GW-028

Annual DP Report (1 of 6)

2016

HOLLYFRONTIER.

March 15, 2017

Mr. Carl Chavez
New Mexico Energy, Minerals and Natural Resources Department
Oil Conservation Division
1220 South St. Francis Drive
Santa Fe, NM 87505

Re: ***2016 Annual Discharge Report*** **Submittal, HollyFrontier Navajo Refining LLC, Artesia Refinery**
Discharge Permit GW-028

Dear Mr. Chavez:

Please find enclosed the original and one electronic copy of the *2016 Annual Discharge Report*, which fulfills requirements Section 2.F of Discharge Permit GW-028.

If you have any questions or comments regarding this report, please feel free to contact me at 575-746-5487 or Robert Combs at 575-746-5382.

Sincerely,

Scott M. Denton
Environmental Manager
HollyFrontier Navajo Refining LLC

cc: Robert Combs, HollyFrontier Navajo Refining LLC, Artesia, New Mexico
Randy Dade, HollyFrontier Navajo Refining LLC, Artesia, New Mexico
Julie Speer, TRC, Austin, Texas
Catriona Smith, TRC, Austin, Texas

2016 ANNUAL DISCHARGE PERMIT REPORT
HOLLYFRONTIER NAVAJO REFINING LLC - ARTESIA REFINERY
DISCHARGE PERMIT GW-028

EXECUTIVE SUMMARY

This report was prepared to fulfill the requirement in Section 2.F. of the Discharge Permit GW-028 (GW-028) for HollyFrontier Navajo Refining LLC (Navajo). The requirement specifies that an Annual Report be submitted to the Oil Conservation Division (OCD) by March 15 following the reporting (calendar) year and should include:

A. Summary of major refinery activities and events.

B. Summary of discharge activities.

C. Summary of all leaks, spills, and releases and corrective actions taken.

D. Summary of discovery of new groundwater contamination.

A. MAJOR REFINERY ACTIVITIES FOR 2016

The refinery conducted normal operations during 2016. The refinery did not undergo any major expansions in regards to production capacity. In 2016, the refinery started construction of a new Prime G unit to comply with Tier III gasoline specifications, and made modifications for a debottlenecking project. A new Nitrogen production unit, owned by a third party, was installed and began operation. There were four new tanks built or put into service in 2016.

RO Reject Water Discharge

In 2016, Navajo continued land application of the RO reject water in accordance with Navajo's Discharge Permit GW-028 and ACO No. WQA-OCD-CO-2016-1 (the 2016 Order) which allows for discharge of reverse osmosis (RO) reject fluids to the Refinery's on-site farms/fields.

Agreed Compliance Order No. WQA-OCD-CO-2015-002

On February 4, 2016, the OCD issued the final determination document approving the May 22, 2015, GW-028 permit modification request, thereby terminating ACO No. WQA-OCD-CO-2015-002 (the 2015 Order).

Monthly Reporting

Monthly reporting for the RO Reject discharge was submitted throughout 2016 (January – February 4 under the 2015 Order, and February 5 through December under GW-028). Copies of the monthly reports submitted during 2016 are included in Appendix B.

Discharge Permit GW-028 Modifications

OCD approved the May 22, 2015 modification request for Discharge Permit GW-028 and issued a modified Discharge Permit on February 4, 2016. The modified permit included an increase of the RO reject fluid discharge limit to 15,000 bpd. Additionally, the modified permit conditions include increasing the frequency of water quality sampling of the RO reject fluids to quarterly and the frequency of reporting to monthly, and weekly reporting of any exceedances of the 15,000 bpd limit.

On March 28, 2016, Navajo notified OCD of their plan to replace the temporary RO unit in operation at the Refinery with a permanent RO unit (third permanent RO unit). This change did not increase the total number of operational units, nor did the change affect the discharge volumes, locations, or quality. OCD authorized the third permanent RO unit on April 1, 2016, and the third permanent RO unit began operation in May 2016. The temporary RO unit operated through May 2016 during transition to the new permanent unit operations. Operation of the temporary unit ceased on June 1, 2016.

Discharge Permit GW-028 Renewal Application

Discharge Permit GW-028 was set to expire on October 21, 2016; thereby triggering the requirement for submittal of a Discharge Permit Renewal Application. Navajo submitted an application for renewal of and modification to Discharge Permit GW-028 on June 23, 2016 (prior to 120 days before the expiration date of GW-028). OCD notified Navajo that the application was administratively complete on July 28, 2016, and Navajo proceeded to complete all required public notices.

On September 9, 2016, OCD notified Navajo that the renewal application did not propose a definitive alternative, or the information required to evaluate such alternative, to replace land application of the RO reject water discharge. As such, OCD will not issue an approval or disapproval of the renewal application until such technical information is provided.

On September 23, 2016, Navajo entered into ACO No. WQA-OCD-CO-2016-1 (the 2016 Order). Continued RO operations and progress with the Discharge Permit renewal application are subject to the provisions of the 2016 Order, until such time Navajo can provide the necessary information regarding the alternative disposal method. Navajo plans to continue land application of the RO reject per Condition III.1.a.iii of the 2016 Order until such time as an alternative disposal method is permitted, installed, and operational, and the Discharge Permit renewal application is approved.

In accordance with Condition III.1.a.i of the 2016 Order, Navajo notified OCD of the selection of underground injection as the alternative disposal method for the RO reject stream permitted under Discharge Permit GW-028 on October 21, 2016. Per Condition III.1.a.ii of the 2016 Order, Navajo submitted a revised renewal application reflecting the selection of underground injection as the alternative disposal method on January 13, 2017.

Injection Well WDW-4

Navajo selected to install a fourth injection well (WDW-4) as an alternate disposal method for the RO reject fluids, as specified in the revised permit application. Navajo completed the seismic study in 2016 and selected a location for the proposed injection well WDW-4. The permit application is being drafted and will be submitted by April 30, 2017, per the schedule provided in the revised application.

RO Reject Fields Investigation and Background Groundwater Investigation

Navajo submitted a *Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation* memo to the OCD on August 20, 2015. A subsequent revision to this memo was submitted to OCD on January 19, 2016, to provide corrections to the RO reject stream water quality results, and is included as Appendix A.

Navajo met with OCD and NMED at the OCD office on March 11, 2016 to discuss the results of the Background Groundwater Investigation as well as the hydrogeologic model and loading report.

An agreement regarding this matter has not yet been reached and future discussions will follow.

Selenium in Wastewater

There were no changes to the SeRT process in 2016. The refinery continues to discharge treated wastewater below the regulatory limits for selenium.

Phase-Separated Hydrocarbon Recovery

In 2016, the system recovered 7,968,010 gallons (189,715 barrels) of groundwater and 33,958 gallons (809 barrels) of PSH. Further details of the recovery system operation are discussed in Section 6 of the *2016 Annual Groundwater Report* that was submitted to OCD and NMED on February 28, 2017.

In March 2016, Navajo obtained shallow water rights and resumed operation of the ground water recovery system. The water rights were obtained by a lease through a third party and will extend through the design and implementation period for a reinjection system. The reinjection system will treat the diverted shallow groundwater (level of treatment to be determined) and reinject the treated groundwater into the shallow water bearing unit. This system will be designed to improve the recoverability of the PSH as well as provide improved capture of the plume to minimize the potential for plume migration.

B. SUMMARY OF DISCHARGE ACTIVITIES

Navajo's primary discharges are treated wastewater from the WWTP (WWTP effluent) and the RO reject. The WWTP effluent is discharged to Navajo's Injection Wells (WDW-1, WDW-2, and WDW-3) and to the City of Artesia's POTW. The details of each discharge are provided below:

1. Injection Wells

The injection rates, volume, and quality of treated wastewater disposed of in the injection wells are reported quarterly in a report to OCD, in addition to monthly C-115 reports. Those reports are included in Appendix B.1. The total injected water volume for 2016 was 4,630,211 barrels.

2. POTW

The flow rates and volumes of treated wastewater discharged to the City of Artesia POTW are recorded daily. This record is included in Appendix B.2. The total transferred water volume for 2016 was 348,390 gallons, or 8,295 barrels.

Navajo continued to discharge the blow-down from cooling towers to the POTW in 2016. The total volume of blow-down discharged to the POTW based on a rate of 71 gallons per minute (gpm) is estimated to be 37,515,793 gallons, or 893,233 barrels.

3. Reverse Osmosis Reject

A secondary discharge stream is the RO reject water which is land applied under OCD Discharge Permit GW-028 to on-site farms/fields. The RO process is fed by fresh groundwater provided by either the refinery's agricultural supply wells or purchased from the City of Artesia. The RO reject fluids contain concentrated salts (primarily chloride, fluoride, and sulfate) and elevated total dissolved solids (TDS). The stream was sampled monthly during January and February in accordance with the 2015 Order, and quarterly for the remainder of 2016 under the modified permit.

The RO reject fluid flow rate is continuously recorded with the process historian for the permanent RO units and on daily logs completed by operations personnel for the temporary RO unit. Based on the data from the process historian and on the logs, the total discharged RO reject water volume for 2016 was 156,510,893 gallons, or 3,726,450 barrels.

C. SUMMARY OF ALL LEAKS, SPILLS, AND RELEASES

The refinery had one spill that was reportable under Discharge Permit GW-028 in 2016. Appendix C includes pertinent information about this event.

1. **August 9, 2016 – Wastewater Pipeline Release**

   At approximately 6:00 p.m. on August 9, 2016, it was discovered that treated wastewater from the refinery was released approximately 5 miles east of Artesia. The release occurred due to a failed collar in the pipeline that conveys the wastewater to injection wells east of the refinery. The pipeline leak was discovered after change in pipeline flow/pressure parameters. Wastewater effluent discharge pumps located at the refinery were shut down and in-line valves were blocked-in to minimize flow back. A field crew was dispatched to repair the line and a vacuum truck was

dispatched to remove the released water which had accumulated at the release location. The released water did not migrate from the release location and the vacuumed water was returned to the refinery wastewater treatment unit. Notifications were made by telephone to OCD Santa Fe, OCD Artesia, and NMED Hazardous Waste Bureau.

A sample of the released water was collected from discharge of the pipeline pump on August 10, 2016 and submitted to Hall Environmental Analysis Laboratory (Hall) for analysis of the same suite as the samples sent for the quarterly effluent monitoring (UIC permits). The only WQCC parameters that were detected in exceedance of WQCC Standards were chloride (320 mg/L), fluoride (13 mg/L), sulfate (1500 mg/L), iron, and TDS (2800 mg/L). Soil samples were collected on October 10, 2016, from within the spill area and unimpacted locations, and submitted to Hall for laboratory analysis of chloride, fluoride, sulfate, and iron. Laboratory analytical results of wastewater effluent and soil samples are summarized in tables included in Appendix C.1. Laboratory analytical reports are included in Appendix C.1. Navajo proposes, due to elevated concentrations of iron, sulfate, chloride, and fluoride, to analyze spill area soil samples for synthetic precipitation leaching procedure (SPLP) for these analytes to assess the potential for leaching to groundwater in order to determine if further corrective action is warranted.

D. SUMMARY OF NEW GROUNDWATER CONTAMINATION

Groundwater contamination and changes in existing constituents are discussed in Section 7 of the *2015 Annual Groundwater Report* that was submitted to OCD and NMED on February 28, 2017. Groundwater conditions measured during 2016 semiannual events were generally consistent with historical results as summarized below:

- The presence and distribution of PSH were generally consistent with previous monitoring results, with minor fluctuations based on the intermittent presence of PSH in select wells over time. PSH thicknesses across the refinery are stable to declining over time. PSH thicknesses are inversely affected by fluctuations in groundwater elevations, which have generally increased since March 2014.

- Concentrations of constituents of concern (COCs) in groundwater have generally remained stable over time, although increasing trends were noted in select wells in specific areas of interest. During 2016 and previous years, the following COCs were detected in groundwater at concentrations in exceedance of their respective Critical Groundwater Screening Level (CGWSL):

    - DRO;
    - Select VOCs including target COCs benzene, toluene, ethylbenzene, xylenes, MTBE, and naphthalene;

    - Select total metals including target COC arsenic; and
    - Water quality parameters chloride, fluoride, sulfate, TDS, and nitrate/nitrite.

- It should be noted, that many of the concentrations of inorganic COCs (manganese, chloride, fluoride, nitrate/nitrite, sulfate, TDS) noted as "exceedances" of CGWSLs in 2016 may actually be similar to and reflective of background groundwater concentrations, as detailed in the background evaluation that was submitted to NMED and OCD in September 2015.
- The PSH and groundwater recovery system operated throughout 2016. Diminishing PSH recovery was observed in each successive quarter in 2016 correlating with declining PSH thickness measured in the subsurface, likely due to elevated groundwater levels.

Appendices

Appendix A *Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation – Revision 1*, January 19, 2016

Appendix B Refinery Discharges

B.1 Treated Wastewater to Injection Wells

B.2 Treated Wastewater to Artesia POTW

B.3 RO Reject Water Discharge

Appendix C Leaks, Spills, and Releases

C.1 August 9, 2016 – Wastewater Pipeline Release

APPENDIX A

***Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation – Revision 1*, January 19, 2016**

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MEMO

To:
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Scott Denton

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From:
Pam Krueger
Michael Hay
Kyle Richards

Date:
January 19, 2016

ARCADIS Project No.:
TX000870.0006

Subject:
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico – Revision 1

Introduction

On behalf of the Navajo Refining Company, LLC (NRC), ARCADIS performed an analysis of groundwater quality and developed a geochemical solute transport model related to the application of the reverse osmosis (RO) plant reject water onto the discharge fields at the Artesia Refinery located in Artesia, New Mexico (the Site). These efforts are intended to support a request for modification of Discharge Permit GW-028 to increase the total volume of reject fluids discharged to the fields. Discharge Permit GW-028is issued and administered by the Oil Conservation Division (OCD) of the New Mexico Energy, Minerals and Natural Resources Department. The permit modification requests that the allowable discharge volume be increased from 10,000 barrels per day (BPD) to 20,000 BPD. In support of the permit modification request and to address the items listed in the OCD email to NRC on June 3, 2015, NRC has been directed to determine the potential impacts to the underlying aquifer that may result from discharge to the RO reject fields. The specific objectives of the evaluation are:

- Perform a complete evaluation of RO reject water quality using all of the available historical data including discharge data from the temporary RO unit that was installed in 2011. The evaluation includes assessment of the variability of constituent concentrations and trends in the data over time.

- Perform a statistical evaluation of the monitoring well groundwater quality, including minimum, maximum, and average concentrations, indicating concentrations that exceed the Water Quality Control Commission (WQCC) standards found in 20 New Mexico Administrative Code (NMAC) 6.2.3103. The statistical evaluation provides additional assessment of data variability and trends over time.

- Estimate mass loading rates for key water constituents to provide insight into the quantities being placed on the RO reject fields.

- Develop and perform simulations using a contaminant hydrogeologic model to estimate impacts to groundwater related to the RO reject fields.

This memorandum is hereby resubmitted as Revision 1, which includes corrections to the RO reject stream water quality results, following the discovery of errors subsequent to the original submission of the memorandum in August, 2015. Although the modifications to the water quality results did not result in any significant modification to the conclusions and recommendations presented in the original memorandum, all affected data tables and modeling results included herein have been updated.

Site Overview and Background

NRC operates a petroleum refinery located at 501 East Main Street in the city of Artesia, Eddy County, New Mexico. The facility has been in operation since the 1920's and processes crude oil into asphalt, fuel oil, gasoline, diesel, jet fuel, and liquefied petroleum gas. The refinery is an active, growing industrial facility.

As part of the overall facility operation, NRC operates three RO units (two permanent, one temporary) that process fresh water as a means to remove contaminants such as minerals and salts. The two permanent units were installed and began operations in the early 1990's while the temporary unit was installed and began operations in 2011. The RO units produce two effluent streams: the RO permeate stream, which is the purified water, and the RO reject water stream, which contains the concentrated salts and minerals that cannot pass through the RO membranes. The RO reject water stream is discharged to the surface of one of two vacant fields located northeast of the Refinery operations areas to water perennial rye grass in those fields.

In 1993, the RO reject stream was permitted to be discharged to a 40-acre rye "farm", which is now called the South RO reject field. It should be noted that the area of the South RO reject field that receives discharge is approximately 29.2 acres in size. In 1999, the permit was amended to include a field north of Eagle Draw, which is now referred to as the North RO reject field. Discharge to the North RO reject field is limited to an area approximately 25.8 acres in size. Both of the fields have earthen berms that limit the area in which discharge occurs, and contain several ditches that disperse flow throughout the field from

the point of discharge. **Figure 1** shows an overview of the Site including the locations of the RO reject fields.

RO Reject Water Quality Evaluation

Based on the request from OCD, ARCADIS performed statistical analyses of the RO Reject Water Quality, using available data from November of 1992 through November of 2014, which provides approximately 22.5 years of data. The GW-28 permit modification approval of April 27, 1993 was the first that required the sampling and analysis of RO reject water. The data collected beginning in November 1992, prior to the 1993 permit modification approval was collected to support NRC's request to discharge RO reject water to Eagle Draw.

The statistical analyses consisted of calculation the maximum, minimum, and average concentrations for the relevant water quality constituents, using the available data. The evaluation also included a trend analysis to determine if concentrations were increasing, decreasing, or remaining stable over the historical data period. The data set includes non-detect values for certain constituents; however, the detection limit for each constituent changed over time, typically a relatively high value in the early analyses and much lower in the more recent sampling. In order to provide a complete analysis, the average calculations show three values:

- An average based on all data (including non-detects) using the reporting limit at the time of analysis for non-detect values.

- An average based on all data (including non-detects) from 2004 to the present, using the reporting limit at the time of analysis for non-detect values.

- An average based on detections only.

The results of the statistical analysis are summarized in **Table 1**. **Appendix A** contains the RO discharge and concentration dataset, and **Appendix B** contains the plots generated from the trend analysis of that data. It should be noted that not all of the samples of the RO reject discharge were analyzed for the same set of constituents during each event, due to changes in the permit requirements, laboratory performing the analyses, and the purpose of the analyses. However, there is adequate data available to evaluate changes and trends in concentrations of key constituents through time.

The results of the RO reject discharge water quality evaluation indicate the following:

- The concentrations of all of the constituents were highly variable over the 22.5 year operating and monitoring period, often with one or two orders of magnitude difference between the minimum and maximum concentration values.

- Most of the metals that have been part of the sampling have results that are non-detect, with few concentration detections relative to the number of sampling events.

- A qualitative analysis of the trend plots for most constituents show stable or decreasing trends, with the exception of pH and bicarbonate, which fluctuate but show no specific trend. In cases where a constituent has typically been below detection, the apparent decreasing trend may be the result of decreasing reporting limits over time (e.g., mercury).

Monitoring Well Water Quality Evaluation

Based on the request from OCD, a statistical evaluation of available historical water quality data for the relevant monitoring wells was performed that included the calculation of the maximum, minimum, and average concentrations for the key constituents. This also included identifying the samples that exceeded WQCC standards and reviewing the distribution of exceedances. The monitoring wells selected are listed below and shown in **Figure 2**.

- RO reject field monitoring wells: MW-114, MW-115, MW-116, MW-117, MW-118, and MW-119; data from 2013 (quarterly) and 2014 (semiannually) was used for the analysis.

- Nearby upgradient monitoring wells: MW-18, MW-54A, MW-54B, MW-55, NCL-44, NCL-49, and NCL-33; data from 2013 and 2014 was used in the analysis as a comparison of nearby upgradient water quality in relation to the RO reject field monitoring wells for the same time period as those wells

- Several nearby wells surrounding the RO reject fields with extensive historical data, from 1992 through 2010: KWB-1A, KWB-10, MW-20, MW-30, MW-45, MW-46, and MW-56. Chloride, fluoride, and sulfate data from these wells from the time period of 1992 through 2010 was selected because this data has previously been presented to OCD for their review.

It should be noted that the monitoring wells located within the RO reject fields were installed in 2013. Not all wells listed above were sampled during every period for the same set of parameters, due to variations in the monitoring program through time. Thus, a comprehensive, historical dataset for all monitoring locations and constituents evaluated was not available; however, the dataset can be used to understand general trends and statistical parameters to provide insight into the local groundwater quality.

The results of the statistical evaluation are summarized in **Table 2** and the full data set used for this evaluation is presented in **Appendix C**. **Appendix C** also includes trend plots for sulfate concentrations in historical wells KWB-1A and MW-45 to provide insight into long term groundwater constituent concentration trends. The trend plots are intended to be illustrative of long term trends at the Site, and were previously submitted to OCD for their review. **Table 2** shows the minimum, maximum, and average

concentrations, as well as the exceedances for each constituent, using the data from both sets of data presented in **Appendix C**. The analysis indicates the following:

- Similar to the RO discharge water quality, the data for the groundwater monitoring network is highly variable.

- The trend plots shown in **Appendix C** for KWB-1A and MW-45 over the data period (1992-2010) show a decreasing trend for sulfate concentrations.

- Chloride, fluoride, and sulfate have numerous exceedances of the WQCC standards in groundwater, along with iron, manganese, and nitrate. This is the case in the RO reject field wells, the background wells, and the surrounding wells with no observed spatial distribution that would suggest one well group is more impacted than another.

- When comparing the historical and the more recent (2013 and 2014 data) average groundwater concentrations for chloride, fluoride, and sulfate, the values for each time period are similar, suggesting concentrations have remained relatively stable over the operation period. If loading effects from the RO discharge was impacting groundwater quality, then the more recent averages would be higher than the historical averages. In fact, the average for the more recent sampling results for chloride and sulfate are lower, as summarized below:

Average Concentration (mg/L)	Historical (1992-2010)	Recent (2013-2014)
Chloride	367.1	238.4
Fluoride	1.6	1.9
Sulfate	2068.7	1700.2

- When considering the data shown in **Appendix B** for the RO reject field monitoring wells, the surrounding wells, and the nearby upgradient wells, there is no discernable pattern of the distribution of WQCC standard exceedances when the data is evaluated qualitatively. Exceedances of the WQCC standards, shown in the highlighted cells, occur in all of the well groups. If the data from the RO reject fields monitoring wells had more exceedances of the WQCC standards, this would confirm that the RO reject water could be a source of groundwater impacts. However, the data from the RO reject fields monitoring wells is similar to the data in surrounding wells, which does not confirm that the discharge of RO reject to the fields is a significant impact to groundwater quality.

It should be noted that a more thorough evaluation of background groundwater quality has been conducted over a 12-month period, according to a work plan approved by OCD. The results of the

background groundwater evaluation will be submitted in a separate report on or before October 4, 2015, as requested by OCD. The analytical results of the background groundwater quality were evaluated statistically to develop an upper tolerance limit (UTL) with 95% confidence and 95% coverage. The proposed alternate standards based on the background UTLs, although not yet approved for use, have been added to **Table 2** for comparison. As can be seen, the average concentrations presented in **Table 2** do not exceed the proposed alternate standards, or the WQCC standards for those constituents where an alternate standard is not proposed.

RO Reject Water Mass Loading Calculations

Mass loading rates for key constituents were calculated to provide insight into the quantity of constituents deposited onto the RO discharge fields. The rates were calculated using the average concentrations for the RO discharge water using data obtained during the period from 1992 to 2014. The calculations also considered the area of the discharge fields (approximately 55 acres total for the North and South fields combined) and used the maximum, minimum, and average flow rates using historical data from 1992 through 2014. As with the RO water quality dataset, this represents the entirety of the available data based on operational period and permit requirements. This led to the estimation of a worst case, best case, and average scenario. The worst case scenario consists of the maximum observed flow rate and the best case scenario consists of the lowest observed flow rate. The results are summarized in **Table 3**. The table shows pounds/acre/year and total tons applied at the surface of the fields, assuming an operational period of 22.5 years.

As expected, major ions (sulfate, chloride, magnesium, calcium, and sodium) have the highest relative loading rates, whereas the trace metals mercury, cadmium, molybdenum, and silver have relatively low loading rates. The calculated mass loading rates for each of the scenarios are indicative of the variability in the constituent concentrations and the flow rates of the RO discharge. It is unlikely that the “worst case” would be the case observed in every year, and the same could be said of the “best case”. Therefore, the “average” case is likely the most representative over the operational period of the system. The significance of the loading rates relative to the observed groundwater concentrations is dependent on the transport of these constituents to groundwater. The mobility of the constituents depends on several flow and transport characteristics, including vadose zone water budget, infiltration capacity, and geochemical processes which may facilitate or limit movement of constituents to the water table. The evaluation of transport using a numerical flow and transport geochemical model is summarized in the next section.

Hydrogeologic Modeling

A geochemical reactive transport model simulating percolation of RO discharge water in the vadose zone beneath the discharge fields was developed to better understand the transport of dissolved constituents to groundwater. Due to uncertainties in the levels of discharge to the north versus the south field, two

scenarios were considered for modeling; one in which 100% of the discharge was sent to the south field (Scenario 1), and one in which 67% was sent to the south field and the remaining 33% was sent to the north field (Scenario 2). These scenarios are based on the observation that the north field was constructed at a later date, and historically the south field has typically had the majority of the discharge water applied.

The model also considered evapotranspiration and resulting solute concentration in the discharge fields prior to infiltration. Evapotranspiration was determined by using the measured pan evaporation rate of 100 inches (Kohler, et al, 1959), which was then adjusted using the crop coefficient for pasture grasses (Jenson et al, 1990). The resulting evapotranspiration was combined with long term average precipitation for a balance deficit of 68 inches. This was then combined with the discharge rate and RO reject field areas (29.2 acres and 25.8 acres for the south and north fields, respectively) to determine a net infiltration rate in inches per day (in/day).

The following infiltration rates were assumed based on an average of the available discharge data from 1992 through 2003:

	Scenario 1 South Field	**Scenario 2a South Field**	**Scenario 2b North Field**
Average Discharge, 1992-2003 (in/day)*	0.348	0.233	0.264
Evapotranspiration (in/day)	0.178	0.178	0.178
Water Lost to Evaporation	51%	76%	67%
Infiltration Rate (in/day)	0.170	0.055	0.086

* Corrected to effective inches per day based on volumetric discharge and field surface area

Model construction and assumptions, geochemical model parameters, and modeling results are described below. **Appendix D** includes parameters and calculations for model inputs, **Appendix E** includes model input files, and **Appendix F** includes model output files. Note that PHREEQC model outputs include a full output file as well as a user-specified "selected output" file. Since the full model output files can be several hundred pages in length, only the selected output file results tables are included in **Appendix F**. The full output files can be regenerated by running the model input files included in **Appendix E**.

Geochemical Model Construction

One-dimensional reactive transport models were constructed for each scenario using the geochemical modeling code PHREEQC with the Wateq4f database (Parkhurst and Appelo 1999). The model was used to 1) predict the concentrations of dissolved constituents at the surface within the discharge fields following evapotranspiration (with solute concentrations changing as a result of evapoconcentration and potential precipitation) and 2) to qualitatively understand concentration dynamics in the seepage water at

the water table interface following transport through the vadose zone. Geochemical processes included in the reactive transport model include aqueous speciation, adsorption to mineral surfaces, cation exchange, and mineral dissolution/precipitation reactions. Specifically, calcite, gypsum, fluorite, rhodochrosite, and barite were allowed to precipitate if they were supersaturated.

The following physical and hydrologic assumptions were included in the model:

- Depth to water table: 25 ft
- Total Porosity: 35%
- Effective Porosity: 20%
- Void Saturation: 95%
- Vadose zone seepage velocity, based on infiltration rates and porosity:
  - Scenario 1: 0.51 in/day
  - Scenario 2a: 0.16 in/day
  - Scenario 2b: 0.26 in/day

The "total porosity" represents the total void space in the vadose zone matrix, while the "effective porosity" represents the portion of the void space potentially containing readily-mobile solution (this can also be referred to as the "mobile porosity"). The approach below assumes that only the cation exchange and sorption sites within the mobile zone are available for reaction with dissolved constituents. A void saturation of 95% was assumed based on the anticipated high degree of saturation in the vadose zone, given the low infiltration rate (less than 1 inch per day) and the high saturation state of the fields.

Influent aqueous concentrations were based on the 2004 to present average RO reject water concentrations, corrected for evapotranspiration. Initial aqueous concentrations within the model domain were arbitrarily low to better illustrate the time at which influent concentrations reach the water table based on the contrast between initial and influent solutions.

Solids Data Evaluation and Geochemical Model Assumptions

Boring logs for monitoring wells MW-114, MW-115, MW-116, MW-117, MW-118, MW-119, and RO-SB-1 (ARCADIS, 2014) indicate that the unsaturated zone beneath the RO discharge fields is composed primarily of silty clay, varying in color from white/light brown to darker red, with interspersed caliche gravels, with the observed clay content varying from approximately 55% to 90%. This material represents the valley fill deposits of the Quaternary Alluvium, and is consistent with information obtained from multiple previous investigations throughout the Refinery and surrounding areas.

Total metals analyses on soil samples collected from boreholes within the RO reject discharge fields (ARCADIS, 2014) indicate the following average elemental compositions:

- Al 9,000 mg/kg
- Fe 6,000 mg/kg
- Ca 120,000 mg/kg
- SO_4 1300 mg/kg

These concentrations suggest that the samples likely comprise large amounts of calcite, with lesser amounts of gypsum, clay minerals, and metal oxides, with the remainder comprising silica oxide phases such as quartz.

The following assumptions were used in the geochemical modeling (described below):

- Solid phases in the unsaturated alluvium controlling surface reactions (including adsorption and cation exchange) are assumed to include iron oxyhydroxides and clay minerals. Specifically, the predominant clay mineral phase was assumed to be kaolinite, with the chemical formula $Al_2Si_2O_5(OH)_4$. Although the specific proportions of clay minerals present in the alluvium in Artesia could not be found, studies on analogous valley fill materials along the Rio Puerco in New Mexico indicate the presence of illite, montmorillonite, and kaolinite, with kaolinite predominating (Heath, 1983). The iron within the alluvium was assumed to be present as iron oxyhydroxides, with ferrihydrite ($Fe(OH)_3$) assumed for modeling purposes.

- Based on the average elemental abundances provided above, the following mineral quantities were calculated (**Appendix D, Table D-1**):

  - Ferrihydrite: 11.5 g/kg 1% of total
  - Kaolinite: 43 g/kg 4% of total
  - Calcite: 298 g/kg 30% of total
  - Gypsum: 2.3 g/kg 0.2% of total

  The remaining 65% of the mineralogy was assumed to be unreactive. Although gypsum content was small, the sulfate content is assumed to be indicative of conditions in thermodynamic equilibrium with gypsum.

Adsorption was accounted for in the model using a surface complexation model for ferrihydrite (Dzombak and Morel 1990), which includes sorption reactions for H^+, Ca^{2+}, Ba^{2+}, Zn^{2+}, Cu^{2+}, Mg^{2+}, Mn^{2+}, $UO2^{2+}$, Fe^{2+}, As(V), SO_4^{2-}, Se(VI), and F^-, with the bicarbonate sorption constants added based on Appelo et al. (2002). Note that arsenic and selenium were assumed to be present in the RO reject water in their most

oxidized forms, and it is assumed that the vadose zone remains oxic down to the water table (i.e., no reduction of arsenic, selenium, or nitrate).

Although the ferrihydrite surface complexation model parameters were used, ferrihydrite itself is an extremely reactive, high-surface area mineral which may not represent all of the iron oxide minerals present in the aquifer. In reality, other slightly less reactive ferric minerals may constitute the majority, including goethite and hematite. For calculation of the surface adsorption sites, a mineral surface area of 30 m^2/g was assumed (typical of goethite; Kosmulski et al. 2004). The surface adsorption site density for ferrihydrite was used, but was scaled back by more than two orders of magnitude (a factor of 500) to provide a conservative estimate of adsorption. Ultimately, the sorption affinity of the aquifer matrix for particular metals must be obtained based on site-specific results. In lieu of this information, the adsorption model included here is not meant to provide quantitative predictions, but rather is intended to provide an illustration of metals dynamics (e.g., the degree of retardation of various metals relative to one another). Increasing the sorption site density is expected to have an approximately linear effect on retardation; for example, a doubling of the concentration of sites for adsorption would result in a doubling of the time required for metals to reach the water table, all else (e.g., solution pH) being equal. The concentrations of "strong" and "weak" sites, as described by Dzombak and Morel (1990), are included in **Appendix D, Table D-2** along with all other model input parameters.

Cation exchange was accounted for using a kaolinite cation exchange capacity of 0.074 mol/kg based on an average of results presented by Ma and Eggleton (1999). The default Wateq4f cation exchange coefficients were used for Na^+, K^+, H^+, Ca^{2+}, Mg^{2+}, Ba^{2+}, Mn^{2+}, Fe^{2+}, Cu^{2+}, Zn^{2+}, and Al^{3+}.

