15	< 6	1300	0.55	7200	970	1800	6.87	2220	165
2000-04	MW-1014B	1108.85	480	< 7.5	520	2100	< 0.15	22000	1500	3200	6.43	2940	290
2000-04	MW-1014C	1105.25	320	14	< 6	870	13	3600	440	1000	6.65	1470	88
2000-07	MW-1000PR	1087.3	140	< 8.7	7.3	710	2.3	5000	550	930	6.3	1200	
2000-07	MW-1000R	1087.74											
2000-07	MW-1002	1092.01	52	< 1.7	< 0.53	66	< 0.005	< 2	5.7	110	6.7	160	
2000-07	MW-1002G	1092	90	< 1.7	< 0.53	110	< 0.005	< 2	12	160	6.6	220	
2000-07	MW-1004												
2000-07	MW-1004P	1104.68	160	< 1.7	0.65	150	0.0086	22	< 5	160	6.3	300	
2000-07	MW-1004S	1106.7	41	< 1.7	1.2	61	< 0.005	< 2	16	100	6.6	150	
2000-07	MW-1005	1138.43	64	< 1.7	0.7	210	21	600	15	470	6.6	520	
2000-07	MW-1005P	1138.08	250	< 1.7	< 0.53	230	0.058	75	< 5	290	6.5	460	
2000-07	MW-1005S	1137.92	170	2.9	< 0.53	170	4.6	240	< 5	200	6.5	330	
2000-07	MW-1010P	1087.16	140	12	14	140	< 0.025	26	< 5	190	6.5	290	
2000-07	MW-1010P	Dup.	150	11	9.9	140	0.013	40	< 5	170			
2000-07	MW-1013	1104.58											
2000-07	MW-1013A	1095.79											
2000-07	MW-1013B	1096.09	660	< 21	14	2300	< 0.36	34000	1600	3300	6.3	3000	
2000-07	MW-1013C	1097.84	520	< 21	< 12	2300	2.2	8400	1600	3300	6.3	3100	
2000-07	MW-1014	1113											
2000-07	MW-1014A	1110.5	430	< 21	< 12	1400	1.2	7100	960	2200	6.6	2000	
2000-07	MW-1014B	1109.47	510	< 21	330	2200	< 0.36	21000	1600	3000	6.3	3000	
2000-07	MW-1014C	1105.82	350	39	< 12	890	13	3500	480	1400	6.4	1400	
2000-10	MW-1000PR	1086.79	170		< 2.7	680	6.6	4200	460	1100	6.19	1189	
2000-10	MW-1000R	1087.01											
2000-10	MW-1002	1090.59	47		< 0.53	58	< 0.005	< 2	5.7	120	6.35	125	
2000-10	MW-1002G	1090.62	89		< 0.53	110	< 0.005	< 2	12	150	6.6	223	
2000-10	MW-1004	1105.86											
2000-10	MW-1004P	1104.4	160		0.8	140	0.008	16	< 5	200	7.16	284	
2000-10	MW-1004P	Dup.	160		< 0.53	140	0.17	79	< 5	200			
2000-10	MW-1004S	1105.86	35		1	58	< 0.005	< 2	18	130	5.99	134.1	
2000-10	MW-1005	1137.55	58		0.58	190	17	390	15	430	6.17	530	
2000-10	MW-1005P	1137.56	240		0.74	220	0.13	38	< 5	260	7.26	448	
2000-10	MW-1005S	1137.2	170		< 0.53	160	4.3	220	< 5	210	7.34	330	
2000-10	MW-1010P	1086.67	150		4.3	140	0.41	250	< 5	220	7.49	268	
2000-10	MW-1013	1105.06											
2000-10	MW-1013A	1096.2											
2000-10	MW-1013B	1096.45	630		< 12	2200	0.84	35000	1500	3200	6.28	3180	
2000-10	MW-1013C	1097.86	550		< 12	2200	1.6	8200	1600	3200	6.37	3310	
2000-10	MW-1014	1113.98											
2000-10	MW-1014A	1111.39	430		< 12	1400	0.96	6700	880	2300	6.68	2250	
2000-10	MW-1014B	1110.09	520		430	2200	< 0.36	21000	1500	2900	6.26	3240	
2000-10	MW-1014C	1106.21	390		< 12	840	12	3200	450	1300	6.36	1490	
2001-01	MW-1000PR	1088.39	180		< 2.7	610	6.8	3700	440	1000	6.13	1192	143
2001-01	MW-1000R	1088.35											
2001-01	MW-1002	1089.93	58		< 0.53	66	< 0.005	< 2	6.7	120	6.55	156.3	
2001-01	MW-1002G	1089.93	90		< 0.53	99	< 0.005	< 2	12	150	6.48	253	
2001-01	MW-1004	1104.61											
2001-01	MW-1004P	1103.36	160		< 0.53	130	0.085	52	< 5	130	7.25	293	46
2001-01	MW-1004S	1104.72	39		< 0.53	56	< 0.005	< 2	19	110	5.9	139.3	180
2001-01	MW-1005	1136.92	58		< 0.53	160	16	370	15	300	6.18	520	

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2001-01	MW-1005P	1136.65	250		< 0.53	210	0.058	24	< 5	260	7.17	454	37
2001-01	MW-1005S	1136.42	170		< 0.53	150	4.1	210	< 5	200	6.95	335	
2001-01	MW-1010P	1088.16	160		< 0.53	140	0.17	180	< 5	170	7.57	270	88
2001-01	MW-1013	1103.78											
2001-01	MW-1013A	1095.72											
2001-01	MW-1013B	1095.86	590		< 12	1900	0.41	30000	1600	3300	6.14	3230	174
2001-01	MW-1013C	1098.03	520		< 12	2100	2.6	7800	1600	3200	6.27	3310	80
2001-01	MW-1013C	Dup.	470		< 12	2000	2.5	7700	1600	3000			
2001-01	MW-1014	1113.86											
2001-01	MW-1014A	1111.59	410		< 12	1200	0.83	5400	970	1900	6.46	2310	113
2001-01	MW-1014B	1109.89	550		450	1900	< 0.36	18000	1400	2600	6.29	3140	226
2001-01	MW-1014C	1106.15	340		< 12	760	11	2900	450	1100	6.46	1452	64
2001-04	MW-1000PR	1091.12	170		14	650	1.3	2900	480	910	5.9	1200	175
2001-04	MW-1000R	1092.76											
2001-04	MW-1002	1095.48	60		< 2.7	72	0.012	< 2	6.4	99	6.5	130	
2001-04	MW-1002G	1095.38	89		< 2.7	110	< 0.005	< 2	11	170	6.3	200	
2001-04	MW-1002G	Dup.	89		< 2.7	110	< 0.005	< 2	11	200			
2001-04	MW-1004	1110.8											
2001-04	MW-1004P	1107.46	160		< 2.7	140	0.055	54	< 5	160	7	260	144
2001-04	MW-1004S	1110.92	35		< 2.7	60	< 0.005	< 2	19	73	5.5	130	230
2001-04	MW-1005	1140.04	61		< 2.7	170	15	350	14	370	5.6	460	
2001-04	MW-1005P	1138.8	240		< 2.7	220	0.055	27	< 5	290	6.7	430	17
2001-04	MW-1005S	1139.04	170		< 2.7	160	4.4	230	< 5	210	6.7	310	
2001-04	MW-1010P	1090.56	150		5.5	140	0.066	64	< 5	130	7.1	250	-8
2001-04	MW-1013	1104.08											
2001-04	MW-1013A	1097.1											
2001-04	MW-1013B	1097.57	530		35	2300	0.72	40000	1600	3300	6	3400	203
2001-04	MW-1013C	1100.12	440		< 13	2300	2.1	9100	1600	3000	6.3	3000	84
2001-04	MW-1014	1114.62											
2001-04	MW-1014A	1112.51	430		< 13	1400	0.69	6700	920	1700	6.3	2300	138
2001-04	MW-1014B	1111.14	520		530	2000	< 0.15	19000	1400	3300	6.1	3200	207
2001-04	MW-1014C	1107.65	330		< 13	830	12	3100	420	1100	6.2	1400	55
2001-04	MW-1015A	1092.09	75	< 2.3	< 2.7	88	0.0082	< 2	8.2	120	7.1	160	
2001-04	MW-1015B	1091.09	180	< 2.3	< 2.7	140	0.069	140	< 5	290	7.6	460	
2001-05	MW-1015A	1089.83	77	< 2.3	< 2.7	83	< 0.005	2.5	9.2	110	7	150	
2001-05	MW-1015B	1089.79	180	< 2.3	< 2.7	140	< 0.005	36	5.1	230	7.8	470	
2001-06	MW-1015A	1089.53	75	< 2.3	< 2.7	85	< 0.005	4.2	8.4	110	7	150	
2001-06	MW-1015B	1089.69	180	< 2.3	< 2.7	140	< 0.005	23	< 5	220	7.6	450	
2001-07	MW-1000PR	1087.88	180	< 11	< 13	660	7	3900	450	950	5.99	1130	147
2001-07	MW-1000R	1088.16											
2001-07	MW-1002	1092.93	54	< 2.3	< 2.7	67	< 0.005	< 2	7.6	79	6.12	123	
2001-07	MW-1002G	1092.9	89	< 2.3	3.6	110	< 0.005	< 2	11	120	6.63	202	
2001-07	MW-1004	1109.31											
2001-07	MW-1004P	1107.3	150	< 2.3	< 2.7	140	0.015	14	< 5	160	6.9	260	99
2001-07	MW-1004S	1109.32	34	< 2.3	< 2.7	60	< 0.005	< 2	22	96	5.6	122	196
2001-07	MW-1005	1140.32	53	< 2.3	< 2.7	180	15	420	14	330	5.87	493	
2001-07	MW-1005P	1140.03	230	< 2.3	< 2.7	230	0.087	48	< 5	250	7.13	428	8
2001-07	MW-1005P	Dup.	240	< 2.3	< 2.7	230	0.77	80	< 5	210			
2001-07	MW-1005S	1139.84	170	< 2.3	< 2.7	170	4.4	230	< 5	190	6.91	308	
2001-07	MW-1010P	1087.82	140	6.1	< 2.7	150	0.16	150	6	140	7.08	250	173
2001-07	MW-1013	1106.08											
2001-07	MW-1013A	1097.19											
2001-07	MW-1013B	1097.63	490	< 15	32	2400	0.89	39000	1600	3400	6.09	3290	252
2001-07	MW-1013C	1099.39	460	< 15	< 13	2300	3.2	9000	1600	3500	6.28	3400	30
2001-07	MW-1014	1115.67											
2001-07	MW-1014A	1112.88	420	< 15	< 13	1500	0.7	6500	960	2000	6.24	2250	147
2001-07	MW-1014B	1112.02	440	< 15	480	2200	< 0.15	20000	1500	3000	6.01	2990	235
2001-07	MW-1014C	1108.11	330	21	< 13	800	11	3000	420	1100	6.15	1360	40
2001-07	MW-1015A	1088.74	75	< 2.3	< 2.7	90	< 0.005	7.5	9.8	110	6.55	153	
2001-07	MW-1015B	1088.67	180	< 2.3	< 2.7	150	< 0.005	19	< 5	240	7.32	451	
2001-08	MW-1015A	1088.12	76	< 2.3	< 2.7	90	< 0.005	9.7	7.6	100	6.68	158.7	
2001-08	MW-1015B	1088.21	180	< 2.3	< 2.7	150	< 0.005	13	5.3	240	7.53	462	
2001-09	MW-1015A	1087.55	79	< 2.3	< 2.7	82	0.02	15	7.8	150	7.19	159.9	
2001-09	MW-1015B	1087.59	180	< 2.3	< 2.7	130	0.0052	18	< 5	290	7.67	458	
2001-10	MW-1000PR	1087.26	190	< 11	< 13	560	2.8	3300	450	940	5.97	1109	163
2001-10	MW-1000R	1087.39											
2001-10	MW-1002	1090.63	53		< 2.7	57	< 0.005	< 2	7.1	140	6.03	123.3	
2001-10	MW-1002G	1090.63	89		< 2.7	94	< 0.005	< 2	11	140	6.1	203	
2001-10	MW-1004	1109.99											
2001-10	MW-1004P	1105.49	160	< 2.3	< 2.7	130	0.1	65	< 5	130	6.81	260	94
2001-10	MW-1004S	1107.06	34	< 2.3	< 2.7	51	< 0.005	< 2	23	110	5.73	121.3	198
2001-10	MW-1004S	Dup.	33	< 2.3	< 2.7	50	< 0.005	< 2	23	110			
2001-10	MW-1005	1138.85	49		< 2.7	170	12	340	15	450	5.72	530	
2001-10	MW-1005P	1138.59	240		< 2.7	200	0.2	68	< 5	270	6.63	424	5
2001-10	MW-1005S	1138.31	170		< 2.7	140	3.9	210	< 5	230	6.45	306	
2001-10	MW-1010P	1087.1	150	13	5.3	120	0.0097	18	5.4	180	6.63	246	
2001-10	MW-1013	1106.69											
2001-10	MW-1013A	1096.9											

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Historical Groundwater Results - Quarterly Parameters

Sample Date (yyyy-mm)	Location	Water Elevation ft	Alkalinity as		Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
			CaCO3 mg/l											
2001-10	MW-1013B	1097.19	560	18	69	2000	0.66	34000	1600	3200	6.06	3320	201	
2001-10	MW-1013C	1099.04	480	22	< 13	2000	2.7	8500	1700	3200	6.22	3380	21	
2001-10	MW-1014	1116.86												
2001-10	MW-1014A	1114.03	430	37	< 13	1300	1.5	6000	1000	1900	6.34	2280	152	
2001-10	MW-1014B	1112.38	510	20	490	1900	< 0.15	18000	1600	2900	6.05	3150	219	
2001-10	MW-1014C	1108.1	350	15	< 13	710	9.6	2900	410	990	6.17	1354	56	
2001-10	MW-1015A	1087.58	77	2.3	< 2.7	78	< 0.005	10	10	130	6.6	160		
2001-10	MW-1015B	1087.67	180	< 2.3	< 2.7	130	< 0.005	8.6	< 5	310	7.1	450		
2001-11	MW-1015A	1087.86	76	< 2.3	< 2.7	85	< 0.005	11	9.7	110	6.6	160		
2001-11	MW-1015B	1087.84	180	< 2.3	< 2.7	140	< 0.005	8.9	< 5	280	7.2	450		
2001-12	MW-1015A	1088.72	78	< 2.3	< 2.7	87	0.023	13	7.8	150	6.52	163.5		
2001-12	MW-1015B	1088.74	180	< 2.3	< 2.7	140	0.0069	11	< 5	300	7.03	468		
2002-01	MW-1000PR	1088.25	190		< 13	570	6.2	3500	440	970	6.09	1099	176	
2002-01	MW-1000R	1088.89												
2002-01	MW-1002	1091.3	59		< 2.7	64	< 0.005	< 2	6.4	110	6.44	129.3		
2002-01	MW-1002G	1091.25	91		< 2.7	99	< 0.005	< 2	10	150	6.54	203		
2002-01	MW-1004	1107.71												
2002-01	MW-1004P	1106.2	160		< 2.7	130	< 0.005	9.6	< 5	190	6.75	276	83	
2002-01	MW-1004P	Dup.	160		< 2.7	130	0.0061	11	< 5	200				
2002-01	MW-1004S	1107.79	34		< 2.7	53	< 0.005	< 2	22	140	5.89	124.1	207	
2002-01	MW-1005	1139.08	55		< 2.7	160	13	380	14	310	5.86	455		
2002-01	MW-1005P	1138.67	250		< 2.7	200	0.077	30	< 5	270	7.03	418	7	
2002-01	MW-1005S	1138.59	170		< 2.7	150	4.1	210	< 5	260	6.86	304		
2002-01	MW-1010P	1087.87	150		< 2.7	130	0.069	76	< 5	230	6.95	246	-25	
2002-01	MW-1013	1105.28												
2002-01	MW-1013A	1097.02												
2002-01	MW-1013B	1097.33	600		52	2100	0.71	36000	1600	3600	6.24	3380	201	
2002-01	MW-1013C	1099.65	510		< 13	2100	4.5	8800	1700	3400	6.32	3430	48	
2002-01	MW-1014	1116.91												
2002-01	MW-1014A	1114.51	460		< 13	1300	0.65	5900	1000	2100	6.55	2280	170	
2002-01	MW-1014B	1112.61	540		540	1900	< 0.15	18000	1500	3100	6.22	3110	222	
2002-01	MW-1014C	1108.48	350		< 13	690	9.2	2600	390	1100	6.55	1341	38	
2002-01	MW-1015A	1088.65	78	< 2.3	< 2.7	82	< 0.005	12	7.8	150	6.85	164.2		
2002-01	MW-1015B	1088.54	180	< 2.3	< 2.7	130	< 0.005	25	< 5	310	7.44	458		
2002-02	MW-1015A	1088.38	78	< 2.3	< 2.7	87	< 0.005	14	7.6	130	6.5	162		
2002-02	MW-1015B	1087.9	180	< 2.3	< 2.7	140	0.03	33	< 5	290	7	483		
2002-03	MW-1015A	1087.91	78	2.3	< 2.7	88	0.0074	15	8.8	120	6.4	170		
2002-03	MW-1015B	1087.79	180	< 2.3	< 2.7	140	0.0066	22	< 5	280	6.5	460		
2002-04	MW-1000PR	1094.71	190		< 13	570	2.6	2800	430	970	6.2	1088	153	
2002-04	MW-1000R	1095.09												
2002-04	MW-1002	1093.61	61		< 2.7	65	< 0.005	< 2	6.8	130	6.5	122		
2002-04	MW-1002	Dup.	60		< 2.7	65	< 0.005	< 2	7	130				
2002-04	MW-1002G	1093.66	91		< 2.7	100	< 0.005	< 2	9.4	150	6.4	201		
2002-04	MW-1004	1107.96												
2002-04	MW-1004P	1105.73	160		< 2.7	140	0.0053	8.3	< 5	170	7.1	263	188	
2002-04	MW-1004S	1108.04	37		< 2.7	58	< 0.005	< 2	22	120	5.9	129	223	
2002-04	MW-1005	1140.78	54		< 2.7	160	12	280	14	400	6.2	472		
2002-04	MW-1005P	1139.89	240		< 2.7	210	0.076	20	< 5	270	7.2	434	2	
2002-04	MW-1005S	1139.89	170		< 2.7	150	4.2	210	< 5	240	7.1	300		
2002-04	MW-1010P	1094.26	150		< 2.7	140	0.18	180	5.5	200	7.1	249	-19	
2002-04	MW-1013	1105.35												
2002-04	MW-1013A	1097.18												
2002-04	MW-1013B	1097.63	520		110	2200	0.36	34000	1600	3200	6.2	3370	205	
2002-04	MW-1013C	1101.39	480		14	2100	3.9	8900	1700	3200	6.3	3420	51	
2002-04	MW-1014	1117.24												
2002-04	MW-1014A	1115.15	410		16	1400	0.51	5900	1000	1900	6.8	2250	155	
2002-04	MW-1014B	1113	500		470	1900	< 0.15	17000	1500	3100	6.4	3140	218	
2002-04	MW-1014C	1109.25	340		15	710	9.1	2600	390	1000	6.4	1310	36	
2002-04	MW-1015A	1093.59	80		< 2.7	86	< 0.005	15	9	140	6.8	164		
2002-04	MW-1015B	1092.33	180		< 2.7	140	< 0.005	73	< 5	320	7.4	467		
2002-07	MW-1000PR	1087.66	200	10	< 13	610	6.2	3600	380	1000	6.28	1093	157	
2002-07	MW-1000R	1088.28												
2002-07	MW-1002	1093.51	59	< 2.6	< 2.7	66	< 0.005	< 2	5.8	120	6.58	123.7		
2002-07	MW-1002G	1093.78	92	< 2.6	< 2.7	110	< 0.005	< 2	8.1	160	6.57	208		
2002-07	MW-1004	1108.97												
2002-07	MW-1004P	1107.04	160	2.9	< 2.7	140	0.0056	9.7	< 5	200	7.39	267	106	
2002-07	MW-1004S	1109.06	38	< 2.7	< 2.7	62	< 0.005	< 2	19	140	6.27	138.4	209	
2002-07	MW-1005	1141.12	50	3.9	< 2.7	180	12	310	12	390	6.03	528		
2002-07	MW-1005P	1141.25	250	4.6	< 2.7	220	0.12	71	< 5	270	7.19	426	26	
2002-07	MW-1005S	1141.05	170	5.7	< 2.7	160	4.4	220	< 5	250	7.03	302		
2002-07	MW-1010P	1087.55	160	18	< 2.7	140	0.03	42	5.8	240	7.43	250	9	
2002-07	MW-1013	1106.66												
2002-07	MW-1013A	1097.44												
2002-07	MW-1013B	1097.95	690	28	150	2300	0.7	39000	1400	3900	6.37	3340	202	
2002-07	MW-1013C	1099.76	520	< 27	< 13	2300	4.1	10000	1500	3500	6.43	3400	49	
2002-07	MW-1014	1117.37												
2002-07	MW-1014A	1114.8	460	< 27	< 13	1400	0.38	6100	910	2100	6.49	2280	177	
2002-07	MW-1014A	Dup.	480	< 27	< 13	1500	0.42	6400	910	2200				

Historical Groundwater Results - Quarterly Parameters

Sample Date	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
2002-07	MW-1014B	1113.19	550	< 27	550	2100	< 0.15	19000	1400	3000	6.25	3100	245
2002-07	MW-1014C	1108.93	350	18	< 13	740	9.4	2700	330	1200	6.6	1269	45
2002-07	MW-1015A	1088.64	79	< 2.7	< 2.7	88	< 0.005	16	7.7	150	6.91	162.8	
2002-07	MW-1015B	1088.82	180	2.8	< 2.7	140	0.069	53	< 5	350	7.55	496	
2002-10	MW-1000PR	1090.89	200		< 13	600	7.4	3400	370	870	6.14	1088	90
2002-10	MW-1000R	1090.59											
2002-10	MW-1002	1095.93	68		< 2.7	72	< 0.005	< 2	< 5	100	6.32	140.5	
2002-10	MW-1002G	1095.89	96		< 2.7	110	< 0.005	< 2	8.2	180	6.43	211	
2002-10	MW-1004	1110.75											
2002-10	MW-1004P	1108.3	160		< 2.7	140	0.033	22	< 5	160	6.96	270	52
2002-10	MW-1004S	1110.88	39		< 2.7	61	< 0.005	< 2	20	140	6.26	135.7	168
2002-10	MW-1005	1141.78	51		< 2.7	210	12	330	13	470	5.8	655	
2002-10	MW-1005	Dup.	50		< 2.7	210	12	320	12	510			
2002-10	MW-1005P	1142.14	240		< 2.7	210	0.23	54	< 5	300	7.18	428	5
2002-10	MW-1005S	1141.94	170		< 2.7	150	4.1	210	< 5	220	6.94	300	
2002-10	MW-1010P	1089.49	150		< 2.7	140	0.035	120	< 5	200	7.28	269	-60
2002-10	MW-1013	1107.28											
2002-10	MW-1013A	1097.85											
2002-10	MW-1013B	1097.3	620		210	2300	< 0.15	36000	1600	3000	6.13	3390	221
2002-10	MW-1013C	1101.33	570		< 13	2300	5.4	9900	1600	3400	6.36	3520	-46
2002-10	MW-1014	1118.66											
2002-10	MW-1014A	1115.5	470		< 13	1400	0.54	5700	930	1800	6.52	2370	86
2002-10	MW-1014B	1114.21	490		450	2000	< 0.15	17000	1300	3300	6.26	3110	221
2002-10	MW-1014C	1110.1	360		< 13	730	9.1	2600	330	810	6.49	1299	38
2002-10	MW-1015A	1090.94	79		< 2.7	84	< 0.005	13	9.1	150	6.65	162.4	
2002-10	MW-1015B	1091.21	180		< 2.7	140	0.42	380	< 5	300	6.87	466	
2003-01	MW-1000PR	1087.45	200	11	< 13	590	6.7	3200	390	990	6.2	1080	170
2003-01	MW-1000R	1088.05											
2003-01	MW-1002	1091.65	65		< 2.7	66	0.012	< 2	6.4	92	6.5	136	
2003-01	MW-1002G	1091.63	92		< 2.7	100	0.0089	< 2	9.9	160	6.6	215	
2003-01	MW-1004	1107.43											
2003-01	MW-1004P	1105.93	160		< 2.7	130	0.053	42	< 5	150	7.2	274	205
2003-01	MW-1004S	1107.52	40		< 2.7	59	< 0.005	< 2	22	110	6.18	208	205
2003-01	MW-1005	1140.47	55		< 2.7	290	12	340	14	620	5.6	1079	
2003-01	MW-1005P	1140.7	250		< 2.7	190	0.52	51	< 5	290	7.2	298	22
2003-01	MW-1005S	1140.35	170		< 2.7	150	3.7	200	< 5	220	7	301	
2003-01	MW-1010P	1086.94	150	19	< 2.7	140	0.036	120	7	180	7.2	257	-24
2003-01	MW-1013	1105.97											
2003-01	MW-1013A	1097.39											
2003-01	MW-1013B	1098.58	630	< 27	92	2200	0.15	33000	1600	3400	6.1	3420	208
2003-01	MW-1013C	1099.8	570	< 27	< 13	2300	5.4	9500	1800	3500	6.5	3510	46
2003-01	MW-1014	1119.07											
2003-01	MW-1014A	1116.36	480	< 27	< 13	1400	0.54	5300	1000	2100	6.5	2370	198
2003-01	MW-1014B	1114.14	610	< 27	590	2000	< 0.15	17000	1500	2800	6.2	3160	232
2003-01	MW-1014C	1109.58	390	< 27	< 13	700	8.3	2400	380	1100	6.4	1311	74
2003-01	MW-1014C	Dup.	370	< 27	< 13	690	8.3	2400	370	1000			
2003-01	MW-1015A	1088.46	79		< 2.7	83	< 0.005	12	8.5	130	6.8	167	
2003-01	MW-1015B	1088.27	180		< 2.7	130	0.12	440	< 5	270	7.4	463	
2003-03	MW-1015A	1088.75					< 0.010	16			7.09	164.4	
2003-03	MW-1015B	1088.76					0.31	170			7.47	458	
2003-04	MW-1000PR	1087.83	200		< 6.7	570	5.1	3200	380	920	6.23	1047	154
2003-04	MW-1000R	1088.35											
2003-04	MW-1002	1091.51	68		< 1.3	71	< 0.010	< 2	< 5	100	6.31	133.6	
2003-04	MW-1002G	1091.43	90		< 1.3	110	< 0.010	< 2	9.5	170	6.51	212	
2003-04	MW-1004	1107.32											
2003-04	MW-1004P	1105.58	170		< 1.3	140	0.032	25	< 5	170	7.47	262	178
2003-04	MW-1004S	1107.39	41		< 1.3	62	< 0.010	< 2	20	120	6.01	136.7	213
2003-04	MW-1005	1139.42	62		< 1.3	390	18	440	22	550	5.71	1080	
2003-04	MW-1005P	1138.93	230		< 1.3	200	0.73	110	< 5	220	7.06	381	-4
2003-04	MW-1005S	1138.82	170		< 1.3	160	4.2	220	< 5	250	6.99	298	
2003-04	MW-1010P	1087.55	150		4.8	140	< 0.010	14	5.3	170	7.58	253	-32
2003-04	MW-1013	1106.02											
2003-04	MW-1013A	1097.95											
2003-04	MW-1013B	1097.87	660		160	2200	1.2	39000	1500	3500	6.21	3340	203
2003-04	MW-1013C	1099.98	540		< 13	2200	4.7	9600	1700	3500	6.39	3450	44
2003-04	MW-1014	1118.91											
2003-04	MW-1014A	1116.82	500		< 13	1400	< 0.29	4600	930	2000	6.38	2280	156
2003-04	MW-1014B	1113.96	610		690	2100	< 0.29	19000	1500	3400	6.29	2970	228
2003-04	MW-1014C	1109.35	380		< 13	690	8	2400	340	990	6.42	1287	7
2003-04	MW-1015A	1088.49	78		< 1.3	88	< 0.010	16	7.7	120	6.89	163.3	
2003-04	MW-1015B	1088.45	180		< 1.3	150	0.3	180	< 5	310	7.83	456	
2003-04	MW-1015B	Dup.	190		< 1.3	140	0.21	250	< 5	320			
2003-07	MW-1000PR	1087.76	200	12	< 6.7	580	6.6	3200	360	810	6.26	1027	150
2003-07	MW-1000R	1088.41											
2003-07	MW-1002	1093	63	< 1.2	< 1.3	65	0.0079	< 1	2.9	100	6.48	121.8	
2003-07	MW-1002G	1092.92	90	< 1.2	< 1.3	110	0.0066	< 1	8	150	6.49	209	
2003-07	MW-1004	1109.01											
2003-07	MW-1004P	1107.3	160	< 1.2	< 1.3	150	0.066	43	< 2.5	160	7.25	263	96

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Historical Groundwater Results - Quarterly Parameters

Sample Date	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
2003-07	MW-1004S	1109.16	42	< 1.2	< 1.3	69	< 0.005	< 1	20	110	6.36	141.9	186
2003-07	MW-1005	1140.38	53	< 1.2	1.4	350	16	450	11	580	5.53	1014	
2003-07	MW-1005P	1140.27	240	< 1.2	< 1.3	230	1.1	74	< 2.5	260	7.11	439	-3
2003-07	MW-1005S	1140.12	170	2.1	< 1.3	160	4.2	230	< 2.5	200	6.95	305	
2003-07	MW-1010P	1087.54	150	11	< 1.3	150	0.031	120	5.9	170	7.34	255	-20
2003-07	MW-1013	1109.38											
2003-07	MW-1013A	1098.2											
2003-07	MW-1013B	1098.71	620	< 2.6	120	2300	0.61	38000	1600	3100	6.25	3290	200
2003-07	MW-1013B	Dup.	580	4.3	110	2300	0.36	37000	1500	3100			
2003-07	MW-1013C	1100.31	500	17	< 13	2300	4.2	9600	1700	3200	6.32	3430	27
2003-07	MW-1014	1119.06											
2003-07	MW-1014A	1116.45	420	< 2.6	< 13	1400	0.32	4200	910	1900	6.62	2230	206
2003-07	MW-1014B	1114.33	530	< 2.6	500	1900	< 0.29	16000	1400	3800	6.28	2900	240
2003-07	MW-1014C	1109.74	340	13	< 13	700	8.2	2500	330	920	6.43	1239	40
2003-07	MW-1015A	1088.38	79	< 1.2	< 1.3	90	< 0.005	12	6.6	130	6.89	166.3	
2003-07	MW-1015B	1088.49	180	< 1.2	< 1.3	140	0.45	170	< 2.5	270	7.58	463	
2003-10	MW-1000PR	1086.98	210	< 6.7	< 6.7	560	6.5	3100	350	810	6.2	1040	166
2003-10	MW-1000R	1087.08											
2003-10	MW-1002	1090.23	65		< 1.3	66	< 0.005	4.9	4.6	110	6.3	135	
2003-10	MW-1002G	1090.23	88		< 1.3	100	< 0.005	1.5	8	160	6.5	209	
2003-10	MW-1004	1106.23											
2003-10	MW-1004P	1104.84	160		< 1.3	130	0.13	69	< 2.5	170	7.3	272	48
2003-10	MW-1004S	1106.29	42		< 1.3	62	< 0.005	5.4	17	120	6.3	143	167
2003-10	MW-1005	1138.41	55		< 1.3	420	18	440	11	850	5.6	1260	
2003-10	MW-1005P	1138.32	240		< 1.3	210	1	74	< 2.5	260	7.3	436	-18
2003-10	MW-1005S	1138.15	170		< 1.3	150	4	210	< 2.5	210	7.2	317	
2003-10	MW-1010P	1086.76	140		< 1.3	140	0.064	130	6.4	180	7.3	343	-47
2003-10	MW-1013	1109.3											
2003-10	MW-1013A	1097											
2003-10	MW-1013B	1097.29	590		110	2300	< 0.29	35000	1500	3200	6.3	3350	199
2003-10	MW-1013B	Dup.	550		140	2200	0.83	37000	1500	3200			
2003-10	MW-1013C	1099.27	540		< 13	2200	6.2	9800	1700	3200	6.4	3520	16
2003-10	MW-1014	1119.25											
2003-10	MW-1014A	1116.5	440		< 13	1400	1	3000	980	2000	6.6	2310	218
2003-10	MW-1014B	1113.77	540		640	2100	< 0.29	19000	1500	3000	6.4	2930	251
2003-10	MW-1014C	1109.01	340		< 1.3	680	7.8	2400	320	910	6.6	1256	55
2003-10	MW-1015A	1087.24	78		< 1.3	83	< 0.005	11	7.1	140	7.1	167	
2003-10	MW-1015B	1087.21	170		< 1.3	130	0.67	290	< 2.5	320	7.8	480	
2004-01	MW-1000PR	1087.59	210		< 6.7	530	4.3	2900	360	790	6.25	1065	98
2004-01	MW-1000R	1087.45											
2004-01	MW-1002	1089.83	64		< 1.3	69	0.006	3.1	6.1	130	6.55	141.5	
2004-01	MW-1002G	1089.8	89		< 1.3	100	< 0.005	2.6	8.6	160	6.62	215	
2004-01	MW-1004	1105.52											
2004-01	MW-1004P	1104.23	160		< 1.3	140	0.11	78	< 2.5	220	7.22	290	52
2004-01	MW-1004S	1105.62	42		< 1.3	62	< 0.005	< 1	19	170	6.21	133.7	208
2004-01	MW-1005	1137.52	56		< 1.3	260	15	360	14	430	5.73	829	
2004-01	MW-1005	Dup.	58		< 1.3	270	19	540	14	510			
2004-01	MW-1005P	1137.38	240		< 1.3	220	0.38	43	< 2.5	260	7.28	438	-2
2004-01	MW-1005S	1137.23	170		< 1.3	150	4.2	220	< 2.5	240	6.9	329	
2004-01	MW-1010P	1083.41											
2004-01	MW-1013	1108.22											
2004-01	MW-1013A	1096.91											
2004-01	MW-1013B	1097.13	580		170	2200	1.6	40000	1600	3200	6.15	3370	212
2004-01	MW-1013C	1099.18	490		40	2200	2.8	9100	1700	3300	6.32	3510	51
2004-01	MW-1014	1118.37											
2004-01	MW-1014A	1116.08	490		< 13	1300	1	3100	1000	2000	6.63	2310	185
2004-01	MW-1014B	1113.07	570		590	2000	< 0.29	17000	1600	3100	6.26	3130	198
2004-01	MW-1014C	1108.52	310		< 1.3	650	7.4	2300	320	930	6.42	1259	34
2004-01	MW-1015A	1087.39	79		< 1.3	85	< 0.005	14	8.7	160	7.17	165.1	
2004-01	MW-1015B	1087.43	180		< 1.3	130	0.44	240	< 2.5	310	7.78	471	
2004-03	MW-1010P		150		2.1	150	0.095	180	6.9	160	7.66	269	
2004-04	MW-1000PR	RD	205	13.5	2.1	540	6.6	3010	363	750			
2004-04	MW-1000PR	1088.38	210		< 6.7	530	7	2900	330	720	6.73	1025	105
2004-04	MW-1000R	1091.37											
2004-04	MW-1002	1092.45	61		< 1.3	65	< 0.005	< 1	6	37	6.74	128.4	
2004-04	MW-1002G	1092.38	90		< 1.3	100	0.022	< 1	8.3	92	6.76	206	
2004-04	MW-1004	1105.88											
2004-04	MW-1004P	1104.46	160		< 1.3	140	0.1	77	< 2.5	160	7.26	275	117
2004-04	MW-1004S	1105.94	43		6.4	64	< 0.005	< 1	19	66	6.58	143.3	156
2004-04	MW-1005	1139.18	57		< 1.3	280	17	430	14	500	6.29	807	
2004-04	MW-1005P	1137.86	240		< 1.3	220	0.11	20	< 2.5	220	7.05	436	4
2004-04	MW-1005S	1138.11	160		< 1.3	150	4.3	210	3.7	130	6.92	298	
2004-04	MW-1010P	RD	144	14.5	1.6	145	< 0.1	92	7.8	178			
2004-04	MW-1010P	1088.35	140		< 1.3	140	0.013	97	8.8	130	7.55	276	20
2004-04	MW-1013	1108.2											
2004-04	MW-1013A	1097.43											
2004-04	MW-1013B	1097.77	560		230	2200	< 0.33	32000	1500	3100	6.29	3260	188
2004-04	MW-1013C	RD	527	9.9	2.3	2180	7.2	9830	1840	3210			

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Historical Groundwater Results - Quarterly Parameters

Sample Date	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
2004-04	MW-1013C	1099.81	490		< 13	2200	7.8	9700	1600	3200	6.65	3520	59
2004-04	MW-1014	1117.83											
2004-04	MW-1014A	RD	463	< 1	6	1320	0.1	3050	1040	1920			
2004-04	MW-1014A	1116.64	470		< 13	1300	0.13	3100	910	1800	6.82	2250	211
2004-04	MW-1014B	RD	461	< 1	492	1920	< 0.1	18800	1480	2530			
2004-04	MW-1014B	1112.89	530		440	1700	< 0.33	14000	1400	2800	6.51	2880	246
2004-04	MW-1014B	Dup.	570		440	1700	< 0.33	14000	1400	2800			
2004-04	MW-1014C	RD		8.4	1.2	657	6.9	2220	330	868			
2004-04	MW-1014C	1108.53	330		< 13	640	7.5	2300	290	820	6.77	1233	53
2004-04	MW-1015A	1089.17	79		< 1.3	86	< 0.005	15	9	62	7.17	167.7	
2004-04	MW-1015B	1089.08	180		< 1.3	140	0.38	120	< 2.5	210	7.49	481	
2004-07	MW-1000PR	1087.4	200	< 1.8	28	530	2.3	2800	310	690	6.1	998	146
2004-07	MW-1000R	1087.74											
2004-07	MW-1002	1092.22	53	< 1.8	< 1.3	60	< 0.005	< 1	5.6	93	6.5	114	
2004-07	MW-1002G	1092.14	90	< 1.8	< 1.3	110	< 0.005	< 1	8.7	140	6.8	202	
2004-07	MW-1004	1108.26											
2004-07	MW-1004P	1106.68	160	< 1.8	< 1.3	140	0.066	97	< 2.5	120	6.8	275	114
2004-07	MW-1004S	1108.32	44	< 1.8	< 1.3	71	< 0.005	< 1	21	100	6.3	152	184
2004-07	MW-1005	1139.35	55	< 1.8	1.9	280	18	520	13	480	6	733	
2004-07	MW-1005P	1139.37	240	< 1.8	< 1.3	220	0.45	93	< 2.5	170	7	428	-5
2004-07	MW-1005S	1139.16	160	< 1.8	< 1.3	160	4.2	220	4.2	150	6.8	294	
2004-07	MW-1010P	1087.09	160	2.3	< 1.3	160	0.18	210	4.3	130	7	284	55
2004-07	MW-1013	1111.69											
2004-07	MW-1013A	1097.86											
2004-07	MW-1013B	1098.27	550	< 2.6	150	2200	< 0.33	24000	1600	3100	6.1	3340	191
2004-07	MW-1013C	1099.75	520	16	< 13	2300	7.4	10000	1400	3200	6.2	3490	45
2004-07	MW-1013C	Dup.	490	9.7	< 13	2200	7.3	10000	1600	3200			
2004-07	MW-1014	1118.45											
2004-07	MW-1014A	1115.52	440	< 2.6	< 13	1400	0.43	2100	940	1900	6.7	2250	175
2004-07	MW-1014B	1113.85	450	< 2.6	520	1900	< 0.33	15000	1300	2600	6.3	2950	191
2004-07	MW-1014C	1109.22	300	15	< 13	660	7.2	2300	290	820	6.4	1171	31
2004-07	MW-1015A	1087.88	78	< 1.8	< 1.3	89	< 0.005	12	7.7	88	6.8	165	183
2004-07	MW-1015B	1087.97	170	< 1.8	< 1.3	140	0.45	190	< 2.5	220	7.1	458	-104
2004-10	MW-1000PR	1087.16	210	3.2	15	500	0.37	2700	320	670	6.4	970	
2004-10	MW-1000R	1087.39											
2004-10	MW-1002	1090.26	56	< 1.8	< 1.3	56	< 0.005	3	4.6	59	6.7	116	
2004-10	MW-1002G	1090.23	93	< 1.8	< 1.3	98	< 0.005	4.1	8.4	110	6.7	204	
2004-10	MW-1004	1106.01											
2004-10	MW-1004P	1104.64	160	< 1.8	1.5	130	< 0.005	17	< 2.5	120	7.3	271	109
2004-10	MW-1004S	1106.12	46	< 1.8	< 1.3	65	< 0.005	1.3	19	76	6.7	146	
2004-10	MW-1005	1138.67	55	4.3	< 1.3	270	15	390	14	550	5.9	799	
2004-10	MW-1005P	1138.05	240	2.6	< 1.3	210	0.47	87	< 2.5	210	7.1	436	-2
2004-10	MW-1005S	1138.06	170	3.9	< 1.3	150	3.7	210	3.6	160	6.6	298	
2004-10	MW-1010P	1086.86	160	3.3	< 1.3	150	0.19	200	6.1	140	6.9	281	64
2004-10	MW-1013	1110.47											
2004-10	MW-1013A	1097.11											
2004-10	MW-1013B	1097.1	640	4.2	380	2200	< 0.33	34000	1600	3100	6.3	3250	204
2004-10	MW-1013C	1099.48	520	17	< 13	2200	7	9800	1700	3200	6.3	3450	50
2004-10	MW-1014	1119.12											
2004-10	MW-1014A	1114.83	490	2.9	< 13	1300	< 0.33	2000	930	1800	6.7	2220	184
2004-10	MW-1014B	1113.33	620	3.6	550	2000	< 0.33	17000	1500	2800	6.3	2950	215
2004-10	MW-1014C	1108.87	350	17	< 13	610	6.6	2100	300	780	6.5	1175	60
2004-10	MW-1015A	1087.22	79	< 1.8	< 1.3	83	< 0.005	11	7.6	95	7.3	164	116
2004-10	MW-1015B	1087.21	180	< 1.8	< 1.3	130	0.3	140	< 2.5	220	7.6	459	-99
2004-10	MW-1015B	Dup.	180	< 1.8	< 1.3	130	0.3	140	< 2.5	230			
2005-01	MW-1000PR	1087.9	220	1.3	16	510	0.51	2500	310	660	6.2	991	133
2005-01	MW-1000R	1087.88											
2005-01	MW-1002	1090.2	59	< 0.73	< 1.3	62	< 0.005	< 1	5.1	24	6.9	122	
2005-01	MW-1002G	1090.42	93	< 0.73	< 1.3	100	< 0.005	< 1	9.6	93	6.6	208	
2005-01	MW-1004	1105.9											
2005-01	MW-1004P	1104.67	160	< 0.73	< 1.3	130	0.058	75	< 2.5	94	7	270	102
2005-01	MW-1004S	1106.02	46	< 0.73	< 1.3	65	< 0.005	< 1	19	110	6.5	146	187
2005-01	MW-1004S	Dup.	46	< 0.73	< 1.3	65	< 0.005	< 1	19	79			
2005-01	MW-1005	1138.48	54	2.3	< 1.3	180	12	310	13	280	6.1	510	
2005-01	MW-1005P	1137.86	250	< 0.73	< 1.3	210	0.85	79	< 2.5	210	7.1	428	15
2005-01	MW-1005S	1137.89	160	2.4	< 1.3	150	3.8	210	4.8	130	6.4	301	
2005-01	MW-1010P	1087.56	150	18	< 1.3	140	< 0.005	92	11	130	6.7	284	72
2005-01	MW-1013	1109.19											
2005-01	MW-1013A	1097.27											
2005-01	MW-1013B	1097.29	580	4.8	180	2200	< 0.33	24000	1700	3000	6.3	3390	207
2005-01	MW-1013C	1099.34	540	20	< 13	2100	7.2	9500	1700	3000	6.3	3540	67
2005-01	MW-1014	1118.5											
2005-01	MW-1014A	1115.84	480	2.3	< 13	1300	< 0.33	2000	990	1800	6.7	2330	246
2005-01	MW-1014B	1113.05	550	5.3	520	2000	< 0.33	16000	1500	2700	6.4	3210	277
2005-01	MW-1014C	1108.62	340	21	< 13	600	6.4	2000	300	730	6.5	1174	70
2005-01	MW-1015A	1087.45	79	< 0.73	< 1.3	83	< 0.005	11	7.7	65	6.9	162	128
2005-01	MW-1015B	1087.61	180	< 0.73	< 1.3	130	0.22	120	< 2.5	230	7.4	464	-89
2005-04	MW-1000PR	1088.23	210	2.7	17	530	0.75	3000	320	660	6.3	882	105

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Historical Groundwater Results - Quarterly Parameters

Sample Date (yyyy-mm)	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
2005-04	MW-1000R	1088.69											
2005-04	MW-1002	1091.64	56	< 0.66	< 1.3	61	< 0.005	< 1	6.1	8	6.8	117	
2005-04	MW-1002G	1091.79	91	< 0.66	< 1.3	100	< 0.005	< 1	9.2	95	6.7	206	
2005-04	MW-1004	1106.18											
2005-04	MW-1004P	1104.74	160	< 0.66	< 1.3	140	< 0.005	26	< 2.5	120	6.6	265	124
2005-04	MW-1004S	1106.28	46	< 0.66	< 1.3	69	< 0.005	< 1	21	45	6.2	148	202
2005-04	MW-1005	1139.08	52	2.3	< 1.3	190	17	450	14	300	6.1	528	
2005-04	MW-1005P	Dup.	51	2.2	< 1.3	190	17	460	14	290			
2005-04	MW-1005P	1137.9	240	< 0.66	< 1.3	220	0.11	17	< 2.5	200	6.7	437	-2
2005-04	MW-1005S	1137.95	160	2.8	< 1.3	150	4.4	240	4.3	170	6.3	294	
2005-04	MW-1010P	1088.2	150	9.9	< 1.3	150	0.034	150	11	110	6.7	284	60
2005-04	MW-1013	1108.43											
2005-04	MW-1013A	1097.16											
2005-04	MW-1013B	1097.61	630	1.7	450	2200	< 0.33	42000	1700	3100	6.2	3420	238
2005-04	MW-1013C	1099.38	520	16	< 13	2200	8.2	10000	1700	3100	6.3	3390	66
2005-04	MW-1014	1117.72											
2005-04	MW-1014A	1115.68	440	1.9	< 13	1300	< 0.33	2000	1000	1800	6.6	2250	276
2005-04	MW-1014B	1112.91	520	2.6	460	1900	< 0.33	16000	1400	2700	6.4	2790	288
2005-04	MW-1014C	1108.19	330	16	< 13	660	7	2300	290	750	6.3	1202	64
2005-04	MW-1015A	1088.58	79	< 0.66	< 1.3	87	< 0.005	16	8.6	51	6.8	162	194
2005-04	MW-1015B	1088.6	180	< 0.66	< 1.3	140	0.29	130	< 2.5	190	7.1	451	-93
2005-07	MW-1000PR	1087.41	210	4	27	560	1.5	2900	330	680	6.7	962	139
2005-07	MW-1000R	1087.59											
2005-07	MW-1002	1090.63	47	< 0.66	1.6	53	< 0.005	< 1	4.9	82	6.7	98	
2005-07	MW-1002G	1090.54	91	< 0.66	< 1.3	110	< 0.005	< 1	8.8	140	6.8	184	
2005-07	MW-1004	1105.97											
2005-07	MW-1004P	1104.59	160	< 0.66	< 1.3	150	0.059	41	< 2.5	130	7.4	270	58
2005-07	MW-1004S	1106.1	47	< 0.66	2	77	< 0.005	< 1	24	100	6.3	158	211
2005-07	MW-1004S	Dup.	47	< 0.66	2	78	< 0.005	< 1	24	260			
2005-07	MW-1005	1138.52	46	1.5	< 1.3	180	14	370	16	270	6.2	497	
2005-07	MW-1005P	1138.3	240	< 0.66	< 1.3	230	0.17	82	< 2.5	230	7.4	428	-1
2005-07	MW-1005S	1138.25	170	3	< 1.3	160	4.5	240	3.9	180	7.2	296	
2005-07	MW-1010P	1087.16	150	22	< 1.3	160	< 0.005	85	14	170	7.9	288	94
2005-07	MW-1013	1110.98											
2005-07	MW-1013A	1096.86											
2005-07	MW-1013B	1097.22	640	1.9	400	2300	< 0.33	39000	1700	3100	6.4	3200	229
2005-07	MW-1013C	1098.89	510	13	< 13	2300	8.5	11000	1800	3100	6.6	3400	17
2005-07	MW-1014	1117.46											
2005-07	MW-1014A	1114.86	500	1.2	< 13	1300	< 0.33	1400	1000	1800	6.8	2170	269
2005-07	MW-1014B	1112.42	570	2.3	560	2100	< 0.33	17000	1500	2800	6.5	3010	299
2005-07	MW-1014C	1107.8	350	15	< 13	650	6.9	2200	300	760	6.9	1150	57
2005-07	MW-1015A	1087.37	78	< 0.66	< 1.3	89	< 0.005	12	8.5	110	7.2	162	
2005-07	MW-1015B	1087.49	180	< 0.66	< 1.3	150	0.4	140	< 2.5	260	8	457	-91
2005-10	MW-1000PR	1087.92	210	2.9	25	580	0.73	2900	330	730	6.6	955	141
2005-10	MW-1000R	1088.17											
2005-10	MW-1002	1092.07	50	< 0.66	< 2.7	60	< 0.005	< 1	5.2	120	6.5	104	
2005-10	MW-1002G	1091.97	89	< 0.66	< 2.7	110	< 0.005	< 1	9	120	6.5	201	
2005-10	MW-1004	1107.51											
2005-10	MW-1004P	1105.6	170	< 0.66	< 2.7	140	< 0.005	21	< 2.5	150	7.1	277	83
2005-10	MW-1004S	1107.58	49	< 0.66	< 2.7	75	0.008	< 1	23	150	7.2	162	186
2005-10	MW-1005	1138.49	61	2	< 2.7	290	17	480	14	450	6	786	
2005-10	MW-1005P	1137.53	240	< 0.66	< 2.7	220	0.03	48	< 2.5	210	6.5	427	-6
2005-10	MW-1005S	1137.6	170	1.9	< 2.7	180	4.2	240	4.2	200	6.4	298	
2005-10	MW-1010P	1087.81	160	3.9	< 2.7	170	0.044	160	8.8	150	7.1	283	25
2005-10	MW-1013	1109.89	510	2.5	< 13	600	22	25000	62	760	6.1	1332	73
2005-10	MW-1013A	1096.84	370	0.86	< 13	680	< 0.33	4500	380	870	6.7	1576	153
2005-10	MW-1013B	1096.98	630	< 0.85	230	2300	< 0.33	30000	1500	3100	6.4	3260	222
2005-10	MW-1013C	1099.2	510	9.2	< 13	2200	8.3	11000	1700	3200	6.7	3410	37
2005-10	MW-1013C	Dup.	500	9.4	< 13	2300	8.7	11000	1700	3100			
2005-10	MW-1014	1117.7	170	< 0.85	< 13	350	< 0.33	1300	200	500	7.1	726	202
2005-10	MW-1014A	1114.97	450	< 0.85	< 13	1300	< 0.33	1500	890	1800	6.7	2270	213
2005-10	MW-1014B	1112.41	470	1.2	400	1800	< 0.33	15000	1300	2400	6.5	2820	261
2005-10	MW-1014C	1108.06	320	14	< 13	630	7	2200	290	790	6.7	1157	54
2005-10	MW-1015A	1088.12	85	< 0.66	3.8	96	< 0.005	13	8.8	110	6.2	161	70
2005-10	MW-1015B	1088.24	180	< 0.66	< 2.7	150	0.3	140	< 2.5	260	6.3	461	-93
2006-01	MW-1000PR	1087.71	210	3	58	480	0.68	2400	300	670	6.8	1014	126
2006-01	MW-1000R	1088.41											
2006-01	MW-1002	1090.67	51	< 0.66	< 2.7	52	< 0.005	< 1	4.6	33	7.1	112	
2006-01	MW-1002G	1090.58	89	< 0.66	< 2.7	94	< 0.005	< 1	8.3	95	7	213	
2006-01	MW-1004	1106.31											
2006-01	MW-1004P	1105.59	160	< 0.66	< 2.7	140	0.35	170	< 2.5	110	7.1	290	95
2006-01	MW-1004S	1106.51	48	< 0.66	< 2.7	58	< 0.005	1	23	75	7	165	175
2006-01	MW-1005	1138.33	51	1.7	< 2.7	200	15	440	14	350	6.5	597	
2006-01	MW-1005P	1137.24	250	< 0.66	< 2.7	200	0.49	75	< 2.5	200	6.9	434	20
2006-01	MW-1005S	1137.47	160	2.4	< 2.7	140	4	210	3.2	160	6.8	316	
2006-01	MW-1010P	1087.51	150	4.3	< 2.7	140	0.057	170	9.2	130	7.2	301	90
2006-01	MW-1013	1108.54	680	0.98	< 13	560	12	22000	79	700	6.4	1211	72
2006-01	MW-1013A	1097.01	340	< 0.85	< 13	500	< 0.33	2900	240	650	6.8	1271	156

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Historical Groundwater Results - Quarterly Parameters

Sample Date	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
2006-01	MW-1013B	1097.17	590	1.1	210	2200	< 0.33	22000	1500	3000	6.4	3480	223
2006-01	MW-1013C		550	13	< 13	2100	7.6	9700	1700	3100	6.3	3480	61
2006-01	MW-1014	1117.27	170	< 0.85	< 13	310	< 0.33	1100	190	540	6.9	748	261
2006-01	MW-1014A	1114.81	480	< 0.85	17	1200	< 0.33	1500	970	1800	6.8	2390	252
2006-01	MW-1014B	1112.12	570	2.4	560	1900	< 0.33	16000	1400	2800	6.5	3350	287
2006-01	MW-1014C	1107.25	300	16	< 13	590	6.2	2000	280	740	6.9	1182	67
2006-01	MW-1014C	Dup.	310	18	< 13	570	6	1900	270	750			
2006-01	MW-1015A	1088.05	76	< 0.66	< 2.7	80	< 0.005	9	8.4	79	7.2	165	160
2006-01	MW-1015B	1087.8	180	< 0.66	< 2.7	140	0.32	110	< 2.5	270	7.2	472	-73
2006-02	MW-1013C	1099.3											
2006-04	MW-1000PR	1088.35	210	1.8	30	530	0.46	2600	300	620	6.62	926	129
2006-04	MW-1000R	1088.82											
2006-04	MW-1002	1092.17	52	< 0.57	< 2.7	61	0.006	< 1	6.2	26	6.72	112	
2006-04	MW-1002G	1092.06	89	< 0.57	< 2.7	110	0.015	< 1	9.1	67	6.76	201	
2006-04	MW-1004	1106.96											
2006-04	MW-1004P	1105.34	160	< 0.57	< 2.7	140	0.2	89	2.5	93	6.31	270	88
2006-04	MW-1004S	1107.08	49	< 0.57	< 2.7	78	0.008	2.6	25	63	5.85	161.6	176
2006-04	MW-1005	1139.51	52	2.2	< 2.7	210	13	320	14	290	6.23	596	
2006-04	MW-1005P	1138.47	250	< 0.57	< 2.7	230	0.22	40	< 2.5	210	6.71	439	6
2006-04	MW-1005S	1138.64	170	2.8	< 2.7	160	4.4	230	4	140	6.56	298	
2006-04	MW-1005S	Dup.	170	2.3	< 2.7	160	4.4	230	4	110			
2006-04	MW-1010P	1088.21	150	4.2	< 2.7	160	0.029	150	13	89	7	278	101
2006-04	MW-1013	1108.42	510	< 1	23	550	2.2	21000	65	640	5.95	1040	150
2006-04	MW-1013A	1097.29	340	< 1	17	730	< 0.33	3900	270	640	6.23	1571	152
2006-04	MW-1013B	1097.65	590	< 1	280	2200	< 0.33	25000	1600	3000	6.1	3300	210
2006-04	MW-1013C	1099.24	520	12	< 13	2300	8.9	11000	1600	3000	6.21	3380	51
2006-04	MW-1014	1117.25	150	< 1	36	340	< 0.33	1200	170	410	6.49	677	271
2006-04	MW-1014A	1114.95	440	< 1	22	1300	< 0.33	2100	880	1700	6.39	2200	268
2006-04	MW-1014B	1112.27	550	1.1	530	1900	< 0.33	14000	1400	2700	6.23	2740	292
2006-04	MW-1014C	1107.9	340	16	< 13	620	6.4	2100	270	700	6.4	1124	80
2006-04	MW-1015A	1088.71	77	< 0.57	< 2.7	90	< 0.005	11	9.1	39	6.96	161.5	173
2006-04	MW-1015B	1088.89	180	< 0.57	< 2.7	140	0.44	100	< 2.5	190	7.11	464	-84
2006-07	MW-1000PR	1086.96	270	1.7	21	480	0.62	2400	310	660	6.47	928	100
2006-07	MW-1000R	1088.31											
2006-07	MW-1002	1089.57	50	< 0.57	2.9	53	< 0.005	< 1	5.1	88	6.49	108.8	
2006-07	MW-1002G	1088.49	86	< 0.57	< 2.7	99	< 0.005	2.9	8.7	140	6.55	199.4	
2006-07	MW-1004												
2006-07	MW-1004P	1103.79	160	< 0.57	26	130	< 0.005	5.6	< 2.5	170	7.11	266	72
2006-07	MW-1004S	1105.22	50	< 0.57	8.9	77	< 0.005	< 1	26	93	7.11	165.3	199
2006-07	MW-1005	1137.18	54	1.7	< 2.7	220	12	340	14	560	6.44	715	
2006-07	MW-1005P	1136.8	240	< 0.57	< 2.7	210	0.6	86	< 2.5	200	6.59	423	1
2006-07	MW-1005S	1137.26	170	2.8	< 2.7	150	4	210	3.8	170	6.66	302	
2006-07	MW-1010P	1086.63	150	4.4	2.8	150	0.045	150	14	150	7.16	290	104
2006-07	MW-1013	1111.08	520	< 1	24	530	3.2	20000	58	630	6.05	1091	92
2006-07	MW-1013	Dup.	560	< 1	29	520	3.2	19000	58	670			
2006-07	MW-1013A	1096.52	320	< 1	16	460	< 0.33	1700	220	600	6.52	1104	160
2006-07	MW-1013B	1096.73	610	1.4	470	2200	< 0.33	36000	1600	3000	6.17	3280	249
2006-07	MW-1013C	1098.2	520	18	14	2200	7	9800	1700	3100	6.09	3300	51
2006-07	MW-1014	1117.53	170	< 1	26	320	< 0.33	940	180	490	6.54	713	175
2006-07	MW-1014A	1114.77	450	< 1	31	1300	< 0.33	1400	1000	1800	6.62	2190	190
2006-07	MW-1014B	1112.1	520	1.8	510	1700	< 0.33	12000	1400	2400	6.41	2780	222
2006-07	MW-1014C	1107.35	350	16	16	580	5.9	1900	260	770	6.55	1080	63
2006-07	MW-1015A	1086.95	79	< 0.57	3.3	82	< 0.005	8.2	8.6	100	6.02	160.8	73
2006-07	MW-1015B	1086.84	170	0.97	< 2.7	140	0.052	97	< 2.5	270	6.33	466	-63
2006-10	MW-1000PR	1085.87	210	2.8	12	550	0.49	2700	290	600	7	948	108
2006-10	MW-1000R	1087.12											
2006-10	MW-1002	1089.47	52	< 0.57	< 2.7	62	< 0.005	< 1	6.3	< 2	6.8	109	
2006-10	MW-1002G	1089.42	87	< 0.57	< 2.7	110	< 0.005	< 1	9.3	37	6.9	200	
2006-10	MW-1004	1104.87											
2006-10	MW-1004P	1103.68	150	< 0.57	< 2.7	150	< 0.005	6.1	3.1	120	7.3	280	75
2006-10	MW-1004P	Dup.	160	< 0.57	< 2.7	150	< 0.005	6.2	4.5	66			
2006-10	MW-1004S	1104.98	51	< 0.57	< 2.7	87	< 0.005	< 1	26	83	6.8	185	181
2006-10	MW-1005	1137.03	54	2.3	< 2.7	300	16	380	15	320	6.3	833	
2006-10	MW-1005P	1136.78	240	< 0.57	< 2.7	230	0.019	39	< 2.5	140	7	456	-3
2006-10	MW-1005S	1136.55	160	2.3	< 2.7	170	4.4	240	4.1	83	7.3	302	
2006-10	MW-1010P	1086.79	160	5.7	< 2.7	170	0.017	110	8.1	92	7.8	289	71
2006-10	MW-1013	1109.73	520	< 1	< 13	580	11	24000	55	620	6.5	1233	81
2006-10	MW-1013A	1096.36	300	< 1	< 13	490	< 0.33	2400	200	560	7	1015	130
2006-10	MW-1013B	1096.54	480	< 1	200	2400	< 0.33	23000	1600	3000	6.5	3360	309
2006-10	MW-1013C	1097.94	580	15	< 13	2200	9.1	11000	1600	3000	6.7	3390	16
2006-10	MW-1014	1117.45	170	< 1	< 13	350	< 0.33	880	180	430	6.7	739	165
2006-10	MW-1014A	1114.6	480	< 1	< 13	1400	0.66	820	1000	1800	6.7	2290	176
2006-10	MW-1014B	1111.88	460	< 1	460	1900	< 0.33	13000	1300	2400	6.5	2900	215
2006-10	MW-1014C	1106.97	330	20	< 13	620	6.1	2000	260	700	7	1113	36
2006-10	MW-1015A	1086.85	78	< 0.57	< 2.7	92	< 0.005	9.5	9.3	21	7.1	162	156
2006-10	MW-1015B	1086.94	180	< 0.57	< 2.7	160	0.32	110	2.5	230	7.5	466	-73
2007-01	MW-1000PR	1087.12	220	1.7	29	530	0.26	2600	290	570	6.8	959	175
2007-01	MW-1000R	1087.25											

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Historical Groundwater Results - Quarterly Parameters

Sample Date	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
2007-01	MW-1002	1089.38	39	< 0.57	< 2.7	57	< 0.005	< 1	5.5	5	6.9	106	
2007-01	MW-1002G	1089.34	81	< 0.57	< 2.7	110	< 0.005	< 1	8.3	43	6.7	208	
2007-01	MW-1004	1104.37											
2007-01	MW-1004P	1103.05	160	< 0.57	< 2.7	140	0.04	79	< 2.5	91	7.2	285	157
2007-01	MW-1004S	1104.49	48	< 0.57	< 2.7	83	< 0.005	< 1	27	46	6.9	178	227
2007-01	MW-1005	1137.54	49	1.5	< 2.7	200	16	460	14	290	6.2	528	
2007-01	MW-1005P	1136.27	250	< 0.57	< 2.7	230	0.41	89	3.7	180	6.9	441	11
2007-01	MW-1005S	1136.33	170	1.9	< 2.7	170	4.1	230	3.5	130	6.7	312	
2007-01	MW-1010P	1087	160	4.3	< 2.7	160	0.038	160	8.7	120	7.3	303	97
2007-01	MW-1010P	Dup.	150	4.4	< 2.7	160	0.035	160	8.4	130			
2007-01	MW-1013	1108.4	560	4	< 13	600	12	24000	72	680	6.4	1168	100
2007-01	MW-1013A	1096.32	320	1.9	< 13	400	< 0.33	1700	170	510	7	885	147
2007-01	MW-1013B	1096.44	570	< 1	290	2200	< 0.33	24000	1600	2900	6.5	3370	286
2007-01	MW-1013C	1098.06	540	9	< 13	2300	9.5	11000	1700	3000	6.6	3460	68
2007-01	MW-1014	1117.15	170	2.1	39	330	< 0.33	1300	170	420	6.8	710	218
2007-01	MW-1014A	1114.68	470	< 1	< 13	1300	< 0.33	780	1000	1700	6.6	3150	254
2007-01	MW-1014B	1111.42	570	< 1	600	1900	< 0.33	15000	1400	2600	6.6	3150	254
2007-01	MW-1014C	1106.92	300	21	< 13	580	6	1900	260	680	6.8	1122	76
2007-01	MW-1015A	1087.99	69	< 0.57	< 2.7	90	< 0.005	8.9	8.8	57	7	163	83
2007-01	MW-1015B	1086.98	160	< 0.57	< 2.7	160	0.35	120	< 2.5	200	7.2	541	-60
2007-04	MW-1000PR	1087.43	230	3.9	13	530	0.38	2600	300	630	6.1	929	207
2007-04	MW-1000R	1087.88											
2007-04	MW-1002	1090.43	50	1.7	< 2.7	56	< 0.005	< 1	5.6	43	7.2	101	
2007-04	MW-1002G	1090.34	88	1.9	< 2.7	110	< 0.005	< 1	9.2	190	6.8	203	
2007-04	MW-1004												
2007-04	MW-1004P	1103.86	160	1.8	< 2.7	140	0.22	82	2.5	110	6.5	266	128
2007-04	MW-1004S	1105.59	54	2.1	< 2.7	92	< 0.005	< 1	30	100	6.4	181	212
2007-04	MW-1005	1137.26	50	3.1	< 2.7	190	16	430	14	89	6.5	508	
2007-04	MW-1005	Dup.	51	2.9	< 2.7	190	16	430	14	170			
2007-04	MW-1005P	1135.62	240	2	< 2.7	230	0.24	28	< 2.5	170	6.8	427	7
2007-04	MW-1005S	1135.91	170	3.6	< 2.7	160	4.2	230	3.5	230	6.9	297	
2007-04	MW-1010P	1087.48	160	5.2	< 2.7	160	0.037	170	8.1	140	6.5	289	154
2007-04	MW-1013	1108.02	550	1.4	< 13	620	3.3	24000	74	670	6.1	1149	87
2007-04	MW-1013A	1096.2	330	< 1	< 13	460	< 0.33	1700	180	540	6.3	1006	137
2007-04	MW-1013B	1096.45	620	3.2	230	2400	< 0.33	23000	1700	3000	5.9	3260	255
2007-04	MW-1013C	1098.24	560	16	< 13	2300	9.3	11000	1700	3100	6.2	3320	51
2007-04	MW-1014	1116.26	170	1.1	17	350	< 0.033	610	180	420	6.2	677	188
2007-04	MW-1014A	1113.98	470	3.7	< 13	1400	0.53	920	950	1800	6.2	2180	180
2007-04	MW-1014B	1111.12	550	3.2	470	1900	< 0.33	14000	1300	2500	6	2750	189
2007-04	MW-1014C	1106.71	340	19	< 13	620	6.1	2000	670	670	6.2	1072	68
2007-04	MW-1015A	1087.59	78	1.6	< 2.7	89	< 0.005	9.3	8.9	67	7.3	162	75
2007-04	MW-1015B	1087.75	180	1.2	< 2.7	140	0.16	81	< 2.5	200	7.2	458	-71
2007-06	MW-1000PR	1086.72	230	2.7	12	500	0.66	2600	300	660	6.4	887	89
2007-06	MW-1000R	1087.06											
2007-06	MW-1002	1089.67	42	< 0.83	< 2.7	46	< 0.005	< 1	4.6	46	6.5	105	
2007-06	MW-1002G	1089.6	88	< 0.83	< 2.7	100	< 0.005	< 1	8.1	130	6.7	227	
2007-06	MW-1004	1104.83											
2007-06	MW-1004P	1103.49	160	< 0.83	< 2.7	140	0.075	110	< 2.5	120	7.1	297	151
2007-06	MW-1004S	1104.94	54	< 0.83	< 2.7	87	< 0.005	< 1	29	110	6.2	205	201
2007-06	MW-1005	1136.98	50	2.2	< 2.7	180	15	410	14	340	6.1	527	
2007-06	MW-1005P	1135.99	260	< 0.83	< 2.7	220	0.24	71	< 2.5	200	7	464	6
2007-06	MW-1005S	1136.17	170	2.1	< 2.7	160	4.2	230	2.9	220	7	331	
2007-06	MW-1010P	1086.67	150	4.7	< 2.7	160	0.031	150	15	180	7.4	326	86
2007-06	MW-1013	1110.51	610	3	< 13	560	9.6	23000	61	700	6.1	1144	84
2007-06	MW-1013A	1096.07	360	2.1	< 13	430	< 0.33	1200	170	530	6.6	974	100
2007-06	MW-1013B	1096.39	620	3.8	240	2100	< 0.33	21000	1600	3000	6.2	3131	216
2007-06	MW-1013C	1097.64	590	22	< 13	2200	11	10000	1700	3100	6.4	71	
2007-06	MW-1014	1115.87	180	1.8	< 13	260	< 0.33	310	170	450	6.4	701	187
2007-06	MW-1014	Dup.	190	2.8	15	330	< 0.33	380	170	430			
2007-06	MW-1014A	1113.49	490	4.4	< 13	1300	< 0.33	640	1000	1800	6.5	2187	182
2007-06	MW-1014B	1110.64	570	6.6	600	1900	< 0.33	14000	1400	2500	6.3	2888	197
2007-06	MW-1014C	1106.19	360	19	< 13	580	5.8	1900	270	720	6.6	1050	51
2007-06	MW-1015A	1086.78	79	< 0.83	< 2.7	86	< 0.005	8.8	8.5	110	6.9	187	285
2007-06	MW-1015B	1086.85											
2007-07	MW-1015B		180	< 0.83	< 2.7	140	0.34	100	< 2.5	290	7.6	594	-27
2007-10	MW-1000PR	1089.31	230	26	< 2.7	520	4.7	2800	300	650	6.5	933	74
2007-10	MW-1000R	1090.03											
2007-10	MW-1002	1090.85	44	< 0.83	< 2.7	50	< 0.005	< 1	4.9	27	6.7	113	
2007-10	MW-1002G	1090.79	90	< 0.83	< 2.7	110	< 0.005	< 1	8.5	77	6.7	228	
2007-10	MW-1004	1109.54											
2007-10	MW-1004P	1105.02	160	< 0.83	< 2.7	150	0.19	84	< 2.5	110	7.3	296	72
2007-10	MW-1004S	1109.7	51	1.5	< 2.7	93	< 0.005	< 1	31	120	6.3	214	211
2007-10	MW-1005	1137.93	51	2.6	< 2.7	190	14	330	14	320	6.1	560	
2007-10	MW-1005P	1136	250	< 0.83	< 2.7	230	0.31	61	< 2.5	220	7.1	457	-12
2007-10	MW-1005S	1136.38	180	3.1	< 2.7	160	4.3	230	< 2.5	220	7.1	326	
2007-10	MW-1010P	1089.09	160	13	< 2.7	170	0.009	90	16	160	7.6	319	159
2007-10	MW-1013	1110.28	620	< 1	< 13	610	15	24000	53	740	6.2	1261	68
2007-10	MW-1013A	1095.72	380	< 1	< 13	490	< 0.33	2600	210	610	6.6	912	85

Historical Groundwater Results - Quarterly Parameters

Sample Date (yyyy-mm)	Location	Water Elevation ft	Alkalinity as		Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
			CaCO3 mg/l											
2007-10	MW-1013B	1095.86	690	3.7	500	2300	< 0.33	38000	1600	3100	6.3	3182	227	
2007-10	MW-1013C	1097.98	570	16	< 13	2300	9.7	11000	1800	3100	6.3	3108	56	
2007-10	MW-1014	1115.95	190	< 1	33	350	< 0.33	580	180	470	6.4	739	220	
2007-10	MW-1014A	1113.13	560	< 1	< 13	1400	< 0.33	890	940	1900	6.6	2175	218	
2007-10	MW-1014A	Dup.	510	1.5	27	1400	< 0.33	880	860	1800				
2007-10	MW-1014B	1110.47	520	1.9	490	1900	< 0.33	13000	1300	2500	6.4	2670	234	
2007-10	MW-1014C	1106.22	360	19	< 13	600	5.8	2000	260	670	6.6	1041	57	
2007-10	MW-1015A	1087.98	86	< 0.83	< 2.7	91	< 0.005	8.7	9.2	140	7	188	169	
2007-10	MW-1015A	Dup.	80	< 0.83	< 2.7	91	< 0.005	8.6	9.4	55				
2007-10	MW-1015B	1087.7	180	< 0.83	< 2.7	160	0.33	100	< 2.5	300	7.7	573	-68	
2008-01	MW-1000PR	1087.62	230	4.6	13	460	0.31	2400	310	690	6.4	921	161	
2008-01	MW-1000PR	Dup.	220	5.3	12	490	0.32	2500	310	670				
2008-01	MW-1000R	1088.01												
2008-01	MW-1002	1090.08	50	1	< 2.7	53	< 0.005	< 1	6.2	97	6.6	122		
2008-01	MW-1002G	1090.02	89	< 0.83	< 2.7	97	< 0.005	< 1	9.4	150	6.6	227		
2008-01	MW-1004	1106.62												
2008-01	MW-1004P	1105.32	160	1.8	< 2.7	140	0.036	66	2.7	230	7.2	286	122	
2008-01	MW-1004S	1106.72	63	< 0.83	< 2.7	89	< 0.005	< 1	33	150	6.3	215	208	
2008-01	MW-1005	1137.51	51	2.7	< 2.7	170	14	360	15	350	6.2	508		
2008-01	MW-1005P	1136.5	220	< 0.83	< 2.7	170	0.25	33	< 2.5	410	7.3	520	-5	
2008-01	MW-1005S	1136.74	180	2	< 2.7	150	4.1	220	< 2.5	220	7	332		
2008-01	MW-1010P	1087.63	160	5.3	< 2.7	150	0.035	160	14	210	7.5	321	72	
2008-01	MW-1013	1109.61	600	2.2	< 13	590	14	24000	78	800	6.2	1183	63	
2008-01	MW-1013A	1097.1	370	< 1	< 13	410	< 0.33	2100	170	590	6.6	963	85	
2008-01	MW-1013B	1097.27	620	3.9	400	2200	< 0.33	31000	1500	3200	6.2	3141	206	
2008-01	MW-1013C	1098.85	590	22	< 13	2100	9.1	10000	1800	3200	6.5	3203	58	
2008-01	MW-1014	1117.28	170	< 1	< 13	310	< 0.33	800	160	480	6.3	661	188	
2008-01	MW-1014A	1114.15	490	< 1	< 13	1300	< 0.33	940	940	1900	6.6	2202	189	
2008-01	MW-1014B	1112.06	600	4.4	500	1900	< 0.33	14000	1400	2800	6.4	2882	211	
2008-01	MW-1014C	1107.58	310	24	< 13	550	5.4	1800	280	750	6.6	1081	59	
2008-01	MW-1015A	1087.41	79	< 0.83	< 2.7	85	< 0.005	7.3	11	140	7.1	189	248	
2008-01	MW-1015B	1087.61	180	< 0.83	< 2.7	140	0.29	94	< 2.5	450	7.7	586	-53	
2008-04	MW-1000PR	1091.29	230	4	7.8	490	0.33	2500	280	710	6.5	880	157	
2008-04	MW-1000R	1092.39												
2008-04	MW-1002	1092.08	53	< 1.5	< 2.7	56	< 0.005	< 1	5.8	96	6.5	134		
2008-04	MW-1002G	1092.04	89	< 1.5	< 2.7	98	< 0.005	< 1	8.8	150	6.6	225		
2008-04	MW-1004	1109.95												
2008-04	MW-1004P	1107.14	160	< 1.5	< 2.7	190	0.18	170	2.5	190	7.1	279	119	
2008-04	MW-1004S	1110.09	56	< 1.5	< 2.7	91	< 0.005	< 1	30	140	6.3	211	171	
2008-04	MW-1005	1139.01	46	2.5	< 2.7	170	14	330	14	320	6.1	453		
2008-04	MW-1005P	1137.53	260	< 1.5	< 2.7	220	1.1	72	< 0.25	350	6.9	478	-7	
2008-04	MW-1005P	Dup.	220	< 1.5	< 2.7	220	1.1	72	< 2.5	350	7.1	474		
2008-04	MW-1005S	1137.92	180	2.9	< 2.7	150	4.3	230	12	220	6.9	324		
2008-04	MW-1010P	1091.2	160	5	< 2.7	160	0.014	150	9.5	190	7.5	319	117	
2008-04	MW-1013	1110.52	570	5.1	< 13	580	4.1	23000	66	770	6.2	1155	52	
2008-04	MW-1013A	1096.94	330	1.5	< 13	500	< 0.33	2800	180	640	6.7	862	83	
2008-04	MW-1013B	1097.36	640	< 1	530	2200	< 0.33	40000	1500	3200	6.2	3200	201	
2008-04	MW-1013B	Dup.	630	2.9	550	2200	< 0.33	39000	1400	3200	6.2	3209		
2008-04	MW-1013C	1099.98	530	16	< 13	2200	9.6	11000	1600	3200	6.4	3156	29	
2008-04	MW-1014	1116.86	180	< 1	< 13	320	< 0.33	260	160	490	6.3	683	149	
2008-04	MW-1014A	1114.25	480	1.2	< 13	1700	< 0.33	1100	880	1900	6.6	2202	142	
2008-04	MW-1014B	1111.97	570	1.9	570	1900	< 0.33	14000	1400	2800	6.4	2815	157	
2008-04	MW-1014C	1107.87	310	24	< 13	570	5.6	1900	190	780	6.6	1069	48	
2008-04	MW-1015A	1090.43	78	< 1.5	< 2.7	88	< 0.005	8.1	9.7	140	6.9	185	153	
2008-04	MW-1015B	1090.08	180	< 1.5	< 2.7	150	0.3	86	< 0.25	350	7.5	580	-57	
2008-06	MW-1000PR	1087.84	220	3.7	21	500	0.46	2500	240	640	6.4	932	117	
2008-06	MW-1000R	1089.12												
2008-06	MW-1002	1092.92	56	< 1.5	< 2.7	66	< 0.005	< 1	7.1	81	6.6	143		
2008-06	MW-1002G	1092.84	88	< 1.5	< 2.7	110	< 0.005	< 1	9.2	150	6.7	233		
2008-06	MW-1002G	Dup.	88	< 1.5	< 2.7	110	0.035	< 1	11	150	6.7	231		
2008-06	MW-1004	1109.48												
2008-06	MW-1004P	1107.51	160	< 1.5	< 2.7	140	0.055	70	2.8	130	7.3	301	143	
2008-06	MW-1004S	1109.6	57	< 1.5	< 2.7	95	< 0.005	< 1	31	130	6.2	215	178	
2008-06	MW-1005	1140.12	50	2.8	< 2.7	180	15	380	16	440	6.1	511		
2008-06	MW-1005P	1139	250	< 1.5	< 2.7	230	1.2	76	< 2.5	230	7.2	460	-8	
2008-06	MW-1005S	1139.17	170	1.6	< 2.7	160	4.5	230	< 2.5	190	7	332		
2008-06	MW-1010P	1087.77	150	23	< 2.7	160	< 0.005	67	13	170	7.5	322	76	
2008-06	MW-1013	1112.75	470	1.7	22	550	3.6	22000	60	660	6.2	1150	88	
2008-06	MW-1013A	1097.88	340	2	< 13	630	< 0.33	3500	270	740	6.6	1195	94	
2008-06	MW-1013B	1098.29	550	2.7	270	2200	< 0.33	21000	1600	3100	6.2	3159	216	
2008-06	MW-1013C	1100	480	18	< 13	2200	10	10000	1700	3100	6.4	3288	36	
2008-06	MW-1014	1118.17	160	< 1.5	22	310	< 0.005	830	140	410	6.3	676	167	
2008-06	MW-1014A	1114.85	530	2	< 13	1300	< 0.33	410	910	1900	6.6	2211	167	
2008-06	MW-1014B	1113.44	580	4.8	570	1900	< 0.33	14000	1300	2600	6.4	2972	202	
2008-06	MW-1014B	Dup.	480	5.5	570	2000	< 0.33	14000	1400	2700	6.5	2975		
2008-06	MW-1014C	1108.96	280	22	< 13	550	5.4	1800	220	690	6.5	1061	52	
2008-06	MW-1015A	1088.69	79	< 1.5	3	89	< 0.005	6.3	10	110	7	189	132	
2008-06	MW-1015B	1088.85	180	< 1.5	< 2.7	150	0.2	89	< 2.5	270	7.8	580	40	

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Historical Groundwater Results - Quarterly Parameters