Model Results

The average aqueous species concentrations from the RO reject water (**Table 1**) before and after evapoconcentration at the ground surface are included in **Table 4**, compared against WQCC standards and the proposed alternate standards. It should be noted that total dissolved solids (TDS) values presented in **Table 4** are calculated as the sum of the average concentrations of cations and anions presented in the table for the discharge and for the three scenarios. The calculated value provides a conservative estimate of TDS, which is higher than the measured values presented in **Appendix A, Table A-2**.

The PHREEQC model selected output file data table is included in **Appendix F**. Upon evaporation, the concentrations of most constituents increased based simply upon the fraction of water lost to evaporation, whereas the pH, alkalinity, and concentrations of calcium, sulfate, fluoride, and barium were controlled by the precipitation of calcite, gypsum, fluorite, and barite. The results demonstrate that only chloride, fluoride, sulfate, and total dissolved solids (TDS) exceed WQCC before and after evapoconcentration. However, only fluoride exceeded the proposed alternate standard before and after evapoconcentration in Scenario 2a. Following evapoconcentration, cadmium also exceeded the WQCC standard in Scenario

2a. However, it is important to note that the geochemical model does not include potential coprecipitation reactions, but arsenic, selenium, and metal cations (including cadmium) can also be coprecipitated in the calcite that forms on evapoconcentration, thereby reducing aqueous concentrations. The evapoconcentrated results are therefore conservative in most cases. Accordingly, the cadmium exceedance on evapoconcentration is not believed to be significant.

Several metals, including chromium, cadmium, lead, nickel, molybdenum, beryllium, cobalt, vanadium, silver, and mercury, were not included further in the geochemical model since they do not represent a water quality risk following evapoconcentration.

The water quality predicted for each discharge scenario following evapoconcentration was used as input to the reactive transport model to simulate the concentrations of seepage discharging to groundwater at the water table interface as a function of time. Results for Scenario 1, 2a, and 2b are shown in **Figures 3, 4, and 5**, respectively. Chloride and nitrate are transported with groundwater conservatively, since no geochemical reactions are assumed to attenuate these constituents. Breakthrough of these analytes at the water table interface therefore provides the seepage time for each scenario, which is 10 months, 2.6 years, and 1.7 years for Scenarios 1, 2a, and 2b, respectively. Note that these breakthrough times are expected to vary linearly based on the actual mobile porosity and saturation state; e.g., a saturated mobile pore volume of one-half of the assumed value would result in a doubling of the seepage velocity, resulting in a 50% decrease in breakthrough time.

The transport of all other analytes is attenuated to various levels depending on the degree of retardation controlled by cation exchange, adsorption, and mineral precipitation. Cation exchange exhibits a relatively small control, based on the fast breakthrough of calcium and magnesium at influent concentrations relative to chloride. Sorption retards the transport of metals and oxoanions to various levels, with uranium, selenium, and zinc exhibiting minimal retardation, whereas copper and arsenic exhibit substantial retardation (breakthrough of arsenic does not occur within the 14-year timeframe shown for Scenarios 2a and 2b). As described above, it is important to point out that the metal retardation predictions are only qualitative without site-specific calibration of the adsorption parameters, and these results are used only to illustrate sorption dynamics rather than to make quantitative predictions.

Overall, the transport model results illustrate that the eventual concentrations reaching the water table are limited by influent concentrations. Discharge volume may affect the extent of evaporation (for example, increased discharge volume may result in a lower proportion of the total water lost to evaporation, and hence more dilute water percolating to depth), but otherwise does not affect the concentration of constituents reaching the water table. Although sorption and exchange reactions may limit the transport time, the concentrations reaching the water table will likely come up to (but are also not anticipated to exceed) the influent concentrations of the RO reject water.

Summary and Conclusions

This memorandum summarizes the results of a water quality evaluation performed to assess impacts from the discharge of RO reject water to discharge fields at the Navajo Refinery Site. This evaluation included an assessment of the RO discharge water quality (summary statistics, trend evaluation, and mass loading assessment) as well as the water quality in monitoring wells beneath, surrounding, and upgradient of the discharge fields. The following observations were noted:

- Constituent concentration trends in the RO discharge were generally stable or slightly decreasing. In many cases, analytes are below detection most of the time, and decreasing trends are the result of decreasing reporting limits.

- A comparison of the analytical results from the RO discharge field monitoring wells against nearby upgradient and surrounding area monitoring wells qualitatively indicates similar concentrations and similar number of exceedances of the WQCC standards, with no clear pattern of distribution of exceedances.

- The comparability of the analytical results from the RO discharge field monitoring wells to results from nearby upgradient and surrounding monitoring wells indicates that exceedances of WQCC standards are not attributable to the RO reject discharge.

Mass loading calculations indicate the loading to the RO discharge fields can be highly variable due to the changes in flow rate and constituent concentration. However, the average mass loading is likely representative of loading conditions over the operational period of the system. The significance of the loading is dependent on the transport characteristics of the vadose zone beneath the fields.

In addition to the water quality assessment, a hydrogeochemical reactive transport model simulating the evapoconcentration and percolation of RO discharge within the vadose zone down to the groundwater table was performed. Key observations from the vadose zone hydrogeochemical model are as follows:

- Evapoconcentration results in increasing solute concentrations, but with the concentrations of several analytes controlled by mineral precipitation. Although the concentrations of other constituents may be reduced via coprecipitation, this process is not included in the model, making the predicted concentrations conservatively high. The minerals that precipitate from solution (e.g., calcite, gypsum, fluorite) do not represent a risk to water quality.

- The transport model illustrates the concept that a steady-state is ultimately reached between RO reject concentrations and the concentrations in seepage to groundwater. Specifically, although geochemical reactions within the vadose zone control the rate at which analytes are transported to groundwater, concentrations of constituents reaching the water table are ultimately limited by the concentrations in the RO discharge water following evapoconcentration. In this way, the concentrations reaching the water table are not dependent on the volume of discharge water.

Based on this evaluation and the observed concentrations in groundwater from wells within the RO reject discharge fields, the water quality data, mass loading estimates, and hydrogeochemical modeling indicate that the RO discharge system is not detrimental to the water quality beneath or downgradient of the fields. The ongoing application of discharge waters has resulted in a system that has reached and maintained a steady-state condition, and therefore the concentrations of constituents are not increasing or adversely impacting groundwater when compared to background conditions.

References

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Tables

Table 1: RO Reject Field Discharge Water Quality Statistics

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

Constituent/ Parameter	Concentration Units	Number of Detections [1]	Maximum Concentration	Minimum Detected Concentration	Average of Detections Only	Average of All Data [2]	Average of 2004 to Present [2]
Chloride	mg/L	134	1090	7.3	227	227	265
Fluoride	mg/L	125	31	0.57	3.2	3.2	3.2
Sulfate	mg/L	134	5897	38	1692	1692	1651
Aluminum	mg/L	20	0.62	0.00668	0.22	0.15	0.015
Arsenic	mg/L	17	1.6	0.00125	0.32	0.11	0.007
Barium	mg/L	45	0.344	0.04	0.074	0.14	0.075
Beryllium	mg/L	3	0.1	0.02	0.073	0.018	0.003
Boron	mg/L	41	0.82	0.02	0.15	0.13	0.08
Cadmium	mg/L	8	0.12	0.01	0.04	0.013	0.0026
Chromium	mg/L	10	0.15	0.01	0.052	0.026	0.006
Cobalt	mg/L	3	0.13	0.0229	0.07	0.031	0.007
Copper	mg/L	12	0.88	0.00177	0.11	0.054	0.019
Iron	mg/L	29	4.08	0.02	0.31	0.20	0.23
Lead	mg/L	6	0.483	0.001	0.085	0.014	0.0065
Magnesium	mg/L	88	504	15.3	187	187	185
Manganese	mg/L	13	0.34	0.003	0.06	0.04	0.006
Mercury	mg/L	1	0.00027	0.00027	0.0003	0.0007	0.00020
Molybdenum	mg/L	22	0.07	0.00639	0.02	0.07	0.010
Nickel	mg/L	20	8.6	0.00127	1.59	0.42	0.0056
Selenium	mg/L	41	0.422	0.001	0.020	0.024	0.009
Silver	mg/L	10	0.11	0.0003	0.02	0.006	0.007
Uranium	mg/L	5	1.3	0.003	0.27	0.60	0.005
Vanadium	mg/L	25	0.14	0.0075	0.03	0.045	0.010
Zinc	mg/L	34	0.316	0.00657	0.05	0.048	0.012
Potassium	mg/L	88	115	0.3	6.0	5.8	3.8
Sodium	mg/L	90	691	13.9	133	133	144
Nitrate (as N)	mg/L	23	4.6	0.1	1.7	1.7	1.3
Calcium	mg/L	90	1200	42.7	548	548	607
pH	standard units	23	8.01	6.8	7.52	7.52	7.73
Bicarbonate	mg/L	93	982	38	443	438	699

Notes:

[1] Based on a total of 139 sampling events conducted at various intervals between 1992 and 2014 (Appendix A)

[2] Non-detect values were incorporated into the average as equal to the respective reporting limits.

mg/L = milligrams per liter

Table 2: Observation Well Groundwater Quality Statistics

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

Constituent/ Parameter	Concentration Units	Number of Exceedances [1]	Maximum Detected Concentration	Minimum Detected Concentration	Average Concentration [2]	WQCC Standard	Proposed Alternate Standards
Chloride	mg/L	60	1057	49	353	250	5930
Fluoride	mg/L	87	6.78	0.1	1.6	1.6	2.95
Sulfate	mg/L	193	3600	26.3	2028	600	4413
Arsenic	mg/L	0	0.0488	0.001	0.0082	0.1	---
Barium	mg/L	0	2.58	0.0009	0.1864	1	---
Cadmium	mg/L	0	0.0008	0.0008	0.0008	0.01	---
Chromium	mg/L	0	0.005	0.001	0.0029	0.05	---
Copper	mg/L	0	0.0141	0.001	0.0023	1	---
Iron	mg/L	6	10.8	0.078	0.6567	1	---
Lead	mg/L	0	0.005	0.0007	0.0027	0.05	---
Manganese	mg/L	11	2.39	0.0025	0.3665	0.2	1.13
Mercury	mg/L	0	0.0002	0.000042	0.00009	0.002	0.0044
Nickel	mg/L	0	0.00541	0.001	0.0028	0.2	---
Selenium	mg/L	0	0.0278	0.001	0.0051	0.05	---
Silver	mg/L	0	0.0008	0.0008	0.0008	0.05	---
Vanadium	mg/L	0	0.005	0.0009	0.0036	---	---
Zinc	mg/L	0	0.00821	0.0025	0.003	10	---
Potassium	mg/L	0	19	0.247	2.78	---	8.75
Sodium	mg/L	0	391	48.6	153	---	4300
Nitrate (as N)	mg/L	7	35.2	0.02	3.58	10	15.1
Calcium	mg/L	0	732	175	482	---	1027
Total Dissolved Solids	mg/L	193	6130	1200	3484	1000	16700

Notes:

[1] Number of samples with concentrations above WQCC standards (Appendix C).

[2] Non-detect values were incorporated into the average as equal to the respective reporting limits.

mg/L = milligrams per liter

WQCC = Water Quality Control Commission

Table 3: RO Reject Field Discharge Mass Loading Estimates

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

Analyte	Average Constituent Concentration (mg/L)	Best Case Scenario	Worst Case Scenario	Average	Best Case Scenario	Worst Case Scenario	Average
		Lbs/Acre/Year			Total Tons		
Chloride	226.71	2178	6274	4000	1338	3857	2459
Fluoride	3.16	30.40	87.58	55.84	18.67	53.84	34.33
Sulfate	1691.79	16251	46819	29851	9982	28780	18349
Aluminum	0.15	1.42	4.10	2.61	0.87	2.52	1.61
Arsenic	0.11	1.05	3.04	1.94	0.65	1.87	1.19
Barium	0.14	1.33	3.82	2.44	0.82	2.35	1.50
Beryllium	0.02	0.17	0.50	0.32	0.11	0.31	0.20
Boron	0.13	1.26	3.64	2.32	0.78	2.24	1.43
Cadmium	0.01	0.12	0.34	0.22	0.07	0.21	0.13
Chromium	0.03	0.25	0.71	0.45	0.15	0.44	0.28
Cobalt	0.03	0.30	0.86	0.55	0.18	0.53	0.34
Copper	0.05	0.51	1.48	0.94	0.32	0.91	0.58
Iron	0.20	1.89	5.44	3.47	1.16	3.35	2.13
Lead	0.01	0.13	0.39	0.25	0.08	0.24	0.15
Magnesium	186.99	1796	5175	3299	1103	3181	2028
Manganese	0.04	0.38	1.10	0.70	0.24	0.68	0.43
Mercury	0.0007	0.006	0.018	0.012	0.00	0.01	0.01
Molybdenum	0.07	0.63	1.81	1.15	0.39	1.11	0.71
Nickel	0.42	4.02	11.58	7.38	2.47	7.12	4.54
Selenium	0.02	0.23	0.66	0.42	0.14	0.41	0.26
Silver	0.01	0.06	0.17	0.11	0.04	0.10	0.07
Uranium	0.60	5.72	16.49	10.51	3.52	10.14	6.46
Vanadium	0.05	0.43	1.25	0.80	0.27	0.77	0.49
Zinc	0.05	0.46	1.34	0.85	0.29	0.82	0.52
Potassium	5.85	56.2	161.9	103.2	34.5	99.5	63.4
Sodium	132.68	1274	3672	2341	783	2257	1439
Nitrate	1.66	15.93	45.89	29.26	9.78	28.21	17.98
Calcium	548.21	5266	15171	9673	3235	9326	5946

Flow Rates for Each Scenario (million gallons/year):

Worst Case = 181.2

Best Case = 62.9

Average = 115.5

Abbreviations:

mg/L = milligrams per liter

lbs/Acre/year = pounds per acre per year

Table 4: Average Aqueous Species Concentrations, RO Discharge Water

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

Analyte	Units	WQCC Standard	Proposed Alternate Standard	RO Discharge[1]	Scenario 1	Scenario 2a	Scenario 2b	Control on Concentration
Chloride	mg/L	250	5930	265	542	1123	813	
Fluoride	mg/L	1.6	2.95	**3.21**	2.36	**3.11**	2.72	Fluorite precipitation
Sulfate	mg/L	600	4413	1651	2844	4391	3561	Gypsum and barite precipitation
Aluminum	mg/L	5	---	0.015	0.0036	0.0042	0.0039	Gibbsite precipitation
Arsenic	mg/L	0.1	---	0.007	0.014	0.028	0.021	
Barium	mg/L	1	---	0.075	0.010	0.010	0.010	Barite precipitation
Beryllium[2]	mg/L	---	---	0.003	0.005	0.010	0.008	
Boron	mg/L	0.75	---	0.085	0.173	0.358	0.260	
Cadmium[2]	mg/L	0.01	---	0.0026	0.005	0.011	0.008	
Chromium[2]	mg/L	0.05	---	0.006	0.012	0.025	0.018	
Cobalt[2]	mg/L	0.05	---	0.007	0.014	0.029	0.021	
Copper	mg/L	1	---	0.019	0.039	0.081	0.059	
Iron	mg/L	1	---	0.225	0.0007	0.0007	0.0007	Ferrihydrite precipitation
Lead[2]	mg/L	0.05	---	0.0065	0.013	0.027	0.020	
Magnesium	mg/L	---	---	185	378	783	567	
Manganese	mg/L	0.2	1.13	0.0064	0.013101	0.02712	0.01965	
Mercury[2]	mg/L	0.002	0.0044	0.0002	0.000408	0.000833	0.00061	
Molybdenum[2]	mg/L	1	---	0.010	0.020	0.042	0.030	
Nickel[2]	mg/L	0.2	---	0.006	0.011	0.023	0.017	
Selenium	mg/L	0.05	---	0.009	0.019	0.039	0.029	
Silver[2]	mg/L	0.05	---	0.007	0.013	0.027	0.020	
Uranium	mg/L	0.03	---	0.005	0.011	0.023	0.017	
Vanadium[2]	mg/L	---	---	0.010	0.020	0.042	0.030	
Zinc	mg/L	10	---	0.012	0.025	0.052	0.038	
Potassium	mg/L	---	8.75	3.8	7.8	16.1	11.7	
Sodium	mg/L	---	4300	181	370	767	555	Adjusted to achieve charge balance
Nitrate	mg/L	10	15.1	1.3	2.7	5.6	4.1	
Calcium	mg/L	---	1027	607	559	524	540	Calcite and gypsum precipitation
pH	s.u.	6 - 9	---	7.73	7.82	7.87	7.85	Calcite precipitation, CO_2 exchange
Bicarbonate	mg/L	---	---	699	30.1	35.9	33.0	Calcite precipitation
TDS[3]	mg/L	1000	16700	3596	4737	7648	6089	

Notes:

Scenario 1: 100% of RO reject water to south field (51% evapotranspiration)

Scenario 2a: 67% of RO reject water to south field (76% evapotranspiration)

Scenario 2b: 33% of RO reject water to north field (67% evapotranspiration)

Values highlighted in yellow exceed the WQCC standard but do not exceed the proposed alternate standard

Values highlighted in green with bold font exceed the WQCC standard and the proposed alternate standard

[1] Values represent average results from 2004 to present, with non-detect values represented by reporting limits

[2] Evapoconcentrated values calculated directly from RO discharge concentration and were not included in the geochemical model

[3] Total dissolved solids calculated as the sum of individual ion concentrations, with alkalinity as mg/L bicarbonate

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Figures

LEGEND:

- RO REJECT WATER DISCHARGE FIELD
- REFINERY FENCELINE
- REJECT FIELD IRRIGATION TRENCHES
- NAVAJO REFINING PROPERTY LINE
- MONTANA REFINING PROPERTY LINE
- APPROXIMATE LOCATION OF FORMER THREE-MILE DITCH AND EXISTING UNDERGROUND DISCHARGE PIPING
- WATERWAYS

NAVAJO REFINING COMPANY, ARTESIA, NEW MEXICO
REVERSE OSMOSIS REJECT FIELDS HYDROGEOLOGIC AND WATER QUALITY EVALUATION

Site Map

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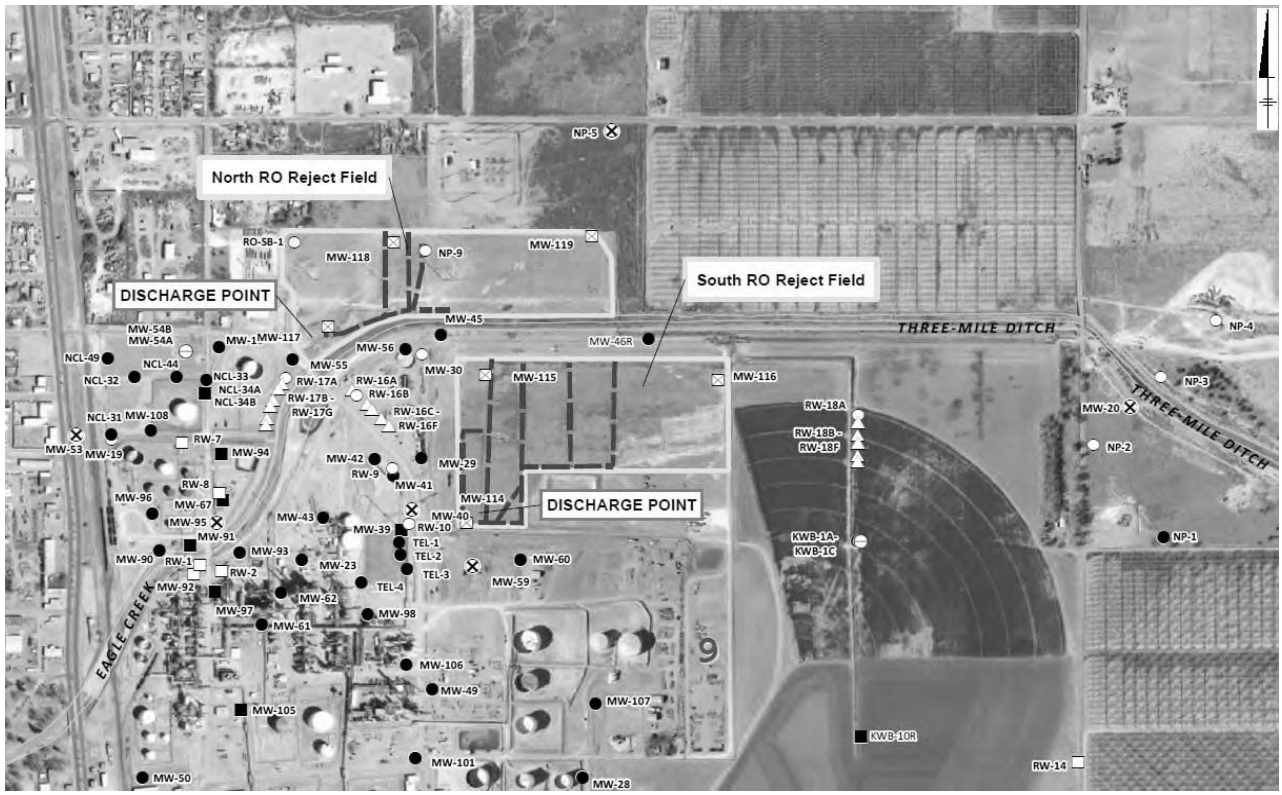
FIGURE
1



Legend

- ○ SOIL BORING LOCATION
- ○ NOT SAMPLED AS PART OF ROUTINE MONITORING PROGRAM
- ⊠ SAMPLES TO BE COLLECTED QUARTERLY
- ⊖ SAMPLES COLLECTED BIENNIALLY
- ⊗ SAMPLES COLLECTED ANNUALLY
- ● SAMPLES COLLECTED SEMIANNUALLY
- □ SAMPLES COLLECTED ANNUALLY IF PSH <0.03 FT
- ■ SAMPLES COLLECTED SEMIANNUALLY IF PSH <0.03 FT
- △ RECOVERY TRENCH WELL LOCATION NOT SAMPLED AS PART OF ROUTINE MONITORING PROGRAM
- REJECT FIELD IRRIGATION TRENCHES
- RO REJECT WATER DISCHARGE FIELD

NAVAJO REFINING COMPANY, ARTESIA, NEW MEXICO
REVERSE OSMOSIS REJECT FIELDS HYDROGEOLOGIC
AND WATER QUALITY EVALUATION

Groundwater Quality Monitoring Well Locations

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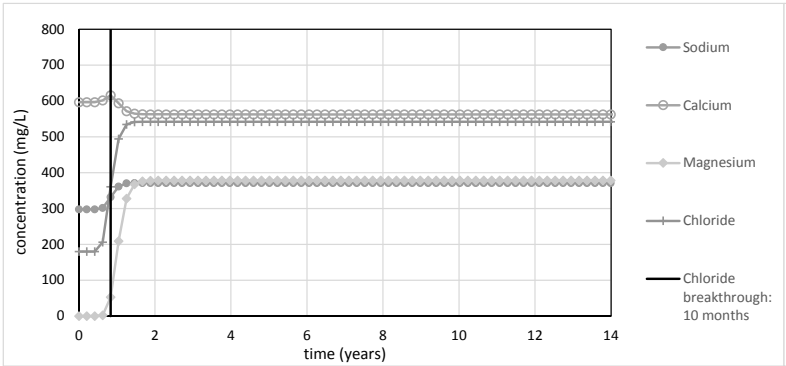
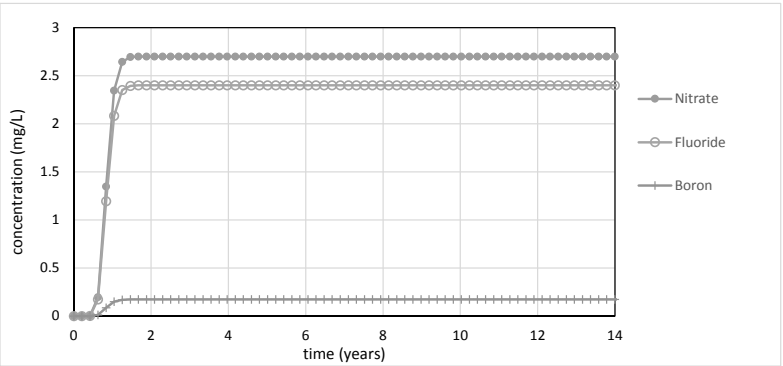
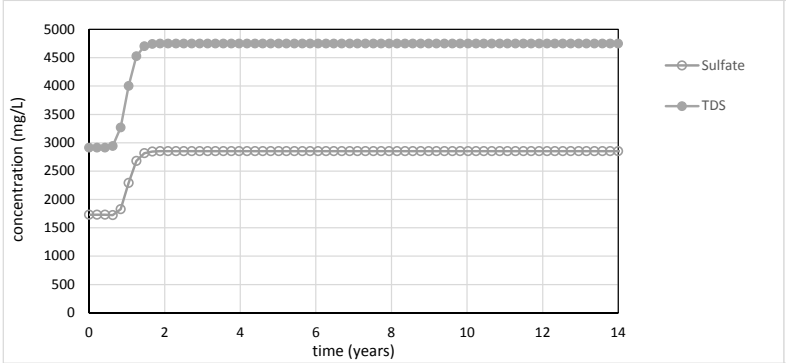
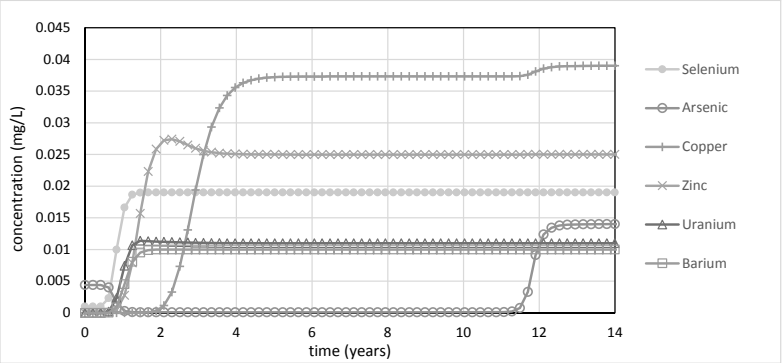
FIGURE
2

Scenario 1: 100% Discharge to South Field
Infiltration Rate = 0.17 in/day









NAVAJO REFINING COMPANY, ARTESIA, NEW MEXICO
REVERSE OSMOSIS REJECT FIELDS HYDROGEOLOGIC
AND WATER QUALITY EVALUATION

Predicted Concentrations at the Vadose Zone-Water Table Interface: Scenario 1

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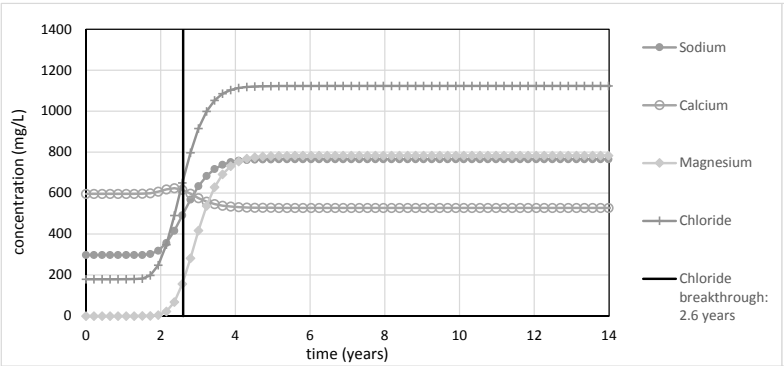
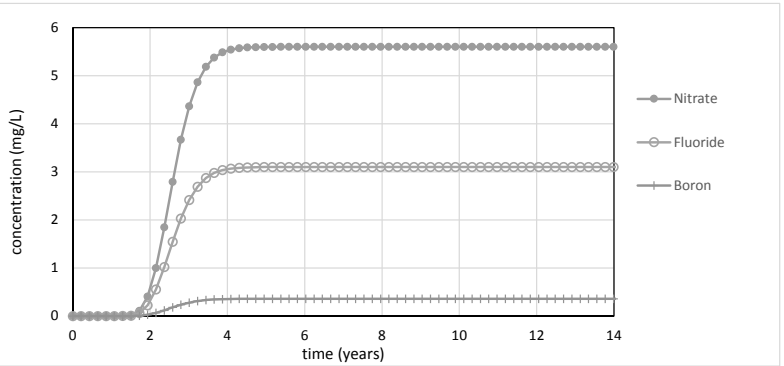
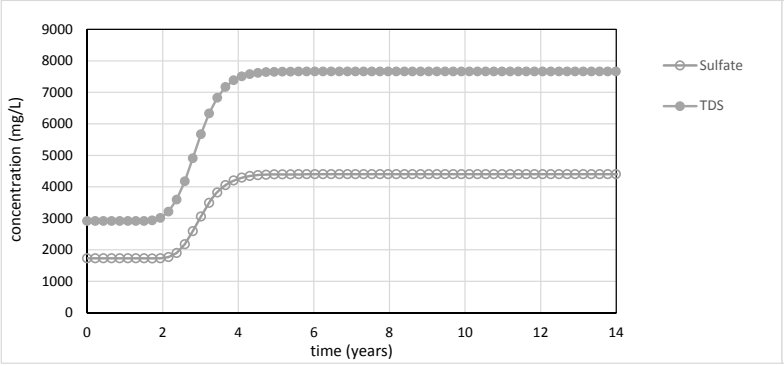
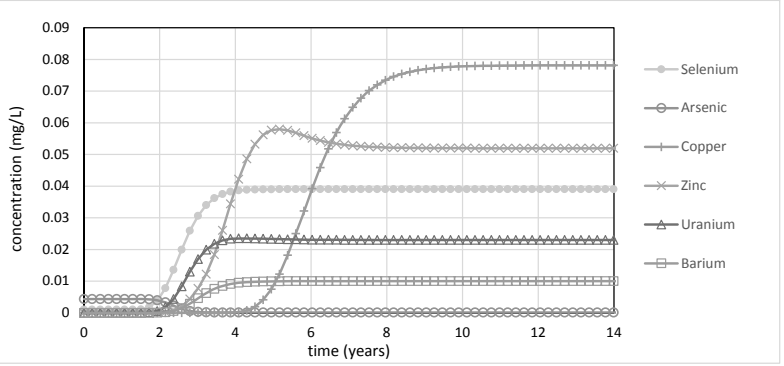
FIGURE
3

Scenario 2a: 67% Discharge to South Field
Infiltration Rate = 0.055 in/day









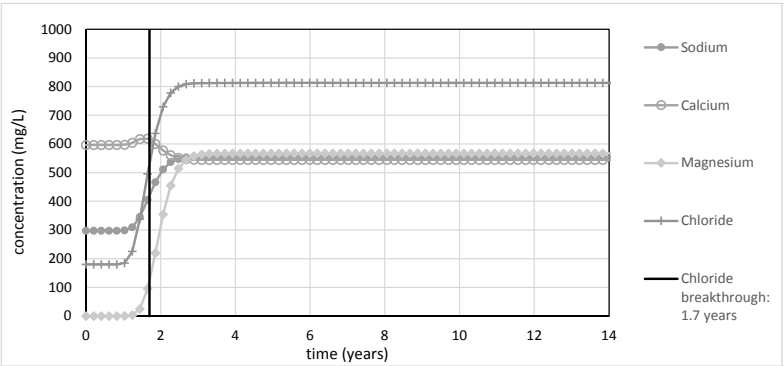
NAVAJO REFINING COMPANY, ARTESIA, NEW MEXICO
REVERSE OSMOSIS REJECT FIELDS HYDROGEOLOGIC
AND WATER QUALITY EVALUATION

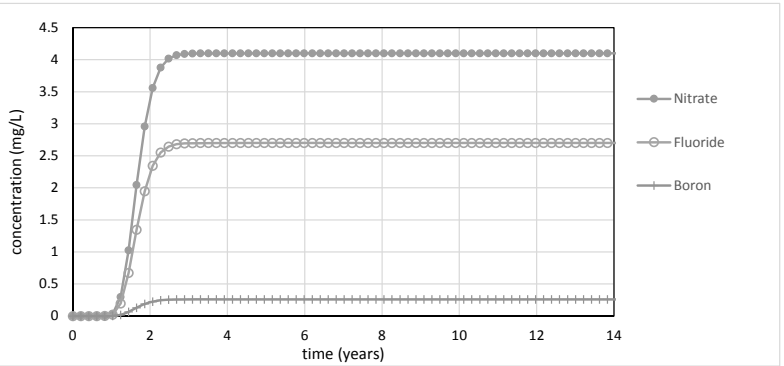
Predicted Concentrations at the Vadose Zone-Water Table Interface: Scenario 2a

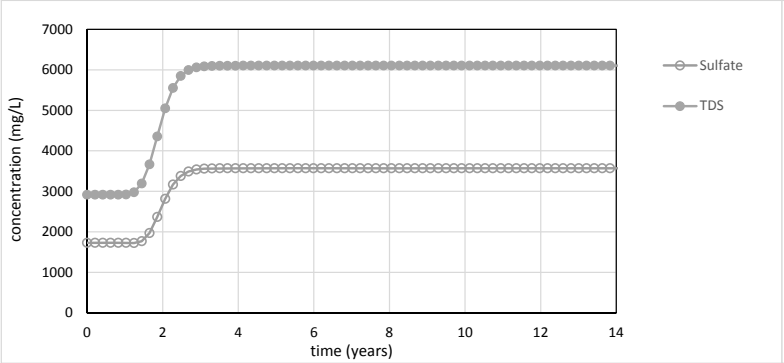
ARCADIS

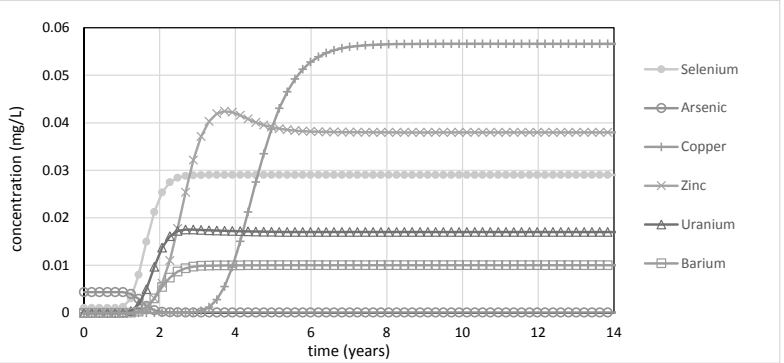
FIGURE
4

Scenario 2b: 33% Discharge to South Field
Infiltration Rate = 0.086 in/day









NAVAJO REFINING COMPANY, ARTESIA, NEW MEXICO
REVERSE OSMOSIS REJECT FIELDS HYDROGEOLOGIC
AND WATER QUALITY EVALUATION

Predicted Concentrations at the Vadose Zone-Water Table Interface: Scenario 2b

ARCADIS

FIGURE
5

ARCADIS

Appendix A

RO Discharge and Concentration Data

Table A-1: RO Discharge Volumes

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

Year	Total Discharge (gallons)	Total Discharge (barrels)	Average Daily Discharge (barrels/day)
1993	79,945,474	1,903,464	5,211
1994	155,533,458	3,703,178	10,139
1995	108,789,126	2,590,217	7,092
1996	107,586,865	2,561,592	7,013
1997	63,425,777	1,510,138	4,135
1998	62,887,000	1,497,310	4,099
1999	95,383,000	2,271,024	6,218
2000	89,719,000	2,136,167	5,849
2001	101,790,000	2,423,571	6,635
2002	114,874,000	2,735,095	7,488
2003	103,964,000	2,475,333	6,777
2004	103,428,000	2,462,571	6,742
2005	NA	NA	NA
2006	NA	NA	NA
2007	NA	NA	NA
2008	136,000,000	3,238,095	8,865
2009	NA	NA	NA
2010	NA	NA	NA
2011	109,241,096	2,600,978	7,121
2012	172,151,612	4,098,848	11,222
2013	171,589,230	4,085,458	11,185
2014	181,177,065	4,313,740	11,810
Max	181,177,065	4,313,740	11,810
Min	62,887,000	1,497,310	4,099
Ave	115,146,159	2,741,575	7,506

NA = discharge volume not available

Table A-2: RO Discharge Water Quality Analytical Results

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

Sample Date	Chloride mg/L	Fluoride mg/L	Sulfate mg/L	Al aluminum mg/L	As arsenic mg/L	B boron mg/L	Ba barium mg/L	Be beryllium mg/L	Cd cadmium mg/L	Co cobalt mg/L	Cr chromium mg/L	Cu copper mg/L	Fe iron mg/L	Mg Magnesium mg/L	Mn manganese mg/L	Hg mercury mg/L	Mo molybdenum mg/L	Ni nickel mg/L
11/4/1992	671	2.5	1780															
11/14/1992	671	2.5	1780															
11/15/1992	636	2.9	2580															
5/17/1993	254	2.2	1640															
5/18/1993	254	2.2	1640															
6/4/1993	237	1.8	1520															
6/15/1993	227	1.6	1650															
7/3/1993	212	1.7	1660															
8/11/1993	192	2.3	1570															
9/21/1993	214		1610															
10/21/1993	218		1500	0.6	ND	ND	0.06	ND	ND	ND	ND	ND		167			ND	
11/12/1993	261		1517	<0.1	<0.1	<0.05	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01		173			<0.05	
11/16/1993	261		1517															
11/18/1993	257		1218	<0.1	<0.1	<0.05	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01		180			<0.05	
12/2/1993	266		2080	<0.1	<0.1	0.3	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01		177			<0.05	
12/17/1993	266		2235	<0.5	<0.1	<0.1	<0.1	<0.05	<0.05	<0.05	<0.05	<0.05	0.3	175	<0.05	<0.001	<0.05	<0.05
1/12/1994	269	2.8	1559	<0.2	<0.1	<0.1	<0.1	<0.01	<0.01	<0.05	<0.05	<0.01	0.05	160	0.34	<0.001	<0.05	<0.05
1/26/1994	278	2.7	1803															
2/16/1994	267	2.24	102															
2/28/1994	259	2.2	38															
3/10/1994	227	2.2	1473															
3/30/1994	304	2.4	1458															
4/8/1994	234	2.3	899	<0.1	<0.1	<0.05	<0.1	<0.05	<0.01	<0.05	<0.01	<0.05	<0.05	161	<0.05	<0.001	<0.05	<0.05
4/21/1994	257	<0.1	1622	<0.1	<0.1	<0.05	<0.05	<0.05	<0.01	<0.05	<0.01	<0.05	<0.05	177	<0.05	<0.001	<0.05	<0.05
5/6/1994	248	2.32	1328	0.1	<0.1	<0.05	<0.05	<0.05	<0.01	<0.05	<0.01	<0.05	0.13	15.3	<0.05	<0.001	<0.05	<0.05
5/16/1994	262	2.5	1314															
6/9/1994	221	2.05	1747															
6/30/1994	253	2.4	2916															
7/19/1994	218.3	2.59	1772															
7/29/1994	237	2.4	2078															
8/11/1994	222.9	2.5	1577	<0.08	<0.1	<0.05	0.15	<0.01	<0.01	<0.05	<0.01	<0.05	<0.05	258	<0.05	<0.001	<0.05	<0.05
8/30/1994	218	2.5	2830	0.3	<0.1	0.28	0.1	<0.01	<0.01	<0.05	0.02	<0.05	0.08	186	<0.05	<0.001	<0.05	<0.05
9/9/1994	227.6	2.5	2080	0.28	<0.1	0.06	0.09	<0.01	<0.01	<0.05	0.01	<0.05	0.11	188.3	<0.05	<0.001	<0.05	<0.05
9/26/1994	209	2.4	1953	0.4	<0.1	<0.05	0.09	<0.01	<0.01	<0.05	<0.01	<0.05	<0.05	196	<0.05	<0.001	<0.05	<0.05
10/11/1994				<0.08	<0.1	<0.05	0.08	<0.01	<0.01	<0.05	<0.01	<0.05	<0.05	191.1	<0.05	<0.001	<0.05	<0.05
10/12/1994	195	2.3	2202															
10/20/1994	223	2.2	1944	<0.08	<0.1	0.05	<0.05	<0.01	<0.01	<0.05	<0.01	<0.05	0.12	200.7	<0.05	<0.001	<0.05	<0.05
11/30/1994	204	2.49	1682	<0.08	<0.1	0.12	<0.5	<0.05	<0.01	<0.05	<0.01	<0.05	0.17	193	<0.1	<0.001	<0.05	<0.05
12/7/1994																		
12/9/1994	197	2.3	2096	0.13	<0.1	<0.05	<0.05	<0.01	<0.01	<0.05	<0.01	<0.05	<0.05	209	<0.05	<0.001	<0.05	<0.05
12/10/1994																		
12/30/1994	214	2.4	1578	<0.08	0.2	<0.05	<0.5	<0.01	0.02	<0.05	0.02	<0.05	0.04	504	<0.1	<0.001	0.07	<0.05
1/12/1995	211	2.3	1641	<0.08	<0.1	<0.05	<0.5	<0.05	0.01	<0.05	0.01	<0.05	0.03	203	<0.1	<0.001	0.06	<0.05
1/26/1995	225	2.7	1495	<0.08	<0.1	<0.05	<0.5	<0.01	<0.01	<0.05	<0.01	<0.05	0.04	209	<0.1	<0.001	<0.05	<0.05
2/10/1995	205	2.4	1562	<0.05	<0.1	<0.05	<0.05	<0.01	<0.01	<0.05	<0.01	<0.05	0.09	176	<0.05	<0.001	<0.05	<0.05
2/22/1995	161	2.3	1626	<0.08	<0.1	<0.05	<0.5	<0.01	<0.01	<0.05	<0.01	<0.05	0.02	454	<0.1	<0.001	<0.05	<0.05
3/10/1995	210	2.4	729	0.11	<0.1	<0.05	<0.5	<0.01	0.01	<0.05	<0.01	<0.05	<0.01	75.9	<0.1	<0.001	<0.05	<0.05
4/10/1995	7.3	2.4	1791	0.08	0.1	<0.05	0.06	<0.05	0.12	<0.05	0.15	<0.05	<0.05	176.9	<0.05	<0.001	<0.05	0.08
4/21/1995	106	2.3	1901	<0.05	<0.1	<0.05	<0.05	<0.05	<0.01	<0.05	<0.01	<0.05	0.06	165.5	<0.05	<0.001	<0.05	<0.05
5/1/1995	158	2.3	1211	<0.05	<0.1	0.82	0.06	<0.05	0.04	<0.05	0.05	<0.05	<0.05	162.8	<0.05	<0.0010	<0.05	0.08

Table A-2: RO Discharge Water Quality Analytical Results

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

Sample Date	Chloride mg/L	Fluoride mg/L	Sulfate mg/L	Al aluminum mg/L	As arsenic mg/L	B boron mg/L	Ba barium mg/L	Be beryllium mg/L	Cd cadmium mg/L	Co cobalt mg/L	Cr chromium mg/L	Cu copper mg/L	Fe iron mg/L	Mg Magnesium mg/L	Mn manganese mg/L	Hg mercury mg/L	Mo molybdenum mg/L	Ni nickel mg/L
5/22/1995	147	2.5	2460	0.09	0.7	0.02	<0.05	<0.05	<0.01	<0.05	0.01	0.01	0.03	170	<0.05	<0.001	<0.05	<0.05
6/5/1995	127	2.5	2890	<0.05	<0.1	<0.05	0.05	<0.05	<0.01	<0.05	<0.01	<0.05	0.08	179	<0.05	<0.001	<0.05	<0.05
7/6/1995	108	2.2	1257															
7/24/1995	103	2.3	1260															
8/9/1995	106	2.2	1268															
8/31/1995	113	2.4	1551															
9/7/1995	88	2.4	1679															
9/26/1995	111	2.4	1417															
10/12/1995	144	2.6	1544	<0.2	<0.2	<0.03	0.06	<0.01	<0.02	<0.03	<0.05	<0.02	0.1	177	0.02	<0.001	0.04	0.6
10/26/1995	180	2.27	1560	<0.2	<0.2	<0.03	<0.03	<0.01	<0.02	<0.03	<0.05	<0.02	<0.03	181	<0.01	<0.001	<0.1	1.2
11/9/1995	155	2.45	1440	<0.2	<0.1	<0.03	<0.2	<0.01	<0.02	<0.03	<0.05	<0.02	<0.03	102.1	<0.01	<0.001	<0.1	1.4
11/22/1995	120	9.9	1995	<0.2	<0.1	<0.03	<0.2	<0.01	<0.02	<0.03	<0.05	<0.02	<0.03	88.7	<0.01	<0.001	<0.1	5.4
12/5/1995	180	2.42	5897	<0.2	<0.1	0.04	<0.2	0.02	0.05	<0.03	<0.05	0.02	<0.03	208	<0.01	<0.001	<0.1	0.6
1/8/1996	152	2.3	1216	<0.2	<0.1	<0.03	<0.2	<0.01	<0.02	<0.03	<0.05	<0.02	<0.03	104	<0.01	<0.001	<0.1	0.6
1/18/1996	107	2.3	1824	<0.2	<0.1	0.42	<0.2	<0.01	<0.02	<0.03	<0.05	<0.02	<0.03	145	<0.01	<0.001	<0.1	<0.1
1/30/1996	107	2.5	1235	<0.20	<0.1	<0.03	<0.2	<0.01	<0.02	<0.03	<0.05	<0.02	<0.03	150.8	<0.01	<0.001	<0.10	<0.1
2/14/1996	129	2.7	1938	<0.1	<0.1	0.31	0.1	<0.01	<0.02	<0.03	<0.05	<0.02	0.2	169	<0.01	<0.001	<0.1	<0.1
2/28/1996	73	2.4	1492	0.6	0.4	<0.03	<0.2	<0.01	0.03	0.06	0.11	0.07	0.1	166	0.06	<0.001	<0.1	<0.2
3/22/1996	105	2.7	2821															
4/23/1996	109	2.3	703	0.3	1	<0.03	<0.2	<0.01	0.02	0.13	0.13	0.09	0.12	273	0.02	<0.001	<0.1	<0.2
4/30/1996	115	2.8	1913	<0.2	0.2	<0.03	<0.2	0.1	<0.02	<0.03	<0.05	0.11	0.21	143	0.03	<0.001	<0.1	6.9
5/10/1996	133	3.1	1657	<0.2	0.2	<0.03	<0.2	0.1	<0.02	<0.03	<0.05	0.11	0.14	332	<0.01	<0.001	<0.1	6.3
5/31/1996	165	2.4	1378	<0.2	1.6	0.04	<0.2	<0.01	<0.02	<0.03	<0.05	<0.02	<0.03	169	<0.01	<0.001	<0.1	<0.2
6/13/1996	203	2.4	2390	<0.2	0.7	0.05	<0.2	<0.01	<0.02	<0.03	<0.05	<0.02	<0.03	180	<0.01	<0.001	<0.1	<0.2
6/28/1996	190	2.5	1980	<0.2	0.2	<0.03	<0.2	<0.01	<0.02	<0.01	<0.05	<0.02	<0.05	153	0.02	<0.001	0.02	8.6
7/12/1996	114	2.4	2550	<0.2	<0.1	0.64	<0.2	<0.01	<0.02	<0.03	<0.05	<0.02	0.11	164	0.03	<0.001	<0.1	<0.2
7/26/1996	85.5	1.8	1600	<0.20	<0.10	<0.03	<0.20	<0.01	<0.02	<0.03	<0.05	<0.02	<0.10	135	0.02	<0.001	<0.10	<0.20
7/31/1996	125	2.6	1480															
8/16/1996	76	3	2150	<0.20	<0.10	<0.03	<0.20	<0.01	<0.02	<0.03	<0.05	<0.02	<0.10	179	0.08	<0.001	<0.10	<0.20
8/23/1996	105	2.6	1430	<0.20	<0.10	<0.03	<0.20	<0.01	<0.02	<0.03	<0.05	<0.02	<0.10	164	<0.01	<0.001	<0.10	<0.20
9/17/1996	37.4	3	1350	<0.20	<0.10	<0.03	<0.20	<0.01	<0.02	<0.03	<0.05	<0.02	<0.03	148	<0.01	<0.001	<0.10	<0.20
9/30/1996	155	3.1	1520	<0.20	<0.10	<0.10	<0.20	<0.01	<0.02	<0.03	<0.05	<0.02	0.37	172	<0.05	<0.001	<0.10	<0.20
3/4/1997	210	3.1	1600	0.62	<0.10	<0.03	<0.20	<0.01	<0.02	<0.03	<0.05	<0.02	<0.03	170	<0.01	<0.001	<0.10	<0.20
6/4/1997	140	0.57	2200	0.032	<0.10	<1.0	<0.20	<0.10	<0.02	<0.03	<0.05	0.88	0.08	280	<0.01	<0.001	<0.10	<0.20
9/15/1997	83	8.5	1900	<0.20	<0.10	<0.1	<0.20	<0.01	<0.01	<0.03	<0.05	<0.02	<0.10	210	<0.01	<0.001	<0.10	<0.20
12/8/1997	350	11	1800	<0.20	<0.10	<0.10	<0.20	<0.05	<0.02	<0.03	<0.05	<0.02	<0.10	200	<0.03	<0.001	<0.10	<0.20
3/5/1998	660	31	1900	<0.10	<0.05	<0.10	<0.10	<0.02	<0.02	<0.05	<0.05	<0.05	<0.05	290	<0.02	<0.0010	<0.02	<0.02
5/11/1998	190	3.5	1700											220				
5/14/1998	190	3.5	1700															
6/9/1998	67	2.9	450	<0.50	<0.005	<0.50	<0.50	<0.10	<0.01	<0.05	<0.01	<0.50	<0.10	69	<0.10	<0.0010	<0.50	<0.01
9/2/1998	190	4.9	2000	<0.50	<0.005	<0.50	<0.50	<0.01	<0.01	<0.05	<0.01	<0.50	<0.50	260	<0.10	<0.001	<0.50	0.02
12/8/1998	430	4	2100	<0.10	<0.10	0.1	<0.10	<0.01	<0.01	<0.05	<0.05	<0.10	<0.10	221	<0.10	<0.0002	<0.10	<0.10
3/5/1999	280	4.2	1900	<0.05	<0.10	<0.50	<0.10	<0.01	<0.01	<0.05	<0.05	<0.10	<1.0	222	<0.20	<0.0002	<0.10	<0.20
9/16/1999	200	4.7	2300	0.11	<0.10	<0.75	<0.10	<0.01	<0.01	<0.05	<0.05	<0.10	<0.10	206	<0.10	<0.0002	<0.10	<0.10
1/13/2000	84	3.8	1900	<0.05	<0.10	<0.10	<0.10	<0.01	<0.01	<0.05	<0.05	<0.10	<0.10		<0.10	<0.0002	<0.10	<0.10
5/31/2000	98	4.2	1700	<0.10	<0.01	0.12	0.06	<0.01	<0.002	<0.01	<0.005	<0.01	0.02	227	<0.01	<0.0002	<0.01	<0.01
8/29/2000	280	3.6	1400	0.24	<0.01	0.13	0.04	<0.01	<0.002	<0.01	<0.005	<0.01	<0.05	180	<0.01	<0.0002	0.02	<0.01
11/30/2000	280	3.7	1700	<0.5	<0.01	0.56	0.04	<0.01	<0.002	<0.01	<0.005	<0.01	<0.02	194	0.003	<0.0002	<0.01	0.01
3/5/2001	410	3.8	1900	ND	ND	0.087	0.063	ND	ND	ND	0.011	ND	ND		0.023	<0.0002	ND	0.028
6/4/2001	201	4.03	1630	ND	ND	0.087	0.063	ND	ND	ND	ND	ND	ND	218	ND	<0.0002	ND	ND

Table A-2: RO Discharge Water Quality Analytical Results

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

Sample Date	Chloride mg/L	Fluoride mg/L	Sulfate mg/L	Al aluminum mg/L	As arsenic mg/L	B boron mg/L	Ba barium mg/L	Be beryllium mg/L	Cd cadmium mg/L	Co cobalt mg/L	Cr chromium mg/L	Cu copper mg/L	Fe iron mg/L	Mg Magnesium mg/L	Mn manganese mg/L	Hg mercury mg/L	Mo molybdenum mg/L	Ni nickel mg/L
10/1/2001	61.2	4.1	1670		<0.050	0.0811	<0.100	<0.0025	<0.025	<0.025	<0.010	<0.0125	<0.050	194	<0.025	<0.0002	<0.050	<0.025
1/3/2002	337	3.78	1820	<0.100	<0.010	0.0722	<0.100	<0.0025	<0.005	<0.025	<0.010	<0.0125	<0.050	240	<0.025	<0.0002	<0.050	<0.025
3/11/2002	72.7	3.55	1410	<0.100	<0.050	0.0532	<0.100	<0.0025	<0.005	<0.025	<0.010	<0.0125	<0.050	192	<0.025	0.00027	<0.050	<0.025
7/9/2002	1090		934	0.347	0.142	0.285	<0.100	<0.0025	<0.005	<0.025	<0.010	<0.0125	4.08	31.7	0.124	<0.0002	<0.050	<0.025
12/10/2002																		
6/10/2003	45	3.29	1480	<0.100	<0.0100	0.097	0.085	<0.00250	<0.00500	<0.0200	<0.0100	<0.0250	0.091	176	<0.0250	<0.000200	<0.0500	<0.0250
9/29/2003	423	2.29	66.7	<0.0100	<0.00500	0.0826	0.0517	<0.00200	<0.00100	<0.00200	<0.00200	0.00463	1.98	127	<0.00500	<0.000200		0.0086
3/1/2004	301	2.92	1530															
6/1/2004	69.5	3.82	1710															
9/1/2004	44.1	3.16	1410															
1/16/2007	515	3.98	2160	<0.0100	<0.00500	<0.0200	0.0638	<0.00200	<0.00200	<0.00500	<0.00500	<0.00500	<0.200			<0.000200	<0.00500	<0.00500
2/22/2007	583	3.38	1920	<0.0100	0.00941	0.0643	0.0681	<0.00200	<0.00200	<0.00500	<0.00500	<0.00500	<0.200	246	<0.00500		0.00813	<0.00500
7/5/2007	328	2.91	1560	0.0168	<0.00500	0.0644	0.0553	<0.00200	<0.00200	<0.00500	<0.00500	<0.00500	<0.200	176	<0.005	<0.000200	0.00882	<0.00500
12/14/2007	464	3.46	1910	<0.0100	<0.00500	0.0752	0.0704	<0.00200	<0.00200	<0.00500	<0.00500	<0.00500	<0.200	208	<0.005	<0.000200	0.00952	<0.00500
2/7/2008	417	2.55	1540	<0.0100	<0.00500	0.0773	0.0564	<0.00200	<0.00200	<0.00500	<0.00500	<0.00500	<0.200	179	<0.00500	<0.000200	0.00639	<0.00500
5/22/2008	293	2.82	1530	<0.0100	<0.00500	0.0819	0.0602	<0.00200	<0.00200	<0.00500	<0.00500	<0.00500	<0.200	180	<0.005	<0.000200	0.0073	<0.00500
8/29/2008	241	3.98	1980	<0.0100	<0.00500	0.0896	0.0783	<0.00200	<0.00200	<0.00500	<0.00500	<0.00500	<0.200	247	<0.005	<0.000200	0.0108	<0.00500
12/4/2008	307	3.76	1810		<0.00500		0.0759		<0.00200		<0.00500					<0.000200		
2/23/2009	325	3.17	1740	<0.0100	<0.00500	0.0786	0.0611	<0.00200	<0.00200	<0.00500	<0.00500	<0.00500	<0.200	215	<0.005	<0.000200	0.00976	<0.00500
5/7/2009	392	2.83	1740	<0.0500	<0.0250	<0.100	0.074	<0.0100	<0.0100	<0.0250	<0.0250	<0.0250	<1.00	198	<0.0250	<0.000200	<0.0250	<0.0250
8/25/2009	461	3.62	1870		<0.00500		0.0751		<0.00200		<0.00500					<0.000200		
11/19/2009	525	3.92	2040		<0.00500		0.0816		<0.00200		<0.00500					<0.000200		
2/25/2010	355	3.1	1650		<0.00500		0.0644		<0.00200		<0.00500					<0.000200		
5/27/2010	180	2.66	1290		<0.00500		0.0529		<0.00200		<0.00500			144		<0.000200		
8/12/2010	357	3.95	2220		<0.00500		0.0819		<0.00400		<0.00500			186		<0.000200		
11/23/2010	344	3.46	1750		<0.0250		0.344		<0.0100		<0.0250					<0.000200		
2/23/2011	378	2.76	1480	<0.0100	<0.00500	0.0629	0.0583	<0.00200	<0.00200	<0.00500	<0.00500	<0.00500	<0.200	166	<0.005	<0.000200	0.00757	<0.00500
5/24/2011	167	3.59	1930	<0.0100	<0.00500	0.0675	0.0681	<0.00200	<0.00200	0.0229	<0.00500	0.0229	<0.200	171	<0.00500	<0.000200	0.0127	<0.00500
8/23/2011	55.3	3.32	1630	0.0226	<0.0100	0.0835	0.0633	<0.00200	<0.00400	<0.0100	<0.0100	<0.0100	<0.400	172	<0.0100	<0.000200	0.0103	<0.0100
11/16/2011	54.4	2.62	1150	<0.0100	0.0124	<0.0500	0.0445	<0.00200	<0.00200	<0.00500	<0.00500	<0.200	<0.200	136	<0.00500	<0.000200	0.00824	0.00563
2/28/2012	68.3	3.08	1180	<0.0100	0.00512	0.0834	0.0478	<0.00200	<0.00200	<0.00500	<0.00500	<0.00500	<0.200	150	<0.00500	<0.000200	0.00894	<0.00500
5/22/2012	246	3.17	1520	<0.0100	<0.00500	0.102	0.0757	<0.00200	<0.00200	<0.00500	<0.00500	<0.00500	<0.200	190	<0.00500	<0.000200	0.00884	0.00633
8/21/2012	182	3.04	1480	<0.0100	<0.00500	0.121	0.0608	<0.00200	<0.00200	<0.00500	<0.00500	0.0423	<0.200	176	<0.00500	<0.000200	0.008	<0.00500
11/15/2012	282	3.3	1930	<0.0100	<0.00500	0.134	0.0697		<0.00200	<0.00500	<0.00500	<0.00500	<0.200		<0.00500	<0.000200	0.00981	<0.00500
11/19/2012																		
2/3/2013	67.5	3.32	1690	0.00668	0.00494	0.143	0.0628		<0.00200	<0.00500	<0.00500	0.00177	<0.200		<0.00500	<0.000200	0.0125	0.00264
3/21/2013																		
5/16/2013																		
9/5/2013																		
11/20/2013	134	2.67	1240	0.0567	0.00125	0.109	0.0533		<0.00200	<0.00500	<0.00500	0.00218	0.113		0.0111		0.00815	0.00127
6/19/2014	36	2.3	1200		0.0036		0.054		<0.0010		<0.0010		<0.010					0.0016
11/6/2014	42	2.9	1400		<0.0010				<0.0010		<0.0010		<0.010		<0.0010			<0.0010

Table A-2: RO Discharge Water Quality Analytical Results
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

Sample Date	Pb lead mg/L	Se selenium mg/L	Ag silver mg/L	U uranium mg/L	V vanadium mg/L	Zn zinc mg/L	K Potassium mg/L	Ca Calcium mg/L	Na Sodium mg/L	NO3-N Nitrate mg/L	NH3-N AMMONIA mg/L	pH mg/L	Carbonate mg/L	Bicarbonate mg/L	Total Dissolved Solids mg/L
11/4/1992															
11/14/1992															
11/15/1992															
5/17/1993															
5/18/1993															
6/4/1993															
6/15/1993															
7/3/1993															
8/11/1993															
9/21/1993															
10/21/1993		ND	ND	ND	ND	0.05	4	515	143				0	389	
11/12/1993		<0.1	<0.01	1.3	<0.05	<0.05	4.6	511	156				0	311	
11/16/1993															
11/18/1993		<0.1	<0.01	<1.0	0.07	<0.05	4.5	605	318				0	347	
12/2/1993		<0.1	<0.01	<1.0	<0.05	<0.05	4.9	513	159				0	368	
12/17/1993	<0.05	<0.1	<0.01	<0.5	<0.1	<0.05	3.1	510	154				0	317	
1/12/1994	<0.05	<0.1	<0.01	<0.5	<0.05	<0.01	3	480	154	0.8	0.1	7.26	0	367	
1/26/1994															
2/16/1994															
2/28/1994															
3/10/1994															
3/30/1994															
4/8/1994	<0.1	<0.2	<0.01	<0.5	<0.05	<0.01	4.1	468	144	0.8	0.72	7.29	0	255	
4/21/1994	<0.1	<0.2	<0.01	<0.5	<0.05	<0.01	4.9	474	171				0	306	
5/6/1994	<0.1	<0.2	<0.01	<0.5	<0.05	0.01	3.2	42.7	13.9				0	285	
5/16/1994															
6/9/1994															
6/30/1994															
7/19/1994															
7/29/1994															
8/11/1994	<0.001	<0.001	<0.001	<0.5	<0.01	0.01	3.6	707	169.5				0	323	
8/30/1994	<0.001	<0.001	<0.001	<0.5	<0.05	0.07	3.6	523.1	132				0	346	
9/9/1994	<0.001	<0.001	0.012	<0.5	<0.05	0.05	3.7	523.2	146	0.83	0.08	7.1	0	322.8	
9/26/1994	<0.001	0.001	<0.001	<0.5	<0.05	0.01	4	490	130.9				0	311	
10/11/1994	<0.001	<0.001	<0.001	<0.5	<0.05	<0.01	3.5	532.5	116.1						
10/12/1994															
10/20/1994	<0.001	0.002	<0.001	<0.5	<0.05	0.02	3	545.5	155.3				0	311	
11/30/1994	<0.001	<0.001	<0.001	<0.5	<0.05	<0.01	3.2	542	135				0	323	
12/7/1994															
12/9/1994	<0.001	<0.001	<0.001	<0.1	<0.05	<0.01	3.6	550	144	0.64	0.64	7.8	0	280	
12/10/1994															
12/30/1994	<0.001	<0.001	<0.001	<0.5	<0.05	0.02	<0.1	182	129				0	323	
1/12/1995	<0.001	<0.001	<0.001	<0.5	<0.05	0.01	0.4	534	130				0	334	
1/26/1995	<0.001	0.005	<0.001	<0.5	<0.05	<0.01	3.3	589	171				0	231	
2/10/1995	0.004	<0.001	<0.001	<0.5	<0.05	<0.01	3.3	510	133				0	286	
2/22/1995	<0.001	<0.001	<0.001	<0.5	<0.05	<0.01	4	160	116				0	288	
3/10/1995	<0.001	0.001	<0.001	<0.5	<0.05	<0.01	1.8	207	62.7	0.1	0.1	7.9	0	310	
4/10/1995	<0.001	<0.001	<0.001	<0.5	<0.05	<0.01	4	547.29	65.1				0	187	
4/21/1995	<0.001	<0.001	<0.001	<0.5	<0.05	<0.05	3.1	520.17	80.4				0	177	
5/1/1995	<0.001	0.002	<0.001	<0.5	<0.05	<0.05	3.3	503.54	103.1				0	182	