Sample Date (yyyy-mm)	Location	Water Elevation ft	Alkalinity as		Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
			CaCO3 mg/l											
2008-10	MW-1000PR	1086.95	230	2.7	13	480	0.63	2600	290	660	6.5	919	175	
2008-10	MW-1000R	1087.38												
2008-10	MW-1002	1090.2	54	< 1.5	< 2.7	58	< 0.005	< 1	6.4	87	6.5	135		
2008-10	MW-1002G	1090.15	93	< 1.5	< 2.7	100	< 0.005	< 1	9.3	140	6.6	237		
2008-10	MW-1004	1105.94												
2008-10	MW-1004P	1104.58	160	< 1.5	< 2.7	140	0.17	160	2.5	190	7.2	302	132	
2008-10	MW-1004S	1106.05	53	< 1.5	< 2.7	85	< 0.005	< 1	30	190	6.3	203	170	
2008-10	MW-1005	1137.82	48	1.7	< 2.7	270	13	330	13	460	5.9	861		
2008-10	MW-1005P	1137.23	250	< 1.5	< 2.7	220	1.1	80	< 2.5	240	7	468	6	
2008-10	MW-1005S	1137.36	180	2.2	< 2.7	160	3.8	220	< 2.5	230	7	336		
2008-10	MW-1010P	1086.88	170	8.6	< 2.7	160	0.024	120	9.5	190	7.5	328	133	
2008-10	MW-1013	1111.19	610	< 2.4	< 13	590	14	24000	51	760	6.2	1389	62	
2008-10	MW-1013A	1096.84	310	< 2.4	< 13	450	< 0.33	2700	210	620	6.7	854	78	
2008-10	MW-1013A	Dup.	340	< 2.4	< 13	460	< 0.33	2700	200	620				
2008-10	MW-1013B	1097.1	210	< 2.4	260	2200	< 0.33	20000	1700	3100	6.3	3134	213	
2008-10	MW-1013C	1098.96	530	17	< 13	2200	9.4	10000	1700	3000	6.5	3163	50	
2008-10	MW-1014	1119.24	190	< 2.4	< 13	320	< 0.33	310	180	540	6.4	739	165	
2008-10	MW-1014A	1116.06	470	< 2.4	< 13	1300	< 0.33	590	970	2000	6.6	2185	162	
2008-10	MW-1014B	1113.37	460	2.8	480	1100	< 0.33	13000	1400	2700	6.4	2814	174	
2008-10	MW-1014C	1108.49	310	17	< 13	570	5.5	1800	260	730	6.6	1058	68	
2008-10	MW-1015A	1087.15	82	< 1.5	< 2.7	88	< 0.005	6.5	11	130	6.9	188	62	
2008-10	MW-1015B	1087.16	180	< 1.5	< 2.7	150	0.32	66	< 2.5	310	7.5	581	-37	
2008-10	MW-1015B	Dup.	180	< 1.5	< 2.7	150	0.32	65	< 2.5	300				
2009-01	MW-1000PR	1087.63	220	4.9	17	470	0.34	2400	260	680	6.4	873	132	
2009-01	MW-1000R	1087.94												
2009-01	MW-1002	1089.6	52	< 1.5	< 2.7	63	< 0.005	< 1	6.5	140	6.7	141		
2009-01	MW-1002G	1089.54	81	< 1.5	< 2.7	100	< 0.005	< 1	8.5	140	6.7	225		
2009-01	MW-1004	1104.46												
2009-01	MW-1004P	1104.25	150	2.5	< 2.7	140	0.41	170	< 2.5	180	7.1	296	124	
2009-01	MW-1004S	1104.54	38	< 1.5	< 2.7	80	< 0.005	< 1	27	150	6.3	194	170	
2009-01	MW-1004S	Dup.	48	< 1.5	< 2.7	80	0.006	< 1	28	120				
2009-01	MW-1005	1136.78	42	2.1	4.2	260	14	340	14	470	6.1	814		
2009-01	MW-1005P	1136.22	240	< 1.5	< 2.7	210	0.91	70	< 2.5	260	7.2	472	7	
2009-01	MW-1005S	1136.46	170	1.8	< 2.7	160	3.8	220	< 2.5	230	7	339		
2009-01	MW-1010P	1087.44	150	3.5	< 2.7	160	0.02	140	13	200	7.5	315	106	
2009-01	MW-1013	1109.57	560	< 2.4	< 13	620	13	25000	73	800	6.1	1230	52	
2009-01	MW-1013A	1096.69	300	< 2.4	< 13	440	< 0.33	2400	180	620	6.6	953	62	
2009-01	MW-1013B	1096.95	660	< 2.4	240	2200	< 0.33	19000	1500	3200	6.2	3075	197	
2009-01	MW-1013C	1098.87	520	17	< 13	2100	10	10000	1600	3100	6.3	3277	51	
2009-01	MW-1014	1118.33	160	< 2.4	< 13	320	< 0.33	260	140	540	6.4	729	196	
2009-01	MW-1014A	1115.84	490	< 2.4	< 13	1300	< 0.33	560	1000	2100	6.6	2138	192	
2009-01	MW-1014B	1112.54	480	< 2.4	480	1800	< 0.33	13000	1300	2700	6.4	2908	216	
2009-01	MW-1014C	1107.83	300	23	< 13	540	5.3	1800	240	810	6.6	1061	76	
2009-01	MW-1014C	Dup.	320	22	< 13	540	5.3	1800	240	730				
2009-01	MW-1015A	1087.52	78	< 1.5	< 2.7	86	< 0.005	6.7	11	150	7.1	187	155	
2009-01	MW-1015B	1087.51	180	< 1.5	< 2.7	150	0.26	70	< 2.5	300	7.6	599	-38	
2009-04	MW-1000PR	1086.89	220	3.5	8.4	470	0.26	2300	280	650	6.5	906	155	
2009-04	MW-1000R	1087.37												
2009-04	MW-1002	1090.13	53	< 1.5	< 2.7	60	< 0.005	< 1	8.7	70	6.5	142		
2009-04	MW-1002G	1090.07	85	< 1.5	< 2.7	100	< 0.005	< 1	7	89	6.6	237		
2009-04	MW-1004	1105.47												
2009-04	MW-1004P	1103.73	160	< 1.5	< 2.7	140	0.072	63	< 2.5	140	7.3	302	87	
2009-04	MW-1004S	1105.58	55	< 1.5	< 2.7	80	0.049	1.5	28	140	6.3	193	198	
2009-04	MW-1005	1137.45	47	< 1.5	< 2.7	190	13	340	14	310	6.1	576		
2009-04	MW-1005P	1135.83	210	< 1.5	< 2.7	210	0.27	62	2.7	280	7.1	540	22	
2009-04	MW-1005S	1136.18	170	3.6	< 2.7	150	4	220	< 2.5	200	7	330		
2009-04	MW-1005S	Dup.	170	2.4	< 2.7	150	4	220	< 2.5	130	7	336		
2009-04	MW-1010P	1086.85	160	18	< 2.7	160	0.042	140	11	170	7.4	325	125	
2009-04	MW-1013	1108.25	680	< 2.4	4.4	570	4.3	23000	65	730	6.2	1172	91	
2009-04	MW-1013A	1096	390	< 2.4	< 1.3	370	0.071	960	150	530	6.7	856	98	
2009-04	MW-1013B	1096.3	490	< 2.4	390	2100	< 0.033	26000	1700	3000	6.2	3181	215	
2009-04	MW-1013C	1097.96	500	15	< 1.3	2100	9.8	9100	1500	3100	6.4	3241	55	
2009-04	MW-1013C	Dup.	460	14	< 1.3	2700	13	12000	1700	3100	6.4	3265	55	
2009-04	MW-1014	1117.03	170	< 2.4	6.3	300	< 0.033	330	160	470	6.4	711	166	
2009-04	MW-1014A	1114.88	470	< 2.4	4.8	1200	< 0.033	210	1100	1900	6.6	2203	162	
2009-04	MW-1014B	1111.43	460	< 2.4	550	1700	< 0.033	11000	1400	2600	6.4	2850	178	
2009-04	MW-1014C	1106.8	310	20	< 1.3	510	4.8	1600	260	720	6.6	1059	72	
2009-04	MW-1015A	1087.28	77	< 1.5	< 2.7	85	< 0.005	6.5	10	120	7	193	162	
2009-04	MW-1015B	1087.27	170	< 1.5	< 2.7	150	0.28	69	< 2.5	290	7.5	583	-44	
2009-06	MW-1000PR	1086.9	230	3.5	15	450	0.52	2200	280	690	6.48	904	158	
2009-06	MW-1000R	1087.29												
2009-06	MW-1002	1089.92	47	< 1.5	< 2.7	49	< 0.005	< 1	5.2	64	6.64	120		
2009-06	MW-1002G	1089.84	87	< 1.5	< 2.7	98	< 0.005	< 1	8.3	170	6.55	242		
2009-06	MW-1002G	Dup.	86	< 1.5	< 2.7	98	< 0.005	< 1	8.7	150				
2009-06	MW-1004	1105.72												
2009-06	MW-1004P	1104.32	160	< 1.5	< 2.7	130	0.067	57	< 2.5	150	7.2	299.4	105	
2009-06	MW-1004S	1105.83	52	< 1.5	< 2.7	77	0.016	< 1	28	95	6.3	189.4	202	
2009-06	MW-1005	1137.78	47	1.8	< 2.7	160	14	310	15	400	6.16	516		

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Historical Groundwater Results - Quarterly Parameters

Sample Date	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
2009-06	MW-1005P	1136.49	240	2.1	< 2.7	200	1.2	65	< 2.5	270	7.09	488.1	-4
2009-06	MW-1005S	1136.79	170	5.9	< 2.7	150	4.2	210	< 2.5	240	6.98	332	
2009-06	MW-1010P	1086.83	150	18	< 2.7	150	0.026	120	16	200	7.44	333.8	100
2009-06	MW-1013	1110.6	580	3.2	14	520	5.3	21000	51	710	6.11	1153	86
2009-06	MW-1013A	1096.57	320	< 2.4	< 13	460	0.044	2400	200	610	6.61	887	126
2009-06	MW-1013B	1096.97	580	3.9	300	2000	< 0.033	20000	1700	3200	6.17	3160	235
2009-06	MW-1013B	Dup.	630	3.9	270	2000	< 0.033	19000	1600	3200			
2009-06	MW-1013C	1098.14	550	18	< 13	2000	9.8	9800	1900	3100	6.35	3251	51
2009-06	MW-1014	1117.02	170	< 2.4	30	290	< 0.033	320	170	460	6.34	710	176
2009-06	MW-1014A	1114.7	500	4.1	18	1200	0.12	200	970	1900	6.54	2195	180
2009-06	MW-1014B	1111.48	510	2.4	490	1800	< 0.033	13000	1300	2800	6.33	2893	216
2009-06	MW-1014C	1106.86	300	19	< 13	510	5	1600	260	720	6.59	1026	69
2009-06	MW-1015A	1087.06	81	< 1.5	< 2.7	83	< 0.005	6.4	11	130	6.83	196	172
2009-06	MW-1015B	1087.01	180	< 1.5	< 2.7	140	0.23	73	< 2.5	300	7.59	585	-46
2009-10	MW-1000PR	1086.56	220	2.8	9.7	500	0.38	2600	270	610	6.4	929	93
2009-10	MW-1000R	1086.74											
2009-10	MW-1002	1088.96	51	< 1.5	12	56	< 0.0037	0.34	5.1	64	6.57	131	
2009-10	MW-1002G	1088.91	80	< 1.5	< 0.31	110	< 0.0037	0.21	8	130	6.59	240.8	
2009-10	MW-1004	1104.19											
2009-10	MW-1004P	1103.1	160	< 1.5	< 0.31	150	1.3	350	< 2.5	150	7.16	315.1	24
2009-10	MW-1004S	1104.28	52	< 1.5	1.5	77	< 0.0037	2.3	24	110	6.21	185.5	182
2009-10	MW-1005	1135.95	33	< 1.5	1.2	230	11	300	15	370	6.03	724	
2009-10	MW-1005P	1135.44	250	< 1.5	< 0.31	220	0.83	72	< 2.5	230	7.05	468.6	-1
2009-10	MW-1005S	1135.59	180	3.3	< 0.31	170	4	220	< 2.5	170	7.02	338.6	
2009-10	MW-1005S	Dup.	180	4.1	< 0.31	170	3.6	240	< 2.5	180			
2009-10	MW-1010P	1086.42	150	25	< 0.31	160	0.02	110	18	160	7.43	327	74
2009-10	MW-1013	1110.93	600	< 2.4	6.8	1100	10	23000	40	700	6.05	1153	75
2009-10	MW-1013A	1096.23	320	< 2.4	1.4	380	0.012	1400	170	520	6.61	862	98
2009-10	MW-1013B	1096.47	600	< 2.4	360	2100	0.031	23000	1600	3000	6.15	3185	227
2009-10	MW-1013C	1097.8	510	15	< 0.31	2100	9.8	10000	1700	3000	6.32	3289	63
2009-10	MW-1014	1117.09	170	< 2.4	7.1	310	< 0.0037	270	170	440	6.33	735	167
2009-10	MW-1014A	1114.28	490	< 2.4	19	1300	0.076	330	940	1800	6.52	2173	173
2009-10	MW-1014B	1111.21	590	2.7	490	1900	0.010	13000	1500	2600	6.32	2964	209
2009-10	MW-1014C	1106.57	300	20	< 0.31	540	4.3	1700	230	670	6.55	1034	71
2009-10	MW-1014C	Dup.	290	20	< 0.31	520	4.2	1600	250	670			
2009-10	MW-1015A	1086.54	82	< 1.5	0.37	88	< 0.0037	7	11	98	6.82	192.4	105
2009-10	MW-1015B	1086.53	180	< 1.5	< 0.31	150	0.12	69	< 2.5	280	7.57	596	-13
2009-12	MW-1004P	1103.61	130	< 0.80	< 2.7	140	0.63	180	< 2.5	110	7.1	301	105
2009-12	MW-1004P	Dup.	130	< 0.80	< 2.7	73	0.32	95	< 2.5	98			
2010-01	MW-1000PR	1087.06	170	< 1.5	12	450	0.32	2300	280	660	6.54	926	87
2010-01	MW-1000R	1087.22											
2010-01	MW-1002	1089.13	39	< 1.5	< 2.7	54	0.007	< 1	5.6	77	6.63	134.6	
2010-01	MW-1002G	1089.07	65	< 1.5	< 2.7	100	< 0.005	< 1	8.4	160	6.64	257.9	
2010-01	MW-1004	1104.43											
2010-01	MW-1004P	1103.32	130	< 1.5	< 2.7	130	0.09	72	< 2.5	140	7.3	296.7	100
2010-01	MW-1004P	Dup.	130	< 1.5	< 2.7	130	0.087	77	< 2.5	170			
2010-01	MW-1004S	1104.51	34	< 1.5	< 2.7	75	< 0.005	< 1	26	120	6.41	194.7	190
2010-01	MW-1005	1136.33	28	< 1.5	< 2.7	160	12	340	15	290	6.21	513	
2010-01	MW-1005P	1135.48	190	< 1.5	< 2.7	200	1.2	62	< 2.5	220	7.22	563	-4
2010-01	MW-1005S	1135.72	150	3.1	< 2.7	150	4.2	220	< 2.5	220	7.17	336.6	
2010-01	MW-1010P	1086.94	120	18	< 2.7	150	0.005	52	22	210	7.57	327.7	69
2010-01	MW-1013	1110.28	410	< 2.4	8	550	5.7	23000	56	900	6.24	1133	70
2010-01	MW-1013A	1096.36	250	< 2.4	< 1.3	450	0.077	3100	180	610	6.69	959	80
2010-01	MW-1013B	1096.54	470	< 2.4	290	2100	< 0.033	20000	2400	3100	6.31	3180	220
2010-01	MW-1013C	1098.23	440	18	< 1.3	2000	9.2	9300	1700	3100	6.46	3249	54
2010-01	MW-1014	1116.71	120	< 2.4	4.2	300	0.066	120	140	480	6.45	691	161
2010-01	MW-1014A	1113.9	400	< 2.4	7.6	1200	< 0.033	190	1100	1900	6.67	2167	158
2010-01	MW-1014B	1111.26	440	3.9	530	1700	< 0.033	12000	1400	2700	6.4	2899	170
2010-01	MW-1014C	1106.72	240	21	< 1.3	500	4.9	1600	250	710	6.69	1026	67
2010-01	MW-1014C	Dup.	240	18	< 1.3	510	4.9	1600	240	700			
2010-01	MW-1015A	1086.91	62	< 1.5	< 2.7	82	0.005	6.5	11	120	7.02	192	127
2010-01	MW-1015B	1087.01	150	< 1.5	< 2.7	140	0.23	62	< 2.5	300	7.6	581	-16
2010-04	MW-1000PR	1086.84	230	2.6	12	480	0.21	2300	240	650	6.44	914	131
2010-04	MW-1000R	1087.42											
2010-04	MW-1002	1090.03	51	< 1.5	< 2.7	54	< 0.005	< 1	4	80	6.8	123.5	
2010-04	MW-1002G	1089.96	88	< 1.5	< 2.7	110	< 0.005	< 1	7.3	160	6.62	262.2	
2010-04	MW-1004	1105.22											
2010-04	MW-1004P	1103.76	170	< 1.5	< 2.7	140	0.35	190	< 2.5	140	7.08	289.4	47
2010-04	MW-1004S	1105.33	51	< 1.5	< 2.7	76	< 0.005	1.1	23	85	6.29	180.3	257
2010-04	MW-1005	1137.52	48	< 1.5	< 2.7	160	14	330	13	370	6.29	504	
2010-04	MW-1005P	1136.03	260	< 1.5	< 2.7	210	1.2	69	< 2.5	240	6.98	469.5	6
2010-04	MW-1005S	1136.33	180	2.2	< 2.7	160	4.6	240	< 2.5	190	6.9	345	
2010-04	MW-1010P	1086.83	150	21	< 2.7	160	0.028	110	16	170	7.44	329.7	111
2010-04	MW-1013	1110.58	580	< 2.4	< 13	570	3.7	24000	51	700	6.15	1133	110
2010-04	MW-1013A	1096.1	360	< 2.4	< 13	450	0.072	2800	170	590	6.61	922	140
2010-04	MW-1013B	1096.39	540	< 2.4	400	2100	< 0.066	29000	1400	3000	6.23	3181	260
2010-04	MW-1013C	1097.76	550	16	< 13	2100	11	10000	1600	3100	6.39	3280	57
2010-04	MW-1014	1115.93	170	< 2.4	< 13	310	< 0.033	170	150	460	6.38	718	189

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Flambeau Mining Company
2017 Annual Report

Historical Groundwater Results - Quarterly Parameters

Sample Date	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
2010-04	MW-1014A	1113.52	450	< 2.4	< 13	1300	< 0.033	140	870	1800	6.55	2216	198
2010-04	MW-1014B	1110.65	520	< 2.4	510	1900	< 0.033	13000	1400	2700	6.36	2879	233
2010-04	MW-1014C	1106.17	300	20	< 13	530	4.9	1700	210	690	6.59	1051	66
2010-04	MW-1015A	1087.17	80	< 1.5	< 2.7	87	< 0.005	6.8	9.5	130	6.97	217	75
2010-04	MW-1015B	1087.2	180	< 1.5	< 2.7	150	0.1	58	< 2.5	310	7.51	587	-28
2010-06	MW-1000PR	1091.22	240	4.9	19	440	0.35	2200	220	620	6.43	907	84
2010-06	MW-1000R	1091.99											
2010-06	MW-1002	1091.26	49	< 2.5	4.1	45	< 0.005	< 1	3.7	46	6.8	112.4	
2010-06	MW-1002G	1091.23	93	< 2.5	3.4	110	< 0.005	< 1	7.4	140	6.52	269.4	
2010-06	MW-1004	1108.24											
2010-06	MW-1004P	1105.73	170	< 2.5	3.4	140	0.32	160	< 2.5	130	7.16	285.9	18
2010-06	MW-1004S	1108.35	55	< 2.5	5.1	74	< 0.005	< 1	23	84	6.29	177.3	205
2010-06	MW-1005	1139.47	52	< 2.5	4.3	160	13	310	13	370	6.02	517	
2010-06	MW-1005P	1137.87	240	< 2.5	3.1	160	0.2	49	< 2.5	300	7.01	617	-11
2010-06	MW-1005S	1138.29	190	3.6	2.9	150	4.3	220	< 2.5	260	6.84	349.1	
2010-06	MW-1010P	1091.45	170	23	7.2	150	0.022	100	18	140	7.39	331.1	68
2010-06	MW-1013	1113.03	590	< 1.3	< 13	550	2.4	23000	44	690	6.18	1096	96
2010-06	MW-1013A	1096.58	350	< 1.3	< 13	450	0.08	2400	170	580	6.65	900	102
2010-06	MW-1013B	1096.97	690	5	590	2100	< 0.05	37000	1300	3100	6.22	3251	243
2010-06	MW-1013C	1099.95	620	23	< 13	2000	9.3	9800	1600	3000	6.37	3245	44
2010-06	MW-1014	1116.51	190	< 1.3	< 13	290	< 0.05	140	140	450	6.44	691	162
2010-06	MW-1014A	1113.64	510	3.7	< 13	1300	< 0.05	130	1000	1800	6.59	2186	158
2010-06	MW-1014B	1111.55	550	3.9	560	1800	< 0.05	12000	1000	2800	6.37	2888	166
2010-06	MW-1014C	1107.56	310	24	16	500	4.6	1600	200	730	6.52	1011	59
2010-06	MW-1015A	1090.08	84	< 2.5	3.8	83	< 0.005	7.2	10	110	6.71	194.6	165
2010-06	MW-1015B	1090.43	190	< 2.5	2.9	140	0.14	56	< 2.5	270	7.45	600	-55
2010-07	MW-1014B	1111.44									6.31	2930	
2010-10	MW-1000PR	1089.9	230	2.9	< 2.7	460	0.56	2500	240	580	6.5	651	89
2010-10	MW-1000R	1090.87	440	< 2.5	99	530	< 0.005	12000	110	640	6.29	747	162
2010-10	MW-1002	1094.8	54	< 2.5	< 2.7	60	< 0.005	< 1	5.3	55	6.59	108.8	
2010-10	MW-1002G	1094.7	86	< 2.5	< 2.7	110	< 0.005	< 1	7.3	110	6.54	190.7	
2010-10	MW-1002G	Dup.	85	< 2.5	< 2.7	110	0.007	< 1	7.1	120			
2010-10	MW-1004	1110.13	37	< 2.5	< 2.7	39	0.032	1.6	8.4	43	6.44	77.3	245
2010-10	MW-1004P	1107.78	160	< 2.5	< 2.7	140	0.45	160	< 2.5	140	7.09	216.4	6
2010-10	MW-1004S	1110.23	51	< 2.5	< 2.7	74	< 0.005	< 1	23	79	6.38	136.7	235
2010-10	MW-1005	1140.03	43	< 2.5	< 2.7	160	14	340	13	300	6.13	354	
2010-10	MW-1005P	1139.28	250	< 2.5	< 2.7	220	1.2	72	< 2.5	220	7.02	303.5	3
2010-10	MW-1005S	1139.5	190	< 2.5	< 2.7	160	4.4	230	< 2.5	190	7.01	225.9	
2010-10	MW-1010P	1089.72	150	21	< 2.7	160	0.036	120	17	130	7.49	233.4	87
2010-10	MW-1013	1112.84	600	< 1.3	< 13	560	6.6	24000	40	730	6.15	870	80
2010-10	MW-1013A	1097.84	370	< 1.3	< 13	470	0.12	3200	180	630	6.67	697	94
2010-10	MW-1013B	1098.15	640	< 1.3	530	2200	< 0.05	37000	1500	3100	6.23	2334	248
2010-10	MW-1013B	Dup.	670	< 1.3	520	2200	< 0.5	37000	1300	3100			
2010-10	MW-1013C	1100.78	540	18	< 13	2200	11	11000	1600	3000	6.37	2511	46
2010-10	MW-1014	1118.04	160	< 1.3	< 13	310	< 0.05	520	130	400	6.42	488	167
2010-10	MW-1014A	1114.4	490	< 1.3	< 13	1300	< 0.05	130	630	1800	6.56	1595	159
2010-10	MW-1014B	1113.34	550	< 1.3	460	1900	< 0.05	13000	1300	2700	6.39	1943	163
2010-10	MW-1014C	1109.12	280	20	< 13	530	5	1700	220	640	6.62	750	65
2010-10	MW-1015A	1090.62	79	< 2.5	< 2.7	85	< 0.005	7.9	9	61	6.7	140.3	113
2010-10	MW-1015B	1090.67	180	< 2.5	< 2.7	150	0.16	58	< 2.5	270	7.37	412.4	85
2011-02	MW-1000PR	1090.08	230	5.1	8.7	420	0.16	2000	240	540	6.48	872	118
2011-02	MW-1000R	1090.78	480	< 2.5	110	430	< 0.05	14000	110	570	6.35	910	133
2011-02	MW-1002	1092.56	64	< 2.5	< 2.7	68	< 0.005	< 1	6.2	87	6.53	166.2	
2011-02	MW-1002G	1092.49	88	< 2.5	< 2.7	110	0.008	< 1	7.7	85	6.57	272	
2011-02	MW-1004	1107.28	38	< 2.5	< 2.7	46	0.017	< 1	14	5	6.61	118.2	229
2011-02	MW-1004P	1106.13	160	< 2.5	< 2.7	130	0.09	68	< 2.5	83	7.01	297	36
2011-02	MW-1004S	1107.34	49	< 2.5	< 2.7	67	0.005	< 1	22	45	6.72	177.2	254
2011-02	MW-1005	1140.68	47	2.5	< 2.7	170	11	330	13	260	6.14	580	
2011-02	MW-1005P	1140.33	250	< 2.5	< 2.7	200	1.2	59	< 2.5	200	7.05	466.3	-4
2011-02	MW-1005S	1140.4	180	3.6	< 2.7	150	4.1	220	< 2.5	160	6.82	342.1	
2011-02	MW-1005S	Dup.	190	3.2	< 2.7	150	4.1	220	< 2.5	130			
2011-02	MW-1010P	1089.83	160	23	< 2.7	150	0.010	92	15	130	7.22	330.6	235
2011-02	MW-1013	1112.81	640	< 1.3	< 13	580	1.8	24000	56	690	6.19	1164	157
2011-02	MW-1013A	1099.29	340	1.4	< 13	500	0.12	3600	180	570	6.59	990	267
2011-02	MW-1013B	1099.55	570	< 1.3	310	2100	< 0.005	22000	1600	3000	6.17	3149	325
2011-02	MW-1013C	1101.87	550	22	< 13	2000	10	10000	1600	3000	6.35	2970	77
2011-02	MW-1014	1121.03	260	< 1.3	< 13	290	0.74	1900	110	420	6.56	793	135
2011-02	MW-1014A	1117.75	490	3.7	< 13	1300	0.016	210	960	1800	6.57	2215	192
2011-02	MW-1014B	1115.76	550	1.7	370	1800	< 0.005	12000	1300	2500	6.34	2903	221
2011-02	MW-1014B	Dup.	530	4.2	370	1800	< 0.005	12000	1300	2500			
2011-02	MW-1014C	1110.94	280	23	< 13	510	4.7	1600	220	600	6.64	1021	85
2011-02	MW-1015A	1090.29	78	< 2.5	< 2.7	80	< 0.005	6.4	11	63	6.56	185.8	90
2011-02	MW-1015B	1090.29	180	< 2.5	< 2.7	140	0.14	58	< 2.5	220	7.06	585	-4
2011-04	MW-1000PR	1088.85	230	5	6.4	430	0.36	2000	240	550	6.45	857	186
2011-04	MW-1000R	1090.2	350	< 2.5	100	420	< 0.05	12000	140	520	6.4	831	198
2011-04	MW-1002	1094.24	68	< 2.5	< 2.7	74	< 0.005	< 1	7.2	43	6.51	169.8	
2011-04	MW-1002G	1094.12	90	< 2.5	< 2.7	110	0.011	< 1	8.9	120	6.67	272.6	
2011-04	MW-1004	1109.9	34	< 2.5	< 2.7	36	0.024	1.3	10	23	6.47	90	215

Historical Groundwater Results - Quarterly Parameters

Sample Date (yyyy-mm)	Location	Water Elevation ft	Alkalinity as		Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
			CaCO3 mg/l	Arsenic ug/l									
2011-04	MW-1004P	1107.84	160	< 2.5	< 2.7	130	0.088	59	< 2.5	90	7.12	296.6	41
2011-04	MW-1004S	1109.97	49	< 2.5	3	66	< 0.005	< 1	22	81	6.45	165.9	194
2011-04	MW-1005		43	< 2.5	< 2.7	200	13	330	15	360	6.16	677	
2011-04	MW-1005P	1140.97	250	< 2.5	< 2.7	210	1.3	61	< 2.5	200	7.06	457.1	5
2011-04	MW-1005S	1142.13	190	< 2.5	< 2.7	160	4.1	230	< 2.5	190	6.96	349.7	
2011-04	MW-1010P	1088.56	150	22	< 2.7	160	0.022	65	25	140	7.29	326.7	118
2011-04	MW-1013	1114.4	630	2.2	43	600	1	25000	53	710	6.14	1159	128
2011-04	MW-1013A	1099.34	350	< 1.3	18	470	0.12	3300	190	560	6.57	913	105
2011-04	MW-1013B	1099.78	630	< 1.3	610	1800	< 0.05	39000	1600	3200	6.22	3076	252
2011-04	MW-1013C	1101.96	560	20	< 13	2000	11	10000	1600	3000	6.36	3121	64
2011-04	MW-1014	1121.5	190	2	15	260	0.32	3700	120	410	6.41	700	169
2011-04	MW-1014A	1118.32	480	2.1	14	1200	< 0.05	180	990	1800	6.54	2205	168
2011-04	MW-1014A	Dup.	500	2.4	19	1300	< 0.05	180	910	1800			
2011-04	MW-1014B	1116.4	540	3.3	420	1600	< 0.05	11000	1300	2500	6.41	2369	157
2011-04	MW-1014C	1111.43	290	21	16	500	4.9	1700	220	640	6.56	1007	80
2011-04	MW-1015A	1089.95	77	< 2.5	< 2.7	82	< 0.005	5.2	10	61	6.84	181.5	179
2011-04	MW-1015B	1090.04	180	< 2.5	< 2.7	140	0.071	52	< 2.5	210	7.37	586	-21
2011-04	MW-1015B	Dup.	190	< 2.5	< 2.7	140	0.072	52	< 2.5	230			
2011-07	MW-1000PR	1087.39	230	5.7	4.5	460	0.48	2200	230	590	6.44	848	168
2011-07	MW-1000R	1088.49	350	< 2.5	90	420	0.069	11000	120	540	6.35	794	182
2011-07	MW-1002	1092.27	66	< 2.5	< 1.3	82	0.015	< 1	7	89	6.43	177.7	
2011-07	MW-1002G	1092.17	88	< 2.5	< 1.3	130	0.04	< 1	8.5	170	6.49	283.8	
2011-07	MW-1002G	Dup.	88	2.9	< 1.3	130	0.04	< 1	9.2	170			
2011-07	MW-1004	1108.55	40	< 2.5	3.5	45	0.044	2.5	11	52	6.29	95.4	264
2011-07	MW-1004P	1107.09	160	< 2.5	< 1.3	150	0.19	90	< 2.5	140	6.98	299.5	-11
2011-07	MW-1004S	1108.64	52	< 2.5	< 1.3	80	0.0083	< 1	23	100	6.32	183.2	129
2011-07	MW-1005	1140.62	50	< 2.5	< 1.3	360	19	490	14	770	6.01	972	
2011-07	MW-1005P	1140.79	250	< 2.5	< 1.3	230	1.3	74	< 2.5	230	6.92	458.2	-22
2011-07	MW-1005S	1140.87	190	< 2.5	< 1.3	170	4.3	230	< 2.5	200	6.84	353.3	
2011-07	MW-1010P	1087.17	150	18	< 1.3	170	0.031	58	25	160	7.29	328.4	80
2011-07	MW-1013	1115.09	660	< 1.3	13	610	2.8	23000	38	700	6.01	1081	134
2011-07	MW-1013	Dup.	580	1.5	13	600	2.7	23000	37	720			
2011-07	MW-1013A	1099.12	350	< 1.3	< 0.73	480	0.18	2700	150	540	6.52	856	299
2011-07	MW-1013B	1099.58	620	3.2	560	2200	0.16	36000	1600	3100	6.16	3062	324
2011-07	MW-1013C	1101.68	520	20	< 1.5	2300	12	9900	1600	3000	6.24	3054	70
2011-07	MW-1014	1123.51	170	2	6.3	300	0.046	1600	120	440	6.34	638	148
2011-07	MW-1014A	1119.85	500	2.4	2.1	1300	0.11	130	980	1900	6.52	2164	226
2011-07	MW-1014B	1117.57	550	3.4	360	1800	0.12	11000	1300	2500	6.28	2720	244
2011-07	MW-1014C	1112.18	290	22	< 0.73	540	4.9	1600	220	690	6.56	1017	81
2011-07	MW-1015A	1088.12	84	< 2.5	< 1.3	92	0.016	4.8	10	88	6.45	187.6	176
2011-07	MW-1015B	1088.27	180	< 2.5	< 1.3	160	0.15	58	< 2.5	280	7.22	589	-45
2011-10	MW-1000PR	1087.64	260	7.6	< 1.3	450	0.6	2200	220	590	6.5	825	104
2011-10	MW-1000R	1088.35	350	< 2.5	80	420	0.056	7200	77	550	6.35	771	130
2011-10	MW-1002	1090.82	75	< 2.5	< 1.3	73	0.0056	< 1	5.3	95	6.81	148.5	
2011-10	MW-1002G	1090.74	92	< 2.5	< 1.3	130	0.0076	1.8	8.9	180	6.71	279.9	
2011-10	MW-1004	1106.9	46	< 2.5	< 1.3	58	0.0062	< 1	17	89	6.3	133	275
2011-10	MW-1004	Dup.	50	< 2.5	< 1.3	59	0.007	< 1	17	70			
2011-10	MW-1004P	1105.68	160	< 2.5	< 1.3	150	0.2	90	< 2.5	150	7.14	300.2	-30
2011-10	MW-1004S	1106.96	53	< 2.5	< 1.3	72	< 0.003	1	23	120	6.37	161.6	274
2011-10	MW-1005	1140	61	< 2.5	< 1.3	360	18	470	15	930	6.04	1117	
2011-10	MW-1005P	1139.25	260	< 2.5	< 1.3	220	1.2	60	< 2.5	220	7.08	458.7	-33
2011-10	MW-1005S	1139.8	180	2.8	< 1.3	170	4.3	220	< 2.5	200	6.85	338.1	
2011-10	MW-1010P	1087.35	170	22	< 1.3	170	0.011	43	26	190	7.44	337.2	15
2011-10	MW-1013	1113.28	610	2.2	5.7	600	5.5	25000	30	760	6.21	1198	56
2011-10	MW-1013A	1098.53	350	< 1.3	< 0.73	440	0.15	2900	160	580	6.66	850	10
2011-10	MW-1013B	1098.86	550	< 1.3	520	2200	0.1	37000	1600	3100	6.28	3124	248
2011-10	MW-1013C	1101.18	520	16	< 0.73	2100	11	9400	1600	3100	6.24	3154	31
2011-10	MW-1014	1123.37	190	< 1.3	1.6	310	< 0.014	660	140	460	6.44	682	188
2011-10	MW-1014A	1120.43	490	< 1.3	4.2	1300	0.023	260	1000	1900	6.59	2166	206
2011-10	MW-1014B	1116.86	470	< 1.3	380	1800	0.035	11000	1400	2600	6.34	2860	218
2011-10	MW-1014B	Dup.	500	1.8	380	1900	0.034	11000	1400	2600			
2011-10	MW-1014C	1111.48	280	18	< 0.73	530	4.9	1500	220	690	6.62	992	44
2011-10	MW-1015A	1087.79	90	< 2.5	< 1.3	91	0.005	5.5	10	110	7.34	187.2	173
2011-10	MW-1015B	1087.82	170	< 2.5	< 1.3	150	0.12	54	< 2.5	290	7.62	588	106
2012-02	MW-1000PR	1087.01	210	3.9	9.9	450	0.23	2100	240	560	6.5	849	303
2012-02	MW-1000R	1087.58	380	< 1.9	94	430	0.011	5500	41	510	6.43	772	307
2012-02	MW-1002	1089.73	65	< 1.9	< 1.3	76	0.0033	< 1	5.3	89	6.53	168	
2012-02	MW-1002G	1089.64	88	< 1.9	< 1.3	130	0.0044	< 1	8.7	150	6.57	193.8	
2012-02	MW-1004	1105.22	47	< 1.9	3.3	78	0.012	1.9	29	71	6.31	176.5	369
2012-02	MW-1004P	1103.91	160	< 1.9	< 1.3	150	0.14	74	< 2.5	130	7.05	303.7	
2012-02	MW-1004S	1105.28	45	< 1.9	2.4	71	< 0.003	< 1	21	73	6.46	164.2	365
2012-02	MW-1005	1138.42	51	1.9	3	380	19	500	15	670	5.93	1132	
2012-02	MW-1005P	1138.16	240	< 1.9	< 1.3	230	1.3	60	< 2.5	230	6.85	466.8	-14
2012-02	MW-1005S	1138.3	190	2.9	< 1.3	170	4.2	220	< 2.5	180	6.67	348.2	
2012-02	MW-1010P	1086.7	150	22	< 1.3	170	0.0072	61	24	160	7.89	334.7	196
2012-02	MW-1013	1110.98	600	< 1.3	8.6	610	7	23000	45	740	6.16	1190	105
2012-02	MW-1013A	1097.52	350	< 1.3	2.1	440	0.11	2900	190	570	6.69	920	106
2012-02	MW-1013B	1097.87	570	1.9	550	2200	0.04	32000	1700	3100	6.24	3157	353

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Historical Groundwater Results - Quarterly Parameters

Sample Date	Location		Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
2012-02	MW-1013B	Dup.		590	6	550	2200	0.046	32000	1700	3200			
2012-02	MW-1013C		1099.83	510	20	9.9	2200	13	9500	1700	3100	6.34	3169	72
2012-02	MW-1014		1120.98	180	< 1.3	9.2	320	< 0.014	1200	130	430	6.49	684	287
2012-02	MW-1014A		1118.66	450	8.2	12	1300	< 0.014	390	1100	1900	6.66	2189	279
2012-02	MW-1014B		1114.78	500	6	440	1900	< 0.014	11000	1400	2600	6.4	2859	211
2012-02	MW-1014C		1109.59	290	22	2.9	530	4.9	1600	240	650	6.76	1035	68
2012-02	MW-1015A		1087.22	77	< 1.9	< 1.3	92	< 0.003	6	9.7	100	7.08	191.8	309
2012-02	MW-1015B		1087.22	180	< 1.9	< 1.3	150	0.12	50	< 2.5	240	7.38	607	41
2012-02	MW-1015B	Dup.		180	< 1.9	< 1.3	150	0.12	51	< 2.5	250			
2012-05	MW-1000PR		1088.04	220	5.8	6.3	460	0.75	2000	250	570	6.93	303.8	117
2012-05	MW-1000R		1088.85	140	1.9	20	130	0.0031	800	27	200	5.88	229.5	279
2012-05	MW-1002		1090.95	58	< 1.9	< 1.3	69	< 0.003	< 1	4.9	73	7.12	150.3	
2012-05	MW-1002G		1090.86	88	< 1.9	< 1.3	130	< 0.003	< 1	8.4	160	6.73	285	
2012-05	MW-1002G	Dup.		88	< 1.9	< 1.3	130	< 0.003	< 1	8.5	170			
2012-05	MW-1004		1108.29	49	< 1.9	1.6	85	0.0066	3.1	31	120	6.33	171.8	366
2012-05	MW-1004P		1105.73	160	< 1.9	< 1.3	150	0.079	89	< 2.5	130	6.93	303.8	
2012-05	MW-1004S		1108.35	46	< 1.9	< 1.3	73	< 0.003	< 1	22	84	7.59	167.8	347
2012-05	MW-1005		1140.64	51	< 1.9	< 1.3	300	14	370	15	770	6.18	920	
2012-05	MW-1005P		1139.63	240	< 1.9	< 1.3	230	1.3	61	< 2.5	240	6.99	472	-20
2012-05	MW-1005S		1139.93	180	2.4	< 1.3	180	4.1	220	< 2.5	200	6.89	351.1	
2012-05	MW-1010P		1087.88	140	25	< 1.3	180	< 0.003	35	26	180	7.22	344.5	194
2012-05	MW-1013		1112	610	1.8	7.6	600	5	22000	31	730	6.12	1148	85
2012-05	MW-1013A		1097.79	340	3.8	1.2	510	0.059	3000	190	610	6.69	938	135
2012-05	MW-1013B		1098.26	560	< 1.3	540	2100	< 0.028	32000	1700	3100	6.2	3236	358
2012-05	MW-1013C		1100.12	500	10	6.7	2000	12	9600	1700	3000	6.41	3220	57
2012-05	MW-1014		1120.13	170	< 1.3	7	310	< 0.014	1000	130	440	6.38	670	278
2012-05	MW-1014A		1117.79	440	< 2.6	7.1	1300	< 0.014	95	930	1900	6.53	2178	242
2012-05	MW-1014A	Dup.		500	< 2.6	7.4	1300	< 0.014	97	940	1800			
2012-05	MW-1014B		1114.33	490	2.9	520	1800	< 0.014	10000	1400	2600	6.32	2857	139
2012-05	MW-1014C		1109.42	280	28	0.86	540	4.8	1500	240	690	6.56	1016	60
2012-05	MW-1015A		1088.07	78	< 1.9	< 1.3	92	< 0.003	5.9	9.9	100	7.61	191.6	237
2012-05	MW-1015B		1087.97	180	< 1.9	< 1.3	150	0.077	47	< 2.5	260	7.63	605	226
2012-06	MW-1000PR		1089.54	220	< 1.9	9.4	440	0.3	2300	240	580	6.4	862	-121
2012-06	MW-1000R		1090.43	120	22	18	150	< 0.003	140	45	200	5.9	357.3	235
2012-06	MW-1002		1091.56	57	3.2	< 1.3	61	< 0.003	< 1	4.2	41	6.69	130.5	
2012-06	MW-1002G		1091.46	89	< 1.9	< 1.3	130	< 0.006	< 1	8.8	150	6.56	292	
2012-06	MW-1004		1109.28	41	3.3	2.3	56	0.0095	2.6	18	51	6.25	131.4	366
2012-06	MW-1004P		1106.62	160	< 1.9	< 1.3	140	0.15	99	< 2.5	110	7.01	305.4	
2012-06	MW-1004S		1109.35	50	< 1.9	1.7	76	< 0.003	< 1	23	98	6.32	175.9	344
2012-06	MW-1005		1140.74	52	< 1.9	< 1.3	300	14	410	15	700	5.99	973	
2012-06	MW-1005P		1139.98	250	< 1.9	< 1.3	220	1.3	66	< 2.5	210	6.97	489.99	-38
2012-06	MW-1005S		1140.22	190	< 1.9	< 1.3	170	4.1	250	< 2.5	170	6.84	355.4	
2012-06	MW-1010P		1089.51	150	24	< 1.3	170	< 0.003	49	27	160	7.21	349.5	171
2012-06	MW-1013		1113.7	610	< 1.3	9.3	570	3.8	22000	34	700	6.1	1134	143
2012-06	MW-1013A		1097.96	340	< 1.3	0.99	480	0.039	3300	190	610	6.62	934	172
2012-06	MW-1013B		1098.44	580	16	570	2200	< 0.014	34000	1600	3100	6.17	3257	345
2012-06	MW-1013C		1100.99	560	6.3	5	2100	11	10000	1700	3000	6.38	3234	40
2012-06	MW-1014		1120.6	170	< 1.3	7.1	300	< 0.014	1300	120	380	6.35	664	297
2012-06	MW-1014	Dup.		170	8.5	6.2	300	< 0.014	1300	120	410			
2012-06	MW-1014A		1117.63	500	< 1.3	6	1300	< 0.028	38	1200	1800	6.56	2179	288
2012-06	MW-1014B		1114.98	470	< 1.3	4.00	1800	< 0.014	11000	1300	2400	6.33	2919	146
2012-06	MW-1014C		1110.19	290	24	0.79	530	4.6	1800	240	720	6.6	1033	56
2012-06	MW-1015A		1088.95	79	< 1.9	< 1.3	89	< 0.003	7	10	78	7.28	196.8	203
2012-06	MW-1015A	Dup.		81	< 1.9	< 1.3	90	< 0.003	6.9	10	83			
2012-06	MW-1015B		1088.84	190	< 1.9	< 1.3	150	0.038	38	< 2.5	240	7.57	611	123
2012-10	MW-1000PR		1086.82	220	< 1.9	8	480	0.23	2200	250	570	6.53	833	-48
2012-10	MW-1000R		1087.3	450	< 1.9	160	500	0.0058	14000	32	560	6.5	854	283
2012-10	MW-1002		1089.16	60	< 1.9	< 1.3	69	< 0.003	< 1	4.5	30	6.79	149.3	
2012-10	MW-1002G		1089.1	87	< 1.9	< 1.3	140	< 0.003	< 1	8.3	120	6.58	283.7	
2012-10	MW-1004		1104.99	50	< 1.9	1.9	85	0.016	1.9	32	97	6.35	181.9	332
2012-10	MW-1004P		1103.75	160	< 1.9	< 1.3	160	0.22	100	< 2.5	140	6.94	307.6	
2012-10	MW-1004S		1105.09	49	< 1.9	< 1.3	77	< 0.003	< 1	23	88	6.66	165.4	346
2012-10	MW-1005		1136.89	55	< 1.9	1.9	500	17	520	15	800	5.92	1502	
2012-10	MW-1005P		1134.07	250	< 1.9	< 1.3	240	1.4	61	< 2.5	210	6.74	468.4	-2
2012-10	MW-1005S		1137.04	190	2.7	< 1.3	180	4.4	230	< 2.5	170	6.84	340.5	
2012-10	MW-1010P		1086.45	150	19	< 1.3	190	< 0.003	34	28	160	7.11	345.3	255
2012-10	MW-1013		1111.26	630	< 1.3	6.4	630	9.2	22000	27	810	6.15	1252	106
2012-10	MW-1013	Dup.		670	< 1.3	7.8	730	10	27000	26	780			
2012-10	MW-1013A		1097.36	320	< 1.3	1.1	430	0.092	2700	150	530	6.61	881	318
2012-10	MW-1013B		1097.7	600	< 1.3	550	2200	< 0.014	32000	1700	3100	6.21	3240	340
2012-10	MW-1013C		1099.48	560	20	9.5	2200	13	8800	1700	3100	6.42	3250	41
2012-10	MW-1014		1120.8	190	< 1.3	4.1	330	< 0.014	600	130	420	6.49	686	255
2012-10	MW-1014A		1118.09	480	< 1.3	12	1500	< 0.014	160	930	1800	6.55	2197	286
2012-10	MW-1014B		1114.32	430	< 1.3	350	1800	< 0.014	10000	1200	2300	6.33	2702	193
2012-10	MW-1014C		1109.18	290	24	1.3	550	4.9	1600	240	670	6.53	1032	63
2012-10	MW-1015A		1086.79	80	< 1.9	< 1.3	99	< 0.003	6.4	9.8	77	7.26	192.7	199
2012-10	MW-1015B		1086.74	180	< 1.9	< 1.3	160	0.042	36	< 2.5	230	7.36	601	-23
2012-10	MW-1015B	Dup.		180	< 1.9	< 1.3	150	0.046	41	< 2.5	230			

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Historical Groundwater Results - Quarterly Parameters

Sample Date	Location		Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
2013-03	MW-1000PR		1086.71	220	4.6	11	450	1.1	2100	230	570	6.61	848	
2013-03	MW-1000R	Dup.		220	5	11	460	1.1	2200	240	570			
2013-03	MW-1000R		1087.19	470	< 0.5	170	470	0.0098	13000	17	540	6.54	832	241
2013-03	MW-1002		1088.82	57	< 0.5	< 1.3	70	0.0035	< 1	4.9	63	7.38	153	
2013-03	MW-1002G		1088.75	80	< 0.5	1.5	130	< 0.003	< 1	8.4	150	6.81	289.1	
2013-03	MW-1004													
2013-03	MW-1004P		1102.12	150	< 0.5	< 1.3	150	0.12	81	2.7	120	7.1	302.8	
2013-03	MW-1004S		1103.3	49	< 0.5	2.3	78	< 0.003	< 1	24	92	6.82	179.3	340
2013-03	MW-1005		1135.76	62	< 0.5	3.6	530	21	580	15	930	5.93	1626	
2013-03	MW-1005P		1135.2	240	< 0.5	< 1.3	230	1.4	63	< 2.5	250	6.83	468.3	9
2013-03	MW-1005S		1135.39	170	2.3	< 1.3	170	4.3	230	< 2.5	200	6.44	343.7	
2013-03	MW-1010P		1086.43	150	20	1.4	180	0.0063	54	26	180	7.16	347.7	159
2013-03	MW-1013		1108.36	580	1.6	5.3	590	14	27000	39	760	6.17	1133	81
2013-03	MW-1013A		1096.32	310	< 1	0.87	410	0.14	2500	150	490	6.73	868	
2013-03	MW-1013B		1096.68	580	< 5	510	2400	0.058	37000	1700	3200	6.26	3222	326
2013-03	MW-1013C		1098.53	550	20	8.1	2300	13	9900	1600	3000	6.34	3157	51
2013-03	MW-1014		1118.33	180	< 1	3.6	310	< 0.014	520	120	420	6.46	691	205
2013-03	MW-1014A		1116.13	430	< 2	10	1300	< 0.014	360	890	1900	6.63	2180	272
2013-03	MW-1014B		1112.33	480	2.3	370	1900	< 0.014	11000	1300	2600	6.37	2752	291
2013-03	MW-1014C		1107.49	270	21	1.5	530	4.9	1600	230	710	6.68	989	69
2013-03	MW-1015A		1086.75	75	< 0.5	1.4	93	< 0.003	7	9.7	110	7.67	195.1	174
2013-03	MW-1015B		1086.81	170	< 0.5	< 1.3	150	0.043	41	< 2.5	230	7.43	593	141
2013-03	MW-1015B	Dup.		180	< 0.5	< 1.3	150	0.046	40	2.6	250			
2013-05	MW-1000PR		1089.45	210	2	7.5	440	0.17	1800	220	540	6.5	842	55
2013-05	MW-1000R		1090.65	340	< 0.5	37	390	< 0.003	270	33	440	6.32	712	385
2013-05	MW-1002		1094.68	65	< 0.5	1.5	71	0.0063	< 1	5.8	42	6.78	182.6	
2013-05	MW-1002G		1094.54	82	< 0.5	< 1.3	130	< 0.003	< 1	8.3	150	6.63	284	
2013-05	MW-1004		1109.12	36	< 0.5	3.5	36	0.05	1.5	9.1	19	6.55	84.1	406
2013-05	MW-1004P		1106.71	150	< 0.5	< 1.3	140	0.14	74	2.5	130	6.75	223.4	
2013-05	MW-1004P	Dup.		150	< 0.5	< 1.3	140	0.13	71	2.6	140			
2013-05	MW-1004S		1109.18	48	< 0.5	1.8	78	< 0.003	< 1	25	84	6.5	182.4	374
2013-05	MW-1005		1138.68	50	0.97	1.6	330	16	430	15	740	5.98	1032	
2013-05	MW-1005P		1137.03	220	< 0.5	< 1.3	220	0.37	64	4.1	250	6.66	556	-3
2013-05	MW-1005S		1137.47	170	2.1	< 1.3	160	4.4	220	< 2.5	170	6.55	340.3	
2013-05	MW-1010P		1089.39	140	17	< 1.3	170	< 0.003	39	27	180	7.24	346.4	186
2013-05	MW-1013		1108.56	580	< 1	6.3	540	12	24000	31	760	6.12	1181	45
2013-05	MW-1013A		1097.63	330	< 1	1.7	470	0.11	3100	190	640	6.69	870	127
2013-05	MW-1013B		1098.09	520	< 1	550	2100	0.053	35000	1600	3200	6.22	3229	372
2013-05	MW-1013C		1100.47	540	15	6.4	2100	12	9100	1500	3100	6.32	3202	37
2013-05	MW-1014		1117.71	160	< 1	5	290	< 0.014	830	120	400	6.63	673	275
2013-05	MW-1014A		1115.45	420	< 1	6.5	1300	< 0.014	53	970	1800	6.6	2251	283
2013-05	MW-1014B		1112.67	470	< 1	430	1800	< 0.014	10000	1300	2700	6.41	2828	220
2013-05	MW-1014C		1108.37	260	19	1.9	510	4.7	1500	210	720	6.73	1028	54
2013-05	MW-1014C	Dup.		270	19	2.5	510	4.7	1500	220	670			
2013-05	MW-1015A		1090.49	81	< 0.5	< 1.3	90	< 0.003	6	9.9	92	6.86	189.2	200
2013-05	MW-1015B		1090.73	170	< 0.5	< 1.3	150	0.17	58	< 2.5	290	7.13	596	-14
2013-06	MW-1000PR		1089.33	210	14	4.6	470	1.3	2400	220	550	6.46	814	112
2013-06	MW-1000R		1090.79	100	< 0.5	11	110	0.0047	380	81	220	6.18	680	105
2013-06	MW-1002		1094.51	61	< 0.5	< 1.3	83	< 0.003	< 1	6.1	76	6.88	169	
2013-06	MW-1002G		1094.41	81	< 0.5	< 1.3	140	< 0.003	< 1	8.1	150	6.76	282	
2013-06	MW-1002G	Dup.		82	< 0.5	< 1.3	130	< 0.003	< 1	8.3	160			
2013-06	MW-1004		1110.6	30	< 0.5	4.8	44	0.036	1.1	13	37	6.73	99	65
2013-06	MW-1004P		1107.24	150	0.52	1.3	150	0.43	150	2.8	140	7.38	296	84
2013-06	MW-1004S		1110.73	45	< 0.5	3.1	82	< 0.003	< 1	27	110	6.31	181.2	75
2013-06	MW-1005		1139.69	47	1.3	2.4	330	18	460	14	690	5.96	891	
2013-06	MW-1005P		1138.5	220	< 0.5	< 1.3	230	0.16	110	3	240	7.1	472	94
2013-06	MW-1005S		1138.93	160	2.4	< 1.3	180	4.8	240	< 2.5	170	6.97	327	
2013-06	MW-1010P		1089.16	140	22	< 1.3	180	0.0051	82	26	170	7.66	346	111
2013-06	MW-1013		1110.7	560	1.3	5.2	600	17	27000	28	780	6.11	1168	46
2013-06	MW-1013A		1098.36	320	< 1	2.5	520	0.097	3000	220	670	6.64	934	47
2013-06	MW-1013B		1098.83	510	< 1	310	2200	< 0.07	18000	1600	3100	6.18	3147	96
2013-06	MW-1013C		1100.81	530	19	9.3	2200	15	10000	1600	3100	6.39	3162	91
2013-06	MW-1014		1118.1	150	< 1	6.4	320	0.014	2100	110	440	6.49	633	57
2013-06	MW-1014A		1115.44	430	< 1	5.9	1300	< 0.014	16	1000	1900	6.58	2155	80
2013-06	MW-1014B		1113.25	450	< 1	560	2000	< 0.07	12000	1400	2800	6.3	2908	92
2013-06	MW-1014B	Dup.		460	< 1	610	1900	< 0.07	13000	1400	2800			
2013-06	MW-1014C		1109.06	270	21	1.6	550	5.1	1700	210	700	6.62	1017	60
2013-06	MW-1015A		1090.03	73	< 0.5	< 1.3	96	< 0.003	5.9	9.8	59	7.15	187	100
2013-06	MW-1015B		1090.24	170	< 0.5	1.4	160	0.089	55	< 2.5	230	7.68	510	124
2013-10	MW-1000PR		1087.73	210	6.6	10	420	0.72	2300	210	560	6.29	862	277.7
2013-10	MW-1000R		1088.3	320	< 1	88	400	< 0.018	4500	93	510	6.2	816	334.7
2013-10	MW-1002		1090.67	52	< 1	< 1	120	< 0.018	< 1	4.8	81	6.31	149	363.5
2013-10	MW-1002G		1090.62	80	< 1	< 1	61	< 0.018	< 1	7.9	150	6.36	281	351.5
2013-10	MW-1002G	Dup.		81	< 1	< 1	120	< 0.018	< 1	7.7	140			
2013-10	MW-1004		1106.16	40	< 1	3.1	59	0.028	< 1	22	77	6.09	166	348.5
2013-10	MW-1004P		1104.77	150	< 1	< 1	140	0.21	96	< 2.5	150	7.08	336	256
2013-10	MW-1004S		1106.27	46	< 1	1	75	0.021	< 1	29	110	6.0	212	361.4
2013-10	MW-1005		1137.63	57	1	1.8	430	17	470	15	860	5.78	1340	254.1

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Historical Groundwater Results - Quarterly Parameters

Sample Date	Location	Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
2013-10	MW-1005P	1136.64	230	< 1	< 1	210	0.92	84	< 2.5	250	7.05	503	117.6
2013-10	MW-1005S	1136.84	170	2.3	< 1	160	4.3	240	< 2.5	210	6.95	357	45
2013-10	MW-1010P	1087.5	150	18	< 1	170	< 0.018	60	23	180	7.42	358	259.4
2013-10	MW-1013	1110.51	600	1.2	3.9	570	11	28000	24	760	5.97	1296	173.4
2013-10	MW-1013A	1096.77	310	< 1	< 1	410	0.13	3400	160	570	6.53	975	275
2013-10	MW-1013B	1097.19	560	< 1	500	2200	0.06	34000	1500	3100	6.1	3490	301.6
2013-10	MW-1013C	1099.24	100	18	< 1	2000	13	9700	1500	3200	6.31	3192	138
2013-10	MW-1014	1118.83	170	< 1	4.6	300	< 0.018	990	120	420	6.31	735	295.8
2013-10	MW-1014A	1115.77	450	< 1	3.8	1200	0.045	81	800	1900	6.48	2213	300
2013-10	MW-1014B	1112.96	460	< 1	510	1800	< 0.018	12000	1300	2600	6.22	2942	260.5
2013-10	MW-1014B	Dup.	510	< 1	460	1800	< 0.018	13000	1200	2600			
2013-10	MW-1014C	1108.19	260	20	< 1	490	4.7	1700	200	680	6.39	1155	163
2013-10	MW-1015A	1087.76	75	< 1	< 1	81	< 0.018	5.3	9	110	6.85	186	202.1
2013-10	MW-1015B	1087.79	170	< 1	< 1	150	0.12	46	< 2.5	280	7.65	553	257.1
2014-03	MW-1000PR	1088.91	230	4.4	6.5	420	1.6	2100	210	540	6.84	839	
2014-03	MW-1000R	1089.48	420	< 0.5	140	440	< 0.018	15000	51	560	6.40	905	
2014-03	MW-1002	1090.78	64	< 0.5	< 1	71	< 0.018	< 1	5.3	84	6.56	159.7	
2014-03	MW-1002G	1090.69	88	< 0.5	< 1	120	< 0.018	< 1	7.6	140	6.79	273.9	
2014-03	MW-1002G	Dup.	89	< 0.5	< 1	120	< 0.018	< 1	7.3	120			
2014-03	MW-1004	1105.06	51	< 0.5	6.7	82	0.026	8.3	32	50	6.58	195.1	
2014-03	MW-1004P	1103.94	160	< 0.5	< 1	140	0.12	78	< 2.5	140	7.41	302.1	
2014-03	MW-1004S	1105.12	51	< 0.5	1.6	81	< 0.018	< 1	33	130	6.49	190.5	
2014-03	MW-1005	1136.57	40	< 0.5	2.2	230	7.9	230	13	430	6.17	950	
2014-03	MW-1005P	1135.39	220	< 0.5	1.5	220	0.23	18	5.5	280	7.13	490	
2014-03	MW-1005S	1135.64	190	2.3	< 1	160	3.7	220	< 2.5	160	7.02	360.7	
2014-03	MW-1010P	1088.63	150	19	< 1	170	< 0.018	32	27	190	7.86	348	
2014-03	MW-1013	1110.91	620	1.1	4.6	590	13	26000	27	700	6.16	1160	
2014-03	MW-1013A	1097.74	330	< 1	< 1	450	0.085	3300	140	500	6.87	824	
2014-03	MW-1013B	1098.31	560	< 1	470	2200	0.071	33000	1500	2900	6.45	3093	
2014-03	MW-1013C	1100.3	580	25	< 1	2200	14	9900	1500	2900	6.64	2959	
2014-03	MW-1014	1118.74	180	< 1	5.8	280	0.094	1200	110	380	6.79	685	
2014-03	MW-1014A	1116.32	470	< 1	5.7	1300	0.024	270	940	1800	6.73	2165	
2014-03	MW-1014B	1113.31	490	< 1	480	1800	0.028	12000	1300	2500	6.52	2596	
2014-03	MW-1014B	Dup.	430	< 1	470	1800	0.027	11000	1300	2500			
2014-03	MW-1014C	1108.64	280	22	1.2	510	5.1	1700	200	630	6.78	1021	
2014-03	MW-1015A	1088.71	80	< 0.5	< 1	86	< 0.018	5.9	8.7	66	7.29	187.8	
2014-03	MW-1015B	1088.82	180	< 0.5	< 1	150	0.22	55	< 2.5	270	7.97	516	
2014-05	MW-1000PR	1090.65	220	4.6	7	420	1.1	2000	210	520	6.49	918	75.7
2014-05	MW-1000R	1092.68	100	< 0.5	26	210	0.08	720	120	270	5.89	436	92.2
2014-05	MW-1002	1098.45	60	< 0.5	< 1	76	0.019	< 1	6	69	6.44	168	113.0
2014-05	MW-1002G	1098.25	92	< 0.5	< 1	130	< 0.018	1.9	8	120	6.56	290	90
2014-05	MW-1002G	Dup.	90	< 1	< 1	120	< 0.018	< 1	7.8	130			
2014-05	MW-1004	1111.07	26	< 0.5	5.3	34	0.15	2.6	12	10	6.34	84.0	109.2
2014-05	MW-1004P	1108.89	160	< 0.5	< 1	140	0.11	74	< 2.5	100	7.30	299	45
2014-05	MW-1004S	1111.23	53	< 0.5	1.6	89	< 0.018	< 1	38	98	6.64	220	88.7
2014-05	MW-1005	1139.85	41	1.4	1.4	230	10	280	13	450	6.04	769	33.4
2014-05	MW-1005P	1138.55	240	< 0.5	< 1	220	1.2	82	< 2.5	200	7.03	473	-43.1
2014-05	MW-1005S	1139.09	170	2.4	< 1	160	4.4	230	< 2.5	180	7.07	346	-87.9
2014-05	MW-1010P	1090.25	150	20	< 1	170	< 0.018	48	26	140	7.34	364	60.4
2014-05	MW-1013	1113.33	650	< 1	9.5	560	11	27000	30	720	5.87	1293	79.6
2014-05	MW-1013A	1099.31	340	< 1	2.7	450	0.037	1700	180	590	6.59	1068	96.0
2014-05	MW-1013B	1099.72	580	< 1	510	2200	0.09	37000	1600	3100	6.17	3456	147.2
2014-05	MW-1013C	1102.52	480	21	< 1	2100	14	9600	1600	2900	6.41	3463	18.9
2014-05	MW-1014	1119.16	160	< 1	7	270	< 0.018	1200	99	320	6.06	685	92.3
2014-05	MW-1014A	1116.02	460	< 1	7.5	1200	< 0.018	420	900	1800	6.412	2370	110.9
2014-05	MW-1014B	1114.93	480	< 1	460	1700	< 0.018	11000	1200	2400	6.20	3004	151.1
2014-05	MW-1014B	Dup.	100	< 1	440	1700	< 0.018	10000	1300	2400			
2014-05	MW-1014C	1110.69	260	22	< 1	510	5	1700	210	610	6.42	1156	27.8
2014-05	MW-1015A	1092.21	78	< 0.5	< 1	87	< 0.018	6.2	8.7	74	7.09	188	43.9
2014-05	MW-1015B	1092.7	180	< 0.5	< 1	150	0.16	58	< 2.5	240	7.88	532	-57.0
2014-06	MW-1000PR	1088.46	220	2.8	15	410	0.57	2100	210	520	6.44	854.4	-11.5
2014-06	MW-1000R	1090.27	200	< 0.5	76	430	< 0.018	12000	280	630	6.31	918.3	64
2014-06	MW-1002	1096.1	64	< 0.5	< 1	77	< 0.018	< 1	6	110	6.38	177.4	101
2014-06	MW-1002G	1096.01	91	< 0.5	< 1	120	< 0.018	< 1	8.5	160	6.52	303.7	84
2014-06	MW-1002G	Dup.	91	< 0.5	< 1	130	< 0.018	< 1	8.5	170			
2014-06	MW-1004	1110.86	28	< 0.5	5.8	37	0.087	2.1	11	59	6.19	91.2	107.0
2014-06	MW-1004P	1108.7	160	< 0.5	< 1	140	0.4	140	< 2.5	80	7.28	308.4	-1.9
2014-06	MW-1004S	1111.03	52	< 0.5	1.2	89	< 0.018	< 1	36	130	6.17	220.6	100
2014-06	MW-1005	1140.17	42	2.3	< 1	270	16	360	15	440	5.78	867.8	98.4
2014-06	MW-1005P	1139.34	230	< 0.5	< 1	220	0.9	98	< 2.5	240	7.05	497.0	-33
2014-06	MW-1005S	1139.74	180	2.4	< 1	160	4.7	230	< 2.5	200	6.94	353.6	187
2014-06	MW-1010P	1088.15	150	18	< 1	170	< 0.018	22	29	180	7.47	362.1	57.9
2014-06	MW-1013	1115.1	660	< 1	10	590	5.7	26000	31	730	6.13	1173	35
2014-06	MW-1013A	1099.77	340	< 1	< 1	490	0.072	2900	210	650	6.58	1039	37
2014-06	MW-1013B	1100.24	530	< 1	540	2200	0.12	36000	1600	3100	6.31	3248	289.4
2014-06	MW-1013C	1102.21	510	20	< 1	2100	14	10000	1600	3000	6.38	3316	157
2014-06	MW-1014	1120.82	140	< 1	10	280	< 0.018	1900	98	390	5.97	616.8	124
2014-06	MW-1014A	1117.13	430	< 1	2.7	1300	< 0.018	36	940	1800	6.42	2429	120.0

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Historical Groundwater Results - Quarterly Parameters

Sample Date (yyymm)	Location	Water Elevation (ft)	Alkalinity as CaCO3 (mg/l)	Arsenic (ug/l)	Copper (ug/l)	Hardness (mg/l)	Iron (mg/l)	Manganese (ug/l)	Sulfate (mg/l)	Total Dissolved Solids (mg/l)	pH (s.u.)	Conductivity (umhos/cm)	Redox Potential (mV)
2014-06	MW-1014B	1116.33	480	< 1	500	1800	< 0.018	10000	1300	2400	6.21	2943	124
2014-06	MW-1014B	Dup.	470	< 1	500	1800	< 0.018	10000	1300	2500			
2014-06	MW-1014C	1111.53	270	21	< 1	520	5	1700	200	710	6.50	1064	35.7
2014-06	MW-1015A	1089.95	78	< 0.5	< 1	87	< 0.018	4.5	8.6	110	6.86	192.8	63.0
2014-06	MW-1015B	1090.07	180	< 0.5	< 1	150	0.22	53	< 2.5	330	7.55	581.4	-90
2014-10	MW-1000PR	1088.6	230	6.6	< 1	410	2.4	2300	200	570	6.11	777	51.5
2014-10	MW-1000R	1089.92	230	< 0.5	83	360	< 0.018	11000	160	500	5.95	735	126.6
2014-10	MW-1002	1093.06	69	< 0.5	< 1	80	< 0.018	< 1	5.6	95	6.39	188	168.7
2014-10	MW-1002G	1092.99	93	< 0.5	< 1	120	< 0.018	< 1	7.8	170	6.41	245	160.7
2014-10	MW-1002G	Dup.	94	< 0.5	< 1	130	< 0.018	< 1	7.7	170			
2014-10	MW-1004	1109.43	35	< 0.5	5.3	40	0.021	< 1	10	80	6.31	126	136.4
2014-10	MW-1004P	1107.81	170	< 0.5	< 1	140	0.43	110	< 2.5	130	6.93	311	-2.5
2014-10	MW-1004S	1109.5	51	< 0.5	1.3	83	< 0.018	< 1	35	110	5.82	212	153.3
2014-10	MW-1005	1140.32	53	1.9	< 1	290	16	410	14	660	5.86	978	41.3
2014-10	MW-1005P	1139.75	260	< 0.5	< 1	220	1.5	68	< 2.5	220	6.96	469	-44.6
2014-10	MW-1005S	1140.02	180	2.5	< 1	150	4.6	230	< 2.5	210	6.77	344	-90.7
2014-10	MW-1010P	1088.36	160	23	< 1	180	< 0.018	29	29	190	6.98	341	144.9
2014-10	MW-1013	1114.88	600	< 1	19	560	2.9	26000	23	680	6.01	1060	81.3
2014-10	MW-1013A	1099.7	330	< 1	3.8	460	0.099	4200	190	620	6.39	914	68.3
2014-10	MW-1013B	1100.08	600	< 1	610	2100	0.036	41000	1600	3200	6.03	2963	159.1
2014-10	MW-1013C	1102.61	510	26	< 1	2000	13	9600	1500	3000	6.18	2905	34.1
2014-10	MW-1014	1124.11	160	< 1	9.4	290	< 0.018	1300	110	420	5.96	600	129.3
2014-10	MW-1014A	1120.32	510	< 1	4	1300	0.019	46	910	1800	6.39	2052	127.2
2014-10	MW-1014B	1117.92	510	< 1	510	2000	< 0.018	12000	1400	2700	6.02	2775	199.7
2014-10	MW-1014B	Dup.	550	1.1	520	1900	< 0.018	12000	1400	2800			
2014-10	MW-1014C	1112.66	270	23	< 1	530	4.9	1600	210	650	6.39	967	24.3
2014-10	MW-1015A	1089.11	80	< 0.5	< 1	83	0.11	7.7	7.8	130	6.78	190	131.3
2014-10	MW-1015B	1089.21	180	< 0.5	< 1	150	0.22	59	< 2.5	310	7.37	544	-35.3
2015-03	MW-1000PR	1089.17	220	8.7	1.1	410	3.6	2300	190	560	6.44	600	71.2
2015-03	MW-1000R	1090.07	200	< 0.5	70	320	< 0.018	9600	88	470	6.19	619	154.3
2015-03	MW-1002	1091.96											
2015-03	MW-1002G	Dup.	92	< 0.5	< 1	130	< 0.018	< 1	8.3	170			
2015-03	MW-1002G	1091.9	93	< 0.5	< 1	130	< 0.018	< 1	7.9	150	6.45	258	136.5
2015-03	MW-1004	1107.63	30	< 0.5	4.9	40	0.04	1.2	13	67	6.12	78	179.8
2015-03	MW-1004P	1105.74	160	< 0.5	< 1	140	0.081	100	2.5	190	7.1	247	32.2
2015-03	MW-1004S	1107.57	44	< 0.5	2.6	66	< 0.018	< 1	26	110	6.11	137	205.9
2015-03	MW-1005	1140.17	50	1.1	1.6	340	16	430	14	600	5.89	964	96.4
2015-03	MW-1005P	1139.57											
2015-03	MW-1005S	1139.55	180	2.3	< 1	160	4.4	230	< 2.5	240	7.01	296	-71.6
2015-03	MW-1010P	1088.80	150	20	< 1	180	0.039	31	29	220	7.51	268	144.3
2015-03	MW-1013	1112.44	590	< 1	14	580	5.4	28000	28	760	6.18	832	127.3
2015-03	MW-1013A	1099.43	360	< 1	1.2	450	0.087	4400	180	670	6.57	677	111.5
2015-03	MW-1013B	1100.56	530	< 1	510	2100	0.08	34000	1600	3200	6.12	2103	193.3
2015-03	MW-1013C	1102.15	500	20	1.6	2100	13	10000	1500	2900	6.35	1820	59.3
2015-03	MW-1014	1123.19	180	< 1	5.4	300	< 0.018	620	110	470	6.36	652	179.2
2015-03	MW-1014A	1120.69	430	< 1	6	1300	< 0.018	310	970	1900	6.55	2030	174
2015-03	MW-1014B	1117.02	470	< 1	500	1900	< 0.018	12000	1300	2600	6.32	2607	186.2
2015-03	MW-1014C	Dup.	300	23	< 1	520	5	1700	200	700			
2015-03	MW-1014C	1111.8	250	23	< 1	540	5	1700	210	680	6.58	947	62
2015-03	MW-1015A	1089.3	78	< 0.5	< 1	89	< 0.018	5.5	7.4	100	6.78	178	207.5
2015-03	MW-1015B	1089.25	180	< 0.5	< 1	150	0.031	47	< 2.5	250	7.66	421	32
2015-04	MW-1002		53	< 0.5	1.2	61	< 0.018	< 1	2.7	43	6.33	137	198.4
2015-04	MW-1005P		230	< 0.5	< 1	220	1.2	92	< 2.5	260	7.04	547	44.6
2015-05	MW-1000PR	1090.81	200	6.5	4.3	410	0.73	2100	190	580	6.36	814	151.1
2015-05	MW-1000R	1091.65	110	0.53	40	200	< 0.018	2800	72	330	5.94	415	368.3
2015-05	MW-1002	Dup.	54	< 0.5	< 1	61	< 0.018	< 1	2.5	130			
2015-05	MW-1002	1093.11	54	0.57	< 1	60	< 0.018	< 1	2.6	73	6.41	140	226.5
2015-05	MW-1002G	1093.02	91	< 0.5	< 1	130	< 0.018	< 1	7.2	180	6.48	301	163.2
2015-05	MW-1004	1111.05	30	< 0.5	4.2	39	< 0.018	< 1	11	26	6.22	84	177.6
2015-05	MW-1004P	1108.09	160	0.64	< 1	140	0.16	94	3	130	7.27	302	10.1
2015-05	MW-1004S	1111.27	42	< 0.5	1.9	63	< 0.018	< 1	25	110	6.16	165	199.5
2015-05	MW-1005	1142.02	49	1.6	1.2	360	14	360	14	870	5.85	1297	81.7
2015-05	MW-1005P	1141.85	240	0.58	< 1	210	0.89	94	< 2.5	240	7.04	466	-16.7
2015-05	MW-1005S	1142.17	170	3.1	< 1	160	3.9	230	< 2.5	210	6.97	349	-59.1
2015-05	MW-1010P	1090.32	150	25	< 1	170	< 0.018	58	20	210	7.52	351	228.2
2015-05	MW-1013	1115.7	620	< 1	25	580	1.1	26000	28	770	6.04	1160	94.6
2015-05	MW-1013A	1098.57	320	< 1	< 1	450	0.034	3200	180	630	6.51	970	90.9
2015-05	MW-1013B	1100.09	560	< 2	380	2000	0.056	25000	1500	3200	6.12	3169	179.1
2015-05	MW-1013C	1102.84	530	24	< 2	2000	14	9700	1500	3000	6.3	3085	68.9
2015-05	MW-1014	1123.53	160	< 1	5.5	280	< 0.018	970	100	410	6.21	657	184.9
2015-05	MW-1014A	1120.42	460	< 2	5.8	1300	0.06	300	920	1900	6.46	2223	168.8
2015-05	MW-1014B	1117.69	510	< 2	420	1800	< 0.036	11000	1200	2700	6.26	2828	175.5
2015-05	MW-1014C	Dup.	260	21	< 1	500	4.8	1600	200	680			
2015-05	MW-1014C	1112.59	260	21	< 1	490	4.8	1500	200	680	6.53	1027	55.7
2015-05	MW-1015A	1090	76	< 0.5	< 1	83	< 0.018	5.7	7	110	7	180	198.7
2015-05	MW-1015B	1089.56	170	0.57	< 1	140	0.094	42	< 2.5	280	7.62	515	13.2
2015-06	MW-1000PR	1088.72	220	5.5	8.3	390	0.48	2100	190	540	6.45	809	131
2015-06	MW-1000R	1090.39	160	< 0.50	57	260	< 0.018	7300	120	410	6.14	596	119.7

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Historical Groundwater Results - Quarterly Parameters

Sample Date	Location		Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
2015-06	MW-1002	Dup.		60	< 0.50	< 1.0	65	< 0.018	< 1.0	3.0	150			
2015-06	MW-1002		1093.41	58	< 0.50	< 1.0	64	< 0.018	< 1.0	2.8	110	6.62	149	106.9
2015-06	MW-1002G		1093.34	95	< 0.50	< 1.0	130	< 0.018	< 1.0	7.3	200	6.49	297	127.5
2015-06	MW-1004		1109.61	30	< 0.50	4.7	34	< 0.018	< 1.0	8.4	79	6.23	87	103.7
2015-06	MW-1004P		1107.81	170	< 0.50	< 1.0	140	0.36	130	< 2.5	160	7.28	306	76.1
2015-06	MW-1004S		1109.72	44	< 0.50	1.9	68	< 0.018	< 1.0	27	96	6.15	160	113.7
2015-06	MW-1005		1141.73	45	0.65	1.6	360	15	480	14	960	5.86	1242	75.7
2015-06	MW-1005P		1141.63	240	< 0.50	< 1.0	220	1.1	70	< 2.5	260	7.09	467	31.3
2015-06	MW-1005S		1141.87	180	2.4	< 1.0	160	4.6	230	< 2.5	210	7	347	-66.7
2015-06	MW-1010P		1088.42	160	22	< 1.0	170	< 0.018	50	21	220	7.52	347	123.4
2015-06	MW-1013		1115.9	610	< 1.0	17	590	1.8	28000	24	770	6.09	1160	75.2
2015-06	MW-1013A		1099.85	340	< 1.0	< 1.0	480	0.046	4200	200	700	6.56	963	82.5
2015-06	MW-1013B		1100.37	590	< 5.0	530	2300	< 0.090	34000	1500	3200	6.2	3163	123
2015-06	MW-1013C		1103.09	500	26	< 5.0	2100	14	11000	1500	3000	6.38	3157	57.2
2015-06	MW-1014		1124.32	180	< 1.0	6.4	290	< 0.018	1900	140	500	6.4	739	127.5
2015-06	MW-1014A		1120.66	450	< 5.0	< 5.0	1400	< 0.090	62	940	1900	6.51	2199	142.1
2015-06	MW-1014B		1118.53	480	< 5.0	520	1900	< 0.090	12000	1300	2700	6.28	2850	149.2
2015-06	MW-1014C	Dup.		280	25	< 1.0	520	4.8	1700	200	700			
2015-06	MW-1014C		1113.19	270	26	< 1.0	520	4.9	1700	200	690	6.57	1008	29.2
2015-06	MW-1015A		1089.3	80	< 0.50	< 1.0	85	< 0.018	4.5	6.7	120	6.97	190	96.7
2015-06	MW-1015B		1089.41	180	< 0.50	< 1.0	150	0.21	61	< 2.5	310	7.67	600	152.2
2015-09	MW-1005	Resample		58.4	1.8	1.2	527	20.2	611	14.5	803			
2015-10	MW-1000PR		1087.28	225	6.8	2.7	434	0.642	2150	68.3	534	6.34	671	101.2
2015-10	MW-1000R		1088.48	247	0.29	89.7	336	0.0183	10600	69.2	450	6.08	682	135.9
2015-10	MW-1002	Dup.		58.6	0.10	1.1	69.0	0.0259	0.37	4.5	104			
2015-10	MW-1002		1090.92	61.2	< 0.099	0.67	67.8	< 0.0100	< 0.18	4.6	96.0	6.5	151	87.1
2015-10	MW-1002G		1090.83	98.2	< 0.099	0.35	144	< 0.0100	0.23	9.2	190	6.5	298	118.5
2015-10	MW-1004		1107.07	41.3	< 0.099	4.2	58.9	< 0.0100	1.4	20.5	92.0	6.06	136	110.1
2015-10	MW-1004P		1105.83	167	0.46	< 0.26	156	0.418	149	3.6	160	7.23	318	-8.4
2015-10	MW-1004S		1107.11	40.9	0.13	1.8	67.2	< 0.0100	0.73	24.7	106	6.07	155	118.8
2015-10	MW-1005		1140.26	57.3	1.2	1.6	418	16.2	540	14.9	1070	5.83	1319	75.7
2015-10	MW-1005P		1139.76	251	0.32	0.32	240	1.07	71.6	< 2.0	234	7.02	466	11.1
2015-10	MW-1005S		1140.07	179	2.4	< 0.26	177	4.29	237	2.3	198	6.99	347	-41.6
2015-10	MW-1010P		1087.06	161	23.0	0.55	185	< 0.0100	83.4	24.4	188	7.45	351	101.9
2015-10	MW-1013		1115.02	630	0.63	7.6	568	4.57	26200	24.9	692	6.05	1106	59.4
2015-10	MW-1013A		1098.88	353	0.26	0.47	468	0.0547	4330	163	586	6.6	970	47.2
2015-10	MW-1013B		1099.29	523	1.0	510	2030	0.0632	30800	1600	2970	6.14	3197	135.5
2015-10	MW-1013C		1101.66	522	21.2	0.78	1940	13.7	9600	1550	2840	6.37	3174	60.1
2015-10	MW-1014		1124.02	194	< 0.099	5.2	332	< 0.0100	455	128	446	6.26	710	136.3
2015-10	MW-1014A		1120.98	488	0.81	3.8	1400	< 0.0100	156	931	1790	6.46	2190	152.2
2015-10	MW-1014B		1117.33	512	1.3	372	1730	< 0.0100	9970	1340	2460	6.25	2680	174.4
2015-10	MW-1014C	Dup.		274	22.8	< 0.26	528	4.83	1580	214	670			
2015-10	MW-1014C		1111.82	273	22.6	0.36	545	4.64	1610	215	676	6.56	1026	57.1
2015-10	MW-1015A		1087.57	83.5	< 0.099	0.46	96.4	0.0101	6.8	8.7	120	6.98	191	127.7
2015-10	MW-1015B		1087.61	184	0.16	< 0.26	161	0.138	34.3	3.2	252	7.55	621	11.3
2016-03	MW-1000PR		1089.9	217	5.5	4.4	410	0.25	1930	187	514	6.53	792	115.8
2016-03	MW-1000R		1091.96	204	0.32	80.4	295	0.0184	7810	75.1	440	6.24	607	134.1
2016-03	MW-1002		1094.48	71.2	< 0.099	1.5	76.9	0.0250	0.94	5.4	128	6.44	158	158
2016-03	MW-1002G	Dup.		74.8	< 0.099	0.82	83.5	< 0.0100	1.2	5.5	126			
2016-03	MW-1002G		1094.36	98.5	< 0.099	0.52	141	< 0.0100	0.86	9.3	192	6.47	311	136.8
2016-03	MW-1004		1109.77	34.3	< 0.099	3.6	37.0	< 0.0100	3.3	12.0	76.0	6.41	85	104.7
2016-03	MW-1004P		1107.68	158	0.34	< 0.26	143	0.363	93.8	3.6	162	7.37	313	-0.4
2016-03	MW-1004S		1109.85	36.7	< 0.099	1.8	60.4	< 0.0100	0.74	24.2	100	6.19	147	127.5
2016-03	MW-1005		1141.5	62.3	1.6	0.91	508	19.7	490	21.3	940	5.85	1580	98.1
2016-03	MW-1005P		1141.16	241	0.35	2.5	224	1.18	57.2	< 10.0	260	7.14	505	27.2
2016-03	MW-1005S		1141.48	168	2.7	0.39	156	4.36	213	< 20.0	192	7.02	333	-21.6
2016-03	MW-1010P		1089.75	153	18.0	0.27	178	< 0.0100	33.7	30.4	180	7.57	361	121.5
2016-03	MW-1013		1113.66	602	0.49	10.4	542	2.85	25100	29.6	686	6.21	1105	65.7
2016-03	MW-1013A		1100.24	350	0.35	1.5	471	0.104	3870	195	626	6.64	983	82.9
2016-03	MW-1013B		1100.75	618	1.1	424	2060	0.0384	28400	1640	3120	6.2	3190	142.3
2016-03	MW-1013C		1103.65	511	21.6	< 0.26	1990	13.9	9160	1590	2910	6.4	2945	44.6
2016-03	MW-1014		1124.06	200	0.38	4.6	313	0.0126	1200	120	474	6.33	691	135.5
2016-03	MW-1014A		1121.48	501	1.3	6.9	1280	0.0145	528	926	1790	6.55	2222	144.9
2016-03	MW-1014B		1118.11	552	1.7	494	1890	0.0227	11200	1380	2620	6.32	2887	166.4
2016-03	MW-1014C	Dup.		268	22.7	0.54	505	4.53	1550	210	672			
2016-03	MW-1014C		1112.95	283	21.3	0.58	510	4.52	1560	208	712	6.6	1028	64.3
2016-03	MW-1015A		1090.74	80.1	< 0.099	0.91	90.5	0.0341	16.9	8.3	132	6.97	190	140.9
2016-03	MW-1015B		1090.98	173	0.23	< 0.26	153	0.173	43.1	2.4	294	7.68	611	85.6
2016-05	MW-1000PR		1088.17	228	14.4	< 0.26	459	3.78	2320	188	524	6.41	799	111.2
2016-05	MW-1000R		1090.01	182	0.36	71.7	296	< 0.0100	9380	91.4	396	6.01	589	170.5
2016-05	MW-1002		1093.74	77.4	< 0.099	0.56	85.7	< 0.0100	2.1	6.1	132	6.4	168	130.3
2016-05	MW-1002G	Dup.		98.4	< 0.099	< 0.26	141	< 0.0100	0.71	10	210			
2016-05	MW-1002G		1093.64	96.2	< 0.099	< 0.26	142	0.0138	5.9	9.9	204	6.55	297	121.3
2016-05	MW-1004		1109.6	23.3	< 0.099	5.1	30.4	0.206	2.8	9.9	62.0	6.45	75	110.2
2016-05	MW-1004P		1107.86	160	0.20	< 0.26	141	0.313	85.0	3.7	166	7.29	304	17.2
2016-05	MW-1004S		1109.69	37.7	< 0.099	1.6	61.2	< 0.0100	0.99	24.2	108	6.26	146	113
2016-05	MW-1005		1141.77	44.3	0.96	0.78	529	15.5	522	15.4	1220	5.82	1609	95.7
2016-05	MW-1005P		1141.64	253	< 0.099	< 0.26	216	0.757	78.9	2.0	240	7.08	450	22.6