Table A-2: RO Discharge Water Quality Analytical Results

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

Sample Date	Pb lead mg/L	Se selenium mg/L	Ag silver mg/L	U uranium mg/L	V vanadium mg/L	Zn zinc mg/L	K Potassium mg/L	Ca Calcium mg/L	Na Sodium mg/L	NO3-N Nitrate mg/L	NH3-N AMMONIA mg/L	pH mg/L	Carbonate mg/L	Bicarbonate mg/L	Total Dissolved Solids mg/L
5/22/1995	<0.001	0.002	<0.001	<0.5	<0.05	<0.01	0.3	549	107.4				0	317	
6/5/1995	<0.001	0.001	<0.001	<0.5	<0.05	<0.01	4	532	103				0	323	
7/6/1995															
7/24/1995															
8/9/1995															
8/31/1995															
9/7/1995															
9/26/1995															
10/12/1995	<0.001	<0.001	<0.001	<0.5	<0.05	<0.02	3.4	510	110				0	332	
10/26/1995	<0.001	<0.001	<0.0001	<0.5	<0.05	<0.02	2.1	552	116				0	290	
11/9/1995	<0.001	<0.001	0.014	<0.5	<0.05	0.04	5.6	272.1	90.5				0	324	
11/22/1995	<0.001	<0.001	<0.0001	<0.5	<0.05	<0.02	3.1	257	115				0	369	
12/5/1995	<0.001	<0.005	0.0013	<0.5	0.05	<0.02	26.3	650	127	<0.01	36.4	6.9	0	320	
1/8/1996	<0.001	<0.005	<0.0005	<0.5	<0.05	<0.02	<1.0	260	106				0	229	
1/18/1996	<0.001	0.005	0.002	<0.5	<0.05	<0.02	3	485	94				0	285	
1/30/1996	0.003	<0.005	<0.0001	<0.5	<0.05	0.13	3.5	444.3	87.6				0	264	
2/14/1996	<0.001	<0.005	<0.0002	<0.5	<0.05	<0.02	3.5	544	94						
2/28/1996	<0.001	0.006	<0.0001	<0.5	0.13	0.03	3.3	492	51.2				0	288	
3/22/1996										0.83	0.9	6.8	0	193	
4/23/1996	<0.001	<0.005	<0.001	<0.5	0.14	0.06	13	836	122				0	110	
4/30/1996	0.001	<0.005	<0.001	<0.5	0.13	0.26	3.4	245	72.9				0	120	
5/10/1996	<0.001	<0.001	0.0003	<0.5	0.13	0.13	6.1	1200	188				234	234	
5/31/1996	<0.001	0.005	<0.0002	<0.5	<0.05	0.04	4.6	489	122				0	230	
6/13/1996	<0.001	0.006	0.0003	<0.5	<0.05	0.03	3.7	546	123				0	248	
6/28/1996	<0.001	0.029	<0.001	<0.5	<0.01	<0.02	3.5	283	115	0.3	<0.50	7	0	238	
7/12/1996	<0.001	0.071	<0.0002	<0.5	<0.05	0.02	3.5	501	72.1				0	292	
7/26/1996	<0.001	<0.005	<0.0002	<0.5	<0.05	<0.02	3.2	417	47.8				0	38	
7/31/1996															
8/16/1996	<0.001	<0.005	<0.0002	<1.0	<0.05	<0.05	3.2	510	66.7				0	300	
8/23/1996	<0.001	<0.005	<0.0002	<1.0	<0.05	0.12	3.7	485	70				0	284	
9/17/1996	<0.001	<0.005	<0.001	<0.5	<0.05	<0.02	3.3	518	44.3	0.7	<0.5	7.6	0	553	
9/30/1996	<0.001	<0.005	<0.001	<0.80	<0.10	0.09	4.4	550	96.8				0	504	
3/4/1997	<0.005	<0.005	0.006	<0.50	<0.05	<0.05	3.8	620	130				<1.00	310	
6/4/1997	0.011	0.021	0.11	<1.0	<0.05	<0.02	115	580	170				<1.0	<1.0	
9/15/1997	<0.005	<0.010	0.03	<1.0	<0.05	<0.02	5	670	80				<1.0	540	
12/8/1997	<0.01	<0.01	<0.005	<0.10	<0.05	<0.02	5.3	850	200	<6.0	<5		<1.00	410	
3/5/1998	<0.005	<0.01	<0.002	<0.10	<0.02	<0.02	7.1	850	275				<1.0	590	
5/11/1998							6.8	740	110				<1.0	680	
5/14/1998															
6/9/1998	<0.01	<0.005	<0.01	<0.50	<0.10	<0.50	5.5	210	17				<1.00	190	
9/2/1998	<0.01	0.01	<0.01	<1.0	0.03	<0.50	8.6	810	140				<1.0	620	
12/8/1998	0.01	<0.01	<0.005	<5.0	<0.10	<0.10	5.1	697	223	4.6	<2.0	7.4	<1.0	540	
3/5/1999	<0.005	<0.01	<0.001	<5.0	<0.10	<0.10	10	776	158				0	609	
9/16/1999	<.005	0.02	<0.001	<0.10	<0.10	<0.10	5.8	733	110				<1.0	620	
1/13/2000	<0.05	<0.05	0.01	<1.0	<0.10	<0.10					<2.0	7.2	<1.0	516	
5/31/2000	<0.01	<0.01	<0.005	<0.10	<0.01	<0.10	5.2	739	85	3.6					
8/29/2000	<0.01	<0.01	<0.005	<0.10	0.01	<0.01	7.4	577	151	1.6			<1.0	548	
11/30/2000	<0.01	<0.01	<0.01	<0.5	0.02	<0.1	6.63	618	156	2.1	<2.0	7.7	<1.0	522	
3/5/2001	ND	0.0077	ND	ND	ND	ND				2.2			<1.0	584	
6/4/2001	ND	ND	ND	ND	ND	ND	6.98	756	134	2.47			<1.0	618	

Table A-2: RO Discharge Water Quality Analytical Results

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

Sample Date	Pb lead mg/L	Se selenium mg/L	Ag silver mg/L	U uranium mg/L	V vanadium mg/L	Zn zinc mg/L	K Potassium mg/L	Ca Calcium mg/L	Na Sodium mg/L	NO3-N Nitrate mg/L	NH3-N AMMONIA mg/L	pH mg/L	Carbonate mg/L	Bicarbonate mg/L	Total Dissolved Solids mg/L
10/1/2001	<0.010	<0.050	<0.0125	<0.050	<0.025	<0.025	5.62	697	56.8	2.84		7.9	<1.0	670	
1/3/2002	<0.010	<0.050	<0.0125	<0.050	<0.025	<0.025	8.29	720	225	2.4	<2.0	7.7	<1.0	666	
3/11/2002	<0.010	<0.050	<0.0125	<0.050	<0.025	<0.025	6.13	533	64.6				<1.0	568	
7/9/2002	<0.010	0.422	<0.0125	<0.020	<0.025	0.316	19.3	170	691	<0.2		7.57	<1.0	90	
12/10/2002															
6/10/2003	0.483	<0.0100	<0.0125	0.02	<0.0250	<0.0250	4.59	555	53.3	2.44			<1.00	602	
9/29/2003	<0.00500	<0.00500	<0.00500	0.003	0.00802	<0.00500	3.68	492	99.3				<5.00	460	
3/1/2004															
6/1/2004															
9/1/2004															
1/16/2007	<0.00500	<0.00500	<0.00500		<0.00500	<0.00500							<5.00	669	
2/22/2007	<0.00500	0.00761	<0.00500		0.0102	0.00734	4.49	735	320	1.56	0.067	7.79	<5.00	638	
7/5/2007	<0.00500	0.00763	<0.00500		0.00974	0.00749	3.47	600	167	1.86	0.243	7.75	<5.00	520	
12/14/2007	<0.00500	0.00793	<0.00500		0.0104	0.00677	4.32	594	218	0.58	0.031	7.63	<5.00	982	
2/7/2008	<0.00500	0.0058	<0.00500		0.00771	<0.00500	3.34	548	206	0.928	0.05	7.7	<5.00	575	
5/22/2008	<0.00500	0.00877	<0.00500		0.0116	0.00694	3.73	562	167				<5.00	296	
8/29/2008	<0.00500	0.00658	<0.00500		0.0106	0.00657	4.68	786	152				<5.00	869	
12/4/2008	<0.00500	0.00942	<0.00500										<5.00	819	
2/23/2009	<0.00500	0.00893	<0.00500		0.0107	<0.00500	4.14	698	192				<5.00	691	
5/7/2009	<0.0250	<0.0250	<0.0250		<0.0250	<0.0250	4	596	224				<5.00	664	
8/25/2009	<0.00500	0.0082	<0.00500										<5.00	729	
11/19/2009	<0.00500	0.00702	<0.00500										<5.00	787	
2/25/2010	<0.00500	0.00668	<0.00500										<5.00	613	
5/27/2010	<0.00500	0.00627	<0.00500				3.22	602	115				<5.00	557	
8/12/2010	<0.0100	0.0106	<0.00500				4.72	651	164				<5.00	920	
11/23/2010	<0.0250	0.0347	<0.0250										<5.00	822	
2/23/2011	<0.00500	0.00551	<0.00500		0.00869	<0.00500	3.51	620	163				<5.00	697	
5/24/2011	<0.00500	0.012	<0.00500		0.0114	0.0167	3.93	622	108				<5.00	848	
8/23/2011	<0.0100	<0.0100	<0.00500		0.0103	<0.0100	3.59	604	49.8				<5.00	773	
11/16/2011	<0.00500	<0.00500	<0.00500		<0.00500	0.0102	3.03	520	40				<5.00	623	
2/28/2012	<0.00500	0.0053	<0.00500		0.00937	0.00861	3.2	480	55.7				<5.00	606	
5/22/2012	<0.00500	0.00806	<0.00500		0.0116	0.0181	4.03	640	145				<5.00	735	
8/21/2012	<0.00500	0.00834	<0.00500		0.00875	0.0559	3.28	582	102				<5.00	651	
11/15/2012	<0.00500	0.00622	<0.00500	0.00531		0.011				<0.100		7.53			3850
11/19/2012															
2/3/2013	<0.00500	0.013	<0.00500	0.00601		0.0132	4.41	625	65.4	3.22					3150
3/21/2013															3300
5/16/2013															2410
9/5/2013															2290
11/20/2013	<0.00500	0.00481	<0.00500	<0.00500		0.00909	3.04	459	83.9	1.06		7.54			2770
6/19/2014	<0.0010	<0.010			0.0075							7.92			2460
11/6/2014	<0.0010	0.0056			0.0087							8.01			2460

Blank cells indicate that analyte was not analyzed for that sample, or the data was not available.
ND = analyte not detected, detection limit not available
< X = analyte not detected with detection limit of X

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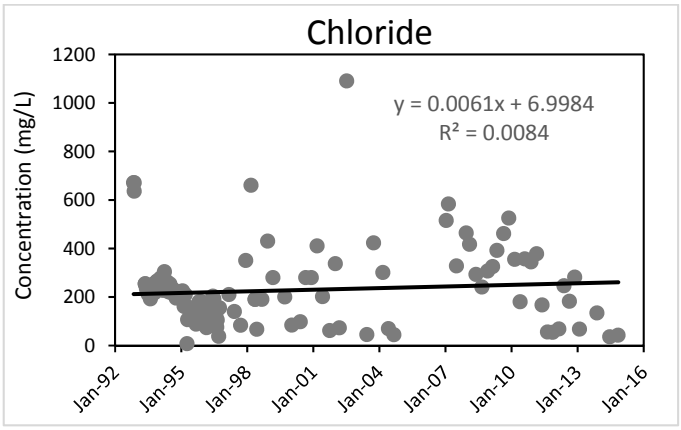
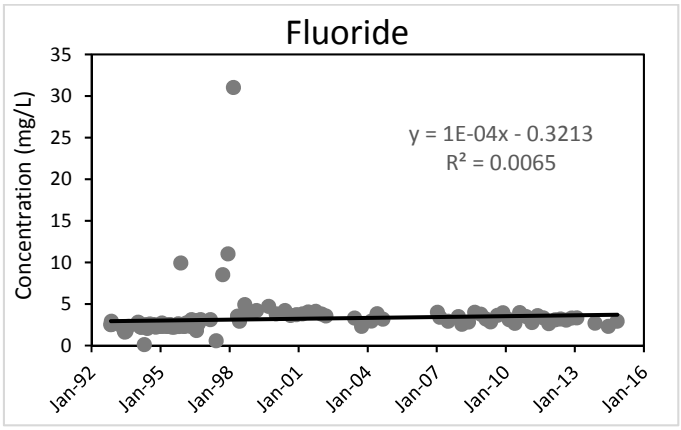
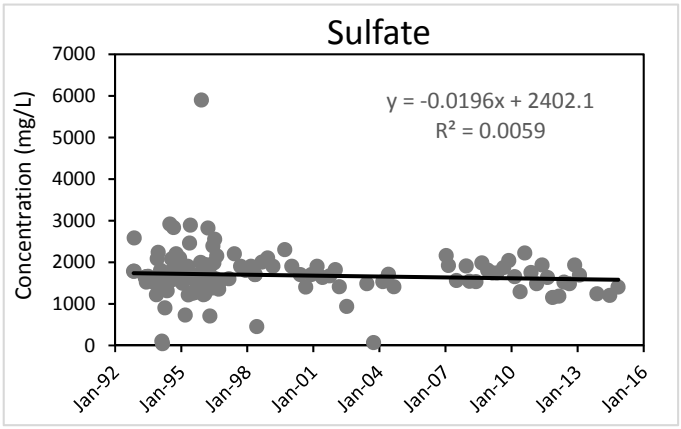
Appendix B

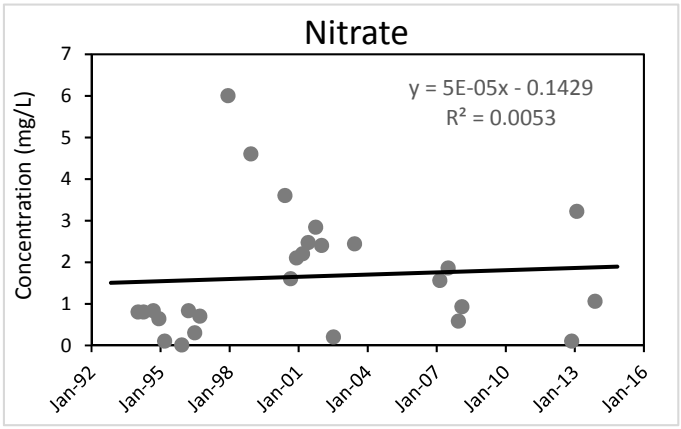
RO Discharge Water Quality Data
Trend Analysis

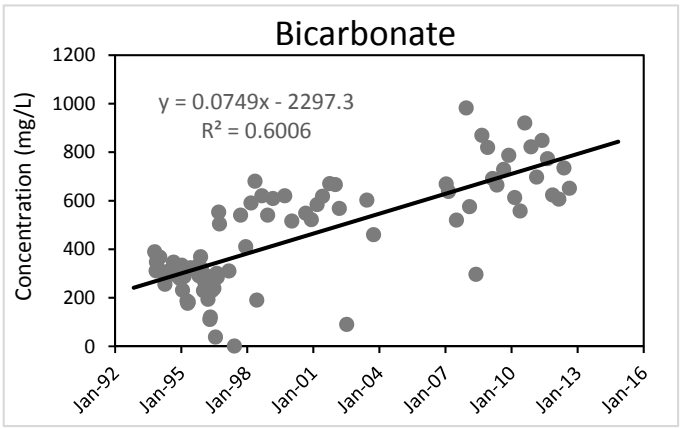
Appendix B: RO Discharge Water Quality Data Trend Analysis

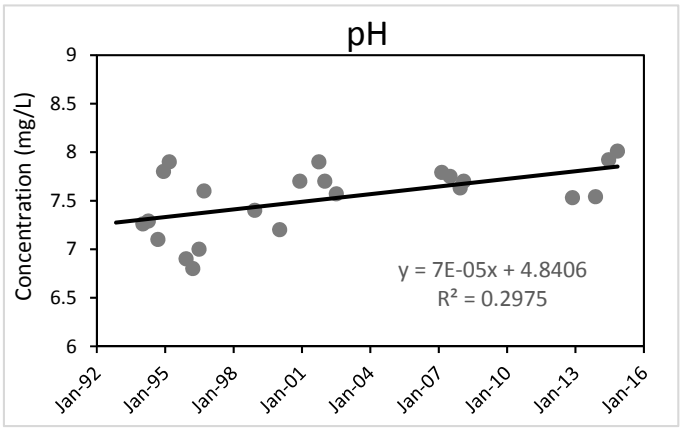


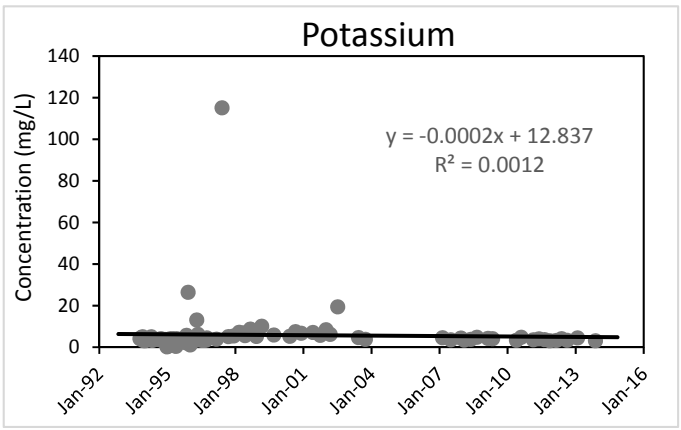


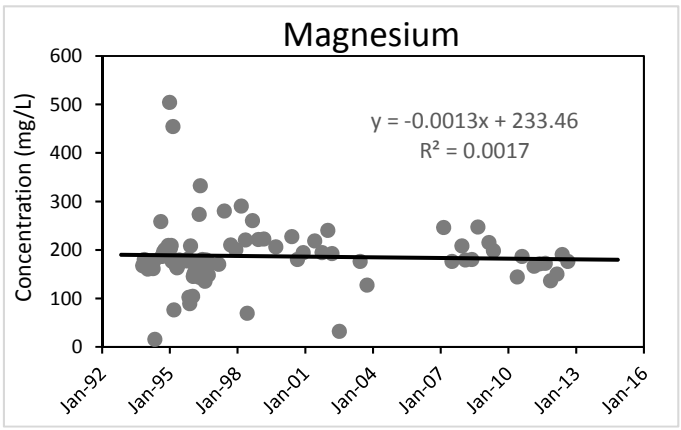




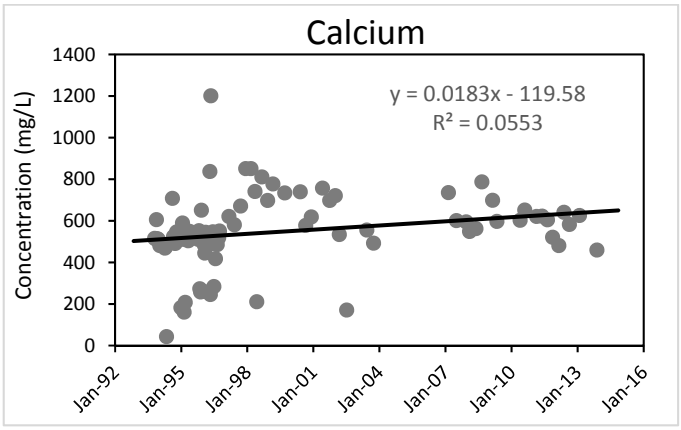


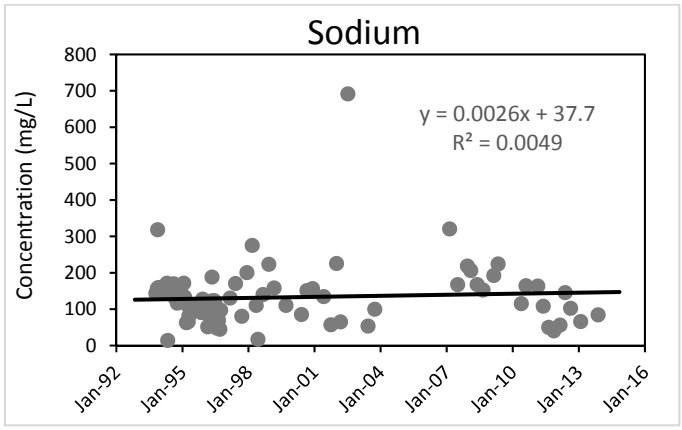


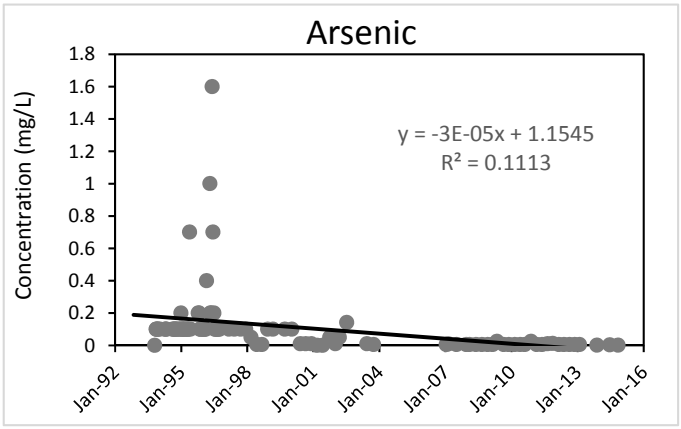


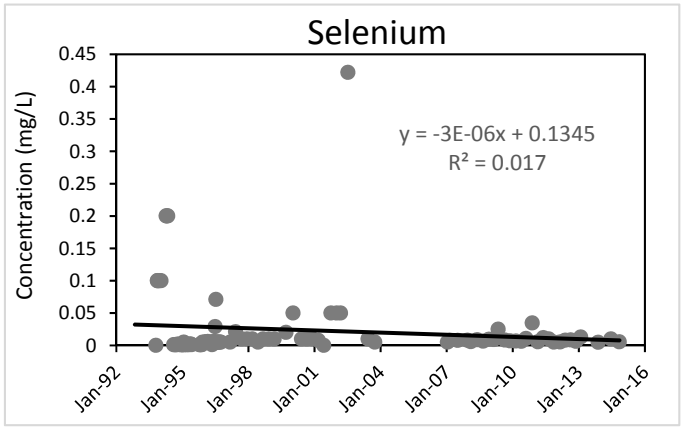


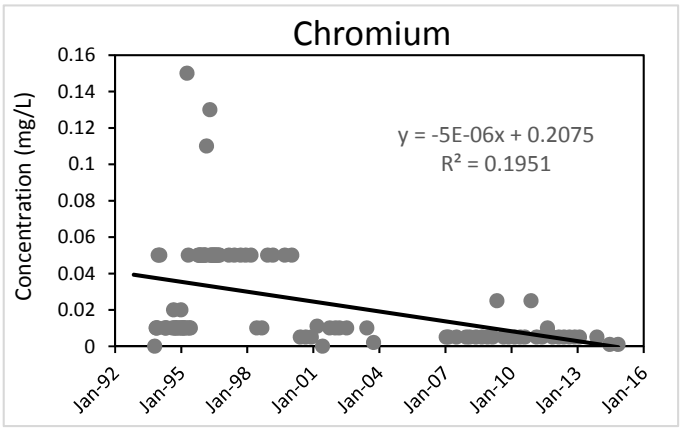
Appendix B: RO Discharge Water Quality Data Trend Analysis

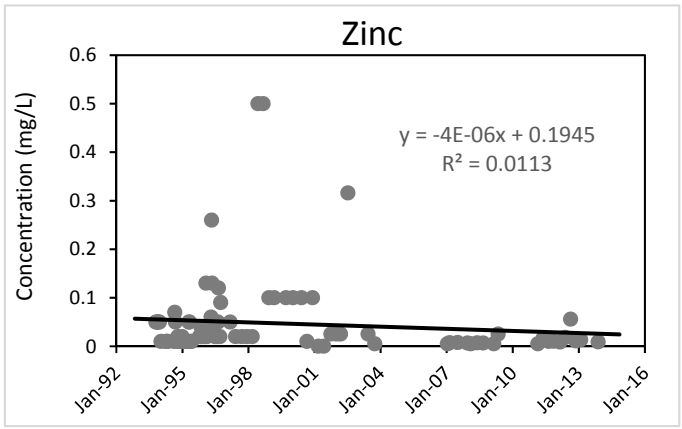


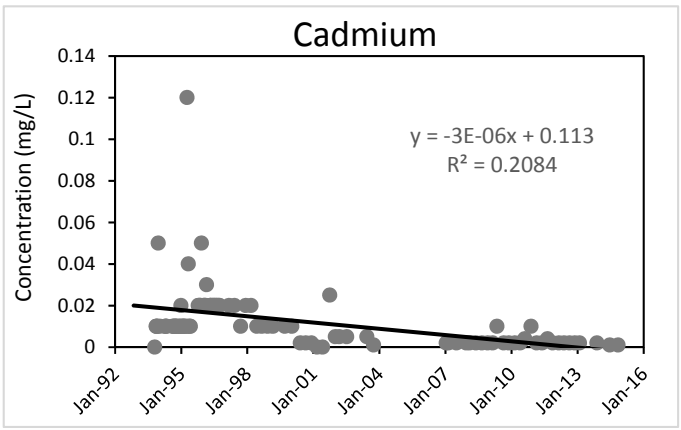


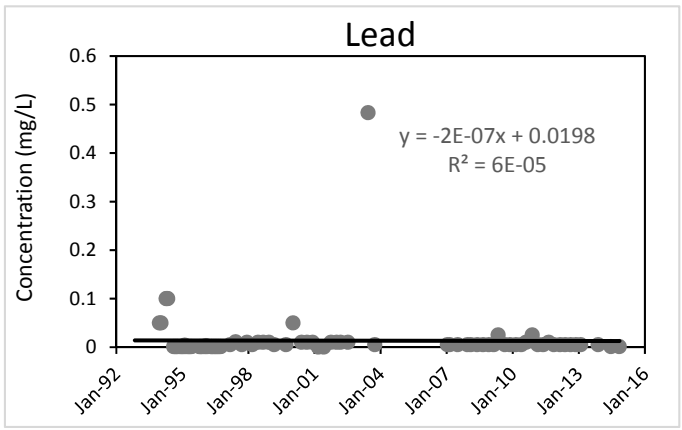




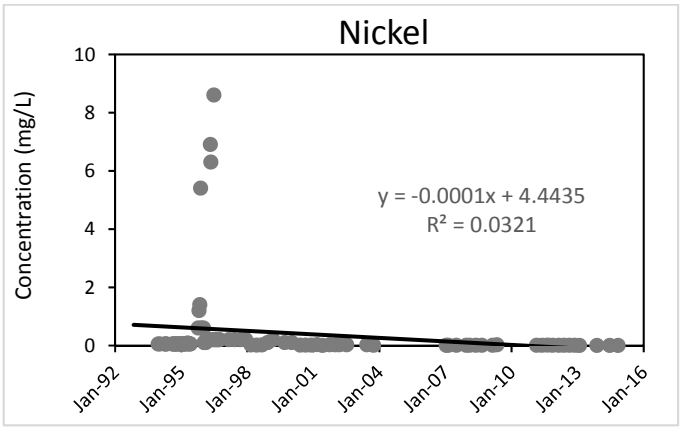


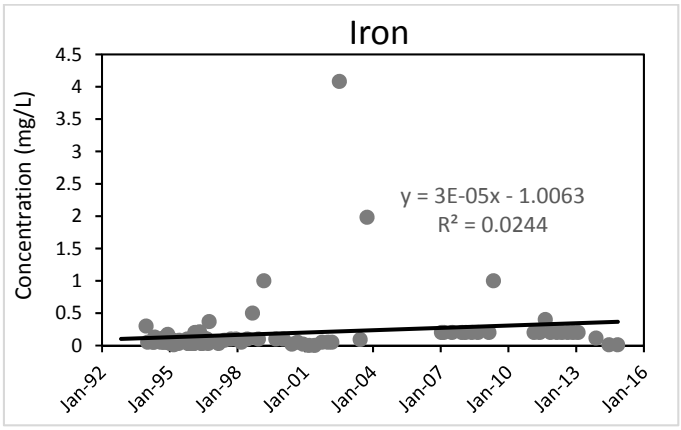


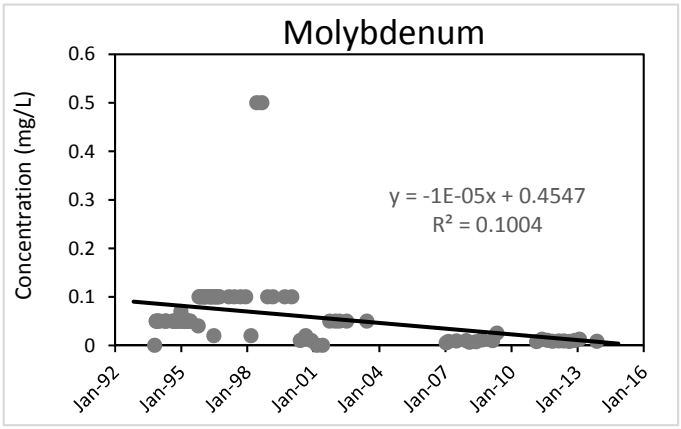


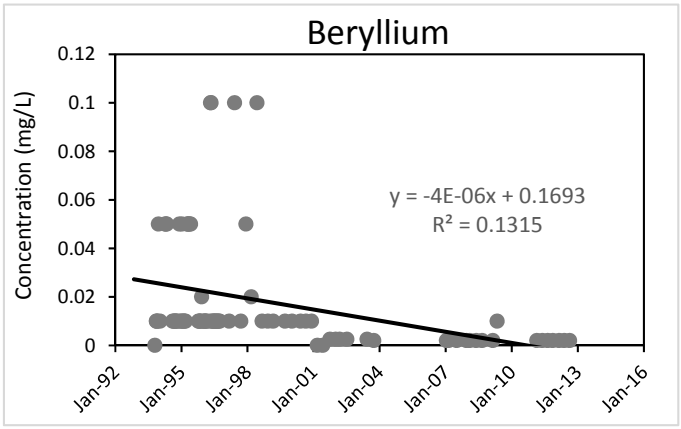


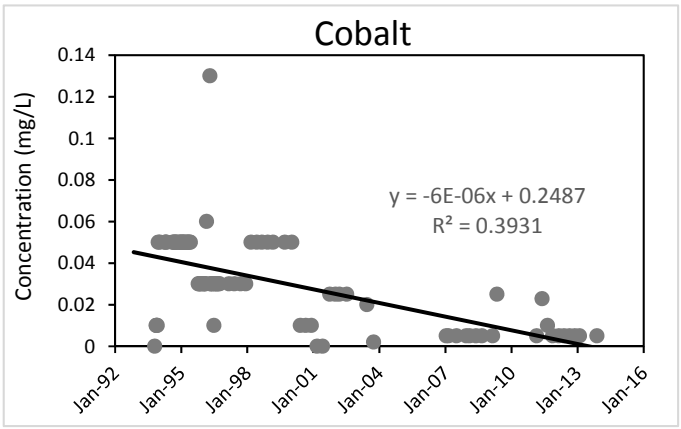
Appendix B: RO Discharge Water Quality Data Trend Analysis