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Historical Groundwater Results - Quarterly Parameters

Sample Date (yyyy-mm)	Location	Water Elevation ft	Alkalinity as		Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
			CaCO3 mg/l	Arsenic ug/l									
2016-05	MW-1005S	1141.93	184	2.2	< 0.26	151	3.98	207	3.1	200	6.86	330	-31.2
2016-05	MW-1010P	1087.98	153	21.7	< 0.26	183	< 0.0100	65.3	27.2	214	7.46	349	76.3
2016-05	MW-1013	1115.07	589	0.63	19.3	608	1.94	30300	5.3	704	6.15	1125	74.6
2016-05	MW-1013A	1099.91	369	0.37	< 0.26	559	0.209	4520	198	660	6.55	1052	46
2016-05	MW-1013B	1100.42	536	1.1	497	2350	0.0660	37800	1640	3000	6.14	3187	137.3
2016-05	MW-1013C	1102.83	483	20.6	< 0.26	2040	14.7	8990	1560	2830	6.37	3119	61.2
2016-05	MW-1014	1124.42	167	< 0.099	4.5	341	< 0.0100	1850	113	432	6.32	665	126.6
2016-05	MW-1014A	1121.12	556	0.36	3.1	1470	< 0.0100	158	929	1770	6.5	2197	122.6
2016-05	MW-1014B	1118.4	555	0.96	399	1890	< 0.0100	11900	1290	2540	6.25	2804	131.6
2016-05	MW-1014C	Dup.	289	23.0	< 0.26	525	4.68	1540	218	658			
2016-05	MW-1014C	1112.96	279	25.6	< 0.26	586	5.09	1740	214	660	6.55	1026	46.5
2016-05	MW-1015A	1089.18	74.7	< 0.099	< 0.26	92.1	< 0.0100	5.6	8.5	124	6.89	187	138.4
2016-05	MW-1015B	1089.26	189	< 0.099	< 0.26	140	0.189	46.5	3.4	266	7.61	570	-2.5
2016-06	MW-1000PR	1091.53	212	6.1	4.3	396	0.465	1800	186	562	6.41	773	109
2016-06	MW-1000R	1092.8	149	0.30	59.6	244	< 0.0100	8050	106	424	5.92	545	145.3
2016-06	MW-1002	1095.4	71.5	< 0.099	0.86	86.5	< 0.0100	1.7	4.9	138	6.42	172	124.8
2016-06	MW-1002G	Dup.	98.1	< 0.099	0.41	141	< 0.0100	0.38	8.9	206			
2016-06	MW-1002G	1095.27	97.0	< 0.099	0.48	142	0.0238	0.28	8.9	220	6.51	302	141.9
2016-06	MW-1004	1109.75	29.1	0.26	5.4	34.3	0.205	2.9	9.7	70.0	6.41	81	102.2
2016-06	MW-1004P	1108.22	164	0.57	0.51	150	0.589	221	2.5	174	7.24	309	123.3
2016-06	MW-1004S	1109.83	34.8	< 0.099	1.7	60.6	< 0.0100	3.3	22.8	112	6.29	145	110.6
2016-06	MW-1005	1141.4	44.6	1.1	0.96	538	20.4	640	14.2	1550	5.78	1764	96.7
2016-06	MW-1005P	1141.35	241	0.26	0.29	226	0.821	64.8	< 2.0	282	7.08	458	30.1
2016-06	MW-1005S	1141.52	167	2.3	< 0.26	155	4.09	207	2.1	210	7.02	330	-42.7
2016-06	MW-1010P	1091.05	154	22.0	0.61	167	< 0.0100	61.8	29.4	212	7.47	347	115.1
2016-06	MW-1013	1116	589	0.57	16.4	556	1.8	24300	22.5	722	6.11	1098	51.7
2016-06	MW-1013A	1100.31	358	0.33	0.47	507	0.25	4220	188	644	6.58	1020	41.6
2016-06	MW-1013B	1100.83	574	0.78	452	2080	0.0461	27000	1560	3140	6.16	3190	135.3
2016-06	MW-1013C	1104.09	499	19.3	0.52	1940	12.7	8830	1480	2940	6.41	3114	48.3
2016-06	MW-1014	1125.44	162	0.16	4.8	299	< 0.0100	1520	111	456	6.28	669	121.5
2016-06	MW-1014A	1121.8	473	0.60	2.4	1310	0.0127	94.9	920	1840	6.51	2204	123.4
2016-06	MW-1014B	1119.38	469	0.96	373	1700	< 0.0100	9010	1240	2540	6.38	2441	130.5
2016-06	MW-1014C	Dup.	269	22.4	14.9	531	4.66	1520	205	674			
2016-06	MW-1014C	1114.03	272	23.0	< 0.26	522	4.66	1460	212	714	6.58	1024	42
2016-06	MW-1015A	1091.54	75.5	< 0.099	0.51	88.4	< 0.0100	7.2	7.2	132	6.96	189	115.6
2016-06	MW-1015B	1091.03	172	0.13	< 0.26	160	0.0448	46.8	< 2.0	326	7.54	587	147.8
2016-10	MW-1000PR	1088.87	221	8.9	3.9	427	0.842	2340	149	536	6.53	777	123.5
2016-10	MW-1000R	1090.36	218	0.32	94.4	329	0.0196	13800	90.1	468	6.16	659	146.3
2016-10	MW-1002	Dup.	72.1	< 0.099	0.85	84.3	< 0.0100	0.30	4.6	120			
2016-10	MW-1002	1093.4	71.1	< 0.099	0.69	84.8	0.0169	0.36	4.6	118	6.56	165	115.3
2016-10	MW-1002G	1093.27	102	< 0.099	0.53	148	0.0186	0.45	9.2	192	6.52	299	133.1
2016-10	MW-1004	1109.57	30.8	< 0.099	4.7	43.3	0.0778	1.3	12.5	80.0	6.26	96	102.7
2016-10	MW-1004P	1107.72	164	0.32	< 0.26	157	0.318	122	2.0	170	7.24	316	7.9
2016-10	MW-1004S	1109.62	38.7	< 0.099	1.6	60.5	0.0151	0.47	21.0	102	6.26	135	115.3
2016-10	MW-1005	1141.18	62.8	1.5	0.75	641	21.6	607	15.4	1540	5.81	1825	114.3
2016-10	MW-1005P	1140.77	255	1.2	0.97	230	1.55	69.2	< 1.0	240	7.12	466	15.3
2016-10	MW-1005S	1141.07	168	2.3	< 0.26	167	3.83	216	1.9	194	6.95	332	-21.4
2016-10	MW-1010P	1088.5	153	18.9	0.60	192	0.0519	61.0	30.1	212	7.53	352	122.4
2016-10	MW-1013	1114.95	579	0.79	7.5	594	7.82	27000	17.3	692	6.11	1078	55
2016-10	MW-1013A	1089.87	366	0.15	0.27	451	0.139	5350	176	608	6.65	973	44.4
2016-10	MW-1013B	1100.32	530	0.61	494	2310	0.0527	30400	1730	3080	6.2	3182	141.3
2016-10	MW-1013C	1103.24	483	21.0	0.41	2090	14.2	10100	1600	2890	6.39	3130	72.2
2016-10	MW-1014	1125.42	179	0.22	5.0	339	0.0372	1270	117	478	6.42	699	152.7
2016-10	MW-1014A	1122.08	474	0.51	5.1	1450	0.0226	292	961	1820	6.58	2188	164.3
2016-10	MW-1014B	1118.94	466	0.85	442	1710	0.0258	9760	1380	2530	6.41	2685	179.7
2016-10	MW-1014C	Dup.	275	23.6	0.48	523	4.54	1560	218	668			
2016-10	MW-1014C	1113.41	276	24.5	0.38	564	4.78	1860	213	700	6.58	1023	72.2
2016-10	MW-1015A	1089.45	79.8	< 0.099	0.37	94.4	0.0161	5.4	7.5	128	6.9	191	131.1
2016-10	MW-1015B	1089.45	178	0.10	< 0.26	167	0.213	46.4	< 1.0	296	7.57	606	101.3
2017-03	MW-1000PR	1088.79	208	6.6	9.7	416	0.235	2110	199	514	6.4	774	114.2
2017-03	MW-1000R	1090.4	165	< 0.099	62.4	251	< 0.0100	9310	76.8	336	6.02	507	145
2017-03	MW-1002	Dup.	63.5	< 0.099	0.75	77.1	0.0140	0.45	4.0	102			
2017-03	MW-1002	1092.95	62.7	< 0.099	0.76	72.3	< 0.0100	0.5	4.2	96.0	6.27	157	125.8
2017-03	MW-1002G	1092.82	98.3	< 0.099	0.39	142	< 0.0100	0.35	10.3	202	6.41	324	150.9
2017-03	MW-1004	1108.78	31.7	< 0.099	4.1	36.3	0.0551	6.7	10.6	58.0	6.17	88	107.7
2017-03	MW-1004P	1107.19	166	0.49	< 0.26	147	0.298	140	2.1	164	7.37	322	56
2017-03	MW-1004S	1108.83	32.7	< 0.099	1.9	55.8	< 0.0100	2.2	23.1	96.0	6.27	132	114.8
2017-03	MW-1005	1141.76	40.6	1.2	1.1	569	15.8	561	15.8	1170	5.89	1866	76.5
2017-03	MW-1005P	1141.44	254	0.28	0.55	236	0.804	92.3	< 1.0	236	6.98	471	20.4
2017-03	MW-1005S	1141.8	161	2.4	< 0.26	154	3.94	225	2.5	192	6.83	324	-36.9
2017-03	MW-1010P	1088.35	165	18.2	0.45	177	< 0.0100	75.3	26.5	206	7.46	356	121.3
2017-03	MW-1013	1114.59	636	0.57	6.8	543	8.78	26100	20.8	698	6.13	1094	64.4
2017-03	MW-1013A	1100.27	371	0.22	0.41	460	0.0844	4430	192	614	6.63	1010	95.1
2017-03	MW-1013B	1100.69	615	0.92	384	2140	0.0766	27700	1650	3090	6.21	3175	132.3
2017-03	MW-1013C	1103.32	396	20.4	< 0.26	2040	12.2	9970	1720	2920	6.4	3127	82.5
2017-03	MW-1014	1125.13	174	< 0.099	5.4	305	< 0.0100	3060	135	434	6.38	675	130.4
2017-03	MW-1014A	1122.04	527	0.89	12.6	1300	0.0124	1760	1020	1800	6.59	2217	137.1
2017-03	MW-1014B	1118.9	519	1.3	398	1740	< 0.0100	10700	1490	2460	6.34	2772	142.1

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Historical Groundwater Results - Quarterly Parameters

Sample Date	Location		Water Elevation ft	Alkalinity as CaCO3 mg/l	Arsenic ug/l	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Total Dissolved Solids mg/l	pH s.u.	Conductivity umhos/cm	Redox Potential mV
2017-03	MW-1014C	Dup.		277	24.5	< 0.26	538	4.68	1650	221	650			
2017-03	MW-1014C		1113.29	269	24.0	< 0.26	520	4.53	1680	233	648	6.6	1021	60.1
2017-03	MW-1015A		1089.36	82.2	< 0.099	0.41	90.5	< 0.0100	7.5	8.1	122	6.82	192	137.4
2017-03	MW-1015B		1089.4	181	< 0.099	< 0.26	143	0.0822	30.6	1.7	266	7.51	597	112.1
2017-05	MW-1000PR		1092.78	216	6.6	10.3	397	0.59	2080	195	514	6.84	763	129.4
2017-05	MW-1000R		1095.33	85.7	< 0.099	13.2	134	< 0.0100	82.1	51.0	202	6.22	321	176.5
2017-05	MW-1002	Dup.		67.9	< 0.28	< 1.1	73.4	< 0.111	< 2.7	3.7	120			
2017-05	MW-1002		1098.47	68.9	< 0.28	< 1.1	75.9	< 0.111	< 2.7	3.7	122	6.7	161	137.1
2017-05	MW-1002G		1098.31	101	< 0.28	< 1.1	150	0.21	< 2.7	9.7	194	6.75	321	131.5
2017-05	MW-1004		1111.56	22.3	< 0.28	7.1	32.1	0.392	6.1	9.5	62.0	6.52	77	139.5
2017-05	MW-1004P		1109.34	169	0.34	< 1.1	151	0.484	180	2.9	200	7.44	310	95.1
2017-05	MW-1004S		1111.81	39.3	< 0.28	1.8	57.4	< 0.111	< 2.7	21.2	90.0	6.41	136	146.2
2017-05	MW-1005		1142.65	67.5	0.80	< 1.1	546	21	725	15.0	1410	6.33	1845	76.1
2017-05	MW-1005P		1142.95	255	< 0.28	< 1.1	229	1.37	80.4	< 1.0	254	7.05	463	17.1
2017-05	MW-1005S		1143.45	159	2.4	< 1.1	151	3.98	220	< 5.0	194	7.01	319	-68.9
2017-05	MW-1010P		1092.33	161	25.9	0.78	182	< 0.0100	51.9	34.2	212	7.52	354	138.6
2017-05	MW-1013		1116.16	610	0.24	12.5	547	3.47	26300	22.9	674	6.25	1075	79
2017-05	MW-1013A		1100.91	343	< 0.099	< 0.26	465	0.0754	4100	143	660	6.75	957	111
2017-05	MW-1013B		1101.51	548	0.84	412	2260	< 0.111	27400	1660	3110	6.26	3151	155.6
2017-05	MW-1013C		1105.86	445	22.1	< 0.26	2000	13.9	9920	1370	2860	6.57	3111	66.2
2017-05	MW-1014		1126.45	166	< 0.099	4.3	331	< 0.0100	1520	131	474	6.49	701	144.8
2017-05	MW-1014A		1122.69	450	0.50	5.0	1360	0.0190	462	851	1890	6.69	2225	141.3
2017-05	MW-1014B		1120.67	387	0.75	423	1700	0.0718	10200	1290	2470	6.48	2580	146.7
2017-05	MW-1014C	Dup.		272	27.1	< 1.1	554	4.7	1770	239	704			
2017-05	MW-1014C		1115.5	273	24.7	< 0.26	531	4.54	1690	243	692	6.83	1016	70.7
2017-05	MW-1015A		1093.4	80.7	< 0.28	< 1.1	91.3	< 0.111	6.9	7.7	124	7.03	194	128.4
2017-05	MW-1015B		1093.81	181	< 0.28	< 1.1	147	0.264	35.3	1.8	262	7.86	517	38.8
2017-06	MW-1000PR		1090.77	221	10.1	< 1.1	407	2.85	2220	172	546	7.04	760	51.9
2017-06	MW-1000R		1092.56	104	< 0.28	40.8	203	< 0.111	5410	107	340	6.58	503	101.5
2017-06	MW-1002	Dup.		74.1	< 0.28	< 1.1	77.2	< 0.111	< 2.7	4.3	116			
2017-06	MW-1002		1096.57	66.6	< 0.28	< 1.1	77.3	< 0.111	< 2.7	4.2	112	6.82	169	82.4
2017-06	MW-1002G		1096.43	103	< 0.28	< 1.1	143	< 0.111	< 2.7	9.7	214	6.41	313	97.6
2017-06	MW-1004		1110.37	29.0	< 0.28	5.9	37.7	0.265	5.3	11.9	68.0	6.22	86	106.7
2017-06	MW-1004P		1108.61	163	< 0.28	< 1.1	152	0.131	67.8	2.4	160	7.25	307	0.9
2017-06	MW-1004S		1110.48	39.8	< 0.28	1.6	62.5	< 0.111	3.2	23.3	106	6.1	141	90.1
2017-06	MW-1005		1142.29	64.9	1.1	< 1.1	586	24.3	788	16.1	1170	5.96	18.51	60.3
2017-06	MW-1005P		1142.34	251	< 0.28	< 1.1	235	1.52	64.3	< 1.0	258	7.03	469	3.2
2017-06	MW-1005S		1142.69	161	2.9	< 1.1	152	3.95	211	3.5	198	7.04	325	-44.6
2017-06	MW-1010P		1090.31	158	19.6	1.3	192	< 0.111	37.0	35.3	222	7.37	375	68.7
2017-06	MW-1013		1116.49	580	0.45	15.7	556	2.2	27400	21.8	706	6.02	1067	36.2
2017-06	MW-1013A		1101.11	364	< 0.28	< 1.1	463	< 0.111	3970	204	644	6.42	986	95
2017-06	MW-1013B		1101.75	573	0.62	475	2100	< 0.111	29900	1740	3040	6.17	3174	110
2017-06	MW-1013C		1105.12	469	21.9	< 1.1	2030	13.9	9730	1670	2880	6.37	2921	43.7
2017-06	MW-1014		1127.05	166	< 0.28	7.3	323	< 0.111	1730	130	504	6.82	680	96.7
2017-06	MW-1014A		1123.26	491	0.41	2.3	1350	< 0.111	90.2	1050	1900	6.78	2182	112.5
2017-06	MW-1014B		1120.86	525	1.0	503	1910	< 0.111	11700	1490	2690	6.62	2943	128.1
2017-06	MW-1014C	Dup.		273	25.2	< 1.1	542	4.66	1650	224	698			
2017-06	MW-1014C		1115.33	279	25.2	< 1.1	557	4.74	1740	215	718	7.28	1026	41.9
2017-06	MW-1015A		1091.56	79.9	< 0.28	< 1.1	91.8	< 0.111	6.2	8.0	130	7.01	192	85.9
2017-06	MW-1015B		1091.59	182	< 0.28	< 1.1	163	0.214	47.1	< 1.0	316	7.17	609	92
2017-10	MW-1000PR		1089.13	219	9.4	< 1.1	396	0.803	1970	192	502	6.41	780	82
2017-10	MW-1000R		1090.26	168	< 0.28	60.5	233	< 0.111	5820	47.5	318	6.06	492	155
2017-10	MW-1002	Dup.		63.7	< 0.28	< 1.1	69.4	< 0.111	< 2.7	3.1	106			
2017-10	MW-1002		1092.29	78.5	< 0.28	< 1.1	68.4	< 0.111	< 2.7	3.1	104	6.48	154	101.3
2017-10	MW-1002G		1092.2	108	< 0.28	< 1.1	148	< 0.111	< 2.7	10.8	204	6.56	327	107.2
2017-10	MW-1004		1108.67	39.7	< 0.28	4.1	55.0	< 0.111	2.9	20.1	80.0	6.16	121	108.2
2017-10	MW-1004P		1107.05	161	0.35	< 1.1	148	0.207	125	2.5	160	7.33	317	24.3
2017-10	MW-1004S		1108.73	45.4	< 0.28	1.6	58.1	< 0.111	4.1	23.5	92.0	6.2	138	95.2
2017-10	MW-1005		1141.39	79.7	1.5	< 1.1	652	21.8	803	17.7	1540	5.83	2001	81.4
2017-10	MW-1005P		1140.79	254	< 0.28	< 1.1	226	1.59	64.2	< 1.0	250	7.07	469	18.1
2017-10	MW-1005S		1141.24	152	2.2	< 1.1	145	3.59	198	3.8	184	7.05	313	-53.3
2017-10	MW-1010P		1088.78	159	21.0	< 1.1	175	< 0.111	62.1	30.1	196	7.42	357	76.9
2017-10	MW-1013		1115.12	626	0.85	4.3	572	13.1	28200	14.7	718	6.14	1101	48.1
2017-10	MW-1013A		1099.86	368	< 0.28	< 1.1	385	< 0.111	3130	214	654	6.67	949	74.6
2017-10	MW-1013B		1100.32	596	0.47	450	2140	< 0.111	31100	1740	3140	6.23	3181	138.1
2017-10	MW-1013C		1103.13	543	22.5	< 1.1	2000	13.6	8910	1570	2960	6.45	3080	70.1
2017-10	MW-1014		1125.5	200	< 0.28	4.0	334	< 0.111	866	144	492	6.36	731	121.7
2017-10	MW-1014A		1122.6	439	0.92	5.9	1340	< 0.111	444	953	1840	6.53	2206	123.2
2017-10	MW-1014B		1118.64	502	1.3	422	1820	< 0.111	11400	1350	2550	6.36	2766	140.2
2017-10	MW-1014C	Dup.		273	22.1	< 1.1	518	4.42	1530	225	666			
2017-10	MW-1014C		1113.06	264	23.1	< 1.1	534	4.53	1610	232	706	6.6	1029	62.8
2017-10	MW-1015A		1089.15	84.7	< 0.28	< 1.1	89.6	< 0.111	7.6	8.1	126	7.02	193	62.4
2017-10	MW-1015B		1089	185	< 0.28	< 1.1	163	0.196	46.9	< 1.0	280	7.64	593	38.8

Attachment 2

Statistical Results

Trend Graphs

Historical Data

(Groundwater - Annual Parameters)

Trend Analysis Results - Groundwater (Annual Parameters)
Year Ending 2017

	Barium	Cadmium	Calcium	Chloride	Chromium	Lead	Magnesium	Mercury	Potassium	Selenium	Silver	Sodium	Zinc
MW-1000PR													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-6	-5	-4	-8	1	2	-4	0	-2	7	-4	-7	-6
p-Level	0.234	0.359	0.484	0.084	1.000	0.816	0.484	1.000	0.816	0.159	0.484	0.159	0.234
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	23	23	23	17	23	23	23	23	15	23	23	14	31
Mann-Kendall S	-58	32	-208	35	25	34	-208	18	2	45	-3	-23	-294
p-Level	0.133	0.417	0.000	0.164	0.530	0.388	0.000	0.657	0.961	0.248	0.958	0.234	0.000
Trend			-				-						-
MW-1000R													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	6	3	-2	4	-6	0	-2	0	0	4	-4	-2	-2
p-Level	0.234	0.65	0.816	0.484	0.234	1	0.816	1	1	0.484	0.484	0.816	0.816
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	7	7	7	7	7	7	7	7	7	7	7	6	7
Mann-Kendall S	5	7	-3	7	2	-4	-5	-4	-3	6	-7	1	0
p-Level	0.562	0.382	0.772	0.382	0.886	0.667	0.562	0.667	0.772	0.472	0.382	1	1
Trend													
MW-1010P													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-4	0	-1	-1	0	-4	1	0	1	0	-4	-7	-3
p-Level	0.484	1.000	1.000	1.000	1.000	0.484	1.000	1.000	1.000	1.000	0.484	0.159	0.650
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	23	23	23	17	23	23	23	23	15	23	23	14	31
Mann-Kendall S	100	-20	159	86	-8	17	164	0	21	-19	1	-53	75
p-Level	0.008	0.620	0.000	0.000	0.855	0.676	0.000	1.000	0.328	0.638	1.000	0.004	0.210
Trend	+		+	+			+						-
MW-1002													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-3	0	-2	-2	2	0	0	0	0	0	0	2	0
p-Level	0.650	1.000	0.816	0.816	0.816	1.000	1.000	1.000	1.000	1.000	1.000	0.816	1.000
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	19	19	18	14	19	19	18	19	14	19	19	13	29
Mann-Kendall S	32	-18	38	59	-2	8	43	0	29	0	0	36	0
p-Level	0.282	0.557	0.164	0.000	0.973	0.809	0.112	1.000	0.126	1.000	1.000	0.030	1.000
Trend				+									
MW-1002G													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	4	0	4	9	-1	0	5	0	0	0	0	8	0
p-Level	0.484	1.000	0.484	0.050	1.000	1.000	0.359	1.000	1.000	1.000	1.000	0.084	1.000
Trend				+									
Trend Results for All Data Since Oct. 1997													
Sample Size	19	19	18	14	19	19	18	19	14	19	19	13	29
Mann-Kendall S	107	-18	77	81	5	0	78	0	16	-25	0	52	-18
p-Level	0.000	0.557	0.002	0.000	0.890	1.000	0.002	1.000	0.419	0.406	1.000	0.000	0.752
Trend	+		+	+			+					+	

**Trend Analysis Results - Groundwater (Annual Parameters)
Year Ending 2017**

	Barium	Cadmium	Calcium	Chloride	Chromium	Lead	Magnesium	Mercury	Potassium	Selenium	Silver	Sodium	Zinc
MW-1004													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	4	0	-4	5	5	2	-4	0	5	2	-4	-8	2
p-Level	0.484	1	0.484	0.359	0.359	0.816	0.484	1	0.359	0.816	0.484	0.084	0.816
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	7	7	7	7	7	7	7	7	7	7	7	6	7
Mann-Kendall S	4	0	-12	9	-4	4	-13	0	2	4	-2	-13	4
p-Level	0.667	1	0.103	0.238	0.667	0.667	0.07	1	0.886	0.667	0.886	0.016	0.667
Trend													
MW-1004S													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-6	0	-6	-8	6	-4	-6	0	-4	2	0	-8	0
p-Level	0.234	1.000	0.234	0.084	0.234	0.484	0.234	1.000	0.484	0.816	1.000	0.084	1.000
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	21	21	21	15	21	21	21	21	15	21	21	14	30
Mann-Kendall S	69	-18	75	-42	9	25	68	0	-17	5	0	-37	0
p-Level	0.039	0.612	0.024	0.041	0.811	0.474	0.042	1.000	0.436	0.905	1.000	0.048	1.000
Trend													
MW-1004P													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-8	0	4	5	0	0	1	0	0	0	0	-1	0
p-Level	0.084	1.000	0.484	0.359	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	21	21	21	15	21	21	21	21	15	21	21	14	30
Mann-Kendall S	64	-11	54	17	-39	0	37	0	18	5	0	-9	7
p-Level	0.056	0.765	0.110	0.436	0.255	1.000	0.281	1.000	0.408	0.905	1.000	0.668	0.916
Trend													
MW-1005													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	8	2	8	8	-5	0	8	0	6	0	0	8	2
p-Level	0.084	0.816	0.084	0.084	0.359	1.000	0.084	1.000	0.234	1.000	1.000	0.084	0.816
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	19	19	18	14	19	19	18	19	14	19	19	13	29
Mann-Kendall S	66	18	41	43	-45	11	46	0	49	0	-6	55	26
p-Level	0.022	0.557	0.132	0.020	0.124	0.730	0.089	1.000	0.006	1.000	0.863	0.000	0.642
Trend									+			+	
MW-1005S													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-8	4	-6	3	2	4	-7	0	-2	4	4	-9	0
p-Level	0.084	0.484	0.234	0.650	0.816	0.484	0.159	1.000	0.816	0.484	0.484	0.050	1.000
Trend												-	
Trend Results for All Data Since Oct. 1997													
Sample Size	19	19	18	14	19	19	18	19	14	19	19	13	29
Mann-Kendall S	30	18	12	19	-3	25	22	0	-3	3	17	-34	0
p-Level	0.315	0.557	0.681	0.330	0.946	0.406	0.432	1.000	0.914	0.946	0.580	0.042	1.000
Trend													

**Trend Analysis Results - Groundwater (Annual Parameters)
Year Ending 2017**

	Barium	Cadmium	Calcium	Chloride	Chromium	Lead	Magnesium	Mercury	Potassium	Selenium	Silver	Sodium	Zinc
MW-1005P													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-5	0	-1	-10	0	-3	9	0	8	0	0	-8	0
p-Level	0.359	1.000	1.000	0.016	1.000	0.650	0.050	1.000	0.084	1.000	1.000	0.084	1.000
Trend				-			+						
Trend Results for All Data Since Oct. 1997													
Sample Size	19	19	19	14	19	19	19	19	14	19	19	13	29
Mann-Kendall S	24	-23	10	30	-14	32	41	0	24	0	0	25	4
p-Level	0.426	0.446	0.756	0.113	0.653	0.282	0.164	1.000	0.213	1.000	1.000	0.146	0.956
Trend													
MW-1015A													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-7	0	-2	-7	2	0	0	0	-10	0	0	-6	0
p-Level	0.159	1.000	0.816	0.159	0.816	1.000	1.000	1.000	0.016	1.000	1.000	0.234	1.000
Trend									-				
Trend Results for All Data Since Oct. 1997													
Sample Size	28	28	18	13	28	28	18	28	13	28	28	12	33
Mann-Kendall S	-318	25	16	20	25	36	43	0	-38	17	-19	7	0
p-Level	0.000	0.638	0.575	0.252	0.638	0.492	0.112	1.000	0.022	0.755	0.725	0.688	1.000
Trend	-												
MW-1015B													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-2	0	3	8	2	0	2	0	2	0	0	-1	0
p-Level	0.816	1.000	0.650	0.084	0.816	1.000	0.816	1.000	0.816	1.000	1.000	1.000	1.000
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	28	28	18	13	28	28	18	28	13	28	28	12	33
Mann-Kendall S	-13	0	80	19	31	25	101	0	21	9	0	39	0
p-Level	0.815	1.000	0.002	0.279	0.557	0.638	0.000	1.000	0.228	0.876	1.000	0.007	1.000
Trend			+				+					+	
MW-1013													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-8	0	-6	-6	5	-4	-2	0	-2	5	-4	-7	0
p-Level	0.084	1.000	0.234	0.234	0.359	0.484	0.816	1.000	0.816	0.359	0.484	0.159	1.000
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	13	13	13	13	13	13	13	13	12	13	13	11	13
Mann-Kendall S	-14	3	9	-56	37	-25	26	0	6	13	5	-17	8
p-Level	0.436	0.905	0.633	0.000	0.026	0.146	0.128	1.048	0.738	0.473	0.812	0.218	0.676
Trend				-									
MW-1013A													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-8	0	-5	0	0	0	-6	0	-2	0	-4	4	0
p-Level	0.084	1.000	0.359	1.000	1.000	1.000	0.234	1.000	0.816	1.000	0.484	0.484	1.000
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	13	13	13	13	13	13	13	13	12	13	13	11	13
Mann-Kendall S	-12	0	-4	-1	8	-11	0	0	15	0	-3	-1	-12
p-Level	0.510	1.048	0.858	1.000	0.676	0.550	1.048	1.048	0.345	1.048	0.905	1.000	0.510
Trend													

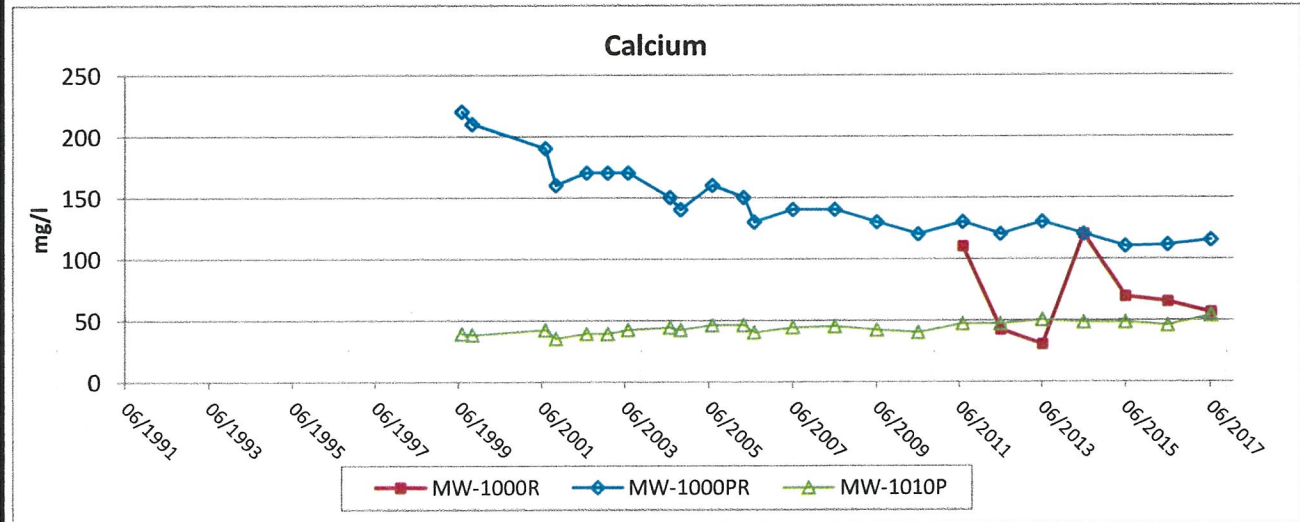
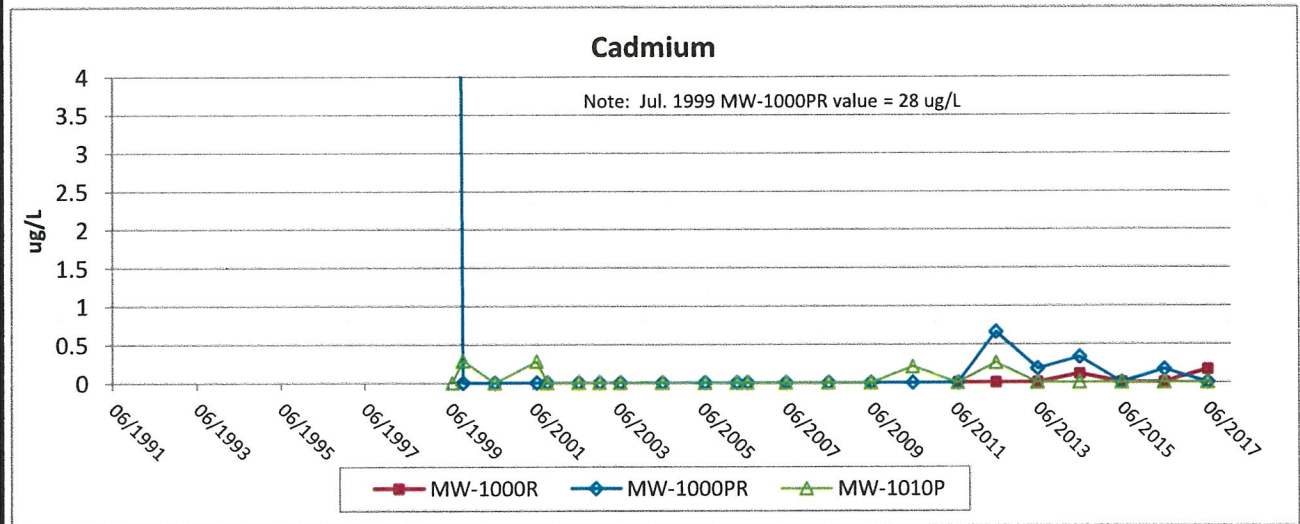
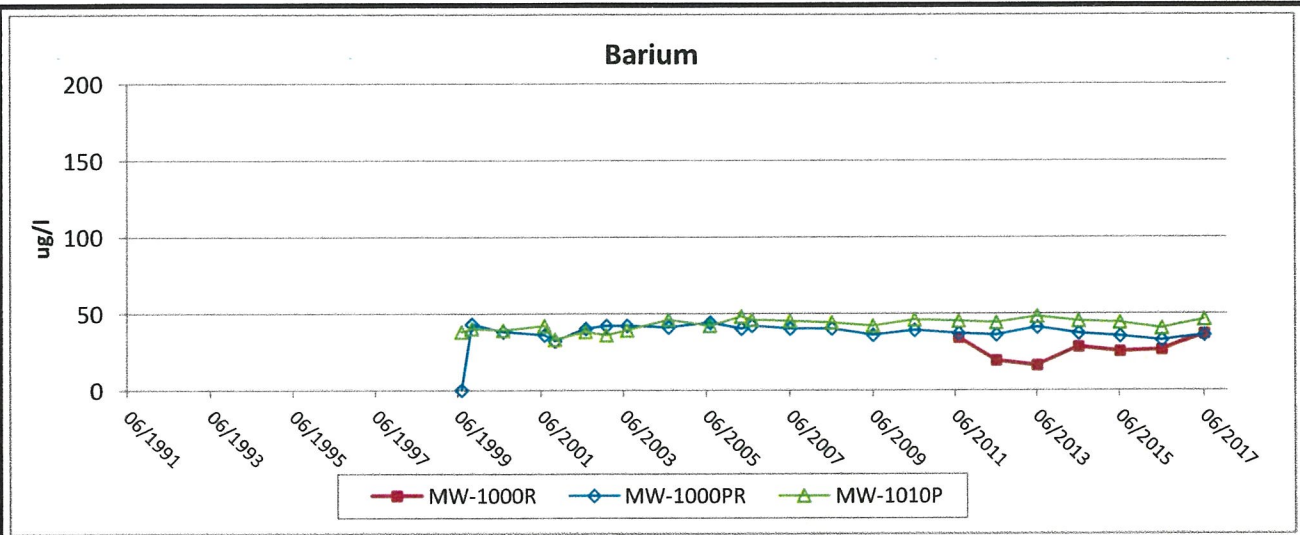
**Trend Analysis Results - Groundwater (Annual Parameters)
Year Ending 2017**

	Barium	Cadmium	Calcium	Chloride	Chromium	Lead	Magnesium	Mercury	Potassium	Selenium	Silver	Sodium	Zinc
MW-1013B													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-3	2	-3	-4	3	-4	-3	0	-4	5	-4	-3	-3
p-Level	0.650	0.816	0.650	0.484	0.650	0.484	0.650	1.000	0.484	0.359	0.484	0.650	0.650
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	25	25	26	20	25	25	26	25	18	25	25	17	33
Mann-Kendall S	116	54	-47	38	-66	40	-92	20	-28	19	-27	-50	267
p-Level	0.006	0.218	0.314	0.234	0.130	0.366	0.044	0.660	0.312	0.677	0.548	0.042	0.000
Trend	+												+
MW-1013C													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-6	0	-3	-6	0	-3	-7	0	-4	0	-4	-3	-2
p-Level	0.234	1.000	0.650	0.234	1.000	0.650	0.159	1.000	0.484	1.000	0.484	0.650	0.816
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	25	25	26	20	25	25	26	25	18	25	25	17	33
Mann-Kendall S	116	-15	-21	82	-23	64	-122	0	7	-23	-26	-59	-251
p-Level	0.006	0.746	0.662	0.008	0.611	0.142	0.007	1.000	0.822	0.611	0.564	0.016	0.000
Trend	+			+			-						-
MW-1014													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-2	2	3	4	2	0	4	0	2	0	-4	2	0
p-Level	0.816	0.816	0.650	0.484	0.816	1.000	0.484	1.000	0.816	1.000	0.484	0.816	1.000
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	13	13	13	13	13	13	13	13	12	13	13	11	13
Mann-Kendall S	13	3	-12	54	10	2	-5	0	-22	-2	-3	-20	0
p-Level	0.473	0.905	0.510	0.000	0.590	0.952	0.812	1.048	0.152	0.952	0.905	0.142	1.048
Trend				+									
MW-1014A													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-5	0	4	7	-1	-4	-2	0	0	2	-4	-8	0
p-Level	0.359	1.000	0.484	0.159	1.000	0.484	0.816	1.000	1.000	0.816	0.484	0.084	1.000
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	22	22	23	17	22	22	23	22	15	22	22	14	30
Mann-Kendall S	10	11	-70	-7	-1	17	-49	0	-13	17	-6	6	127
p-Level	0.802	0.780	0.068	0.808	1.000	0.656	0.208	1.000	0.558	0.656	0.890	0.789	0.024
Trend													
MW-1014B													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	-4	-5	-2	-4	-1	-3	-4	0	-3	7	-4	-2	2
p-Level	0.484	0.359	0.816	0.484	1.000	0.650	0.484	1.000	0.650	0.159	0.484	0.816	0.816
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	25	25	26	19	25	25	26	25	18	25	25	17	33
Mann-Kendall S	116	-168	-142	87	-3	70	-183	0	-29	-20	0	-64	-343
p-Level	0.006	0.000	0.002	0.002	0.963	0.108	0.000	1.000	0.294	0.660	1.000	0.008	0.000
Trend	+	-	-	+			-					-	-

**Trend Analysis Results - Groundwater (Annual Parameters)
Year Ending 2017**

	Barium	Cadmium	Calcium	Chloride	Chromium	Lead	Magnesium	Mercury	Potassium	Selenium	Silver	Sodium	Zinc
MW-1014C													
Trend Results for Most Recent 5 Years													
Sample Size	5	5	5	5	5	5	5	5	5	5	5	5	5
Mann-Kendall S	0	0	1	7	0	0	2	-2	-3	0	-4	2	-2
p-Level	1.000	1.000	1.000	0.159	1.000	1.000	0.816	0.816	0.650	1.000	0.484	0.816	0.816
Trend													
Trend Results for All Data Since Oct. 1997													
Sample Size	25	25	26	20	25	25	26	25	18	25	25	17	33
Mann-Kendall S	186	17	-250	135	-29	7	-259	18	-47	-43	3	-19	-504
p-Level	0.000	0.711	0.000	0.000	0.517	0.890	0.000	0.694	0.082	0.330	0.963	0.465	0.000
Trend	+		-	+			-						-

Notes: Overall increasing trend denoted by "+".
 Overall decreasing trend denoted by "-".
 Long term trend tests performed at a Type I (two-tailed) error rate of 0.01.
 5-Year Trend tests performed at a Type I (two-tailed) error rate of 0.05.
 N/A - No trend test performed due to insufficient data.



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Figure B-8a

Groundwater Trend Graphs - Annual Results
MW-1000R/MW-1000PR/MW-1010P

Scale: NA

Date: January 2018

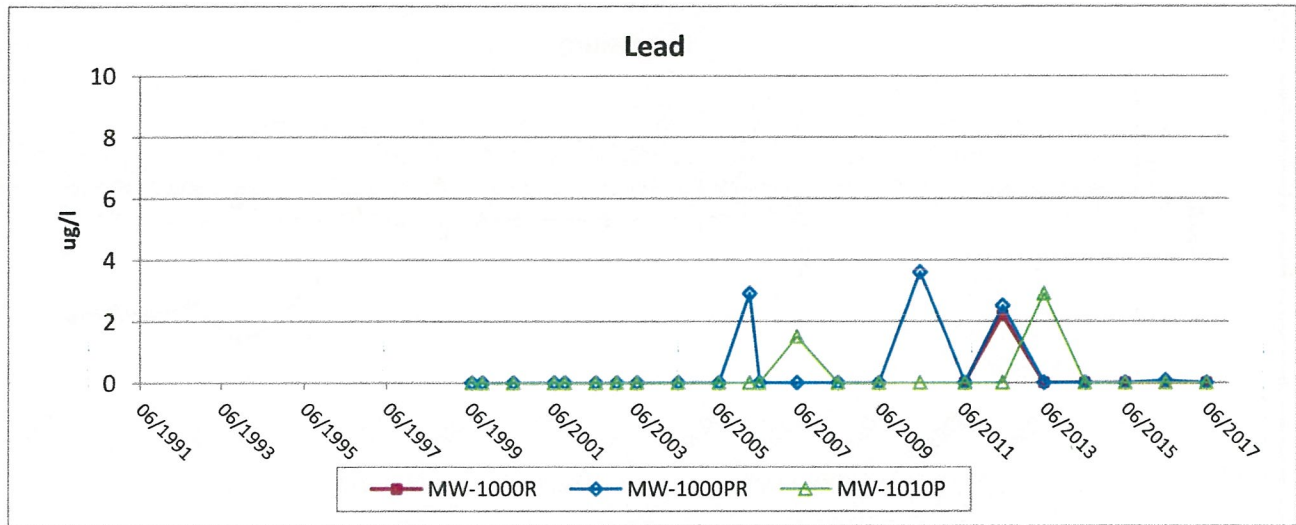
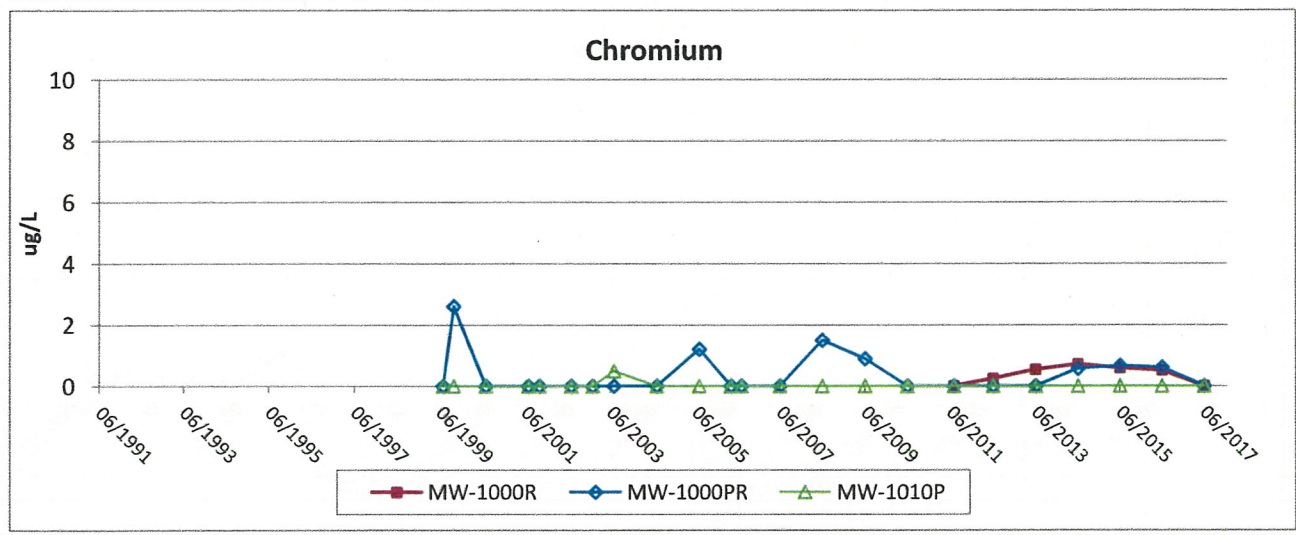
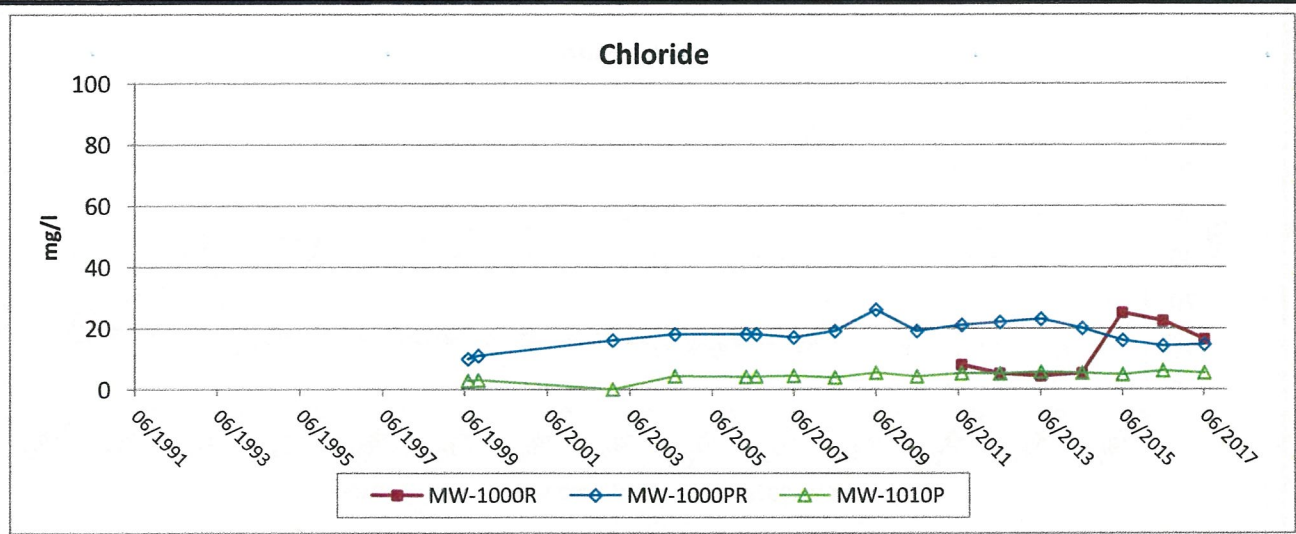
Prepared By: SGL

Checked By: SVF

Scope: 17F777-00

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Figure B-8b

Groundwater Trend Graphs - Annual Results
MW-1000R/MW-1000PR/MW-1010P

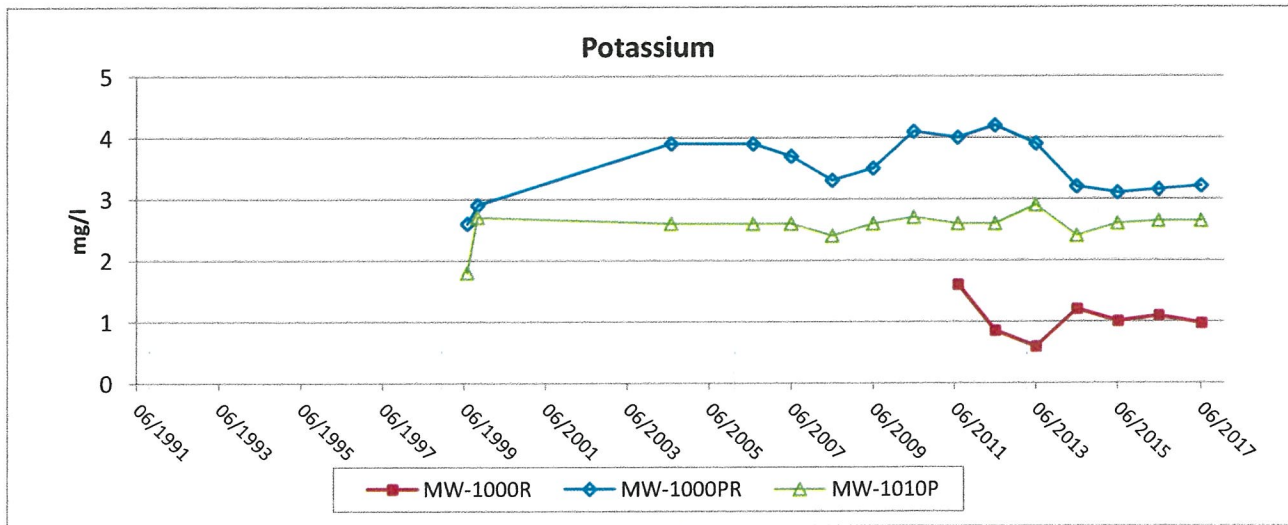
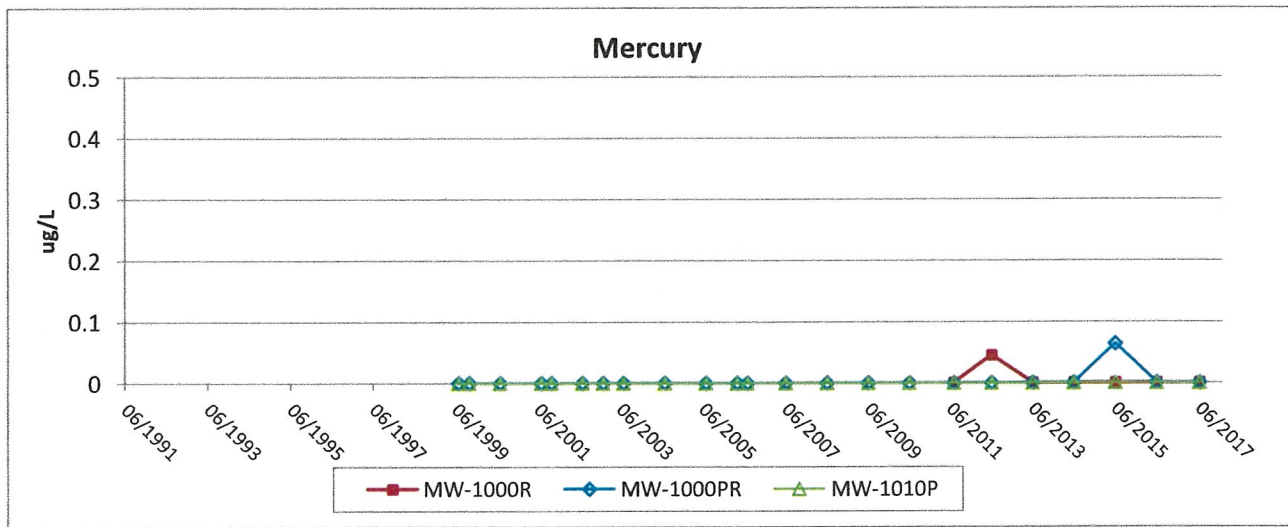
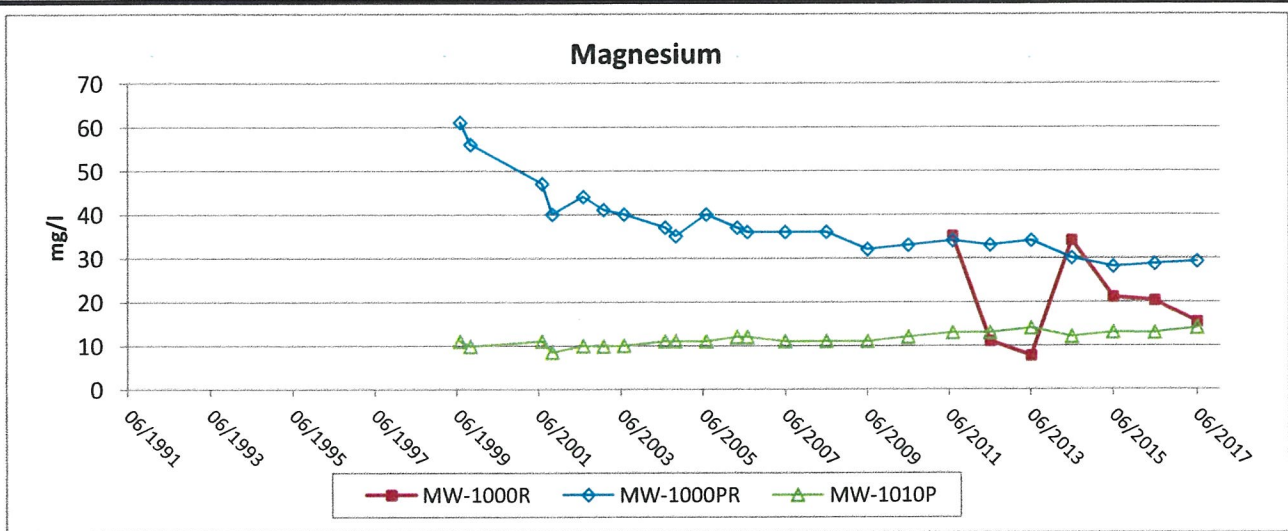
Scale: NA

Date: January 2018

Prepared By: SGL

Checked By: SVF

Scope: 17F777-00



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Figure B-8c

Groundwater Trend Graphs - Annual Results

MW-1000R/MW-1000PR/MW-1010P

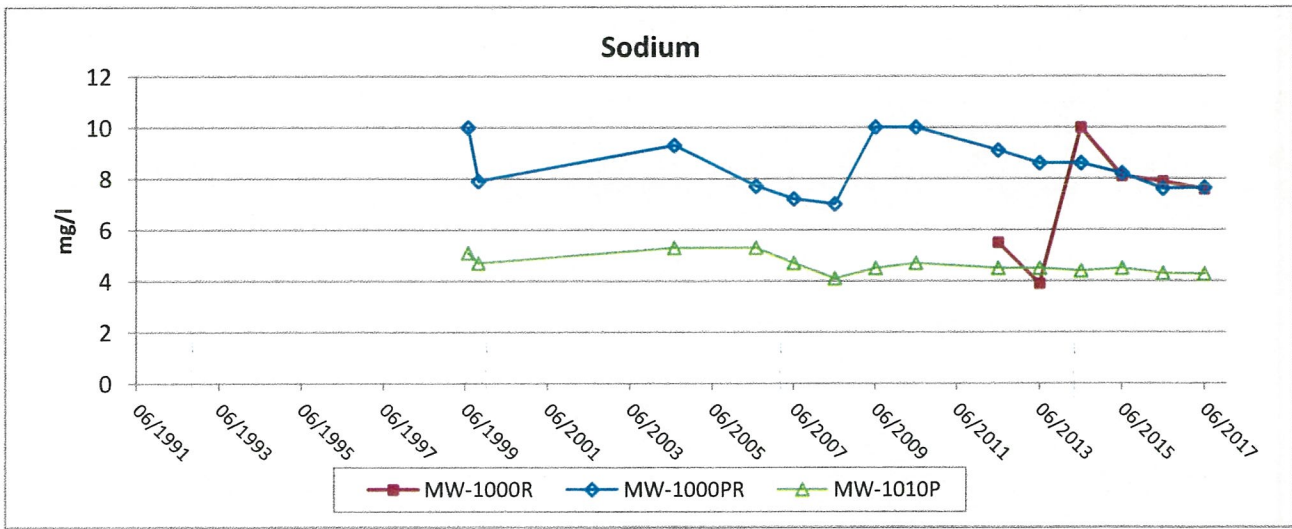
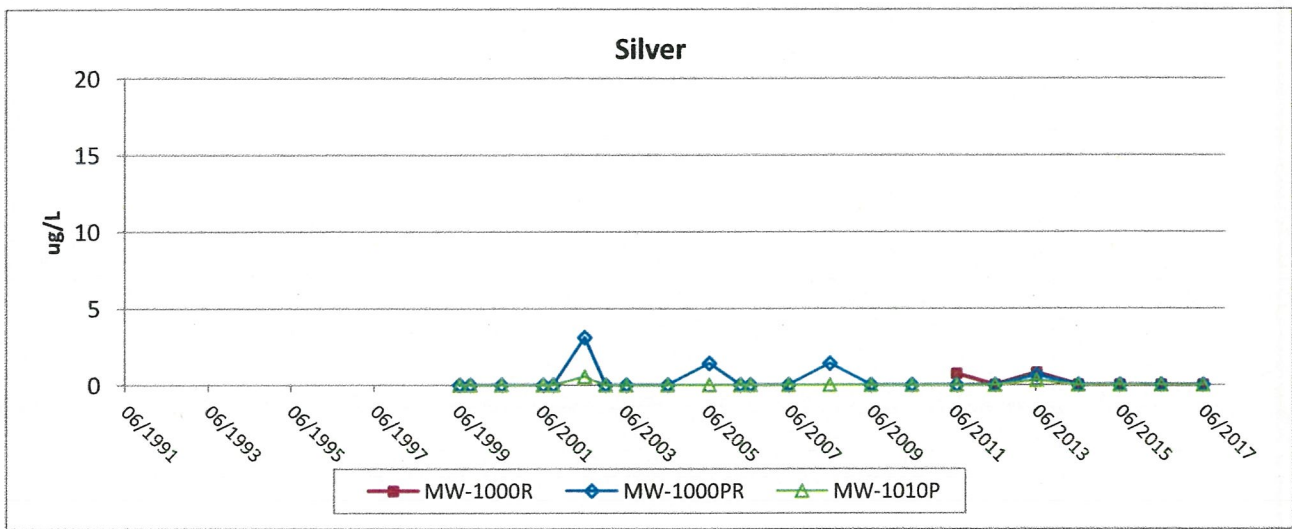
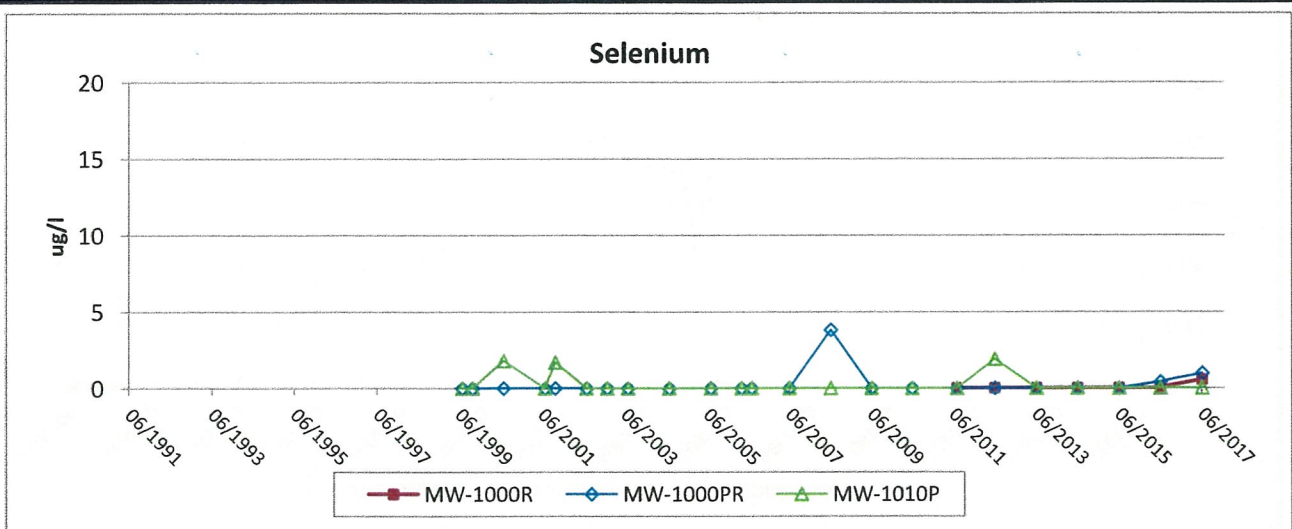
Scale: NA

Date: January 2018

Prepared By: SGL

Checked By: SVF

Scope: 17F777-00



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Figure B-8d

Groundwater Trend Graphs - Annual Results
MW-1000R/MW-1000PR/MW-1010P

Scale: NA

Date: January 2018

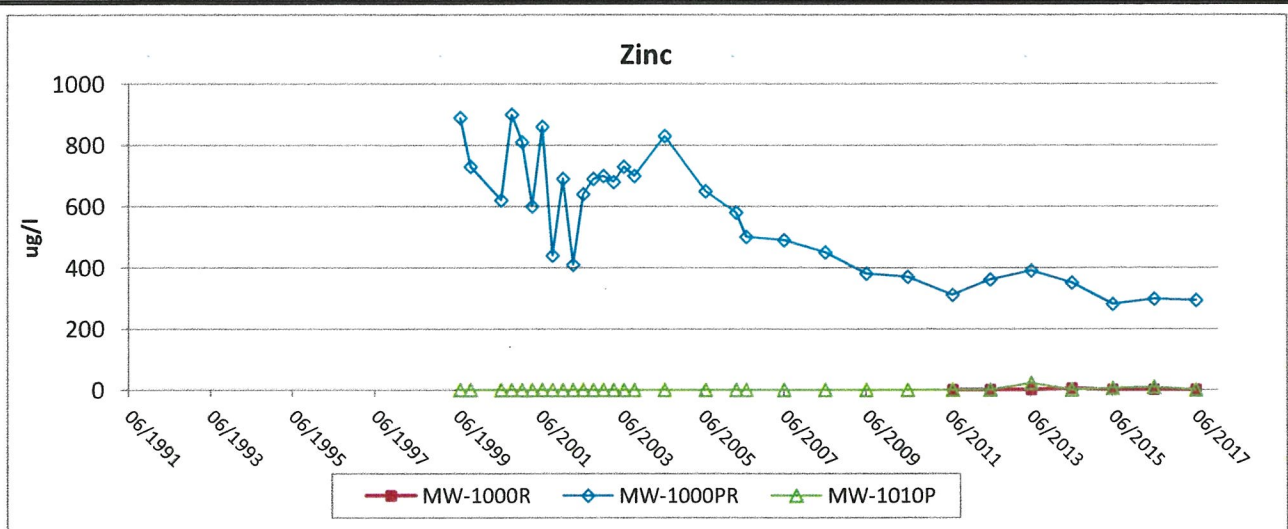
Prepared By: SGL


Checked By: SVF

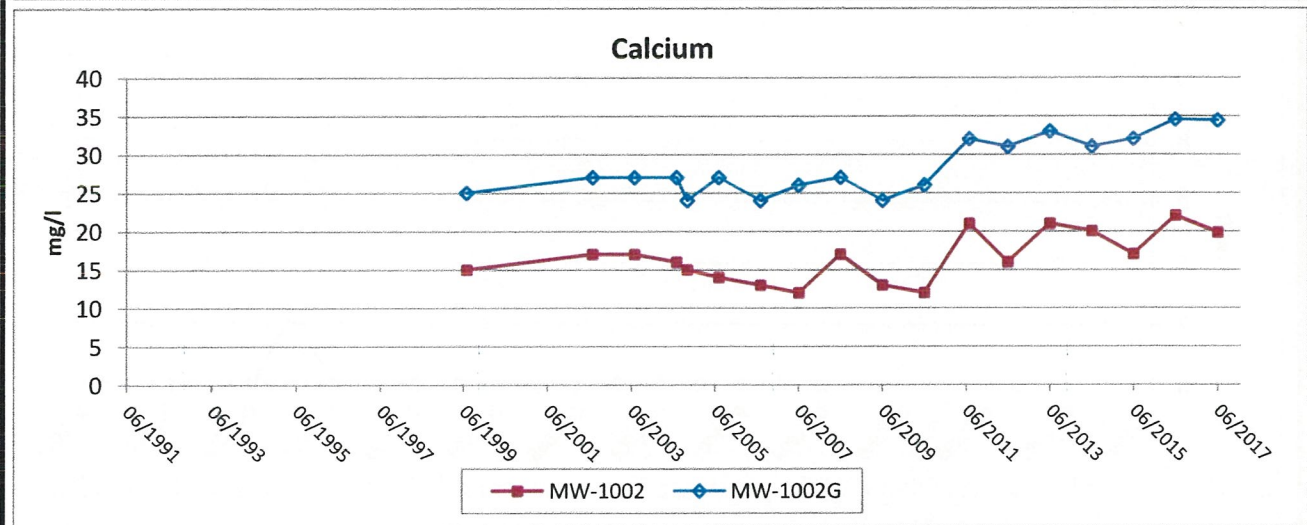
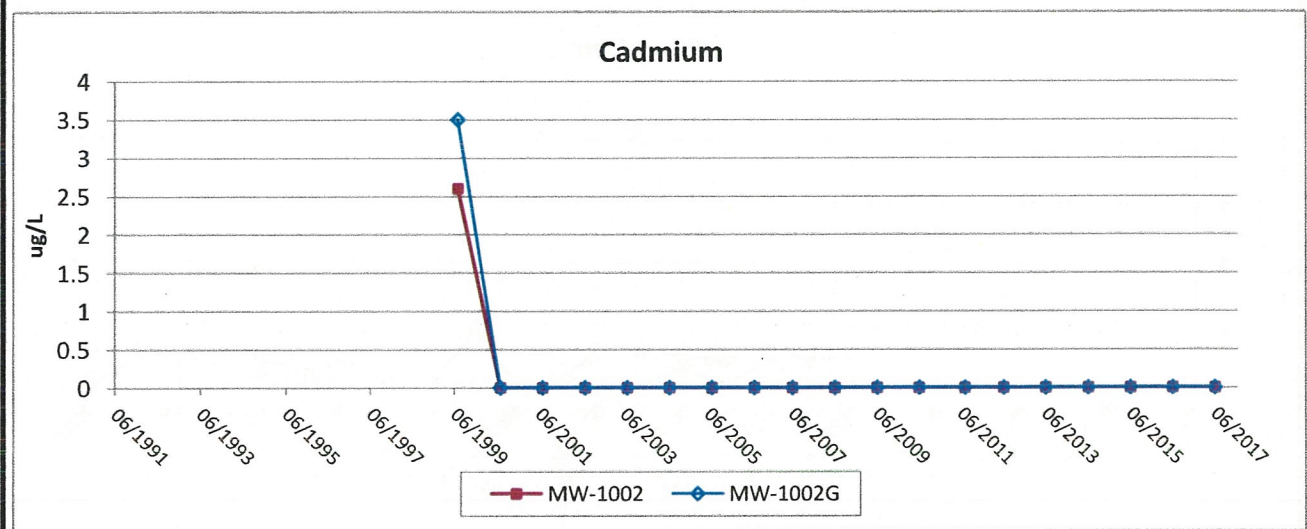
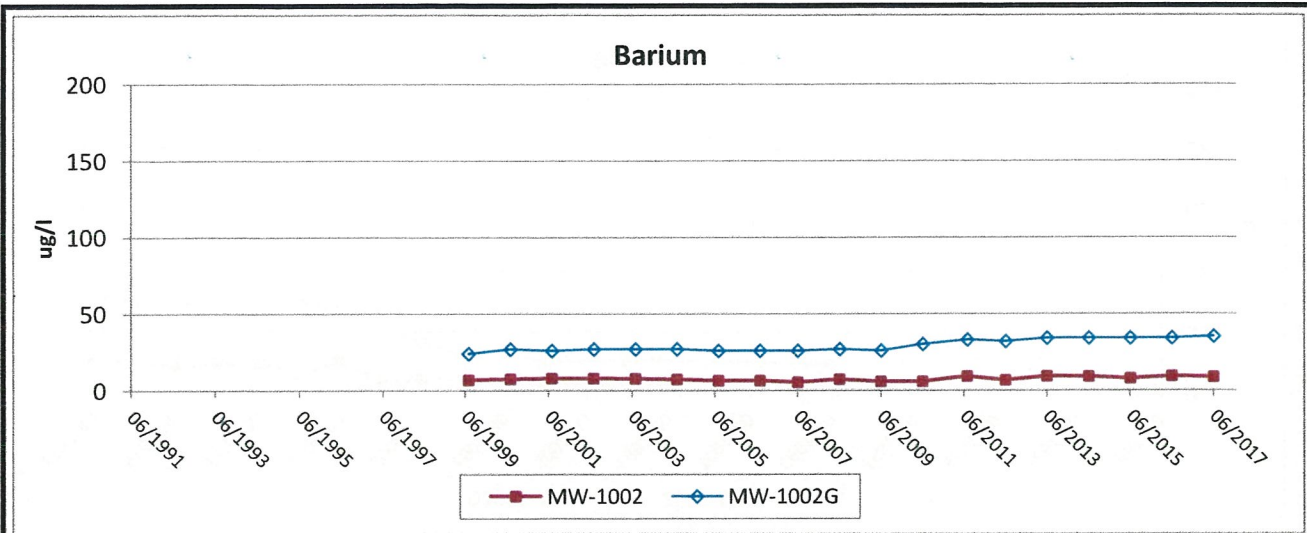
Scope: 17F777-00

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Figure B-8e		
Groundwater Trend Graphs - Annual Results		
MW-1000R/MW-1000PR/MW-1010P		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00



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Figure B-9a

Groundwater Trend Graphs - Annual Results
MW-1002/MW-1002G

Scale: NA

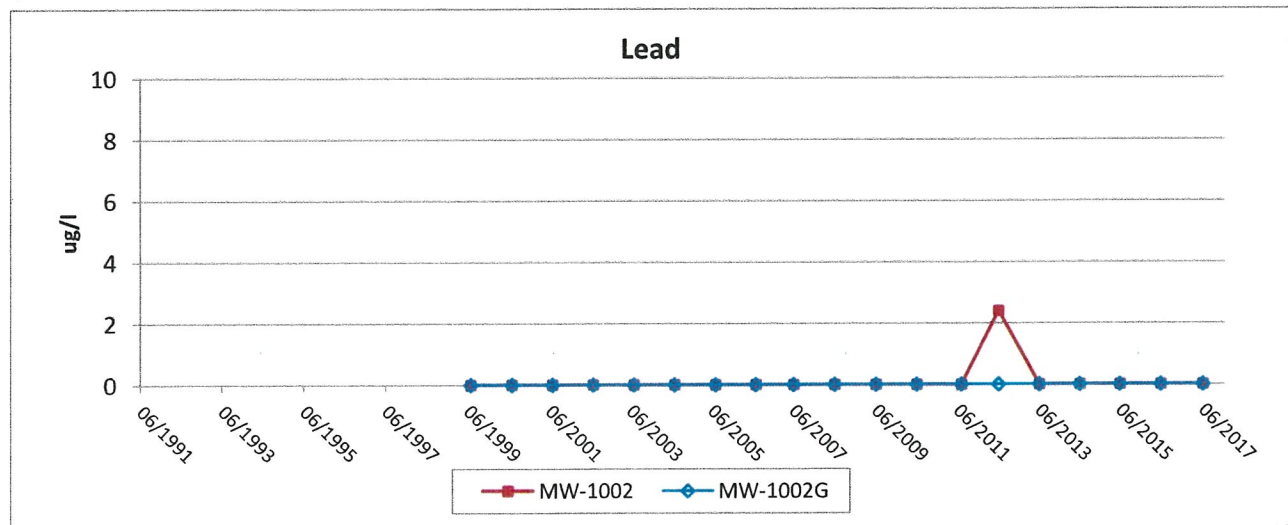
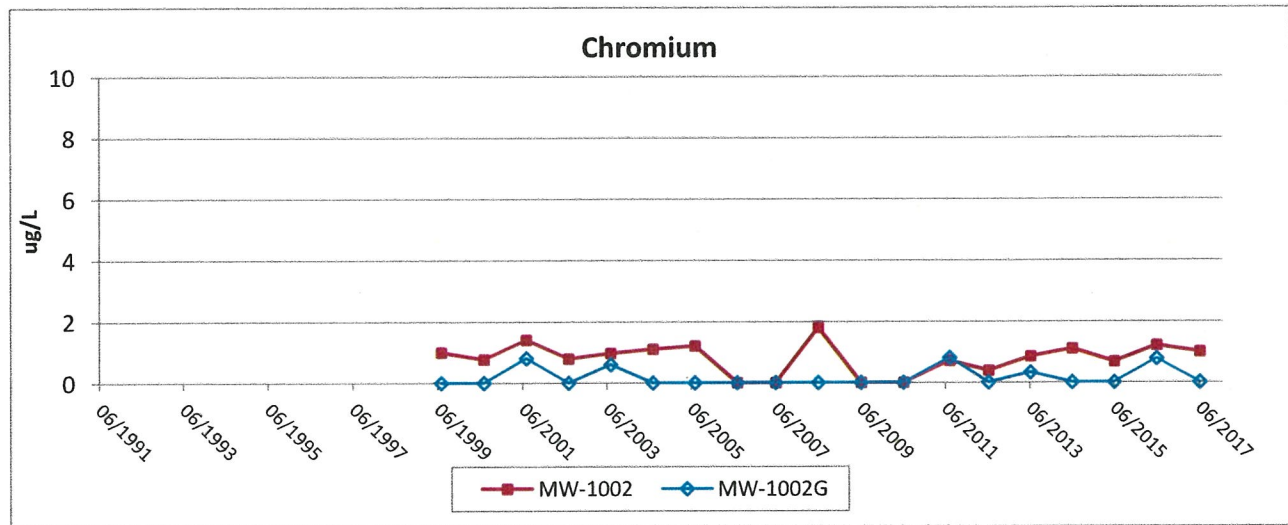
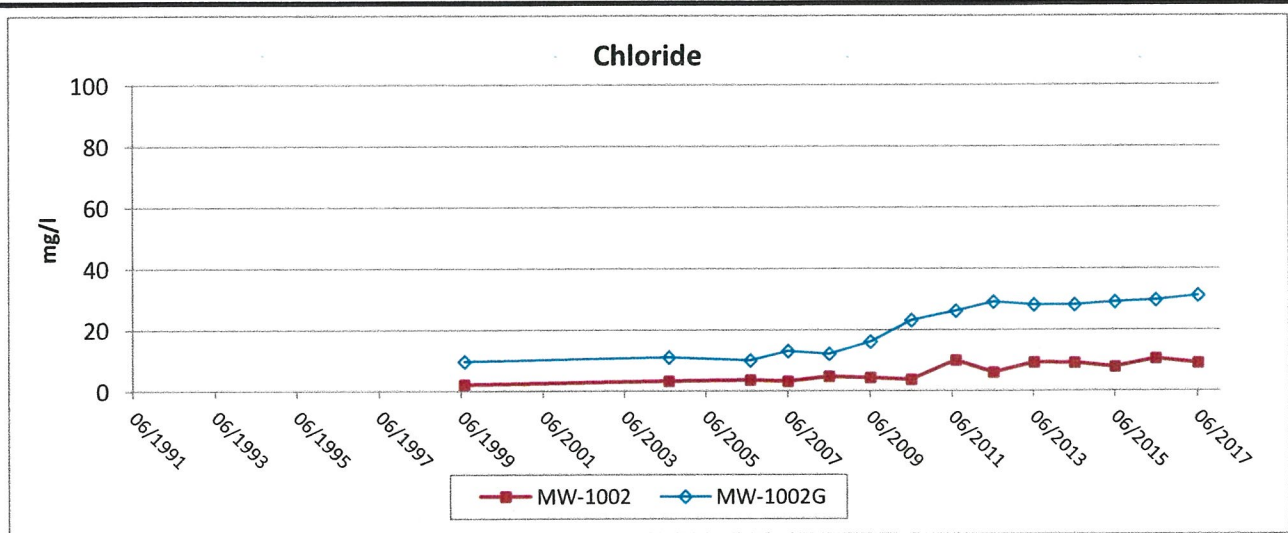
Date: January 2018


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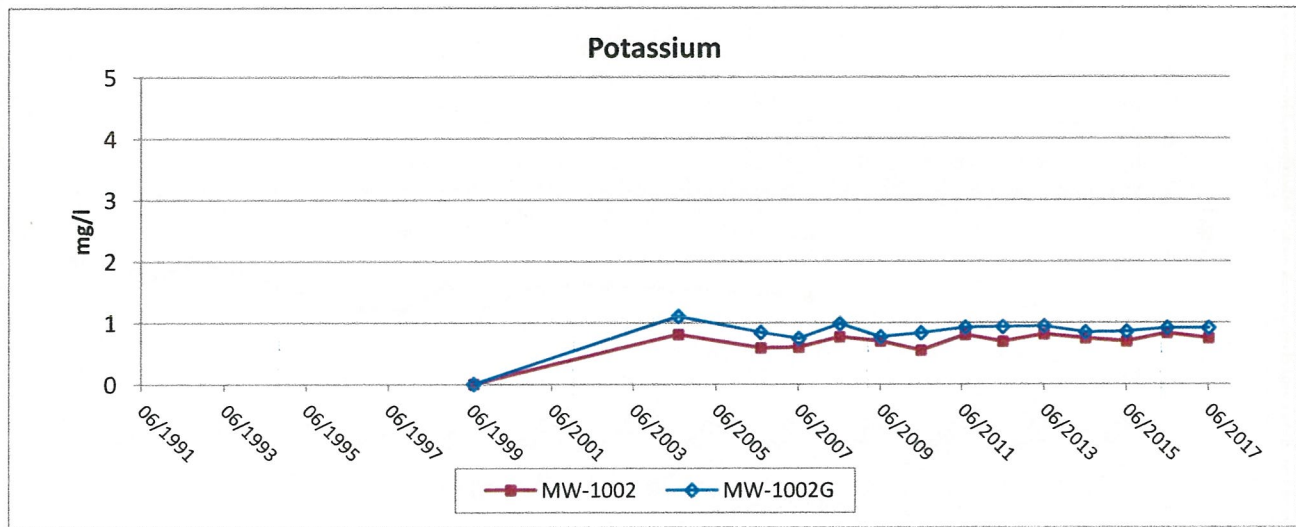
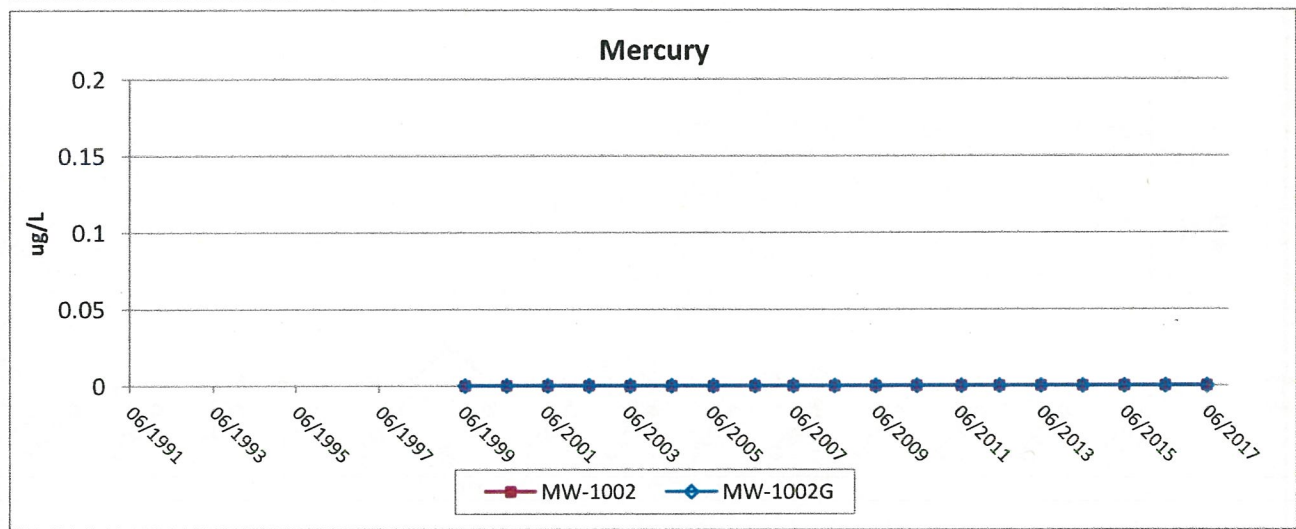
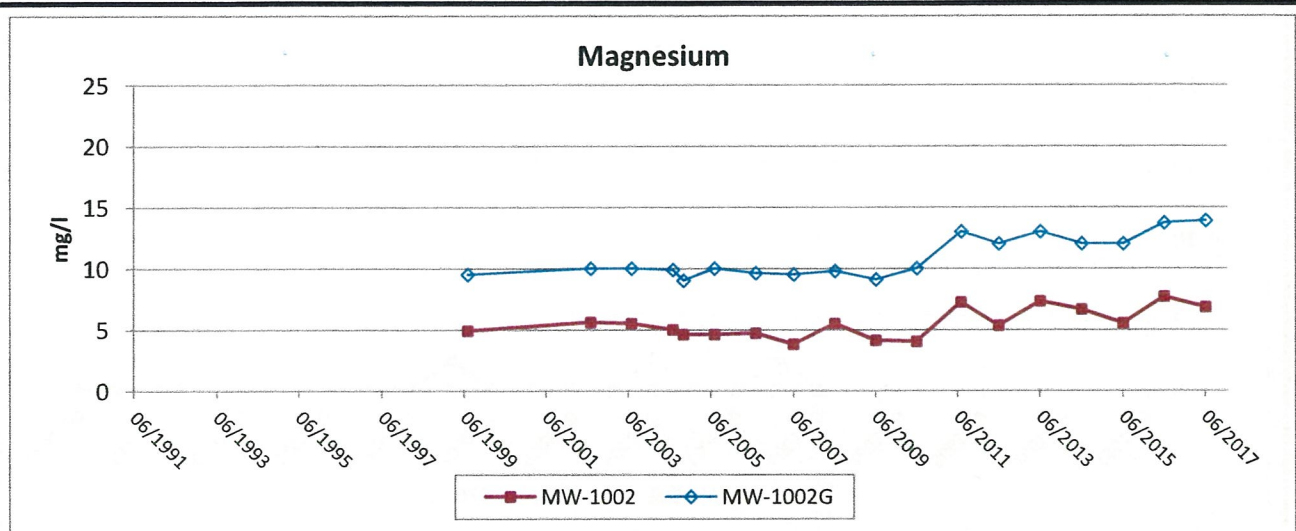
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Figure B-9b

Groundwater Trend Graphs - Annual Results

MW-1002/MW-1002G

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
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Figure B-9c

Groundwater Trend Graphs - Annual Results

MW-1002/MW-1002G

Scale: NA

Date: January 2018

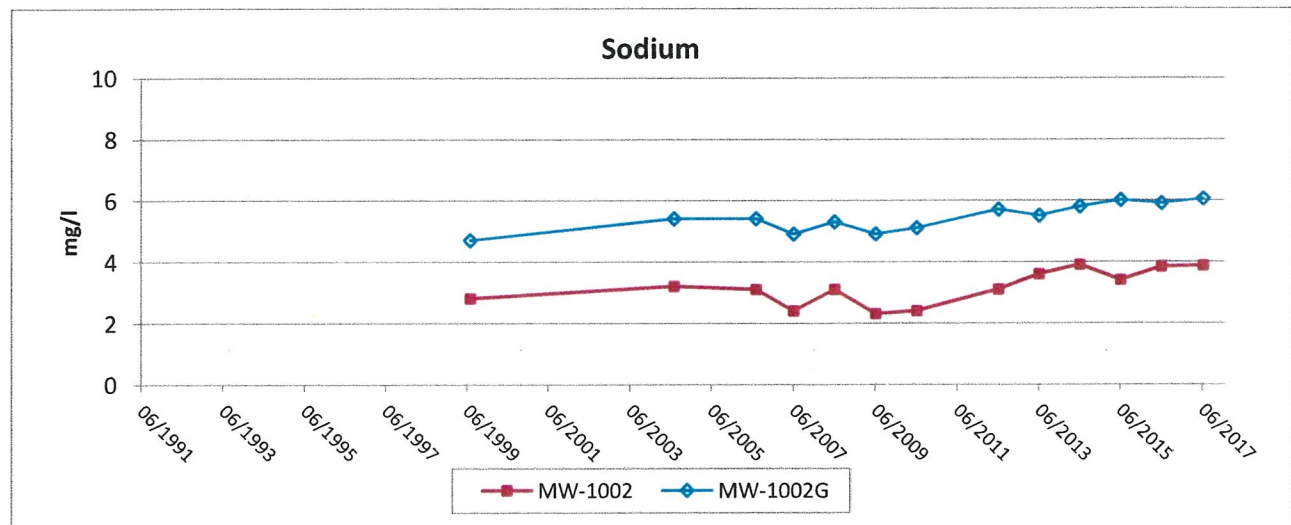
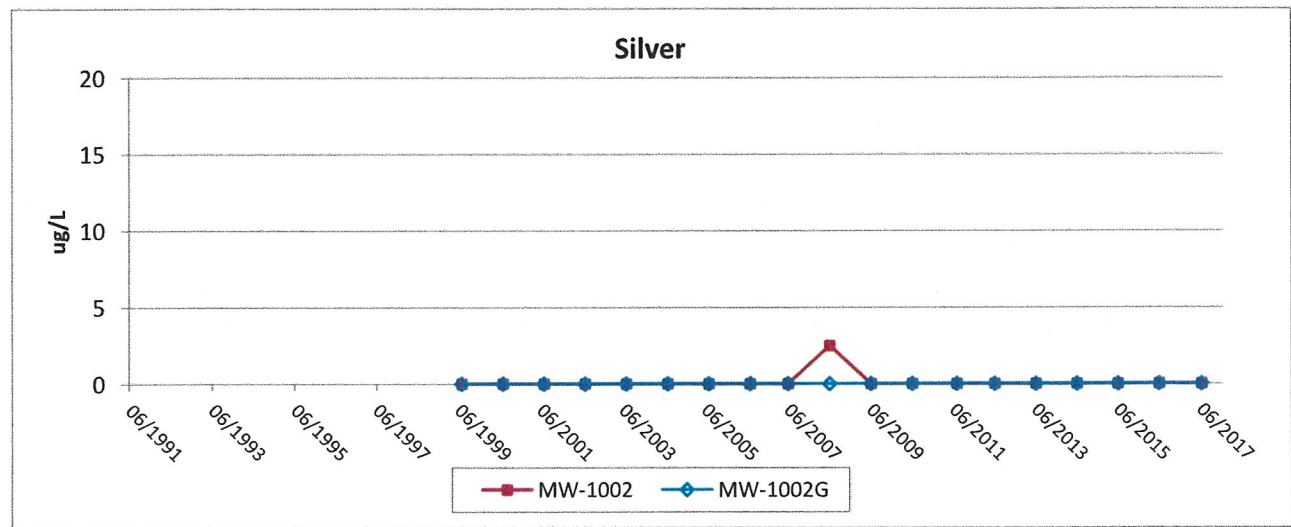
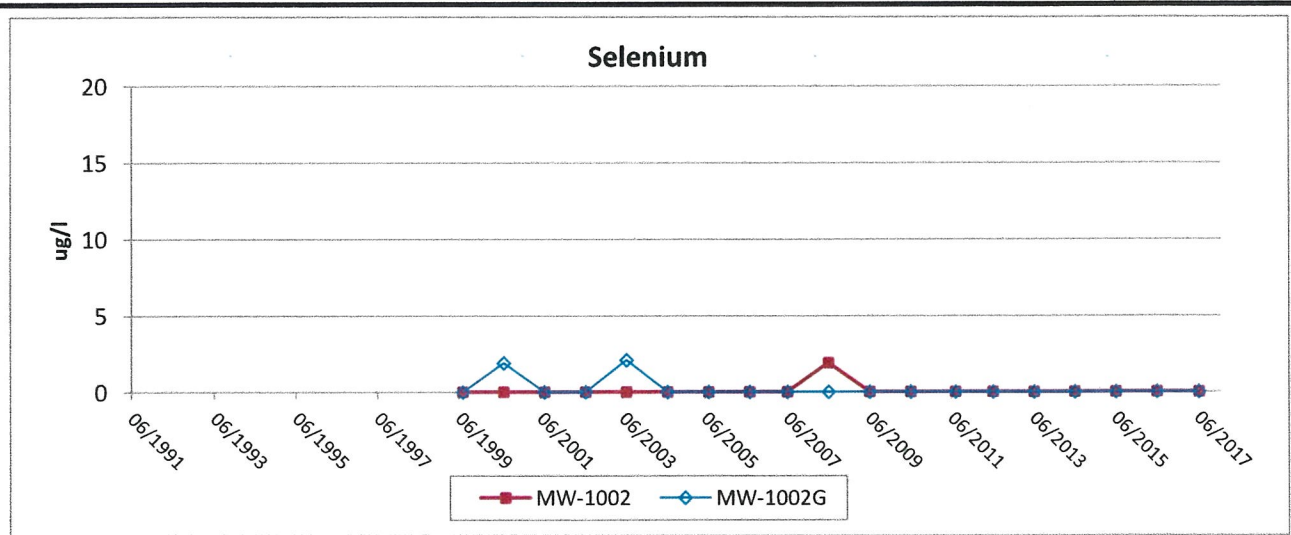
Prepared By: SGL


Checked By: SVF

Scope: 17F777-00

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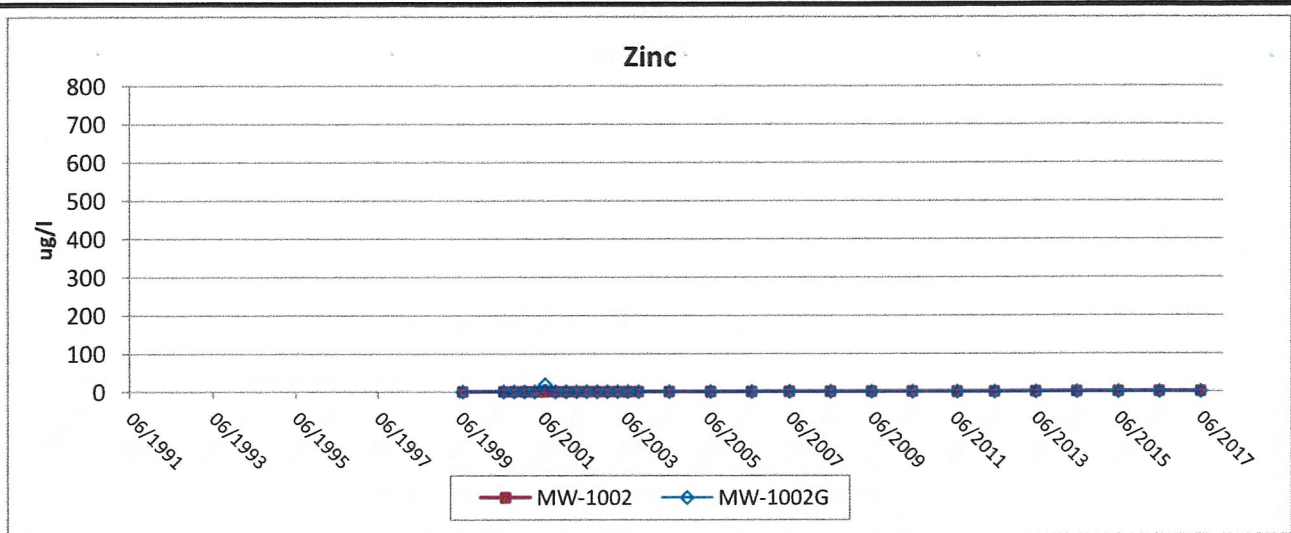
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Figure B-9d

Groundwater Trend Graphs - Annual Results

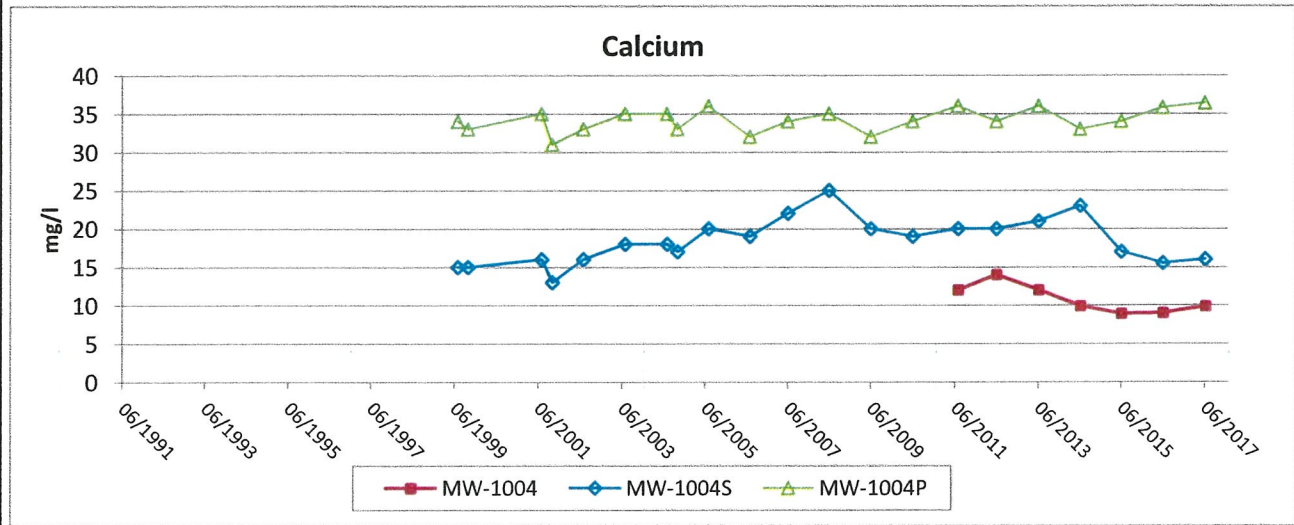
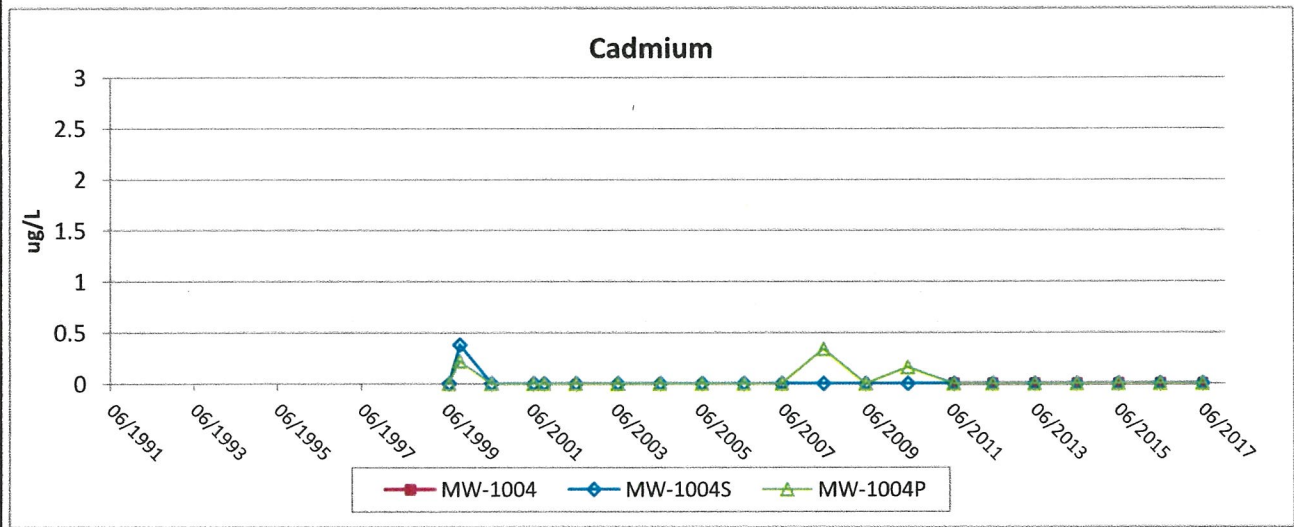
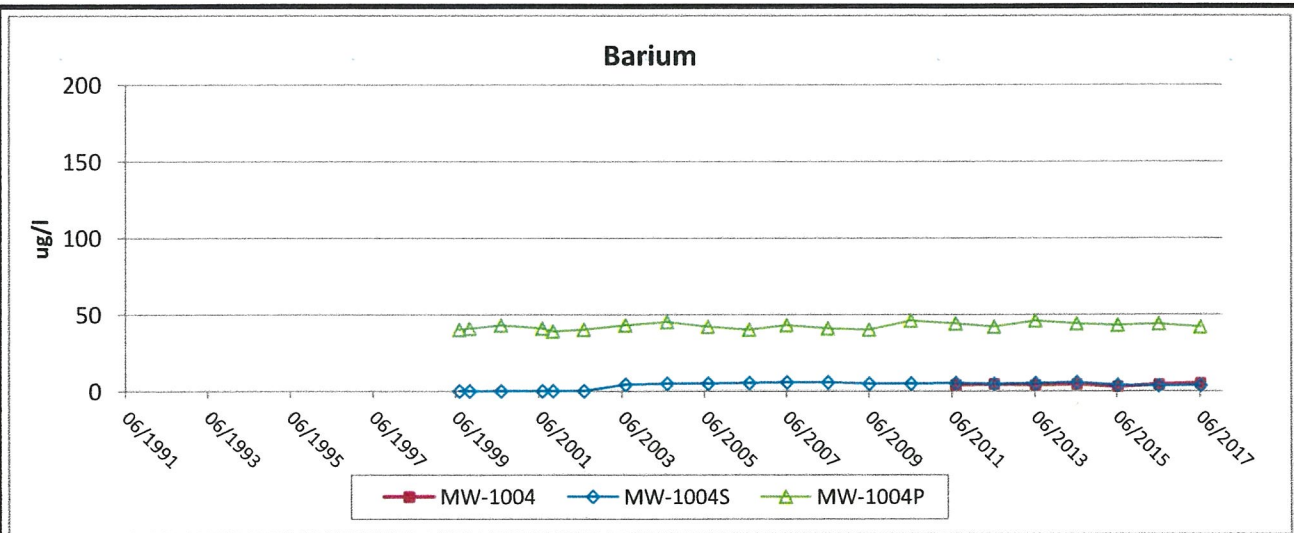
MW-1002/MW-1002G


Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	



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Figure B-9e	
Groundwater Trend Graphs - Annual Results	
MW-1002/MW-1002G	
Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	

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Figure B-10a

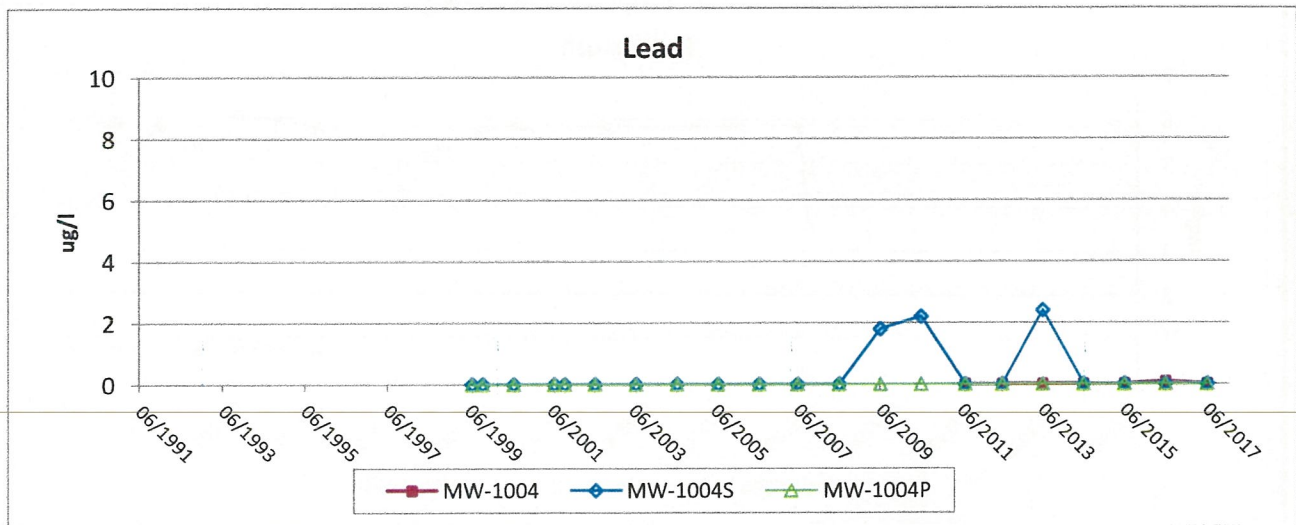
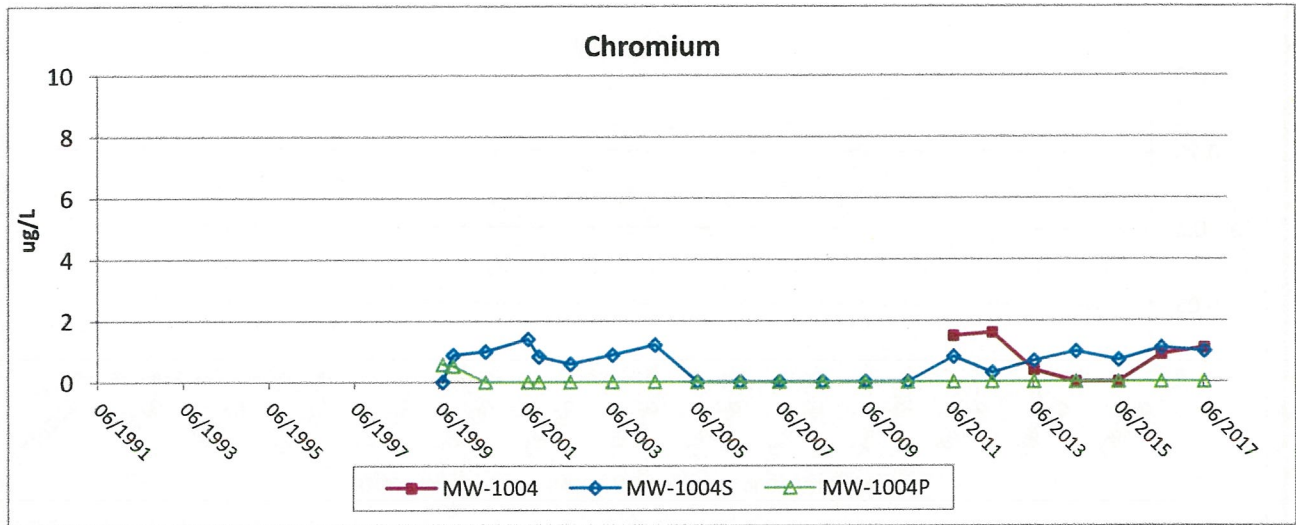
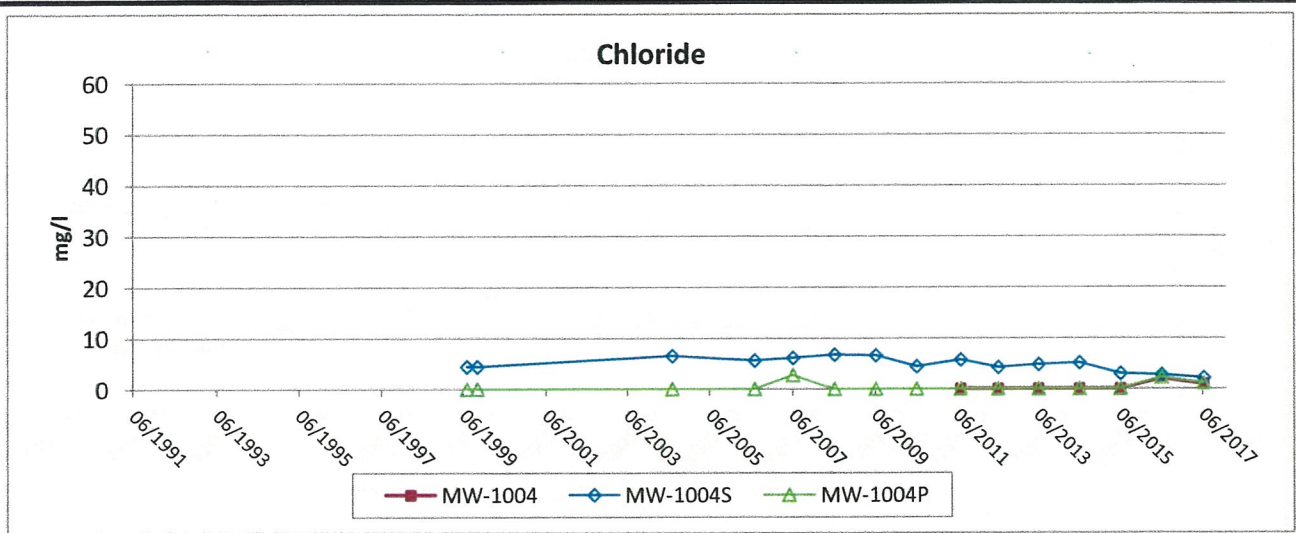
Groundwater Trend Graphs - Annual Results

MW-1004/MW-1004S/MW-1004P

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	

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Figure B-10b

Groundwater Trend Graphs - Annual Results

MW-1004/MW-1004S/MW-1004P

Scale: NA

Date: January 2018

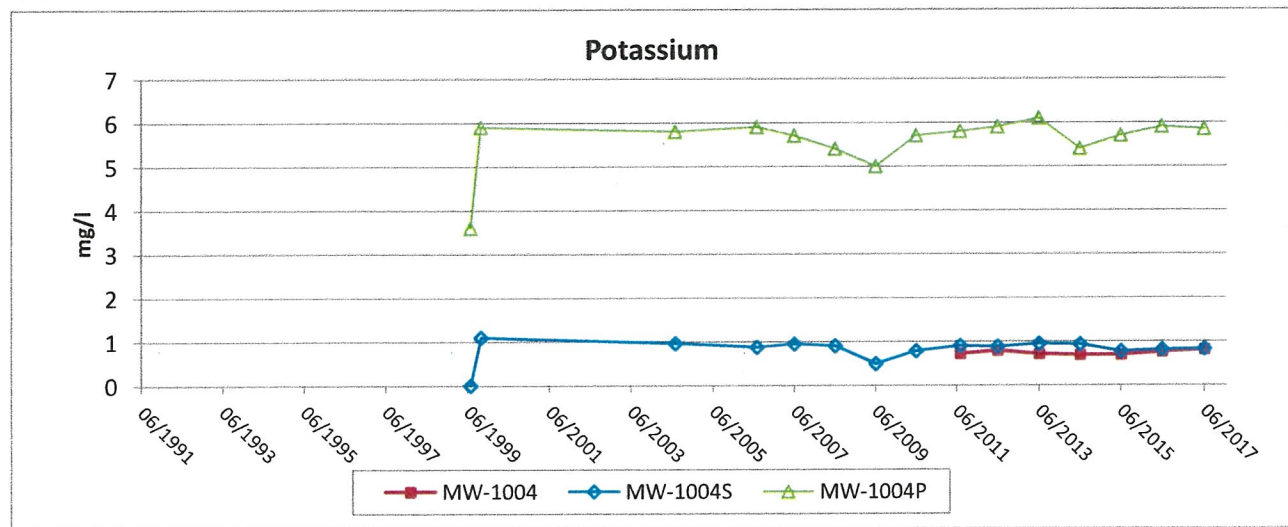
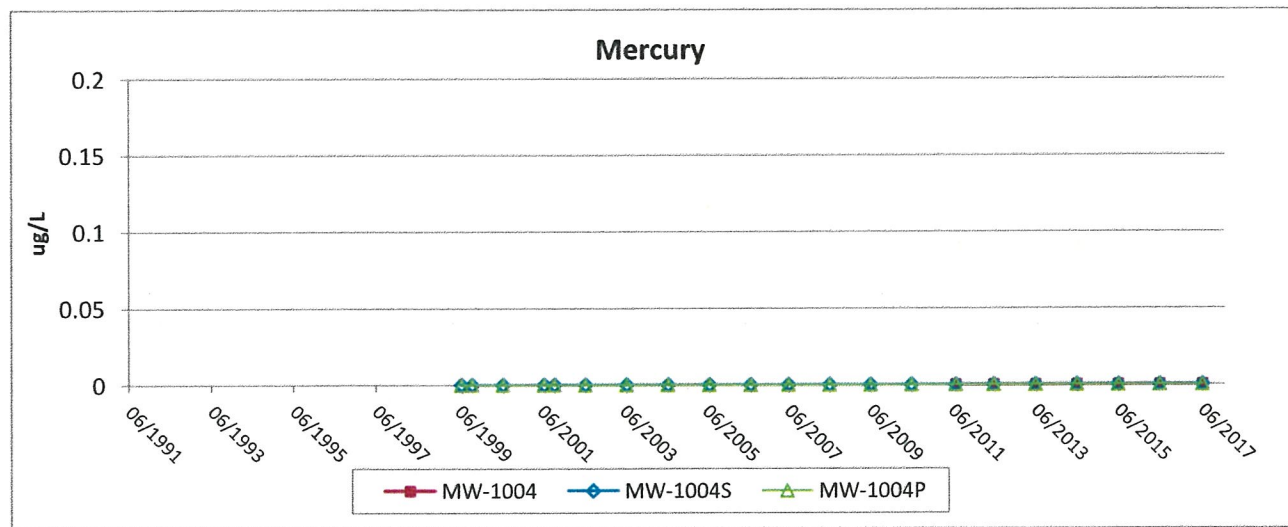
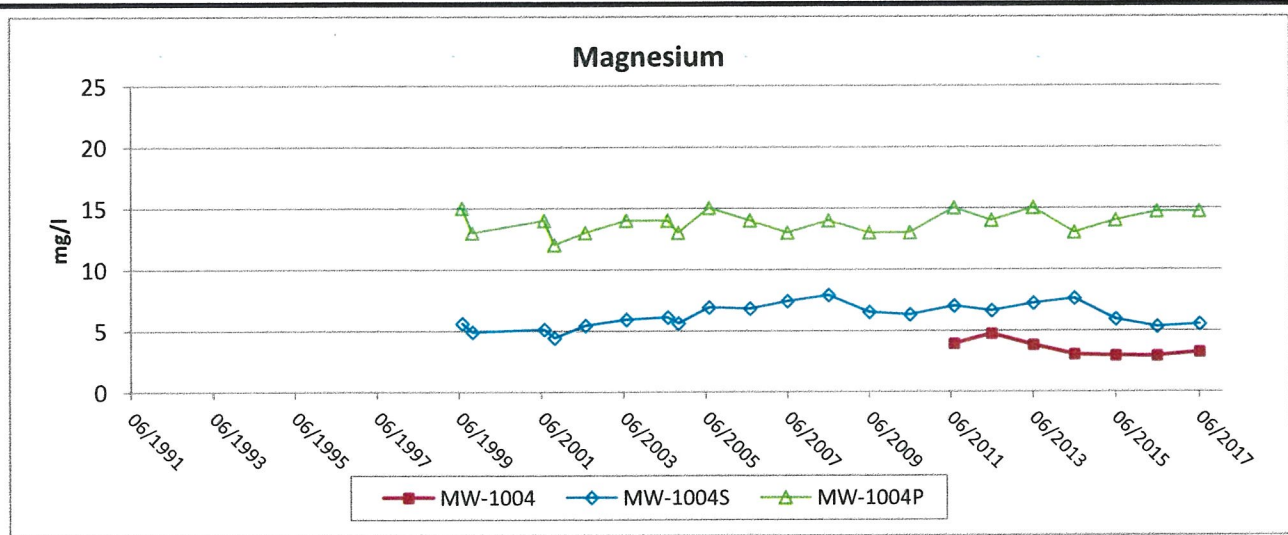
Prepared By: SGL


Checked By: SVF

Scope: 17F777-00

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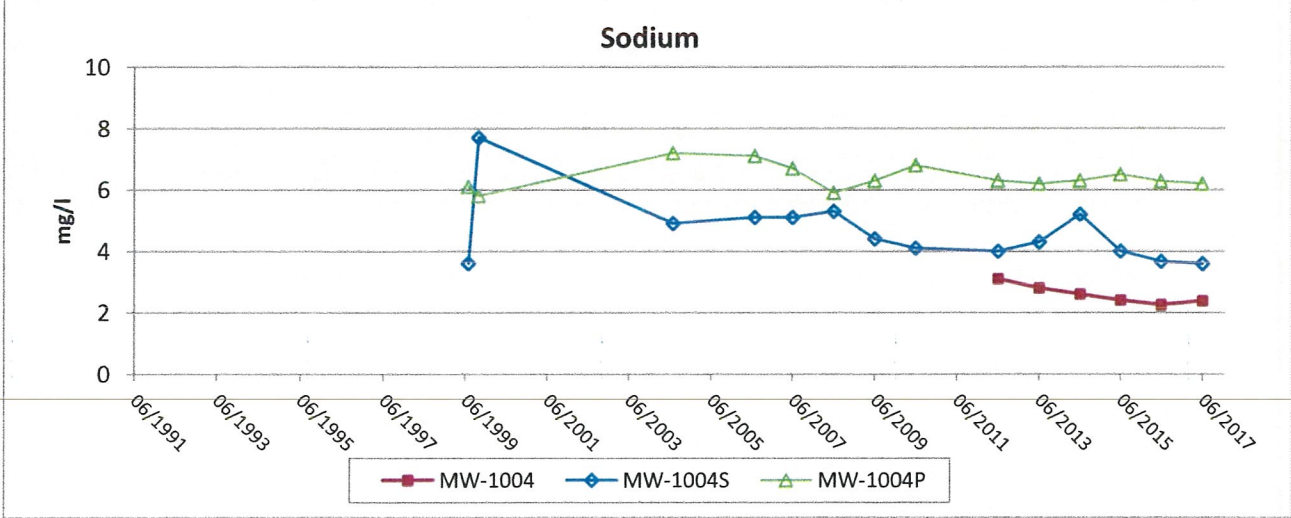
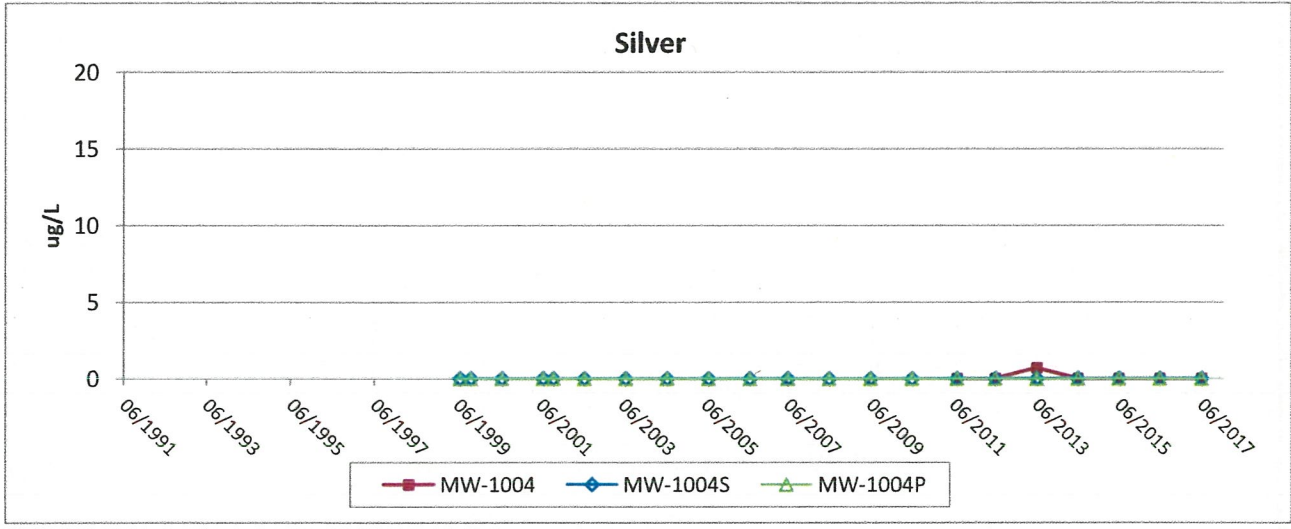
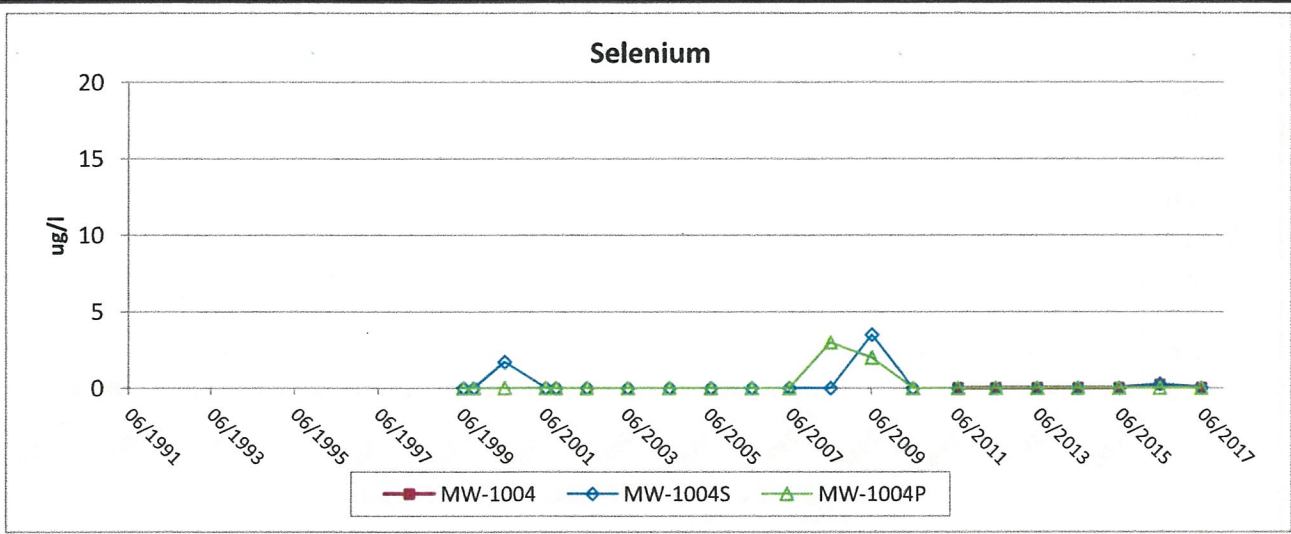
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Figure B-10c

Groundwater Trend Graphs - Annual Results

MW-1004/MW-1004S/MW-1004P

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	





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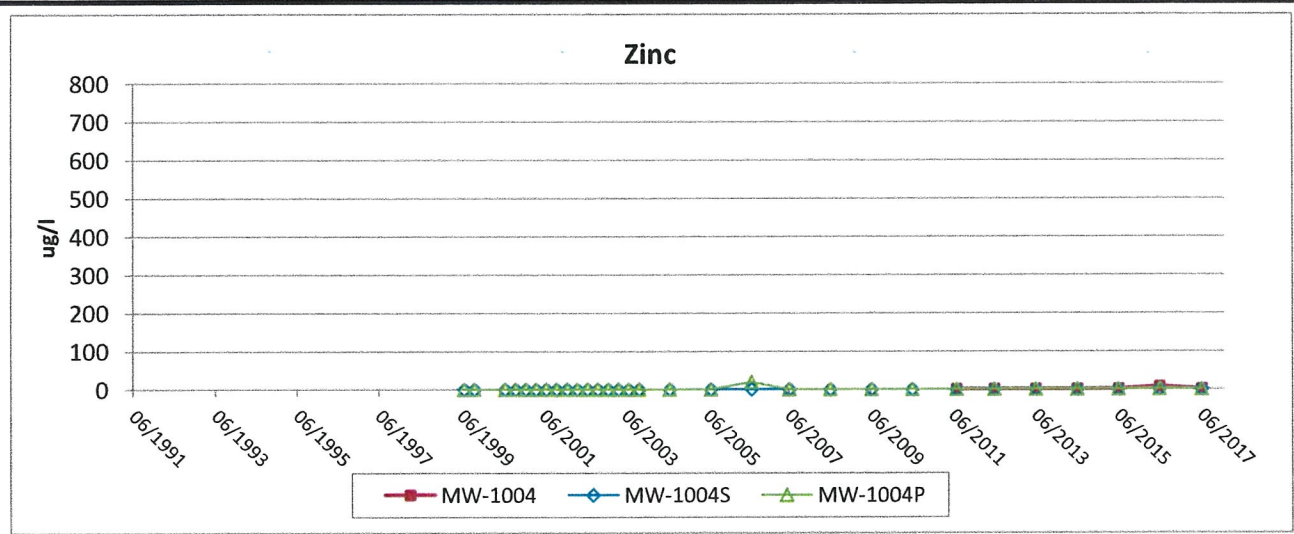
Figure B-10d


Groundwater Trend Graphs - Annual Results

MW-1004/MW-1004S/MW-1004P

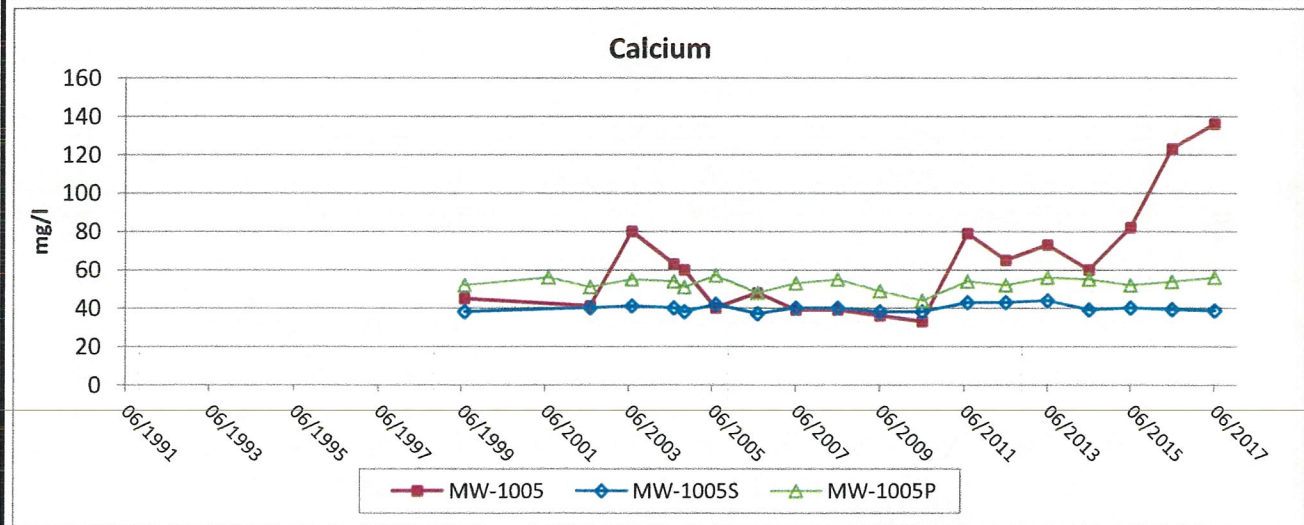
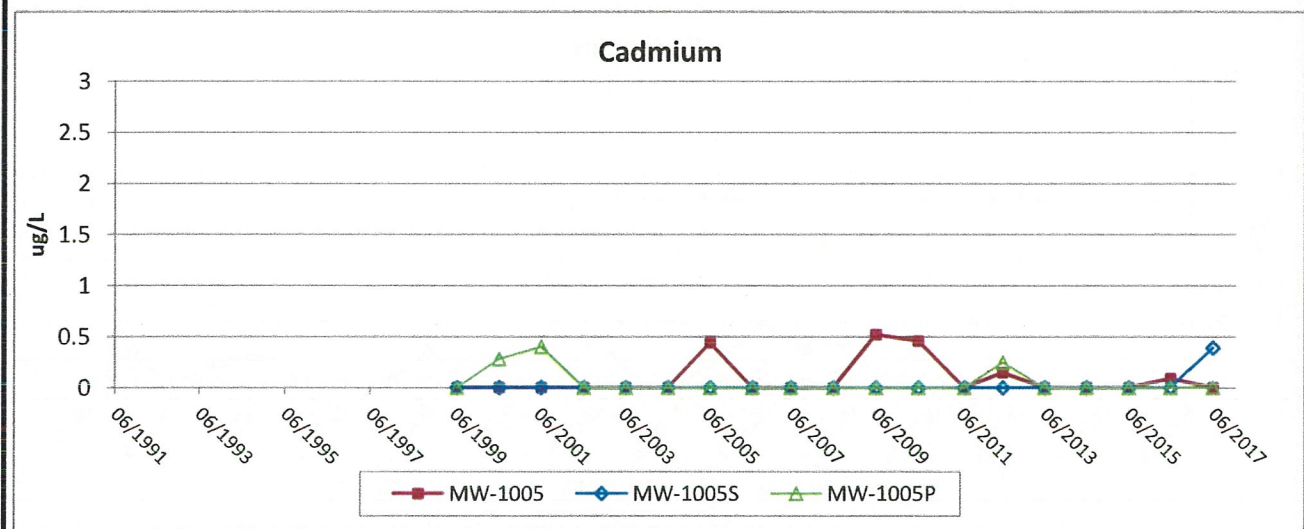
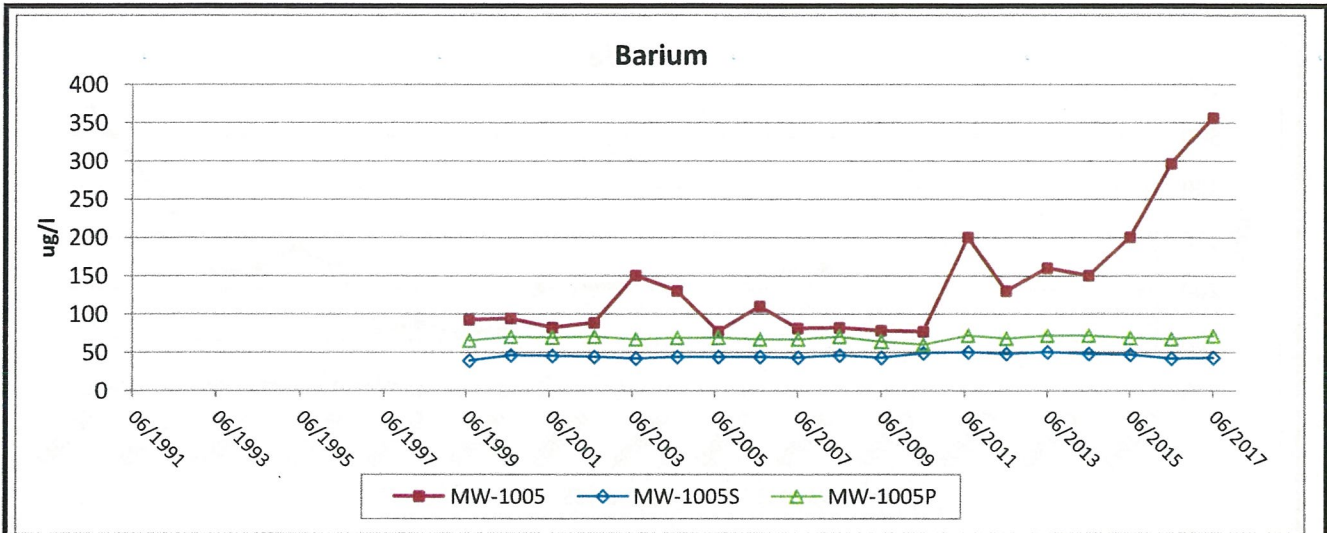
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Scope: 17F777-00	


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Figure B-10e		
Groundwater Trend Graphs - Annual Results		
MW-1004/MW-1004S/MW-1004P		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00

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Figure B-11a

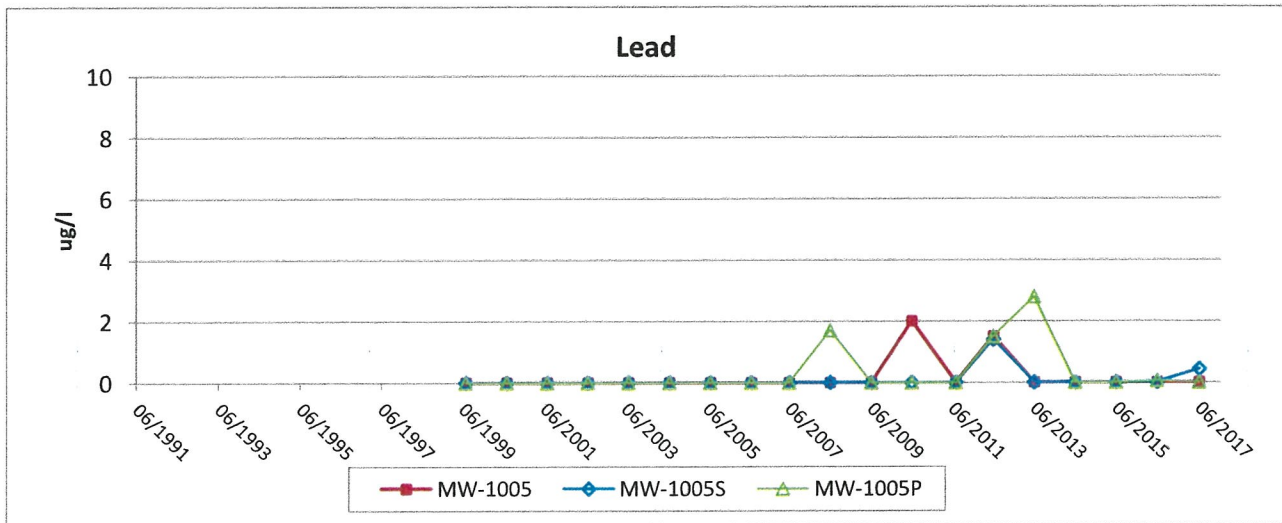
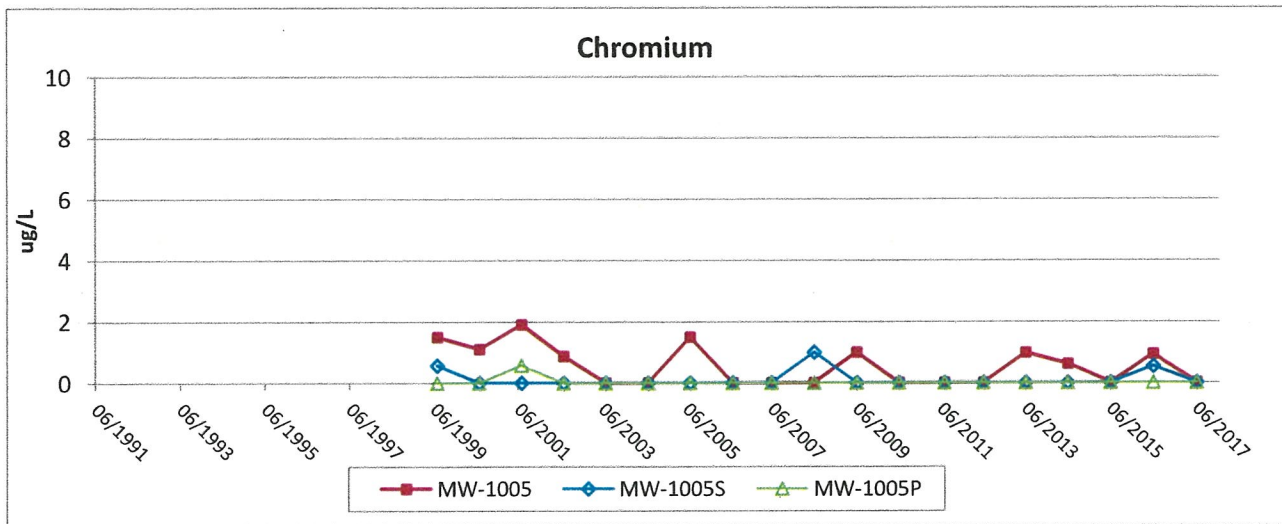
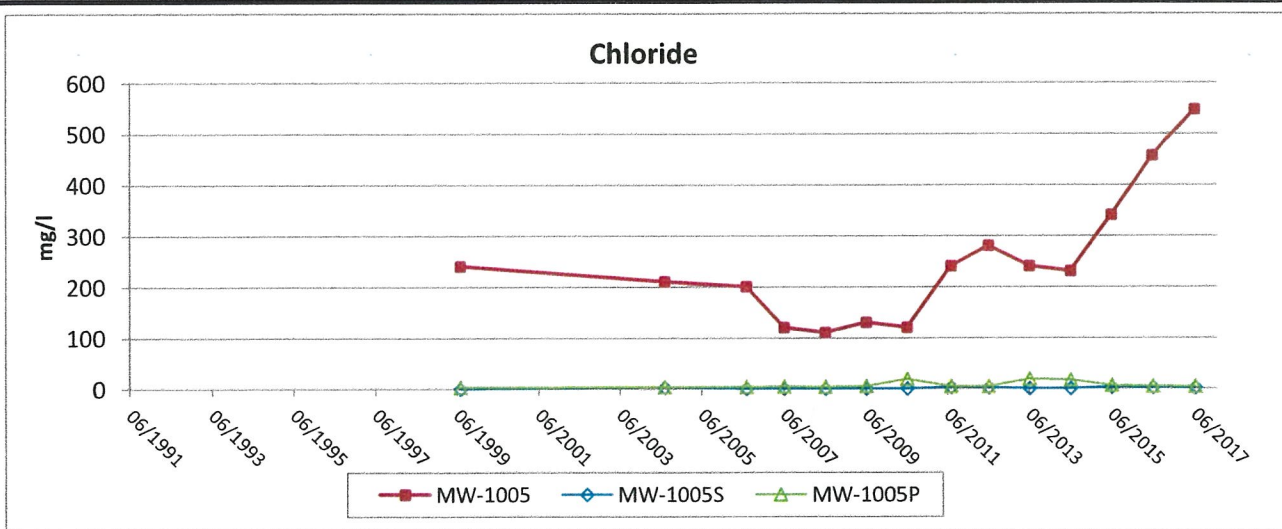
Groundwater Trend Graphs - Annual Results

MW-1005/MW-1005S/MW-1005P

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	

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Figure B-11b

Groundwater Trend Graphs - Annual Results

MW-1005/MW-1005S/MW-1005P

Scale: NA

Date: January 2018

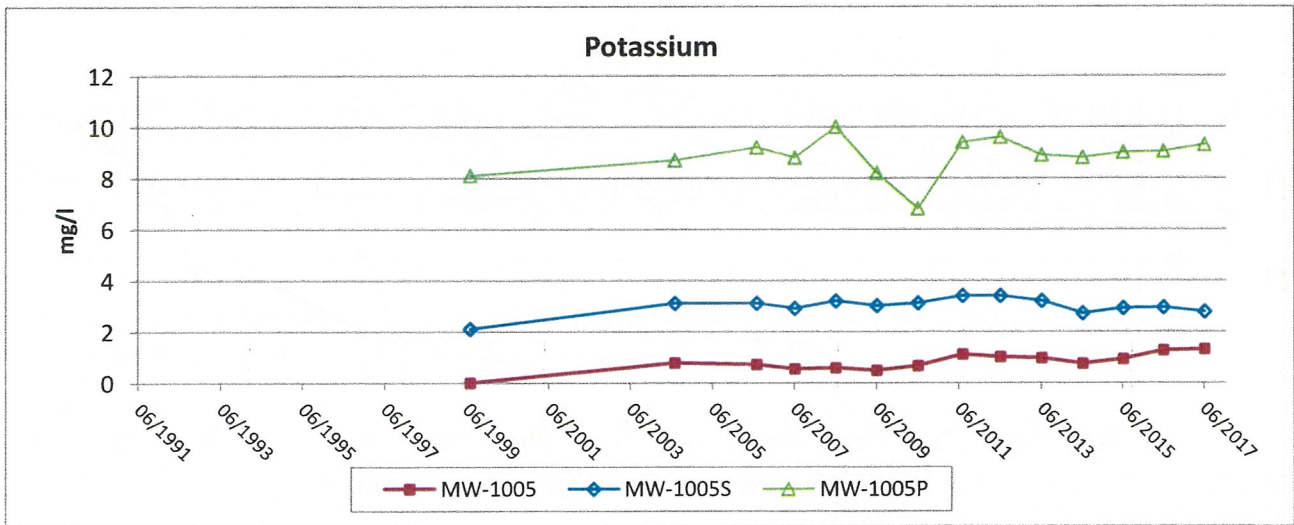
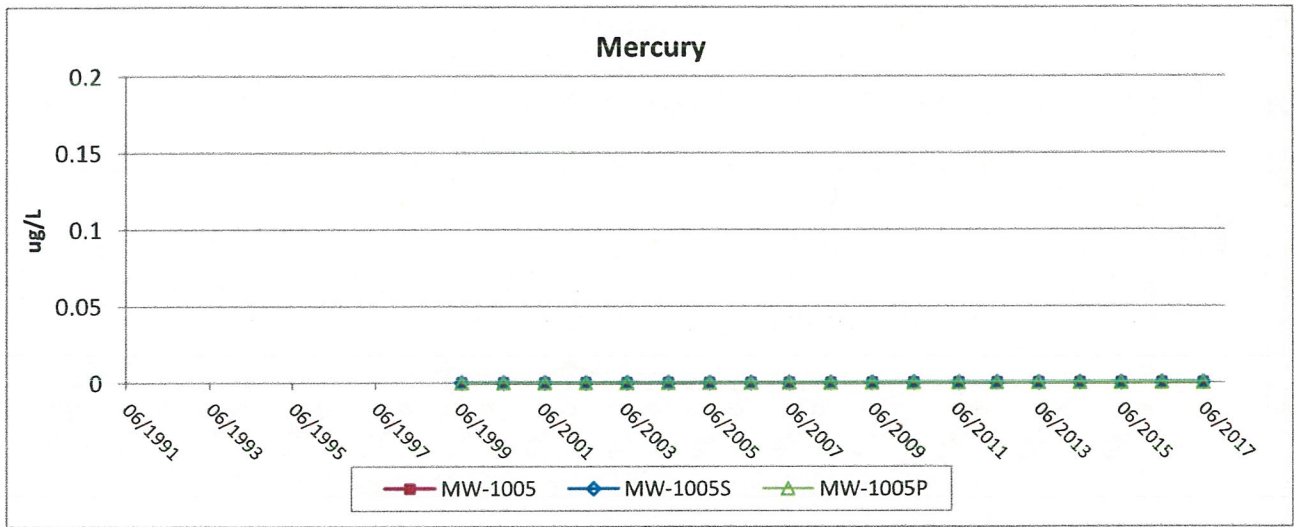
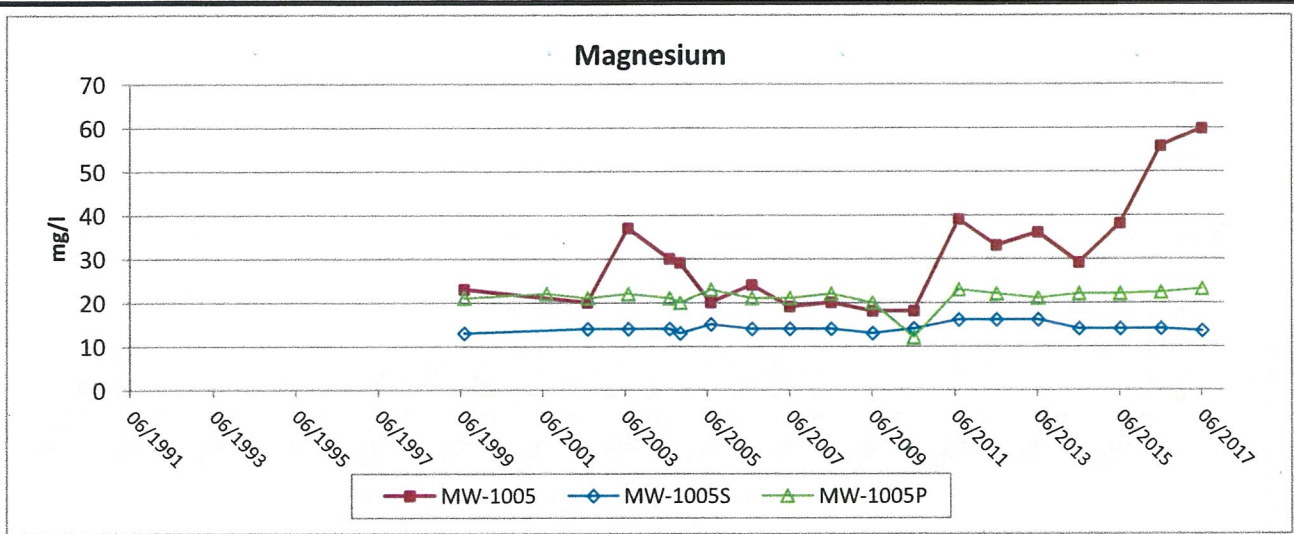
Prepared By: SGL

Checked By: SVF

Scope: 17F777-00

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Figure B-11c

Groundwater Trend Graphs - Quarterly Results
MW-1005/MW-1005S/MW-1005P

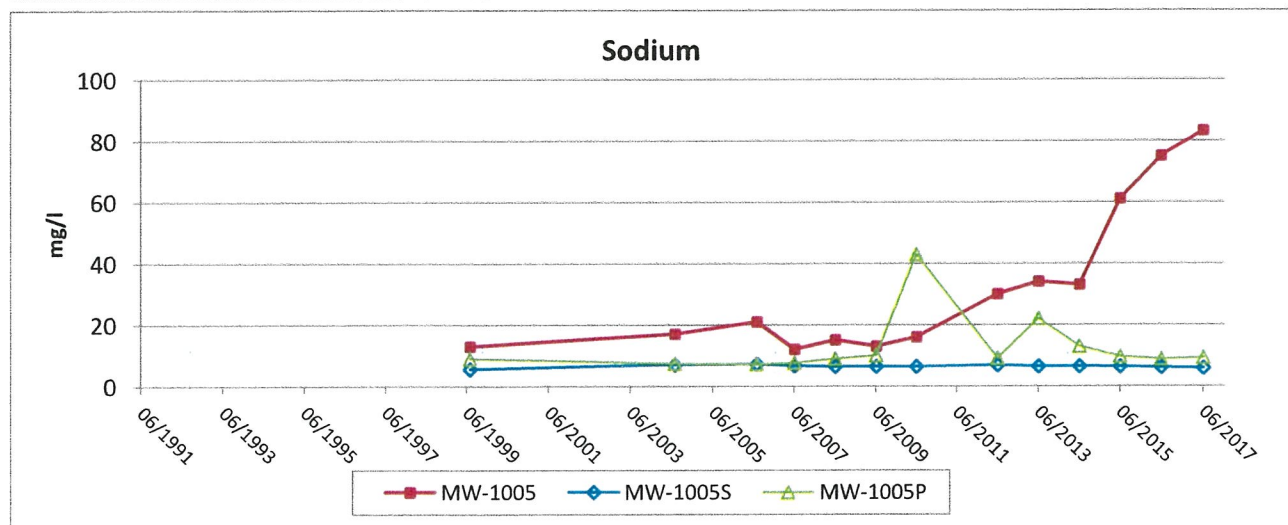
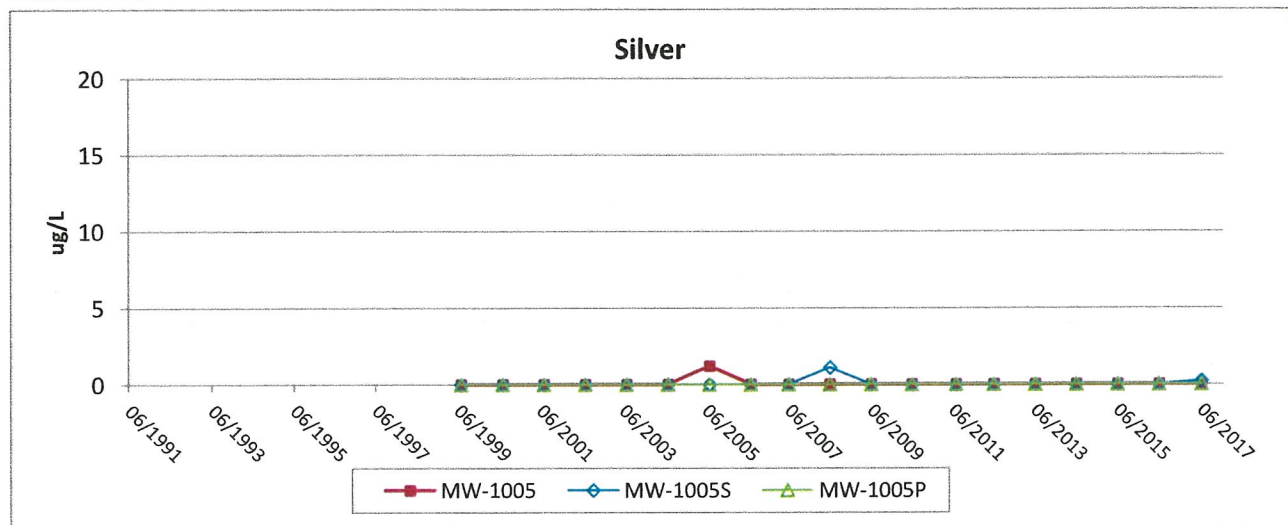
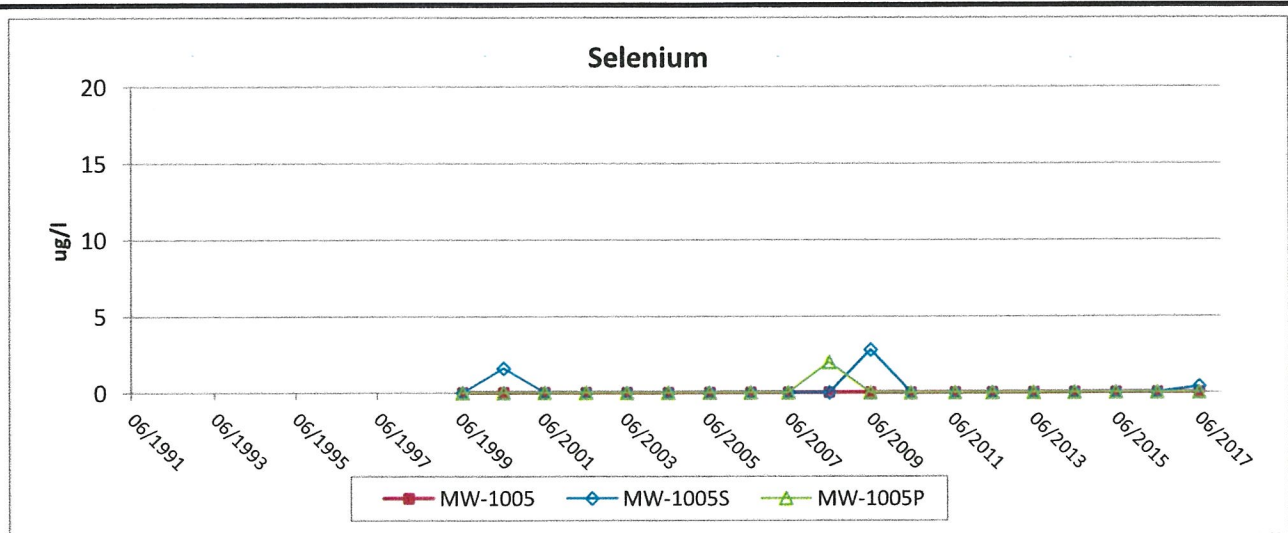
Scale: NA


Date: January 2018

Prepared By: SGL

Checked By: SVF

Scope: 17F777-00





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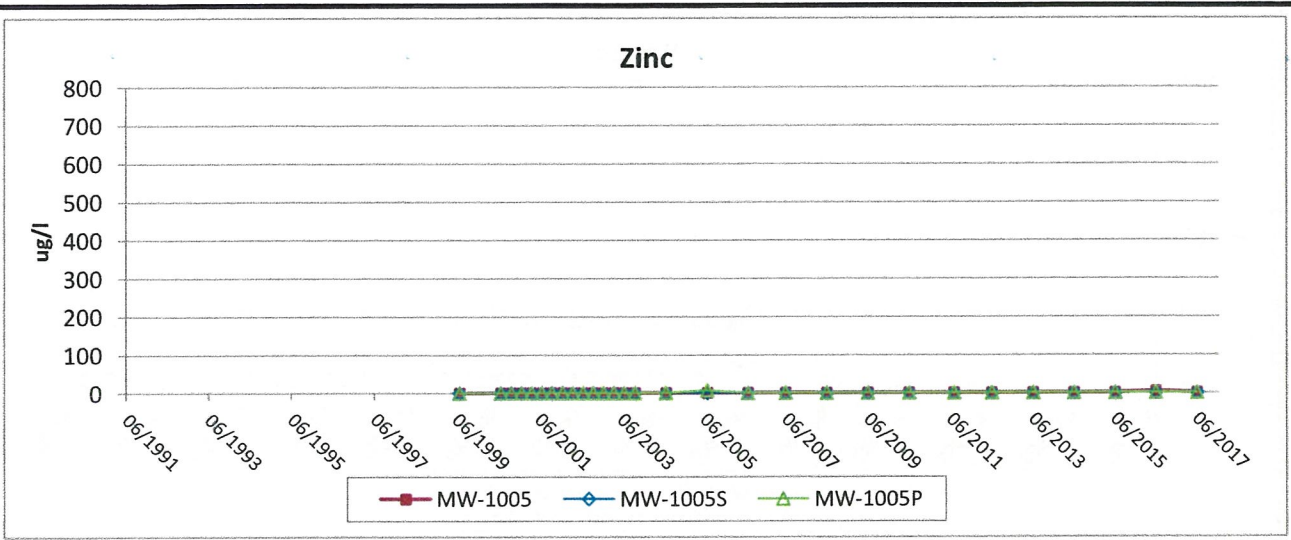
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Figure B-11d


Groundwater Trend Graphs - Annual Results

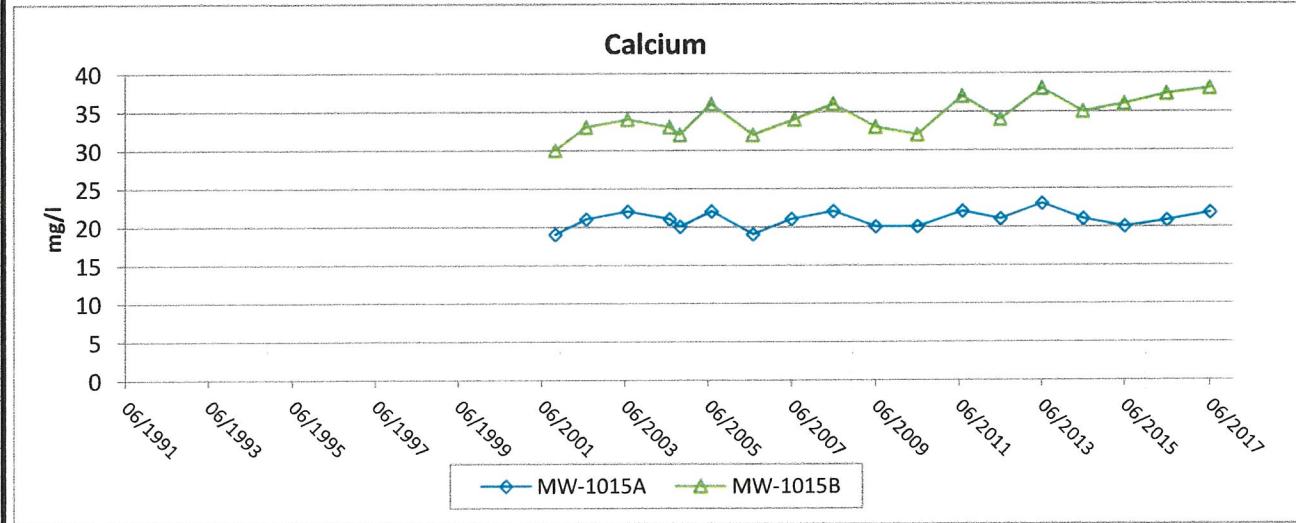
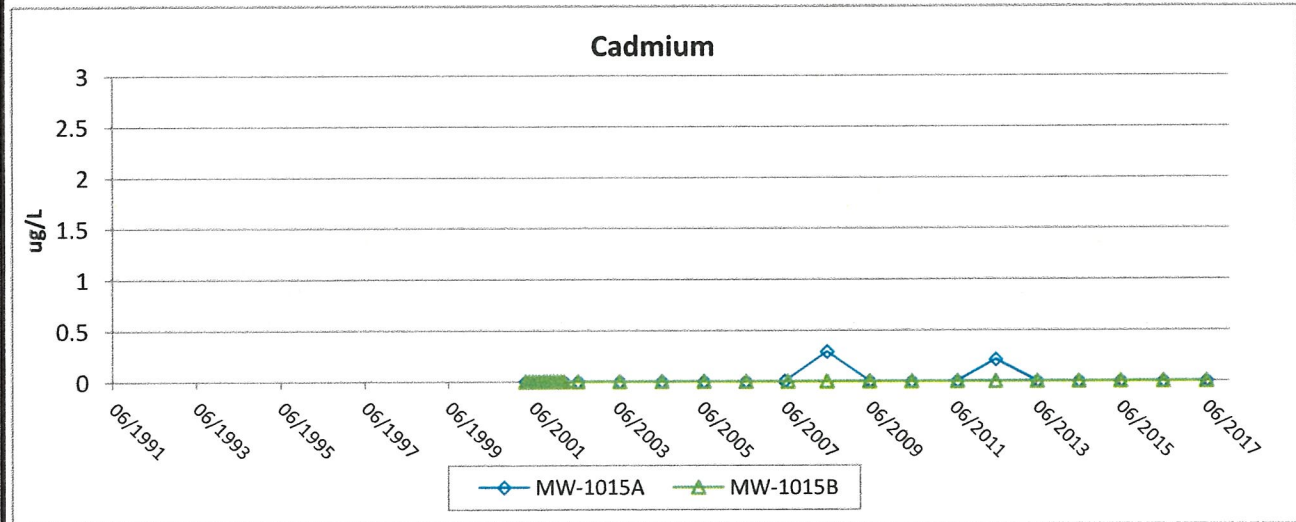
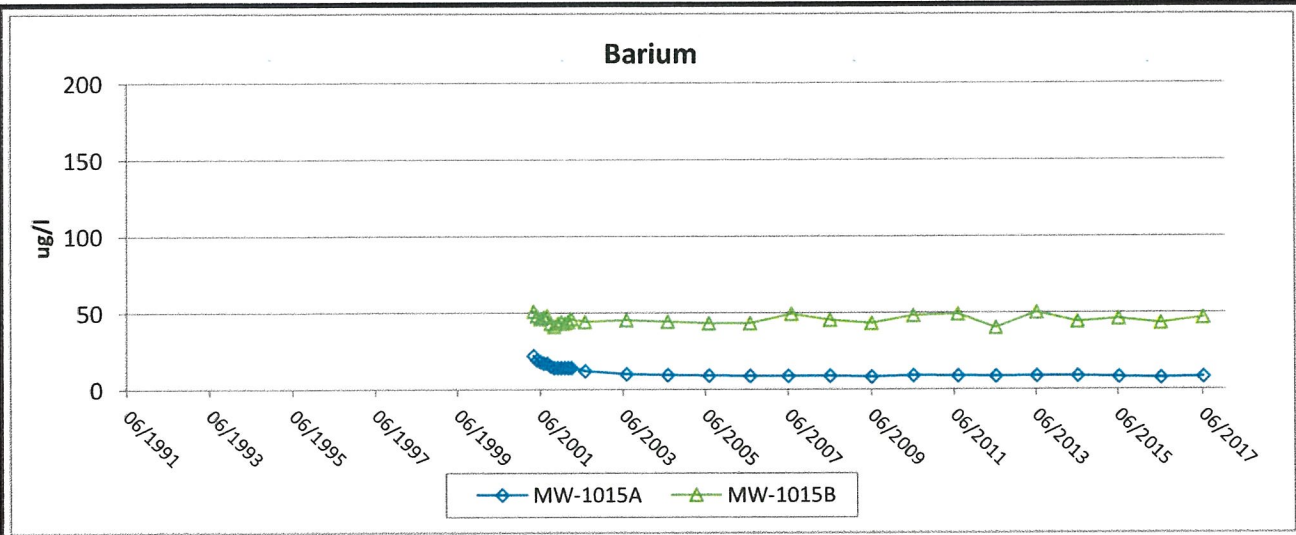
MW-1005/MW-1005S/MW-1005P


Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	



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Figure B-11e		
Groundwater Trend Graphs - Annual Results		
MW-1005/MW-1005S/MW-1005P		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00





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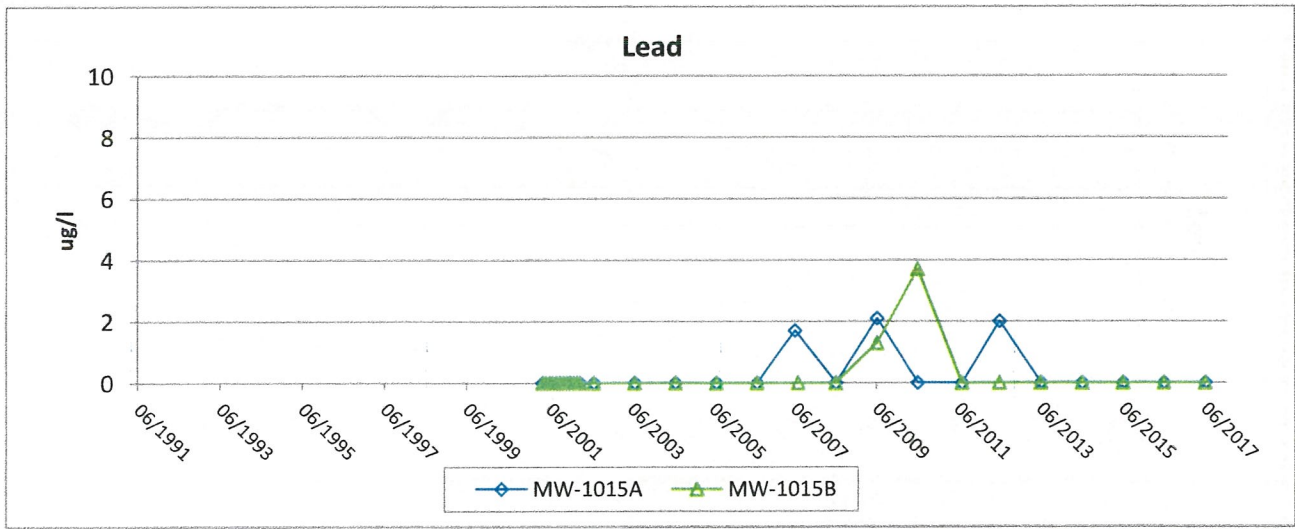
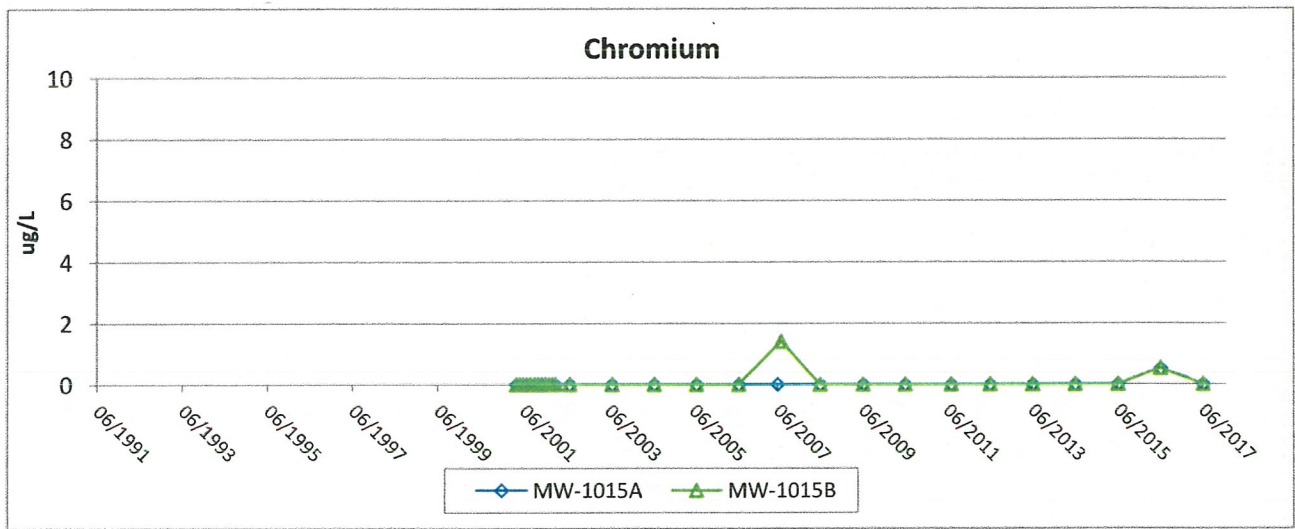
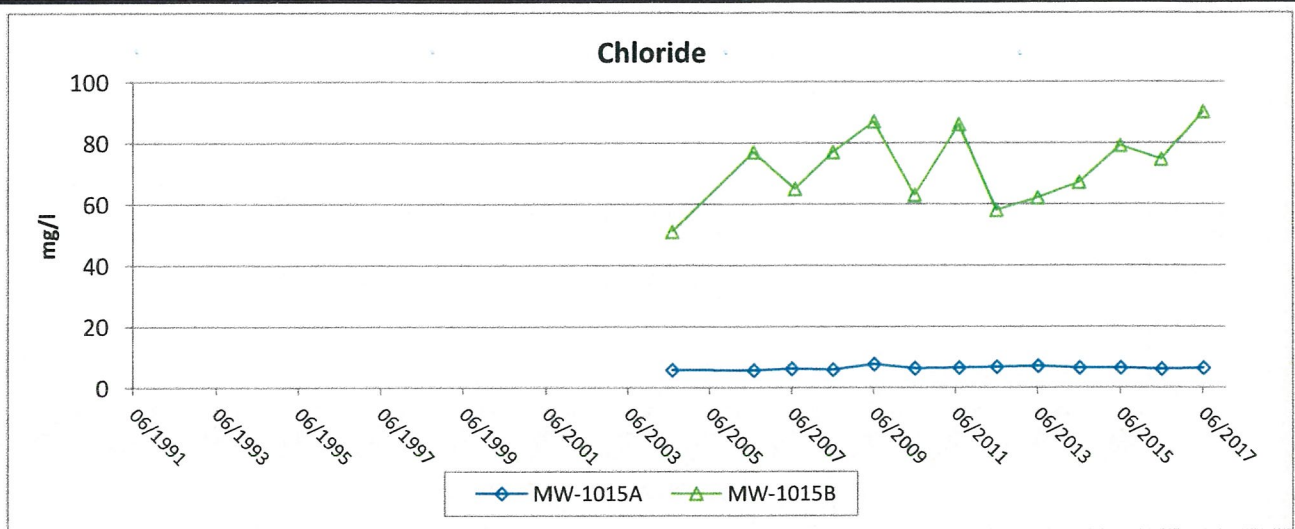
Figure B-12a