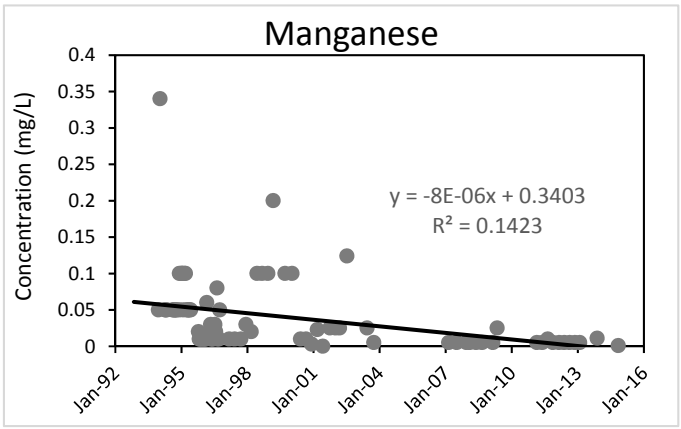


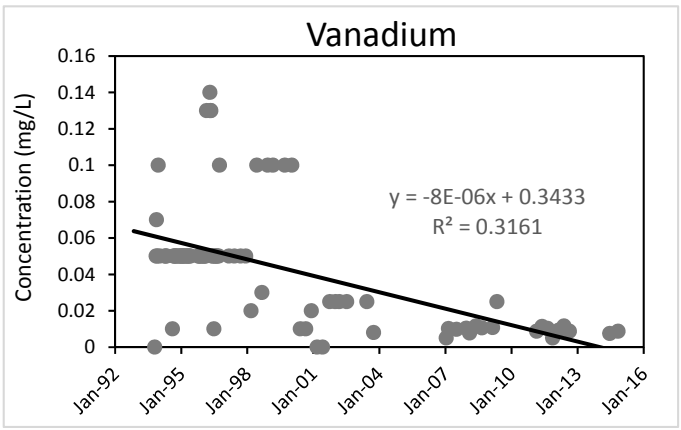


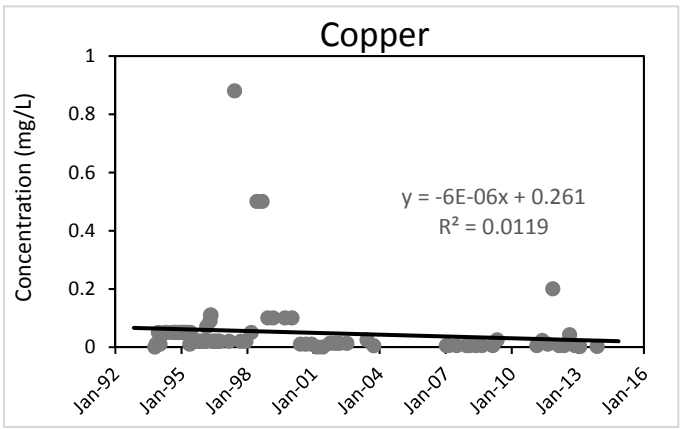




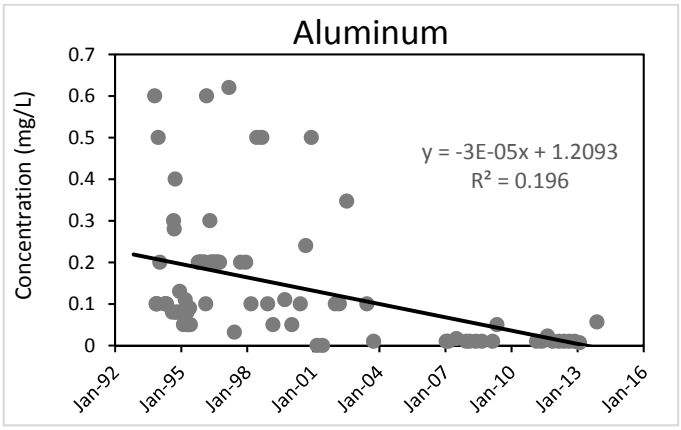


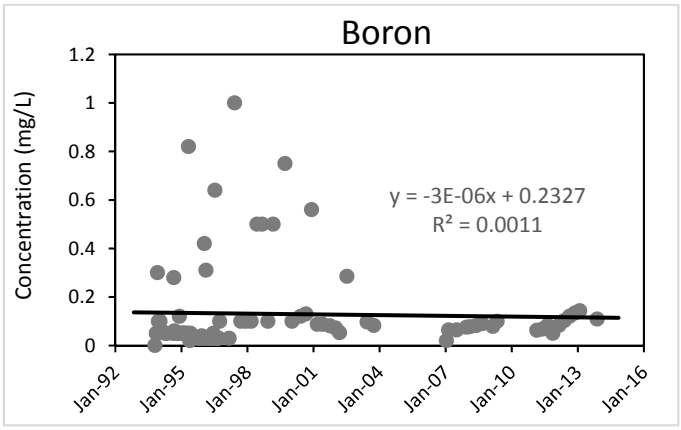


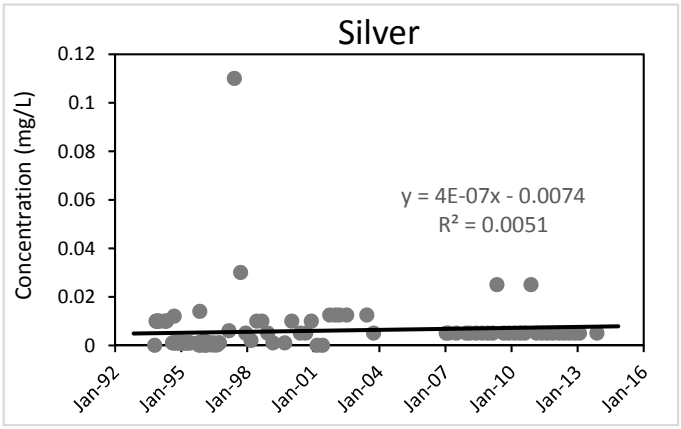


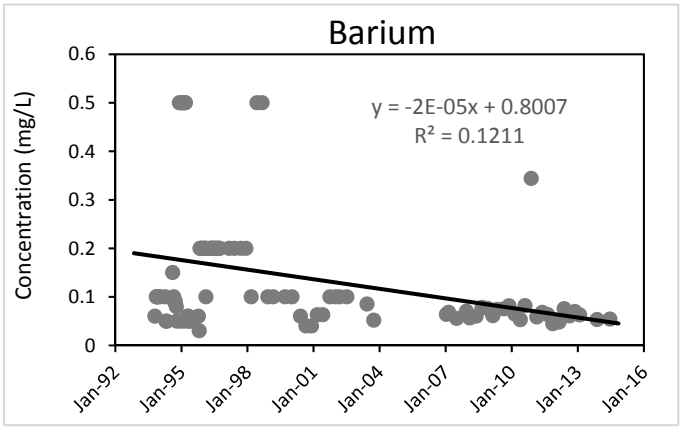


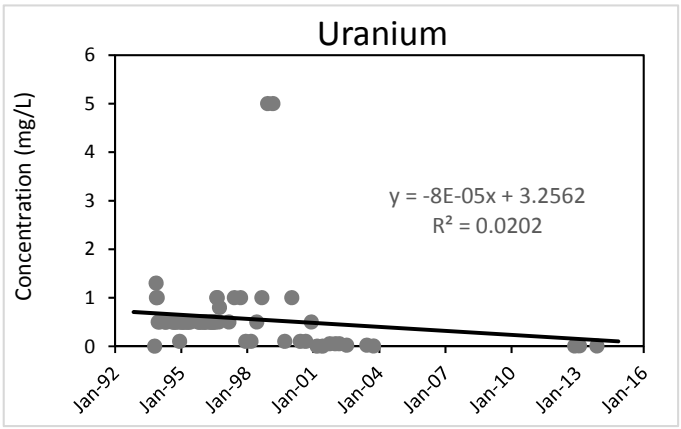
Appendix B: RO Discharge Water Quality Data Trend Analysis

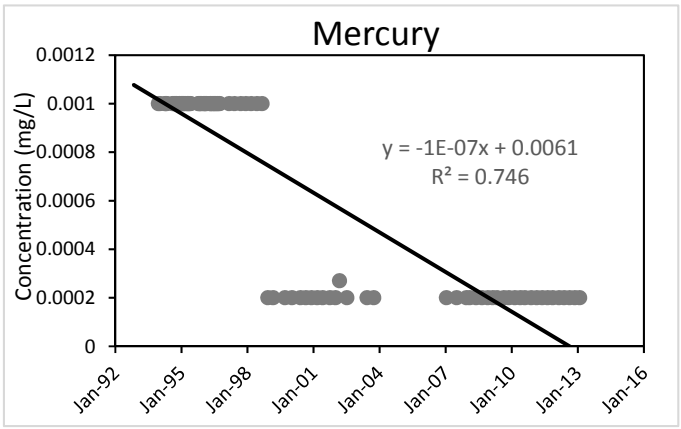












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Appendix C

Groundwater Monitoring Well
Water Quality

		Analyte:		Calcium	Chloride	Fluoride (F-, Anion)	Nitrate/Nitrite	Potassium	Sodium	Sulfate	Total Dissolved Solids
		Units:		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
		CGWSL:		---	250	1.6	10	---	---	600	1000
		CGWSL Source:			WQCC Dom	WQCC HH	USEPA MCL			WQCC Dom	WQCC Dom
Location Name	**Location**	**Date**	**Dup**								
N RO Reject Field	MW-117	2/3/2013		568	154	2.73		6.92	176	2310	3910
	MW-117	5/15/2013		524	137	2.29	0.03	4.37	160	2010	4260
	MW-117	9/4/2013		550	71	2.8		8.92	118	2020	3970
	MW-117	11/20/2013		556	92.4	3.95	0.03	7.54	115	2190	4150
	MW-117	4/30/2014		646	97	3.03	0.15	9.29	167	2140	4980
	MW-117	11/13/2014	FD	640	96	2.4	0.64	5	98	2200	3300
	MW-117	11/13/2014		610	96	3	0.65	5.2	110	2000	3000
	MW-118	2/5/2013		563	296	5.16		7.95	218	2450	4610
	MW-118	5/15/2013		530	287	5.39	2.09	7.2	229	2250	5090
	MW-118	9/4/2013		543	132	4.48		7.69	215	2310	4550
N RO Reject Field	MW-118	11/20/2013		532	90.1	6.78	0.03	6.92	163	2470	4640
	MW-118	4/30/2014		732	92.3	5.58	0.15	6.15	134	2190	5200
	MW-118	11/13/2014		670	160	4.9	0.98	6.2	140	2700	3700
	MW-119	2/5/2013		494	116	2.36		0.87	127	2090	3670
	MW-119	5/15/2013		491	118	2.43	1.91	0.794	120	1970	4030
	MW-119	9/4/2013		635	244	2.28		0.993	133	1940	4030
	MW-119	11/20/2013		551	185	3.17	0.03	1.1	98.8	2210	4130
	MW-119	4/30/2014	FD	655	216	2.62	0.174	1.08	136	1830	4140
	MW-119	4/30/2014	FD								
	MW-119	4/30/2014		680	235	2.61	0.176	1.13	140	1980	4200
	MW-119	11/13/2014		670	49	2.6	0.02	1.8	77	2300	3200
NCL	Background: MW-18	4/12/2012		319	213	1.14	15.3	1.21	80.9	1010	2490
	Background: MW-18	10/8/2012		498	96.7	2.06	32.6	10.1	72	1710	3410
	Background: MW-18	4/11/2013	FD	480	141	1.11	32.5	2.85	97.1	1640	3440
	Background: MW-18	4/11/2013		494	143	1.13	32.5	2.86	97.3	1590	3110
	Background: MW-18	10/18/2013		456	114	2.26	21.3	13.3	64.7	1450	3260
	Background: MW-18	4/17/2014		507	159	0.954	35.2	2.89	83.2	1830	3700
	Background: MW-54A	4/16/2012		354	195	1.07	1	0.247	70.6	545	1850
	Background: MW-54A	10/2/2012		397	262	1.58	11	0.53	84.3	857	2210
	Background: MW-54A	4/5/2013		347	212	0.947	1	0.302	66.5	621	1950
	Background: MW-54A	10/22/2013		355	224	1.27	1.66	0.393	74.9	657	2060
	Background: MW-54A	4/17/2014		354	211	0.6	0.15	0.275	69.2	666	1800
	Background: MW-54A	11/13/2014		370	190	1.2	0.85	0.38	74	680	1900
	Background: MW-54B	4/5/2013		345	176	0.500	1	1.16	48.8	747	2050
	Background: MW-55	4/12/2012		441	359	1.72	9.31	1.03	237	2550	5000
	Background: MW-55	10/10/2012	FD	498	216	2.26	8.15	1.48	165	2560	4540
	Background: MW-55	10/10/2012		510	225	2.27	6.94	1.48	163	2470	4270
	Background: MW-55	4/11/2013		596	337	1.37	7.65	1.08	235	2460	4620
	Background: MW-55	10/25/2013		519	327	1.6	5.25	0.835	214	2280	4450
	Background: MW-55	4/17/2014	FD	573	445	1.1	9.43	0.882	231	2600	5360
	Background: MW-55	4/17/2014		560	357	1.14	9.61	0.926	233	2670	5100
	Background: MW-55	11/13/2014		610	190	2.4	6.5	0.9	130	2300	3600
NCL	Background: NCL-33	4/12/2012		298	368	2.39	1	3.76	81.2	534	2070
	Background: NCL-33	10/8/2012		350	349	2.29	1	3.81	110	459	1920
	Background: NCL-33	4/11/2013		343	321	1.85	1	3.65	111	401	2010

				Analyte:	Calcium	Chloride	Fluoride (F-, Anion)	Nitrate/Nitrite	Potassium	Sodium	Sulfate	Total Dissolved Solids
				Units:	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
				CGWSL:	---	250	1.6	10	---	---	600	1000
				CGWSL Source:		WQCC Dom	WQCC HH	USEPA MCL			WQCC Dom	WQCC Dom
Location Name	Location	Date	Dup									
	Background: NCL-33	10/18/2013			303	340	2.52	0.5	3.7	98.2	448	1820
	Background: NCL-33	4/17/2014			358	302	1.83	0.15	3.78	105	557	1920
	Background: NCL-33	11/12/2014			450	340	2.6	0.02	5	110	720	2100
	Background: NCL-44	4/11/2012			208	160	1.82	1	1.68	48.6	441	1560
	Background: NCL-44	10/8/2012			262	157	1.72	1	2.37	66	432	1620
	Background: NCL-44	4/11/2013			283	153	1.42	1	2.43	65.1	471	1780
	Background: NCL-44	10/18/2013			250	146	1.7	0.5	2.09	64.6	399	1810
	Background: NCL-44	4/17/2014			265	149	1.2	0.15	2.06	66	454	1720
	Background: NCL-44	11/12/2014			290	850	1.8	0.02	2.2	70	450	1500
	Background: NCL-49	4/16/2012			415	119	0.665	5.6	0.614	121	1420	2800
	Background: NCL-49	10/2/2012	FD		454	127	0.679	6.08	0.823	123	1790	3000
	Background: NCL-49	10/2/2012			450	118	0.683	5.59	0.834	121	1750	2970
	Background: NCL-49	4/9/2013			397	117	0.553	5.16	0.737	126	1580	3190
	Background: NCL-49	10/22/2013			450	106	0.622	4.65	0.699	130	1490	2940
	Background: NCL-49	4/17/2014			430	104	0.501	5.21	0.625	116	1680	3000
	Background: NCL-49	11/13/2014			440	98	0.65	4.3	0.72	120	1500	2600
	Background: NCL-49	11/13/2014	FD		430	98	0.59	4.5	0.75	120	1700	2600
S RO Reject Field	MW-114	2/3/2013			600	158	1.76		2.86	146	2200	3760
	MW-114	5/15/2013			576	150	1.91	0.03	2.76	123	1800	3990
	MW-114	9/5/2013			672	199	1.82		2.94	138	1950	3870
	MW-114	11/21/2013			558	422	1.37	0.03	0.678	250	3060	5390
	MW-114	4/29/2014			611	167	2.07	0.15	2.84	152	1920	3620
	MW-114	11/12/2014			620	200	2.2	0.36	2.7	130	2300	3400
	MW-115	2/3/2013			518	422	1.1		1.78	199	2790	4960
	MW-115	5/15/2013	FD		495	364	1.15	0.03	0.766	201	2420	4990
	MW-115	5/15/2013			511	373	1.18	0.03	0.78	206	2490	5510
	MW-115	9/4/2013			622	530	0.845		0.782	247	2900	6130
	MW-115	11/21/2013			606	428	1.36	0.03	0.709	261	3090	5370
	MW-115	4/29/2014			569	222	1.29	0.15	0.645	227	2470	4880
	MW-115	11/12/2014			690	500	1.5	0.02	0.72	340	3000	5700
	MW-116	2/3/2013			624	389	1.31		1.06	206	2250	3650
	MW-116	5/16/2013			578	330	1.19	0.03	1.38	194	2080	4480
S RO Reject Field	MW-116	9/4/2013	FD		631	339	1.11		1.22	230	2140	4470
	MW-116	9/4/2013			588	344	1.17		1.21	235	2180	4440
	MW-116	11/20/2013	FD		616	331	1.51	0.487	1.37	235	2470	4210
	MW-116	11/20/2013			606	331	1.61	0.457	1.3	235	2470	4570
	MW-116	4/29/2014			607	221	1.43	2.86	1.39	241	2160	4520
	MW-116	11/12/2014			580	240	1.7	0.74	1.6	230	2200	3700

Analyte:				Calcium	Chloride	Fluoride (F-, Anion)	Nitrate/Nitrite	Potassium	Sodium	Sulfate	Total Dissolved Solids
Units:				mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
CGWSL:				---	250	1.6	10	---	---	600	1000
CGWSL Source:					WQCC Dom	WQCC HH	USEPA MCL			WQCC Dom	WQCC Dom
Location Name	**Location**	**Date**	**Dup**								

red text = reporting limit/detection limit

green text = J flag

duplicate row not used in stats

= Exceedance of CGWSL

Max				732	850	6.78	35.20	19.00	391	3090	6130
Min				175	49	0.50	0.02	0.25	49	100	1200
Ave				482	238	1.95	3.58	2.78	153	1700	3484

		Analyte:		Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver
		cas_rn		7440-38-2	7440-39-3	7440-43-9	7440-47-3	7440-50-8	7439-89-6	7439-92-1	7439-96-5	7439-97-6	7440-02-0	7782-49-2	7440-22-4
		Units:		mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
		CGWSL:		0.01	1	0.005	0.05	1	1	0.015	0.2	0.002	0.2	0.05	0.05
		CGWSL Source:		USEPA MCL	WQCC HH	USEPA MCL	WQCC HH	WQCC Dom	WQCC Dom	USEPA MCL	WQCC Dom	WQCC HH	WQCC Irr	USEPA MCL	WQCC HH
Location Name	**Location**	**Date**	**Dup**												
N RO Reject Field	MW-117	2/3/2013		0.00498	**0.0235**	**0.0008**	**0.0012**	**0.0141**	**0.078**	**0.0007**	**0.108**	**0.000042**	**0.00413**	0.00427	**0.0008**
	MW-117	5/15/2013		0.00367	**0.0113**	**0.0008**	**0.001**	**0.001**	**0.078**	**0.0007**	**0.00978**	**0.000042**	**0.001**	0.00585	**0.0008**
	MW-117	9/4/2013		**0.00559**	**0.0108**	**0.0008**	**0.001**	**0.001**	**0.078**	**0.0007**	**0.00502**	**0.000042**	**0.00189**	0.00316	**0.0008**
	MW-117	11/20/2013		0.00347	**0.0108**	**0.0008**	**0.001**	**0.00345**	**0.11**	**0.00125**	**0.00982**	**0.000042**	**0.00305**	0.0038	**0.0008**
	MW-117	4/30/2014		0.00328	**0.0009**		**0.001**		**0.078**	**0.0007**	**0.0204**			0.00425	
	MW-118	2/5/2013		**0.011**	**0.0145**	**0.0008**	**0.0012**	**0.00156**	**0.078**	**0.0007**	**0.0232**	**0.000042**	**0.00173**	**0.00861**	**0.0008**
	MW-118	5/15/2013		**0.0146**	**0.00919**	**0.0008**	**0.001**	**0.00156**	**0.078**	**0.0007**	**0.0025**	**0.000042**	**0.00184**	**0.0127**	**0.0008**
	MW-118	9/4/2013		**0.0156**	**0.0099**	**0.0008**	**0.001**	**0.001**	**0.078**	**0.0007**	**0.0025**	**0.000042**	**0.00131**	**0.0129**	**0.0008**
	MW-118	11/20/2013		**0.0125**	**0.00964**	**0.0008**	**0.00105**	**0.00338**	**0.179**	**0.00107**	**0.00526**	**0.000042**	**0.00214**	0.00327	**0.0008**
	MW-118	4/30/2014		**0.00974**	**0.0009**		**0.001**		**0.078**	**0.0007**	**0.0121**			0.00108	
	MW-119	2/5/2013		0.00294	**0.00981**	**0.0008**	**0.0012**	**0.00309**	**0.078**	**0.0007**	**0.0424**	**0.000042**	**0.00174**	0.00246	**0.0008**
	MW-119	5/15/2013		**0.00537**	**0.00625**	**0.0008**	**0.001**	**0.00137**	**0.078**	**0.0007**	**0.0025**	**0.000042**	**0.00163**	**0.00506**	**0.0008**
	MW-119	9/4/2013		**0.00595**	**0.00864**	**0.0008**	**0.001**	**0.001**	**0.078**	**0.0007**	**0.0025**	**0.000042**	**0.0014**	**0.0066**	**0.0008**
	MW-119	11/20/2013		0.00438	**0.00973**	**0.0008**	**0.00116**	**0.00311**	**0.185**	**0.0007**	**0.00459**		**0.00222**	0.00144	**0.0008**
	MW-119	4/30/2014	FD	0.00461	**0.0009**		**0.001**		**0.078**	**0.0007**	**0.0025**			0.00402	
	MW-119	4/30/2014		0.00468	**0.0009**		**0.001**		**0.078**	**0.0007**	**0.0025**			0.00393	
NCL	Background: MW-18	4/12/2012		0.005	**0.0159**		**0.005**		**0.2**	**0.005**	**0.0061**	**0.0002**	**0.005**	**0.00653**	
	Background: MW-18	4/11/2013	FD	0.005	**0.0185**		**0.005**		**0.2**	**0.005**	**0.005**	**0.0002**	**0.005**	**0.00965**	
	Background: MW-18	4/11/2013		0.005	**0.0184**		**0.005**		**0.2**	**0.005**	**0.00555**	**0.0002**	**0.005**	**0.00971**	
	Background: MW-18	4/17/2014		0.00488	**0.0183**		**0.0017**		**0.078**	**0.000942**	**0.011**	**0.000042**	**0.00102**	**0.0136**	
	Background: MW-54A	4/16/2012		**0.00573**	**0.0179**		**0.005**		**0.2**	**0.005**	**0.523**			0.005	
	Background: MW-54A	4/5/2013		0.005	**0.0183**		**0.005**		**0.2**	**0.005**	**0.498**			0.005	
	Background: MW-54A	4/17/2014		**0.0062**	**0.0182**		**0.001**		**0.078**	**0.0007**	**0.491**			0.00228	
	Background: MW-54B	4/5/2013		0.005	**0.0157**		**0.005**		**0.2**	**0.005**	**0.138**			0.005	
	Background: MW-55	4/12/2012		**0.00615**	**0.00902**		**0.005**		**0.2**	**0.005**	**0.0963**	**0.0002**	**0.00541**	**0.0278**	
NCL	Background: MW-55	4/11/2013		0.005	**0.00863**		**0.005**		**0.2**	**0.005**	**0.0285**	**0.0002**	**0.005**	**0.0195**	
	Background: MW-55	4/17/2014	FD	**0.00659**	**0.00871**		**0.001**		**0.078**	**0.0007**	**0.0596**	**0.000042**	**0.00345**	**0.0272**	
	Background: MW-55	4/17/2014		**0.00641**	**0.00965**		**0.001**		**0.078**	**0.0007**	**0.0595**	**0.000042**	**0.004**	**0.0253**	
	Background: NCL-33	4/12/2012		0.005	**0.0237**		**0.005**		**1.46**	**0.005**	**0.0967**			0.005	
	Background: NCL-33	4/11/2013		0.005	**0.0269**		**0.005**		**2.48**	**0.005**	**0.0848**			0.005	
	Background: NCL-33	4/17/2014		0.00264	**0.0247**		**0.001**		**2.68**	**0.0007**	**0.0855**			0.00104	
	Background: NCL-44	4/11/2012		**0.0488**	**0.0269**		**0.005**		**1.32**	**0.005**	**0.643**			0.005	
	Background: NCL-44	4/11/2013		**0.0354**	**0.0279**		**0.005**		**1.3**	**0.005**	**0.753**			0.005	
	Background: NCL-44	4/17/2014		**0.0372**	**0.0289**		**0.001**		**1.21**	**0.0007**	**0.661**			0.001	
	Background: NCL-49	4/16/2012		0.005	**0.0116**		**0.005**		**0.2**	**0.005**	**0.005**			**0.00626**	
	Background: NCL-49	4/9/2013		0.005	**0.0111**		**0.005**		**0.2**	**0.005**	**0.005**			**0.00506**	
	Background: NCL-49	4/17/2014		0.00338	**0.0112**		**0.001**		**0.078**	**0.0007**	**0.0025**			**0.00503**	
S RO Reject Field	MW-114	2/3/2013		**0.00561**	**0.0204**	**0.0008**	**0.0012**	**0.0015**	**0.078**	**0.0007**	**1.51**	**0.000042**	**0.00651**	0.00222	**0.0008**
	MW-114	5/15/2013		0.00437	**0.0129**	**0.0008**	**0.001**	**0.001**	**0.078**	**0.0007**	**0.844**	**0.000042**	**0.0041**	**0.00636**	**0.0008**
	MW-114	9/5/2013		**0.00502**	**0.017**	**0.0008**	**0.001**	**0.00197**	**0.078**	**0.0007**	**1.42**	**0.000042**	**0.00558**	0.00245	**0.0008**
	MW-114	11/21/2013		**0.00539**	**0.0112**	**0.0008**	**0.00119**	**0.001**	**0.167**	**0.0007**	**0.035**		**0.00369**	0.00451	**0.0008**
	MW-114	4/29/2014		0.00297	**0.0136**		**0.001**		**0.078**	**0.0007**	**1.13**			0.001	
	MW-115	2/3/2013		0.00499	**0.0309**	**0.0008**	**0.0012**	**0.00704**	**0.078**	**0.0007**	**0.255**	**0.000042**	**0.00483**	**0.0081**	**0.0008**
	MW-115	5/15/2013	FD	0.00427	**0.011**	**0.0008**	**0.001**	**0.00151**	**0.078**	**0.0007**	**0.023**	**0.000042**	**0.00225**	**0.00734**	**0.0008**

				Analyte:	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Lead	Manganese	Mercury	Nickel	Selenium	Silver
				cas_rn	7440-38-2	7440-39-3	7440-43-9	7440-47-3	7440-50-8	7439-89-6	7439-92-1	7439-96-5	7439-97-6	7440-02-0	7782-49-2	7440-22-4
				Units:	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l
				CGWSL:	0.01	1	0.005	0.05	1	1	0.015	0.2	0.002	0.2	0.05	0.05
				CGWSL Source:	USEPA MCL	WQCC HH	USEPA MCL	WQCC HH	WQCC Dom	WQCC Dom	USEPA MCL	WQCC Dom	WQCC HH	WQCC Irr	USEPA MCL	WQCC HH
Location Name	**Location**	**Date**	**Dup**													
	MW-115	5/15/2013		0.00478	**0.0107**	**0.0008**	**0.001**	**0.001**	**0.078**	**0.0007**	**0.0267**	**0.000042**	**0.001**	0.00654	**0.0008**
	MW-115	9/4/2013		0.00467	**0.0106**	**0.0008**	**0.001**	**0.001**	**0.078**	**0.0007**	**0.0362**	**0.000042**	**0.00208**	**0.00568**	**0.0008**
	MW-115	11/21/2013		**0.00616**	**0.011**	**0.0008**	**0.001**	**0.001**	**0.078**	**0.0007**	**0.0249**		**0.00206**	**0.00506**	**0.0008**
	MW-115	4/29/2014		0.00368	**0.0087**		**0.001**		**0.078**	**0.0007**	**0.0216**			0.00166	
	MW-116	2/3/2013		0.00274	**0.0161**	**0.0008**	**0.0012**	**0.0015**	**0.078**	**0.0007**	**0.0437**	**0.000131**	**0.0012**	0.00203	**0.0008**
	MW-116	5/16/2013		**0.00502**	**0.0111**	**0.0008**	**0.00119**	**0.00176**	**0.201**	**0.0007**	**0.0342**	**0.000046**	**0.00204**	**0.00733**	**0.0008**
	MW-116	9/4/2013	FD	0.00467	**0.00946**	**0.0008**	**0.001**	**0.001**	**0.078**	**0.0007**	**0.00366**	**0.00006**	**0.00112**	**0.00558**	**0.0008**
	MW-116	9/4/2013		**0.00535**	**0.00928**	**0.0008**	**0.001**	**0.001**	**0.078**	**0.0007**	**0.00478**	**0.000061**	**0.00115**	0.00493	**0.0008**
	MW-116	11/20/2013	FD	**0.00526**	**0.011**	**0.0008**	**0.001**	**0.001**	**0.132**	**0.0007**	**0.00576**		**0.00144**	**0.00582**	**0.0008**
	MW-116	11/20/2013		**0.00525**	**0.00989**	**0.0008**	**0.001**	**0.001**	**0.078**	**0.0007**	**0.0092**		**0.00245**	**0.00611**	**0.0008**
	MW-116	4/29/2014		0.00348	**0.0095**		**0.001**		**0.078**	**0.0007**	**0.0025**			**0.00563**	

red text = reporting/detection limit

green text = J flag

duplicate row not used in stats

= Exceedance of CGWSL

Max	0.0488	2.58	0.0008	0.005	0.0141	10.8	0.005	2.39	0.0002	0.005	0.0278	0.0008
Min	0.001	0.0009	0.0008	0.001	0.001	0.078	0.0007	0.0025	0.000042	0.001	0.001	0.0008
Ave	0.0082	0.1864	0.0008	0.0029	0.0023	0.6567	0.0027	0.3665	0.00009	0.0028	0.0051	0.0008

		Analyte:		Vanadium	Zinc
		cas_rn		7440-62-2	7440-66-6
		Units:		mg/l	mg/l
		CGWSL:		0.0631	10
		CGWSL Source:		NMED TW	WQCC Dom
Location Name	**Location**	**Date**	**Dup**		
N RO Reject Field	MW-117	2/3/2013			**0.0123**
	MW-117	5/15/2013			**0.0025**
	MW-117	9/4/2013			**0.00266**
	MW-117	11/20/2013			**0.0343**
	MW-117	4/30/2014			
	MW-118	2/5/2013			**0.0025**
	MW-118	5/15/2013			**0.0025**
	MW-118	9/4/2013			**0.0025**
	MW-118	11/20/2013			**0.0407**
	MW-118	4/30/2014			
	MW-119	2/5/2013			**0.0025**
	MW-119	5/15/2013			**0.0025**
	MW-119	9/4/2013			**0.0025**
	MW-119	11/20/2013			**0.0241**
	MW-119	4/30/2014	FD		
	MW-119	4/30/2014			
NCL	Background: MW-18	4/12/2012		**0.0155**	
	Background: MW-18	4/11/2013	FD	**0.0157**	
	Background: MW-18	4/11/2013		**0.0156**	
	Background: MW-18	4/17/2014		**0.0161**	
	Background: MW-54A	4/16/2012			
	Background: MW-54A	4/5/2013			
	Background: MW-54A	4/17/2014			
	Background: MW-54B	4/5/2013			
	Background: MW-55	4/12/2012		**0.0178**	
NCL	Background: MW-55	4/11/2013		**0.0165**	
	Background: MW-55	4/17/2014	FD	**0.0156**	
	Background: MW-55	4/17/2014		**0.0156**	
	Background: NCL-33	4/12/2012			
	Background: NCL-33	4/11/2013			
	Background: NCL-33	4/17/2014			
	Background: NCL-44	4/11/2012			
	Background: NCL-44	4/11/2013			
	Background: NCL-44	4/17/2014			
	Background: NCL-49	4/16/2012			
	Background: NCL-49	4/9/2013			
	Background: NCL-49	4/17/2014			
S RO Reject Field	MW-114	2/3/2013			**0.00343**
	MW-114	5/15/2013			**0.0025**
	MW-114	9/5/2013			**0.0025**
	MW-114	11/21/2013			**0.0806**
	MW-114	4/29/2014			
	MW-115	2/3/2013			**0.00973**
	MW-115	5/15/2013	FD		**0.0025**

		Analyte:		Vanadium	Zinc
		cas_rn		7440-62-2	7440-66-6
		Units:		mg/l	mg/l
		CGWSL:		0.0631	10
		CGWSL Source:		NMED TW	WQCC Dom
Location Name	**Location**	**Date**	**Dup**		
	MW-115	5/15/2013			**0.00821**
	MW-115	9/4/2013			**0.0025**
	MW-115	11/21/2013			**0.0257**
	MW-115	4/29/2014			
	MW-116	2/3/2013			**0.0025**
	MW-116	5/16/2013			**0.0025**
	MW-116	9/4/2013	FD		**0.0025**
	MW-116	9/4/2013			**0.0025**
	MW-116	11/20/2013	FD		**0.0218**
	MW-116	11/20/2013			**0.0311**
	MW-116	4/29/2014			

red text = reporting/detection limit

green text = J flag

duplicate row not used in stats

= Exceedance of CGWSL

Max	0.005	0.00821
Min	0.0009	0.0025
Ave	0.0036	0.0029

Location	KWB-1A	KWB-1A	KWB-1A	KWB-10	KWB-10	KWB-10	MW-20	MW-20	MW-20	MW-30	MW-30	MW-30	MW-45	MW-45	MW-45	MW-46	MW-46	MW-46	MW-56	MW-56	MW-56
Analyte	Chloride	Fluoride	Sulfate	Chloride	Fluoride	Sulfate	Chloride	Fluoride	Sulfate	Chloride	Fluoride	Sulfate	Chloride	Fluoride	Sulfate	Chloride	Fluoride	Sulfate	Chloride	Fluoride	Sulfate
Units	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
Date																					
10/1/1990													283	2.59	1310	638	3.17	1250			
11/14/1992													671	2.5	1780						
11/15/1992																636	2.9	2580			
11/12/1994														2							
11/14/1994												1.5									
3/9/1995	333	1.2	2365																		
3/10/1995													1057	2.3	3197						
6/14/1995													972		3040						
6/28/1995	328		2540																		
6/29/1995																					
1/20/1997	260	1.4	3600										670	2.4	2700						
1/13/2000	340	1.9	2400																		
1/21/2000													470	2.9	2200						
6/15/2002	262	1.96	2000	185	1.4	26.3															
4/1/2008	210	1.01	1830				431	2.45	3080				204	1.8	1720				426	0.1	1700
9/1/2008				196	0.653	1940	398	2.14	3150				223	1.86	1580				310	1.01	1830
4/1/2009	210	0.784	1890	181	0.384	1760	353	2.32	3120				264	1.75	1690				329	0.75	1920
9/1/2009	198	0.955	1850										343	2	1840				337	0.854	1850
9/1/2009																			338	0.853	1830
10/1/2009				157	0.501	1710	301	2.46	3000												
3/1/2010										416	1.02	1930	353	1.65	2060				306	0.863	1790
4/1/2010	223	1.11	1950	158	0.582	1900	279	2.51	3170												
10/10/2010	220	1.15	1490																360	1.1	1800
10/1/2010	248	1.18	1660																		
11/1/2010													377	1.96	1920	357	2.02	2050			
11/1/2010													368	1.82	1730						
Min	198.0	0.8	1490.0	157.0	0.4	26.3	279.0	2.1	3000.0	416.0	1.0	1930.0	204.0	1.7	1310.0	357.0	2.0	1250.0	306.0	0.1	1700.0
Avg	257.5	1.3	2143.2	175.4	0.7	1467.3	352.4	2.4	3104.0	416.0	1.3	1930.0	481.2	2.1	2059.0	543.7	2.7	1960.0	343.7	0.8	1817.1
Max	340.0	2.0	3600.0	196.0	1.4	1940.0	431.0	2.5	3170.0	416.0	1.5	1930.0	1057.0	2.9	3197.0	638.0	3.2	2580.0	426.0	1.1	1920.0