Groundwater Trend Graphs - Annual Results

MW-1015A/MW-1015B

Scale: NA	Date: January 2018
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Scope: 17F777-00	

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Figure B-12b

Groundwater Trend Graphs - Annual Results

MW-1015A/MW-1015B

Scale: NA

Date: January 2018

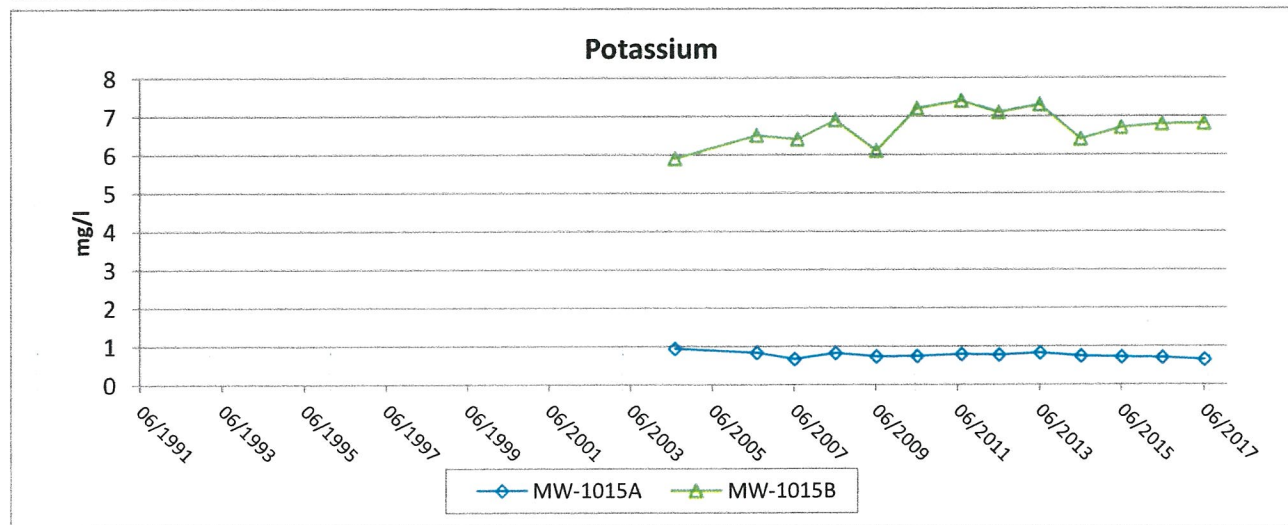
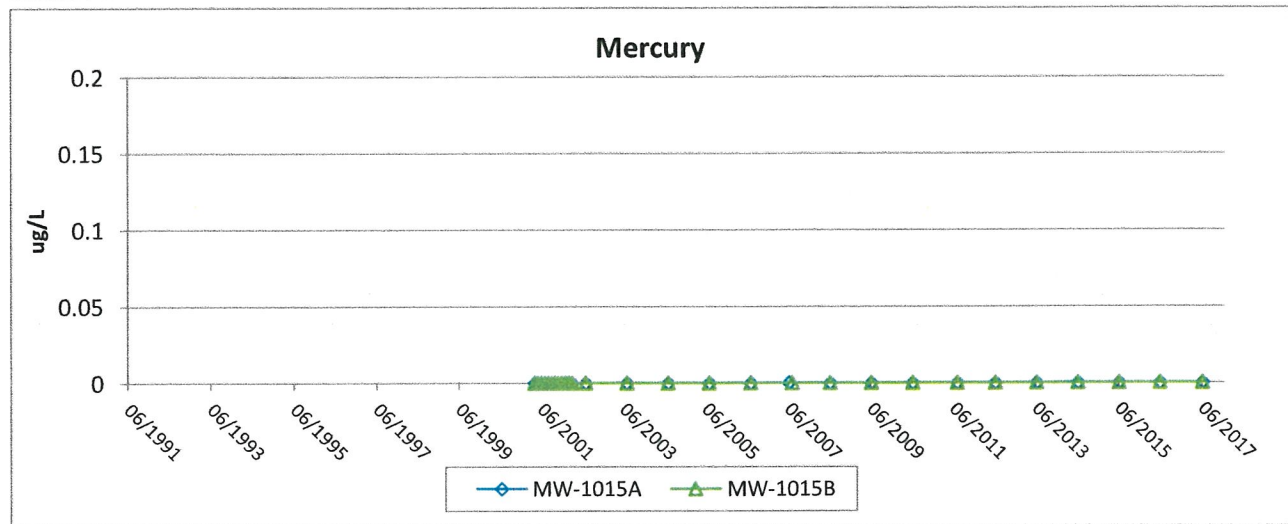
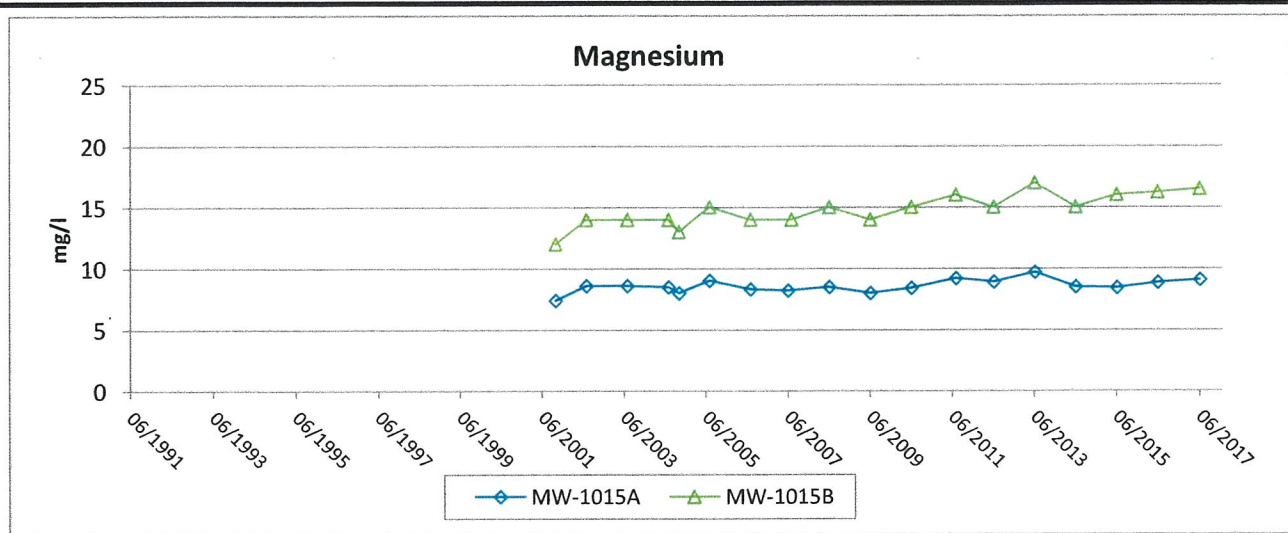
Prepared By: SGL


Checked By: SVF

Scope: 17F777-00

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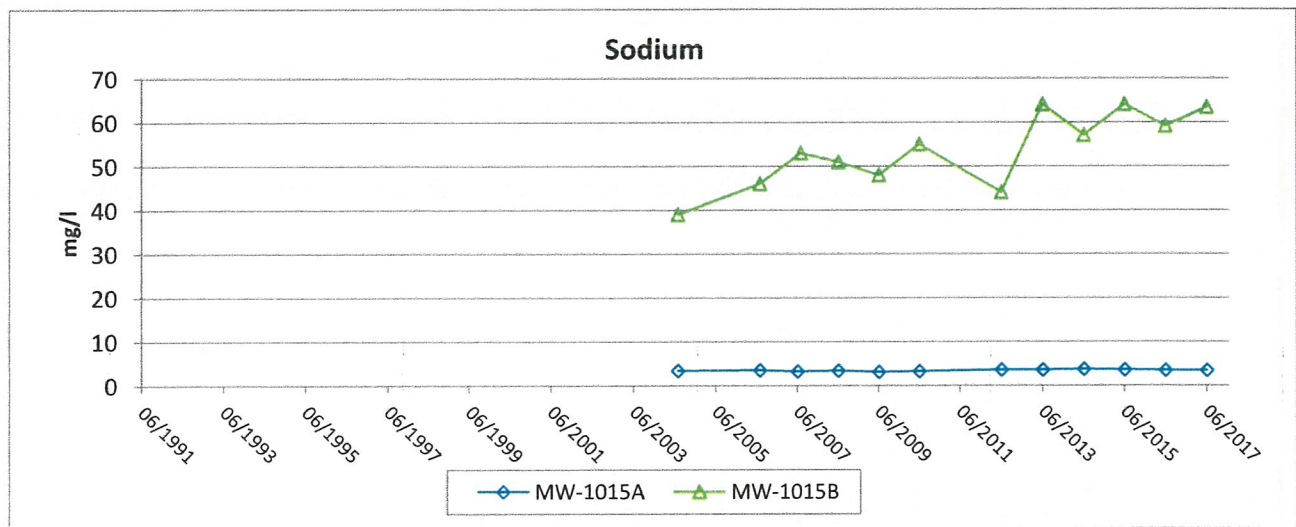
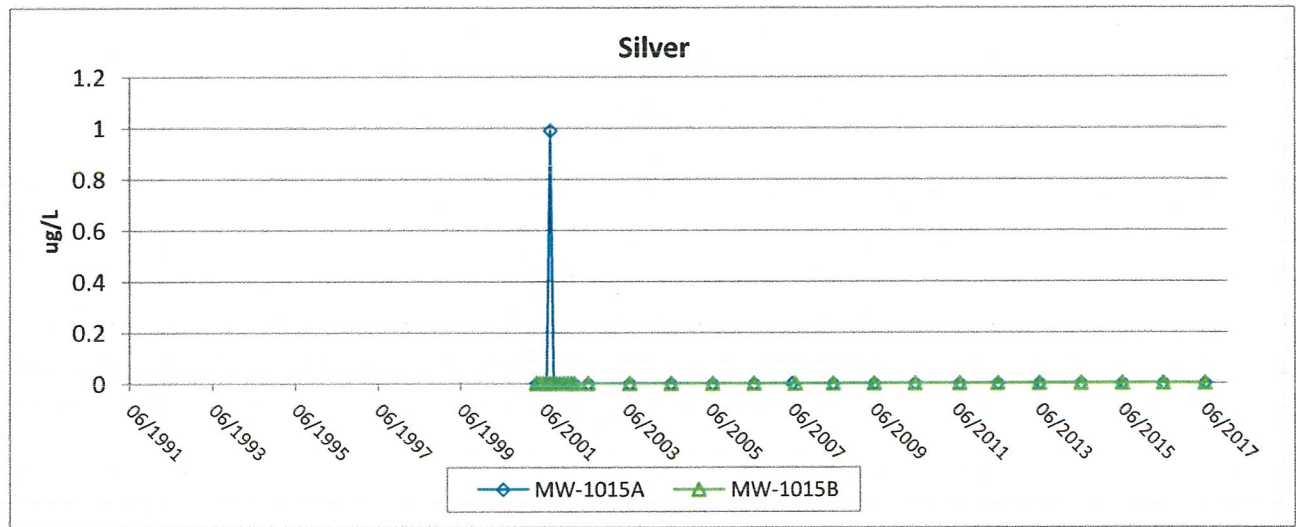
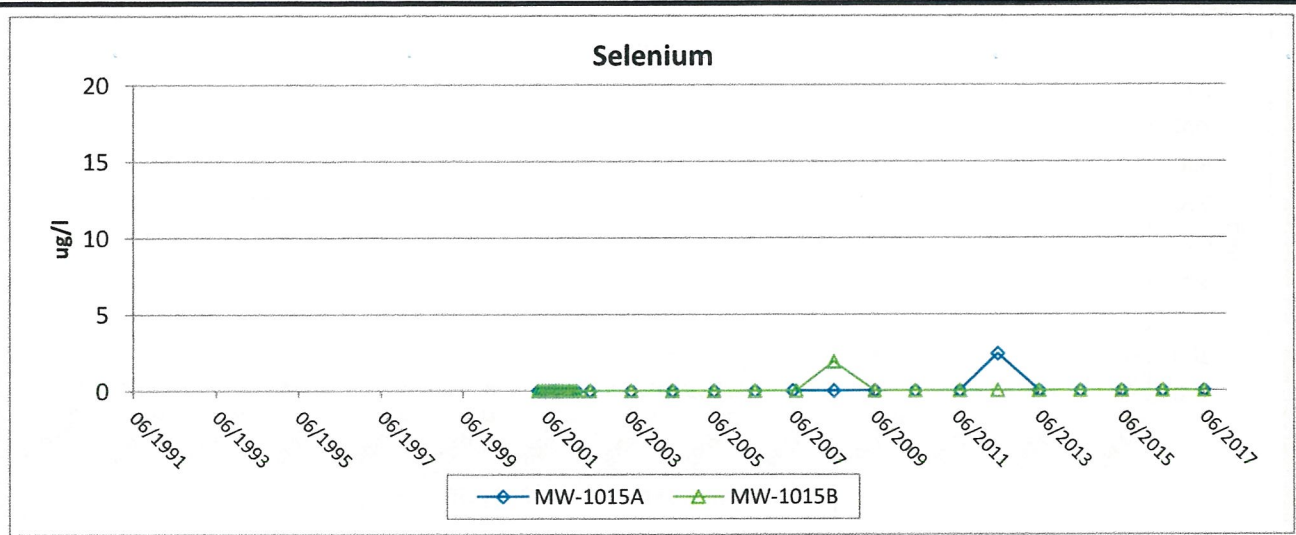
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Figure B-12c

Groundwater Trend Graphs - Annual Results

MW-1015A/MW-1015B

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	



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Figure B-12d

Groundwater Trend Graphs - Annual Results

MW-1015A/MW-1015B

Scale: NA

Date: January 2018

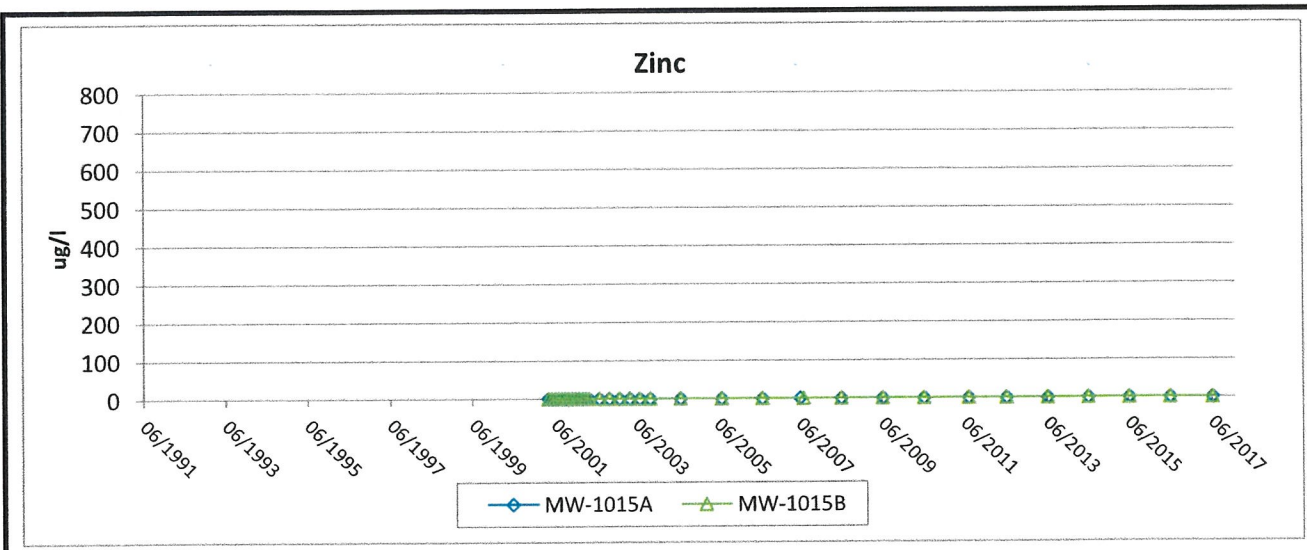
Prepared By: SGL


Checked By: SVF

Scope: 17F777-00

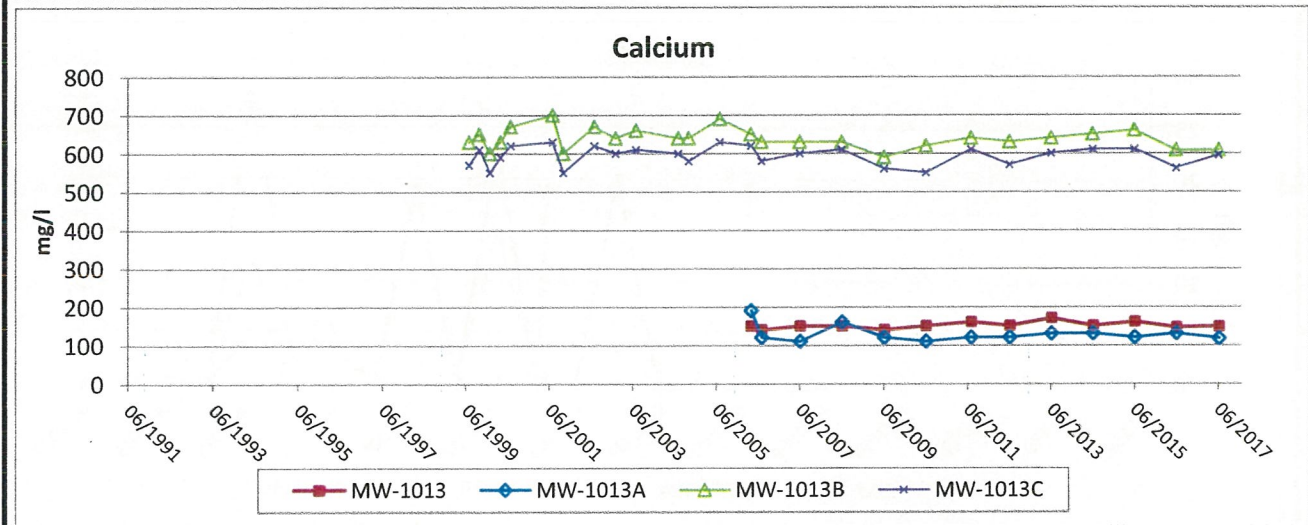
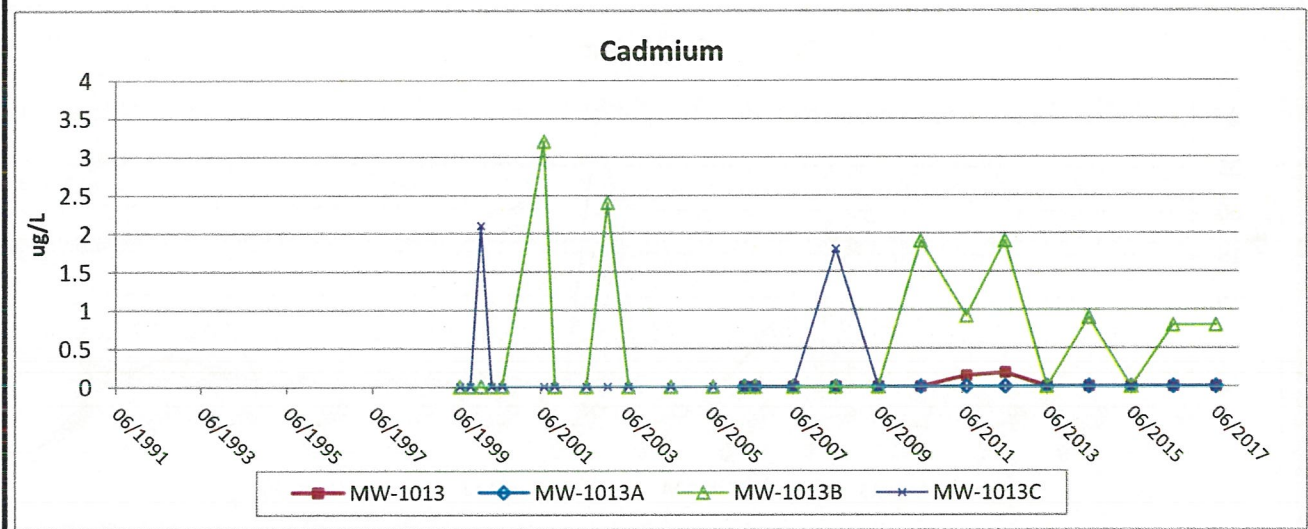
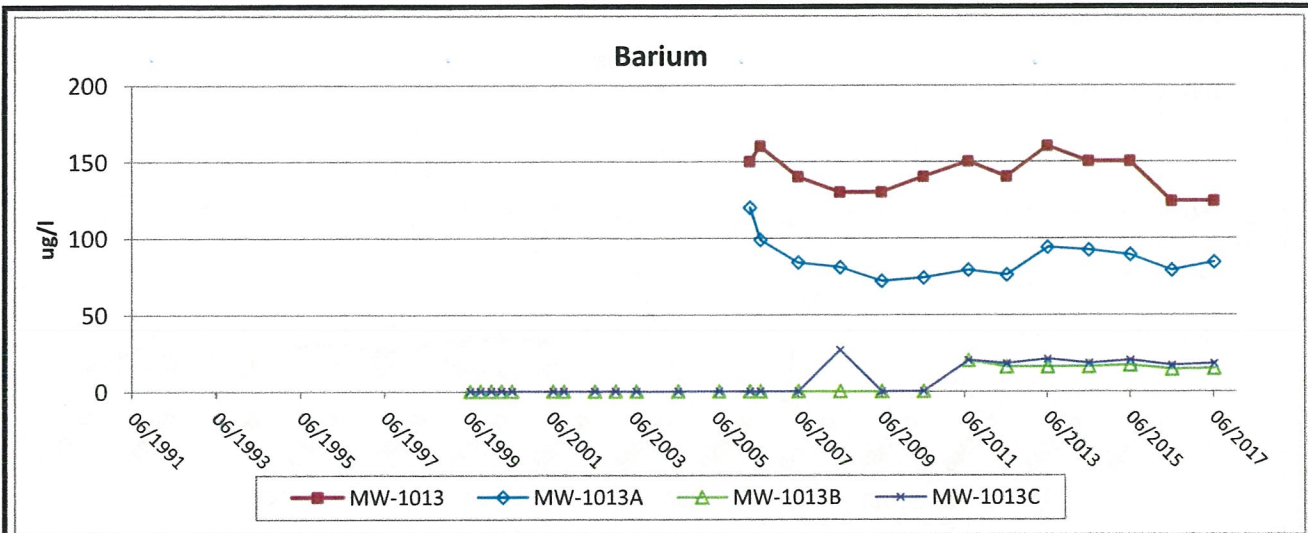
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Figure B-12e		
Groundwater Trend Graphs - Annual Results		
MW-1015A/MW-1015B		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00

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Figure B-13a

Groundwater Trend Graphs - Annual Results (In-Pit Wells)
MW-1013/MW-1013A/MW-1013B/MW-1013C

Scale: NA

Date: January 2018

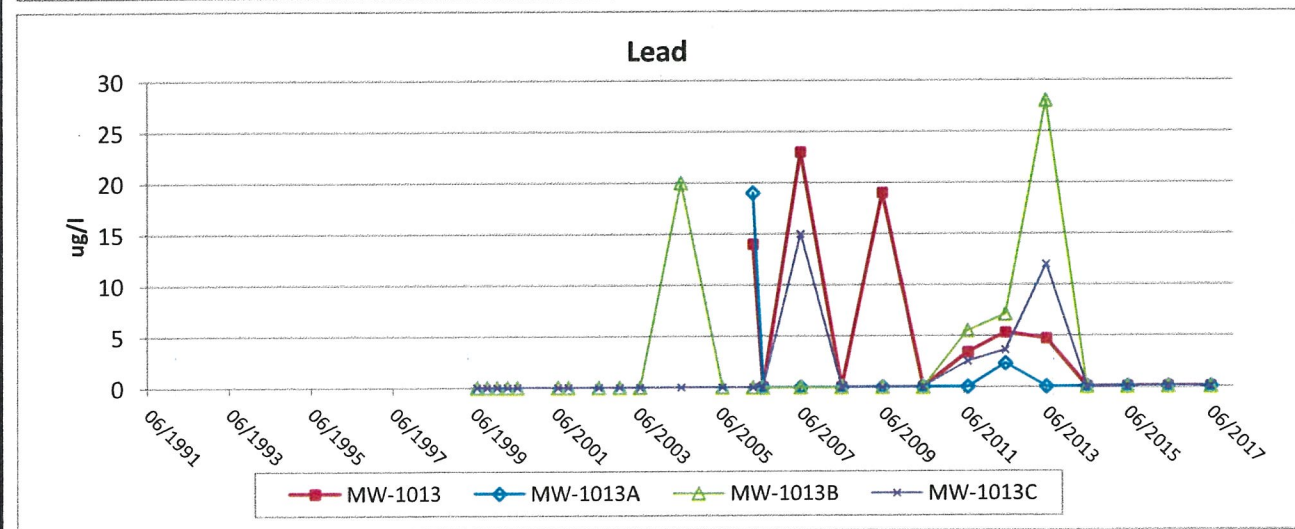
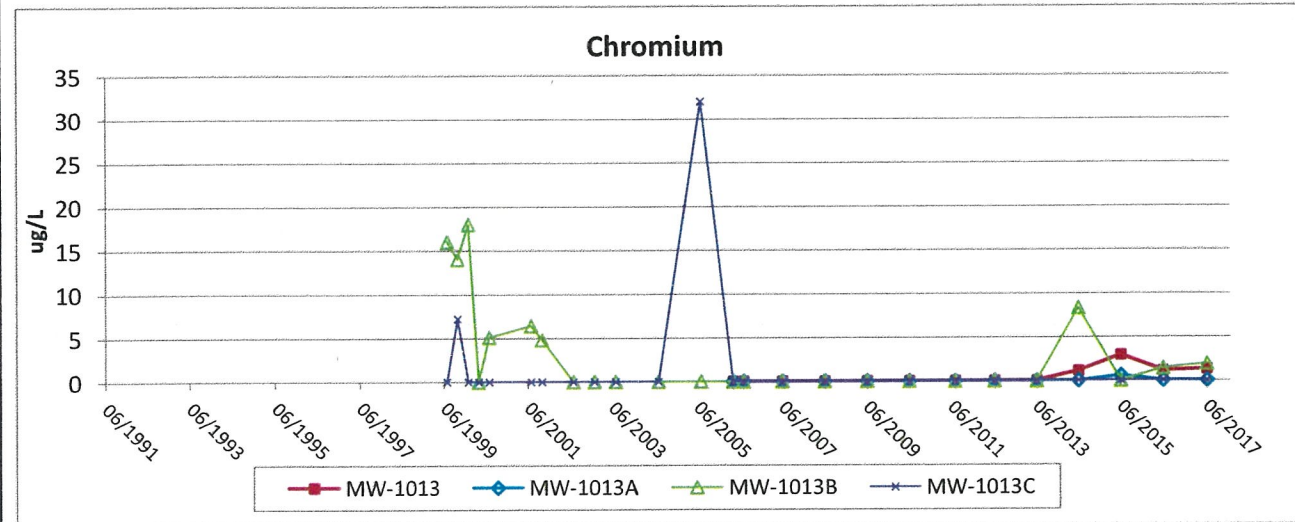
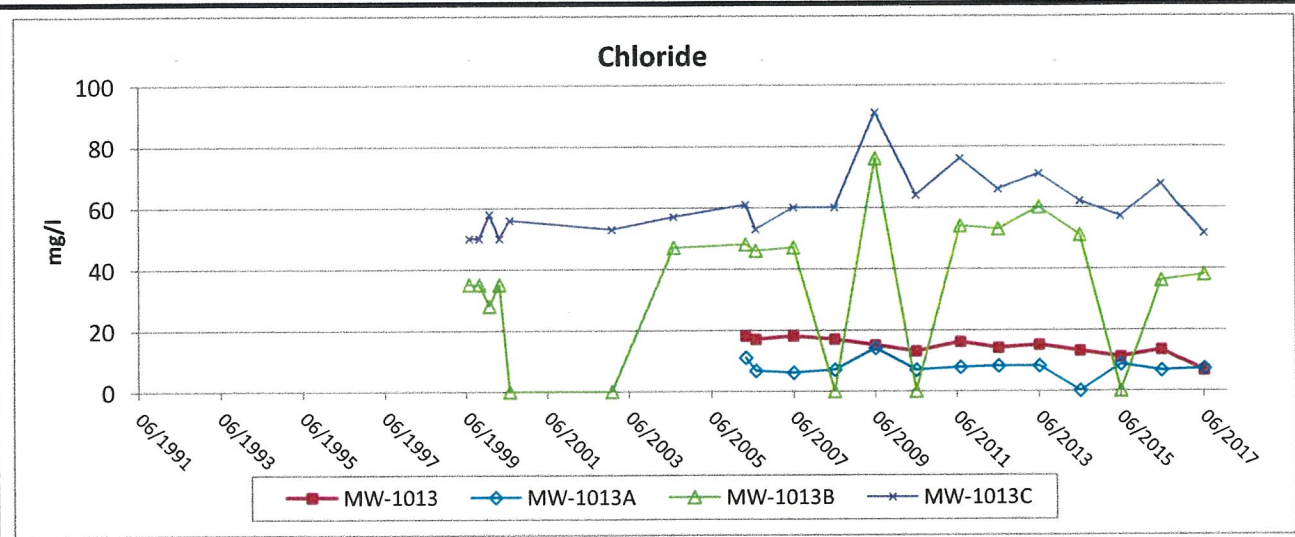
Prepared By: SGL


Checked By: SVF

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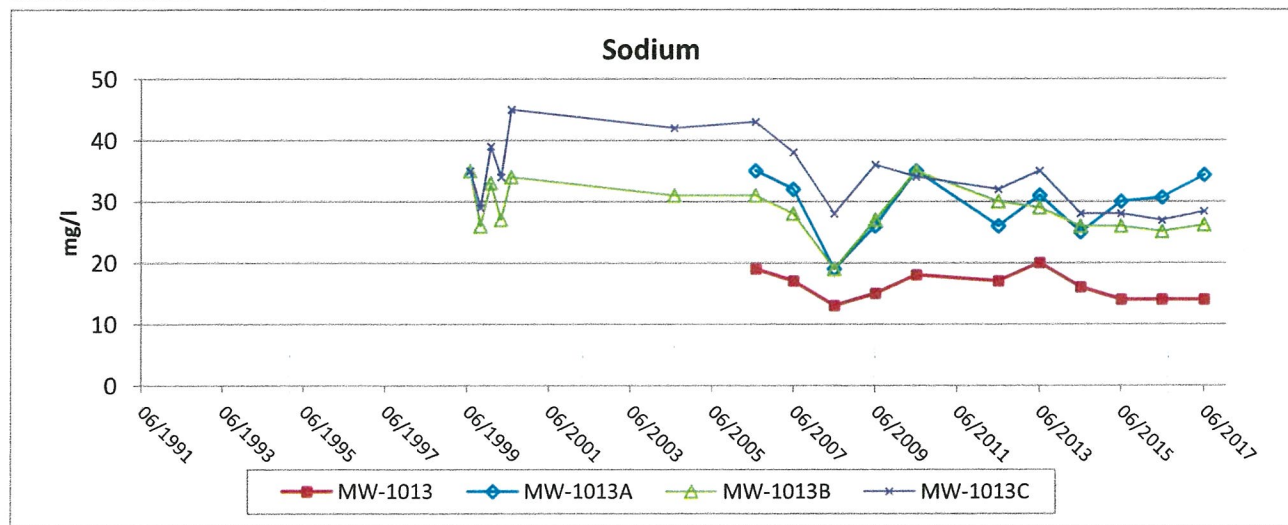
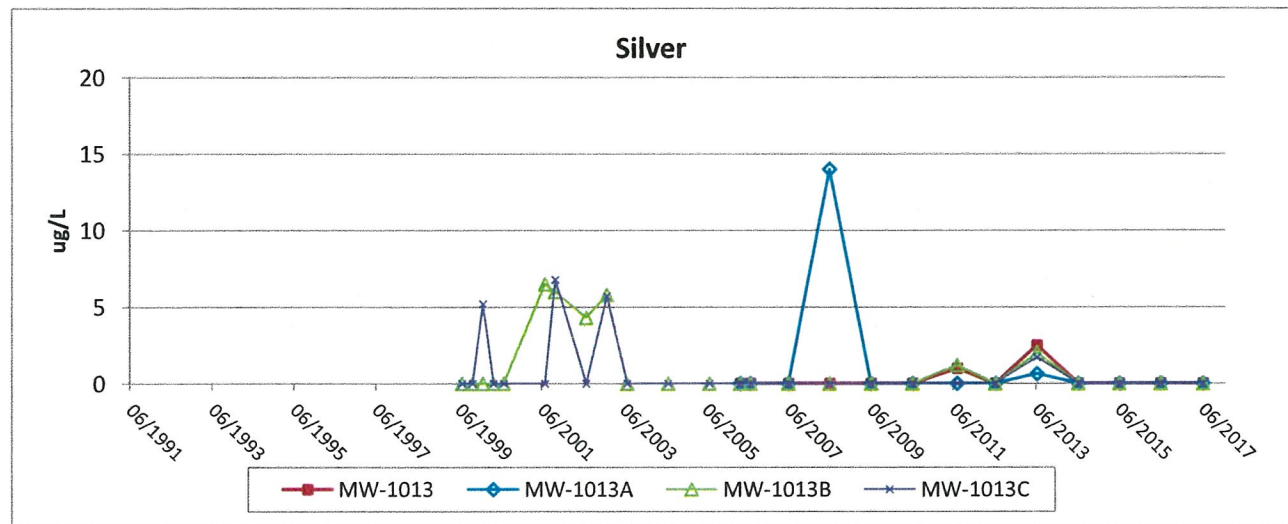
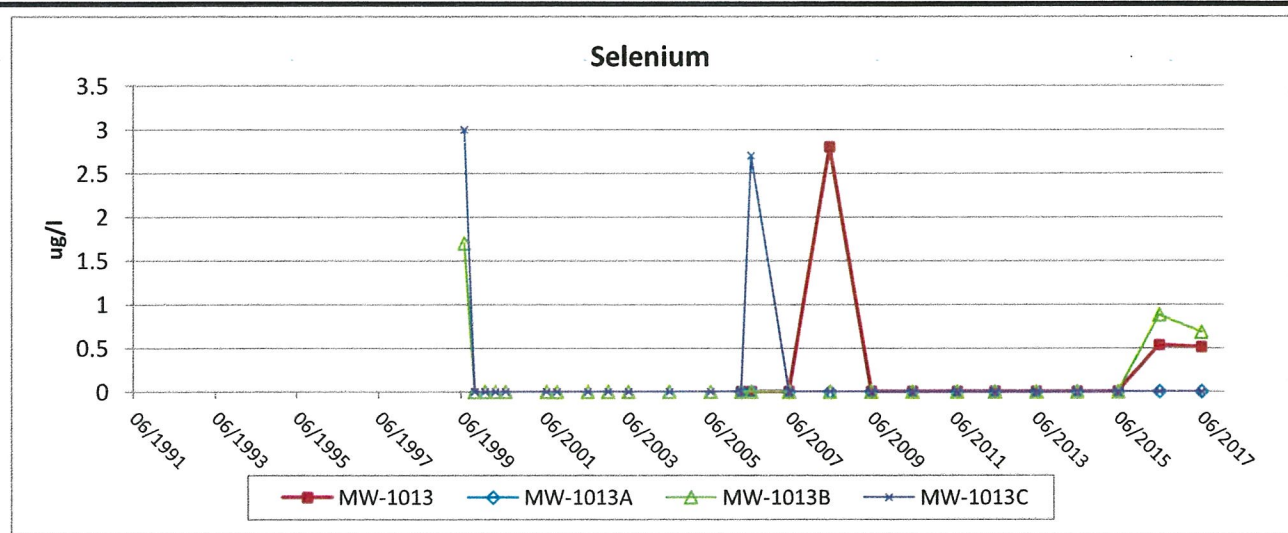
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Figure B-13b

Groundwater Trend Graphs - Annual Results (In-Pit Wells)

MW-1013/MW-1013A/MW-1013B/MW-1013C

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	





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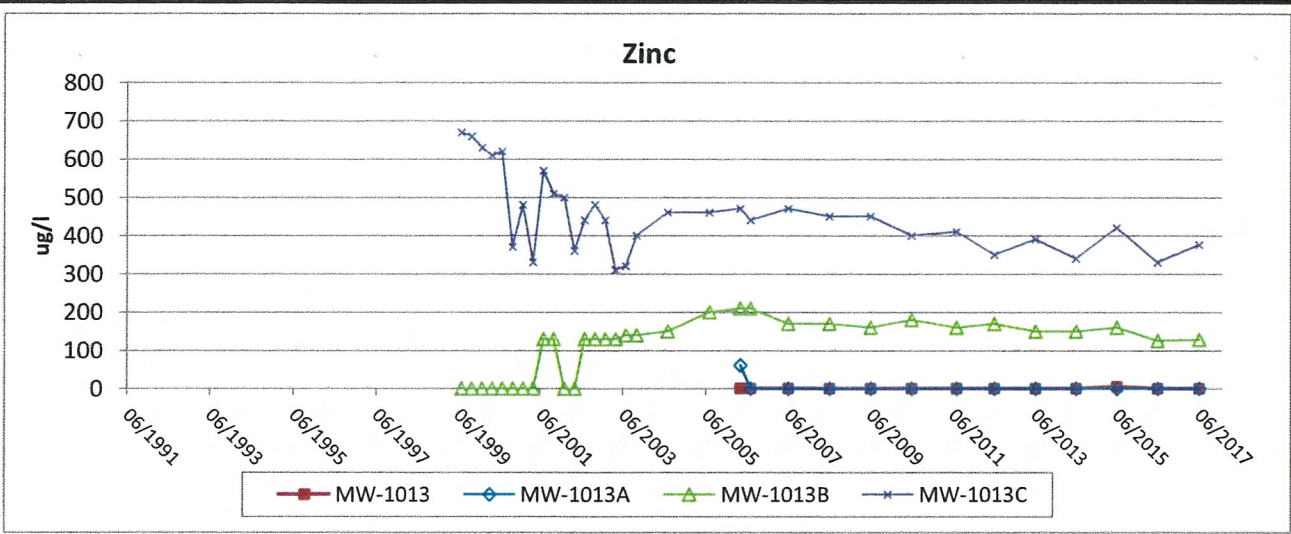
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Figure B-13d

Groundwater Trend Graphs - Annual Results (In-Pit Wells)

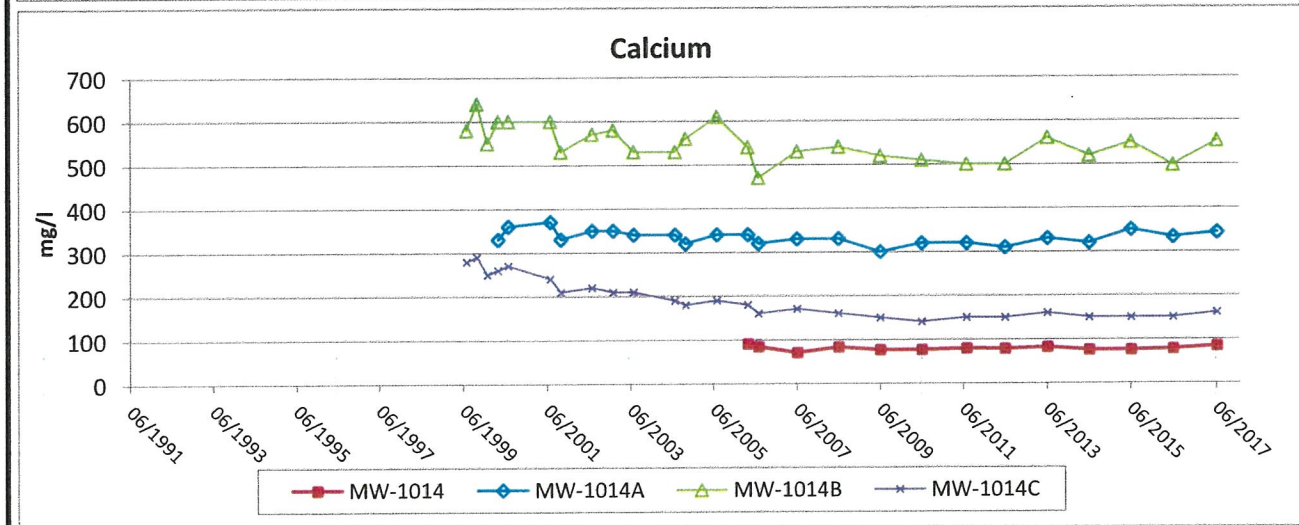
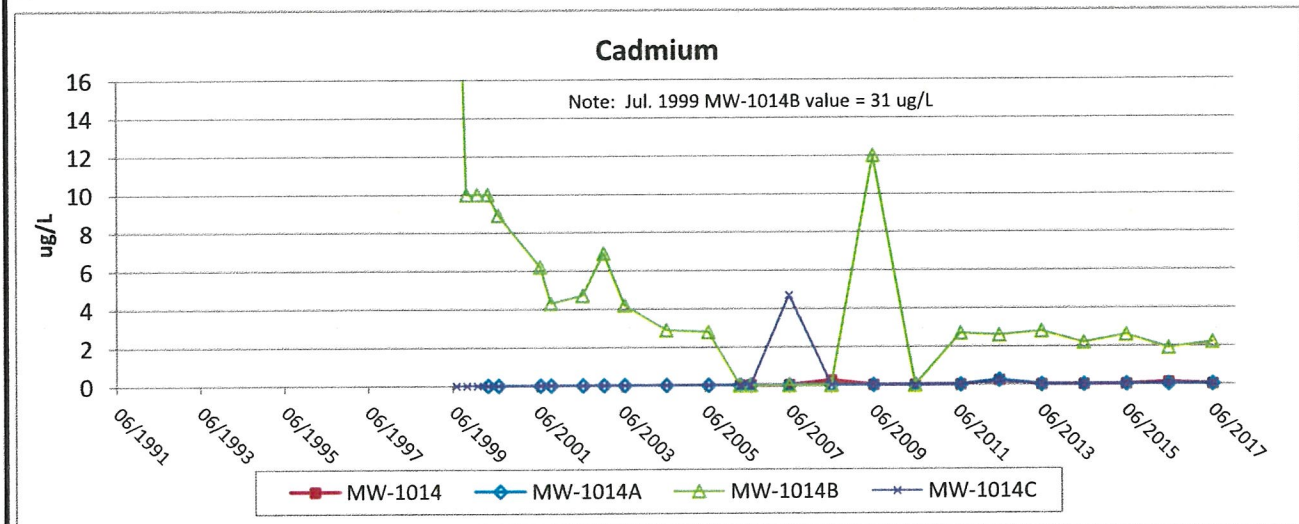
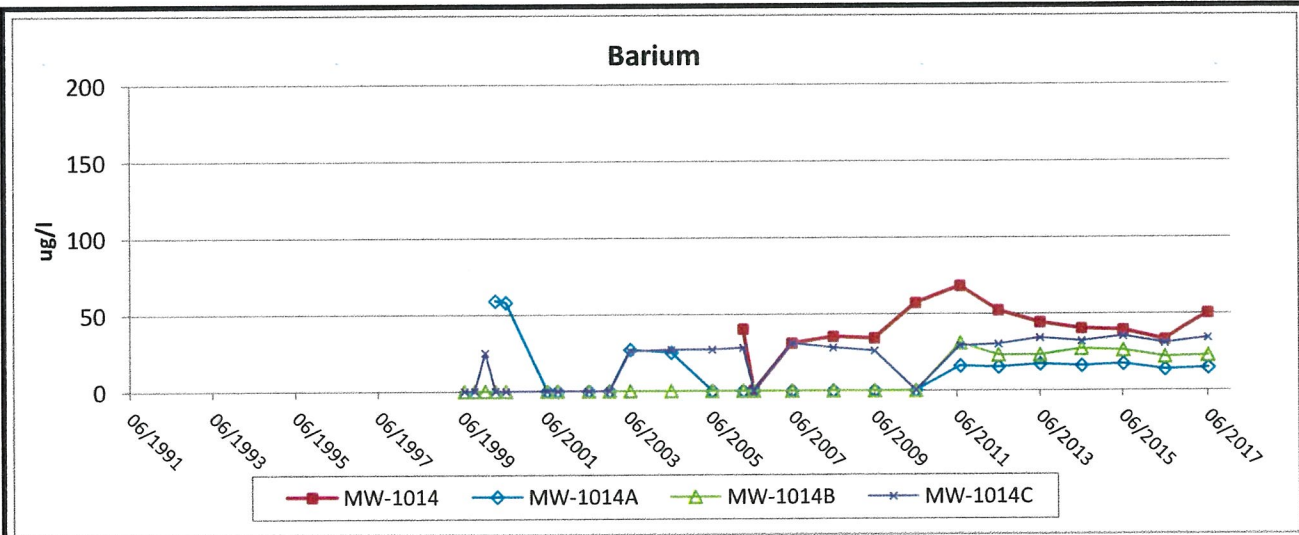
MW-1013/MW-1013A/MW-1013B/MW-1013C


Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	



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Figure B-13e	
Groundwater Trend Graphs - Annual Results (In-Pit Wells)	
MW-1013/MW-1013A/MW-1013B/MW-1013C	
Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	

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Figure B-14a

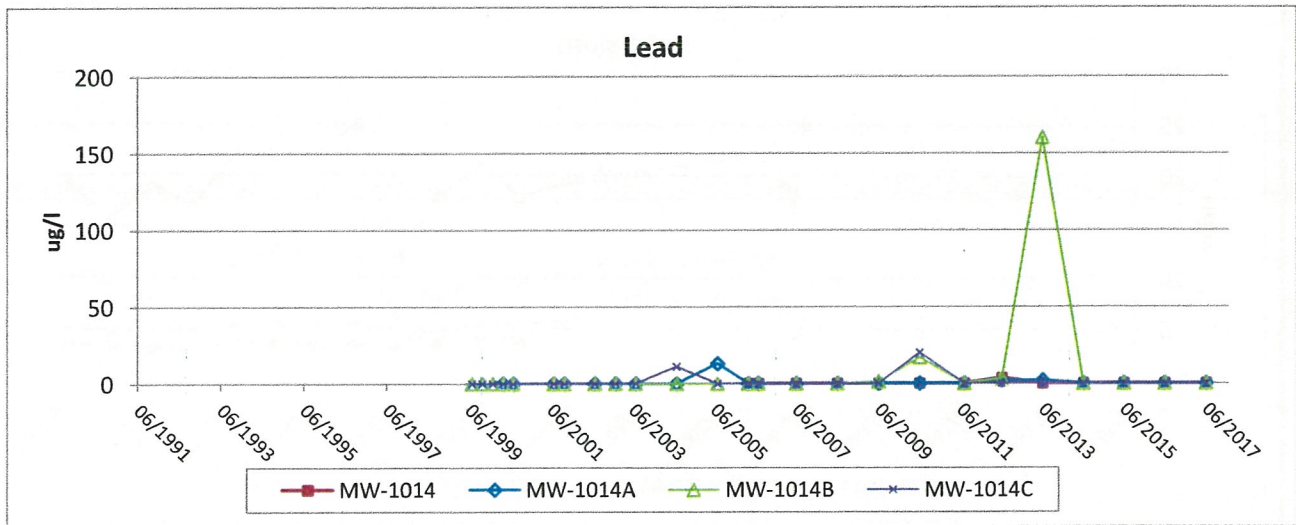
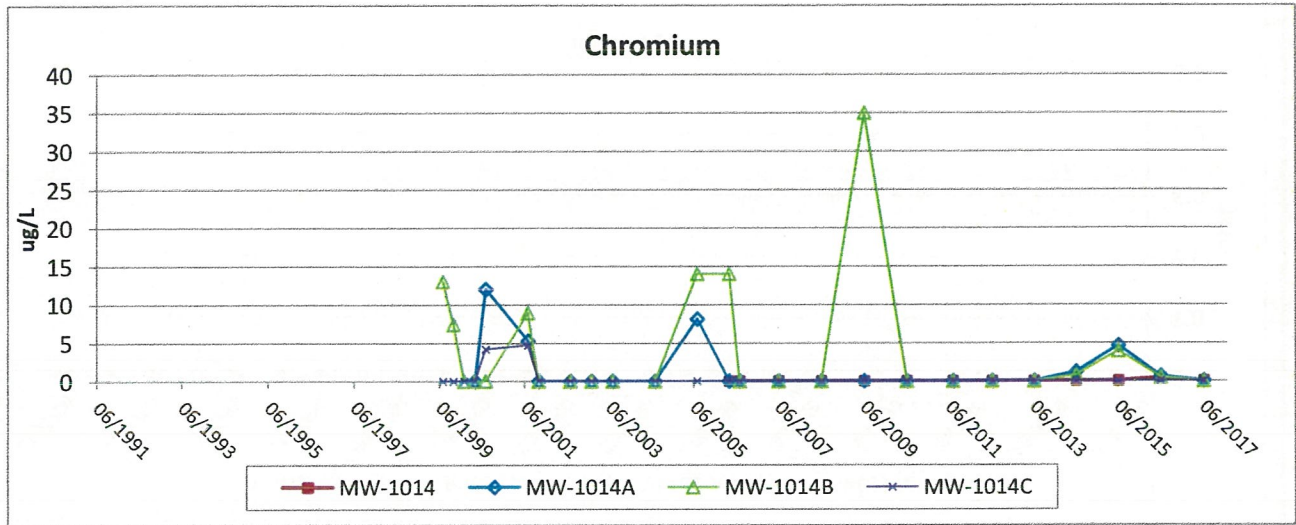
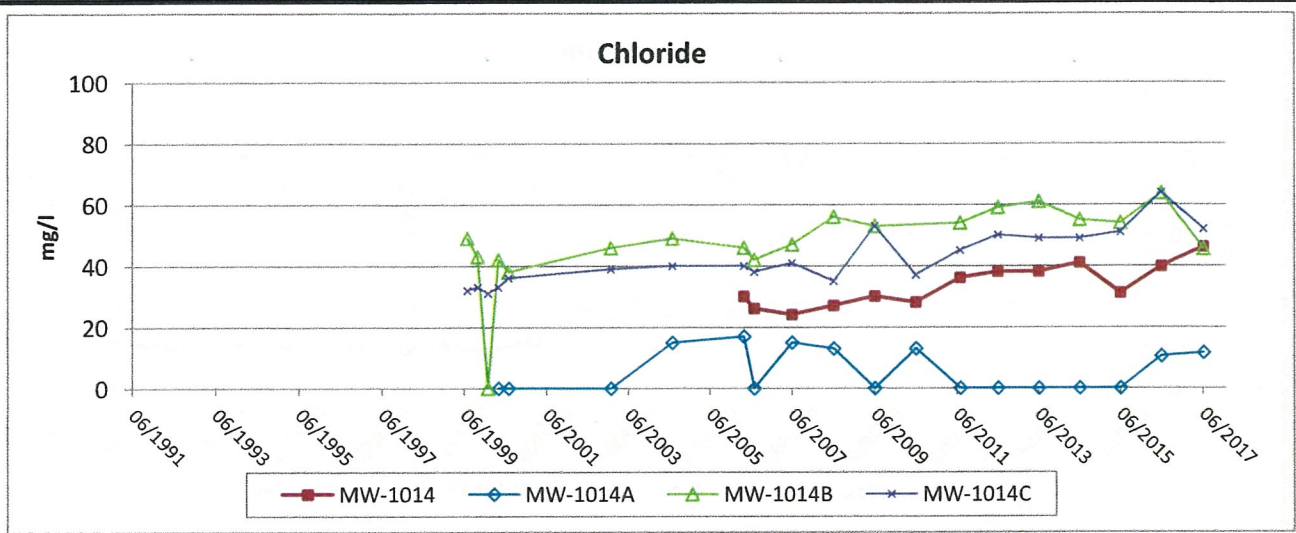
Groundwater Trend Graphs - Annual Results (In-Pit Wells)

MW-1014/MW-1014A/MW-1014B/MW-1014C

Scale: NA Date: January 2018

Prepared By: SGL Checked By: SVF Scope: 17F777-00

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Figure B-14b

Groundwater Trend Graphs - Annual Results (In-Pit Wells)
MW-1014/MW-1014A/MW-1014B/MW-1014C

Scale: NA

Date: January 2018

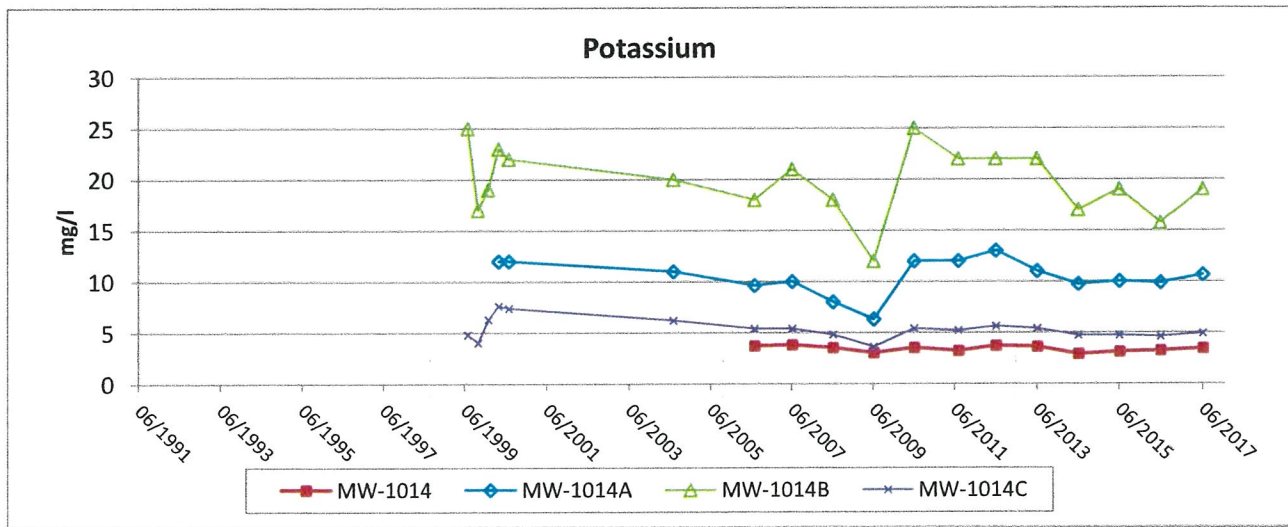
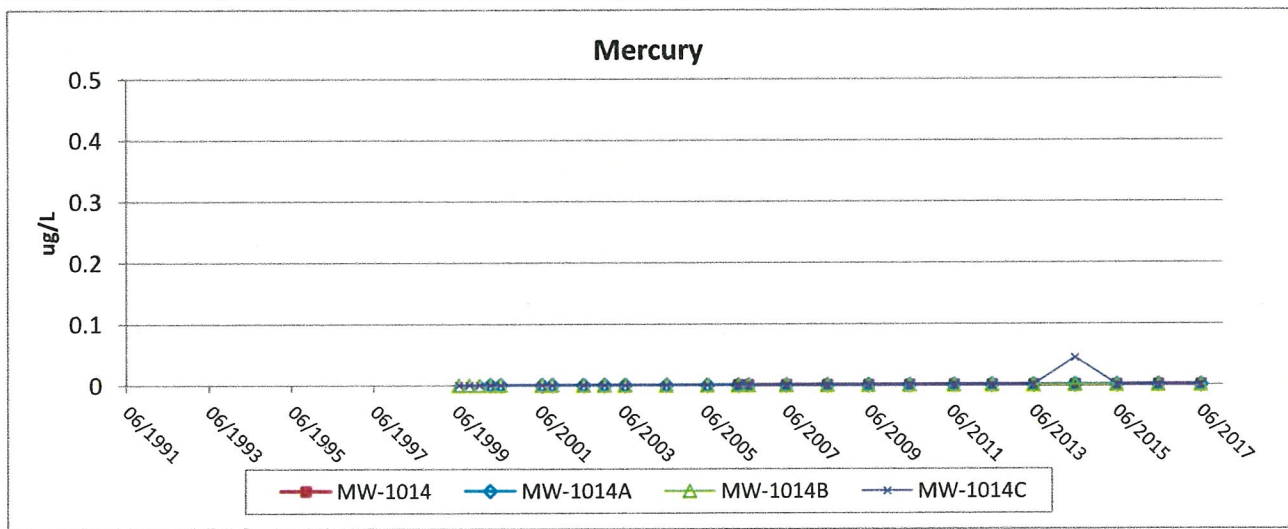
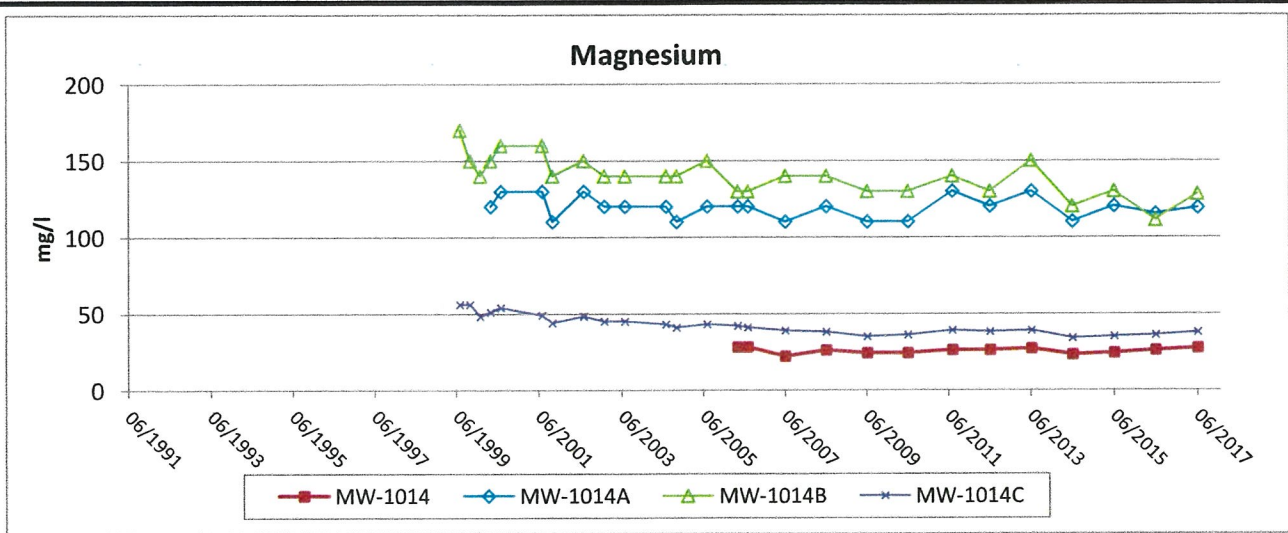
Prepared By: SGL


Checked By: SVF

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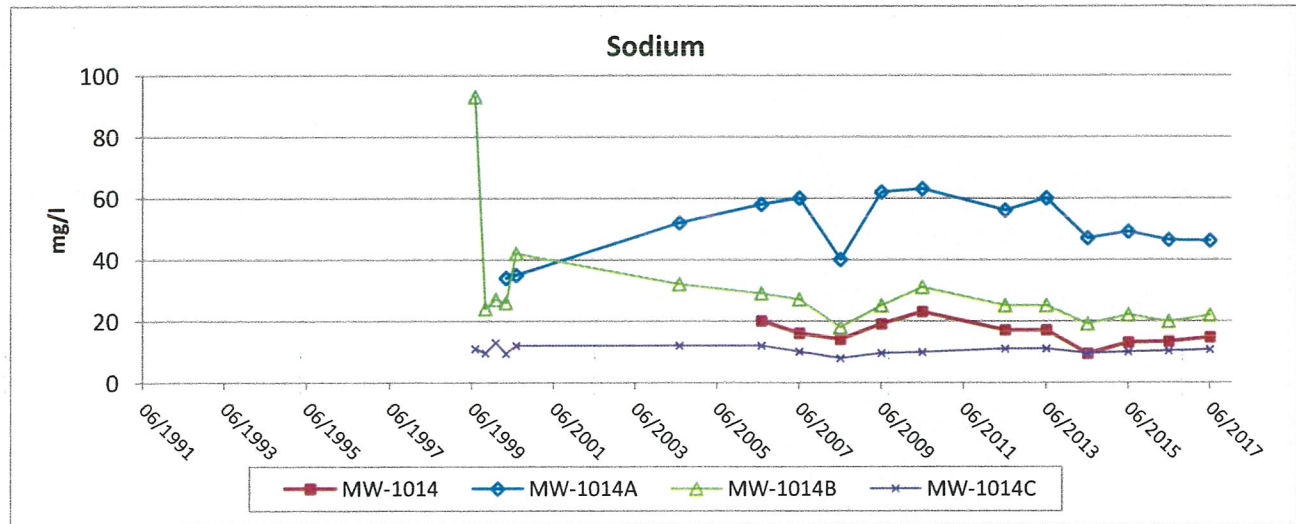
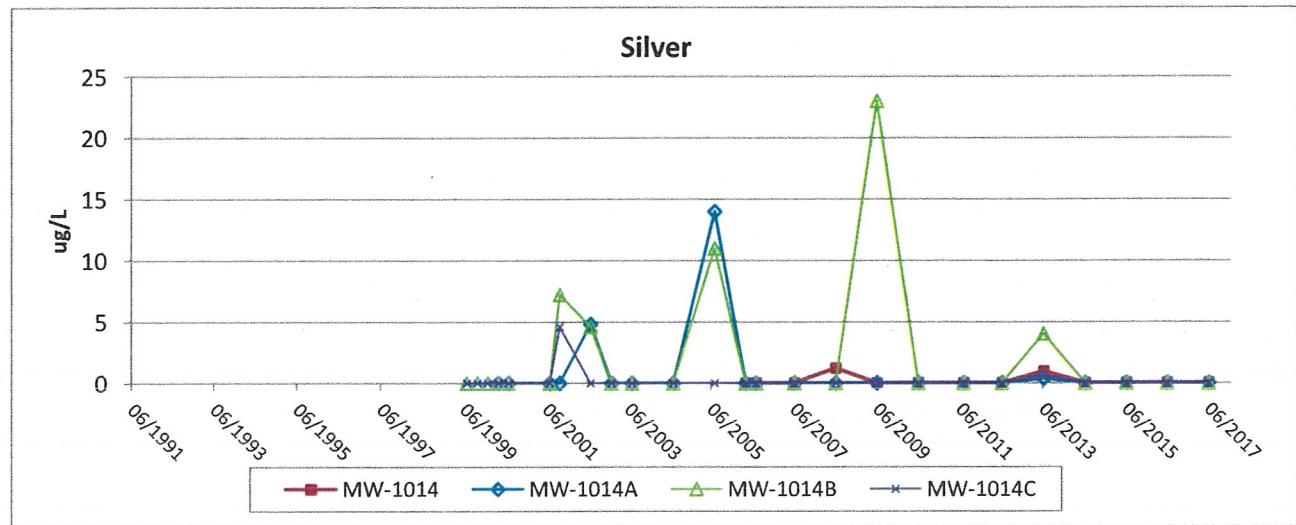
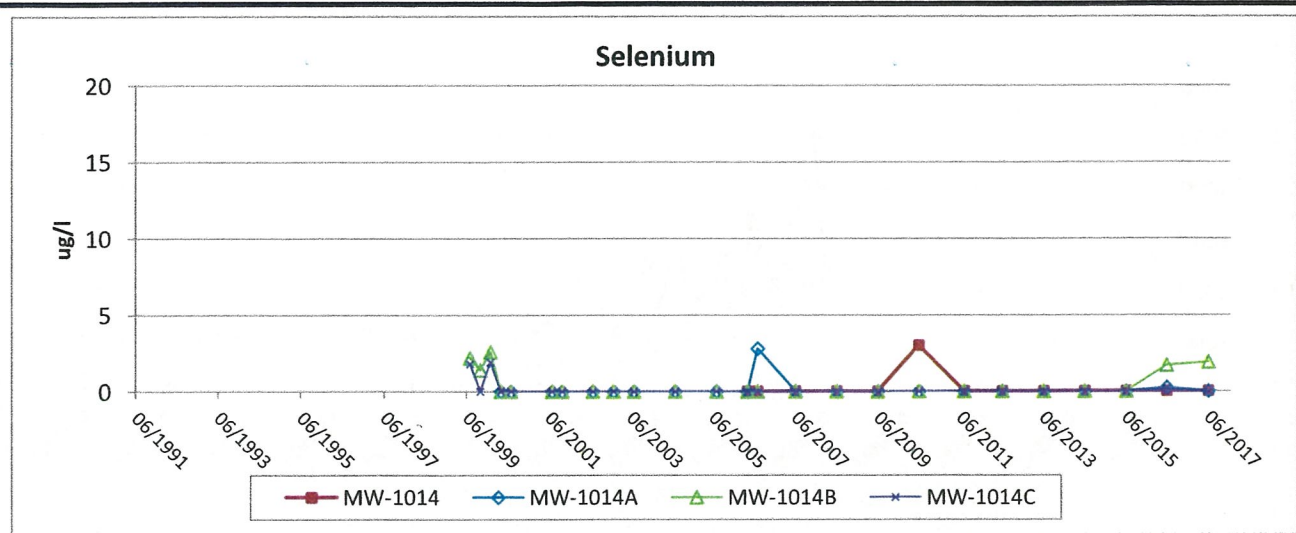
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Figure B-14c

Groundwater Trend Graphs - Annual Results (In-Pit Wells)

MW-1014/MW-1014A/MW-1014B/MW-1014C

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	



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Figure B-14d

Groundwater Trend Graphs - Annual Results (In-Pit Wells)

MW-1014/MW-1014A/MW-1014B/MW-1014C

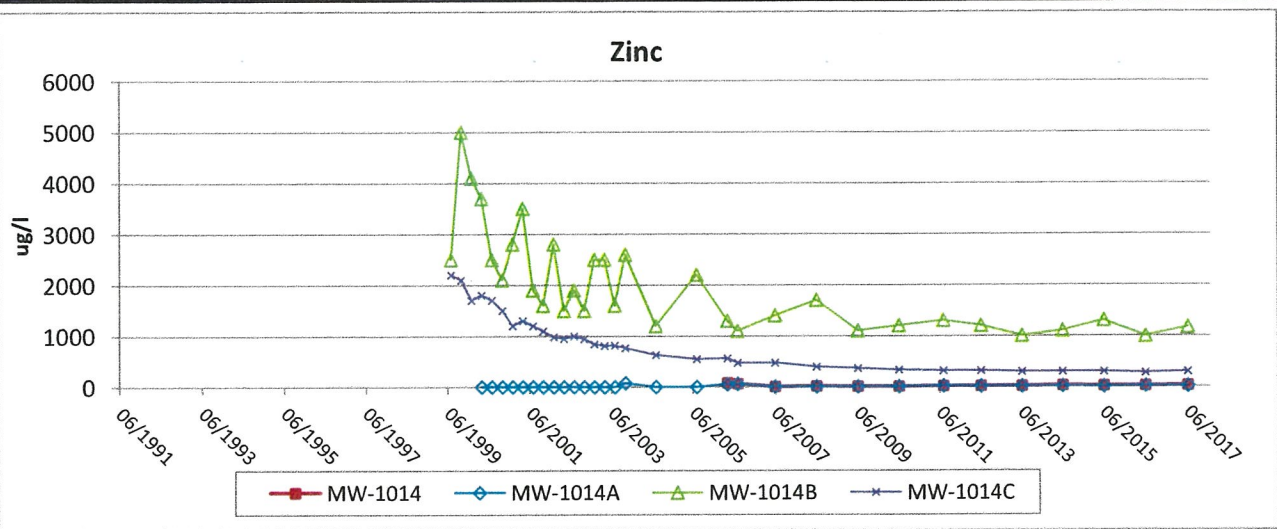
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Date: January 2018

Prepared By: SGL

Checked By: SVF

Scope: 17F777-00



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Figure B-14e	
Groundwater Trend Graphs - Annual Results (In-Pit Wells)	
MW-1014/MW-1014A/MW-1014B/MW-1014C	
Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	

Historical Groundwater Results - Annual Parameters

Sample Date Location (yyyy-mm)	Barium ug/l	Cadmium ug/l	Calcium mg/l	Chloride mg/l	Chromium ug/l	Lead ug/l	Magnesium mg/l	Mercury ug/l	Potassium mg/l	Selenium ug/l	Silver ug/l	Sodium mg/l	Zinc ug/l
1999-07 MW-1000PR	<50	28	220	10	<4.2	<14	61	<0.05	2.6	<1.3	<4.5	10	890
1999-07 MW-1000PR	<50	<21	220	10	<4.2	<14	62	<0.05	2.8	1.6	<4.5	10	880
1999-07 MW-1002	6.7	2.6	15	2	1	<1.4	4.9	<0.05	<1.1	<1.3	<4.5	2.8	<12
1999-07 MW-1002G	24	3.5	25	9.7	<0.42	<1.4	9.5	<0.05	<1.1	<1.3	<4.5	4.7	<12
1999-07 MW-1004P	40	<2.1	34	<1.7	0.58	<1.4	15	<0.05	3.6	<1.3	<4.5	6.1	<12
1999-07 MW-1004S	<5	<2.1	15	4.4	<0.42	<1.4	5.6	<0.05	<1.1	<1.3	<4.5	3.6	<12
1999-07 MW-1005	92	<2.1	45	240	1.5	<1.4	23	<0.05	<1.1	<1.3	<4.5	13	<12
1999-07 MW-1005P	65	<2.1	52	3.5	<0.42	<1.4	21	<0.05	8.1	<1.3	<4.5	9	<12
1999-07 MW-1005S	39	<2.1	38	<1.7	0.57	<1.4	13	<0.05	2.1	<1.3	<4.5	5.6	<12
1999-07 MW-1010P	38	<2.1	39	2.9	<0.42	<1.4	11	<0.05	1.8	<1.3	<4.5	5.1	<12
1999-07 MW-1013B	<50	<2.1	630	35	16	<14	150	<0.05	8.2	1.7	<4.5	35	<120
1999-07 MW-1013C	<50	<2.1	570	50	<4.2	<14	170	<0.05	25	3	<4.5	93	670
1999-07 MW-1014B	<50	31	580	49	13	<14	170	<0.05	23	2.2	<4.5	11	2500
1999-07 MW-1014C	<50	<2.1	280	32	<4.2	<14	56	<0.05	4.8	1.8	<4.5	11	2200
1999-10 MW-1000PR	43	<2.1	210	11	2.6	<2.9	56	<0.05	2.9	<1.3	<0.9	7.9	730
1999-10 MW-1004P	41	0.22	33	<1.7	0.53	<1.4	13	<0.05	5.9	<1.3	<0.45	5.8	<12
1999-10 MW-1004S	<5	0.38	15	4.4	0.88	<1.4	4.9	<0.05	1.1	<1.3	<0.45	7.7	<12
1999-10 MW-1010P	40	0.29	38	3.1	<0.42	<1.4	9.8	<0.05	2.7	<1.3	<0.45	4.7	<12
1999-10 MW-1013B	41	<0.21	40	2.6	<0.42	<1.4	10	<0.05	2.6	<1.3	<0.45	3.7	<12
1999-10 MW-1013C	<50	<4.2	650	35	14	<14	150	<0.05	5.9	<1.3	<4.5	26	<120
1999-10 MW-1014B	<50	<4.2	610	50	7.2	<14	170	<0.05	26	<1.3	<4.5	29	660
1999-10 MW-1014C	<50	10	640	43	7.4	<14	150	<0.05	17	1.4	<4.5	24	5000
2000-01 MW-1013B	<50	<2.1	290	33	<4.2	<14	56	<0.05	4	<1.3	<4.5	9.6	2100
2000-01 MW-1013C	<50	<2.1	600	28	18	<14	150	<0.05	6.4	<1.3	<4.5	33	<120
2000-01 MW-1014B	<50	2.1	550	58	<4.2	<14	170	<0.05	23	<1.3	5.2	39	630
2000-01 MW-1014C	<50	10	550	<100	<4.2	<14	140	<0.05	19	2.6	<4.5	27	4100
2000-01 MW-1014C	25	<0.21	250	31	<0.42	<1.4	48	<0.05	6.3	1.9	<0.45	13	1700
2000-04 MW-1013B	<50	<3.1	630	35	<6.2	<24	150	<0.05	8.5	<7.8	<4.7	27	<120
2000-04 MW-1013C	<50	<3.1	590	50	<6.2	<24	170	<0.05	25	<7.8	<4.7	34	610
2000-04 MW-1014A	59	<3.1	330	<50	<6.2	<24	120	<0.05	12	<7.8	<4.7	34	<120
2000-04 MW-1014B	<50	10	600	42	<6.2	<24	150	<0.05	23	<7.8	<4.7	26	3700
2000-04 MW-1014C	<50	<3.1	260	33	<6.2	<24	51	<0.05	7.6	<7.8	<4.7	9.4	1800
2000-07 MW-1000PR	38	<1			<3.7	<7.2		<0.05		<1.6	<2.7		620
2000-07 MW-1002	7.3	<0.21			0.77	<1.4		<0.05		<1.6	<0.55		<12
2000-07 MW-1002G	27	<0.21			<0.74	<1.4		<0.05		1.9	<0.55		<12
2000-07 MW-1004P	43	<0.21			<0.74	<1.4		<0.05		<1.6	<0.55		<12
2000-07 MW-1004S	<5	<0.21			1	<1.4		<0.05		1.7	<0.55		<12
2000-07 MW-1005	94	<0.21			1.1	<1.4		<0.05		<1.6	<0.55		<12
2000-07 MW-1005P	70	0.28			<0.74	<1.4		<0.05		<1.6	<0.55		<12
2000-07 MW-1005S	46	<0.21			<0.74	<1.4		<0.05		1.6	<0.55		<12
2000-07 MW-1010P	39	<1			<3.7	<7.2		<0.05		1.8	<2.7		<60
2000-07 MW-1010P	39	0.69			<0.74	<1.4		<0.05		<1.6	<0.55		<12
2000-07 MW-1013B	<50	<2.3	670	<40	5.1	<9.6	160	<0.05	7.2	<17	<5.5	34	<120
2000-07 MW-1013C	<50	<2.3	620	56	<4	<9.6	180	<0.05	24	<17	<5.5	45	620
2000-07 MW-1014A	58	<2.3	360	<25	12	<9.6	130	<0.05	12	<17	<5.5	35	<120
2000-07 MW-1014B	<50	8.9	600	38	<4	<9.6	160	<0.05	22	<17	<5.5	42	2500
2000-07 MW-1014C	<50	<2.3	270	36	4.2	<9.6	54	<0.05	7.4	<17	<5.5	12	1700
2000-10 MW-1000PR													900

Historical Groundwater Results - Annual Parameters

Sample Date Location (yyyy-mm)	Barium ug/l	Cadmium ug/l	Calcium mg/l	Chloride mg/l	Chromium ug/l	Lead ug/l	Magnesium mg/l	Mercury ug/l	Potassium mg/l	Selenium ug/l	Silver ug/l	Sodium mg/l	Zinc ug/l
2000-10 MW-1002													< 12
2000-10 MW-1002G													< 12
2000-10 MW-1004P													< 12
2000-10 MW-1004P Dup.													< 12
2000-10 MW-1004S													< 12
2000-10 MW-1005													< 12
2000-10 MW-1005P													< 12
2000-10 MW-1005S													< 12
2000-10 MW-1010P													< 12
2000-10 MW-1013B													< 12
2000-10 MW-1013C													< 120
2000-10 MW-1014A													370
2000-10 MW-1014B													< 120
2000-10 MW-1014C													2100
2001-01 MW-1000PR													1500
2001-01 MW-1002													810
2001-01 MW-1002G													< 12
2001-01 MW-1004P													< 12
2001-01 MW-1004S													< 12
2001-01 MW-1005													< 12
2001-01 MW-1005P													< 12
2001-01 MW-1005S													< 12
2001-01 MW-1010P													< 12
2001-01 MW-1013B													< 120
2001-01 MW-1013C Dup.													480
2001-01 MW-1014A													470
2001-01 MW-1014B													< 120
2001-01 MW-1014C													2800
2001-04 MW-1000PR													1200
2001-04 MW-1002													600
2001-04 MW-1002G													< 12
2001-04 MW-1004P Dup.													< 12
2001-04 MW-1004S													< 12
2001-04 MW-1005													< 12
2001-04 MW-1005P													< 12
2001-04 MW-1005S													< 12
2001-04 MW-1010P													< 12
2001-04 MW-1013B													< 120
2001-04 MW-1013C													330
2001-04 MW-1014A													< 120
2001-04 MW-1014B													3500
2001-04 MW-1014C													1300
2001-04 MW-1015A	22	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-04 MW-1015B	51	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-05 MW-1015A	19	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-05 MW-1015B	48	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-06 MW-1015A	18	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12

Historical Groundwater Results - Annual Parameters

Sample Date Location (yyyy-mm)	Barium ug/l	Cadmium ug/l	Calcium mg/l	Chloride mg/l	Chromium ug/l	Lead ug/l	Magnesium mg/l	Mercury ug/l	Potassium mg/l	Selenium ug/l	Silver ug/l	Sodium mg/l	Zinc ug/l
2001-06 MW-1015B	46	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-07 MW-1000PR	36	< 1.1	190		< 2.9	< 4.6	47	< 0.05		< 1.6	< 2.8		860
2001-07 MW-1002	7.7	< 0.23			1.4	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-07 MW-1002G	26	< 0.23			0.81	< 0.92		< 0.05		< 1.6	< 0.56		19
2001-07 MW-1004P	41	< 0.23	35		< 0.57	< 0.92	14	< 0.05		< 1.6	< 0.56		< 12
2001-07 MW-1004S	< 5	< 0.23	16		1.4	< 0.92	5.1	< 0.05		< 1.6	< 0.56		< 12
2001-07 MW-1005	82	< 0.23			1.9	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-07 MW-1005P	89	0.4	56		0.58	< 0.92	22	< 0.05		< 1.6	< 0.56		< 12
2001-07 MW-1005P Dup.	68	< 0.23	56		< 0.57	< 0.92	22	< 0.05		< 1.6	< 0.56		< 12
2001-07 MW-1005S	45	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-07 MW-1010P	42	0.28	42		< 0.57	< 0.92	11	< 0.05		< 1.6	< 0.56		< 12
2001-07 MW-1013B	< 50	3.2	700		6.4	< 7.9	160	< 0.05		< 1.0	6.5		130
2001-07 MW-1013C	< 50	< 1.7	630		< 3.4	< 7.9	180	< 0.05		< 1.0	< 3.1		570
2001-07 MW-1014A	< 50	< 1.7	370		5.3	< 7.9	130	< 0.05		< 1.0	< 3.1		< 120
2001-07 MW-1014B	< 50	6.2	600		8.9	< 7.9	160	< 0.05		< 1.0	< 3.1		1900
2001-07 MW-1014C	< 50	< 1.7	240		4.7	< 7.9	49	< 0.05		< 1.0	< 3.1		1200
2001-07 MW-1015A	17	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-07 MW-1015B	47	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-08 MW-1015A	17	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	0.99		< 12
2001-08 MW-1015B	48	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-09 MW-1015A	15	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-09 MW-1015B	43	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-10 MW-1000PR	32	< 1.1	160		< 2.9	< 4.6	40	< 0.05		< 1.6	< 2.8		440
2001-10 MW-1002													< 12
2001-10 MW-1002G													< 12
2001-10 MW-1004P	39	< 0.23	31		< 0.57	< 0.92	12	< 0.05		< 1.6	< 0.56		< 12
2001-10 MW-1004S	< 5	< 0.23	13		0.83	< 0.92	4.4	< 0.05		< 1.6	< 0.56		< 12
2001-10 MW-1004S Dup.	< 5	< 0.23	13		0.68	< 0.92	4.3	< 0.05		2.2	< 0.56		< 12
2001-10 MW-1005													< 12
2001-10 MW-1005P													< 12
2001-10 MW-1005S													< 12
2001-10 MW-1010P	33	< 0.23	35		< 0.57	< 0.92	8.4	< 0.05		1.7	< 0.56		< 12
2001-10 MW-1013B	< 50	< 1.7	600		4.8	< 7.9	130	< 0.05		< 16	6		130
2001-10 MW-1013C	< 50	< 1.7	550		< 3.4	< 7.9	160	< 0.05		< 16	6.8		510
2001-10 MW-1014A	< 50	< 1.7	330		< 3.4	< 7.9	110	< 0.05		< 16	< 3.1		< 120
2001-10 MW-1014B	< 50	4.3	530		< 3.4	< 7.9	140	< 0.05		< 16	7.2		1600
2001-10 MW-1014C	< 50	< 1.7	210		< 3.4	< 7.9	44	< 0.05		< 1.6	4.6		1100
2001-10 MW-1015A	14	< 0.23	19		< 0.57	< 0.92	7.4	< 0.05		< 1.6	< 0.56		< 12
2001-10 MW-1015B	41	< 0.23	30		< 0.57	< 0.92	12	< 0.05		< 1.6	< 0.56		< 12
2001-11 MW-1015A	14	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-11 MW-1015B	43	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-12 MW-1015A	14	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2001-12 MW-1015B	44	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2002-01 MW-1000PR													690
2002-01 MW-1002													< 12
2002-01 MW-1002G													< 12
2002-01 MW-1004P													< 12
2002-01 MW-1004P Dup.													< 12
2002-01 MW-1004S													< 12

Historical Groundwater Results - Annual Parameters

Sample Date Location (yyyy-mm)	Barium ug/l	Cadmium ug/l	Calcium mg/l	Chloride mg/l	Chromium ug/l	Lead ug/l	Magnesium mg/l	Mercury ug/l	Potassium mg/l	Selenium ug/l	Silver ug/l	Sodium mg/l	Zinc ug/l
2002-01 MW-1005													< 12
2002-01 MW-1005P													< 12
2002-01 MW-1005S													< 12
2002-01 MW-1010P													< 12
2002-01 MW-1013B													< 120
2002-01 MW-1013C													500
2002-01 MW-1014A													< 120
2002-01 MW-1014B													2800
2002-01 MW-1014C													980
2002-01 MW-1015A	14	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2002-01 MW-1015B	43	< 0.23			< 0.57	< 0.92		< 0.05		< 1.6	< 0.56		< 12
2002-02 MW-1015A	14	< 0.23			< 0.57	< 0.92		< 0.05		< 2.5	< 0.56		< 12
2002-02 MW-1015B	44	< 0.23			< 0.57	< 0.92		< 0.05		< 2.5	< 0.56		< 12
2002-03 MW-1015A	14	< 0.23			< 0.57	< 0.92		< 0.05		< 2.5	< 0.56		< 12
2002-03 MW-1015B	46	< 0.23			< 0.57	< 0.92		< 0.05		< 2.5	< 0.56		< 12
2002-04 MW-1000PR													410
2002-04 MW-1002													< 10
2002-04 MW-1002													< 10
2002-04 MW-1002G	Dup.												< 10
2002-04 MW-1004P													< 10
2002-04 MW-1004S													< 10
2002-04 MW-1005													< 10
2002-04 MW-1005P													< 10
2002-04 MW-1005S													< 10
2002-04 MW-1010P													< 10
2002-04 MW-1013B													< 120
2002-04 MW-1013C													360
2002-04 MW-1014A													< 120
2002-04 MW-1014B													1500
2002-04 MW-1014C													950
2002-04 MW-1015A													< 10
2002-04 MW-1015B													< 10
2002-07 MW-1000PR	40	< 1.1	170		< 2.2	< 9.2	44	< 0.05		< 2.5	3.1		640
2002-07 MW-1002	7.8	< 0.23	17		0.79	< 0.92	5.6	< 0.05		< 2.5	< 0.47		< 10
2002-07 MW-1002G	27	< 0.23	27		< 0.44	< 0.92	10	< 0.05		< 2.5	< 0.47		< 10
2002-07 MW-1004P	40	< 0.23	33		< 0.44	< 0.92	13	< 0.05		< 2.5	< 0.47		< 10
2002-07 MW-1004S	< 5	< 0.23	16		0.59	< 0.92	5.4	< 0.05		< 2.5	< 0.47		< 10
2002-07 MW-1005	88	< 0.23	41		0.87	< 0.92	20	< 0.05		< 2.5	< 0.47		< 10
2002-07 MW-1005P	70	< 0.23	51		< 0.44	< 0.92	21	< 0.05		< 2.5	< 0.47		< 10
2002-07 MW-1005S	44	< 0.23	40		< 0.44	< 0.92	14	< 0.05		< 2.5	< 0.47		< 10
2002-07 MW-1010P	38	< 0.23	39		< 0.44	< 0.92	9.9	< 0.05		< 2.5	0.55		< 10
2002-07 MW-1013B	< 50	< 1.7	670		< 4.5	< 7.4	160	< 0.05		< 15	4.3		130
2002-07 MW-1013C	< 50	< 1.7	620		< 4.5	< 7.4	190	< 0.05		< 15	< 4.3		440
2002-07 MW-1014A	< 50	< 1.7	350		< 4.5	< 7.4	130	< 0.05		< 15	4.8		< 120
2002-07 MW-1014A	< 50	< 1.7	370		< 4.5	< 7.4	130	< 0.05		< 15	< 4.3		< 120
2002-07 MW-1014B	< 50	4.7	570		< 4.5	< 7.4	150	< 0.05		< 15	4.6		1900
2002-07 MW-1014C	< 50	< 1.7	220		< 4.5	< 7.4	48	< 0.05		< 15	< 4.3		1000
2002-07 MW-1015A	12	< 0.23	21		< 0.44	< 0.92	8.6	< 0.05		< 2.5	< 0.47		< 10
2002-07 MW-1015B	44	< 0.23	33		< 0.44	< 0.92	14	< 0.05		< 2.5	< 0.47		< 10

Historical Groundwater Results - Annual Parameters

Sample Date Location (yyyy-mm)	Barium ug/l	Cadmium ug/l	Calcium mg/l	Chloride mg/l	Chromium ug/l	Lead ug/l	Magnesium mg/l	Mercury ug/l	Potassium mg/l	Selenium ug/l	Silver ug/l	Sodium mg/l	Zinc ug/l
2002-10 MW-1000PR													690
2002-10 MW-1002													< 10
2002-10 MW-1002G													< 10
2002-10 MW-1004P													< 10
2002-10 MW-1004S													< 10
2002-10 MW-1005													< 10
2002-10 MW-1005 Dup.													< 10
2002-10 MW-1005P													< 10
2002-10 MW-1005S													< 10
2002-10 MW-1010P													< 10
2002-10 MW-1013B													130
2002-10 MW-1013C													480
2002-10 MW-1014A													< 120
2002-10 MW-1014B													1500
2002-10 MW-1014C													940
2002-10 MW-1015A													< 10
2002-10 MW-1015B													< 10
2003-01 MW-1000PR	42	< 1.1	170	16	< 2.2	< 9.2	41	< 0.05		< 13	< 2.4		700
2003-01 MW-1002													< 10
2003-01 MW-1002G													< 10
2003-01 MW-1004P													< 10
2003-01 MW-1004S													< 10
2003-01 MW-1005													< 10
2003-01 MW-1005P													< 10
2003-01 MW-1005S													< 10
2003-01 MW-1010P	36	< 0.23	39	< 5	< 0.44	< 0.92	9.8	< 0.05		< 2.5	< 0.47		< 10
2003-01 MW-1013B	< 50	2.4	640	< 50	< 4.5	< 7.4	150	< 0.05		< 30	5.8		130
2003-01 MW-1013C	< 50	< 1.7	600	53	< 4.5	< 7.4	180	< 0.05		< 30	5.7		440
2003-01 MW-1014A	< 50	< 1.7	350	< 20	< 4.5	< 7.4	120	< 0.05		< 30	< 4.3		< 120
2003-01 MW-1014B	< 50	6.9	580	46	< 4.5	< 7.4	140	< 0.05		< 30	< 4.3		2500
2003-01 MW-1014C	< 50	< 1.7	210	39	< 4.5	< 7.4	45	< 0.05		< 30	< 4.3		840
2003-01 MW-1014C Dup.	< 50	< 1.7	200	42	< 4.5	< 7.4	45	< 0.05		< 30	< 4.3		860
2003-01 MW-1015A													< 10
2003-01 MW-1015B													< 10
2003-04 MW-1000PR													680
2003-04 MW-1002													< 10
2003-04 MW-1002G													< 10
2003-04 MW-1004P													< 10
2003-04 MW-1004S													< 10
2003-04 MW-1005													< 10
2003-04 MW-1005P													< 10
2003-04 MW-1005S													< 10
2003-04 MW-1010P													< 10
2003-04 MW-1013B													< 10
2003-04 MW-1013C													130
2003-04 MW-1014A													310
2003-04 MW-1014B													< 100
2003-04 MW-1014C													2500
2003-04 MW-1015A													810
2003-04 MW-1015A													< 10

Historical Groundwater Results - Annual Parameters

Sample Date (yyyy-mm)	Location	Barium ug/l	Cadmium ug/l	Calcium mg/l	Chloride mg/l	Chromium ug/l	Lead ug/l	Magnesium mg/l	Mercury ug/l	Potassium mg/l	Selenium ug/l	Silver ug/l	Sodium mg/l	Zinc ug/l
2003-04	MW-1015B													< 10
2003-04	MW-1015B	Dup.												< 10
2003-07	MW-1000PR	42	< 0.85	170		< 2.2	< 4.7	40	< 0.025		< 2	< 2		730
2003-07	MW-1002	7.6	< 0.17	17		0.96	< 0.94	5.5	< 0.025		< 2	< 0.4		< 5
2003-07	MW-1002G	27	< 0.17	27		0.6	< 0.94	10	< 0.025		2.1	< 0.4		< 5
2003-07	MW-1004P	43	< 0.17	35		< 0.43	< 0.94	14	< 0.025		< 2	< 0.4		< 5
2003-07	MW-1004S	4.3	< 0.17	18		0.88	< 0.94	5.9	< 0.025		< 2	< 0.4		< 5
2003-07	MW-1005	150	< 0.85	80		< 0.43	< 0.94	37	< 0.025		< 2	< 2		< 5
2003-07	MW-1005P	67	< 0.17	55		< 0.43	< 0.94	22	< 0.025		< 2	< 0.4		< 5
2003-07	MW-1005S	42	< 0.17	41		< 0.43	< 0.94	14	< 0.025		< 2	< 0.4		< 5
2003-07	MW-1010P	39	< 0.17	42		0.5	< 0.94	10	< 0.025		< 2	< 0.4		< 5
2003-07	MW-1013B	< 25	< 2.1	660		< 6.4	< 10	150	< 0.025		< 2.7	< 7.7		140
2003-07	MW-1013B	< 25	< 2.1	660		< 6.4	< 10	150	< 0.025		< 2.7	< 7.7		130
2003-07	MW-1013C	Dup.												
2003-07	MW-1013C	< 25	< 2.1	610		< 6.4	< 10	180	< 0.025		< 2.7	< 7.7		320
2003-07	MW-1014A	27	< 2.1	340		< 6.4	< 10	120	< 0.025		< 2.7	< 7.7		< 50
2003-07	MW-1014B	< 25	4.2	530		< 6.4	< 10	140	< 0.025		< 2.7	< 7.7		1600
2003-07	MW-1014C	26	< 2.1	210		< 6.4	< 10	45	< 0.025		< 13	< 7.7		820
2003-07	MW-1015A	9.8	< 0.17	22		< 0.43	< 0.94	8.6	< 0.025		< 2	< 0.4		< 5
2003-07	MW-1015B	45	< 0.17	34		< 0.43	< 4.7	14	< 0.025		< 2	< 0.4		< 5
2003-10	MW-1000PR													700
2003-10	MW-1002													< 5
2003-10	MW-1002G													< 5
2003-10	MW-1004P													< 5
2003-10	MW-1004S													< 5
2003-10	MW-1005													< 5
2003-10	MW-1005P													< 5
2003-10	MW-1005S													< 5
2003-10	MW-1010P													< 5
2003-10	MW-1013B													140
2003-10	MW-1013B													150
2003-10	MW-1013C													400
2003-10	MW-1014A													77
2003-10	MW-1014B													2600
2003-10	MW-1014C													770
2003-10	MW-1015A													< 5
2003-10	MW-1015B													< 5
2004-04	MW-1000PR	RD	0.3	151	17.3	< 1	< 1	39.7	< 0.03		< 1	< 0.1		623
2004-04	MW-1010P	RD	0.06	40.9	3.2	< 1	< 1	10.4	< 0.03		< 1	< 0.1		< 16
2004-04	MW-1013C	RD	0.1	576	52.4	5.4	< 1	180	< 0.03		< 1	0.3		454
2004-04	MW-1014A	RD	1.05	331	10.9	1.5	< 1	119	< 0.03		< 1	< 0.1		< 16
2004-04	MW-1014B	RD	4.39	538	39	4.3	< 1	139	< 0.03		< 1	< 0.1		1470
2004-04	MW-1014C	RD	< 0.05	185	38.2	< 1	< 1	47.3	< 0.03		< 1	< 0.1		638
2004-07	MW-1000PR	41	< 0.8	150	18	< 2.3	< 5.2	37	< 0.025	3.9	< 2.1	< 3.4	9.3	830
2004-07	MW-1002	7.1	< 0.16	16	3.2	1.1	< 1	5	< 0.025	0.81	< 2.1	< 0.67	3.2	< 5
2004-07	MW-1002G	27	< 0.16	27	11	< 0.45	< 1	9.9	< 0.025	1.1	< 2.1	< 0.67	5.4	< 5
2004-07	MW-1004P	45	< 0.16	35	< 2.5	< 0.45	< 1	14	< 0.025	5.8	< 2.1	< 0.67	7.2	< 5
2004-07	MW-1004S	4.8	< 0.16	18	6.5	1.2	< 1	6.1	< 0.025	0.96	< 2.1	< 0.67	4.9	< 5
2004-07	MW-1005	130	< 0.16	63	210	< 0.45	< 1	30	< 0.025	0.78	< 2.1	< 0.67	17	< 5
2004-07	MW-1005P	69	< 0.16	54	4.2	< 0.45	< 1	21	< 0.025	8.7	< 2.1	< 0.67	7.4	< 5

Historical Groundwater Results - Annual Parameters

Sample Date (yyyy-mm)	Location	Barium ug/l	Cadmium ug/l	Calcium mg/l	Chloride mg/l	Chromium ug/l	Lead ug/l	Magnesium mg/l	Mercury ug/l	Potassium mg/l	Selenium ug/l	Silver ug/l	Sodium mg/l	Zinc ug/l
2004-07	MW-1005S	44	<0.16	40	2.6	<0.45	<1	14	<0.025	3.1	<2.1	<0.67	7	<5
2004-07	MW-1010P	46	<0.16	44	4.3	<0.45	<1	11	<0.025	2.6	<2.1	<0.67	5.3	<5
2004-07	MW-1013B	<25	<1.7	640	47	<5.1	20	150	<0.025	6.8	<8	<6.7	31	150
2004-07	MW-1013C	<25	<1.7	600	57	<5.1	<8.7	180	<0.025	26	<16	<6.7	42	460
2004-07	MW-1013C	Dup.	<1.7	590	61	<5.1	14	180	<0.025	25	<8	<6.7	41	460
2004-07	MW-1014A	25	<1.7	340	15	<5.1	<8.7	120	<0.025	11	<8	<6.7	52	<50
2004-07	MW-1014B	<25	2.9	530	49	<5.1	<8.7	140	<0.025	20	<8	<6.7	32	1200
2004-07	MW-1014C	27	<1.7	190	40	<5.1	11	43	<0.025	6.2	<8	<6.7	12	630
2004-07	MW-1015A	9.2	<0.16	21	5.8	<0.45	<1	8.5	<0.025	0.94	<2.1	<0.67	3.4	<5
2004-07	MW-1015B	44	<0.16	33	51	<0.45	<1	14	<0.13	5.9	<2.1	<0.67	39	<5
2004-10	MW-1000PR			140				35						
2004-10	MW-1002			15				4.6						
2004-10	MW-1002G			24				9						
2004-10	MW-1004P			33				13						
2004-10	MW-1004S			17				5.6						
2004-10	MW-1005			60				29						
2004-10	MW-1005P			51				20						
2004-10	MW-1005S			38				13						
2004-10	MW-1010P			42				11						
2004-10	MW-1013B			640				140						
2004-10	MW-1013C			580				170						
2004-10	MW-1014A			320				110						
2004-10	MW-1014B			560				140						
2004-10	MW-1014C			180				41						
2004-10	MW-1015A			20				8						
2004-10	MW-1015B			32				13						
2004-10	MW-1015B	Dup.		32				13						
2005-07	MW-1000PR	44	<0.17	160		1.2	<1.2	40	<0.025		<2	1.4		650
2005-07	MW-1002	6.2	<0.17	14		1.2	<1.2	4.6	<0.025		<2	<0.47		<5
2005-07	MW-1002G	26	<0.17	27		<0.55	<1.2	10	<0.025		<2	<0.47		<5
2005-07	MW-1004P	42	<0.17	36		<0.55	<1.2	15	<0.025		<2	<0.47		<5
2005-07	MW-1004S	4.8	<0.17	20		<0.55	<1.2	6.9	<0.025		<2	<0.47		<5
2005-07	MW-1004S	Dup.		20		1.3	<1.2	6.9	<0.025		<2	0.95		<5
2005-07	MW-1005	77	0.44	40		1.5	<1.2	20	<0.025		<2	1.2		<5
2005-07	MW-1005P	69	<0.17	57		<0.55	<1.2	23	<0.025		<2	<0.47		7.1
2005-07	MW-1005S	44	<0.17	42		<0.55	<1.2	15	<0.025		<2	<0.47		<5
2005-07	MW-1010P	42	<0.17	46		<0.55	<1.2	11	<0.025		<2	<0.47		<5
2005-07	MW-1013B	<25	<1.7	690		<4.5	<10	150	<0.025		<1.9	<6.7		200
2005-07	MW-1013C	<25	<1.7	630		32	<10	190	<0.025		<1.9	<6.7		460
2005-07	MW-1014A	<25	<1.7	340		8.1	13	120	<0.025		<7.4	14		<50
2005-07	MW-1014B	<25	2.8	610		14	<10	150	<0.025		<1.9	11		2200
2005-07	MW-1014C	27	<1.7	190		<4.5	<10	43	<0.025		<1.9	<6.7		550
2005-07	MW-1015A	8.9	<0.17	22		<0.55	<1.2	9	<0.025		<2	<0.47		<5
2005-07	MW-1015B	43	<0.17	36		<0.55	<1.2	15	<0.025		<2	<0.47		<5
2006-04	MW-1000PR	40	<0.17	150	18	<0.88	2.9	37	<0.025		<1.8	<1.1		580
2006-04	MW-1010P	48	<0.17	46	4.1	<0.88	<1.3	12	<0.025		<1.8	<1.1		<5
2006-04	MW-1013	150	<1.7	150	18	<10	14	44	<0.025		<2.4	<12		<50
2006-04	MW-1013A	120	<1.7	190	11	<10	19	62	<0.025		<2.4	<12		61
2006-04	MW-1013B	<25	<1.7	650	48	<10	<13	150	<0.025		<2.4	<12		210

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Sample Date (yyyy-mm)	Location	Barium ug/l	Cadmium ug/l	Calcium mg/l	Chloride mg/l	Chromium ug/l	Lead ug/l	Magnesium mg/l	Mercury ug/l	Potassium mg/l	Selenium ug/l	Silver ug/l	Sodium mg/l	Zinc ug/l
2006-04	MW-1013C	<25	<1.7	620	61	<10	<13	180	<0.025		<2.4	<12		470
2006-04	MW-1014	40	<1.7	91	30	<10	<13	28	<0.025		<2.4	<12		79
2006-04	MW-1014A	<25	<1.7	340	17	<10	<13	120	<0.025		<2.4	<12		55
2006-04	MW-1014B	<25	<1.7	540	46	14	<13	130	<0.025		<2.4	<12		1300
2006-04	MW-1014C	28	<1.7	180	40	<10	<13	42	<0.025		<2.4	<12		560
2006-07	MW-1000PR	42	<0.17	130	18	<0.88	<1.3	36	<0.025	3.9	<1.8	<1.1	7.7	500
2006-07	MW-1002	6.3	<0.17	13	3.5	<0.88	<1.3	4.7	<0.025	0.59	<1.8	<1.1	3.1	<5
2006-07	MW-1002G	26	<0.17	24	10	<0.88	<1.3	9.6	<0.025	0.84	<1.8	<1.1	5.4	<5
2006-07	MW-1004P	40	<0.17	32	<2.5	<0.88	<1.3	14	<0.025	5.9	<1.8	<1.1	7.1	20
2006-07	MW-1004S	5.3	<0.17	19	5.6	<0.88	<1.3	6.8	<0.025	0.87	<1.8	<1.1	5.1	<5
2006-07	MW-1005	110	<0.17	48	200	<0.88	<1.3	24	<0.025	0.71	<1.8	<1.1	21	<5
2006-07	MW-1005P	67	<0.17	48	4	<0.88	<1.3	21	<0.025	9.2	<1.8	<1.1	7.2	<5
2006-07	MW-1005S	44	<0.17	37	<2.5	<0.88	<1.3	14	<0.025	3.1	<1.8	<1.1	7.2	<5
2006-07	MW-1010P	46	<0.17	40	4.2	<0.88	<1.3	12	<0.025	2.6	<1.8	<1.1	5.3	<5
2006-07	MW-1013	160	<1.7	140	17	<10	<13	45	<0.025	3.1	<2.4	<12	19	<50
2006-07	MW-1013 Dup.	150	<1.7	140	17	<10	<13	43	<0.025	3.1	3.4	<12	18	<50
2006-07	MW-1013A	99	<1.7	120	6.7	<10	<13	42	<0.025	7.1	<2.4	<12	35	<50
2006-07	MW-1013B	<25	<1.7	630	46	<10	<13	150	<0.025	6.3	<4.8	<12	31	210
2006-07	MW-1013C	<25	<1.7	580	53	<10	<13	180	<0.025	24	2.7	<12	43	440
2006-07	MW-1014	<25	<1.7	84	26	<10	<13	28	<0.025	3.7	<2.4	<12	20	59
2006-07	MW-1014A	<25	<1.7	320	<18	<10	<13	120	<0.025	9.6	2.8	<12	58	57
2006-07	MW-1014B	<25	<1.7	470	42	<10	<13	130	<0.025	18	<2.4	<12	29	1100
2006-07	MW-1014C	<25	<1.7	160	38	<10	<13	41	<0.025	5.4	<2.4	<12	12	470
2006-07	MW-1015A	8.5	<0.17	19	5.7	<0.88	<1.3	8.3	<0.025	0.83	<1.8	<1.1	3.5	<5
2006-07	MW-1015B	43	<0.17	32	7.7	<0.88	<1.3	14	<0.025	6.5	<1.8	<1.1	4.6	<5
2007-06	MW-1000PR	40	<0.17	140	17	<0.88	<1.3	36	<0.025	3.7	<1.8	<1.1	7.2	490
2007-06	MW-1002	5.3	<0.17	12	3.1	<0.88	<1.3	3.8	<0.025	0.6	<1.8	<1.1	2.4	<5
2007-06	MW-1002G	26	<0.17	26	13	<0.88	<1.3	9.5	<0.025	0.74	<1.8	<1.1	4.9	<5
2007-06	MW-1004P	43	<0.17	34	2.7	<0.88	<1.3	13	<0.025	5.7	<1.8	<1.1	6.7	<5
2007-06	MW-1004S	5.7	<0.17	22	6.1	<0.88	<1.3	7.4	<0.025	0.94	<1.8	<1.1	5.1	<5
2007-06	MW-1005	81	<0.17	39	120	<0.88	<1.3	19	<0.025	0.54	<1.8	<1.1	12	<5
2007-06	MW-1005P	67	<0.17	53	4.4	<0.88	<1.3	21	<0.025	8.8	<1.8	<1.1	7.6	<5
2007-06	MW-1005S	43	<0.17	40	<2.5	<0.88	<1.3	14	<0.025	2.9	<1.8	<1.1	6.6	<5
2007-06	MW-1010P	45	<0.17	44	4.4	<0.88	1.5	11	<0.025	2.6	<1.8	<1.1	4.7	<5
2007-06	MW-1013	140	<1.7	150	18	<10	23	45	<0.025	2.9	<2.4	<12	17	<50
2007-06	MW-1013A	84	<1.7	110	6.1	<10	<13	37	<0.025	7.2	<2.4	<12	32	<50
2007-06	MW-1013B	<25	<1.7	630	47	<10	<13	140	<0.025	6.4	<2.4	<12	28	170
2007-06	MW-1013C	<25	<1.7	600	60	<10	15	170	<0.025	25	<2.4	<12	38	470
2007-06	MW-1014	31	<1.7	70	24	<10	<13	22	<0.025	3.8	<2.4	<12	16	<50
2007-06	MW-1014 Dup.	39	<1.7	86	24	<10	<13	27	<0.025	3.8	<2.4	<12	20	<50
2007-06	MW-1014A	<25	<1.7	330	15	<10	<13	110	<0.025	10	<2.4	<12	60	<50
2007-06	MW-1014B	<25	<1.7	530	47	<10	<13	140	<0.025	21	<2.4	<12	27	1400
2007-06	MW-1014C	31	4.7	170	41	<10	<13	39	<0.025	5.4	<2.4	<12	10	470
2007-06	MW-1015A	8.5	<0.17	21	6.2	<0.88	1.7	8.2	<0.025	0.66	<1.8	<1.1	3.2	<5
2007-07	MW-1015B	49	<0.17	34	55	1.4	<1.3	14	<0.025	6.4	<1.8	<1.1	53	<5
2008-06	MW-1000PR	40	<0.17	140	19	1.5	<1.3	36	<0.025	3.3	3.8	1.4	7	450
2008-06	MW-1002	7.1	<0.17	17	4.6	1.8	<1.3	5.5	<0.025	0.77	1.9	2.5	3.1	<5
2008-06	MW-1002G	27	<0.17	27	12	<0.88	<1.3	9.8	<0.025	0.98	<1.8	<1.1	5.3	<5
2008-06	MW-1002G Dup.	27	0.4	26	13	<0.88	<1.3	9.8	<0.025	0.79	<1.8	<1.1	4.9	<5

Historical Groundwater Results - Annual Parameters

Sample Date Location (yyyy-mm)	Barium ug/l	Cadmium ug/l	Calcium mg/l	Chloride mg/l	Chromium ug/l	Lead ug/l	Magnesium mg/l	Mercury ug/l	Potassium mg/l	Selenium ug/l	Silver ug/l	Sodium mg/l	Zinc ug/l
2008-06 MW-1004P	41	0.34	35	<2.5	<0.88	<1.3	14	<0.025	5.4	3	<1.1	5.9	<5
2008-06 MW-1004S	5.6	<0.17	25	6.7	<0.88	<1.3	7.9	<0.025	0.9	<1.8	<1.1	5.3	<5
2008-06 MW-1005	82	<0.17	39	110	<0.88	<1.3	20	<0.025	0.58	<1.8	<1.1	15	<5
2008-06 MW-1005P	70	<0.17	55	3.9	<0.88	1.7	22	<0.025	10	2	<1.1	9	<5
2008-06 MW-1005S	46	<0.17	40	<2.5	1	<1.3	14	<0.025	3.2	<1.8	1.1	6.4	<5
2008-06 MW-1010P	44	<0.17	45	3.9	<0.88	<1.3	11	<0.025	2.4	<1.8	<1.1	4.1	<5
2008-06 MW-1013	130	<1.7	150	17	<10	<1.3	44	<0.025	2.6	2.8	<1.2	13	<50
2008-06 MW-1013A	81	<1.7	160	7	<10	<1.3	53	<0.025	6.4	<2.4	14	19	<50
2008-06 MW-1013B	<25	<1.7	630	<50	<10	<1.3	140	<0.025	5.6	<2.4	<1.2	19	170
2008-06 MW-1013C	27	1.8	610	60	<10	<1.3	170	<0.025	22	<2.4	<1.2	28	450
2008-06 MW-1014	35	0.25	83	27	<0.88	<1.3	26	<0.025	3.5	<1.8	1.2	14	12
2008-06 MW-1014A	<25	<1.7	330	13	<10	<1.3	120	<0.025	8	<2.4	<1.2	40	<50
2008-06 MW-1014B	<25	<1.7	540	56	<10	<1.3	140	<0.025	18	<2.4	<1.2	18	1700
2008-06 MW-1014B Dup.	<25	4.2	550	36	<10	<1.3	140	<0.025	21	<2.4	<1.2	29	1700
2008-06 MW-1014C	28	<1.7	160	35	<10	<1.3	38	<0.025	4.8	<2.4	<1.2	7.8	390
2008-06 MW-1015A	8.7	0.29	22	5.9	<0.88	<1.3	8.5	<0.025	0.82	<1.8	<1.1	3.4	<5
2008-06 MW-1015B	45	<0.17	36	77	<0.88	<1.3	15	<0.025	6.9	1.9	<1.1	5.1	<5
2009-06 MW-1000PR	36	<0.17	130	26	0.89	<1.3	32	<0.025	3.5	<1.8	<1.1	10	380
2009-06 MW-1002	5.6	<0.17	13	4.2	<0.88	<1.3	4.1	<0.025	0.7	<1.8	<1.1	2.3	<5
2009-06 MW-1002G	26	<0.17	24	16	<0.88	<1.3	9.1	<0.025	0.77	<1.8	<1.1	4.9	<5
2009-06 MW-1002G Dup.	26	<0.17	24	17	<0.88	1.6	9	<0.025	0.71	<1.8	<1.1	4.7	<5
2009-06 MW-1004P	40	<0.17	32	<2.5	<0.88	<1.3	13	<0.025	5	2	<1.1	6.3	<5
2009-06 MW-1004S	4.8	<0.17	20	6.6	<0.88	1.8	6.5	<0.025	0.49	3.5	<1.1	4.4	<5
2009-06 MW-1005	78	0.52	36	130	1	<1.3	18	<0.025	0.48	<1.8	<1.1	13	<5
2009-06 MW-1005P	64	<0.17	49	5.2	<0.88	<1.3	20	<0.025	8.2	<1.8	<1.1	10	<5
2009-06 MW-1005S	43	<0.17	38	<2.5	<0.88	<1.3	13	<0.025	3	2.8	<1.1	6.4	<5
2009-06 MW-1010P	42	<0.17	42	5.5	<0.88	<1.3	11	<0.025	2.6	<1.8	<1.1	4.5	<5
2009-06 MW-1013	130	<1.7	140	15	<10	19	42	<0.025	2.6	<3.1	<1.2	15	<50
2009-06 MW-1013A	72	<1.7	120	14	<10	<1.3	40	<0.025	6.4	<3.1	<1.2	26	<50
2009-06 MW-1013B	<25	<1.7	590	76	<10	<1.3	130	<0.025	3.6	<3.1	<1.2	27	160
2009-06 MW-1013B Dup.	<25	<1.7	580	77	<10	<1.3	130	<0.025	2.7	<3.1	<1.2	27	160
2009-06 MW-1013C	<25	<1.7	560	91	<10	<1.3	160	<0.025	20	<2.4	<1.2	36	450
2009-06 MW-1014	34	<1.7	76	30	<10	<1.3	24	<0.025	3	<3.1	<1.2	19	<50
2009-06 MW-1014A	<25	<1.7	300	<50	<10	<1.3	110	<0.025	6.3	<3.1	<1.2	62	<50
2009-06 MW-1014B	<25	12	520	53	35	1.3	130	<0.025	12	<3.1	23	25	1100
2009-06 MW-1014C	26	<1.7	150	53	<10	<1.3	35	<0.025	3.6	<3.1	<1.2	9.5	360
2009-06 MW-1015A	7.9	<0.17	20	7.7	<0.88	2.1	8	<0.025	0.73	<1.8	<1.1	3.1	<5
2009-06 MW-1015B	43	<0.17	33	87	<0.88	1.3	14	<0.025	6.1	<1.8	<1.1	48	<5
2010-06 MW-1000PR	39	<0.16	120	19	<1.3	3.6	33	<0.025	4.1	<1.8	<0.77	10	370
2010-06 MW-1002	5.7	<0.16	12	3.6	<1.3	<1.2	4	<0.025	0.55	<1.8	<0.77	2.4	<5
2010-06 MW-1002G	30	<0.16	26	23	<1.3	<1.2	10	<0.025	0.83	<1.8	<0.77	5.1	<5
2010-06 MW-1004P	46	0.16	34	<2.5	<1.3	<1.2	13	<0.025	5.7	<1.8	<0.77	6.8	<5
2010-06 MW-1004S	4.8	<0.16	19	4.4	<1.3	2.2	6.3	<0.025	0.78	<1.8	<0.77	4.1	<5
2010-06 MW-1005	77	0.46	33	120	<1.3	2	18	<0.025	0.65	<1.8	<0.77	16	<5
2010-06 MW-1005P	60	<0.16	44	19	<1.3	<1.2	12	<0.025	6.8	<1.8	<0.77	43	<5
2010-06 MW-1005S	49	<0.16	38	<2.5	<1.3	<1.2	14	<0.025	3.1	<1.8	<0.77	6.4	<5
2010-06 MW-1010P	46	0.21	40	4.2	<1.3	<1.2	12	<0.025	2.7	<1.8	<0.77	4.7	<5
2010-06 MW-1013	140	<1.7	150	13	<11	<1.3	45	<0.025	3.3	<2.4	<1.4	18	<50
2010-06 MW-1013A	74	<1.7	110	6.9	<11	<1.3	39	<0.025	7.5	<2.4	<1.4	35	<50

Historical Groundwater Results - Annual Parameters

Sample Date (yy-mm)	Location	Barium (ug/l)	Cadmium (ug/l)	Calcium (mg/l)	Chloride (mg/l)	Chromium (ug/l)	Lead (ug/l)	Magnesium (mg/l)	Mercury (ug/l)	Potassium (mg/l)	Selenium (ug/l)	Silver (ug/l)	Sodium (mg/l)	Zinc (ug/l)
2010-06	MW-1013B	< 25	1.9	620	< 50	< 11	< 13	140	< 0.025	8.6	< 2.4	< 14	35	180
2010-06	MW-1013C	< 25	< 1.7	550	64	< 11	< 13	150	< 0.025	30	< 2.4	< 14	34	400
2010-06	MW-1014	57	< 1.7	76	28	< 11	< 13	24	< 0.025	3.5	3	< 14	23	< 50
2010-06	MW-1014A	< 25	< 1.7	320	13	< 11	< 13	110	< 0.025	12	< 2.4	< 14	63	< 50
2010-06	MW-1014B	< 25	< 1.7	510	37	< 11	17	130	< 0.025	25	< 2.4	< 14	31	1200
2010-06	MW-1014C	< 25	< 1.7	140	37	< 11	20	36	< 0.025	5.4	< 2.4	< 14	9.8	330
2010-06	MW-1015A	8.9	< 0.16	20	6.3	< 1.3	< 1.2	8.4	< 0.025	0.74	< 1.8	< 0.77	3.2	< 5
2010-06	MW-1015B	48	< 0.16	32	63	< 1.3	3.7	15	< 0.025	7.2	< 1.8	< 0.77	55	< 5
2011-07	MW-1000PR	37	< 0.13	130	21	< 0.18	< 1.4	34	< 0.025	4	< 1.8	< 0.26		310
2011-07	MW-1000R	34	< 0.13	110	8	< 0.18	< 1.4	35	< 0.025	1.6	< 1.8	0.74		< 5
2011-07	MW-1002	9.1	< 0.13	21	9.9	0.71	< 1.4	7.2	< 0.025	0.8	< 1.8	< 0.26		< 5
2011-07	MW-1002G	33	< 0.13	32	26	0.81	< 1.4	13	< 0.025	0.92	< 1.8	< 0.26		< 5
2011-07	MW-1002G	Dup.	< 0.13	32	26	0.83	< 1.4	12	< 0.025	0.91	< 1.8	3.1		< 5
2011-07	MW-1004	3.9	< 0.13	12	< 2.5	1.5	< 1.4	3.9	< 0.025	0.72	< 1.8	< 0.26		< 5
2011-07	MW-1004P	44	< 0.13	36	< 2.5	< 0.18	< 1.4	15	< 0.025	5.8	< 1.8	< 0.26		< 5
2011-07	MW-1004S	5	< 0.13	20	5.7	0.82	< 1.4	7	< 0.025	0.9	< 1.8	< 0.26		< 5
2011-07	MW-1005	200	< 0.13	79	240	< 0.18	< 1.4	39	< 0.025	1.1	< 1.8	< 0.26		< 5
2011-07	MW-1005P	72	< 0.13	54	4.7	< 0.18	< 1.4	23	< 0.025	9.4	< 1.8	< 0.26		< 5
2011-07	MW-1005S	50	< 0.13	43	2.7	< 0.18	< 1.4	16	< 0.025	3.4	< 1.8	< 0.26		< 5
2011-07	MW-1010P	45	< 0.13	47	5.3	< 0.18	< 1.4	13	< 0.025	2.6	< 1.8	< 0.26		< 5
2011-07	MW-1013	150	0.14	160	16	< 0.67	3.4	51	< 0.025	3.6	< 1.2	1		< 5
2011-07	MW-1013	Dup.	< 0.12	160	16	< 0.67	2.1	50	< 0.025	3.6	< 1.2	2.3		< 5
2011-07	MW-1013A	79	< 0.12	120	7.8	< 0.67	< 1.4	43	< 0.025	7.8	< 1.2	< 0.28		< 5
2011-07	MW-1013B	20	0.92	640	54	< 0.67	5.5	150	< 0.025	8.3	< 1.2	1.2		160
2011-07	MW-1013C	20	< 0.12	610	76	< 0.67	2.5	170	< 0.025	32	< 1.2	< 0.28		410
2011-07	MW-1014	68	< 0.12	79	36	< 0.67	< 1.4	26	< 0.025	3.2	< 1.2	< 0.28		7.2
2011-07	MW-1014A	16	< 0.12	320	< 25	< 0.67	< 1.4	130	< 0.025	12	< 1.2	< 0.28		13
2011-07	MW-1014B	31	2.7	500	54	< 0.67	< 1.4	140	< 0.025	22	< 1.2	< 0.28		1300
2011-07	MW-1014C	29	< 0.12	150	45	< 0.67	< 1.4	39	< 0.025	5.2	< 1.2	< 0.28		310
2011-07	MW-1015A	8.6	< 0.13	22	6.5	< 0.18	< 1.4	9.2	< 0.025	0.79	< 1.8	< 0.26		< 5
2011-07	MW-1015B	49	< 0.13	37	86	< 0.18	< 1.4	16	< 0.025	7.4	< 1.8	< 0.26		< 5
2012-06	MW-1000PR	36	0.66	120	22	< 0.23	2.5	33	< 0.025	4.2	< 1.8	< 0.26	9.1	360
2012-06	MW-1000R	19	< 0.13	42	5.2	0.25	2.2	11	0.045	0.85	< 1.8	< 0.26	5.5	< 5
2012-06	MW-1002	6.6	< 0.13	16	5.9	0.39	2.4	5.3	< 0.025	0.69	< 1.8	< 0.26	3.1	< 5
2012-06	MW-1002G	32	< 0.13	31	29	< 0.23	< 1.4	12	< 0.025	0.93	< 1.8	< 0.26	5.7	< 5
2012-06	MW-1004	4.5	< 0.13	14	< 2.5	1.6	< 1.4	4.7	< 0.025	0.79	< 1.8	< 0.26	3.1	< 5
2012-06	MW-1004P	42	< 0.13	34	< 2.5	< 0.23	< 1.4	14	< 0.025	5.9	< 1.8	< 0.26	6.3	< 5
2012-06	MW-1004S	4.7	< 0.13	20	4.2	0.3	< 1.4	6.6	< 0.025	0.88	< 1.8	< 0.26	4	< 5
2012-06	MW-1005	130	0.15	65	280	< 0.23	1.5	33	< 0.025	1	< 1.8	< 0.26	30	< 5
2012-06	MW-1005P	68	0.25	52	4.8	< 0.23	1.5	22	< 0.025	9.6	< 1.8	< 0.26	9.1	< 5
2012-06	MW-1005S	48	< 0.13	43	2.5	< 0.23	1.4	16	< 0.025	3.4	< 1.8	< 0.26	6.8	< 5
2012-06	MW-1010P	44	0.26	47	5.2	< 0.23	< 1.4	13	< 0.025	2.6	1.9	< 0.26	4.5	< 5
2012-06	MW-1013	140	0.18	150	14	< 0.67	5.3	49	< 0.025	3.4	< 2.7	< 0.28	17	< 5
2012-06	MW-1013A	76	< 0.12	120	8.2	< 0.67	2.3	43	< 0.025	7.7	< 2.7	< 0.28	26	< 5
2012-06	MW-1013B	16	1.9	630	53	< 0.67	7.1	150	< 0.025	8.4	< 2.7	< 0.28	30	170
2012-06	MW-1013C	18	< 0.6	570	66	< 0.67	3.6	160	< 0.025	31	< 2.7	< 0.28	32	350
2012-06	MW-1014	52	0.22	78	38	< 0.67	3.5	26	< 0.025	3.7	< 2.7	< 0.28	17	7
2012-06	MW-1014	Dup.	< 0.12	78	39	< 0.67	< 1.4	26	< 0.025	3.7	< 2.7	3.9	17	7
2012-06	MW-1014A	15	0.25	310	< 25	< 0.67	1.9	120	< 0.025	13	< 2.7	< 0.28	56	7.2

Historical Groundwater Results - Annual Parameters

Sample Date Location (yyyy-mm)	Barium ug/l	Cadmium ug/l	Calcium mg/l	Chloride mg/l	Chromium ug/l	Lead ug/l	Magnesium mg/l	Mercury ug/l	Potassium mg/l	Selenium ug/l	Silver ug/l	Sodium mg/l	Zinc ug/l
2012-06 MW-1014B	23	2.6	500	59	<0.67	3.2	130	<0.025	22	<2.7	<0.56	25	1200
2012-06 MW-1014C	30	0.18	150	50	<0.67	<1.4	38	<0.025	5.6	<2.7	<0.28	11	310
2012-06 MW-1015A	8.3	0.21	21	6.7	<0.23	2	8.9	<0.025	0.77	2.4	<0.26	3.5	<5
2012-06 MW-1015A	Dup.	8.3	<0.13	21	<0.23	<1.4	8.9	<0.025	0.77	<1.8	<0.26	3.4	<5
2012-06 MW-1015B	40	<0.13	34	58	<0.23	<1.4	15	<0.025	7.1	<1.8	<0.26	44	<5
2013-06 MW-1000PR	41	0.18	130	23	<0.23	<1.4	34	<0.025	3.9	<2	<0.65	8.6	390
2013-06 MW-1000R	16	<0.13	30	4.3	0.54	<1.4	7.6	<0.025	0.59	<2	0.81	3.9	<5
2013-06 MW-1002	9.1	<0.13	21	9.1	0.85	<1.4	7.3	<0.025	0.81	<2	<0.26	3.6	<5
2013-06 MW-1002G	34	<0.13	33	28	0.33	<1.4	13	<0.025	0.94	<2	<0.26	5.5	<5
2013-06 MW-1002G	Dup.	33	31	28	<0.23	3	13	<0.025	0.94	<2	<0.26	6.2	<5
2013-06 MW-1004	3.7	<0.13	12	<2.5	0.38	<1.4	3.8	<0.025	0.71	<2	0.69	2.8	<5
2013-06 MW-1004P	46	<0.13	36	<2.5	<0.23	<1.4	15	<0.025	6.1	<2	<0.26	6.2	<5
2013-06 MW-1004S	5.1	<0.13	21	4.8	0.68	2.4	7.2	<0.025	0.94	<2	<0.26	4.3	<5
2013-06 MW-1005	160	<0.13	73	240	0.98	<1.4	36	<0.025	0.95	<2	<0.26	34	<5
2013-06 MW-1005P	72	<0.13	56	19	<0.23	2.8	21	<0.025	8.9	<2	<0.26	22	<5
2013-06 MW-1005S	50	<0.13	44	<2.5	<0.23	<1.4	16	<0.025	3.2	<2	<0.26	6.4	<5
2013-06 MW-1010P	48	<0.13	50	5.7	<0.23	2.9	14	<0.025	2.9	<2	0.32	4.5	22
2013-06 MW-1013	160	<0.12	170	15	<0.67	4.7	45	<0.025	3.4	<2	2.5	20	<5
2013-06 MW-1013A	94	<0.12	130	8.2	<0.67	<1.4	47	<0.025	8.1	<2	0.64	31	<5
2013-06 MW-1013B	16	<0.6	640	60	<3.4	28	150	<0.025	6.6	<2	2	29	150
2013-06 MW-1013C	21	<0.6	600	71	<3.4	12	170	<0.025	27	<2	1.7	35	390
2013-06 MW-1014	44	<0.12	82	38	<0.67	<1.4	27	<0.025	3.6	<2	0.95	17	7.8
2013-06 MW-1014A	17	<0.12	330	<25	<0.67	1.9	130	<0.025	11	<2	0.35	60	7.6
2013-06 MW-1014B	23	2.8	560	61	<3.4	160	150	<0.025	22	<2	4	25	1000
2013-06 MW-1014B	Dup.	23	540	44	<3.4	29	170	<0.025	24	<2	<1.4	36	1200
2013-06 MW-1014C	34	<0.12	160	49	<0.67	<1.4	39	<0.025	5.4	<2	0.65	11	290
2013-06 MW-1015A	8.7	<0.13	23	7	<0.23	<1.4	9.7	<0.025	0.82	<2	<0.26	3.5	<5
2013-06 MW-1015B	50	<0.13	38	62	<0.23	<1.4	17	<0.025	7.3	<2	<0.26	64	<5
2014-06 MW-1000PR	37	0.33	120	20	0.57	<0.1	30	<0.025	3.2	<2	<0.13	8.6	350
2014-06 MW-1000R	28	0.11	120	5.3	0.71	<0.1	34	<0.025	1.2	<2	<0.13	10	5
2014-06 MW-1002	8.8	<0.1	20	9	1.1	<0.1	6.6	<0.025	0.74	<2	<0.13	3.9	<5
2014-06 MW-1002G	Dup.	34	<0.1	31	<0.5	<0.1	12	<0.025	0.83	<2	<0.13	5.8	<5
2014-06 MW-1004	4.5	<0.1	9.9	<2.5	<0.5	<0.1	3	<0.025	0.69	<2	<0.13	2.6	<5
2014-06 MW-1004P	44	<0.1	33	<2.5	<0.5	<0.1	13	<0.025	5.4	<2	<0.13	6.3	<5
2014-06 MW-1004S	5.7	<0.1	23	5.1	0.99	<0.1	7.6	<0.025	0.93	<2	<0.13	5.2	<5
2014-06 MW-1005	150	<0.1	60	230	0.61	<0.1	29	<0.025	0.74	<2	<0.13	33	<5
2014-06 MW-1005P	72	<0.1	55	17	<0.5	<0.1	22	<0.025	8.8	<2	<0.13	13	<5
2014-06 MW-1005S	48	<0.1	39	<2.5	<0.5	<0.1	14	<0.025	2.7	<2	<0.13	6.4	<5
2014-06 MW-1010P	45	<0.1	48	5.4	<0.5	<0.1	12	<0.025	2.4	<2	<0.13	4.4	<5
2014-06 MW-1013	150	<0.25	150	13	1.1	<0.25	49	<0.025	2.9	<2	<0.25	16	<5
2014-06 MW-1013A	92	<0.25	130	<13	<0.5	<0.25	44	<0.025	7.3	<2	<0.25	25	<5
2014-06 MW-1013B	16	0.9	650	51	8.3	<0.25	140	<0.025	5.8	<2	<0.25	26	150
2014-06 MW-1013C	18	<0.25	610	62	<0.5	<0.25	140	<0.025	23	<2	<0.25	28	340
2014-06 MW-1014	40	<0.25	75	41	<0.5	<0.25	23	<0.025	2.9	<2	<0.25	9.3	17
2014-06 MW-1014A	16	<0.25	320	<25	1.2	<0.25	110	<0.025	9.7	<2	<0.25	47	11
2014-06 MW-1014B	Dup.	27	520	43	0.56	<0.25	120	<0.025	17	<2	<0.25	19	1100
2014-06 MW-1014B	27	2.2	520	55	0.76	<0.25	120	<0.025	17	<2	<0.25	19	1100
2014-06 MW-1014C	32	<0.25	150	49	<0.5	<0.25	34	0.044	4.7	<2	<0.25	9.4	290

Historical Groundwater Results - Annual Parameters

Sample Date Location (yyyy-mm)	Barium ug/l	Cadmium ug/l	Calcium mg/l	Chloride mg/l	Chromium ug/l	Lead ug/l	Magnesium mg/l	Mercury ug/l	Potassium mg/l	Selenium ug/l	Silver ug/l	Sodium mg/l	Zinc ug/l
2014-06 MW-1015A	8.5	<0.1	21	6.4	<0.5	<0.1	8.5	<0.025	0.74	<2	<0.13	3.7	<5
2014-06 MW-1015B	44	<0.1	35	67	<0.5	<0.1	15	<0.025	6.4	<2	<0.13	57	<5
2015-06 MW-1000PR	35	<0.10	110	16	0.66	<0.10	28	0.064	3.1	<2.0	<0.13	8.2	280
2015-06 MW-1000R	25	<0.10	69	25	0.59	<0.10	21	<0.025	1.0	<2.0	<0.13	8.1	<5.0
2015-06 MW-1002	7.4	<0.10	17	8.0	0.70	<0.10	5.6	<0.025	0.69	<2.0	<0.13	3.3	<5.0
2015-06 MW-1002G	7.6	<0.10	17	7.7	0.67	<0.10	5.5	<0.025	0.69	<2.0	<0.13	3.4	<5.0
2015-06 MW-1002G	34	<0.10	32	29	<0.50	<0.10	12	<0.025	0.85	<2.0	<0.13	6.0	<5.0
2015-06 MW-1004	2.7	<0.10	8.9	<2.5	<0.50	<0.10	2.9	<0.025	0.69	<2.0	<0.13	2.4	<5.0
2015-06 MW-1004P	43	<0.10	34	<2.5	<0.50	<0.10	14	<0.025	5.7	<2.0	<0.13	6.5	<5.0
2015-06 MW-1004S	3.9	<0.10	17	3.0	0.70	<0.10	5.9	<0.025	0.77	<2.0	<0.13	4.0	<5.0
2015-06 MW-1005	200	<0.10	82	340	<0.50	<0.10	38	<0.025	0.92	<2.0	<0.13	61	<5.0
2015-06 MW-1005P	69	<0.10	52	6.8	<0.50	<0.10	22	<0.025	9.0	<2.0	<0.13	9.6	<5.0
2015-06 MW-1005S	47	<0.10	40	2.7	<0.50	<0.10	14	<0.025	2.9	<2.0	<0.13	6.3	<5.0
2015-06 MW-1010P	44	<0.10	48	4.9	<0.50	<0.10	13	<0.025	2.6	<2.0	<0.13	4.5	5.4
2015-06 MW-1013	150	<0.25	160	11	2.9	<0.25	48	<0.025	3.1	<2.0	<0.25	14	5.1
2015-06 MW-1013A	89	<0.25	120	8.6	0.57	<0.25	42	<0.025	7.4	<2.0	<0.25	30	<5.0
2015-06 MW-1013B	17	<1.3	660	<50	<2.5	<1.3	150	0.13	6.5	<10	<1.3	26	160
2015-06 MW-1013C	20	<1.3	610	57	<2.5	<1.3	140	<0.13	25	<10	<1.3	28	420
2015-06 MW-1014	39	<0.25	75	31	<0.50	<0.25	24	<0.025	3.1	<2.0	<0.25	13	12
2015-06 MW-1014A	17	<1.3	350	<25	4.6	<1.3	120	<0.13	10	<10	<1.3	49	<25
2015-06 MW-1014B	26	2.6	550	54	3.9	<1.3	130	<0.13	19	<10	<1.3	22	1300
2015-06 MW-1014C	36	<0.25	150	51	<0.50	<0.25	36	<0.025	4.7	<2.0	<0.25	10	290
2015-06 MW-1014C	35	<0.25	150	51	<0.50	<0.25	35	<0.025	4.7	<2.0	<0.25	9.9	290
2015-06 MW-1015A	7.9	<0.10	20	6.4	<0.50	<0.10	8.4	<0.025	0.71	<2.0	<0.13	3.5	<5.0
2015-06 MW-1015B	46	<0.10	36	79	<0.50	<0.10	16	<0.025	6.7	<2.0	<0.13	64	<5.0
2015-09 MW-1005	317	0.091	122	397	0.61	<0.033	53.9	<0.022	1.36	<0.16	<0.086	71.9	5.4
2016-06 MW-1000PR	32.4	0.17	111	14.2	0.61	0.072	28.6	<0.13	3.15	0.41	<0.016	7.6	297
2016-06 MW-1000R	26.1	<0.089	64.7	22.4	0.52	<0.040	20.2	<0.13	1.09	<0.21	<0.016	7.89	<3.1
2016-06 MW-1002	9.1	<0.089	22	10.4	1.2	<0.040	7.66	<0.13	0.825	<0.21	<0.016	3.82	<3.1
2016-06 MW-1002G	32.5	<0.089	34.6	29.7	0.47	<0.040	13.3	<0.13	0.901	<0.21	<0.016	5.54	<3.1
2016-06 MW-1002G	34.0	<0.089	34.5	29.6	0.78	<0.040	13.7	<0.13	0.91	<0.21	<0.016	5.9	<3.1
2016-06 MW-1004	4.1	<0.089	8.96	2.0	0.89	0.077	2.89	<0.13	0.752	0.22	<0.016	2.26	5.9
2016-06 MW-1004P	43.8	<0.089	35.8	2.2	<0.39	<0.040	14.7	<0.13	5.9	<0.21	<0.016	6.28	<3.1
2016-06 MW-1004S	3.4	<0.089	15.5	2.7	1.1	<0.040	5.28	<0.13	0.804	0.26	<0.016	3.66	<3.1
2016-06 MW-1005	296	0.089	123	457	0.93	<0.040	55.7	<0.13	1.26	<0.21	<0.016	75	3.8
2016-06 MW-1005P	67.2	<0.089	53.8	4.6	<0.39	0.059	22.3	<0.13	9.04	<0.21	<0.016	8.76	<3.1
2016-06 MW-1005S	42.0	<0.089	39.2	2.5	0.54	<0.040	14	<0.13	2.93	<0.21	<0.016	5.92	<3.1
2016-06 MW-1010P	40.2	<0.089	45.5	6.1	<0.39	<0.040	12.9	<0.13	2.64	<0.21	<0.016	4.29	8.6
2016-06 MW-1013	124	<0.089	146	13.3	1.1	<0.040	46.1	<0.13	3	0.53	<0.016	14	<3.1
2016-06 MW-1013A	78.9	<0.089	130	6.6	<0.39	<0.040	44.7	<0.13	7.06	<0.21	<0.016	30.6	<3.1
2016-06 MW-1013B	14.2	0.80	608	36.1	1.4	<0.040	138	<0.13	5.69	0.88	<0.016	25.1	126
2016-06 MW-1013C	16.8	<0.089	561	67.6	<0.39	0.080	130	<0.13	22.1	<0.21	<0.016	26.9	330
2016-06 MW-1014	32.8	0.10	77.5	39.7	0.40	<0.040	25.7	<0.13	3.19	<0.21	<0.016	13.3	6.8
2016-06 MW-1014A	13.3	<0.089	333	10.5	0.59	<0.040	115	<0.13	9.84	0.24	<0.016	46.3	9.0
2016-06 MW-1014B	21.8	1.9	497	63.7	0.47	0.068	111	<0.13	15.7	1.7	<0.016	19.8	986
2016-06 MW-1014C	30.4	<0.089	155	52.8	<0.39	0.60	35.2	<0.13	4.63	<0.21	<0.016	9.68	270
2016-06 MW-1014C	30.4	<0.089	150	63.9	<0.39	<0.040	35.8	<0.13	4.58	<0.21	<0.016	10.2	267
2016-06 MW-1015A	7.4	<0.089	20.8	6.0	0.52	<0.040	8.82	<0.13	0.691	<0.21	<0.016	3.98	<3.1
2016-06 MW-1015B	43.0	<0.089	37.3	74.6	0.53	<0.040	16.2	<0.13	6.79	<0.21	<0.016	59.1	<3.1

Historical Groundwater Results - Annual Parameters

Sample Date Location (yyyy-mm)	Barium ug/l	Cadmium ug/l	Calcium mg/l	Chloride mg/l	Chromium ug/l	Lead ug/l	Magnesium mg/l	Mercury ug/l	Potassium mg/l	Selenium ug/l	Silver ug/l	Sodium mg/l	Zinc ug/l
2017-06 MW-1000PR	36.0	< 0.081	115	14.7	< 1.0	< 0.20	29.2	< 0.13	3.21	0.98	< 0.10	7.64	293
2017-06 MW-1000R	36.6	0.17	56	16.3	< 1.0	< 0.20	15.3	< 0.13	0.964	0.56	< 0.10	7.57	< 4.6
2017-06 MW-1002	8.7	0.18	20.3	8.6	1.2	0.23	6.47	< 0.13	0.66	< 0.32	0.10	3.68	< 4.6
2017-06 MW-1002	Dup.												
2017-06 MW-1002G	8.3	< 0.081	19.8	8.9	1.0	< 0.20	6.79	< 0.13	0.744	< 0.32	< 0.10	3.87	< 4.6
2017-06 MW-1002G	35.0	< 0.081	34.4	31.0	< 1.0	< 0.20	13.9	< 0.13	0.909	< 0.32	< 0.10	6.05	< 4.6
2017-06 MW-1004	4.9	< 0.081	9.84	0.90	1.1	< 0.20	3.19	< 0.13	0.801	< 0.32	< 0.10	2.38	< 4.6
2017-06 MW-1004P	41.8	< 0.081	36.4	1.1	< 1.0	< 0.20	14.7	< 0.13	5.84	< 0.32	< 0.10	6.2	< 4.6
2017-06 MW-1004S	3.6	< 0.081	16	2.1	1.0	< 0.20	5.48	< 0.13	0.82	< 0.32	< 0.10	3.59	< 4.6
2017-06 MW-1005	356	< 0.081	136	547	< 1.0	< 0.20	59.7	< 0.13	1.31	< 0.32	< 0.10	83.2	< 4.6
2017-06 MW-1005P	71.2	< 0.081	56	4.1	< 1.0	< 0.20	23.1	< 0.13	9.3	< 0.32	< 0.10	9.18	< 4.6
2017-06 MW-1005S	42.8	0.39	38.5	1.5	< 1.0	0.43	13.5	< 0.13	2.77	0.39	0.21	5.8	< 4.6
2017-06 MW-1010P	46.1	< 0.081	53.6	5.4	< 1.0	< 0.20	14	< 0.13	2.64	< 0.32	< 0.10	4.27	< 4.6
2017-06 MW-1013	124	< 0.081	148	6.6	1.3	< 0.20	45.3	< 0.13	3.01	0.51	< 0.10	14	< 4.6
2017-06 MW-1013A	84.1	< 0.081	117	7.2	< 1.0	< 0.20	41.4	< 0.13	7.47	< 0.32	< 0.10	34.3	< 4.6
2017-06 MW-1013B	14.7	0.80	608	37.9	1.9	< 0.20	141	< 0.13	5.91	0.68	< 0.10	26.2	128
2017-06 MW-1013C	17.8	< 0.081	594	51.5	< 1.0	< 0.20	132	< 0.13	24.5	< 0.32	< 0.10	28.4	376
2017-06 MW-1014	50.1	< 0.081	84.2	46.1	< 1.0	< 0.20	27.3	< 0.13	3.42	< 0.32	< 0.10	14.6	15.6
2017-06 MW-1014A	14.5	< 0.081	343	11.5	< 1.0	< 0.20	119	< 0.13	10.6	< 0.32	< 0.10	46.1	7.8
2017-06 MW-1014B	22.6	2.2	553	45.4	< 1.0	< 0.20	128	< 0.13	19	1.9	< 0.10	21.9	1170
2017-06 MW-1014C	32.9	< 0.081	157	51.6	< 1.0	< 0.20	36.5	< 0.13	4.83	< 0.32	< 0.10	10.4	290
2017-06 MW-1014C	34.1	< 0.081	161	51.9	< 1.0	< 0.20	37.6	< 0.13	4.89	< 0.32	< 0.10	10.7	290
2017-06 MW-1015A	7.9	< 0.081	21.8	6.3	< 1.0	< 0.20	9.07	< 0.13	0.647	< 0.32	< 0.10	3.38	< 4.6
2017-06 MW-1015B	46.5	< 0.081	38	90.1	< 1.0	< 0.20	16.5	< 0.13	6.81	< 0.32	< 0.10	63.4	< 4.6

Attachment 3

Statistical Results

Trend Graphs

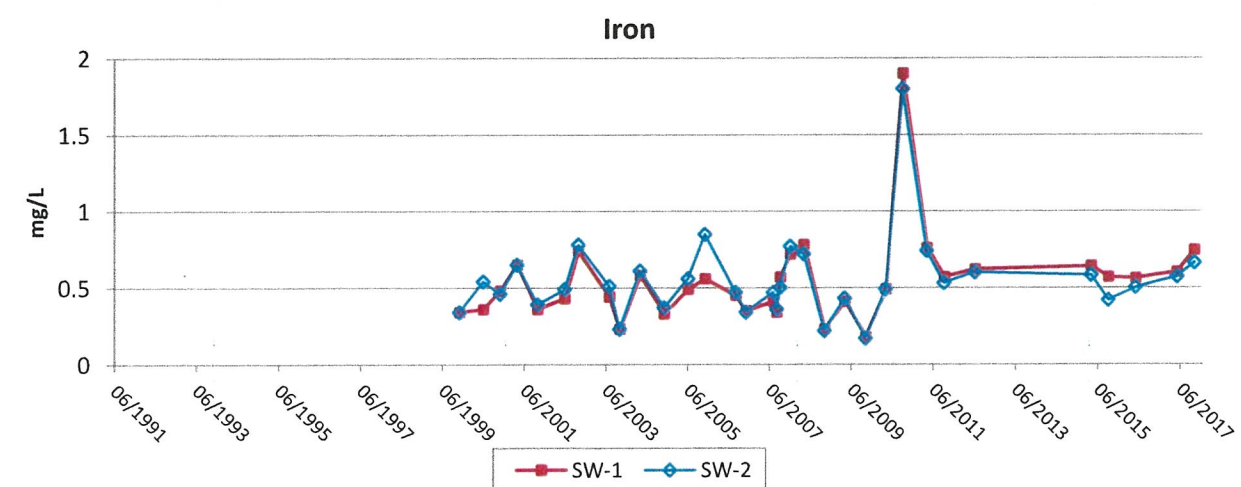
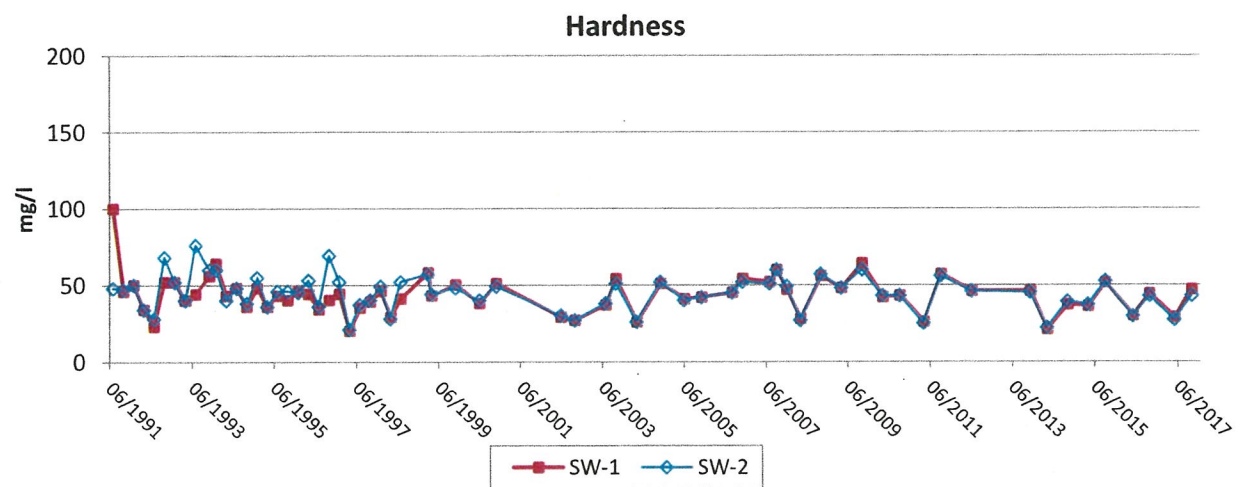
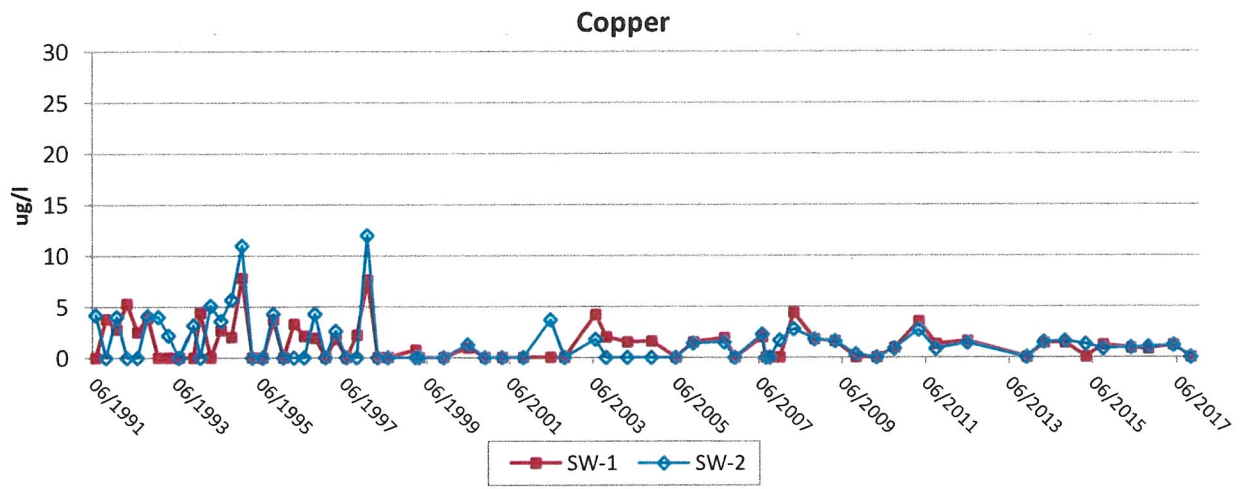
Historical Data

(Surface Water)

**Trend Analysis Results - Surface Water
Year Ending 2017**

	Conductivity (Field) (umhos/cm)	pH(Field) (su)	Copper	Hardness	Iron	Manganese	Dissolved Oxygen	Redox Potential	Total Suspended Solids
SW-1									
Trend Results for Most Recent 5 Years									
Sample Size	9	9	9	9	5	2	9	9	9
Mann-Kendall S	2	-2	-7	2	2	NA	-20	2	5
p-Level	0.920	0.920	0.544	0.920	0.816	NA	0.044	0.920	0.687
Trend									
Trend Results for All Data Since Oct. 1997									
Sample Size	43	43	43	40	33	30	18	9	17
Mann-Kendall S	-152	-70	14	-9	140	85	27	2	-34
p-Level	0.114	0.470	0.887	0.927	0.030	0.134	0.330	0.920	0.176
Trend									
SW-2									
Trend Results for Most Recent 5 Years									
Sample Size	9	9	9	9	5	2	9	9	9
Mann-Kendall S	2	0	-7	0	4	NA	-16	0	2
p-Level	0.920	1.000	0.544	1.000	0.484	NA	0.120	1.000	0.920
Trend									
Trend Results for All Data Since Oct. 1997									
Sample Size	43	43	43	40	33	30	18	9	17
Mann-Kendall S	-180	-14	158	-66	62	28	24	0	-34
p-Level	0.061	0.892	0.082	0.452	0.348	0.633	0.389	1.000	0.176
Trend									

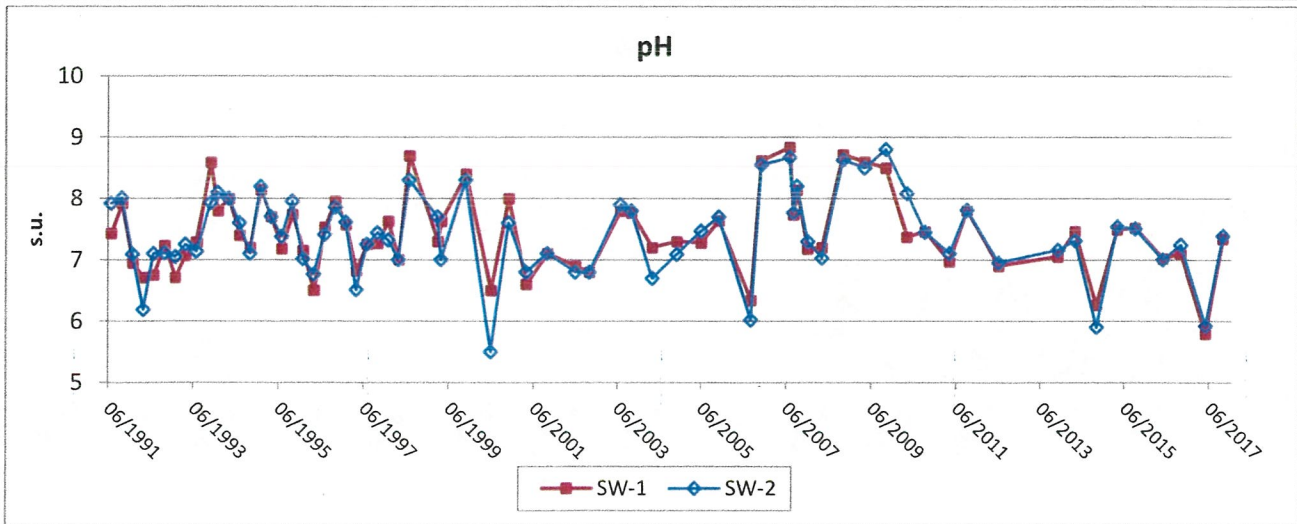
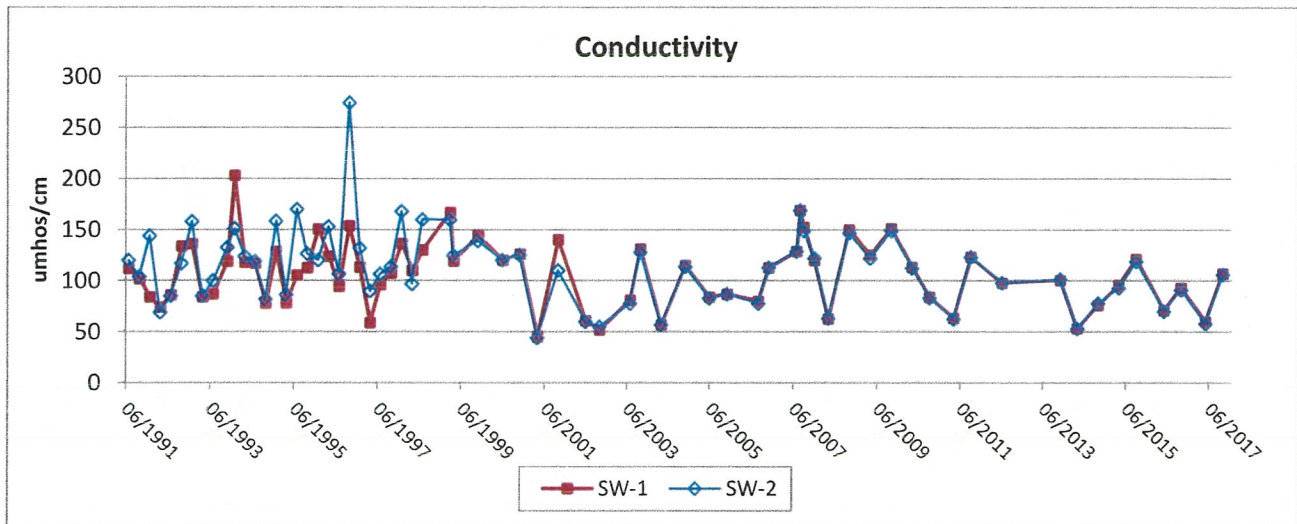
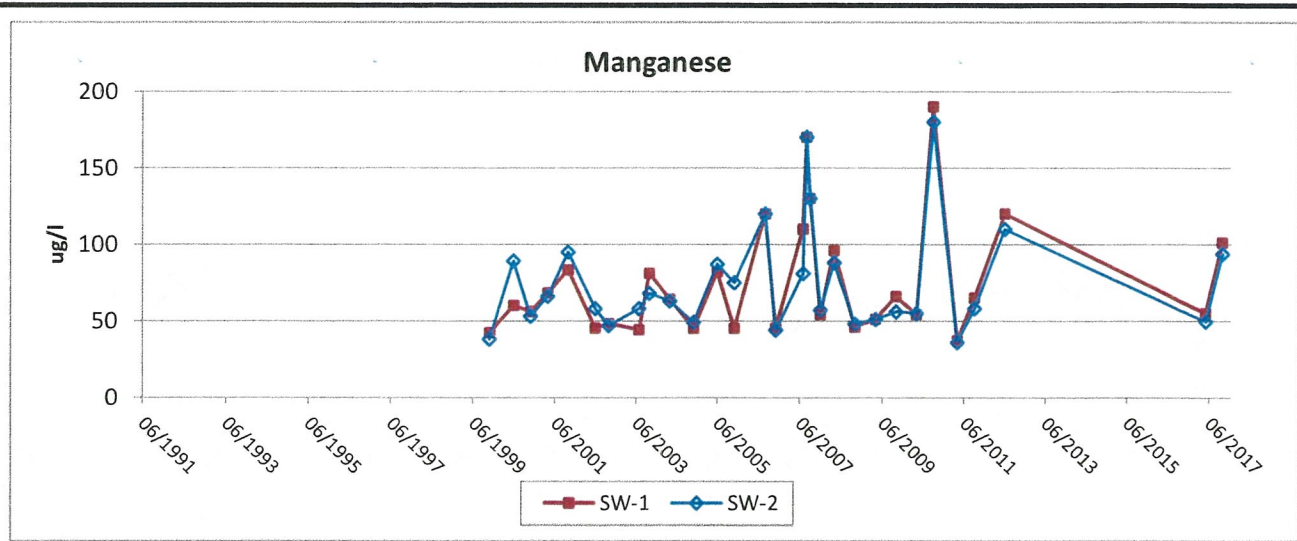
Notes: Overall increasing trend denoted by "+".
Overall decreasing trend denoted by "-".
All trend tests performed at a Type I (two-tailed) error rate of 0.01.