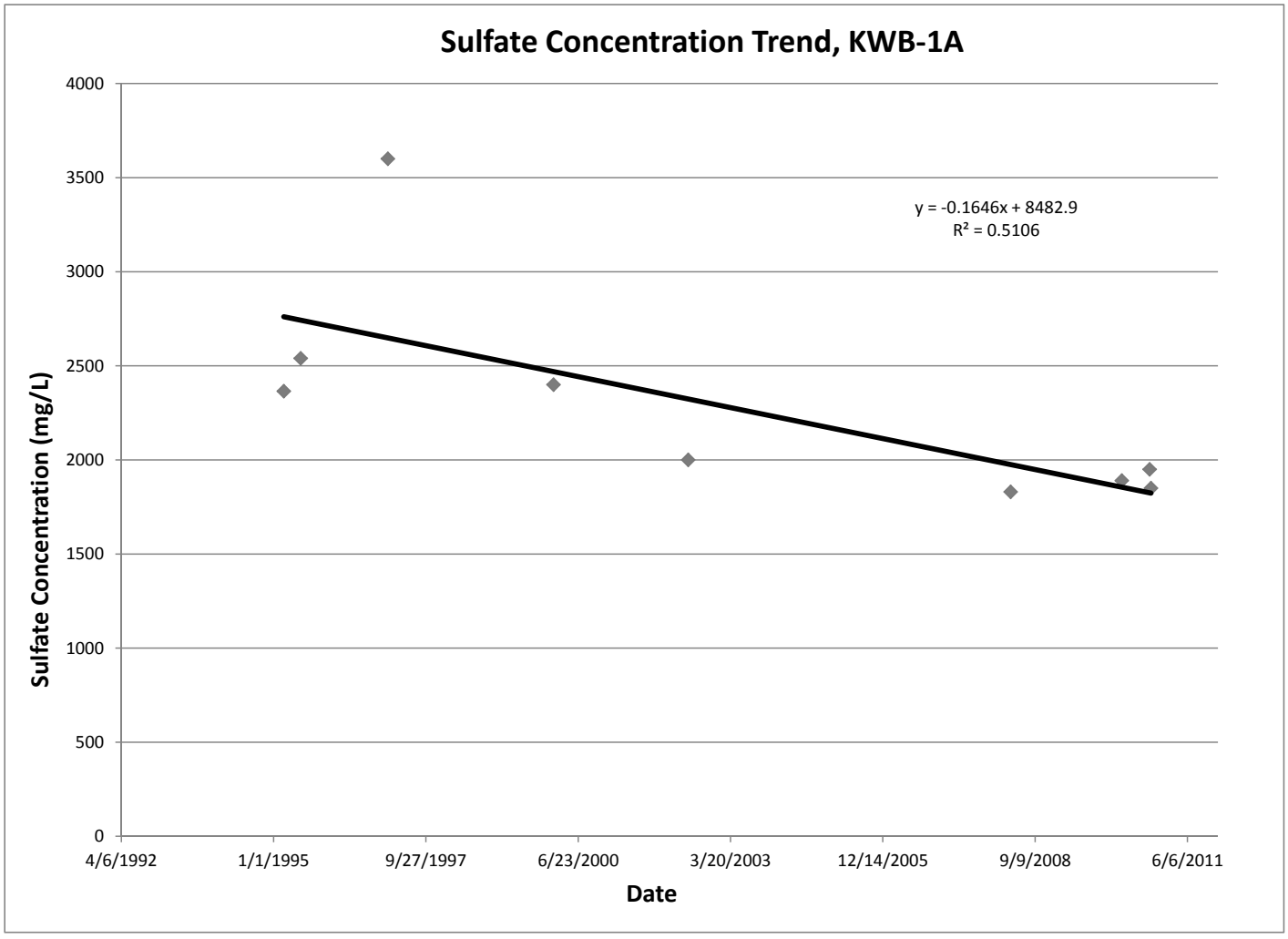
CGWSL

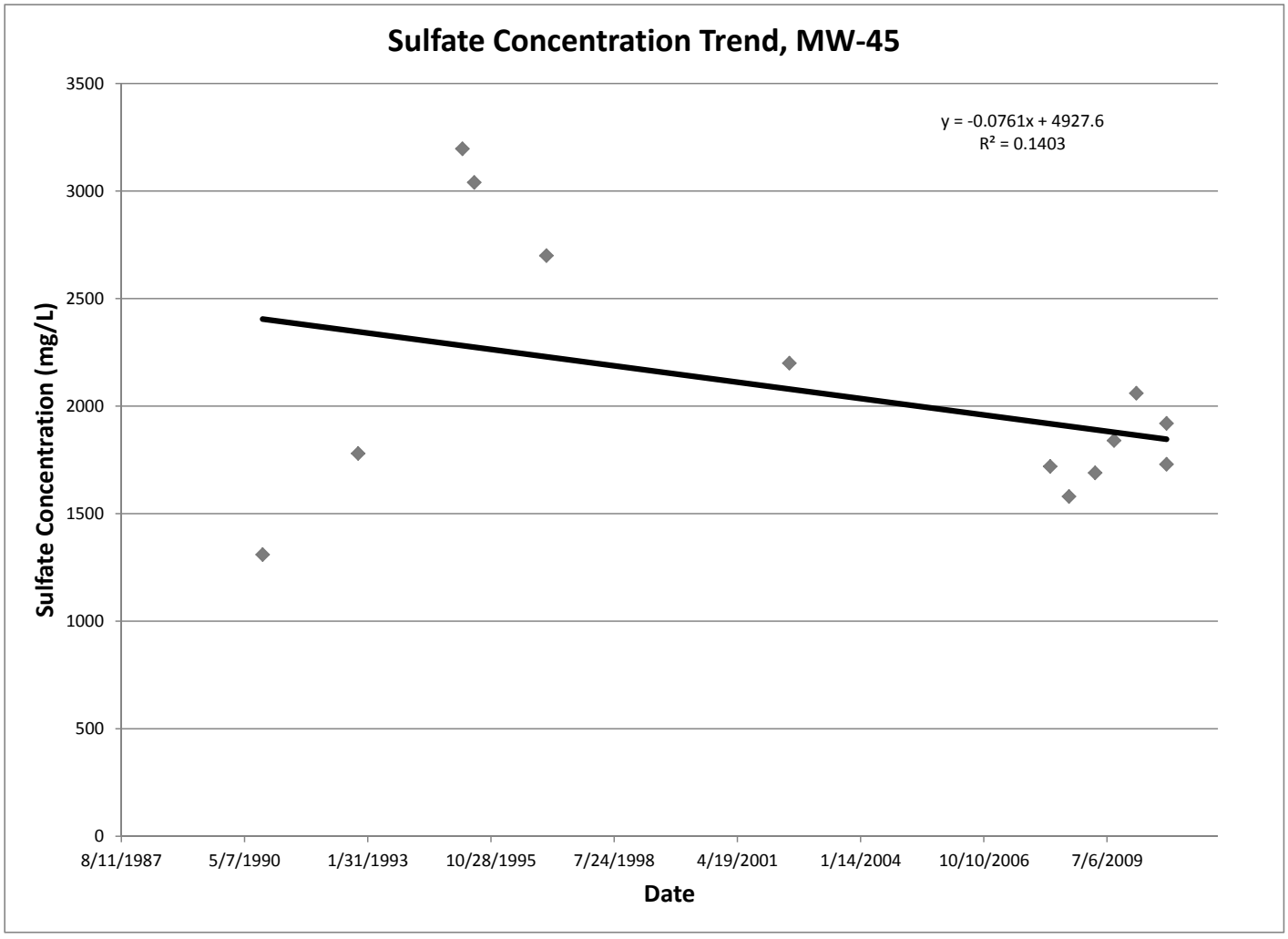
Chloride = 250

Fluoride = 1.5

Sulfate = 600

Exceeds CGWSL


Sulfate Concentration Trend, KWB-1A
y = -0.1646x + 8482.9
R² = 0.5106
Sulfate Concentration (mg/L)
4000
3500
3000
2500
2000
1500
1000
500
0
4/6/1992
1/1/1995
9/27/1997
6/23/2000
3/20/2003
12/14/2005
9/9/2008
6/6/2011
Date


Sulfate Concentration Trend, MW-45
y = -0.0761x + 4927.6
R² = 0.1403
Sulfate Concentration (mg/L)
3500
3000
2500
2000
1500
1000
500
0
8/11/1987
5/7/1990
1/31/1993
10/28/1995
7/24/1998
4/19/2001
1/14/2004
10/10/2006
7/6/2009
Date

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Appendix D

Transport Model Input Parameters and Assumptions

Table D-1: Mineral Abundances Based on Average Soil Analytical Results
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

Element	Elemental Abundance	Element Formula Weight	Mineral	Mineral Formula	Mineral Formula Weight	Calculated Mineral Quantity	Percent of Total
	mg/kg	g/mol			g/mol	mg/kg	%
Al	9,000	26.98	Kaolinite	$Al_2Si_2O_5(OH)_4$	258.14	43,055	4.3
Fe	6,000	55.85	Ferrihydrite	$Fe(OH)_3$	106.85	11,479	1.1
SO_4	1,300	96.07	Gypsum	$CaSO_4*2H_2O$	172.15	2,329	0.2
Ca (total)	120,000	40.08					
Ca (as gypsum) [a]	542	40.08	Gypsum	$CaSO_4*2H_2O$			
Ca (as calcite) [b]	119,458	40.08	Calcite	$CaCO_3$	100.08	298,286	29.8

Notes:

[a] Calcium present as gypsum estimated from calculated gypsum content, with gypsum content calculated based on sulfate content

[b] Calcium present as calcite estimated as total calcium minus calcium present as gypsum

Table D-2: Model Input Parameters and Assumptions
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

Model Domain	**Value**	**Units**	**Comment/Reference**
Domain length	25	ft	
Total Porosity	0.35		
Effective Porosity	0.2		
Effective porosity water saturation	0.9		
Effective saturated porosity	0.18	L sat/L total	
Bulk Density	1.7	kg/L total	
Mobile zone solution quantity per mass solid	0.106	L sat/kg solid	
Cation Exchange on Kaolinite	**Value**	**Units**	**Comment/Reference**
Kaolinite CEC	0.074	mol/kg kaolinite	Ma and Eggleton (1999)
Total kaolinite concentration	0.043	kg/kg solid	
Mobile zone kaolinite concentration	0.025	kg/kg solid	
Mobile zone exchange site concentration	0.0172	mol/L	
Adsorption on Ferrihydrite	**Value**	**Units**	**Comment/Reference**
Ferrihydrite surface area	30	m^2/g	Dzombak and Morel (1990), scaled down 10x
Downscale Factor	500	x	
Total ferrihydrite concentration	2.30E-05	kg/kg solid	
Mobile zone ferrihydrite concentration (solids mass basis)	1.31E-05	kg/kg solid	
Mobile zone ferrihydrite concentration (solution basis)	1.24E-04	kg/L	
	0.1241	g/L	
Weak site density	2.255	sites/nm^2	Dzombak and Morel (1990)
	3.746E-06	mol sites/m^2	
Weak site concentration (solution basis for PHREEQC)	1.39E-05	mol/L	
Strong site density	0.0564	sites/nm^2	Dzombak and Morel (1990)
	9.369E-08	mol sites/m^2	
Strong site concentration (solution basis for PHREEQC)	3.49E-07	mol/L	
Scenario 1: 100% South	**Value**	**Units**	**Comment/Reference**
Discharge to pond	0.348	in/day	
Evapotranspiration rate (corrected for precipitation)	0.178	in/day	
Percentage of total water lost to evapotranspiration	51.1%		
Infiltration rate, evapotranspiration-corrected	0.17	in/day	
Quantity of water to remove on evapotranspiration	28.39	moles/L	
Seepage velocity	0.944	in/day	
Number of grid cells in the domain	25		
Cell lengths	1.000	ft	
Time step	12.706	days	
Shifts	600		
Total Run Time	20.886	years	
Scenario 2a: 67% South	**Value**	**Units**	**Comment/Reference**
Discharge to pond	0.233	in/day	
Evapotranspiration rate (corrected for precipitation)	0.178	in/day	
Percentage of total water lost to evapotranspiration	76.4%		
Infiltration rate, evapotranspiration-corrected	0.055	in/day	
Quantity of water to remove on evapotranspiration	42.40	moles	
Seepage velocity	0.306	in/day	
Number of grid cells in the domain	25		
Cell lengths	1.000	ft	
Time step	39.273	days	
Shifts	150		
Total Run Time	16.139	years	
Scenario 2b: 33% North	**Value**	**Units**	**Comment/Reference**
Discharge to pond	0.264	in/day	
Evapotranspiration rate (corrected for precipitation)	0.178	in/day	
Percentage of total water lost to evapotranspiration	67.4%		
Infiltration rate, evapotranspiration-corrected	0.086	in/day	
Quantity of water to remove on evapotranspiration	37.42	moles	
Seepage velocity	0.478	in/day	
Number of grid cells in the domain	25		
Cell lengths	1.000	ft	
Time step	25.116	days	
Shifts	250		
Total Run Time	17.203	years	

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Appendix E

PHREEQC Model Input Files

```
TITLE Navajo Refinery RO Reject Infiltration - Batch Evapotranspiration Model

selected_output
      -file       output.sel
      -reset            FALSE
      -solution         TRUE
      -ph               TRUE
      -pe               TRUE
      -alkalinity       TRUE
      -ionic_strength   TRUE
      -water            TRUE
      -charge_balance   TRUE
      -saturation_indices  Calcite  Gypsum  Barite  Fluorite  Rhodochrosite
Fe(OH)3(a)
      -totals  C  S(6) Ca Fe(2) Fe(3)
      -molalities  HCO3- CO3-2 CO2 O2 H2
      -equilibrium_phases  Calcite  Gypsum  Barite  Fluorite  Rhodochrosite
Fe(OH)3(a)
user_punch
-headings Alk_ppm totC_ppm Na_ppm Ca_ppm Mg_ppm K_ppm Cl_ppm SO4_ppm NO3_ppm F_ppm
Al_ppm FeIII_ppm As_ppm Se_ppm U_ppm Zn_ppm Mn_ppm Cu_ppm B_ppm Ba_ppm

-start
10    Alk_ppm = ALK * 50.05 * 1000
11    totC_ppm = TOT("C") * (1.008+12.0111+3*16.0) * 1000

20    Na_ppm = TOT("Na") * 22.9898 * 1000
21    Ca_ppm = TOT("Ca") * 40.08 * 1000
22    Mg_ppm = TOT("Mg") * 24.312 * 1000
23    K_ppm = TOT("K") * 39.102 * 1000

30    Cl_ppm = TOT("Cl") * 35.453 * 1000
31    SO4_ppm = TOT("S(6)") * 96.056 * 1000
32    NO3_ppm = TOT("N(5)") * 14.0067 * 1000
33    F_ppm = TOT("F") * 18.9984 * 1000

40    Al_ppm = TOT("Al") * 26.9815 * 1000
41    FeIII_ppm = TOT("Fe(3)") * 55.847 * 1000

50    As_ppm = TOT("As") * 74.9216 * 1000
51    Se_ppm = TOT("Se") * 78.96 * 1000
52    U_ppm = TOT("U") * 238.0290 * 1000
53    Zn_ppm = TOT("Zn") * 65.37 * 1000
54    Mn_ppm = TOT("Mn") * 54.938 * 1000
57    Cu_ppm = TOT("Cu") * 63.546 * 1000
58    B_ppm = TOT("B") * 10.81 * 1000
59    Ba_ppm = TOT("Ba") * 137.34 * 1000

110   punch Alk_ppm
111   punch totC_ppm

120   punch Na_ppm
121   punch Ca_ppm
122   punch Mg_ppm
123   punch K_ppm

130   punch Cl_ppm
131   punch SO4_ppm
132   punch NO3_ppm
133   punch F_ppm

140   punch Al_ppm
141   punch FeIII_ppm
```

```
150   punch As_ppm
151   punch Se_ppm
152   punch U_ppm
153   punch Zn_ppm
154   punch Mn_ppm
157   punch Cu_ppm
158   punch B_ppm
159   punch Ba_ppm

end

# RO reject, based on averages from 2004 to present

solution 1
       units        mg/kgw
       temp         20
       pe           8
       pH           7.73
       C(4)         699.3
       Na           144.1        charge
       Ca           606.5
       Mg           184.7
       K            3.8
       Cl           264.9        # charge
       S(6)         1651.3
       N(5)         1.33
       F            3.21
       As(5)        0.0067
       Se(6)        0.0093
       U            0.0054
       Zn           0.0123
       Mn(2)        0.0064
       Cu           0.0192
       B            0.0846
       Ba           0.0749
       Al           0.0154
       Fe(3)        0.225
end

# Scenario 1: 100% to south pond, 51.1% evaporation on 55.5 mol/L
use solution 1
reaction 1
       H2O    -1
       28.39 moles
save solution 11
end

# Scenario 2a: 67% to south pond, 76.4% evaporation on 55.5 mol/L
use solution 1
reaction 2
       H2O    -1
       42.40 moles
save solution 12
end

# Scenario 2b: 33% to north pond, 67.4% evaporation on 55.5 mol/L
use solution 1
reaction 3
       H2O    -1
       37.42 moles
save solution 13
end
```

```
equilibrium_phases 1
Calcite              0.0    0.0
Gypsum        0.0    0.0
Barite        0.0    0.0
Fluorite      0.0    0.0
Rhodochrosite 0.0    0.0
Gibbsite      0.0    0.0
Fe(OH)3(a)    0.0    0.0
CO2(g)        -3.5   1.0
O2(g)         -0.68  1.0
end

use solution 11
use equilibrium_phases 1
save solution 21
end

use solution 12
use equilibrium_phases 1
save solution 22
end

use solution 13
use equilibrium_phases 1
save solution 23
end
```

```
title   Navajo Refinery RO Reject Infiltration

#  Scenario 1
#  100% of RO Discharge to South Field

SURFACE_SPECIES

# Carbonate adsorption to ferrihydrite: Appelo et al. 2002

        Hfo_wOH + CO3-2 + H+ = Hfo_wCO3- + H2O
        log_k   12.78

        Hfo_wOH + CO3-2 + 2H+= Hfo_wHCO3 + H2O
        log_k   20.37

END


# Initial condition in the vadose zone (arbitrary), low metals, sodium-exchanged

solution 1-25
       units        mg/kgw
       temp         20
       pe           8
       pH           8.0
       C(4)         400    calcite      1.0
       Na           300.0
       Ca           800
       S(6)         2200
       Cl           10.0         charge
       As(5)        0.001
       Se(6)        0.001

end

# Adsorption on ferrihydrite (scaled-back reactivity):
surface 1-25
       -equilibrate 1
       # Site concentration (mol/L), surface area (m^3/g), mineral concentration
(g/L):
       Hfo_wOH             1.39e-5             30     0.1241       # Weak sites
       Hfo_sOH             3.49e-7             30     0.1241       # Strong sites
end

# Cation exchange on kaolinite:
exchange 1-25
       -equilibrate 1
       X      0.0172
end

equilibrium_phases 1-25
       calcite             0.0    1.0
       gypsum       0.0    1.0
end


# Inflow: Scenario 1 solution following evapotranspiration

solution 0
       units        mg/kgw
       temp         20
       pe           8
       pH           7.82
```

```
       C(4)          30.1
       Na            370     charge
       Ca            559
       Mg            378
       K             7.8
       Cl            542
       S(6)          2844
       N(5)          2.7
       F             2.4
       As(5)         0.014
       Se(6)         0.019
       U             0.011
       Zn            0.025
       Mn(2)         0.013
       Cu            0.039
       B             0.173
       Ba            0.010
end

transport
       -cells              25
       -lengths            1.0          # ft
       -dispersivities            0.5          # ft
       -warnings           false
       -flow_direction            forward
       -boundary_cond             flux   flux
       -time_step          12.706       # days
       -shifts                    600
       -punch_cells        25           # To selected output file
       -punch_frequency    6
       -print_cells        25           # To output file
       -print_frequency    600

selected_output
      -file       output.sel
      -reset            FALSE
      -solution         TRUE
      -time         TRUE
      -ph               TRUE
      -pe               TRUE
      -alkalinity       TRUE
      -ionic_strength   TRUE
      -water            TRUE
      -charge_balance   TRUE
      -saturation_indices  Calcite  Gypsum  Barite  Fluorite  Rhodochrosite
Fe(OH)3(a)
      -totals  C  S(6) Ca Fe(2) Fe(3)
      -molalities  HCO3- CO3-2 CO2 O2 H2
      -equilibrium_phases  Calcite  Gypsum  Barite  Fluorite  Rhodochrosite
Fe(OH)3(a)
user_punch
-headings Alk_ppm totC_ppm Na_ppm Ca_ppm Mg_ppm K_ppm Cl_ppm SO4_ppm NO3_ppm F_ppm
Al_ppm FeIII_ppm As_ppm Se_ppm U_ppm Zn_ppm Mn_ppm Cu_ppm B_ppm Ba_ppm

-start
10    Alk_ppm = ALK * 50.05 * 1000
11    totC_ppm = TOT("C") * (1.008+12.0111+3*16.0) * 1000

20    Na_ppm = TOT("Na") * 22.9898 * 1000
21    Ca_ppm = TOT("Ca") * 40.08 * 1000
22    Mg_ppm = TOT("Mg") * 24.312 * 1000
23    K_ppm = TOT("K") * 39.102 * 1000
```

```
30    Cl_ppm = TOT("Cl") * 35.453 * 1000
31    SO4_ppm = TOT("S(6)") * 96.056 * 1000
32    NO3_ppm = TOT("N(5)") * 14.0067 * 1000
33    F_ppm = TOT("F") * 18.9984 * 1000

40    Al_ppm = TOT("Al") * 26.9815 * 1000
41    FeIII_ppm = TOT("Fe(3)") * 55.847 * 1000

50    As_ppm = TOT("As") * 74.9216 * 1000
51    Se_ppm = TOT("Se") * 78.96 * 1000
52    U_ppm = TOT("U") * 238.0290 * 1000
53    Zn_ppm = TOT("Zn") * 65.37 * 1000
54    Mn_ppm = TOT("Mn") * 54.938 * 1000
57    Cu_ppm = TOT("Cu") * 63.546 * 1000
58    B_ppm = TOT("B") * 10.81 * 1000
59    Ba_ppm = TOT("Ba") * 137.34 * 1000

110   punch Alk_ppm
111   punch totC_ppm

120   punch Na_ppm
121   punch Ca_ppm
122   punch Mg_ppm
123   punch K_ppm

130   punch Cl_ppm
131   punch SO4_ppm
132   punch NO3_ppm
133   punch F_ppm

140   punch Al_ppm
141   punch FeIII_ppm

150   punch As_ppm
151   punch Se_ppm
152   punch U_ppm
153   punch Zn_ppm
154   punch Mn_ppm
157   punch Cu_ppm
158   punch B_ppm
159   punch Ba_ppm

end
```

```
title   Navajo Refinery RO Reject Infiltration

#  Scenario 2a
#  67% of RO Discharge to South Field

SURFACE_SPECIES

# Carbonate adsorption to ferrihydrite: Appelo et al. 2002

        Hfo_wOH + CO3-2 + H+ = Hfo_wCO3- + H2O
        log_k   12.78

        Hfo_wOH + CO3-2 + 2H+= Hfo_wHCO3 + H2O
        log_k   20.37

END


# Initial condition in the vadose zone (arbitrary), low metals, sodium-exchanged

solution 1-25
       units        mg/kgw
       temp         20
       pe           8
       pH           8.0
       C(4)         400    calcite      1.0
       Na           300.0
       Ca           800
       S(6)         2200
       Cl           10.0         charge
       As(5)        0.001
       Se(6)        0.001

end

# Adsorption on ferrihydrite (scaled-back reactivity):
surface 1-25
       -equilibrate 1
       # Site concentration (mol/L), surface area (m^3/g), mineral concentration
(g/L):
       Hfo_wOH             1.39e-5             30     0.1241       # Weak sites
       Hfo_sOH             3.49e-7             30     0.1241       # Strong sites
end

# Cation exchange on kaolinite:
exchange 1-25
       -equilibrate 1
       X      0.0172
end

equilibrium_phases 1-25
       calcite             0.0    1.0
       gypsum       0.0    1.0
end


# Inflow: Scenario 2a solution following evapotranspiration

solution 0
       units        mg/kgw
       temp         20
       pe           8
       pH           7.87
```

```
       C(4)          35.9
       Na            767    charge
       Ca            524
       Mg            783
       K             16.1
       Cl            1123
       S(6)          4391
       N(5)          5.6
       F             3.1
       As(5)         0.028
       Se(6)         0.039
       U             0.023
       Zn            0.052
       Mn(2)         0.027
       Cu            0.081
       B             0.358
       Ba            0.010

end

transport
       -cells              25
       -lengths            1.0          # ft
       -dispersivities            0.5          # ft
       -warnings           false        # true during de-bugging
       -flow_direction            forward
       -boundary_cond             flux   flux
       -time_step          39.273       # days
       -shifts                    150
       -punch_cells        25           # To selected output file
       -punch_frequency    2
       -print_cells        25           # To output file
       -print_frequency    150

selected_output
      -file       output.sel
      -reset            FALSE
      -solution         TRUE
      -time         TRUE
      -ph               TRUE
      -pe               TRUE
      -alkalinity       TRUE
      -ionic_strength   TRUE
      -water            TRUE
      -charge_balance   TRUE
      -saturation_indices  Calcite  Gypsum  Barite  Fluorite  Rhodochrosite
Fe(OH)3(a)
      -totals  C  S(6) Ca Fe(2) Fe(3)
      -molalities  HCO3- CO3-2 CO2 O2 H2
      -equilibrium_phases  Calcite  Gypsum  Barite  Fluorite  Rhodochrosite
Fe(OH)3(a)
user_punch
-headings Alk_ppm totC_ppm Na_ppm Ca_ppm Mg_ppm K_ppm Cl_ppm SO4_ppm NO3_ppm F_ppm
Al_ppm FeIII_ppm As_ppm Se_ppm U_ppm Zn_ppm Mn_ppm Cu_ppm B_ppm Ba_ppm

-start
10    Alk_ppm = ALK * 50.05 * 1000
11    totC_ppm = TOT("C") * (1.008+12.0111+3*16.0) * 1000

20    Na_ppm = TOT("Na") * 22.9898 * 1000
21    Ca_ppm = TOT("Ca") * 40.08 * 1000
22    Mg_ppm = TOT("Mg") * 24.312 * 1000
23    K_ppm = TOT("K") * 39.102 * 1000
```

```
30    Cl_ppm = TOT("Cl") * 35.453 * 1000
31    SO4_ppm = TOT("S(6)") * 96.056 * 1000
32    NO3_ppm = TOT("N(5)") * 14.0067 * 1000
33    F_ppm = TOT("F") * 18.9984 * 1000

40    Al_ppm = TOT("Al") * 26.9815 * 1000
41    FeIII_ppm = TOT("Fe(3)") * 55.847 * 1000

50    As_ppm = TOT("As") * 74.9216 * 1000
51    Se_ppm = TOT("Se") * 78.96 * 1000
52    U_ppm = TOT("U") * 238.0290 * 1000
53    Zn_ppm = TOT("Zn") * 65.37 * 1000
54    Mn_ppm = TOT("Mn") * 54.938 * 1000
57    Cu_ppm = TOT("Cu") * 63.546 * 1000
58    B_ppm = TOT("B") * 10.81 * 1000
59    Ba_ppm = TOT("Ba") * 137.34 * 1000

110   punch Alk_ppm
111   punch totC_ppm

120   punch Na_ppm
121   punch Ca_ppm
122   punch Mg_ppm
123   punch K_ppm

130   punch Cl_ppm
131   punch SO4_ppm
132   punch NO3_ppm
133   punch F_ppm

140   punch Al_ppm
141   punch FeIII_ppm

150   punch As_ppm
151   punch Se_ppm
152   punch U_ppm
153   punch Zn_ppm
154   punch Mn_ppm
157   punch Cu_ppm
158   punch B_ppm
159   punch Ba_ppm

end
```

```
title   Navajo Refinery RO Reject Infiltration

#  Scenario 2b
#  33% of RO Discharge to North Field

SURFACE_SPECIES

# Carbonate adsorption to ferrihydrite: Appelo et al. 2002

        Hfo_wOH + CO3-2 + H+ = Hfo_wCO3- + H2O
        log_k   12.78

        Hfo_wOH + CO3-2 + 2H+= Hfo_wHCO3 + H2O
        log_k   20.37

END


# Initial condition, low metals, sodium-exchanged

solution 1-25
       units        mg/kgw
       temp         20
       pe           8
       pH           8.0
       C(4)         400    calcite      1.0
       Na           300.0
       Ca           800
       S(6)         2200
       Cl           10.0         charge
       As(5)        0.001
       Se(6)        0.001

end

# Adsorption on ferrihydrite (scaled-back reactivity):
surface 1-25
       -equilibrate 1
       # Site concentration (mol/L), surface area (m^3/g), mineral concentration
(g/L):
       Hfo_wOH             1.39e-5             30     0.1241       # Weak sites
       Hfo_sOH             3.49e-7             30     0.1241       # Strong sites
end

# Cation exchange on kaolinite:
exchange 1-25
       -equilibrate 1
       X      0.0172
end

equilibrium_phases 1-25
       calcite             0.0    1.0
       gypsum       0.0    1.0
end


# Inflow: Scenario 2b solution following evapotranspiration

solution 0
       units        mg/kgw
       temp         20
       pe           8
       pH           7.85
```

```
       C(4)          33.0
       Na            555       charge
       Ca            540
       Mg            567
       K             11.7
       Cl            813
       S(6)          3561
       N(5)          4.1
       F             2.7
       As(5)         0.021
       Se(6)         0.029
       U             0.017
       Zn            0.038
       Mn(2)         0.020
       Cu            0.059
       B             0.260
       Ba            0.010

end

transport
       -cells              25
       -lengths            1.0           # ft
       -dispersivities            0.5           # ft
       -warnings           false         # true during de-bugging
       -flow_direction            forward
       -boundary_cond             flux   flux
       -time_step          25.116        # days
       -shifts                    250
       -punch_cells        25            # To selected output file
       -punch_frequency    3
       -print_cells        25            # To output file
       -print_frequency    250

selected_output
      -file       output.sel
      -reset            FALSE
      -solution         TRUE
      -time         TRUE
      -ph               TRUE
      -pe               TRUE
      -alkalinity       TRUE
      -ionic_strength   TRUE
      -water            TRUE
      -charge_balance   TRUE
      -saturation_indices  Calcite  Gypsum  Barite  Fluorite  Rhodochrosite
Fe(OH)3(a)
      -totals  C  S(6) Ca Fe(2) Fe(3)
      -molalities  HCO3- CO3-2 CO2 O2 H2
      -equilibrium_phases  Calcite  Gypsum  Barite  Fluorite  Rhodochrosite
Fe(OH)3(a)
user_punch
-headings Alk_ppm totC_ppm Na_ppm Ca_ppm Mg_ppm K_ppm Cl_ppm SO4_ppm NO3_ppm F_ppm
Al_ppm FeIII_ppm As_ppm Se_ppm U_ppm Zn_ppm Mn_ppm Cu_ppm B_ppm Ba_ppm

-start
10    Alk_ppm = ALK * 50.05 * 1000
11    totC_ppm = TOT("C") * (1.008+12.0111+3*16.0) * 1000

20    Na_ppm = TOT("Na") * 22.9898 * 1000
21    Ca_ppm = TOT("Ca") * 40.08 * 1000
22    Mg_ppm = TOT("Mg") * 24.312 * 1000
23    K_ppm = TOT("K") * 39.102 * 1000
```

```
30    Cl_ppm = TOT("Cl") * 35.453 * 1000
31    SO4_ppm = TOT("S(6)") * 96.056 * 1000
32    NO3_ppm = TOT("N(5)") * 14.0067 * 1000
33    F_ppm = TOT("F") * 18.9984 * 1000

40    Al_ppm = TOT("Al") * 26.9815 * 1000
41    FeIII_ppm = TOT("Fe(3)") * 55.847 * 1000

50    As_ppm = TOT("As") * 74.9216 * 1000
51    Se_ppm = TOT("Se") * 78.96 * 1000
52    U_ppm = TOT("U") * 238.0290 * 1000
53    Zn_ppm = TOT("Zn") * 65.37 * 1000
54    Mn_ppm = TOT("Mn") * 54.938 * 1000
57    Cu_ppm = TOT("Cu") * 63.546 * 1000
58    B_ppm = TOT("B") * 10.81 * 1000
59    Ba_ppm = TOT("Ba") * 137.34 * 1000

110   punch Alk_ppm
111   punch totC_ppm

120   punch Na_ppm
121   punch Ca_ppm
122   punch Mg_ppm
123   punch K_ppm

130   punch Cl_ppm
131   punch SO4_ppm
132   punch NO3_ppm
133   punch F_ppm

140   punch Al_ppm
141   punch FeIII_ppm

150   punch As_ppm
151   punch Se_ppm
152   punch U_ppm
153   punch Zn_ppm
154   punch Mn_ppm
157   punch Cu_ppm
158   punch B_ppm
159   punch Ba_ppm

end
```

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Appendix F

PHREEQC Model Selected Output Files

Table F-1: Batch PHREEQC Model Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

soln	pH	pe	Alk	mu	mass_H2O	charge	C	S(6)	Ca	Fe(2)	Fe(3)	m_HCO3-	m_CO3-2	m_CO2	m_O2	m_H2	Calcite
1	7.73	8	0.011317	0.066097	1	1.66E-17	1.15E-02	1.72E-02	1.51E-02	0.00E+00	4.03E-06	1.00E-02	4.21E-05	3.62E-04	1.40E-25	2.54E-35	0.00E+00
1	7.65214	12.0763	0.023165	0.125646	0.488526	3.52E-17	2.35E-02	3.52E-02	3.10E-02	4.03E-14	8.25E-06	1.96E-02	7.92E-05	7.94E-04	1.36E-09	0.00E+00	0.00E+00
1	7.56737	12.2165	0.047927	0.240685	0.236122	2.54E-17	4.85E-02	7.28E-02	6.41E-02	1.55E-13	1.71E-05	3.79E-02	1.47E-04	1.73E-03	2.20E-09	0.00E+00	0.00E+00
1	7.60574	12.1533	0.03473	0.180551	0.325842	-3.63E-17	3.52E-02	5.28E-02	4.64E-02	8.52E-14	1.24E-05	2.83E-02	1.12E-04	1.23E-03	1.78E-09	0.00E+00	0.00E+00
11	7.82249	13.2355	0.000497	0.090545	0.488525	2.12E-16	4.94E-04	2.97E-02	1.40E-02	8.20E-19	1.29E-08	4.29E-04	2.38E-06	1.21E-05	2.86E-04	0.00E+00	5.53E-03
12	7.87066	13.1875	0.0006	0.141842	0.235989	3.26E-17	5.88E-04	4.58E-02	1.32E-02	7.70E-19	1.27E-08	4.96E-04	3.41E-06	1.20E-05	2.83E-04	0.00E+00	5.58E-03
13	7.84761	13.2105	0.000547	0.114628	0.325755	-2.86E-17	5.40E-04	3.72E-02	1.36E-02	7.94E-19	1.28E-08	4.63E-04	2.87E-06	1.21E-05	2.85E-04	0.00E+00	5.57E-03

Table F-1: Batch PHREEQC Model Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

d_Calcite	Gypsum	d_Gypsum	Barite	d_Barite	Fluorite	d_Fluorite	Rhodochrosite	d_Rhodochrosite	Fe(OH)3(a)	d_Fe(OH)3(a)	si_Calcite	si_Gypsum	si_Barite	si_Fluorite
0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.3841	-0.0898	0.7795	0.4502
0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.771	0.2845	1.1384	1.155
0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	2.1467	0.6533	1.5015	1.8428
0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.982	0.4907	1.3399	1.5412
5.53E-03	2.69E-03	2.69E-03	5.08E-07	5.08E-07	5.40E-05	5.40E-05	0.00E+00	0.00E+00	4.02E-06	4.02E-06	0	0	0	0
5.58E-03	6.38E-03	6.38E-03	5.28E-07	5.28E-07	6.50E-05	6.50E-05	0.00E+00	0.00E+00	4.03E-06	4.03E-06	0	0	0	0
5.57E-03	5.08E-03	5.08E-03	5.21E-07	5.21E-07	6.10E-05	6.10E-05	0.00E+00	0.00E+00	4.02E-06	4.02E-06	0	0	0	0

Table F-1: Batch PHREEQC Model Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

si_Rhodochrosite	si_Fe(OH)3(a)	Alk_ppm	totC_ppm	Na_ppm	Ca_ppm	Mg_ppm	K_ppm	Cl_ppm	SO4_ppm	NO3_ppm	F_ppm	Al_ppm	FeIII_ppm	As_ppm	Se_ppm	U_ppm
-1.2936	2.4844	5.66E+02	6.99E+02	1.81E+02	6.07E+02	1.85E+02	3.80E+00	2.65E+02	1.65E+03	1.33E+00	3.21E+00	1.54E-02	2.25E-01	6.70E-03	9.30E-03	5.40E-03
-0.954	2.7829	1.16E+03	1.43E+03	3.70E+02	1.24E+03	3.78E+02	7.78E+00	5.42E+02	3.38E+03	2.72E+00	6.57E+00	3.15E-02	4.61E-01	1.37E-02	1.90E-02	1.11E-02
-0.6237	3.0845	2.40E+03	2.96E+03	7.66E+02	2.57E+03	7.82E+02	1.61E+01	1.12E+03	6.99E+03	5.63E+00	1.36E+01	6.52E-02	9.53E-01	2.84E-02	3.94E-02	2.29E-02
-0.7688	2.9509	1.74E+03	2.15E+03	5.55E+02	1.86E+03	5.67E+02	1.17E+01	8.13E+02	5.07E+03	4.08E+00	9.85E+00	4.73E-02	6.91E-01	2.06E-02	2.85E-02	1.66E-02
-2.128	0	2.49E+01	3.01E+01	3.70E+02	5.63E+02	3.78E+02	7.78E+00	5.42E+02	2.85E+03	2.72E+00	2.37E+00	3.63E-03	7.19E-04	1.37E-02	1.90E-02	1.11E-02
-1.7894	0	3.01E+01	3.59E+01	7.67E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.64E+00	3.14E+00	4.18E-03	7.10E-04	2.84E-02	3.94E-02	2.29E-02
-1.9405	0	2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.08E+00	2.74E+00	3.91E-03	7.15E-04	2.06E-02	2.85E-02	1.66E-02

Table F-1: Batch PHREEQC Model Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

Zn_ppm	Mn_ppm	Cu_ppm	B_ppm	Ba_ppm
1.23E-02	6.40E-03	1.92E-02	8.46E-02	7.49E-02
2.52E-02	1.31E-02	3.93E-02	1.73E-01	1.53E-01
5.21E-02	2.71E-02	8.13E-02	3.58E-01	3.17E-01
3.77E-02	1.96E-02	5.89E-02	2.60E-01	2.30E-01
2.52E-02	1.31E-02	3.93E-02	1.73E-01	1.04E-02
5.21E-02	2.71E-02	8.14E-02	3.58E-01	9.91E-03
3.78E-02	1.96E-02	5.89E-02	2.60E-01	1.01E-02

Table F-2: PHREEQC Model Scenario 1 Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

soln	time	pH	pe	Alk	mu	mass_H2O	charge	C	S(6)	Ca	Fe(2)	Fe(3)	m_HCO3-	m_CO3-2	m_CO2	m_O2	m_H2	Calcite	d_Calcite
25	0	7.1653	11.3285	1.62E-03	0.0549479	1.00E+00	-1.44E-07	1.82E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.52E-03	1.67E-06	2.03E-04	1.60E-14	0.00E+00	1.00E+00	2.40E-04
25	76.236	7.1653	11.5088	1.62E-03	0.0549479	1.00E+00	-1.44E-07	1.82E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.52E-03	1.67E-06	2.03E-04	8.42E-14	0.00E+00	1.00E+00	0.00E+00
25	152.472	7.16533	12.081	1.62E-03	0.0549488	1.00E+00	-1.44E-07	1.82E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.52E-03	1.67E-06	2.03E-04	1.64E-11	0.00E+00	1.00E+00	-1.60E-10
25	228.708	7.18132	12.4545	1.55E-03	0.0555677	1.00E+00	-2.55E-07	1.73E-03	1.79E-02	1.50E-02	0.00E+00	0.00E+00	1.45E-03	1.66E-06	1.87E-04	5.91E-10	0.00E+00	1.00E+00	-1.84E-08
25	304.944	7.32946	12.4042	1.12E-03	0.0624821	1.00E+00	-9.74E-07	1.20E-03	1.90E-02	1.54E-02	0.00E+00	0.00E+00	1.03E-03	1.70E-06	9.37E-05	1.45E-09	0.00E+00	1.00E+00	-4.45E-07
25	381.18	7.60952	12.1177	6.81E-04	0.0768884	1.00E+00	-1.14E-06	6.99E-04	2.39E-02	1.48E-02	0.00E+00	0.00E+00	6.11E-04	2.01E-06	2.86E-05	1.36E-09	0.00E+00	1.00E+00	-5.98E-07
25	457.416	7.77474	11.9359	0.000526	0.0866056	1.00E+00	-4.41E-07	5.28E-04	2.79E-02	1.43E-02	0.00E+00	0.00E+00	4.60E-04	2.27E-06	1.46E-05	1.17E-09	0.00E+00	1.00E+00	-1.35E-07
25	533.652	7.81558	11.8902	0.000498	0.0897339	1.00E+00	-7.81E-08	4.97E-04	2.93E-02	1.41E-02	0.00E+00	0.00E+00	4.32E-04	2.36E-06	1.24E-05	1.12E-09	0.00E+00	1.00E+00	-2.60E-08
25	609.888	7.8222	11.8827	0.000495	0.0904109	1.00E+00	9.05E-09	4.93E-04	2.96E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-4.95E-09
25	686.124	7.82312	11.8817	0.000494	0.0905284	1.00E+00	2.39E-08	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.28E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	3.28E-09
25	762.36	7.82323	11.8815	0.000494	0.0905462	1.00E+00	2.65E-08	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.28E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.47E-08
25	838.596	7.82321	11.8816	0.000494	0.0905486	1.00E+00	2.76E-08	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.28E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	3.28E-08
25	914.832	7.82314	11.8817	0.000495	0.0905489	1.00E+00	2.95E-08	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	5.16E-08
25	991.068	7.82303	11.8818	0.000495	0.0905489	1.00E+00	3.21E-08	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	6.00E-08
25	1067.3	7.82291	11.8819	0.000495	0.0905488	1.00E+00	3.58E-08	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	5.50E-08
25	1143.54	7.8228	11.882	0.000496	0.0905488	1.00E+00	3.88E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	4.28E-08
25	1219.78	7.82271	11.8821	0.000496	0.0905487	1.00E+00	4.20E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	3.00E-08
25	1296.01	7.82266	11.8822	0.000496	0.0905487	1.00E+00	4.36E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.96E-08
25	1372.25	7.82262	11.8823	0.000496	0.0905486	1.00E+00	4.55E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.23E-08
25	1448.48	7.82259	11.8823	0.000496	0.0905486	1.00E+00	4.59E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	7.45E-09
25	1524.72	7.82258	11.8823	0.000496	0.0905486	1.00E+00	4.69E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	4.42E-09
25	1600.96	7.82257	11.8823	0.000496	0.0905486	1.00E+00	4.67E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	2.58E-09
25	1677.19	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.74E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.48E-09
25	1753.43	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.70E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	8.35E-10
25	1829.66	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.75E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	4.66E-10
25	1905.9	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.72E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	2.53E-10
25	1982.14	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.74E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.37E-10
25	2058.37	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.74E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	6.84E-11
25	2134.61	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.73E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	3.49E-11
25	2210.84	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.75E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.29E-11
25	2287.08	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.72E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	5.17E-12
25	2363.32	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.77E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-2.46E-12
25	2439.55	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.70E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-3.13E-12
25	2515.79	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.78E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-5.64E-12
25	2592.02	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.69E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-5.61E-12
25	2668.26	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.79E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-5.14E-12
25	2744.5	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.68E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-6.94E-12
25	2820.73	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.80E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-3.34E-12
25	2896.97	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.68E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-8.45E-12
25	2973.2	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.79E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-7.96E-13
25	3049.44	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.69E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-1.06E-11
25	3125.68	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.78E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	2.44E-12
25	3201.91	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.71E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-1.37E-11
25	3278.15	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.76E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	6.57E-12
25	3354.38	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.73E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-1.80E-11
25	3430.62	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.73E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.20E-11
25	3506.86	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.76E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-2.43E-11
25	3583.09	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.69E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.85E-11
25	3659.33	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.80E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-3.82E-11
25	3735.56	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.66E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	3.09E-12
25	3811.8	7.82256	11.8823	0.000496	0.0905486	1.00E+00	4.83E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-1.92E-10

Table F-2: PHREEQC Model Scenario 1 Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

25	3888.04	7.82256	11.8823	0.000496	0.0905486	1	4.63E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-7.21E-10
25	3964.27	7.82256	11.8823	0.000496	0.0905486	1	4.85E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-4.12E-09
25	4040.51	7.82256	11.8823	0.000496	0.0905486	1	4.61E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-2.00E-08
25	4116.74	7.82256	11.8823	0.000496	0.0905486	1	4.84E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-8.08E-08
25	4192.98	7.82257	11.8823	0.000496	0.0905486	1	4.50E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-1.64E-07
25	4269.22	7.82261	11.8823	0.000496	0.0905487	1	4.38E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-1.57E-07
25	4345.45	7.82272	11.8821	0.000496	0.0905489	1	2.66E-08	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-5.25E-08
25	4421.69	7.82279	11.8821	0.000496	0.090549	1	9.81E-09	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-1.00E-08
25	4497.92	7.82281	11.882	0.000496	0.090549	1	3.57E-09	4.94E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-2.30E-09
25	4574.16	7.82281	11.882	0.000496	0.090549	1	1.36E-09	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-5.71E-10
25	4650.4	7.82282	11.882	0.000496	0.0905491	1	5.32E-10	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-1.26E-10
25	4726.63	7.82282	11.882	0.000496	0.0905491	1	2.05E-10	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-1.09E-11
25	4802.87	7.82282	11.882	0.000496	0.0905491	1	7.04E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.40E-11
25	4879.1	7.82282	11.882	0.000496	0.0905491	1	1.29E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.49E-11
25	4955.34	7.82282	11.882	0.000496	0.0905491	1	-1.20E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.09E-11
25	5031.58	7.82282	11.882	0.000496	0.0905491	1	-2.31E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	7.08E-12
25	5107.81	7.82282	11.882	0.000496	0.0905491	1	-2.81E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	4.32E-12
25	5184.05	7.82282	11.882	0.000496	0.0905491	1	-3.04E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	2.55E-12
25	5260.28	7.82282	11.882	0.000496	0.0905491	1	-3.15E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.49E-12
25	5336.52	7.82282	11.882	0.000496	0.0905491	1	-3.20E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	8.70E-13
25	5412.76	7.82282	11.882	0.000496	0.0905491	1	-3.22E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	4.86E-13
25	5488.99	7.82282	11.882	0.000496	0.0905491	1	-3.23E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	2.86E-13
25	5565.23	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.70E-13
25	5641.46	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.03E-13
25	5717.7	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	6.97E-14
25	5793.94	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	3.38E-14
25	5870.17	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	9.77E-15
25	5946.41	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	6.66E-15
25	6022.64	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.78E-15
25	6098.88	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-3.11E-15
25	6175.12	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	2.44E-15
25	6251.35	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-5.77E-15
25	6327.59	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-4.66E-15
25	6403.82	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-4.44E-16
25	6480.06	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-6.66E-15
25	6556.3	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-2.00E-15
25	6632.53	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-5.55E-15
25	6708.77	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-4.89E-15
25	6785	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-6.66E-16
25	6861.24	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-2.89E-15
25	6937.48	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	1.11E-15
25	7013.71	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-2.66E-15
25	7089.95	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-8.88E-15
25	7166.18	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-9.77E-15
25	7242.42	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-2.22E-15
25	7318.66	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-2.89E-15
25	7394.89	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-3.33E-15
25	7471.13	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-6.44E-15
25	7547.36	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-1.55E-15
25	7623.6	7.82282	11.882	0.000496	0.0905491	1	-3.24E-11	4.93E-04	2.97E-02	1.40E-02	0.00E+00	0.00E+00	4.29E-04	2.38E-06	1.21E-05	1.11E-09	0.00E+00	1.00E+00	-3.11E-15

Table F-2: PHREEQC Model Scenario 1 Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

Gypsum	d_Gypsum	Barite	d_Barite	Fluorite	d_Fluorite	Rhodochrosite	d_Rhodochrosite	Fe(OH)3(a)	d_Fe(OH)3(a)	si_Calcite	si_Gypsum	si_Barite	si_Fluorite	si_Rhodochrosite	si_Fe(OH)3(a)
1.00E+00	4.90E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-999.999	-999.999	-999.999	-1.00E+03
1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-999.999	-999.999	-999.999	-1.00E+03
1.00E+00	6.01E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-6.7005	-7.4566	-7.8511	-1.00E+03
1.00E+00	1.31E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-2.7452	-1.9654	-4.2857	-1.00E+03
1.01E+00	1.63E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-1.1026	-0.3256	-2.9328	-1.00E+03
1.01E+00	1.96E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.3774	0.0185	-2.3809	-1.00E+03
1.01E+00	7.39E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.1154	0.0289	-2.1872	-1.00E+03
1.01E+00	1.77E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0398	0.0153	-2.1337	-1.00E+03
1.01E+00	3.36E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0214	0.0106	-2.123	-1.00E+03
1.01E+00	5.41E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0174	0.0096	-2.1217	-1.00E+03
1.01E+00	6.91E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0166	0.0095	-2.1218	-1.00E+03
1.01E+00	-1.18E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0165	0.0095	-2.1221	-1.00E+03
1.01E+00	-3.50E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1224	-1.00E+03
1.01E+00	-4.35E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1228	-1.00E+03
1.01E+00	-4.10E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1232	-1.00E+03
1.01E+00	-3.24E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1234	-1.00E+03
1.01E+00	-2.29E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1236	-1.00E+03
1.01E+00	-1.51E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1237	-1.00E+03
1.01E+00	-9.46E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-5.74E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-3.43E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-1.98E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-1.16E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-6.28E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-3.78E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-1.75E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-1.25E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-3.11E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-4.57E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	1.02E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-1.94E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	1.73E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-6.58E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	1.18E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	4.76E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	3.98E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	1.78E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-1.44E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	3.26E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-3.10E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	4.82E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-4.74E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	6.32E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-6.15E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	7.58E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-7.13E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	8.44E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-7.47E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	9.19E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	-4.74E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03
1.01E+00	2.24E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-1.00E+03

Table F-2: PHREEQC Model Scenario 1 Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

1.01E+00	6.81E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-999.999
1.01E+00	4.03E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-999.999
1.01E+00	1.95E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-999.999
1.01E+00	7.82E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-999.999
1.01E+00	1.56E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-999.999
1.01E+00	1.43E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0095	-2.1238	-999.999
1.01E+00	4.73E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	9.35E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	2.27E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	6.17E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	1.66E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	3.71E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	1.69E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-5.88E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-5.86E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-4.26E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-2.76E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-1.69E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-1.01E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-6.00E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-3.40E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-2.01E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-1.20E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-7.31E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-4.91E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-2.42E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-7.55E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-5.11E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-1.55E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	1.78E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-1.55E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	3.77E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	2.89E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	2.22E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	4.44E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	1.33E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	3.55E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	3.33E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	6.66E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	1.78E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	-4.44E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	1.78E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	5.77E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	6.66E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	1.55E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	2.00E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	2.22E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	4.00E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	1.33E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999
1.01E+00	1.78E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0164	0.0094	-2.1238	-999.999

Table F-2: PHREEQC Model Scenario 1 Selected Output File

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

Alk_ppm	totC_ppm	Na_ppm	Ca_ppm	Mg_ppm	K_ppm	Cl_ppm	SO4_ppm	NO3_ppm	F_ppm	Al_ppm	FeIII_ppm	As_ppm	Se_ppm	U_ppm	Zn_ppm	Mn_ppm	Cu_ppm	B_ppm	Ba_ppm
8.10E+01	1.11E+02	2.98E+02	5.96E+02	0.00E+00	0.00E+00	1.80E+02	1.73E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.38E-03	1.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
8.10E+01	1.11E+02	2.98E+02	5.96E+02	0.00E+00	0.00E+00	1.80E+02	1.73E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.38E-03	1.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
8.10E+01	1.11E+02	2.98E+02	5.96E+02	3.39E-04	3.55E-06	1.80E+02	1.73E+03	3.53E-04	3.13E-04	0.00E+00	0.00E+00	4.38E-03	1.00E-03	1.49E-07	8.14E-10	2.62E-08	0.00E+00	2.27E-05	2.15E-09
7.75E+01	1.05E+02	3.02E+02	6.01E+02	1.78E+00	2.19E-02	2.06E+02	1.72E+03	1.96E-01	1.74E-01	0.00E+00	0.00E+00	4.00E-03	2.31E-03	1.91E-04	1.01E-05	9.72E-05	0.00E+00	1.26E-02	1.95E-05
5.58E+01	7.33E+01	3.32E+02	6.16E+02	5.28E+01	7.07E-01	3.61E+02	1.83E+03	1.35E+00	1.20E+00	0.00E+00	0.00E+00	1.67E-03	9.97E-03	2.33E-03	4.59E-04	2.24E-03	2.00E-18	8.63E-02	8.71E-04
3.41E+01	4.27E+01	3.61E+02	5.94E+02	2.09E+02	3.17E+00	4.94E+02	2.29E+03	2.34E+00	2.08E+00	0.00E+00	0.00E+00	2.83E-04	1.66E-02	7.42E-03	2.75E-03	7.63E-03	5.75E-12	1.50E-01	4.52E-03
2.63E+01	3.22E+01	3.70E+02	5.72E+02	3.28E+02	5.77E+00	5.35E+02	2.68E+03	2.64E+00	2.35E+00	0.00E+00	0.00E+00	1.20E-04	1.86E-02	1.07E-02	7.86E-03	1.14E-02	3.41E-08	1.69E-01	8.05E-03
2.49E+01	3.03E+01	3.71E+02	5.64E+02	3.67E+02	7.12E+00	5.41E+02	2.82E+03	2.69E+00	2.39E+00	0.00E+00	0.00E+00	1.01E-04	1.90E-02	1.14E-02	1.57E-02	1.28E-02	3.03E-06	1.73E-01	9.50E-03
2.48E+01	3.01E+01	3.71E+02	5.63E+02	3.76E+02	7.61E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	9.80E-05	1.90E-02	1.13E-02	2.23E-02	1.30E-02	4.51E-05	1.73E-01	9.89E-03
2.47E+01	3.01E+01	3.71E+02	5.63E+02	3.78E+02	7.75E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	9.77E-05	1.90E-02	1.12E-02	2.59E-02	1.31E-02	2.88E-04	1.73E-01	9.98E-03
2.47E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.79E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	9.75E-05	1.90E-02	1.12E-02	2.72E-02	1.31E-02	1.14E-03	1.73E-01	1.00E-02
2.47E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	9.71E-05	1.90E-02	1.12E-02	2.74E-02	1.31E-02	3.29E-03	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	9.63E-05	1.90E-02	1.11E-02	2.71E-02	1.30E-02	7.34E-03	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	9.49E-05	1.90E-02	1.11E-02	2.65E-02	1.30E-02	1.31E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	9.33E-05	1.90E-02	1.11E-02	2.60E-02	1.30E-02	1.94E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	9.19E-05	1.90E-02	1.10E-02	2.56E-02	1.30E-02	2.50E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	9.09E-05	1.90E-02	1.10E-02	2.53E-02	1.30E-02	2.93E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	9.01E-05	1.90E-02	1.10E-02	2.52E-02	1.30E-02	3.23E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.97E-05	1.90E-02	1.10E-02	2.51E-02	1.30E-02	3.43E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.94E-05	1.90E-02	1.10E-02	2.51E-02	1.30E-02	3.55E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.92E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.63E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.91E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.67E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.91E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.70E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.91E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.71E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.91E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.72E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.91E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.91E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.91E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.91E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.91E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.91E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.91E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.91E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.91E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.91E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.92E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.92E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.92E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.92E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.92E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.92E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.92E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.92E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.92E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.92E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.92E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.93E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.93E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.93E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	8.94E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02

Table F-2: PHREEQC Model Scenario 1 Selected Output File

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	9.02E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	9.41E-05	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.15E-04	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	2.24E-04	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.73E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	7.80E-04	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.74E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	3.31E-03	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.76E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	9.14E-03	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.81E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.24E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.85E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.34E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.88E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.38E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.89E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.39E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.89E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02
2.48E+01	3.01E+01	3.71E+02	5.62E+02	3.78E+02	7.80E+00	5.42E+02	2.85E+03	2.70E+00	2.40E+00	0.00E+00	0.00E+00	1.40E-02	1.90E-02	1.10E-02	2.50E-02	1.30E-02	3.90E-02	1.73E-01	1.00E-02

Table F-3: PHREEQC Model Scenario 2a Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

soln	time	pH	pe	Alk	mu	mass_H2O	charge	C	S(6)	Ca	Fe(2)	Fe(3)	m_HCO3-	m_CO3-2	m_CO2	m_O2	m_H2	Calcite	d_Calcite
25	0	7.1653	11.3285	1.62E-03	0.0549479	1.00E+00	-1.44E-07	1.82E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.52E-03	1.67E-06	2.03E-04	1.60E-14	0.00E+00	1.00E+00	2.40E-04
25	78.546	7.1653	11.4496	1.62E-03	0.0549479	1.00E+00	-1.44E-07	1.82E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.52E-03	1.67E-06	2.03E-04	4.88E-14	0.00E+00	1.00E+00	-4.00E-15
25	157.092	7.1653	11.5053	1.62E-03	0.0549479	1.00E+00	-1.44E-07	1.82E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.52E-03	1.67E-06	2.03E-04	8.15E-14	0.00E+00	1.00E+00	-1.33E-15
25	235.638	7.1653	11.5168	1.62E-03	0.0549479	1.00E+00	-1.44E-07	1.82E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.52E-03	1.67E-06	2.03E-04	9.06E-14	0.00E+00	1.00E+00	0.00E+00
25	314.184	7.1653	11.5382	1.62E-03	0.0549479	1.00E+00	-1.44E-07	1.82E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.52E-03	1.67E-06	2.03E-04	1.10E-13	0.00E+00	1.00E+00	-2.22E-16
25	392.73	7.1653	11.8106	1.62E-03	0.0549479	1.00E+00	-1.44E-07	1.82E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.52E-03	1.67E-06	2.03E-04	1.36E-12	0.00E+00	1.00E+00	-7.84E-14
25	471.276	7.16531	12.1263	0.001619	0.0549505	1.00E+00	-1.45E-07	1.82E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.52E-03	1.67E-06	2.03E-04	2.48E-11	0.00E+00	1.00E+00	2.88E-11
25	549.822	7.16561	12.314	0.001617	0.0550072	1.00E+00	-1.54E-07	1.81E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.51E-03	1.67E-06	2.03E-04	1.40E-10	0.00E+00	1.00E+00	2.22E-09
25	628.368	7.16792	12.4331	0.001601	0.0554205	1.00E+00	-2.14E-07	1.79E-03	1.80E-02	1.50E-02	0.00E+00	0.00E+00	1.50E-03	1.66E-06	2.00E-04	4.29E-10	0.00E+00	1.00E+00	2.81E-08
25	706.914	7.17747	12.504	0.001553	0.056994	1.00E+00	-4.02E-07	1.74E-03	1.80E-02	1.52E-02	0.00E+00	0.00E+00	1.45E-03	1.65E-06	1.89E-04	9.00E-10	0.00E+00	1.00E+00	1.37E-07
25	785.46	7.20399	12.5293	0.00146	0.0609526	1.00E+00	-7.75E-07	1.62E-03	1.84E-02	1.54E-02	0.00E+00	0.00E+00	1.36E-03	1.67E-06	1.65E-04	1.45E-09	0.00E+00	1.00E+00	2.98E-07
25	864.006	7.25921	12.5038	0.001328	0.0684248	1.00E+00	-1.29E-06	1.45E-03	1.98E-02	1.56E-02	0.00E+00	0.00E+00	1.22E-03	1.75E-06	1.30E-04	1.90E-09	0.00E+00	1.00E+00	1.59E-07
25	942.552	7.34826	12.427	0.001174	0.0796703	1.00E+00	-1.79E-06	1.26E-03	2.27E-02	1.54E-02	0.00E+00	0.00E+00	1.07E-03	1.94E-06	9.13E-05	2.12E-09	0.00E+00	1.00E+00	-4.21E-07
25	1021.1	7.46118	12.3142	0.001018	0.0934466	1.00E+00	-2.05E-06	1.07E-03	2.70E-02	1.49E-02	0.00E+00	0.00E+00	9.13E-04	2.22E-06	5.92E-05	2.12E-09	0.00E+00	1.00E+00	-7.84E-07
25	1099.64	7.57693	12.1922	0.000879	0.107307	1.00E+00	-1.97E-06	9.03E-04	3.18E-02	1.44E-02	0.00E+00	0.00E+00	7.74E-04	2.54E-06	3.79E-05	1.99E-09	0.00E+00	1.00E+00	-6.82E-07
25	1178.19	7.67675	12.0844	0.000771	0.119043	1.00E+00	-1.65E-06	7.81E-04	3.63E-02	1.39E-02	0.00E+00	0.00E+00	6.68E-04	2.82E-06	2.57E-05	1.84E-09	0.00E+00	1.00E+00	-4.51E-07
25	1256.74	7.75183	12.0023	0.000698	0.12773	1.00E+00	-1.22E-06	6.99E-04	3.98E-02	1.36E-02	0.00E+00	0.00E+00	5.95E-04	3.04E-06	1.91E-05	1.72E-09	0.00E+00	1.00E+00	-2.72E-07
25	1335.28	7.80241	11.9466	0.000652	0.13355	1.00E+00	-8.11E-07	6.49E-04	4.22E-02	1.34E-02	0.00E+00	0.00E+00	5.50E-04	3.19E-06	1.57E-05	1.64E-09	0.00E+00	1.00E+00	-1.59E-07
25	1413.83	7.83358	11.9121	0.000625	0.137169	1.00E+00	-4.89E-07	6.19E-04	4.37E-02	1.33E-02	0.00E+00	0.00E+00	5.24E-04	3.29E-06	1.39E-05	1.59E-09	0.00E+00	1.00E+00	-8.93E-08
25	1492.37	7.8515	11.8922	0.000611	0.139295	1.00E+00	-2.63E-07	6.03E-04	4.47E-02	1.33E-02	0.00E+00	0.00E+00	5.09E-04	3.34E-06	1.29E-05	1.56E-09	0.00E+00	1.00E+00	-4.41E-08
25	1570.92	7.86124	11.8814	0.000603	0.140489	1.00E+00	-1.16E-07	5.95E-04	4.52E-02	1.32E-02	0.00E+00	0.00E+00	5.02E-04	3.37E-06	1.24E-05	1.55E-09	0.00E+00	1.00E+00	-1.10E-08
25	1649.47	7.86631	11.8757	0.000599	0.141135	1.00E+00	-2.76E-08	5.91E-04	4.55E-02	1.32E-02	0.00E+00	0.00E+00	4.98E-04	3.39E-06	1.22E-05	1.54E-09	0.00E+00	1.00E+00	1.83E-08
25	1728.01	7.86885	11.8729	0.000598	0.141474	1.00E+00	2.35E-08	5.89E-04	4.56E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.40E-06	1.21E-05	1.53E-09	0.00E+00	1.00E+00	4.76E-08
25	1806.56	7.87005	11.8715	0.000597	0.141648	1.00E+00	5.26E-08	5.88E-04	4.57E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	7.60E-08
25	1885.1	7.87058	11.8709	0.000597	0.141735	1.00E+00	6.93E-08	5.88E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.95E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	9.98E-08
25	1963.65	7.87076	11.8707	0.000597	0.141778	1.00E+00	7.96E-08	5.88E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.95E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	1.15E-07
25	2042.2	7.87078	11.8707	0.000597	0.141798	1.00E+00	8.73E-08	5.88E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.95E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	1.21E-07
25	2120.74	7.87071	11.8708	0.000598	0.141808	1.00E+00	9.36E-08	5.88E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.95E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	1.18E-07
25	2199.29	7.87061	11.8709	0.000598	0.141812	1.00E+00	9.90E-08	5.88E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.95E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	1.08E-07
25	2277.83	7.87051	11.871	0.000598	0.141814	1.00E+00	1.04E-07	5.88E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	9.61E-08
25	2356.38	7.87041	11.8712	0.000599	0.141815	1.00E+00	1.09E-07	5.88E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	8.24E-08
25	2434.93	7.87032	11.8713	0.000599	0.141816	1.00E+00	1.13E-07	5.88E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	6.89E-08
25	2513.47	7.87024	11.8714	0.000599	0.141816	1.00E+00	1.16E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	5.65E-08
25	2592.02	7.87017	11.8714	0.000599	0.141816	1.00E+00	1.19E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	4.56E-08
25	2670.56	7.87012	11.8715	0.000599	0.141816	1.00E+00	1.21E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	3.63E-08
25	2749.11	7.87008	11.8715	0.0006	0.141816	1.00E+00	1.23E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	2.86E-08
25	2827.66	7.87005	11.8716	0.0006	0.141816	1.00E+00	1.25E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	2.24E-08
25	2906.2	7.87002	11.8716	0.0006	0.141816	1.00E+00	1.26E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	1.74E-08
25	2984.75	7.87	11.8716	0.0006	0.141816	1.00E+00	1.27E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	1.34E-08
25	3063.29	7.86998	11.8716	0.0006	0.141816	1.00E+00	1.28E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	1.03E-08
25	3141.84	7.86997	11.8717	0.0006	0.141816	1.00E+00	1.28E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	7.82E-09
25	3220.39	7.86996	11.8717	0.0006	0.141816	1.00E+00	1.29E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	5.94E-09
25	3298.93	7.86996	11.8717	0.0006	0.141816	1.00E+00	1.29E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	4.49E-09
25	3377.48	7.86995	11.8717	0.0006	0.141816	1.00E+00	1.29E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	3.38E-09
25	3456.02	7.86995	11.8717	0.0006	0.141816	1.00E+00	1.29E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	2.53E-09
25	3534.57	7.86994	11.8717	0.0006	0.141816	1.00E+00	1.30E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	1.89E-09
25	3613.12	7.86994	11.8717	0.0006	0.141816	1.00E+00	1.30E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	1.41E-09
25	3691.66	7.86994	11.8717	0.0006	0.141816	1.00E+00	1.29E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	1.05E-09
25	3770.21	7.86994	11.8717	0.0006	0.141816	1.00E+00	1.30E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	7.73E-10
25	3848.75	7.86994	11.8717	0.0006	0.141816	1.00E+00	1.30E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	5.68E-10
25	3927.3	7.86994	11.8717	0.0006	0.141816	1.00E+00	1.30E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	4.15E-10