Foth <small>Foth Infrastructure & Environment, LLC</small>		
FLAMBEAU MINING COMPANY		
Figure B-15a Surface Water Trend Graphs SW-1/SW-2		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00

Flambeau Mining Co.
2017 Annual Report

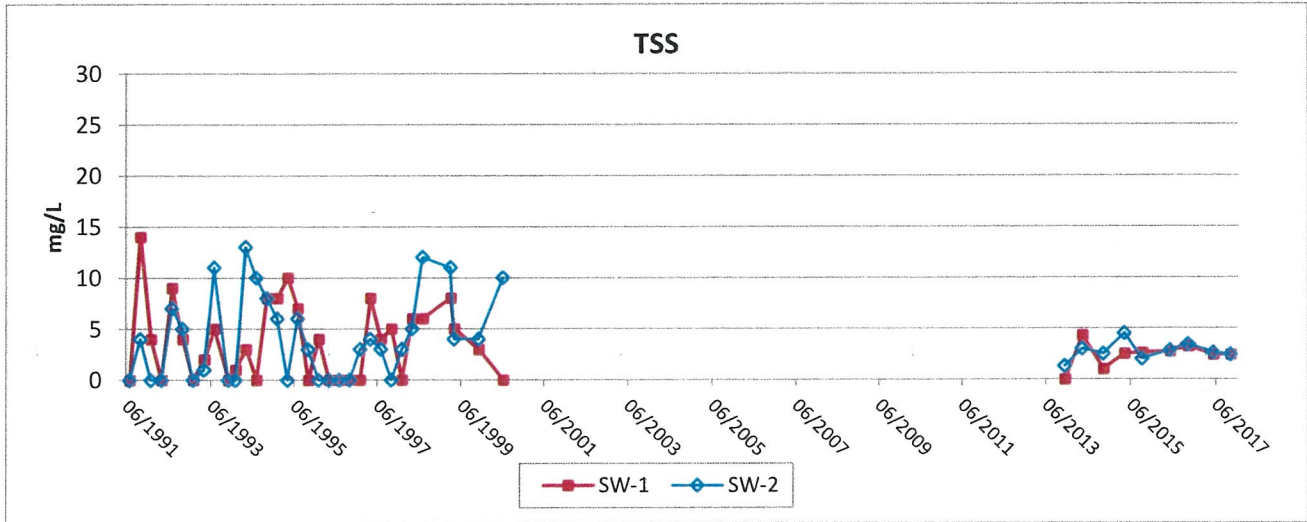
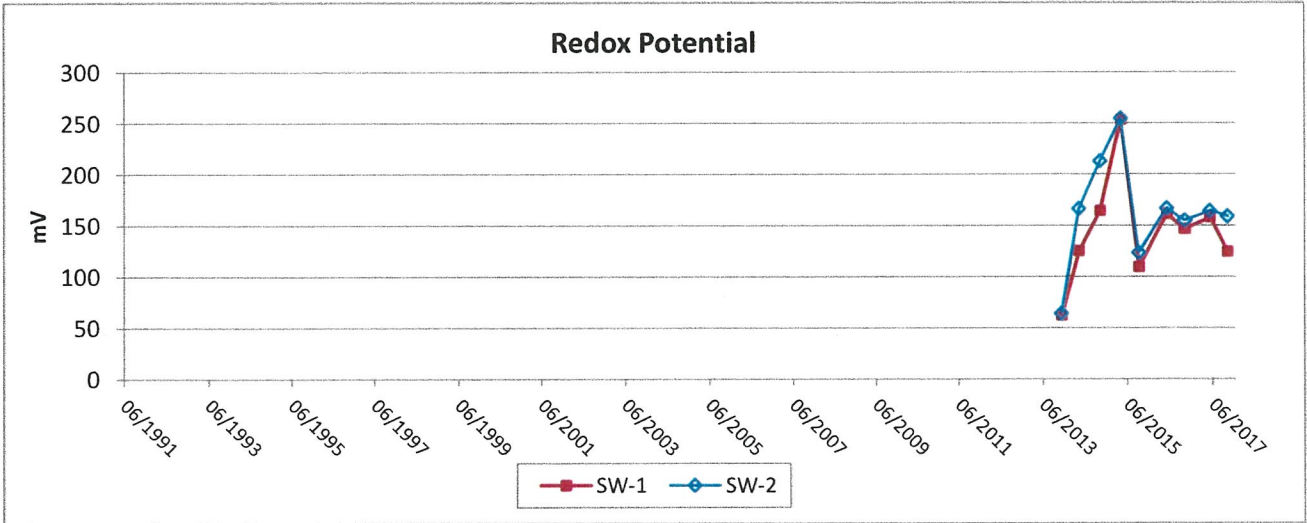
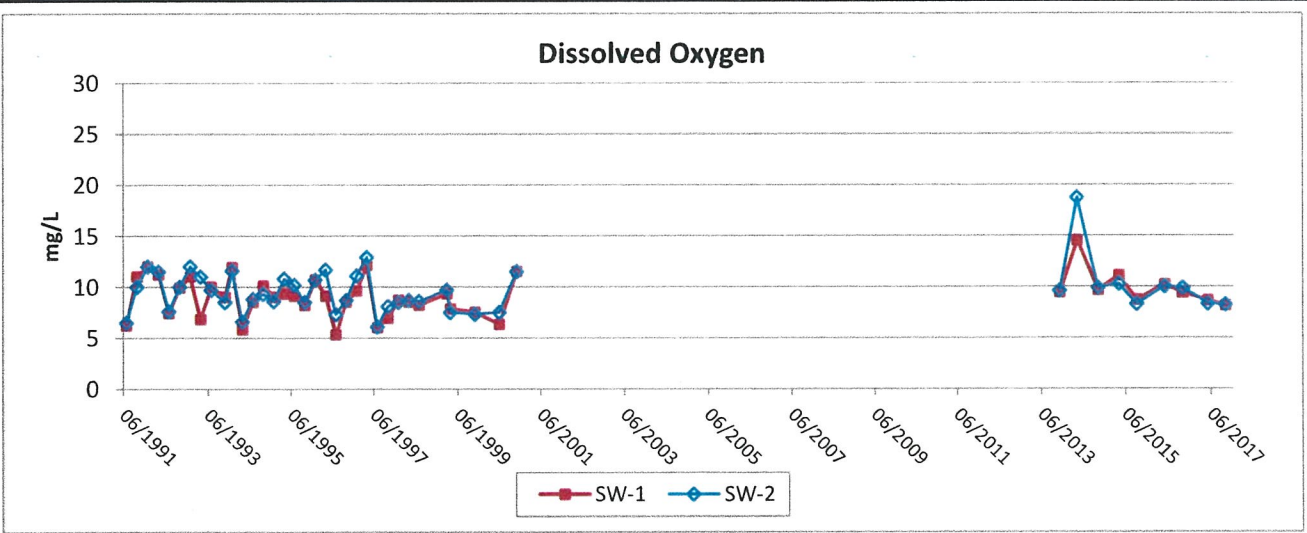
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 Foth Infrastructure & Environment, LLC		
FLAMBEAU MINING COMPANY		
Figure B-15b		
Surface Water Trend Graphs		
SW-1/SW-2		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00

Flambeau Mining Co.
2017 Annual Report

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Foth <small>Foth Infrastructure & Environment, LLC</small>		
FLAMBEAU MINING COMPANY		
Figure B-15c Surface Water Trend Graphs SW-1/SW-2		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00

Historical Surface Water Results

Sample Date (yyyy-mm)	Location	Conductivity umhos/cm	pH s.u.	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Zinc ug/l	Dissolved Oxygen mg/l	Redox Potential mV	Total Suspended Solids mg/l
1991-07	SW-1	112	7.43	< 3	100				20	6.2		< 1
1991-07	SW-2	120	7.92	4.2	48				20	6.5		< 1
1991-10	SW-1	102	7.92	3.8	46				24	11		14
1991-10	SW-2	104	8.01	< 2	47				< 3	10		4
1992-01	SW-1	84	6.95	2.8	50				8	12		4
1992-01	SW-2	144	7.09	4	50				4	12		< 1
1992-04	SW-1	74	6.71	5.3	34				11	11.2		< 1
1992-04	SW-2	69	6.19	< 2	34				9	11.5		< 1
1992-07	SW-1	86	6.75	2.5	23				6	7.4		9
1992-07	SW-2	85	7.1	< 2	28				8	7.6		7
1992-10	SW-1	134	7.23	3.9	52				< 3	9.9		4
1992-10	SW-2	117	7.11	4.1	68				< 3	10		5
1993-01	SW-1	136	6.71	< 2	52				7	11		< 1
1993-01	SW-2	158	7.05	4	52				8	12		< 1
1993-04	SW-1	84	7.07	< 2	40				< 3	6.8		2
1993-04	SW-2	85	7.25	2.2	40				< 3	11		1
1993-07	SW-1	87	7.29	< 12	44				< 3	10		5
1993-07	SW-2	100	7.14	< 12	76				9	9.7		11
1993-11	SW-1	118.9	8.59	< 2	56				< 3	9		< 1
1993-11	SW-2	132.6	7.93	3.2	60				4	8.5		< 1
1994-01	SW-1	203	7.8	4.4	64				7	11.9		1
1994-01	SW-2	151	8.1	< 2	60				5	11.6		< 1
1994-04	SW-1	118	8	< 2	43				9	5.8		3
1994-04	SW-2	124	8	5.1	40				7	6.6		13
1994-07	SW-1	117	7.4	2.7	48				11	8.5		< 1
1994-07	SW-2	119	7.6	3.6	48				9	8.8		10
1994-10	SW-1	78	7.2	2	36				17	10.1		8
1994-10	SW-2	82	7.1	5.7	38				23	9.3		8
1995-01	SW-1	128.5	8.14	7.8	48				16	9		8
1995-01	SW-2	158.3	8.19	11	55				21	8.6		6
1995-04	SW-1	78.1	7.7	< 3.8	36				< 12	9.3		10
1995-04	SW-2	86.2	7.7	< 3.8	36				< 12	10.8		< 1
1995-04	SW-2	Dup.		< 3.8	36				< 12			< 1
1995-07	SW-1	105.5	7.18	< 1.7	43				< 12	9.1		7
1995-07	SW-2	170	7.38	< 1.7	46				< 12	10.2		6
1995-10	SW-1	112.5	7.74	3.7	40				< 12	8.2		< 1
1995-10	SW-2	126.3	7.95	4.3	46				13	8.5		3
1996-01	SW-1	150.5	7.15	< 1.7	46				< 12	10.7		4
1996-01	SW-2	120.2	7.01	< 1.7	45				< 12	10.7		< 1
1996-04	SW-1	124	6.5	3.3	44				< 12	9.1		< 1
1996-04	SW-2	153.1	6.76	< 1.7	53				< 12	11.7		< 1
1996-07	SW-1	94.5	7.53	2.1	34				< 12	5.3		< 1
1996-07	SW-2	106.8	7.41	< 1.7	36				< 12	7.3		< 1
1996-10	SW-1	153.5	7.95	1.9	40				< 12	8.5		< 1
1996-10	SW-2	274	7.86	4.3	69				23	8.7		< 1
1997-01	SW-1	113.3	7.57	< 1.7	44				21	9.6		< 1
1997-01	SW-2	132	7.61	< 1.7	52				< 12	11.1		3
1997-04	SW-1	58.9	6.82	1.8	20				13	12.1		8
1997-04	SW-2	89.6	6.51	2.6	21				17	12.9		4
1997-07	SW-1	96.1	7.25	< 1.7	35				< 12	6		4
1997-07	SW-2	106.8	7.25	< 1.7	37				< 12	6.1		3
1997-10	SW-1	107.6	7.27	2.2	39				< 12	6.9		5
1997-10	SW-2	113.8	7.44	< 1.7	40				< 12	8.1		< 1
1998-01	SW-1	136.3	7.63	7.6	46				43	8.7		< 1
1998-01	SW-2	167.9	7.32	12	49				89	8.5		3
1998-04	SW-1	110	7	< 1.7	29				< 12	8.5		6
1998-04	SW-2	97	7	< 1.7	28				< 12	8.7		5
1998-07	SW-1	130	8.7	< 1.7	41				< 12	8.2		6
1998-07	SW-2	160	8.3	< 1.7	52				< 12	8.6		12
1999-03	SW-1	166.7	7.3	0.74	58				< 12	9.3		8
1999-03	SW-2	159.6	7.7	< 0.6	57				< 12	9.7		11
1999-04	SW-1	119.3	7.63	< 0.6	43				< 12	7.8		5
1999-04	SW-2	124.7	7	< 0.6	44				< 12	7.5		4
1999-11	SW-1	144	8.4	< 0.6	50	0.34	42	7.7	< 12	7.5		3
1999-11	SW-2	139	8.3	< 0.6	48	0.34	38	7.9	< 12	7.3		4
2000-06	SW-1	120	6.5	0.94	38	0.36	60	5.2	< 12	6.3		< 1
2000-06	SW-2	120	5.5	1.3	40	0.54	89	5.2	< 12	7.5		10

Historical Surface Water Results

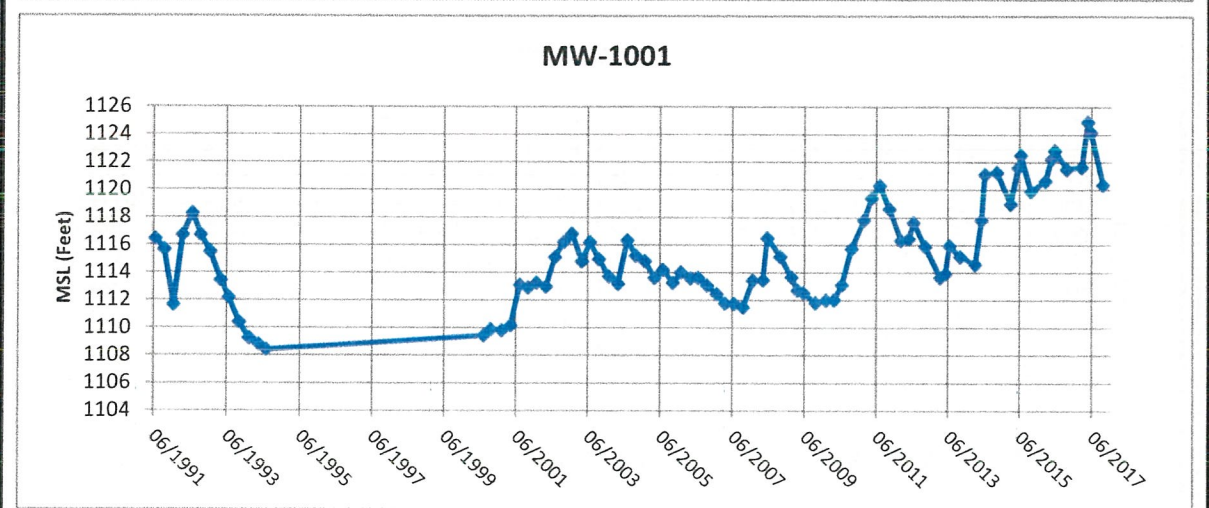
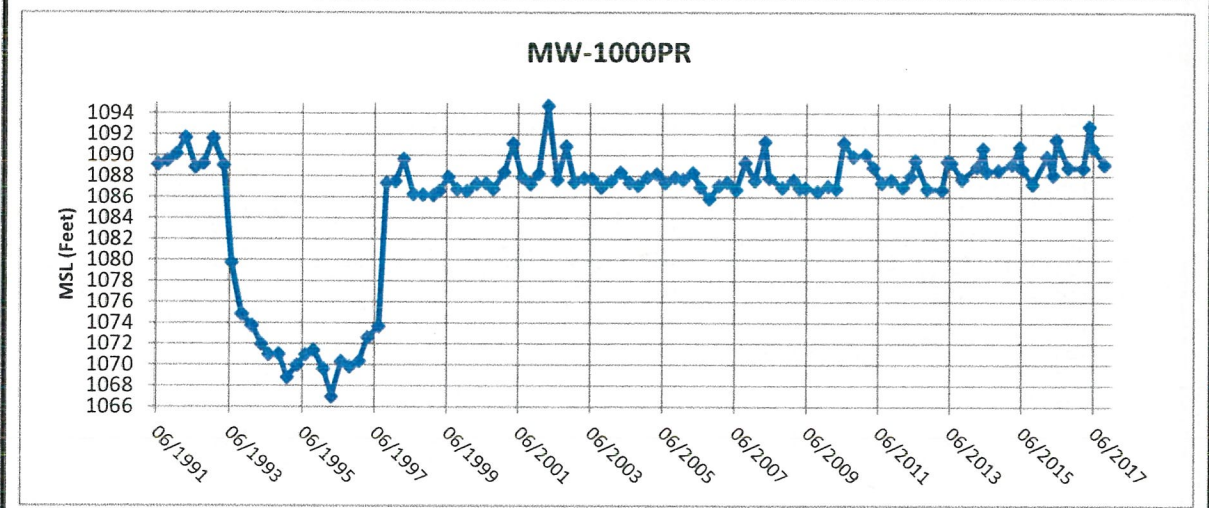
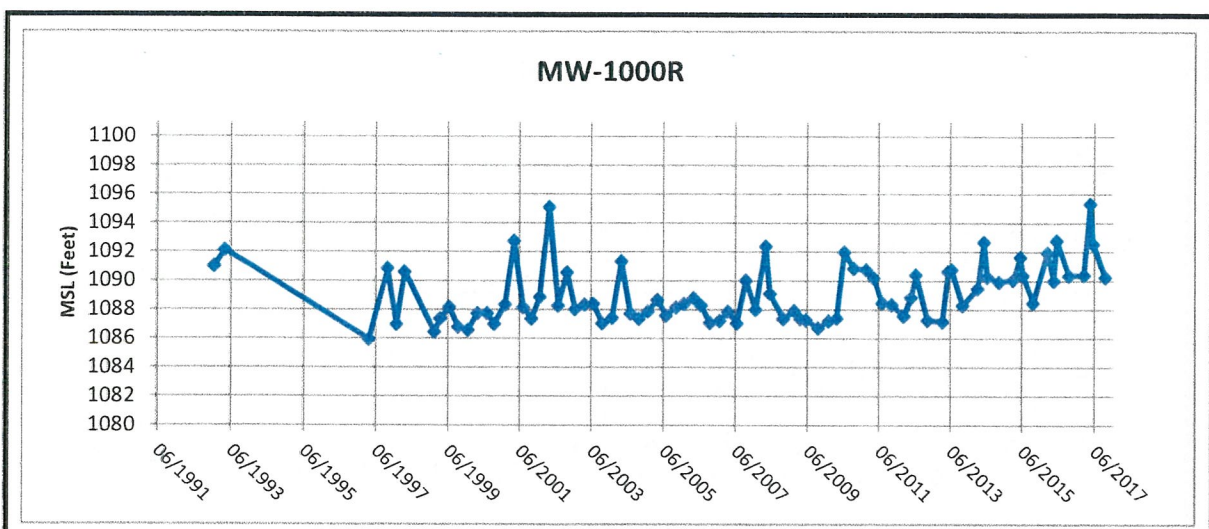
Sample Date (yyyy-mm)	Location	Conductivity umhos/cm	pH s.u.	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Zinc ug/l	Dissolved Oxygen mg/l	Redox Potential mV	Total Suspended Solids mg/l
2000-11	SW-1	126	8	< 1.2	51	0.48	56	8.6	< 12	11.5		
2000-11	SW-2	125	7.6	< 1.2	49	0.46	53	8.4	< 12	11.5		
2001-04	SW-1	45	6.6	< 1.3		0.65	68	< 5	< 12			
2001-04	SW-2	44	6.8	< 1.3		0.65	66	< 5	< 12			
2001-10	SW-1	140	7.1	< 1.3		0.36	83	8.8	< 12			
2001-10	SW-2	110	7.1	< 1.3		0.39	95	8.9	< 12			
2002-06	SW-1	61	6.9	< 1.3	29	0.43	45	< 5	< 12			
2002-06	SW-2	60	6.8	3.7	30	0.49	58	< 5	< 12			
2002-10	SW-1	52	6.8	< 1.3	27	0.74	48	< 5	< 12			
2002-10	SW-2	55	6.8	< 1.3	27	0.78	47	< 5	< 12			
2003-07	SW-1	81	7.8	4.2	37	0.44	44	2.6	5.1			
2003-07	SW-2	78	7.9	1.8	38	0.51	58	2.6	< 5			
2003-10	SW-1	131	7.77	2	54	0.23	81	6.7	< 5			
2003-10	SW-2	128	7.8	< 1.3	51	0.23	68	7.1	< 5			
2004-04	SW-1	57	7.2	1.5	26	0.58	64	5.4	28			
2004-04	SW-2	57	6.7	< 1.3	26	0.61	63	5.4	< 5			
2004-11	SW-1	115	7.3	1.6	51	0.33	45	7.2	< 5			
2004-11	SW-2	114	7.09	< 1.3	52	0.37	49	6.3	8.8			
2005-06	SW-1	84	7.28	< 1.3	41	0.49	82	< 2.5	6			
2005-06	SW-2	83	7.47	< 1.3	40	0.56	87	5.7	< 5			
2005-11	SW-1	87	7.64	1.5	42	0.56	45	7.2	< 5			
2005-11	SW-2	87	7.7	1.4	42	0.85	75	7.3	5.9			
2006-08	SW-1	80	6.34	1.9	45	0.45	120	4.7	7.3			
2006-08	SW-2	78	6.02	1.5	45	0.47	120	4.3	6.9			
2006-11	SW-1	113	8.62	< 1.3	54	0.35	45	8.1	7.1			
2006-11	SW-2	113	8.55	< 1.3	52	0.34	44	8.1	7.8			
2006-11	SW-2	Dup.		< 1.3	52	0.34	44	8.1	7.8			
2007-07	SW-1	129	8.84	2	52	0.41	110	6.9	12			
2007-07	SW-2	129	8.67	2.3	51	0.47	81	7	11			
2007-08	SW-1	169	7.74	< 1.3		0.34	170	10	7.5			
2007-08	SW-2	169	7.77	< 1.3		0.36	170	10	6.4			
2007-09	SW-1	152.4	8.14	< 1.3	60	0.57	130	10	6			
2007-09	SW-2	149	8.2	< 1.3	60	0.5	130	11	5.4			
2007-12	SW-1	120	7.18	< 1.3	47	0.72	54	7.7	< 5			
2007-12	SW-1	Dup.		< 1.3	51	0.76	56	8.8	< 5			
2007-12	SW-2	122	7.3	1.7	49	0.77	57	9.1	6.5			
2008-04	SW-1	62.7	7.2	4.4	28	0.78	96	4.7	8.5			
2008-04	SW-2	63.2	7.03	2.8	27	0.72	88	4.9	5.5			
2008-10	SW-1	149.9	8.72	1.8	56	0.23	46	9.5	6.1			
2008-10	SW-1	Dup.		2.2	58	0.24	48	9.8	5.5			
2008-10	SW-2	146.6	8.63	1.8	57	0.22	48	9.4	6.9			
2009-04	SW-1	125	8.6	1.6	48	0.41	51	8.7	6.5			
2009-04	SW-2	122	8.5	1.6	48	0.43	51	9	6			
2009-10	SW-1	151	8.5	< 0.29	64	0.18	66	9.4	2.2			
2009-10	SW-2	149	8.8	0.32	60	0.17	56	9.8	< 2			
2010-04	SW-1	113.1	7.37	< 1.3	42	0.49	54	6.1	< 5.0			
2010-04	SW-2	112.4	8.08	< 1.3	43	0.49	55	6.7	< 5.0			
2010-04	SW-2	Dup.		< 1.3	41	0.44	54	6.5	< 5.0			
2010-09	SW-1	84.1	7.46	0.94	43	1.9	190	3.3	5.8			
2010-09	SW-2	83.2	7.45	0.89	43	1.8	180	2.9	5.2			
2011-04	SW-1	63.4	6.97	3.5	26	0.76	37	3.3	< 5			
2011-04	SW-2	62.5	7.10	2.7	25	0.74	36	3.3	< 5			
2011-09	SW-1	123.1	7.80	1.3	57	0.57	65	5.3	< 5			
2011-09	SW-2	123.2	7.81	0.86	56	0.53	58	5.4	< 5			
2012-06	SW-1	98	6.9	1.6	46	0.62	120	4.7	< 5			
2012-06	SW-2	98	6.95	1.4	46	0.6	110	4.8	< 5			
2013-11	SW-1	100.3	7.05	< 0.73	46			< 5	9.42	62	< 1	
2013-11	SW-2	101.2	7.16	< 0.73	45			< 5	9.58	64	1.3	
2014-04	SW-1	53	7.46	1.4	21			5.8	14.51	124.8	4.3	
2014-04	SW-2	53	7.31	1.5	22			8	18.73	166.4	3	
2014-10	SW-1	76	6.26	1.4	37			< 5.0	9.63	164.2	1.0	
2014-10	SW-2	78	5.9	1.6	39			6.1	9.88	212.7	2.5	
2015-04	SW-1	95	7.49	< 1.3	36	0.64		< 5	11.07	253.4	2.5	
2015-04	SW-2	93	7.54	1.3	37	0.58		< 5	10.25	254.7	4.5	
2015-09	SW-1	121	7.52	1.2	51.3	0.567		< 3.1	8.68	109.3	2.6	
2015-09	SW-2	119	7.51	0.84	52.3	0.418		< 3.1	8.27	123.4	2.0	
2016-05	SW-1	Dup.		0.88	30.6	0.548		< 3.1				2.8


Historical Surface Water Results

Sample Date (yyyy-mm)	Location	Conductivity umhos/cm	pH s.u.	Copper ug/l	Hardness mg/l	Iron mg/l	Manganese ug/l	Sulfate mg/l	Zinc ug/l	Dissolved Oxygen mg/l	Redox Potential mV	Total Suspended Solids mg/l
2016-05	SW-1	71	7.02	0.87	29.7	0.559			< 3.1	10.17	160.9	2.7
2016-05	SW-2	70	7	0.95	29.4	0.5			< 3.1	10	166.7	2.8
2016-10	SW-1	93	7.1	0.80	43.9				3.1	9.36	146.3	3.2
2016-10	SW-2	91	7.24	1.0	42.6				3.1	9.86	154.7	3.4
2017-05	SW-1	Dup.		< 1.1	28.4	0.575	55.5					2.6
2017-05	SW-1		60	5.79	1.2	28.7	0.601	54.6		8.63	157.80	2.4
2017-05	SW-2		58	5.92	1.2	27.2	0.57	49.4		8.32	164.20	2.6
2017-10	SW-1	Dup.		< 1.1	45.4	0.778	104					2.4
2017-10	SW-1		107	7.34	< 1.1	46.8	0.745	101		8.12	124.10	2.4
2017-10	SW-2		106	7.39	< 1.1	42.8	0.662	93.7		8.22	159.00	2.4

Attachment 4

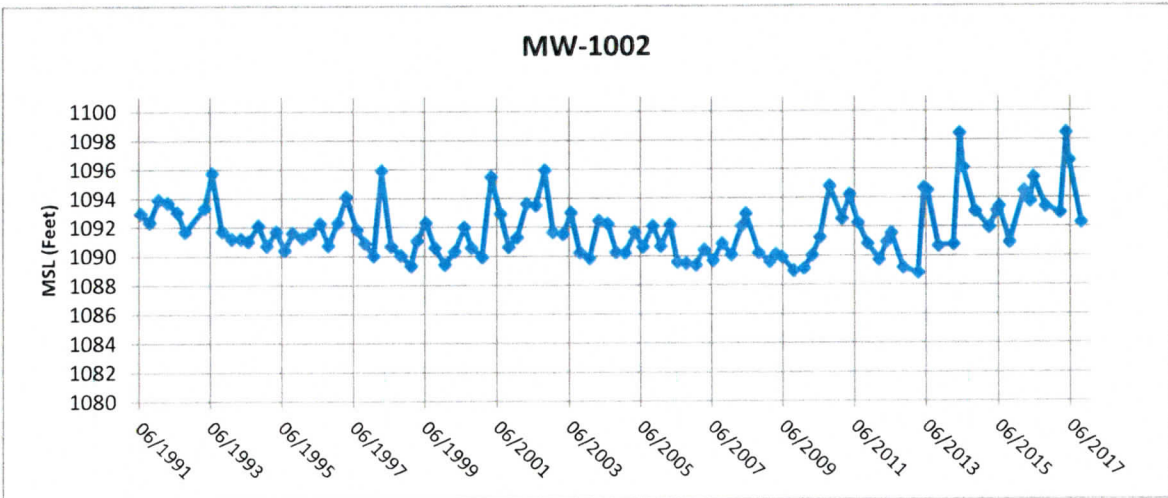
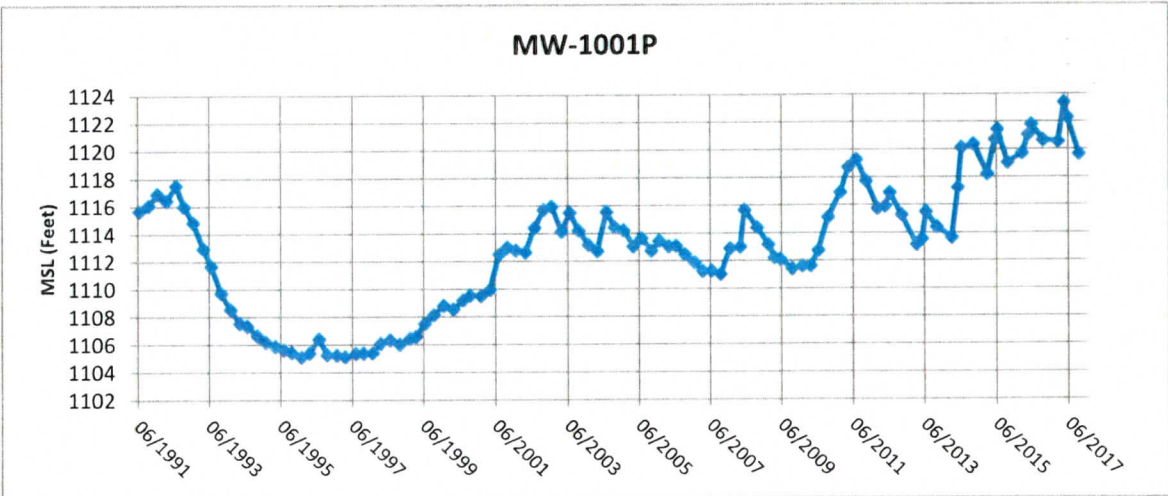
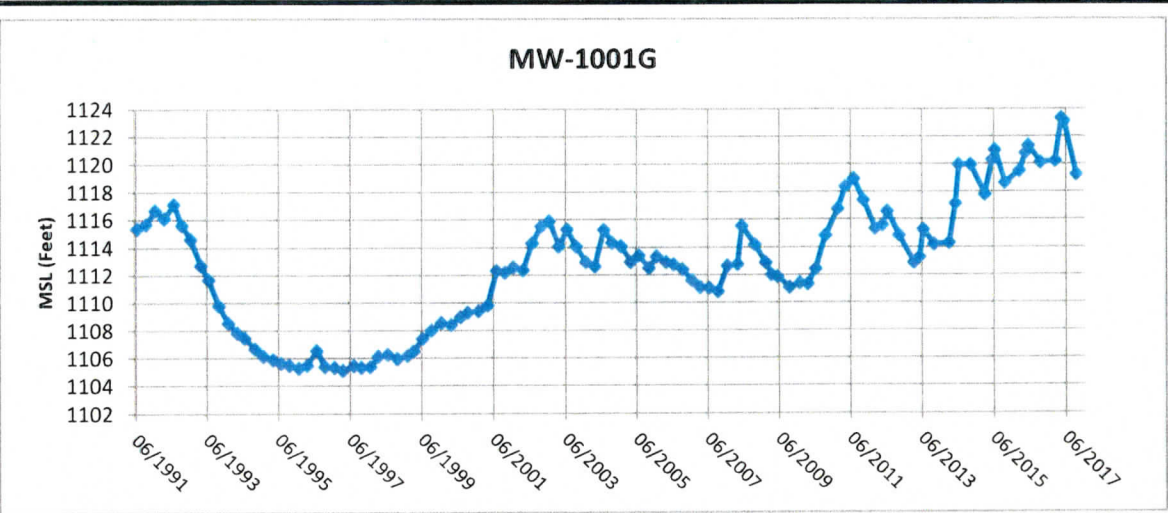
Hydrographs




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FLAMBEAU MINING COMPANY	
Figure B-16a Hydrographs	
Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	

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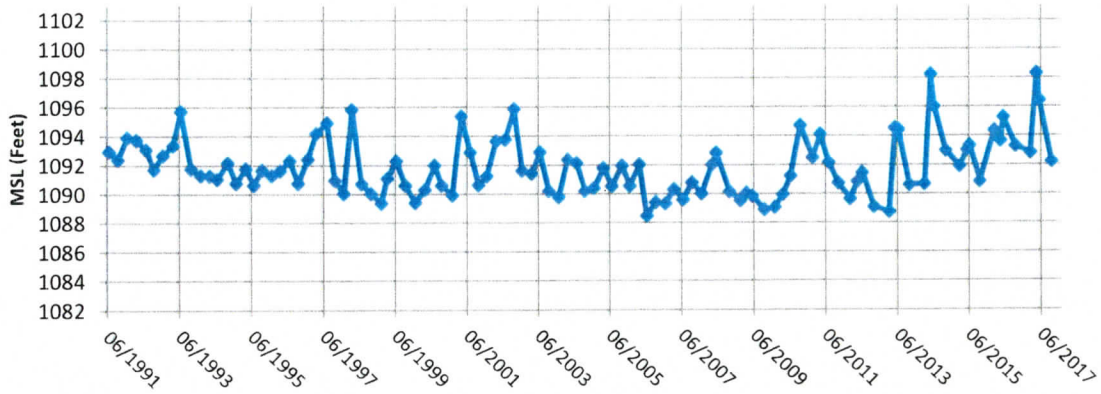


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FLAMBEAU MINING COMPANY	
Figure B-16b Hydrographs	
Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	

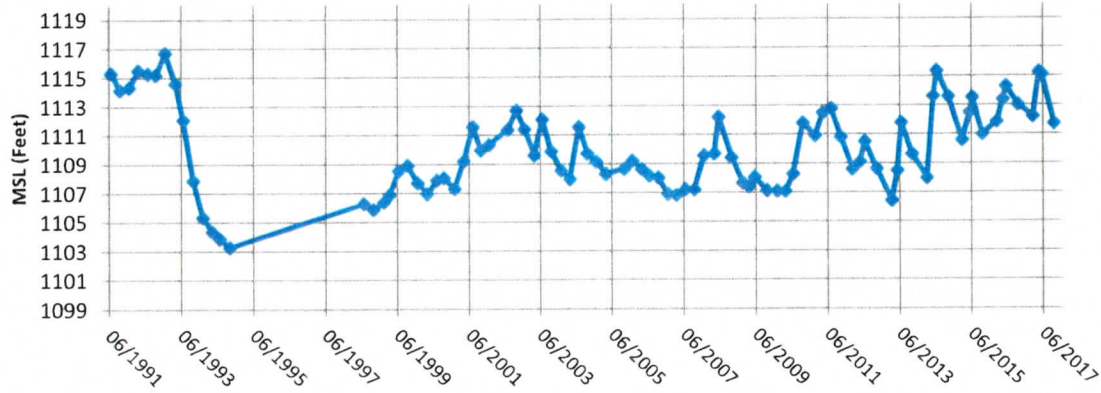
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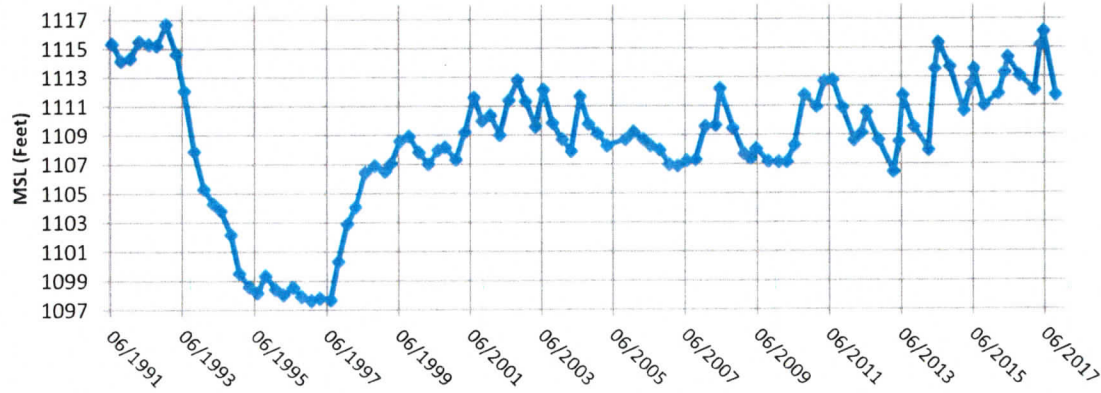
MW-1002G



MW-1003



MW-1003P



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Figure B-16c
Hydrographs

Scale: NA

Date: January 2018

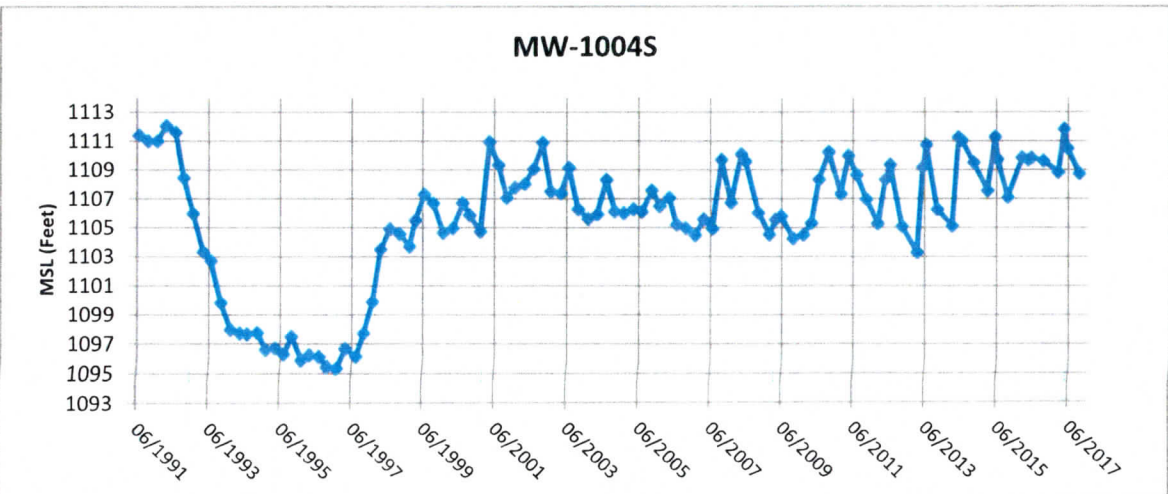
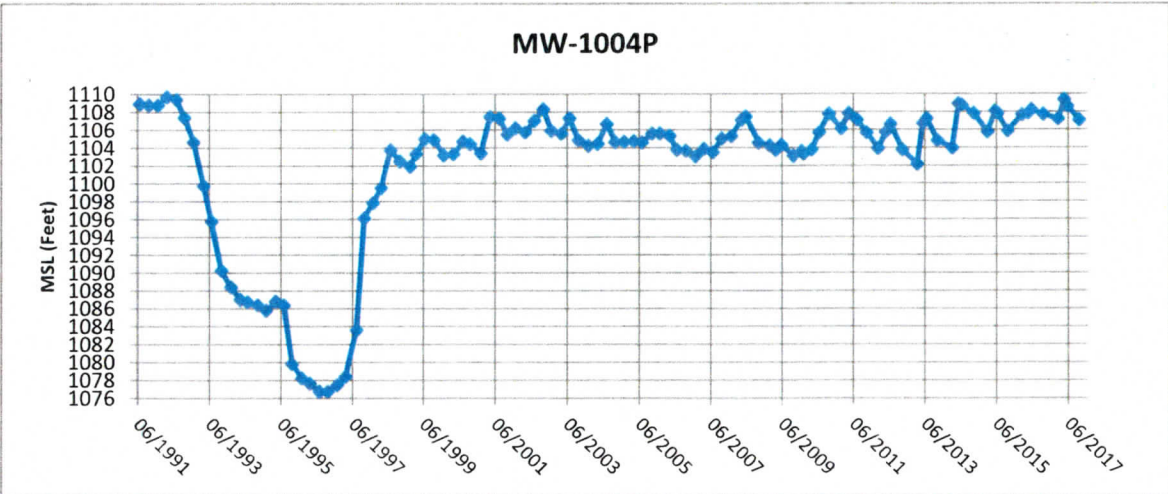
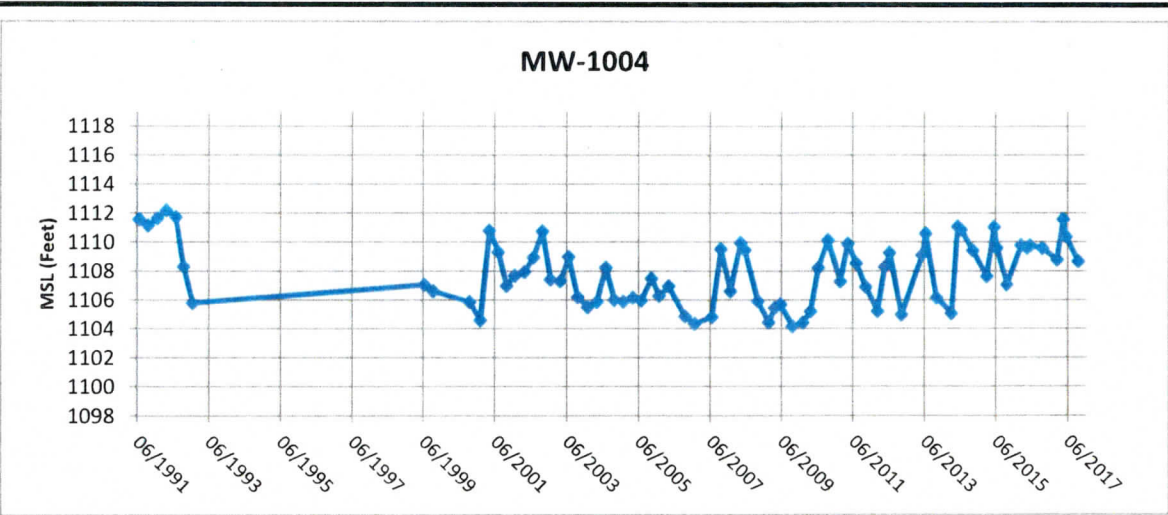
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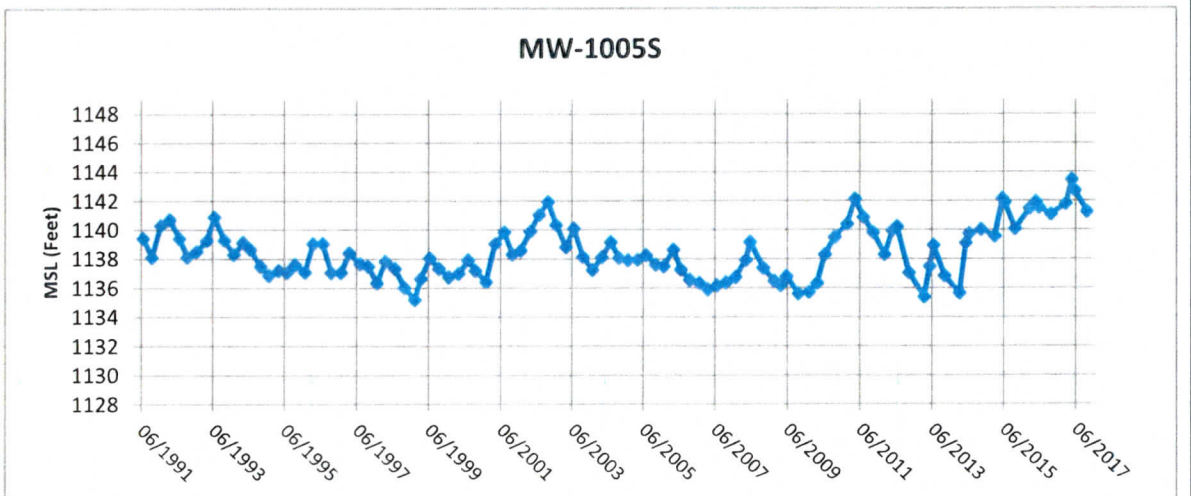
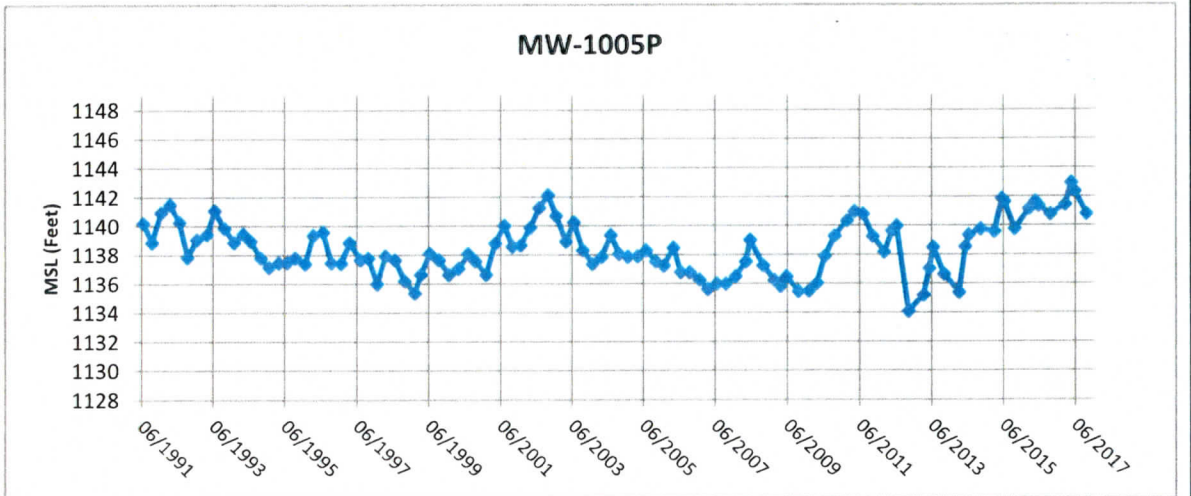
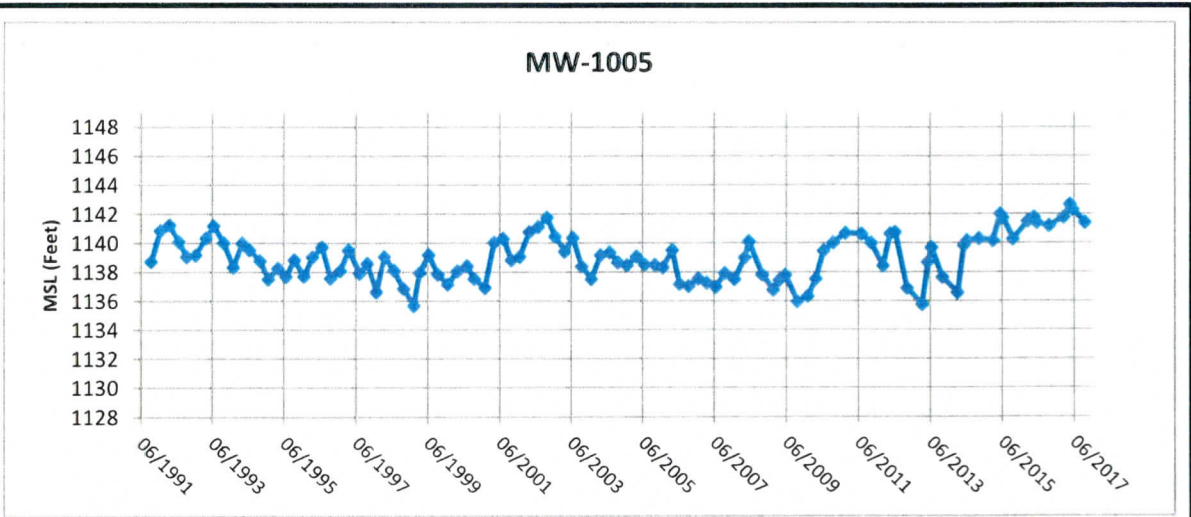
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Figure B-16d Hydrographs	
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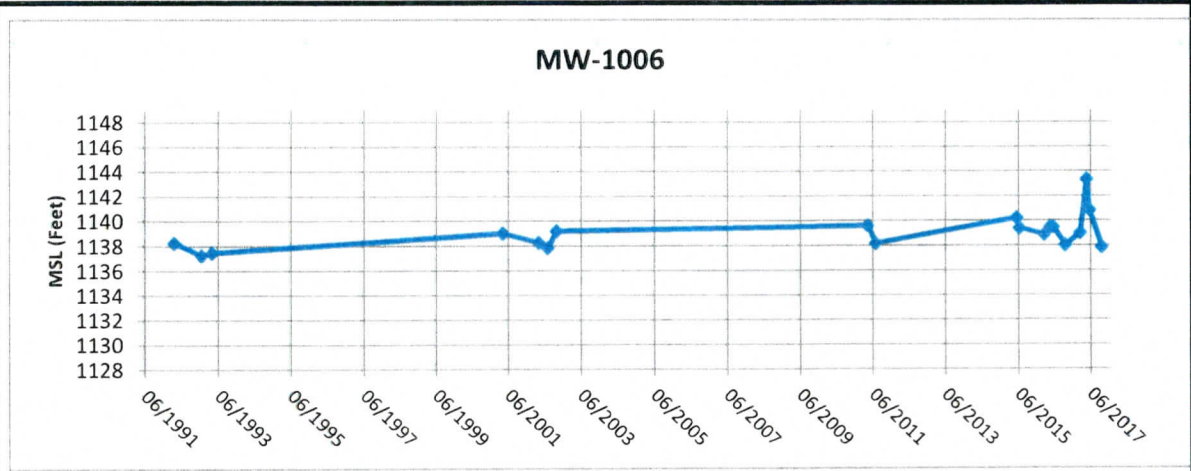
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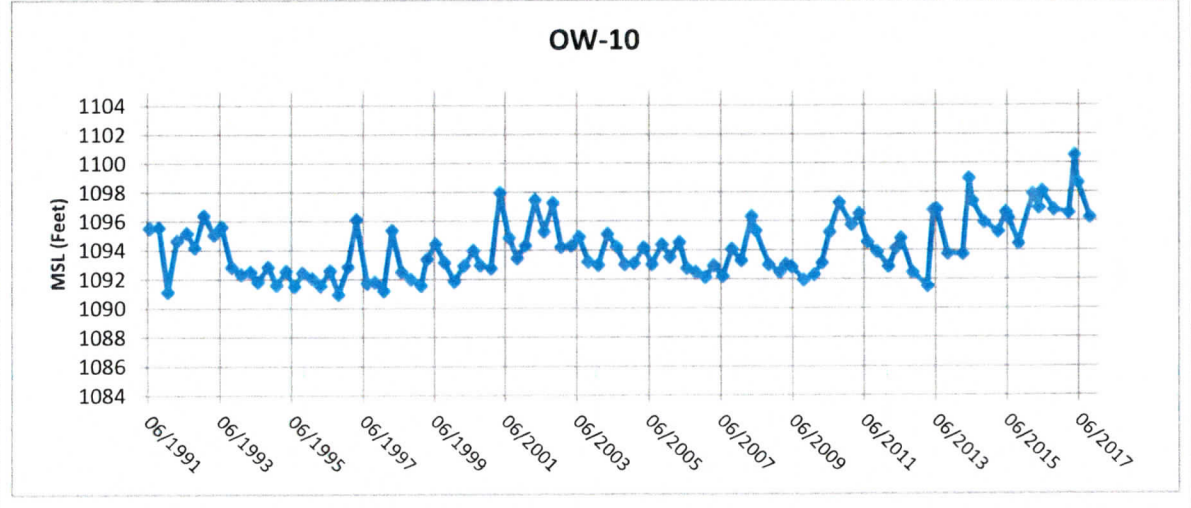
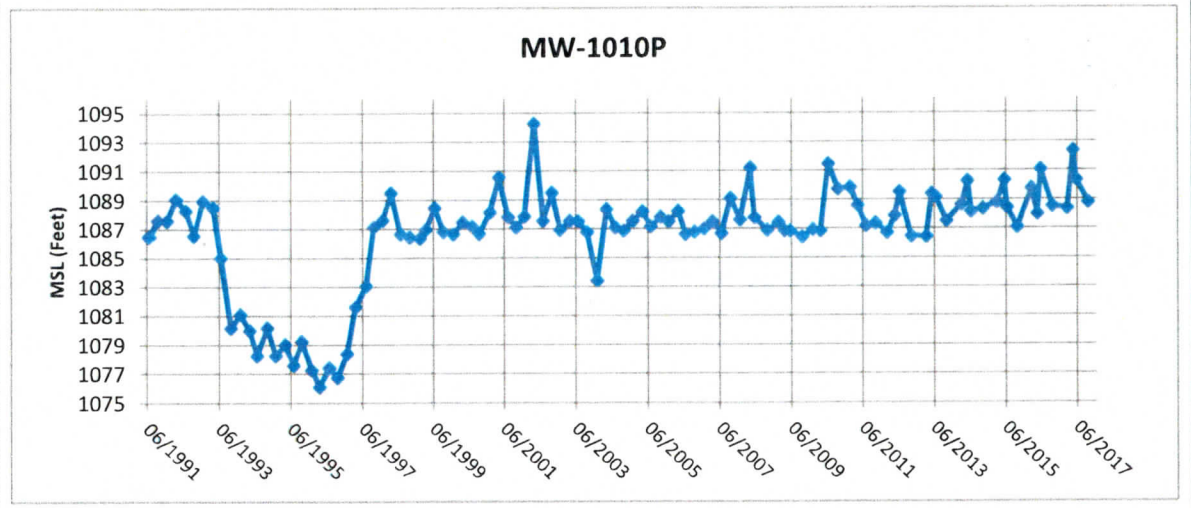
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FLAMBEAU MINING COMPANY	
Figure B-16e Hydrographs	
Scale: NA	Date: January 2018
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Scope: 17F777-00	


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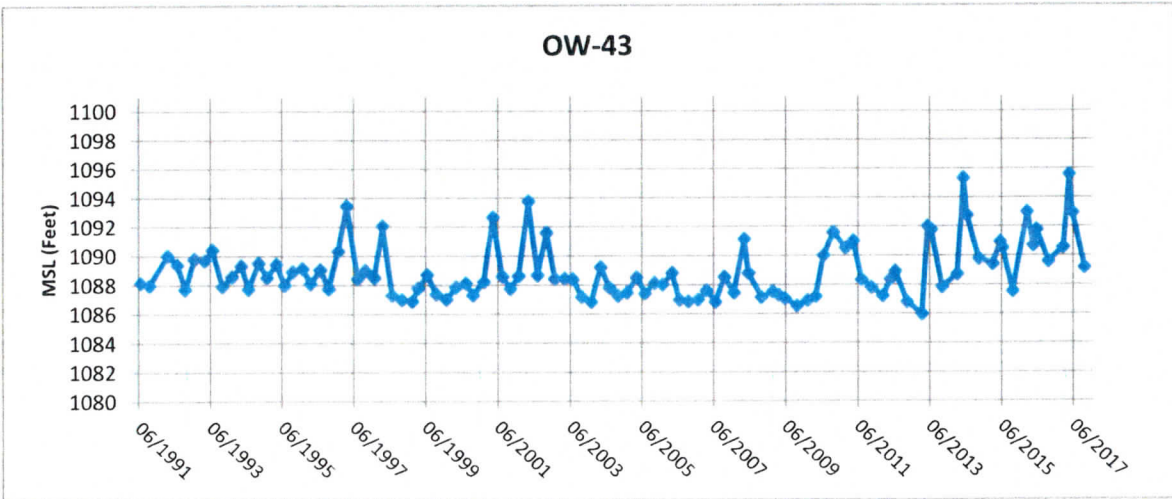
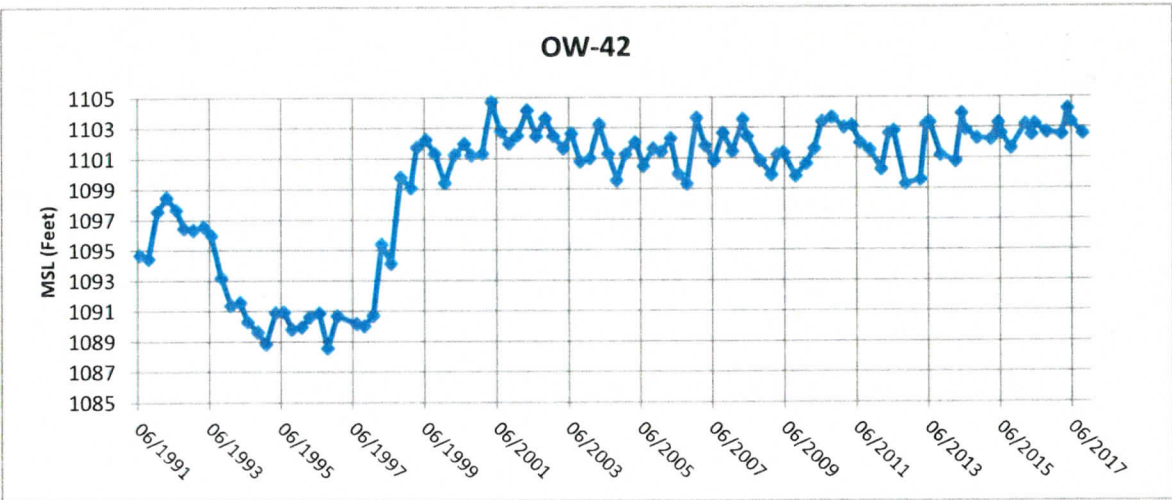
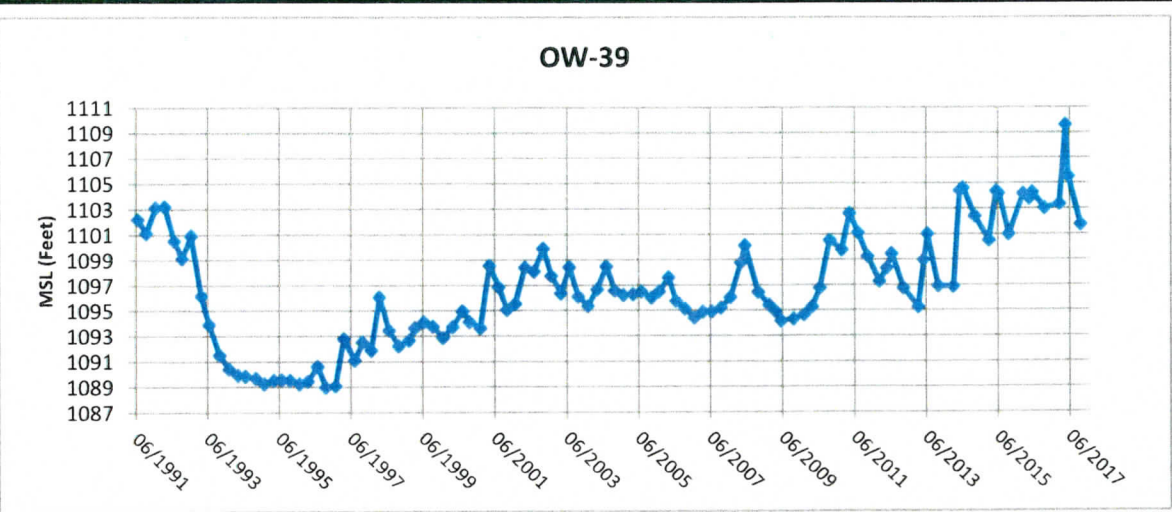
Note: Gaps between collected data are due to dry well.



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FLAMBEAU MINING COMPANY	
Figure B-16f Hydrographs	
Scale: NA	Date: January 2018
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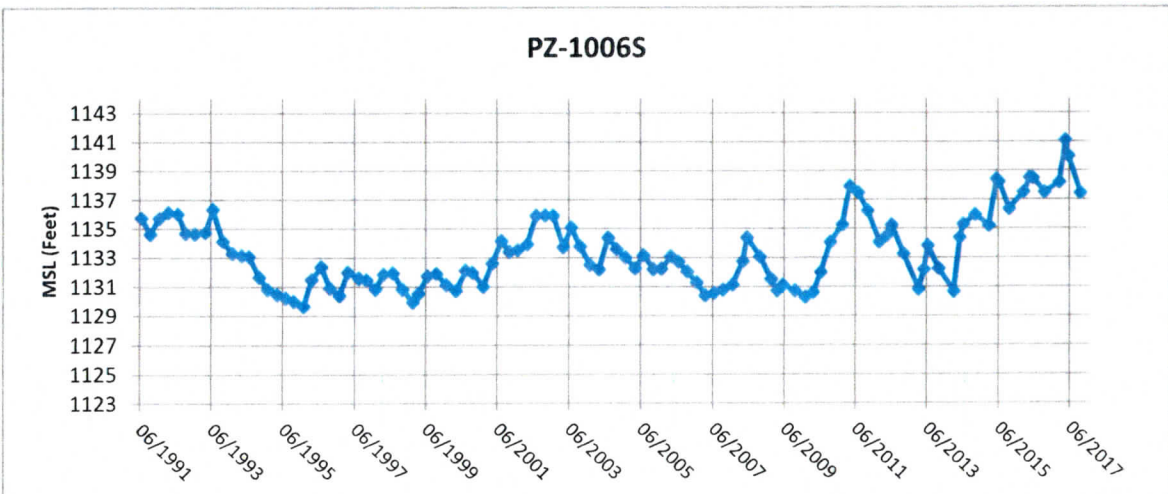
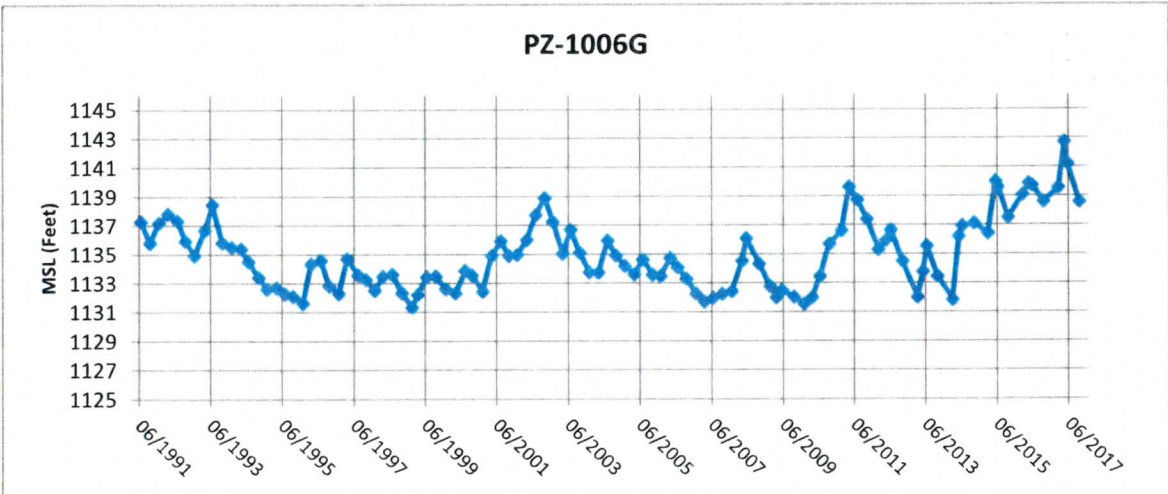
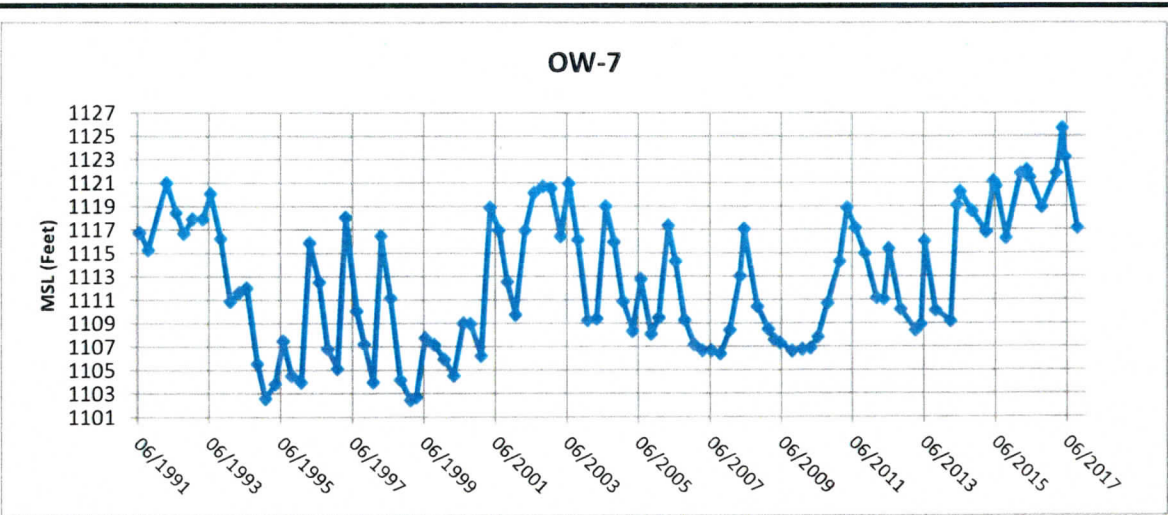
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FLAMBEAU MINING COMPANY		
Figure B-16g Hydrographs		
Scale: NA	Date: January 2018	
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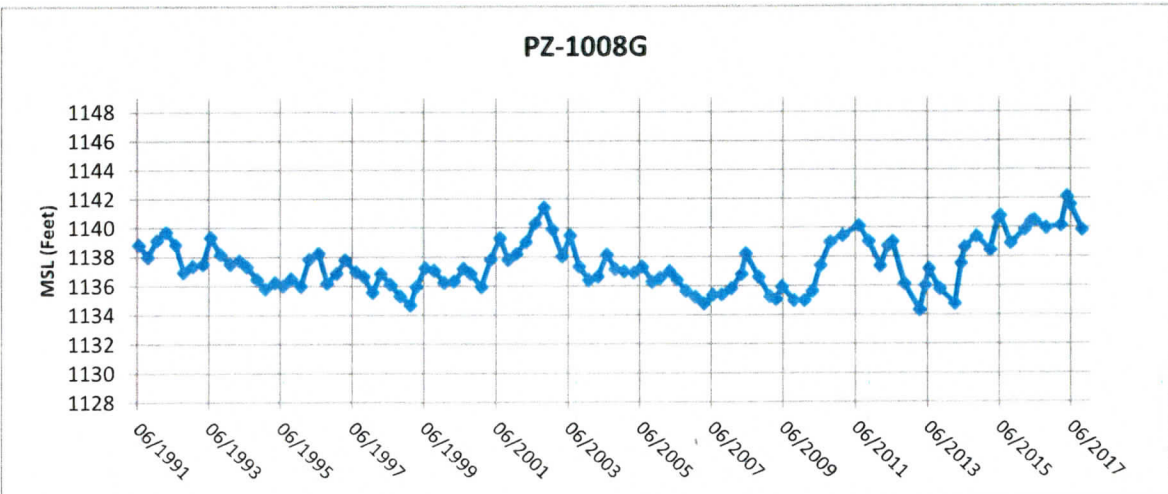
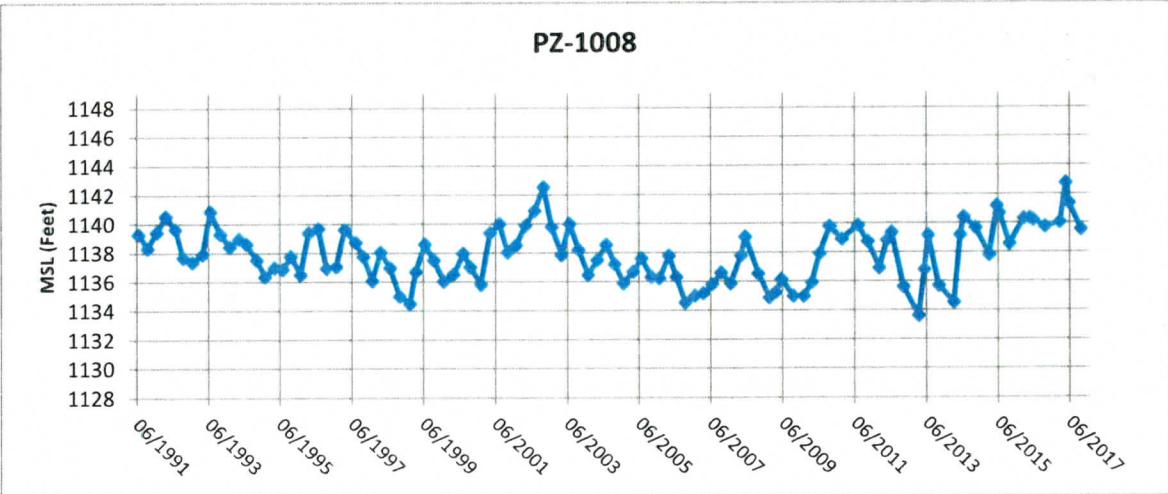
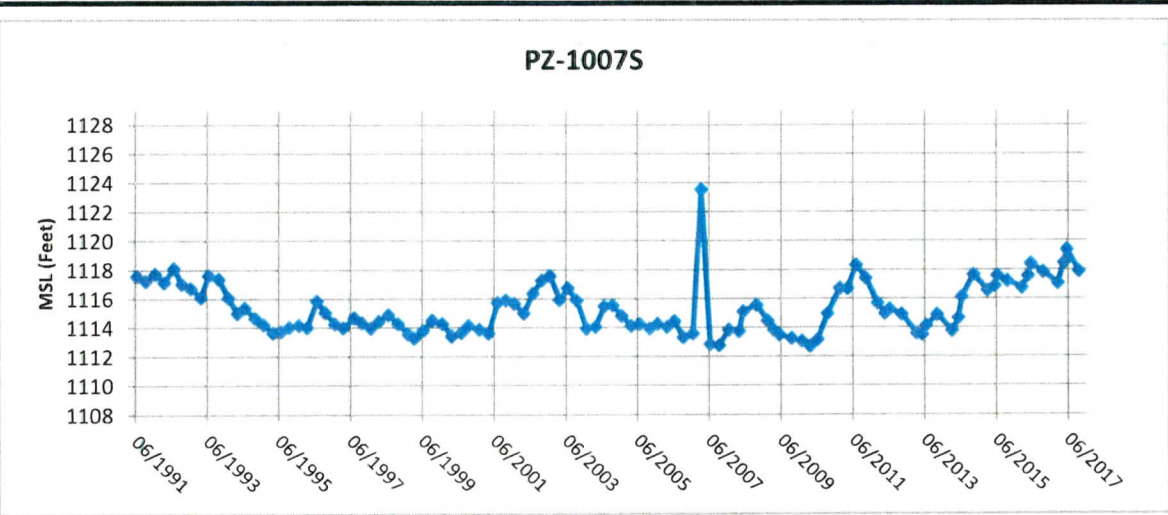
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Figure B-16h Hydrographs	
Scale: NA	Date: January 2018
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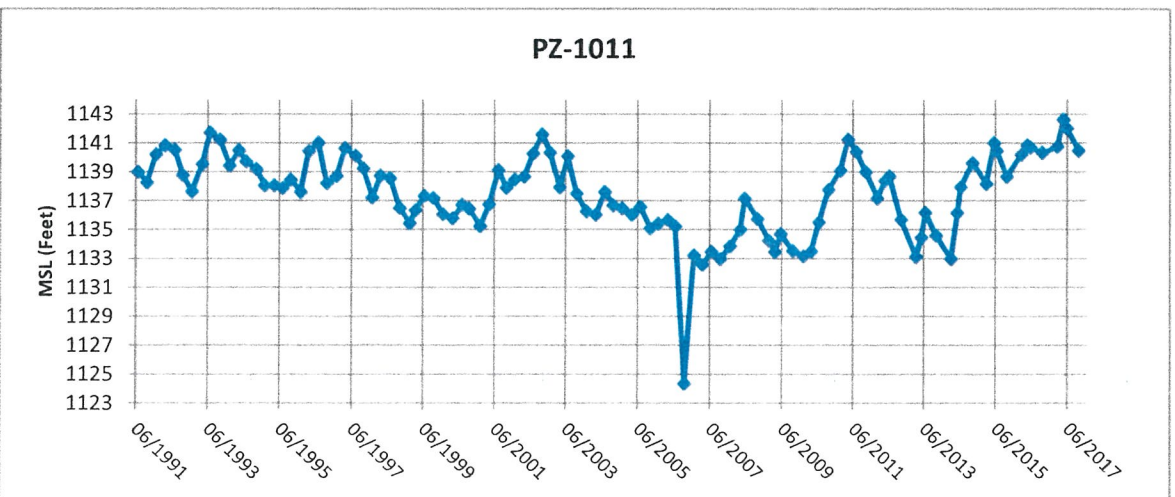
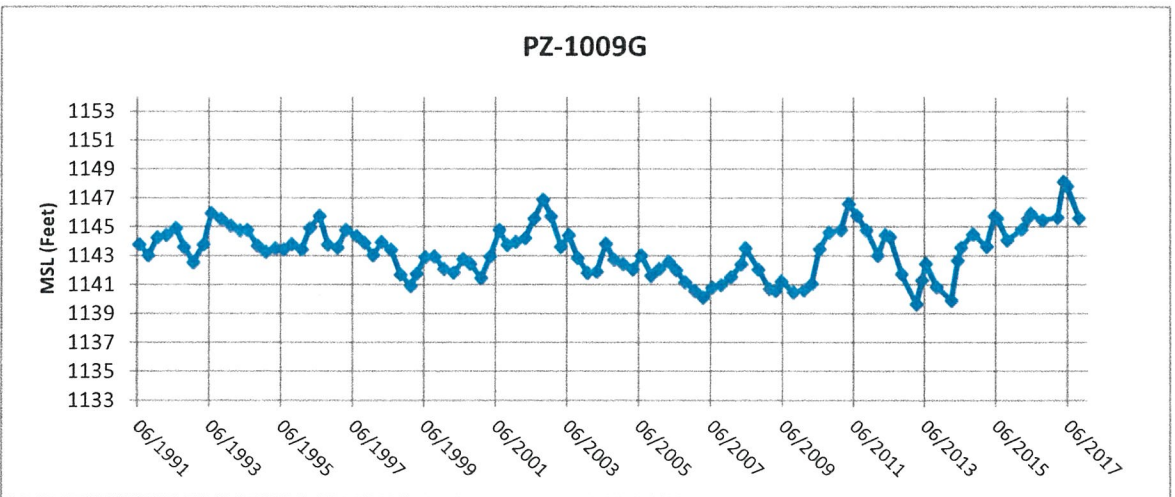
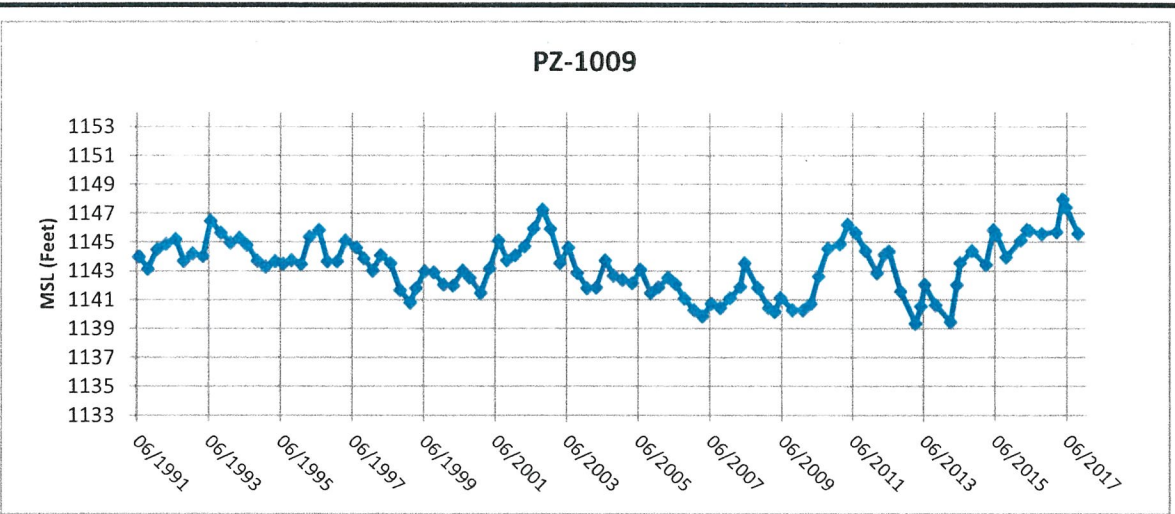
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Figure B-16i Hydrographs	
Scale: NA	Date: January 2018
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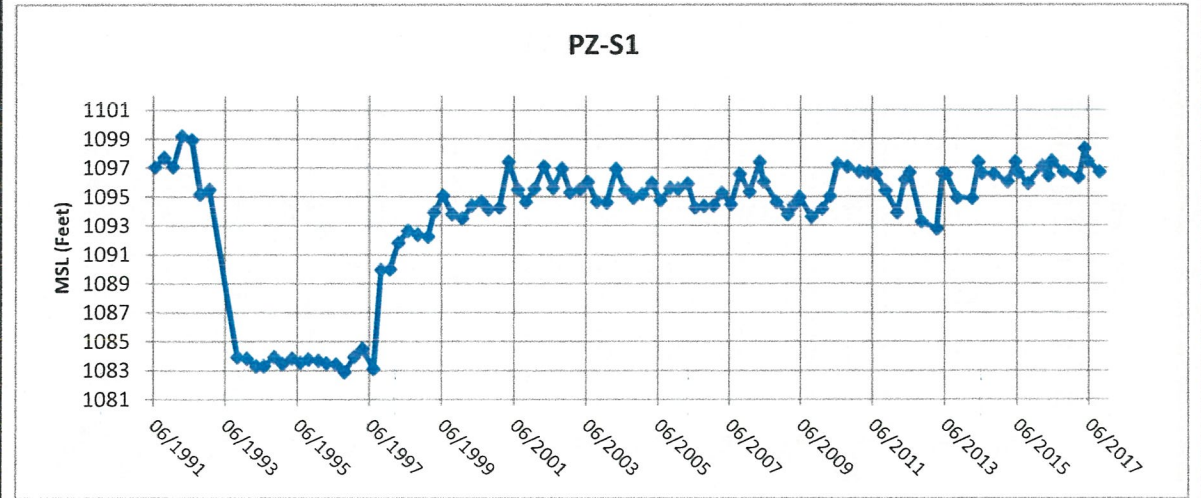
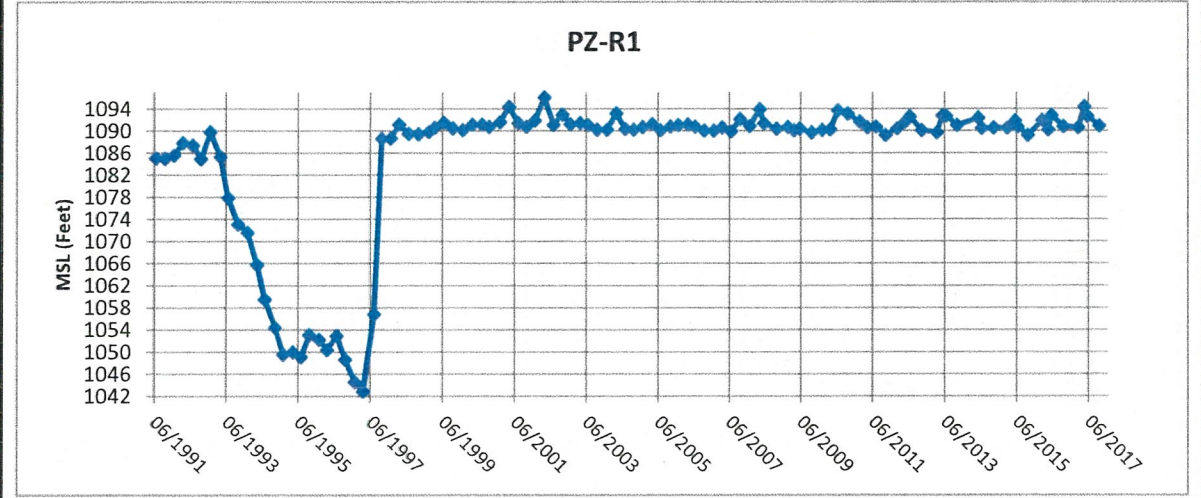
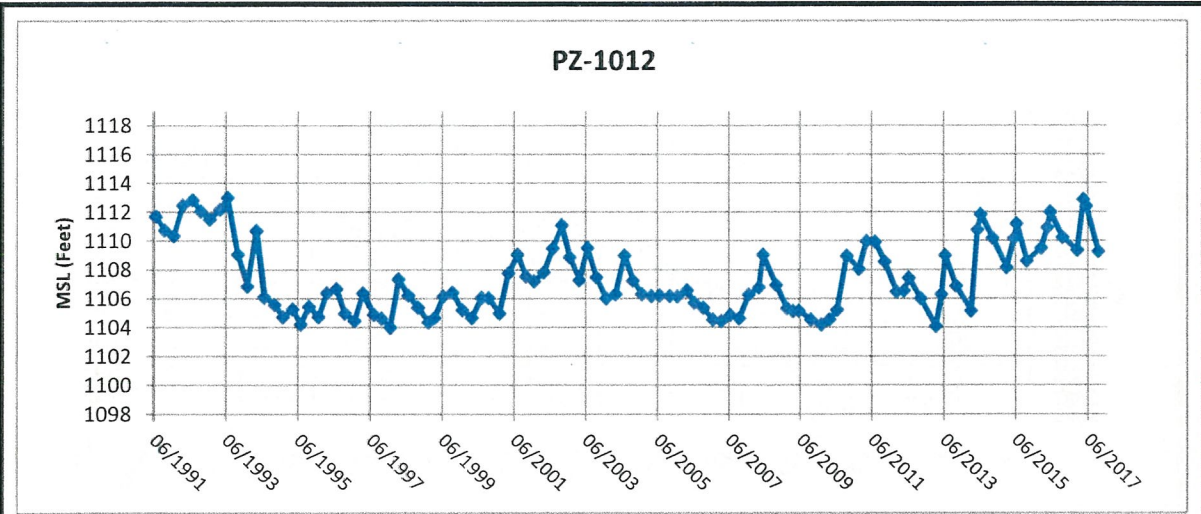
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FLAMBEAU MINING COMPANY		
Figure B-16j Hydrographs		
Scale: NA	Date: January 2018	
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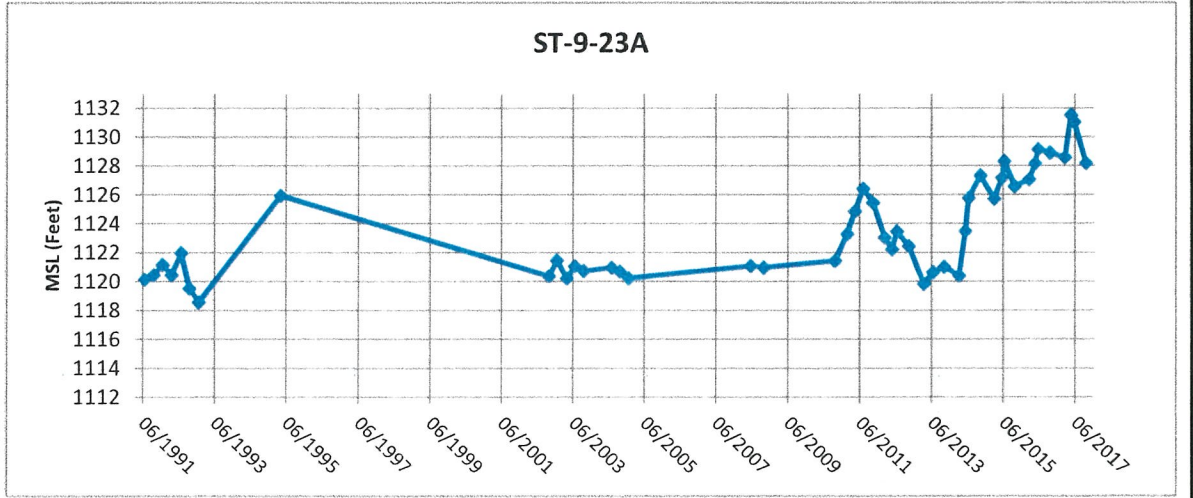
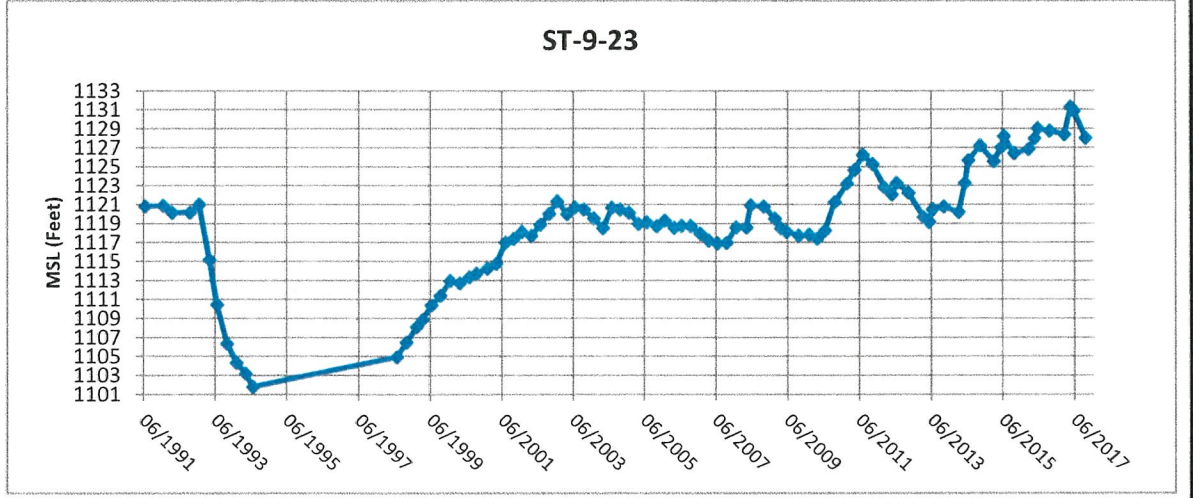
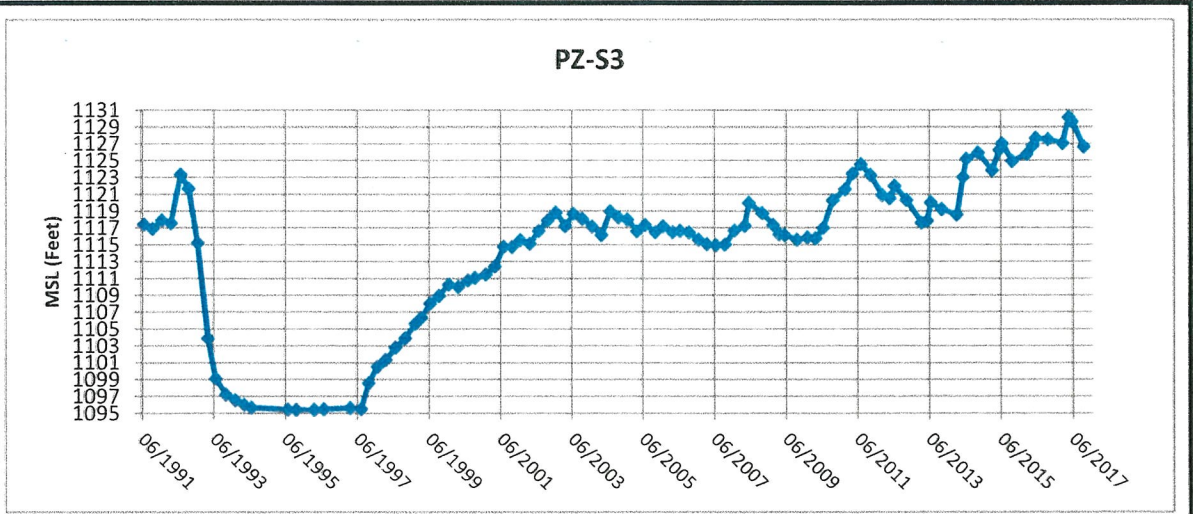
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FLAMBEAU MINING COMPANY		
Figure B-16k Hydrographs		
Scale: NA	Date: January 2018	
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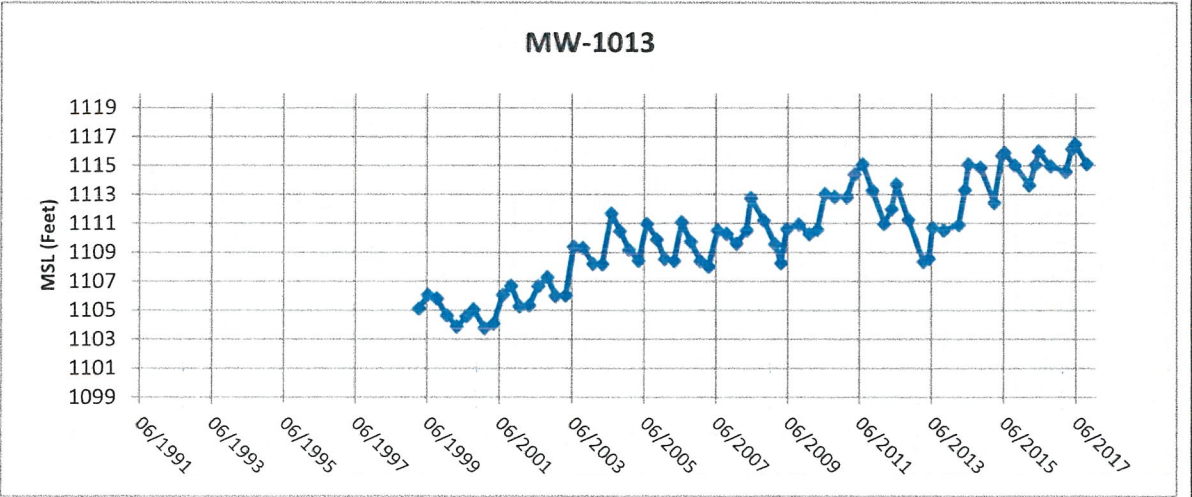
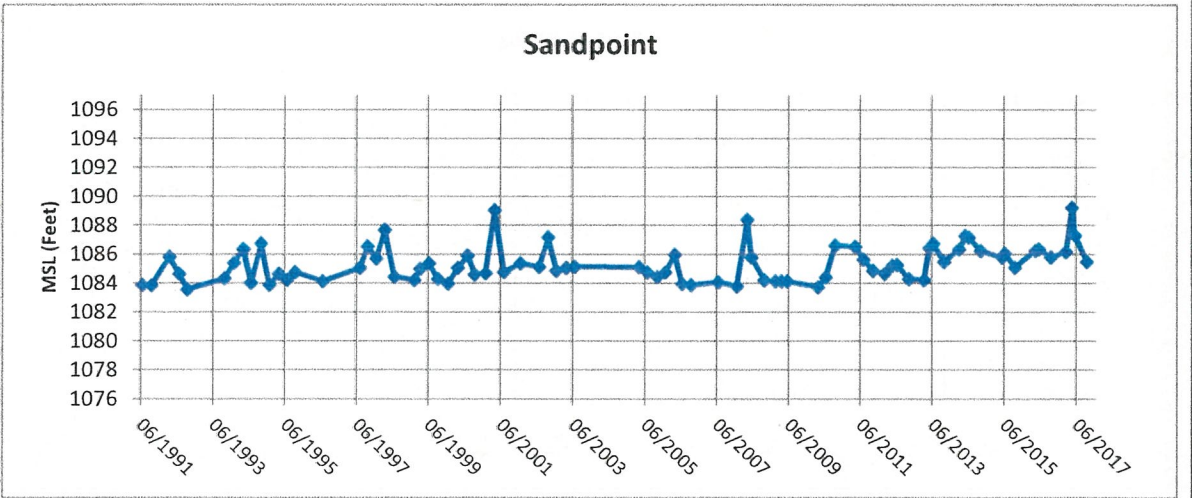
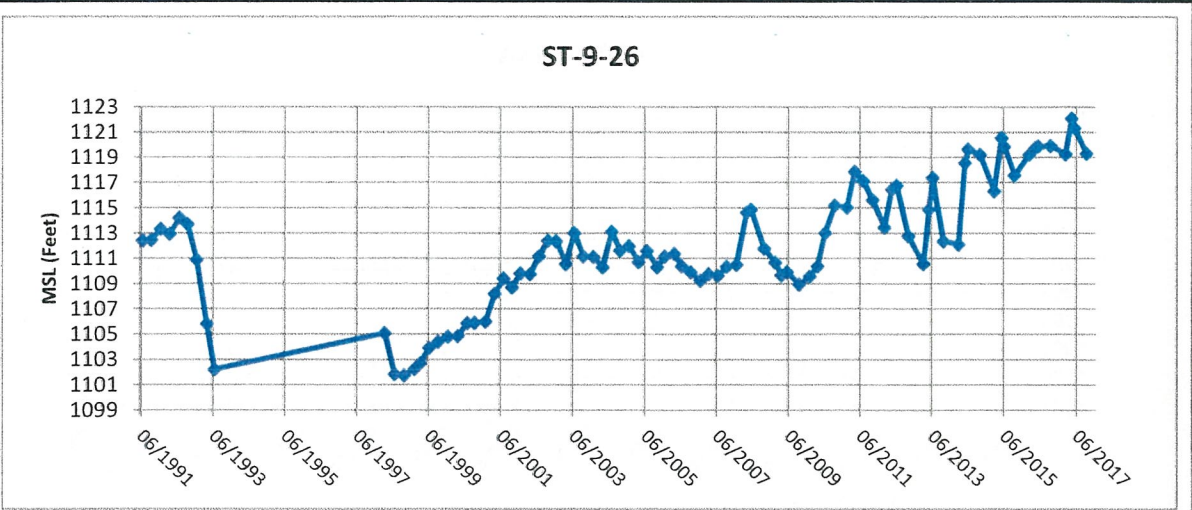
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FLAMBEAU MINING COMPANY		
Figure B-16I Hydrographs		
Scale: NA	Date: January 2018	
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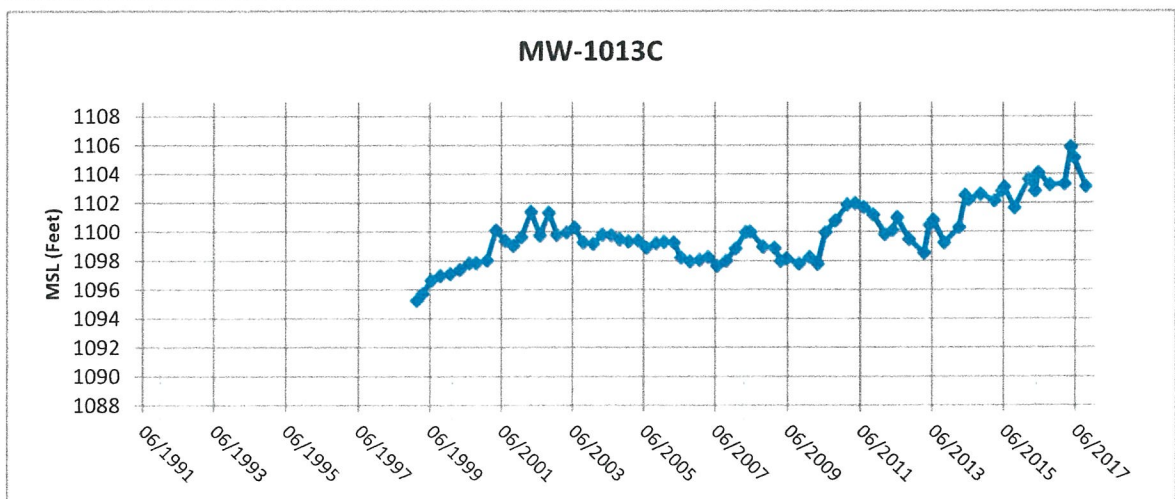
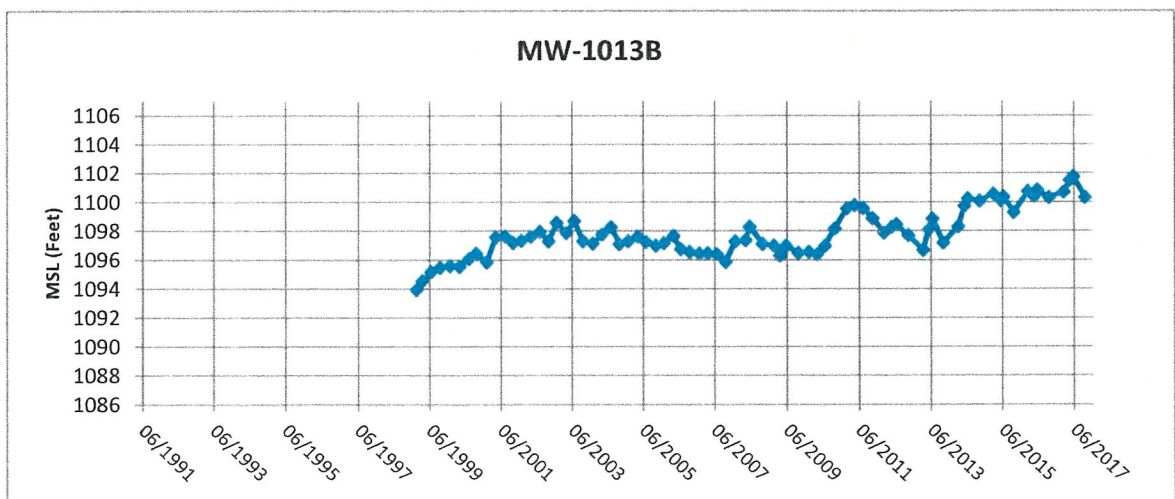
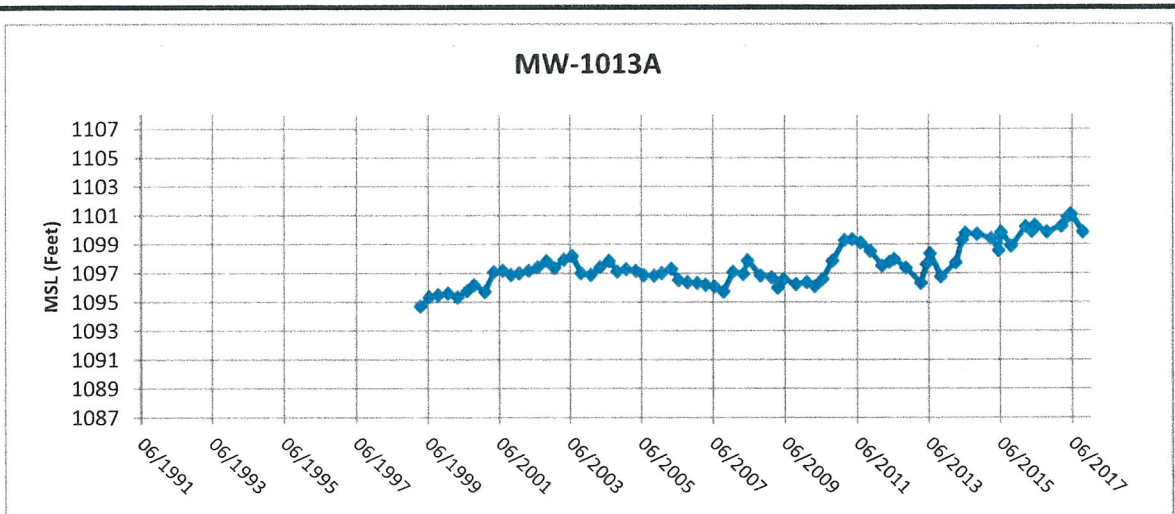
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Foth <small>Foth Infrastructure & Environment, LLC</small>		
FLAMBEAU MINING COMPANY		
Figure B-16m Hydrographs		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00

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2017 Annual Report

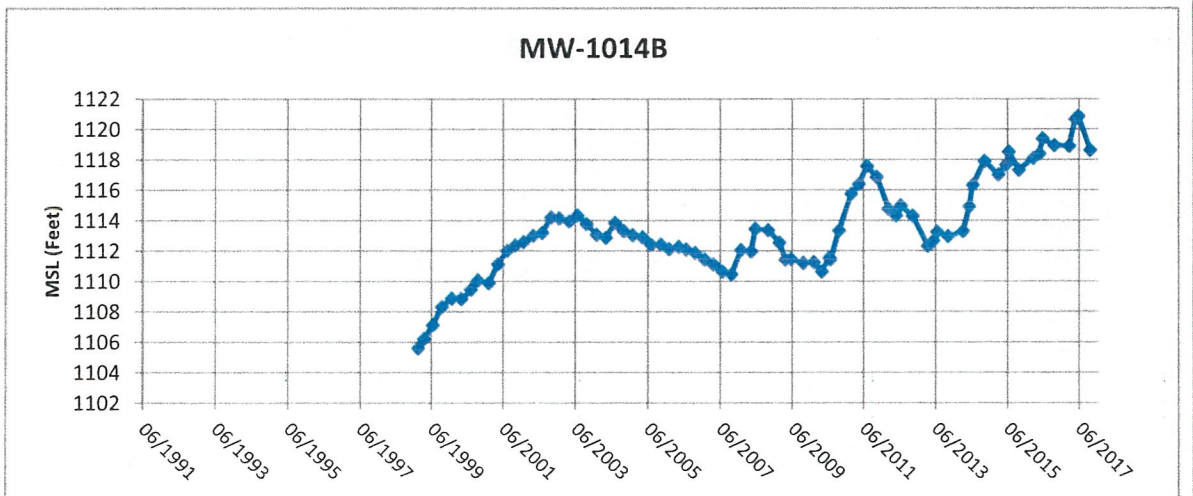
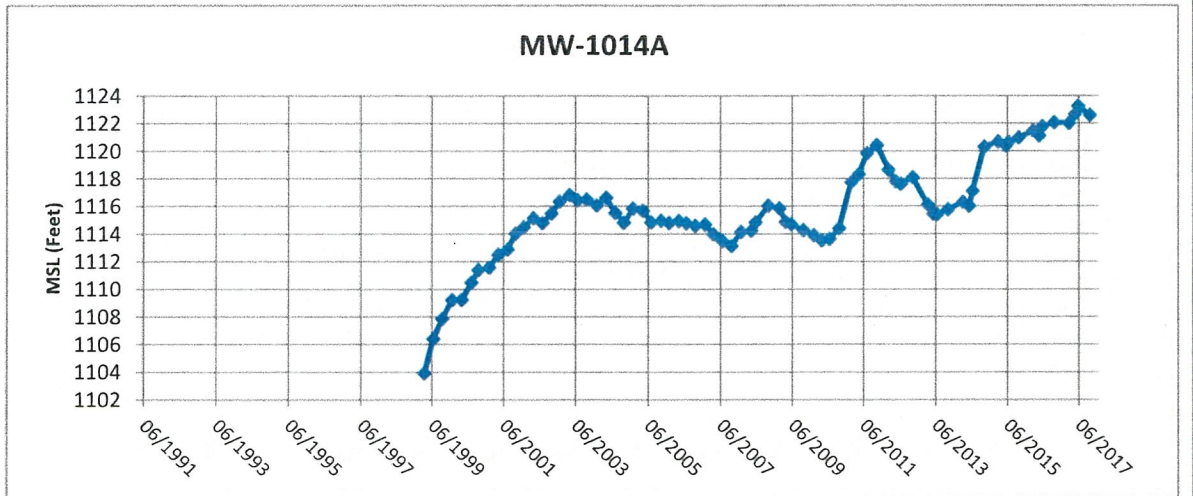
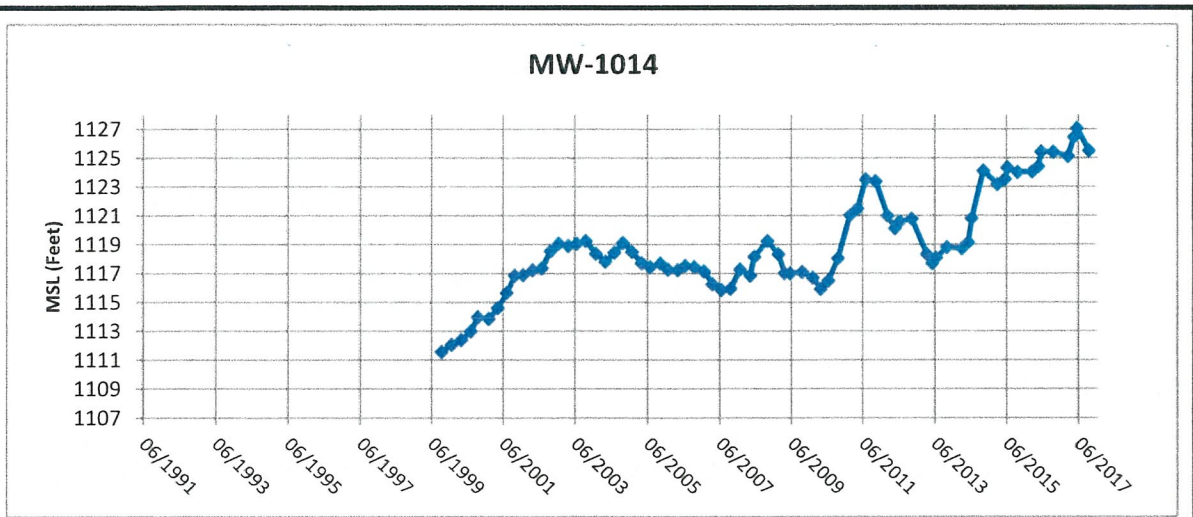
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 <small>Foth Infrastructure & Environment, LLC</small>		
FLAMBEAU MINING COMPANY		
Figure B-16n Hydrographs		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00

Flambeau Mining Co.
2017 Annual Report

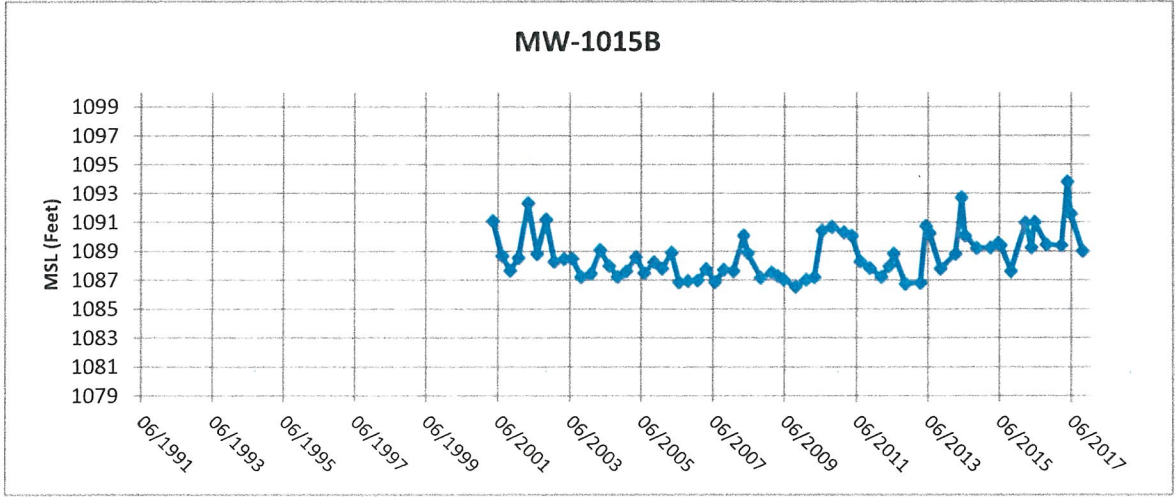
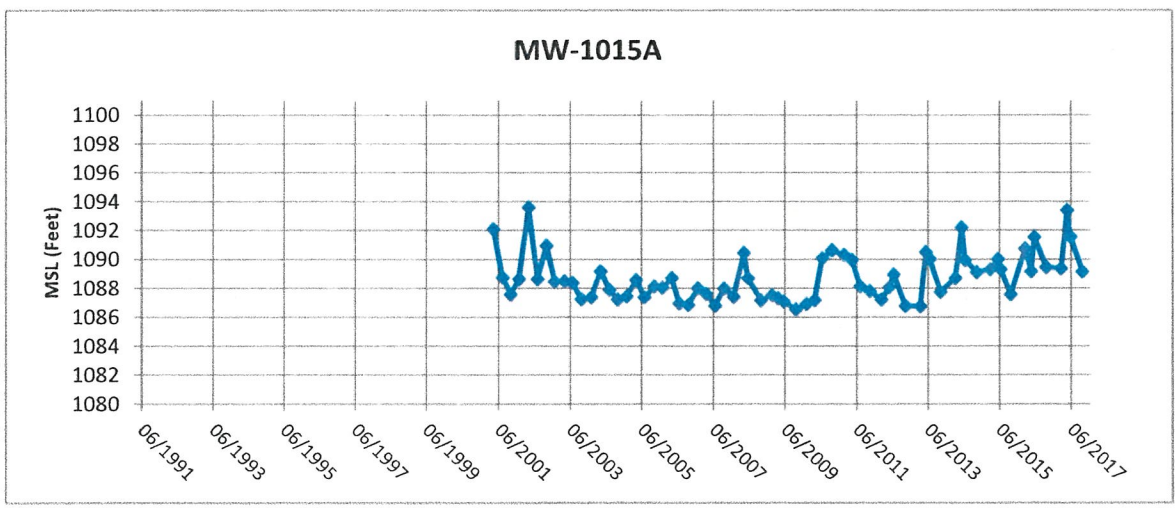
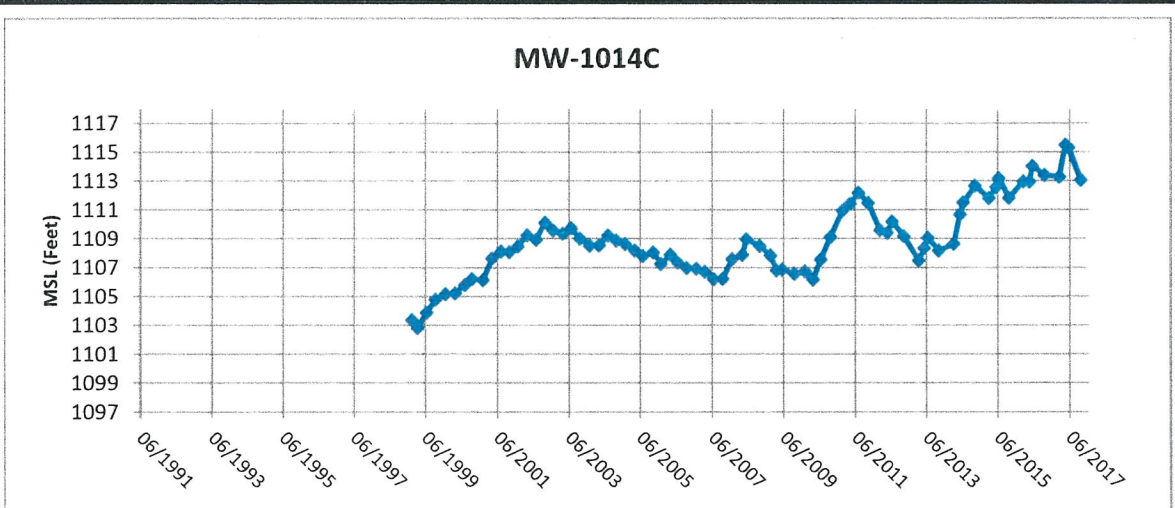
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 <small>Foth Infrastructure & Environment, LLC</small>		
FLAMBEAU MINING COMPANY		
Figure B-16o Hydrographs		
Scale: NA	Date: January 2018	
Prepared By: SGL	Checked By: SVF	Scope: 17F777-00

Flambeau Mining Co.
2017 Annual Report

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Foth
Foth Infrastructure & Environment, LLC

FLAMBEAU MINING COMPANY

Figure B-16p
Hydrographs

Scale: NA	Date: January 2018
Prepared By: SGL	Checked By: SVF
Scope: 17F777-00	

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Attachment 5

WT-5 Water Levels

Wetland 1 (WT-5) Water Level Readings

Date	Level (ft.)	Elevation	Comment
3/19/2017	0.5	(1)	Partially frozen.
5/23/2017	0.08	(1)	
6/20/2017	-	(1)	Approximately 1 inch of standing water but below staff gauge reading.
10/17/2017	-	(1)	Approximately 1 inch of standing water but below staff gauge reading.

⁽¹⁾"0" mark elevation not established.

Appendix C

**2017 Ecological Monitoring for the Flambeau Copper Park Business
and Recreation Area**



APPLIED ECOLOGICAL SERVICES

TO: Sharon Kozicki, PG
Foth Infrastructure and Environment LLC
2121 Innovation Court, Suite 300
De Pere, WI 54115-5126

FROM: John L. Larson Ph.D.
Applied Ecological Services (AES)
17921 Smith Road, PO Box 256
Brodhead, WI 53520

DATE: Revised September 21, 2017

RE: Memo: 2017 Ecological monitoring for the Flambeau Copper Park Business
& Recreation Project (AES Project #14-0863)

Dear Sharon,

On August 9, 2017 a site visit by AES, Max Malmquist (Rio Tinto) and Nick Glander (Foth) was made to view and assess the 2017 progress of the above referenced project. This site visit constituted the second of three annual site assessments per the WDNR permit. Data collected in 2017 was consolidated into 5 main sections; East, West and North Areas, East-West Swale; and Wetland #7. Where appropriate, a chronological photography representation of the various areas restored is included. Observations through August 9, 2017 are as follows:

1.0 East Area

The East Area (Figure 1) was constructed and seeded in fall 2015 (Photographs 1, 2 & 5). Throughout 2016 and continuing into 2017, a variety of wetland and upland prairie species have established (Photographs 3, 4 & 6). Two vegetation seeded areas were evaluated on August 9, 2017. These were; 1) emergent that included the naturalized low flow channel and wet prairie community and 2) upland prairie that included both a newly seeded upland prairie slope and an existing upland prairie slope. Within each of the two areas, plant species were identified and each species was given an estimate of visual cover (%). Due to plant layering the visual areal cover estimate can exceed 100%.

1.1 East Area Emergent

Both the naturalized low flow channel and the bottom areas were vegetated by September 2016 and vegetation has been well established through August 9, 2017. Approximately 30 plant species were observed in the emergent area in 2017 (Appendix 1 Table 2). Of the seven emergent species seeded (Table 1), three were observed and of the sixteen wet prairie species seeded (Table 2), eight were observed along with an additional 24 native volunteer species. The vegetation coverage was estimated at 90% with native species comprising 87% of the total cover.



Photograph 1. East Area naturalized low flow channel with side tapering on November 11, 2015.



Photograph 2. East Area naturalized low flow channel with erosion blanket on November 17, 2015.



Photograph 3. Vegetated naturalized low flow channel (dark green strip) and wet meadow with cattails in East Area, taken on September 8, 2016.



Photograph 4. Vegetated East Area with low flow channel and wet meadow, taken on August 9, 2017.



Photograph 5. East Area and naturalized low flow channel with initial seed germination on June 16, 2016. Erosion blanket is still intact.



Photograph 6. East Area and naturalized low flow channel (darker green areas) and wet prairie areas in between, taken on August 9, 2017.

Table 1. Emergent species seeded in the low flow channel in the East and North Areas and emergent zones in the West Area.

Species	Common Name
<i>Alisma subcordatum</i>	Water plantain
<i>Echinochloa crusgalli</i>	Barnyard grass
<i>Iris virginica shrevei</i>	Wild iris
<i>Sagittaria latifolia</i>	Arrowhead
<i>Scirpus fluviatilis</i>	River bulrush
<i>Scirpus validus creber</i>	Soft stem bulrush
<i>Sparganium eurycarpum</i>	Burreed

Table 2. Wet prairie species seeded in the East, North, and West Emergent Areas

Species	Common Name
<i>Asclepias incarnata</i>	Marsh milkweed
<i>Aster novae-angliae</i>	New England aster
<i>Aster umbellatus</i>	Flat top aster
<i>Calamagrostis canadensis</i>	Canada blue joint grass
<i>Carex lacustris</i>	Lake bank sedge
<i>Carex scoparia</i>	Painted broom sedge
<i>Carex vulpinoidea</i>	Fox sedge
<i>Elymus virginicus</i>	Virginia wild rye
<i>Eupatorium perfoliatum</i>	Boneset
<i>Euthamia graminifolia</i>	Grass leaf goldenrod
<i>Helenium autumnale</i>	Sneezeweed
<i>Lobelia siphilitica</i>	Great blue lobelia
<i>Scirpus atrovirens</i>	Dark green bulrush
<i>Scirpus cyperinus</i>	Wool grass
<i>Spartina pectinata</i>	Cord grass
<i>Verbena hastata</i>	Blue vervain

1.2 East Area Prairie Slope

The East Area side slopes had been restored to upland prairie (Photograph 7). Minor disturbance areas resulting from area construction in 2015 were re-seeded with an upland prairie species mix (Table 3). Of the 12 seeded species, 8 were observed in August 2017 on the side slopes (Appendix 1, Table 1). Overall vegetation cover was estimated at 101% with natives comprising 59% cover. Overall and native % cover associated with the recently seeded slope areas was generally somewhat less (Photograph 8). These newly seeded areas contained seedlings of black-eyed Susan (*Rudbeckia hirta*), yellow coneflower (*Ratibida pinnata*) and Canada wild rye (*Elymus canadensis*) with occasional beardtongue (*Penstemon digitalis*), bergamot (*Monarda fistulosa*), switch grass (*Panicum virgatum*), big bluestem grass (*Andropogon gerardii*) and Indian grass (*Sorghastrum nutans*).



Photograph 7. East Area prairie slope dominated by saw tooth sunflower, taken on August 9, 2017.



Photograph 8. Recently seeded upland prairie on the East Area buffer slope, taken on August 9, 2017.

Table 3. Upland prairie species seeded on (East, West & North Areas) side slopes.

Species	Common Name
Grasses	
<i>Andropogon gerardii</i>	Big blue stem
<i>Elymus canadensis</i>	Canada wild rye
<i>Panicum virgatum</i>	Switch grass
<i>Schizachyrium scoparium</i>	Little blue stem
<i>Sorghastrum nutans</i>	Indian grass
Wildflowers	
<i>Desmodium canadense</i>	Canada tick trefoil
<i>Monarda fistulosa</i>	Bergamot
<i>Penstemon digitalis</i>	Smooth Penstemon
<i>Ratibida pinnata</i>	Yellow coneflower
<i>Rudbeckia hirta</i>	Black eyed Susan
<i>Solidago rigida</i>	Stiff goldenrod
<i>Tradescantia ohiensis</i>	Spiderwort

2.0 North Area

The North Area (Figure 1) was constructed and seeded in fall 2015 (Photographs 9, 10 & 14). Native seed was observed germinating in June, 2016 (Photograph 11) and was densely covered with vegetation in September 2016 and August 2017 (Photographs 12, 13, 15 & 16). The North Area consists of a naturalized low flow channel along and a wet prairie in the emergent area and an upland prairie on side slopes and was evaluated on August 9, 2017. Within the two zones, plant species were identified and given an estimate of visual cover (%).

2.1 North Area Emergent

The North Area naturalized low flow channel was seeded with an emergent mix (Table 1) and the remainder was seeded with a wet prairie seed mix (Table 2). Of the seven emergent species seeded, three were observed growing in the low flow channel (Appendix 1 Table 4). Of the 16 wet prairie species seeded, 12 were observed in August 2017 along with 15 additional native wetland species. Overall plant cover was estimated at 86% with native species comprising 64% of the vegetation cover.

2.2 North Area Prairie Slopes

The upland prairie slope surrounding the North Area had been partially disturbed during construction and these areas were over seeded with an upland species mix (Table 3). A variety of native species were observed on the north area slopes (Appendix 1 Table 3). Eight of the 12 seeded species were observed. Overall vegetation cover was 98% for the upland prairie buffer, of which 55% cover was by native species.



Photograph 9. North Area naturalized low flow channel, looking east on November 11, 2015.



Photograph 10. North Area naturalized low flow channel with erosion blanket installed on November 17, 2015, looking east.



Photograph 11. North Area low flow channel looking east on June 16, 2016.



Photograph 12. North Area naturalized low flow channel (S shaped depression) amongst wet meadow "fingers" in September, 2016.



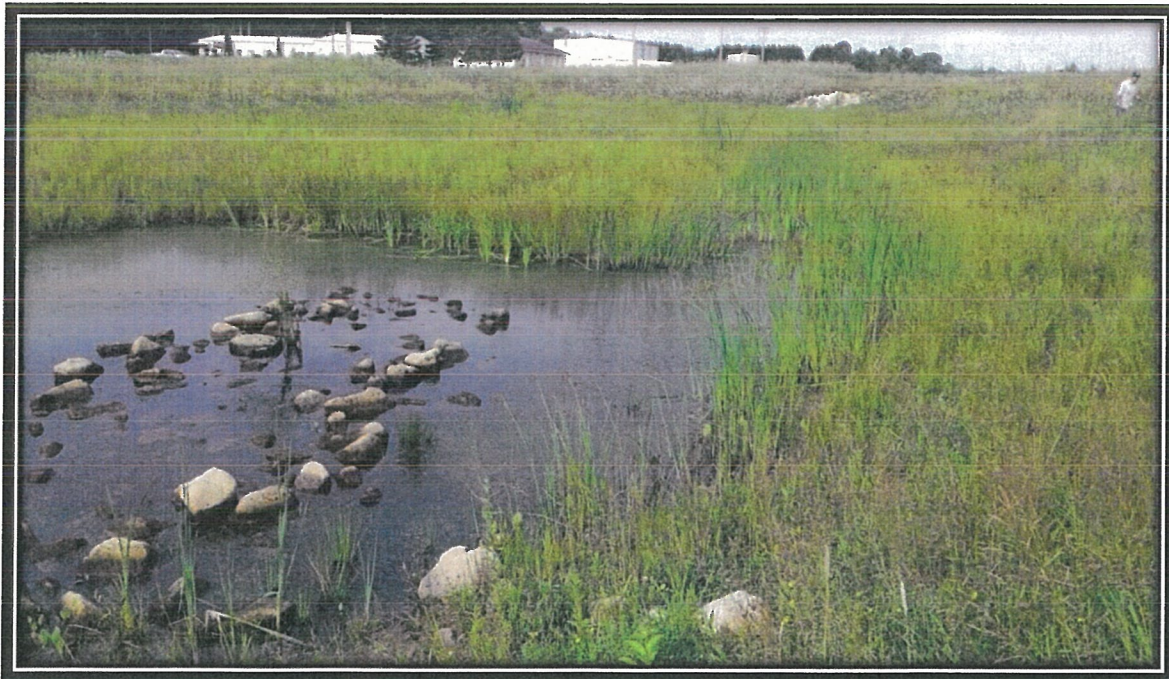
Photograph 13. North Area with darker green low flow channel evident looking east, August 9, 2017.



Photograph 14. North Area looking west with naturalized low flow channel erosion control and side slope blanket along western slope on November 17, 2015.



Photograph 15. North Area looking west with naturalized low flow channel and rock-lined swale, September 8, 2016.



Photograph 16. North Area looking west with naturalized low flow channel and rock-lined swale (mostly under water), August 9, 2017.

2.3 North Area Rock-lined Inlet

A rock-lined surface water inlet was installed in the northwest corner of the North Area as an erosion control measure (Photograph 17). The upland slope near the inlet was seeded with an

upland native mix (Table 3). Seedling germination was evident by June 2016 and the area was well vegetated by September 2016 through August 9, 2017 (Photographs 18 & 19).



Photo 17. Surface water inlet in the northwestern corner of North Area with rock rip rap and side slope with erosion blanket in November, 2015.



Photograph 18. Surface water inlet in the northwestern corner of North Area, with side slope stabilized on September 8, 2016.



Photograph 19. Surface water inlet in the northwestern corner of North Area with rock rip rap, August 9, 2017.

2.4 North Area Connection to East Area

A rock-lined swale connection between the North and East Areas was completed in November 2015 (Photograph 20). Seed germination along the slopes of this swale connection was observable in June 2016 and swale and upland prairie side slope was fully vegetated by August 9, 2017 (Photograph 21).



Photograph 20. North and East Area rock-lined swale connection completed and slopes blanketed on November 17, 2015.



Photograph 21. North Area southwest outlet swale connection to East Area, August 9, 2017

3.0 East-West Swale

Reshaping/contouring of an East-West Swale (Figure 1) connecting the West Area to the East Area began in 2015 and continued into June 2016 (Photograph 22). After the re-shaping was completed, the bottom was seeded with the emergent mix and the slopes seeded with wet prairie and upland prairie seed (Tables 1-3). After seeding, erosion control blanket was installed. By September 2016, portions of the swale had been vegetated with a mixture of native species (Photographs 23 & 24), and by August 2017 were dominated by native species (Photograph 25). Twenty two native species were observed in the East-West Swale in August 2017 (Appendix 1, Table 5). The overall cover of the swale bottom and slopes was estimated at 84% with natives comprising 75% of the cover (Appendix 1, Table 5).

4.0 West Area

The West Area (Figure 1) final grading was completed in 2016 (Photograph 26) after which areas were seeded (Tables 1-3). No seed germination was evident in the West Area until the September 2016 assessment (Photograph 27). Of the seven emergent species seeded in the West Area, three were observed in August 2017 while 5 of the seeded wet prairie species were observed and four of the seeded upland prairie species were observed (Appendix 1, Table 6). A variety of native wetland species have established around the shoreline of the three emergent zones (Photograph 28-30).



Photograph 22. East-West Swale final shaping and erosion control blanket in place along the swale, June 16, 2016.



Photograph 23. East-West Swale at the connection to the West Area on September 8, 2016.



Photograph 24. East-West Swale emergent and prairie vegetation on September 8, 2016.



Photograph 25. East-West Swale with wetland and prairie species on August 9, 2017.



Photograph 26. Final grading of the West Area on June 16, 2016.



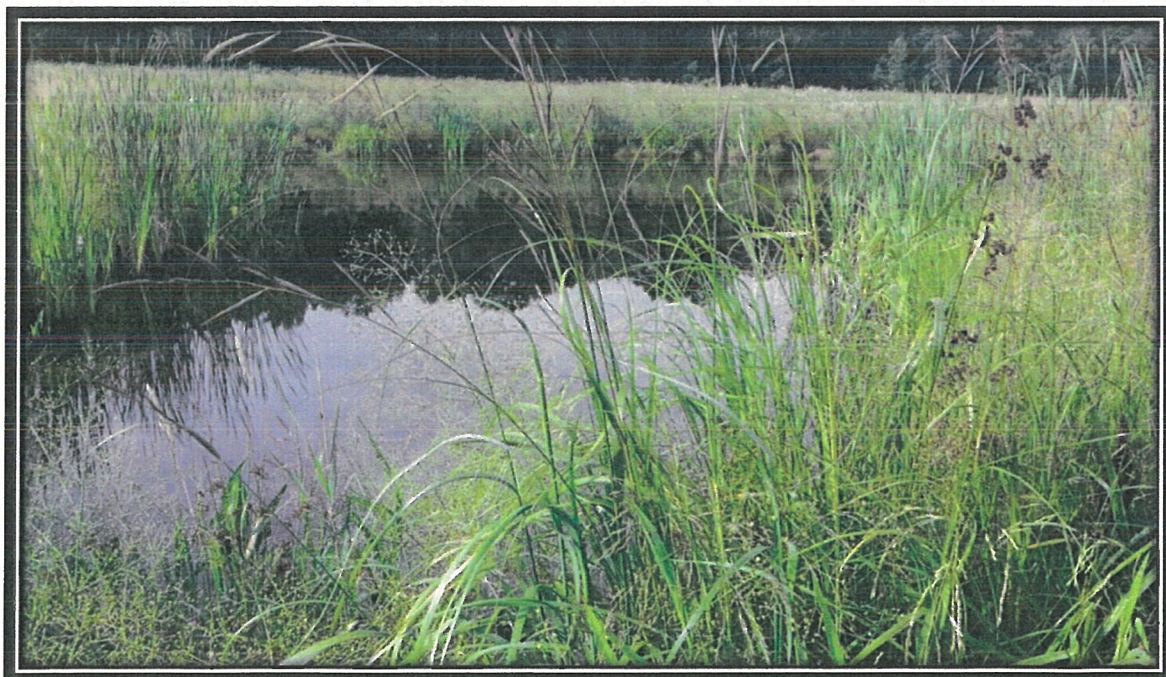
Photograph 27. West Area emergent pool on September 8, 2016.



Photograph 28. West Area emergent pool on August 9, 2017.



Photograph 29. West Area emergent pool with upland prairie side slope on August 9, 2017.



Photograph 30. West Area emergent pool with upland prairie side slope on the right on August 9, 2017.

Wetland # 7

Wetland # 7 (Figure 1) is an existing wetland along the east side of the project site. Herbicide treatment to reed canary grass (*Phalaris arundinacea*) and a prescribed burn (Photograph 31) occurred in spring 2016. This was followed up with an enhancement seeding. The Wetland # 7 evaluation in August, 2017 found reed canary grass was still present in wetland #7 but had been reduced in both density and stature from the pre-treatment condition. By August 2017, a variety of wetland plants were observed growing in wetland #7 (Photograph 32 & 33). The existing seed/propagules bank and over-seeded wet prairie species had become well established in areas. Overall cover of vegetation was estimated at 93 % with native species comprising 53% of the cover (Appendix 1, Table 7).

The upland buffer for wetland #7 continues to contain a variety of non-native weeds and a few native upland species such as black-eyed Susan, yellow cone flower and switch grass. Several species, burdock (*Arctium minus*), Canada thistle (*Cirsium arvense*) and reed canary grass are recommended for herbicide treatment in 2018.



Photograph 31. Wetland # 7 after prescribed burn with native species emergence on June 16, 2016.



Photograph 32. Wetland 7 with sedges and other natives on August 9, 2017.



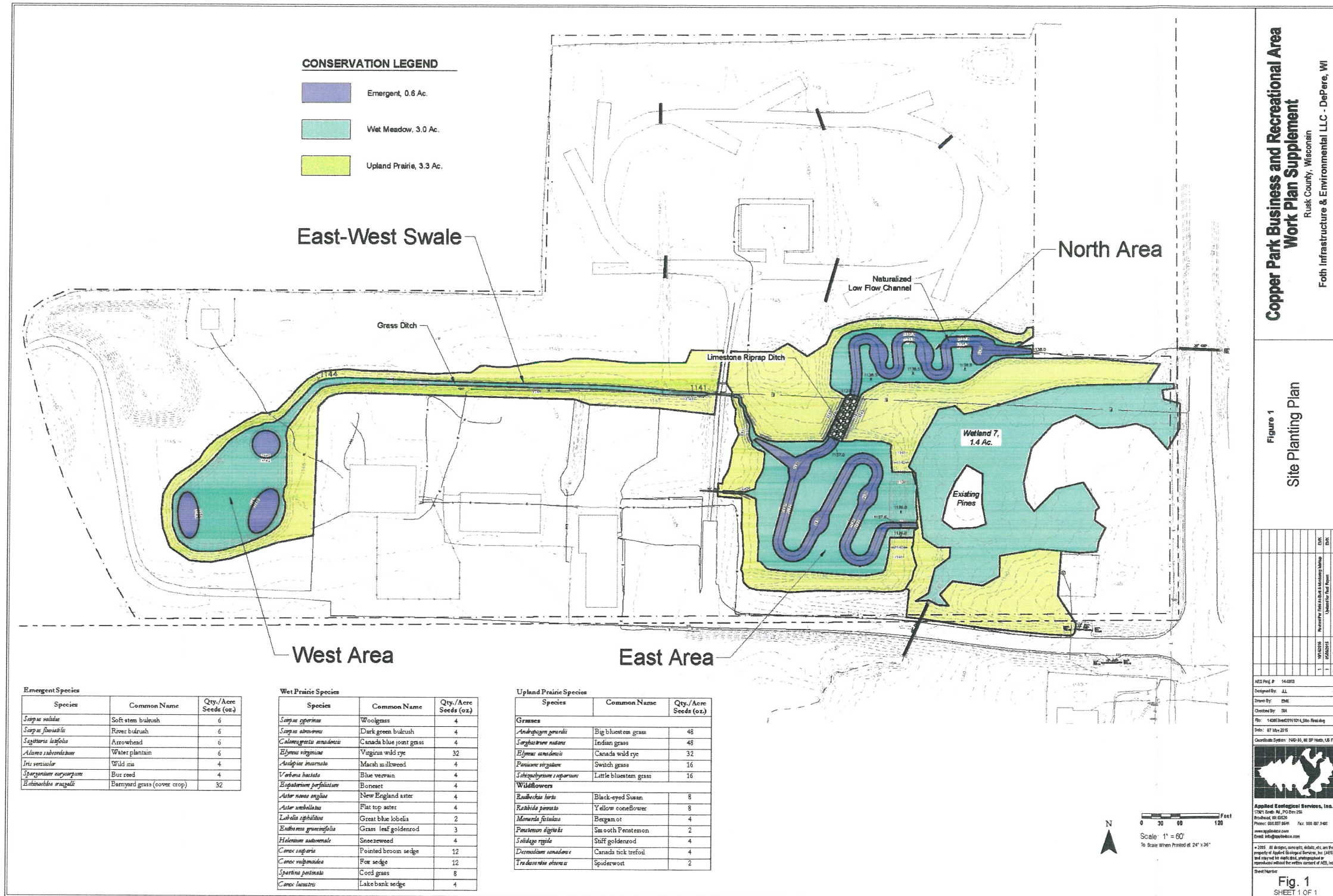
Photograph 33. Wetland 7 with native vegetation along Stream C on August 9, 2017.

Activities recommended for 2018:

- 1) Conduct the third year 3 of the required vegetation management activities to include invasive species management as directed by client. Conduct the third year 3 of the

required three years of the annual monitoring site visits (and report) in July/August as directed by client.

Figure 1. Flambeau Copper Park Business and Recreation Project Seeding Plan.



Appendix 1. Plant species Lists by Area and Zone at the Flambeau Copper Park Business and Recreation Area.

Table 1. East Area Upland Prairie		
Species	Common Name	Cover Percent %
Agrostis alba	Red top	2
Ambrosia artemisiifolia	Common ragweed	25
Andropogon gerardii	Big bluestem grass	2
Bromus tectorum	Brome	2
Cirsium arvense	Field thistle	1
Daucus carota	Queen Anne's lace	2
Digitaria sanguinalis	Hairy crab grass	1
Elymus canadensis	Canada wild rye	5
Epilobium coloratum	Cinnamon willow herb	1
Erigeron strigosus	Daisy fleabane	1
Euthamia graminifolia	Common grass-leaved goldenrod	2
Helianthus grosseserratus	Sawtooth sunflower	10
Lotus corniculatus	Bird's foot trefoil	5
Monarda fistulosa	Wild bergamot	1
Oenothera biennis	Common evening primrose	1
Panicum virgatum	Switch grass	1
Penstemon digitalis	Smooth fox glove	1
Ratibida pinnata	Yellow coneflower	1
Rudbeckia hirta	Black-eyed Susan	2
Solidago canadensis	Canada goldenrod	1
Solidago gigantea	Tall goldenrod	1
Sorghastrum nutans	Indian grass	1
Spartina pectinata	Prairie cord grass	1
Symphyotrichum pilosum	Frost aster	2
Trifolium hybridum	Alsike clover	25
Trifolium pratense	Red clover	2
Trifolium repens	White clover	2
Total Estimated Cover		101
Total Estimated Native Species Cover		59

Table 2. East Area Bottom		
Species	Common Name	Percent %
Agalinus tenuifolia	Common fox glove	1
Agrostis alba	Red top grass	1
Alisma subcordatum	Common water plantain	5
Asclepias incarnata	Swamp milkweed	1
Eleocharis obtusa	Blunt spike rush	20
Elymus canadensis	Canada wild rye	1
Elymus virginicus	Virginia wild rye	2
Epilobium coloratum	Cinnamon willow herb	1
Euthamia graminifolia	Common grass-leaved goldenrod	1

<i>Glyceria striata</i>	Fowl manna grass	1
<i>Helenium autumnale</i>	Sneezeweed	1
<i>Helianthus grosseserratus</i>	Saw tooth sunflower	2
<i>Impatiens capensis</i>	Jewelweed	1
<i>Juncus effusus</i>	Common rush	1
<i>Leersia oryzoides</i>	Rice cut grass	4
<i>Lemna minor</i>	Duck weed	1
<i>Lotus corniculatus</i>	Bird foot trefoil	2
<i>Penthorum sedoides</i>	Ditch stone crop	1
<i>Rudbeckia hirta</i>	Black eyed Susan	1
<i>Sagittaria latifolia</i>	Common arrowhead	10
<i>Scirpus atrovirens</i>	Dark green rush	1
<i>Scirpus validus creber</i>	Great bulrush	3
<i>Spartina pectinata</i>	Prairie cord grass	1
<i>Symphyotrichum novae-angliae</i>	New England aster	1
<i>Symphyotrichum lanceolatum</i>	Panicle aster	1
<i>Symphyotrichum pilosum</i>	Frost aster	2
<i>Typha angustifolia</i>	Narrow-leaved cattail	10
<i>Typha latifolia</i>	Broad-leaved cattail	15
<i>Verbena hastata</i>	Blue vervain	1
Total Estimated Cover		90
Total Estimated Native Species Cover		87

Table 3. North Area Upland Prairie		
Species	Common Name	Cover Percent %
<i>Agrostis alba</i>	Redtop	2
<i>Ambrosia artemisiifolia</i>	Common ragweed	10
<i>Andropogon gerardii</i>	Big bluestem grass	8
<i>Daucus carota</i>	Queen Anne's lace	3
<i>Echinochloa crusgalli</i>	Barnyard grass	1
<i>Elymus canadensis</i>	Canada wild rye	1
<i>Erechtites hieracifolia</i>	Burn weed	1
<i>Erigeron strigosus</i>	Daisy fleabane	1
<i>Euthamia graminifolia</i>	Common grass-leaved goldenrod	1
<i>Glyceria striata</i>	Fowl manna grass	1
<i>Helianthus grosseserratus</i>	Sawtooth sunflower	1
<i>Lotus corniculatus</i>	Bird's foot trefoil	10
<i>Monarda fistulosa</i>	Wild bergamot	2
<i>Panicum virgatum</i>	Switchgrass	2
<i>Phalaris arundinacea</i>	Reed canary grass	20
<i>Phleum pratense</i>	Timothy	1
<i>Polygonum persicaria</i>	Lady's thumb	1
<i>Ratibida pinnata</i>	Yellow coneflower	2
<i>Rudbeckia hirta</i>	Black-eyed Susan	1
<i>Scirpus atrovirens</i>	Dark green bulrush	1
<i>Scirpus cyperinus</i>	Wool grass	1

<i>Solidago canadensis</i>	Canada goldenrod	2
<i>Solidago gigantea</i>	Late goldenrod	1
<i>Solidago rigida</i>	Stiff goldenrod	1
<i>Sorghastrum nutans</i>	Indian grass	10
<i>Symphotrichum lanceolatum</i>	Panicked aster	2
<i>Symphotrichum novae-angliae</i>	New England aster	2
<i>Symphotrichum pilosum</i>	Hairy aster	2
<i>Trifolium arvense</i>	Rabbit foot clover	1
<i>Trifolium hybridum</i>	Alsike clover	5
<i>Verbena hastata</i>	Blue vervain	1
Total Estimated Cover		98
Total Estimated Native Species Cover		55

Table 4. North Area Bottom		
Species	Common Name	Cover Percent %
<i>Agrostis alba</i>	Red top grass	1
<i>Alisma subcordatum</i>	Common water plantain	1
<i>Amaranthus tuberculatus</i>	Roughfruit amaranth	1
<i>Ambrosia artemisiifolia elatior</i>	Common ragweed	10
<i>Asclepias incarnata</i>	Swamp milkweed	1
<i>Bidens cernua</i>	Noding bur marigold	1
<i>Carex scoparia</i>	Lance-fruited oval sedge	2
<i>Carex vulpinoidea</i>	Brown fox sedge	2
<i>Eleocharis obtusa</i>	Blunt spike rush	2
<i>Eleocharis sp.</i>	Spikerush	2
<i>Elymus canadensis</i>	Canada wild rye	1
<i>Elymus virginicus</i>	Virginia wild rye	5
<i>Epilobium coloratum</i>	Cinnamon willow herb	1
<i>Erechtites hieracifolia</i>	Fireweed	1
<i>Erigeron strigosus</i>	Daisy fleabane	1
<i>Euthamia graminifolia</i>	Common grass-leaved goldenrod	2
<i>Helenium autumnale</i>	Sneezeweed	1
<i>Hypericum canadense</i>	Canadian St. John's wort	2
<i>Juncus dudleyi</i>	Dudley's rush	1
<i>Juncus effusus</i>	Common rush	1
<i>Lobelia siphilitica</i>	Great blue lobelia	1
<i>Lotus corniculatus</i>	Bird's foot trefoil	10
<i>Mimulus ringens</i>	Monkey flower	1
<i>Phalaris arundinacea</i>	Reed canary grass	5
<i>Polygonum hydropiperoides</i>	Water pepper	2
<i>Rorippa islandica</i>	Rough marsh grass	1
<i>Sagittaria latifolia</i>	Arrowhead	2
<i>Scirpus atrovirens</i>	Dark green rush	2
<i>Scirpus cyperinus</i>	Wool grass	2
<i>Scirpus validus</i>	Great bulrush	2
<i>Setaria glauca</i>	Yellow foxtail	1

<i>Spartina pectinata</i>	Prairie cord grass	5
<i>Symphotrichum lanceolatum</i>	Panicked aster	2
<i>Symphotrichum novae-angliae</i>	New England aster	3
<i>Symphotrichum pilosum</i>	Hairy aster	2
<i>Trifolium arvense</i>	Rabbit-foot clover	1
<i>Trifolium hybridum</i>	Alsike clover	3
<i>Typha latifolia</i>	Broad-leaved cattail	1
<i>Verbena hastata</i>	Blue vervain	1
Total Estimated Cover		86
Total Estimated Native Species Cover		64

Table 5. East-West Swale		
Species	Common Name	Percent %
<i>Alisma subcordatum</i>	Common water plantain	5
<i>Ambrosia artemisiifolia</i>	Common ragweed	5
<i>Andropogon gerardii</i>	Big bluestem grass	5
<i>Asclepias incarnata</i>	Swamp milkweed	2
<i>Bidens cernua</i>	Nodding bur marigold	1
<i>Bidens frondosa</i>	Common beggar's tick	2
<i>Carex scoparia</i>	Lance-fruited oval sedge	2
<i>Carex vulpinoidea</i>	Fox sedge	2
<i>Daucus carota</i>	Queen Anne's lace	1
<i>Elymus canadensis</i>	Canadian wild rye	5
<i>Euthamia graminifolia</i>	Common grass-leaved goldenrod	2
<i>Fraxinus pennsylvanica</i>	Green ash	1
<i>Glyceria striata</i>	Fowl manna grass	1
<i>Helianthus grosseserratus</i>	Sawtooth Sunflower	2
<i>Panicum virgatum</i>	Switchgrass	3
<i>Phalaris arundinacea</i>	Reed canary grass	5
<i>Ratibida pinnata</i>	Yellow coneflower	1
<i>Rhamnus frangula</i>	Glossy buckthorn	3
<i>Sagittaria latifolia</i>	Common arrowhead	10
<i>Scirpus atrovirens</i>	Dark green rush	3
<i>Scirpus cyperinus</i>	Wool grass	2
<i>Solidago rigida</i>	Stiff goldenrod	2
<i>Sorghastrum nutans</i>	Indian grass	5
<i>Symphotrichum lanceolatum</i>	Panicked aster	2
<i>Tradescantia ohiensis</i>	Common spiderwort	5
<i>Trifolium hybridum</i>	Alsike clover	5
<i>Typha angustifolia</i>	Narrow-leaved cattail	2
Total Estimated Cover		84
Total Estimated Native Species Cover		75

Table 6. West Area		
Species	Common Name	Percent %
<i>Agropyron repens</i>	Quack grass	2
<i>Agrostis alba</i>	Redtop grass	1
<i>Alisma subcordatum</i>	Common water plantain	5
<i>Ambrosia artemisiifolia</i>	Common ragweed	2
<i>Asclepias incarnata</i>	Swamp milkweed	1
<i>Carex scoparia</i>	Pointed broom sedge	2
<i>Carex vulpinoidea</i>	Fox sedge	1
<i>Cyperus sp.</i>	Nut sedge	3
<i>Daucus carota</i>	Queen Anne's Lace	2
<i>Echinochloa crusgalli</i>	Barnyard grass	5
<i>Eleocharis obtusa</i>	Blunt spike rush	8
<i>Elymus canadensis</i>	Canada wild rye	2
<i>Erigeron strigosus</i>	Fleabane	2
<i>Euthamia graminifolia</i>	Grass leaf goldenrod	2
<i>Glyceria grandis</i>	Reed manna grass	2
<i>Juncus effusus</i>	Common rush	1
<i>Leersia oryzoides</i>	Rice cut grass	2
<i>Lotus corniculatus</i>	Bired foot trefoil	2
<i>Mimulus ringens</i>	Monkey flower	1
<i>Oenothera biennis</i>	Evening primrose	1
<i>Panicum dichotomiflorum</i>	Knee grass	3
<i>Panicum virgatum</i>	Switch grass	2
<i>Phalaris arundinacea</i>	Reed canary grass	2
<i>Phleum pratense</i>	Timothy	1
<i>Polygonum pennsylvanicum</i>	Pinkweed	1
<i>Ratibida pinnata</i>	Yellow coneflower	1
<i>Rhus typhina</i>	Staghorn sumac	1
<i>Rorippa palustris hispida</i>	Rough marsh cress	1
<i>Rudbeckia hirta</i>	Black eyed Susan	2
<i>Rumex crispus</i>	Curly dock	1
<i>Sagittaria latifolia</i>	Common arrowhead	5
<i>Scirpus atrovirens</i>	Dark green bulrush	2
<i>Setaria faberi</i>	Giant foxtail	2
<i>Solidago canadensis</i>	Canada goldenrod	3
<i>Symphyotrichum lanceolatum</i>	Panicle aster	1
<i>Symphyotrichum pilosum</i>	Frost aster	2
<i>Trifolium arvense</i>	Rabbit foot clover	2
<i>Typha latifolia</i>	Broad-leaved cattail	5
Total Estimated Cover		68
Total Estimated Native Species Cover		61

Table 7. Wetland # 7		
Species	Common Name	Percent %
<i>Ambrosia artemisiifolia</i>	Common ragweed	2
<i>Arctium minus</i>	Common burdock	1
<i>Asclepias incarnata</i>	Swamp milkweed	1
<i>Bidens frondosa</i>	Common beggar's ticks	2
<i>Carex bebbii</i>	Bebb's oval sedge	1
<i>Carex crinita</i>	Fringed sedge	2
<i>Carex lacustris</i>	Common lake sedge	2
<i>Carex scoparia</i>	Pointed broom sedge	2
<i>Carex vulpinoidea</i>	Fox Sedge	1
<i>Cicuta maculata</i>	Water hemlock	1
<i>Cirsium arvense</i>	Canada thistle	2
<i>Eupatorium perfoliatum</i>	Boneset	1
<i>Euthamia graminifolia</i>	Common grass-leaved goldenrod	2
<i>Geum canadense</i>	White avens	1
<i>Glyceria</i> sp.	Manna grass	1
<i>Helianthus grosseserratus</i>	Sawtooth sunflower	1
<i>Hypericum canadense</i>	Canadian St. John's wort	1
<i>Impatiens capensis</i>	Orange jewelweed	1
<i>Juncus effusus</i>	Common rush	2
<i>Leersia oryzoides</i>	Rice cut grass	2
<i>Lindenia dubia</i>	False pimpernel	1
<i>Lobelia siphilitica</i>	Great blue lobelia	1
<i>Onoclea sensibilis</i>	Sensitive fern	3
<i>Phalaris arundinacea</i>	Reed canary grass	35
<i>Pinus resinosa</i>	Red pine	2
<i>Polygonum amphibium</i>	Water knotweed	1
<i>Polygonum sagittatum</i>	Arrow-leaved tear thumb	5
<i>Ranunculus pensylvanicus</i>	Bristly buttercup	1
<i>Scirpus atrovirens</i>	Dark green rush	1
<i>Scirpus cyperinus</i>	Wool grass	3
<i>Solidago canadensis</i>	Canadian goldenrod	2
<i>Solidago gigantea</i>	Late goldenrod	1
<i>Symphyotrichum lanceolatum</i>	Panicled aster	2
<i>Symphyotrichum novae angliae</i>	New England aster	1
<i>Typha latifolia</i>	Broad-leaved cattail	1
<i>Urtica dioica</i>	Nettle	1
<i>Verbascum thapsus</i>	Moth mullein	1
<i>Verbena hastata</i>	Blue vervain	2
Total Estimated Cover		93
Total Estimated Native Species Cover		53

Appendix D

**Color and Infrared Vegetation Review for the Reclaimed
Flambeau Mine**



APPLIED ECOLOGICAL SERVICES

November 10, 2017

Sharon Kozicki
Foth Infrastructure & Environment, LLC
2121 Innovation Court, Suite 300
De Pere, WI 54115-5126

RE: Vegetation Monitoring using Aerial Imagery Interpretation, Reclaimed Flambeau Mine, Rusk County, Wisconsin.

INTRODUCTION

This report documents 2017 efforts associated with vegetation monitoring via desktop interpretation of drone-based aerial imagery (2017, natural and color Infrared) and field reconnaissance of the Reclaimed Flambeau Mine site in Rusk County, WI. This effort was completed in accordance with Sections 2.5 and 3.1.6 of the updated Monitoring Plan (Foth and VanDyke, 1991). In addition monitoring requirements found in Section 4.6 of the Surface Reclamation Ecological Monitoring Program states that “aerial photography will be qualitatively evaluated to gauge the vegetation cover and representative plant communities over the entire site” (Applied Ecological Services, 1998). For this project, aerial imagery was acquired by Foth (August of 2017) and the aerial image interpretation and field reconnaissance were completed by Applied Ecological Services, Inc. (AES). This report contains the methods, results and conclusions of vegetation monitoring.

METHODS

AES utilized field confirmation, newly acquired aerial imagery, and desktop interpretation, to evaluate 2017 vegetation conditions on the 170-acre Flambeau Mine site. The following is an overview of the steps involved in the project process:

- Used ArcGIS “Collector” and mobile device in the field to collect reference conditions (GPS points and photos) to relate to what can be interpreted on the aerial photography.
- Integrated newly collected (2017) multi-spectral aerial imagery (acquired by Foth) into GIS.
- Utilized GIS based desktop aerial interpretation (Infrared (IR) and Normalized Difference Vegetation Index (NDVI)) to evaluate vegetation conditions over the site.

Two AES staff field verified existing vegetation cover types in early August for one day. A mobile tablet device was used to collect reference and observational data associated with vegetation health, vigor and species composition. Representative areas of vegetation observations were recorded and site features were described and photographed via ESRI GIS Collector (Figure 1).

Geo-referenced aerial imagery acquired on August 9, 2017 (Natural Color RGB Imagery) and August 31, 2017 (Multispectral Imagery) by Foth was integrated with field information and used to inform the aerial interpretation and vegetation monitoring process. The qualitative assessment involved desktop interpretation using previously mapped historic vegetation community types, field observations (Figure 1), natural color aerial (Figure 2), false color aerial (Figure 3) and the derived NDVI (Figure 4).

RESULTS

The revegetation phase of reclamation at the Flambeau Mine began in spring of 1998 with seeding occurring in 2001. The majority of the site was seeded and reclaimed to wildlife habitat and non-consumptive vegetation for passive recreational use. The 2003 AES report as part of the 2012 Annual Reclamation Report, documented an average of 93% plant cover with the Industrial Outlot averaging 91% plant cover. The Annual Report also contained a plant community map which served as a baseline for evaluating future vegetation conditions (AES, 2003).

As a part of the 2017 assessment, Figures 1-4 were the focus for interpreting vegetation conditions with the following observations:

Historic Vegetation Community Types with 2017 Field Observation Points (Figure 1): The field verification effort found healthy prairie and wet prairie habitats throughout the majority of the restored mine site. In addition open water and emergent wetland habitat, cattails and a few other wetland species dominated pond edges. Swales draining to the ponds occasionally had clones/clumps of the non-native reed canary grass, but these areas were typically small in size and localized. A visual estimate of native plant cover found that the majority of the site exceeded 90% coverage.

Several woodland areas planted to a variety of native deciduous and evergreen trees and shrubs (white birch, bur oak, aspen, white pine, white spruce, hazelnut, and sumac) were beginning to resemble upland forests in the vicinity of the mine. Trees in excess of 20 feet and shrubs in excess of 8 feet were common throughout the planted woodlands.

Natural Color Aerial Photograph (Aug 2017) (Figure 2): Natural color aerial imagery as seen on Figure 2 shows the red=band 1, green=band 2 and blue=band 3 with the representation of the aerial imagery seen as "natural color" or as the colors would appear to the human eye in real life. Darker blackish blue colors on the north and southwest sides of the site show areas of open water with emergent aquatic plant growth within them. A clump of trees can be seen on the north central portion of the site along with a network of trails (white linear features) and swales (dark green areas) throughout the site. Overall, vegetation cover appears healthy and vigorous for all plant communities including wetland, prairie and woodland cover types. The area with the least dense vegetation would be seen on the west side of the Industrial Outlot where topsoil was removed for construction activities associated with the Cooper Park Business and Recreation Area (Figure 2-4, labeled "Sparse/Dormant Vegetation").

False-Color Infrared Aerial Photograph (Aug 2017) (Figure 3): False color aerial imagery as seen on Figure 3 shows the red=band 4 (Infrared), green=band 2 and blue=band 3, which visually represent the aerial imagery as "false color" IR. Because gradients of red are more easily seen with the human eye, it is standard practice to visualize the IR as red, which in turn emphasizes the vegetation and greenness as more intense colored red tones on the image. False color IR shows the live or most vigorous vegetation cover as red tones and where vegetation is sparse and least dense (like trails or bare soil areas), it appears as white. To emphasize the value of using false color infrared when monitoring vegetation, one can look at the open water areas (on Figure 3) where submergent vegetation along the littoral edge of the wetland areas are visible as a dark red color. In addition very intense shades of red would indicate more dense vegetation growing with more vigor. Pale red and pink shades would show a gradient of less dense, less green vegetation and tan areas would show areas of dormant vegetation. Figure 3 shows a matrix of vegetation densities throughout the upland grassland areas appearing similar to what

one would expect on a “natural” site with healthy vegetation. This type of patch work often is the result of topography and available moisture in the soil to support vegetation growth.

Normalized Vegetation Index (NDVI) (Figure 4): is a method that uses the red and IR data from the aerial imagery as compiled using the following mathematical equation, $NDVI = (NIR - Red) / (NIR + Red)$. The result of this calculation is a vegetation index number that is valued between zero and two hundred and fifty five (0-255). A value of 255 would be areas of the most “greenness” or most plant vigor/density and 0 would be areas that have the least or no greenness. NDVI is often used to evaluate vegetation health, greenness, and levels of chlorophyll and can be used to identify areas of vegetation stress in both natural and agricultural landscapes. Figure 4 represents the relative vegetation index value for the Flambeau Mine Site.

Historic monthly precipitation data: were compiled for three weather stations (Big Falls-10.5 miles NE of site, Ladysmith-1.4 miles NW of site and Ladysmith/LDYW3 which is located on-site). Table 1 data were from National Center for Environmental Information, formerly (NCDC), and used to compare 8 months of 2017 precipitation to past (1981-2010) precipitation trends (Table 1).

Table 1. 2017 Total Monthly Precipitation (inches) compared to Long-term Averages for Ladysmith, WI. Wet to normal precipitation in the spring months with drier July and August season. 2017 precipitation events supported healthy vegetation conditions found on site.

Weather Station	BIGFALLSHYDRO ¹				LADYSMITH 3 W ²			
	Prec. Normal (1981-2010) (in) ³	Prec. in 2017 (in)	2017 Deviation from Normal	Wet/Dry/Normal Months ⁴	Prec. Normal (1981-2010) (in) ³	Prec. in 2017 (in)	2017 Deviation from Normal	Wet/Dry/Normal Months ⁴
1	0.96	1.16	0.2	Normal	0.98	1.64	0.66	Wet
2	0.92	1.09	0.17	Normal	0.93	1.16	0.23	Normal
3	1.72	1.12	-0.6	Dry	1.82	0.79	-1.03	Dry
4	2.64	2.45	-0.19	Normal	2.65	5.29	2.64	Wet
5	3.58	5.25	1.67	Wet	3.51	8.27	4.76	Wet
6	3.82	1.09	-2.73	Dry	5.13	7.06	1.93	Wet
7	3.75	1.66	-2.09	Dry	3.73	2.41	-1.32	Dry
8	3.94	4.54	0.6	Normal	4.53	1.3	-3.23	Dry
9	4.28				4.07			
10	3.24				3.23			
11	2.1				1.96			
12	1.32				1.33			
Annual Sum	32.27				33.87			
First 8 month's Sum	21.33	18.36			23.28	27.92		

Data Source: <https://www.ncdc.noaa.gov/data-access/land-based-station-data>

¹ Graphic location of the station, latitude: 45.5556; longitude: -90.9592.

² Graphic location of the station, latitude: 45.4651; longitude: -91.1236.

³ The 1981-2010 Climate Normal is NCDC's latest three-decade averages of climatological variables, including precipitation.

⁴ Wet/Dry/Normal month determined by comparing actual precipitation to 30% threshold values in the Climate Normal

In addition precipitation data was also compiled from an on-site weather station: # STATION: LDYW3, # STATION NAME: LADYSMITH, # LATITUDE: 45.433333, # LONGITUDE: -91.116667, # ELEVATION [ft]: 1147, # STATE: WI table 2.

Table 2. 2017 Total Monthly Precipitation (inches) compared to Long-term Averages for weather station located on site. Wet to normal precipitation in the spring months with a dry July, wet august and normal September.

Month	Prec. Normals (2011, 2012, 2016) (in) ¹	Prec. 2017 (in)	2017 Deviation from Normal	Wet/Dry/Normal Months ²
1	0.34	1.28	0.94	Wet
2	1.03	1.08	0.05	Normal
3	1.97	1.06	-0.91	Dry
4	2.89	4.21	1.32	Wet
5	4.07	8.01	3.94	Wet
6	4.16	4.35	0.19	Normal
7	4.04	1.9	-2.14	Dry
8	3.68	5.65	1.97	Wet
9	2.88	2.32	-0.56	Normal
10	2.12	4.23	2.11	Wet
11	1.03			
12	1.16			
Annual Sum	29.38			
First 10 month's Sum	27.19	34.09		
Notes:				
1 The three year of 2011, 2012, and 2016 average				
2 Wet/Dry/Normal month determined by comparing actual precipitation to 30% threshold values in the Climate Normal				

The precipitation trends are generally well aligned between the 3 stations. If we compare the “on-site” station (LDYW3) with LADYSMITH 3 W² (1.4 miles NE) we observe some variation in July (normal vs. wet) and August (wet vs. dry), probably due to localized storms however both show precipitation that would support healthy vegetation. (Note: The columns with some variation are highlighted in gray.)

Results of comparing precipitation trends at the three local weather stations would show a relatively wet winter and spring (January-June) with some variation in July and August as a result of isolated and localized thunderstorms. As seen in the field and per the aerial imagery, vegetation conditions show little to zero stress and were supported by the wet spring and sufficient precipitation throughout the summer season.

CONCLUSIONS

The three main plant communities: wetland, woodland and upland grasslands remain in the same areas as originally planted. As supported by aerial and field observations greater than 90% of the Flambeau restored mine site has excellent vegetation cover. The field visit confirmed these areas were dominated by native plant species. Swales were all well vegetated without any signs of erosion however they did contain some non-native reed canary grass in localized small patches. The remaining portions of the restored mine site was well vegetated at greater than 90% vegetation coverage. When looking at the aerial imagery and NDVI as compared to 2013 the overall vegetation cover has significantly more “red”

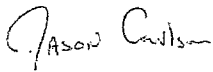
tones which would suggest the vegetation was more "green" and potentially more dense than 2012. Direct comparison are be difficult to 2012 because the imagery was taken later in the season when vegetation was more dormant. Less greenness in 2012 could also be due to less precipitation during the 2012 growing season. No areas of erosion or areas of dead or devoid vegetation were observed over the site.

REFERENCES

- 2003 Annual Reclamation Report-Attachment 3: Analysis of Revegetation Success for Reclamation of the Flambeau Mine, Ladysmith, Wisconsin in 2003. Applied Ecological Services. November 2003.
- Surface Reclamation Ecological Monitoring Program. Applied Ecological Services. December 1998.
- Updated Monitoring Plan. Foth and VanDyke. July 1991

If you have any questions regarding the information contained within this letter, or require any additional information, please call myself or John Larson at 608.897.8641.

Sincerely,
AES Consulting Services

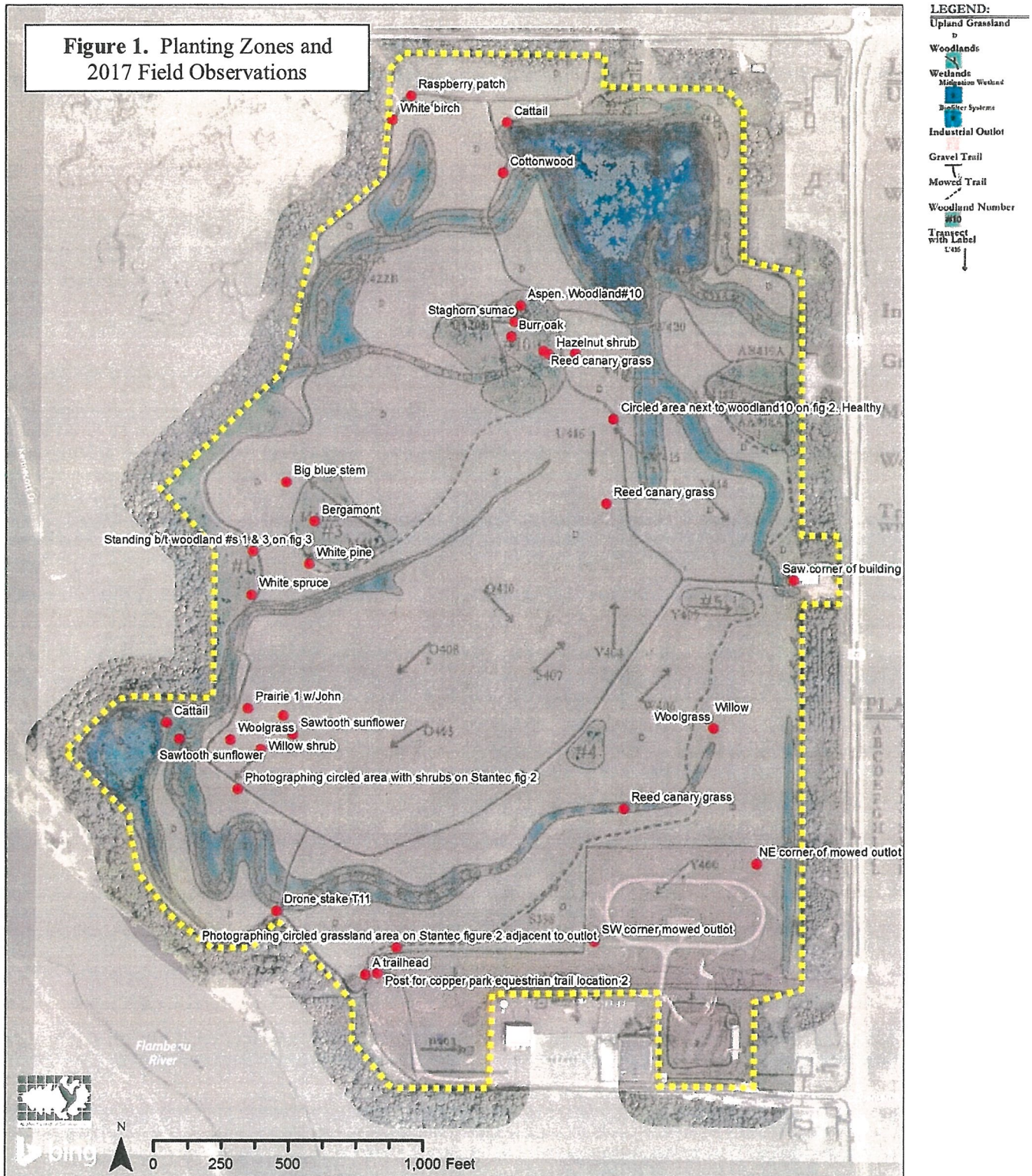


Jason Carlson
Director of Geospatial Services

John Larson
Senior Ecologist

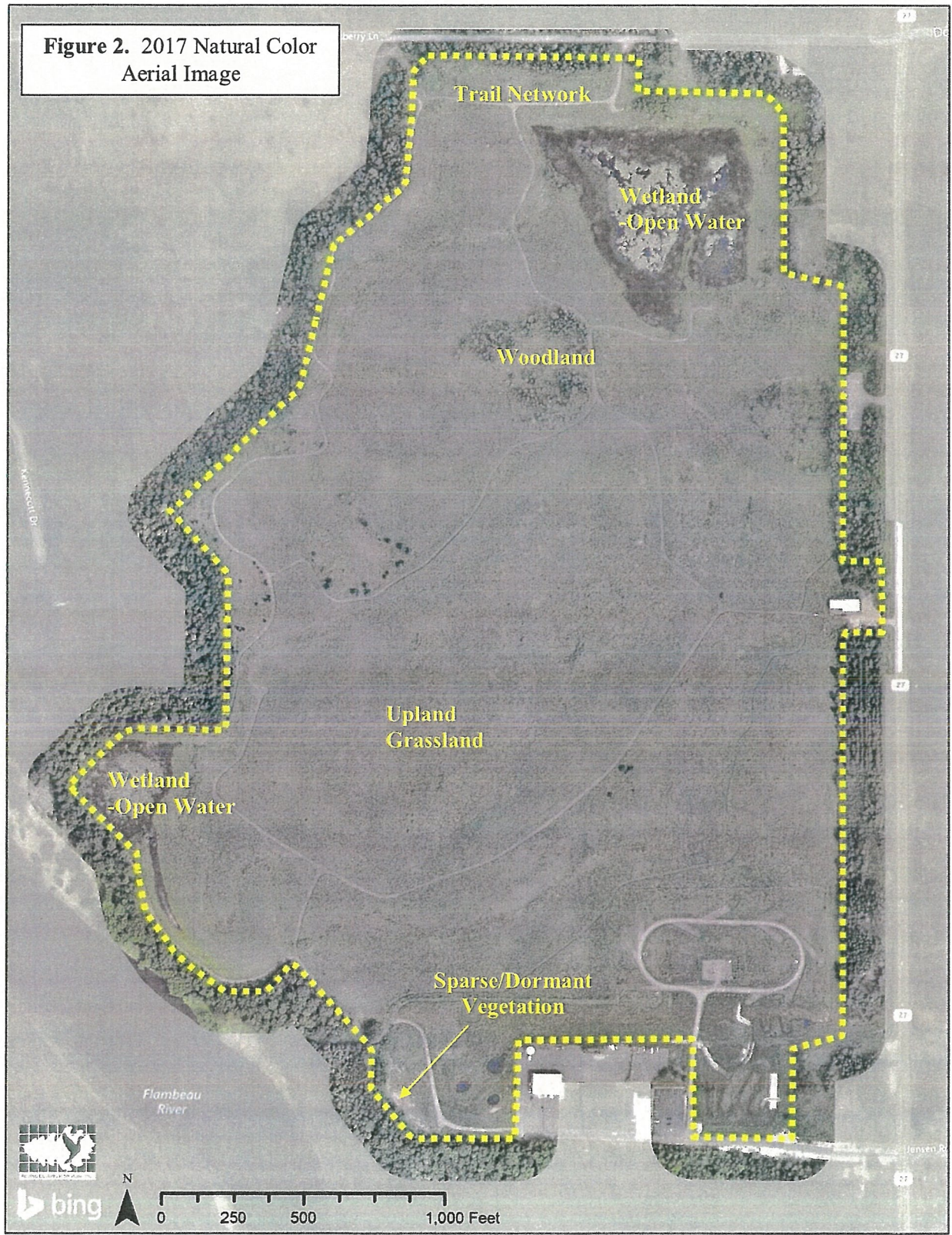
LIST OF FIGURES

- Figure 1. Historic Vegetation Community Types with 2017 Field Observation Points
- Figure 2. Natural Color Aerial Photograph (Aug 2017)
- Figure 3. False Color Infrared Aerial Photograph (Aug 2017)
- Figure 4. Normalized Vegetation Index (NDVI)

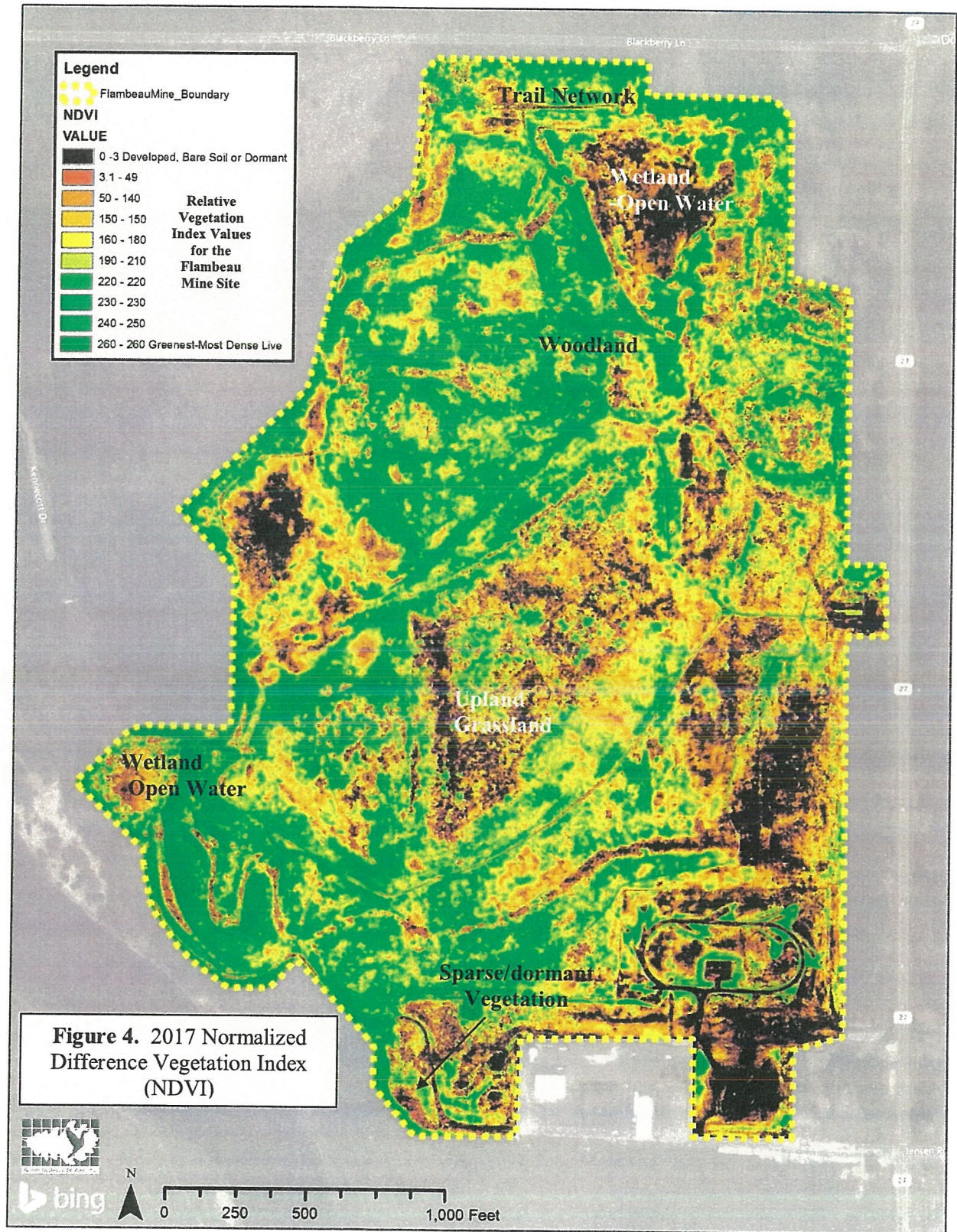


Source: 2003 Annual Reclamation Report-Attachment 3: Analysis of Revegetation Success for Reclamation of the Flambeau Mine, Ladysmith, Wisconsin in 2003. Applied Ecological Services. November 2003.

Figure 2. 2017 Natural Color Aerial Image







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