Table F-3: PHREEQC Model Scenario 2a Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

25	4005.85	7.86994	11.8717	0.0006	0.141816	1	1.29E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	3.03E-10
25	4084.39	7.86994	11.8717	0.0006	0.141816	1	1.30E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	2.20E-10
25	4162.94	7.86994	11.8717	0.0006	0.141816	1	1.30E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	1.56E-10
25	4241.48	7.86994	11.8717	0.0006	0.141816	1	1.29E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	1.11E-10
25	4320.03	7.86993	11.8717	0.0006	0.141816	1	1.30E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	7.95E-11
25	4398.58	7.86993	11.8717	0.0006	0.141816	1	1.30E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	5.39E-11
25	4477.12	7.86993	11.8717	0.0006	0.141816	1	1.30E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	3.35E-11
25	4555.67	7.86993	11.8717	0.0006	0.141816	1	1.29E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	2.25E-11
25	4634.21	7.86993	11.8717	0.0006	0.141816	1	1.30E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	1.53E-11
25	4712.76	7.86993	11.8717	0.0006	0.141816	1	1.31E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	5.06E-12
25	4791.31	7.86993	11.8717	0.0006	0.141816	1	1.29E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	-1.47E-12
25	4869.85	7.86993	11.8717	0.0006	0.141816	1	1.29E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	-1.97E-13
25	4948.4	7.86993	11.8717	0.0006	0.141816	1	1.31E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	-2.64E-12
25	5026.94	7.86993	11.8717	0.0006	0.141816	1	1.30E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	-1.04E-11
25	5105.49	7.86993	11.8717	0.0006	0.141816	1	1.29E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	-9.37E-12
25	5184.04	7.86993	11.8717	0.0006	0.141816	1	1.30E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	-3.66E-12
25	5262.58	7.86993	11.8717	0.0006	0.141816	1	1.31E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	-9.84E-12
25	5341.13	7.86993	11.8717	0.0006	0.141816	1	1.30E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	-1.60E-11
25	5419.67	7.86993	11.8717	0.0006	0.141816	1	1.29E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	-6.90E-12
25	5498.22	7.86993	11.8717	0.0006	0.141816	1	1.30E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	-3.74E-12
25	5576.77	7.86993	11.8717	0.0006	0.141816	1	1.31E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	-1.70E-11
25	5655.31	7.86994	11.8717	0.0006	0.141816	1	1.29E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	-1.52E-11
25	5733.86	7.86993	11.8717	0.0006	0.141816	1	1.29E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	4.77E-13
25	5812.4	7.86993	11.8717	0.0006	0.141816	1	1.31E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	-8.84E-12
25	5890.95	7.86993	11.8717	0.0006	0.141816	1	1.31E-07	5.89E-04	4.58E-02	1.32E-02	0.00E+00	0.00E+00	4.96E-04	3.41E-06	1.20E-05	1.53E-09	0.00E+00	1.00E+00	-2.42E-11

Table F-3: PHREEQC Model Scenario 2a Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

Gypsum	d_Gypsum	Barite	d_Barite	Fluorite	d_Fluorite	Rhodochrosite	d_Rhodochrosite	Fe(OH)3(a)	d_Fe(OH)3(a)	si_Calcite	si_Gypsum	si_Barite	si_Fluorite	si_Rhodochrosite	si_Fe(OH)3(a)
1.00E+00	4.90E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-999.999	-999.999	-999.999	-1.00E+03
1.00E+00	1.55E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-999.999	-999.999	-999.999	-1.00E+03
1.00E+00	4.44E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-999.999	-999.999	-999.999	-1.00E+03
1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-999.999	-999.999	-999.999	-1.00E+03
1.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-999.999	-999.999	-999.999	-1.00E+03
1.00E+00	9.70E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-9.4372	-11.6949	-10.122	-1.00E+03
1.00E+00	2.56E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-6.6201	-7.2341	-7.4776	-1.00E+03
1.00E+00	7.82E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-4.813	-4.5984	-5.823	-1.00E+03
1.00E+00	7.97E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-3.5369	-2.891	-4.6852	-1.00E+03
1.01E+00	4.11E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-2.5885	-1.7431	-3.8662	-1.00E+03
1.01E+00	1.30E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-1.864	-0.9715	-3.2641	-1.00E+03
1.01E+00	2.73E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-1.306	-0.4794	-2.8173	-1.00E+03
1.01E+00	3.99E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.8823	-0.2007	-2.4855	-1.00E+03
1.01E+00	4.17E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.5727	-0.0673	-2.2436	-1.00E+03
1.01E+00	3.34E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.3584	-0.0144	-2.0743	-1.00E+03
1.01E+00	2.27E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.2174	0.0019	-1.9605	-1.00E+03
1.01E+00	1.42E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.128	0.0038	-1.8863	-1.00E+03
1.01E+00	8.50E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0729	0.001	-1.8396	-1.00E+03
1.01E+00	4.93E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0399	-0.0027	-1.8116	-1.00E+03
1.01E+00	2.78E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0205	-0.0058	-1.7956	-1.00E+03
1.01E+00	1.53E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0095	-0.0081	-1.7871	-1.00E+03
1.01E+00	8.20E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0033	-0.0096	-1.7828	-1.00E+03
1.01E+00	4.28E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.0002	-0.0105	-1.7808	-1.00E+03
1.01E+00	2.16E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.002	-0.0111	-1.7802	-1.00E+03
1.01E+00	1.04E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.003	-0.0114	-1.7801	-1.00E+03
1.01E+00	4.62E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.0035	-0.0115	-1.7804	-1.00E+03
1.01E+00	1.72E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.0037	-0.0116	-1.7807	-1.00E+03
1.01E+00	3.25E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.0039	-0.0117	-1.7811	-1.00E+03
1.01E+00	-2.93E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.0039	-0.0117	-1.7814	-1.00E+03
1.01E+00	-5.24E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7816	-1.00E+03
1.01E+00	-5.69E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7818	-1.00E+03
1.01E+00	-5.30E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.782	-1.00E+03
1.01E+00	-4.59E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7821	-1.00E+03
1.01E+00	-3.82E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7822	-1.00E+03
1.01E+00	-3.10E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7822	-1.00E+03
1.01E+00	-2.47E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7823	-1.00E+03
1.01E+00	-1.94E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7823	-1.00E+03
1.01E+00	-1.51E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7823	-1.00E+03
1.01E+00	-1.17E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-1.00E+03
1.01E+00	-8.97E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-1.00E+03
1.01E+00	-6.85E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-1.00E+03
1.01E+00	-5.21E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-1.00E+03
1.01E+00	-3.93E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-1.00E+03
1.01E+00	-2.96E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-1.00E+03
1.01E+00	-2.23E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-1.00E+03
1.01E+00	-1.67E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-1.00E+03
1.01E+00	-1.23E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-1.00E+03
1.01E+00	-9.14E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-1.00E+03
1.01E+00	-6.89E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-1.00E+03
1.01E+00	-4.97E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-1.00E+03
1.01E+00	-3.50E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-1.00E+03

Table F-3: PHREEQC Model Scenario 2a Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

1.01E+00	-2.70E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	-2.04E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	-1.26E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	-8.49E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	-8.37E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	-5.29E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	-8.13E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	-1.70E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	-3.52E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	3.46E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	2.69E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	-1.43E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	-1.85E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	3.58E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	2.65E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	-3.06E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	3.18E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	5.71E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	1.54E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	-4.17E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	3.93E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	5.90E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	-4.03E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	-2.77E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999
1.01E+00	8.16E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	0.004	-0.0117	-1.7824	-999.999

Table F-3: PHREEQC Model Scenario 2a Selected Output File

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

Alk_ppm	totC_ppm	Na_ppm	Ca_ppm	Mg_ppm	K_ppm	Cl_ppm	SO4_ppm	NO3_ppm	F_ppm	Al_ppm	FeIII_ppm	As_ppm	Se_ppm	U_ppm	Zn_ppm	Mn_ppm	Cu_ppm	B_ppm	Ba_ppm
8.10E+01	1.11E+02	2.98E+02	5.96E+02	0.00E+00	0.00E+00	1.80E+02	1.73E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.38E-03	1.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
8.10E+01	1.11E+02	2.98E+02	5.96E+02	0.00E+00	0.00E+00	1.80E+02	1.73E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.38E-03	1.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
8.10E+01	1.11E+02	2.98E+02	5.96E+02	0.00E+00	0.00E+00	1.80E+02	1.73E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.38E-03	1.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
8.10E+01	1.11E+02	2.98E+02	5.96E+02	0.00E+00	0.00E+00	1.80E+02	1.73E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.38E-03	1.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
8.10E+01	1.11E+02	2.98E+02	5.96E+02	0.00E+00	0.00E+00	1.80E+02	1.73E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.38E-03	1.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
8.10E+01	1.11E+02	2.98E+02	5.96E+02	1.58E-06	1.43E-08	1.80E+02	1.73E+03	4.31E-06	2.38E-06	0.00E+00	0.00E+00	4.38E-03	1.00E-03	1.32E-09	2.74E-12	1.40E-10	0.00E+00	2.76E-07	3.94E-12
8.10E+01	1.11E+02	2.98E+02	5.96E+02	8.11E-04	7.95E-06	1.80E+02	1.73E+03	7.33E-04	4.04E-04	0.00E+00	0.00E+00	4.38E-03	1.01E-03	3.75E-07	2.21E-09	6.19E-08	0.00E+00	4.69E-05	2.59E-09
8.09E+01	1.11E+02	2.98E+02	5.97E+02	4.19E-02	4.34E-04	1.82E+02	1.73E+03	1.52E-02	8.40E-03	0.00E+00	0.00E+00	4.37E-03	1.10E-03	1.16E-05	1.68E-07	2.80E-06	0.00E+00	9.73E-04	1.66E-07
8.02E+01	1.09E+02	3.03E+02	6.00E+02	6.52E-01	6.99E-03	1.98E+02	1.73E+03	1.09E-01	5.99E-02	0.00E+00	0.00E+00	4.29E-03	1.74E-03	1.14E-04	3.61E-06	3.86E-05	0.00E+00	6.94E-03	3.15E-06
7.78E+01	1.06E+02	3.19E+02	6.07E+02	4.87E+00	5.32E-02	2.48E+02	1.73E+03	4.06E-01	2.24E-01	0.00E+00	0.00E+00	3.99E-03	3.76E-03	5.68E-04	3.52E-05	2.58E-04	0.00E+00	2.60E-02	2.82E-05
7.31E+01	9.87E+01	3.56E+02	6.19E+02	2.20E+01	2.43E-01	3.48E+02	1.77E+03	1.00E+00	5.53E-01	0.00E+00	0.00E+00	3.32E-03	7.79E-03	1.82E-03	2.00E-04	1.06E-03	6.10E-20	6.39E-02	1.51E-04
6.64E+01	8.84E+01	4.17E+02	6.24E+02	6.84E+01	7.70E-01	4.91E+02	1.90E+03	1.85E+00	1.02E+00	0.00E+00	0.00E+00	2.29E-03	1.35E-02	4.36E-03	7.57E-04	2.99E-03	2.63E-17	1.18E-01	5.50E-04
5.87E+01	7.66E+01	4.92E+02	6.16E+02	1.57E+02	1.83E+00	6.50E+02	2.18E+03	2.79E+00	1.54E+00	0.00E+00	0.00E+00	1.24E-03	1.99E-02	8.33E-03	2.07E-03	6.34E-03	1.19E-14	1.79E-01	1.45E-03
5.09E+01	6.50E+01	5.68E+02	5.97E+02	2.82E+02	3.49E+00	7.98E+02	2.59E+03	3.67E+00	2.03E+00	0.00E+00	0.00E+00	5.94E-04	2.59E-02	1.29E-02	4.38E-03	1.07E-02	3.66E-12	2.34E-01	2.89E-03
4.40E+01	5.51E+01	6.34E+02	5.76E+02	4.18E+02	5.57E+00	9.15E+02	3.06E+03	4.37E+00	2.42E+00	0.00E+00	0.00E+00	3.08E-04	3.06E-02	1.70E-02	7.71E-03	1.52E-02	5.14E-10	2.79E-01	4.61E-03
3.86E+01	4.77E+01	6.84E+02	5.59E+02	5.38E+02	7.77E+00	9.99E+02	3.49E+03	4.86E+00	2.69E+00	0.00E+00	0.00E+00	1.89E-04	3.40E-02	1.99E-02	1.22E-02	1.91E-02	2.91E-08	3.11E-01	6.25E-03
3.49E+01	4.27E+01	7.18E+02	5.47E+02	6.29E+02	9.83E+00	1.05E+03	3.82E+03	5.18E+00	2.87E+00	0.00E+00	0.00E+00	1.38E-04	3.62E-02	2.18E-02	1.84E-02	2.21E-02	7.10E-07	3.31E-01	7.56E-03
3.26E+01	3.96E+01	7.39E+02	5.39E+02	6.92E+02	1.16E+01	1.09E+03	4.05E+03	5.38E+00	2.98E+00	0.00E+00	0.00E+00	1.13E-04	3.75E-02	2.29E-02	2.60E-02	2.42E-02	8.49E-06	3.44E-01	8.50E-03
3.13E+01	3.78E+01	7.51E+02	5.34E+02	7.31E+02	1.29E+01	1.10E+03	4.20E+03	5.49E+00	3.04E+00	0.00E+00	0.00E+00	1.01E-04	3.82E-02	2.34E-02	3.44E-02	2.56E-02	5.71E-05	3.51E-01	9.11E-03
3.06E+01	3.68E+01	7.58E+02	5.31E+02	7.55E+02	1.39E+01	1.11E+03	4.29E+03	5.54E+00	3.07E+00	0.00E+00	0.00E+00	9.48E-05	3.86E-02	2.35E-02	4.22E-02	2.64E-02	2.48E-04	3.54E-01	9.49E-03
3.02E+01	3.63E+01	7.62E+02	5.30E+02	7.68E+02	1.47E+01	1.12E+03	4.34E+03	5.57E+00	3.09E+00	0.00E+00	0.00E+00	9.17E-05	3.88E-02	2.35E-02	4.86E-02	2.68E-02	7.79E-04	3.56E-01	9.72E-03
3.00E+01	3.61E+01	7.64E+02	5.29E+02	7.75E+02	1.52E+01	1.12E+03	4.37E+03	5.59E+00	3.09E+00	0.00E+00	0.00E+00	9.01E-05	3.89E-02	2.35E-02	5.32E-02	2.70E-02	1.94E-03	3.57E-01	9.85E-03
2.99E+01	3.59E+01	7.64E+02	5.28E+02	7.79E+02	1.55E+01	1.12E+03	4.38E+03	5.59E+00	3.10E+00	0.00E+00	0.00E+00	8.92E-05	3.90E-02	2.34E-02	5.62E-02	2.71E-02	4.07E-03	3.58E-01	9.92E-03
2.99E+01	3.59E+01	7.65E+02	5.28E+02	7.81E+02	1.57E+01	1.12E+03	4.39E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.85E-05	3.90E-02	2.33E-02	5.76E-02	2.72E-02	7.45E-03	3.58E-01	9.96E-03
2.99E+01	3.59E+01	7.65E+02	5.28E+02	7.82E+02	1.59E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.80E-05	3.90E-02	2.33E-02	5.80E-02	2.72E-02	1.22E-02	3.58E-01	9.98E-03
2.99E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.60E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.73E-05	3.90E-02	2.32E-02	5.76E-02	2.71E-02	1.82E-02	3.58E-01	9.99E-03
2.99E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.60E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.66E-05	3.90E-02	2.32E-02	5.68E-02	2.71E-02	2.50E-02	3.58E-01	9.99E-03
2.99E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.59E-05	3.90E-02	2.31E-02	5.59E-02	2.71E-02	3.22E-02	3.58E-01	1.00E-02
2.99E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.52E-05	3.90E-02	2.31E-02	5.51E-02	2.71E-02	3.92E-02	3.58E-01	1.00E-02
2.99E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.45E-05	3.90E-02	2.31E-02	5.44E-02	2.71E-02	4.58E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.39E-05	3.90E-02	2.31E-02	5.38E-02	2.70E-02	5.18E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.34E-05	3.90E-02	2.30E-02	5.34E-02	2.70E-02	5.69E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.30E-05	3.90E-02	2.30E-02	5.30E-02	2.70E-02	6.13E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.27E-05	3.90E-02	2.30E-02	5.28E-02	2.70E-02	6.49E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.24E-05	3.90E-02	2.30E-02	5.26E-02	2.70E-02	6.78E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.22E-05	3.90E-02	2.30E-02	5.24E-02	2.70E-02	7.01E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.21E-05	3.90E-02	2.30E-02	5.23E-02	2.70E-02	7.20E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.19E-05	3.90E-02	2.30E-02	5.22E-02	2.70E-02	7.34E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.18E-05	3.90E-02	2.30E-02	5.22E-02	2.70E-02	7.45E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.18E-05	3.90E-02	2.30E-02	5.21E-02	2.70E-02	7.54E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.21E-02	2.70E-02	7.61E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.66E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.70E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.73E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.75E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.76E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.78E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.79E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.79E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.80E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.80E-02	3.58E-01	1.00E-02

Table F-3: PHREEQC Model Scenario 2a Selected Output File

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.80E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.16E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02
3.00E+01	3.59E+01	7.65E+02	5.28E+02	7.83E+02	1.61E+01	1.12E+03	4.40E+03	5.60E+00	3.10E+00	0.00E+00	0.00E+00	8.17E-05	3.90E-02	2.30E-02	5.20E-02	2.70E-02	7.81E-02	3.58E-01	1.00E-02

Table F-4: PHREEQC Model Scenario 2b Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

soln	time	pH	pe	Alk	mu	mass_H2O	charge	C	S(6)	Ca	Fe(2)	Fe(3)	m_HCO3-	m_CO3-2	m_CO2	m_O2	m_H2	Calcite	d_Calcite
25	0	7.1653	11.3285	1.62E-03	0.0549479	1.00E+00	-1.44E-07	1.82E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.52E-03	1.67E-06	2.03E-04	1.60E-14	0.00E+00	1.00E+00	2.40E-04
25	75.348	7.1653	11.4868	1.62E-03	0.0549479	1.00E+00	-1.44E-07	1.82E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.52E-03	1.67E-06	2.03E-04	6.87E-14	0.00E+00	1.00E+00	-2.89E-15
25	150.696	7.1653	11.5383	1.62E-03	0.0549479	1.00E+00	-1.44E-07	1.82E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.52E-03	1.67E-06	2.03E-04	1.10E-13	0.00E+00	1.00E+00	-6.66E-16
25	226.044	7.1653	11.5765	1.62E-03	0.0549479	1.00E+00	-1.44E-07	1.82E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.52E-03	1.67E-06	2.03E-04	1.57E-13	0.00E+00	1.00E+00	-1.33E-14
25	301.392	7.16532	12.107	1.62E-03	0.0549496	1.00E+00	-1.44E-07	1.82E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.52E-03	1.67E-06	2.03E-04	2.08E-11	0.00E+00	1.00E+00	-7.24E-11
25	376.74	7.16662	12.3606	1.61E-03	0.0550638	1.00E+00	-1.64E-07	1.81E-03	1.80E-02	1.49E-02	0.00E+00	0.00E+00	1.51E-03	1.66E-06	2.02E-04	2.18E-10	0.00E+00	1.00E+00	1.17E-09
25	452.088	7.17938	12.4825	0.001551	0.0562181	1.00E+00	-3.24E-07	1.73E-03	1.80E-02	1.51E-02	0.00E+00	0.00E+00	1.45E-03	1.65E-06	1.88E-04	7.52E-10	0.00E+00	1.00E+00	5.07E-08
25	527.436	7.22795	12.5035	0.001384	0.0606231	1.00E+00	-7.71E-07	1.52E-03	1.84E-02	1.54E-02	0.00E+00	0.00E+00	1.29E-03	1.67E-06	1.48E-04	1.42E-09	0.00E+00	1.00E+00	9.79E-08
25	602.784	7.33533	12.423	0.001143	0.0700563	1.00E+00	-1.37E-06	1.23E-03	2.05E-02	1.54E-02	0.00E+00	0.00E+00	1.05E-03	1.80E-06	9.33E-05	1.82E-09	0.00E+00	1.00E+00	-4.09E-07
25	678.132	7.48994	12.2685	0.000904	0.0832632	1.00E+00	-1.65E-06	9.43E-04	2.46E-02	1.50E-02	0.00E+00	0.00E+00	8.15E-04	2.07E-06	4.99E-05	1.82E-09	0.00E+00	1.00E+00	-7.86E-07
25	753.48	7.64093	12.1068	0.000725	0.0960223	1.00E+00	-1.41E-06	7.40E-04	2.93E-02	1.44E-02	0.00E+00	0.00E+00	6.40E-04	2.37E-06	2.74E-05	1.64E-09	0.00E+00	1.00E+00	-5.15E-07
25	828.828	7.74703	11.9905	0.000623	0.10508	1.00E+00	-9.14E-07	6.26E-04	3.30E-02	1.40E-02	0.00E+00	0.00E+00	5.40E-04	2.61E-06	1.79E-05	1.49E-09	0.00E+00	1.00E+00	-2.46E-07
25	904.176	7.80484	11.9264	0.000575	0.110237	1.00E+00	-4.75E-07	5.73E-04	3.52E-02	1.38E-02	0.00E+00	0.00E+00	4.93E-04	2.75E-06	1.42E-05	1.40E-09	0.00E+00	1.00E+00	-1.10E-07
25	979.524	7.83117	11.8971	0.000555	0.112768	1.00E+00	-1.98E-07	5.52E-04	3.63E-02	1.37E-02	0.00E+00	0.00E+00	4.73E-04	2.82E-06	1.28E-05	1.36E-09	0.00E+00	1.00E+00	-4.70E-08
25	1054.87	7.84182	11.8852	0.000548	0.113889	1.00E+00	-5.62E-08	5.44E-04	3.68E-02	1.36E-02	0.00E+00	0.00E+00	4.66E-04	2.85E-06	1.23E-05	1.35E-09	0.00E+00	1.00E+00	-1.74E-08
25	1130.22	7.84581	11.8807	0.000546	0.11435	1.00E+00	8.11E-09	5.41E-04	3.70E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-2.61E-10
25	1205.57	7.84722	11.8791	0.000545	0.11453	1.00E+00	3.46E-08	5.40E-04	3.71E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	1.54E-08
25	1280.92	7.84769	11.8786	0.000545	0.114597	1.00E+00	4.50E-08	5.40E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.62E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	3.43E-08
25	1356.26	7.8478	11.8784	0.000545	0.114621	1.00E+00	5.01E-08	5.40E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.62E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	5.60E-08
25	1431.61	7.84778	11.8785	0.000545	0.114629	1.00E+00	5.32E-08	5.40E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.62E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	7.58E-08
25	1506.96	7.8477	11.8786	0.000545	0.114632	1.00E+00	5.60E-08	5.40E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	8.81E-08
25	1582.31	7.8476	11.8787	0.000546	0.114633	1.00E+00	5.98E-08	5.40E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	9.05E-08
25	1657.66	7.84748	11.8788	0.000546	0.114633	1.00E+00	6.36E-08	5.40E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	8.44E-08
25	1733	7.84737	11.8789	0.000546	0.114633	1.00E+00	6.72E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	7.34E-08
25	1808.35	7.84727	11.879	0.000547	0.114633	1.00E+00	7.10E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	6.05E-08
25	1883.7	7.84719	11.8791	0.000547	0.114633	1.00E+00	7.41E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	4.80E-08
25	1959.05	7.84712	11.8792	0.000547	0.114633	1.00E+00	7.63E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	3.70E-08
25	2034.4	7.84707	11.8793	0.000547	0.114633	1.00E+00	7.86E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	2.79E-08
25	2109.74	7.84703	11.8793	0.000547	0.114633	1.00E+00	8.03E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	2.07E-08
25	2185.09	7.847	11.8794	0.000547	0.114633	1.00E+00	8.10E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	1.52E-08
25	2260.44	7.84698	11.8794	0.000547	0.114633	1.00E+00	8.22E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	1.10E-08
25	2335.79	7.84697	11.8794	0.000547	0.114633	1.00E+00	8.30E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	7.87E-09
25	2411.14	7.84696	11.8794	0.000547	0.114633	1.00E+00	8.29E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	5.60E-09
25	2486.48	7.84695	11.8794	0.000547	0.114633	1.00E+00	8.35E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	3.96E-09
25	2561.83	7.84694	11.8794	0.000547	0.114633	1.00E+00	8.41E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	2.78E-09
25	2637.18	7.84694	11.8794	0.000547	0.114633	1.00E+00	8.36E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	1.94E-09
25	2712.53	7.84694	11.8794	0.000547	0.114633	1.00E+00	8.40E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	1.35E-09
25	2787.88	7.84693	11.8794	0.000547	0.114633	1.00E+00	8.45E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	9.30E-10
25	2863.22	7.84693	11.8794	0.000547	0.114633	1.00E+00	8.38E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	6.37E-10
25	2938.57	7.84693	11.8794	0.000547	0.114633	1.00E+00	8.40E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	4.36E-10
25	3013.92	7.84693	11.8794	0.000547	0.114633	1.00E+00	8.47E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	2.94E-10
25	3089.27	7.84693	11.8794	0.000547	0.114633	1.00E+00	8.39E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	1.96E-10
25	3164.62	7.84693	11.8794	0.000547	0.114633	1.00E+00	8.40E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	1.31E-10
25	3239.96	7.84693	11.8794	0.000547	0.114633	1.00E+00	8.48E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	8.47E-11
25	3315.31	7.84693	11.8794	0.000547	0.114633	1.00E+00	8.40E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	5.19E-11
25	3390.66	7.84693	11.8794	0.000547	0.114633	1.00E+00	8.39E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	3.40E-11
25	3466.01	7.84693	11.8794	0.000547	0.114633	1.00E+00	8.49E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	1.92E-11
25	3541.36	7.84693	11.8794	0.000547	0.114633	1.00E+00	8.40E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	6.84E-12
25	3616.7	7.84693	11.8794	0.000547	0.114633	1.00E+00	8.38E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	4.33E-12
25	3692.05	7.84693	11.8794	0.000547	0.114633	1.00E+00	8.50E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	2.39E-13
25	3767.4	7.84693	11.8794	0.000547	0.114633	1.00E+00	8.41E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-7.10E-12

Table F-4: PHREEQC Model Scenario 2b Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

25	3842.75	7.84693	11.8794	0.000547	0.114633	1	8.36E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-4.06E-12
25	3918.1	7.84693	11.8794	0.000547	0.114633	1	8.50E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-4.07E-12
25	3993.44	7.84693	11.8794	0.000547	0.114633	1	8.42E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-1.19E-11
25	4068.79	7.84693	11.8794	0.000547	0.114633	1	8.34E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-5.99E-12
25	4144.14	7.84693	11.8794	0.000547	0.114633	1	8.51E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-3.70E-12
25	4219.49	7.84693	11.8794	0.000547	0.114633	1	8.44E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-1.44E-11
25	4294.84	7.84693	11.8794	0.000547	0.114633	1	8.32E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-5.89E-12
25	4370.18	7.84693	11.8794	0.000547	0.114633	1	8.51E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-1.57E-12
25	4445.53	7.84693	11.8794	0.000547	0.114633	1	8.46E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-1.73E-11
25	4520.88	7.84693	11.8794	0.000547	0.114633	1	8.30E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-4.81E-12
25	4596.23	7.84693	11.8794	0.000547	0.114633	1	8.51E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	1.53E-12
25	4671.58	7.84693	11.8794	0.000547	0.114633	1	8.48E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-2.16E-11
25	4746.92	7.84693	11.8794	0.000547	0.114633	1	8.27E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-2.58E-12
25	4822.27	7.84693	11.8794	0.000547	0.114633	1	8.50E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	5.49E-12
25	4897.62	7.84693	11.8794	0.000547	0.114633	1	8.52E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-2.85E-11
25	4972.97	7.84693	11.8794	0.000547	0.114633	1	8.25E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	1.78E-12
25	5048.32	7.84693	11.8794	0.000547	0.114633	1	8.49E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	1.02E-11
25	5123.66	7.84693	11.8794	0.000547	0.114633	1	8.55E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-3.92E-11
25	5199.01	7.84693	11.8794	0.000547	0.114633	1	8.23E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	9.90E-12
25	5274.36	7.84693	11.8794	0.000547	0.114633	1	8.46E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	1.48E-11
25	5349.71	7.84693	11.8794	0.000547	0.114633	1	8.60E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-5.79E-11
25	5425.06	7.84693	11.8794	0.000547	0.114633	1	8.21E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	1.86E-11
25	5500.4	7.84693	11.8794	0.000547	0.114633	1	8.43E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-4.73E-12
25	5575.75	7.84693	11.8794	0.000547	0.114633	1	8.65E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-1.72E-10
25	5651.1	7.84693	11.8794	0.000547	0.114633	1	8.19E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-2.72E-10
25	5726.45	7.84693	11.8794	0.000547	0.114633	1	8.38E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-1.14E-09
25	5801.8	7.84693	11.8794	0.000547	0.114633	1	8.72E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-4.41E-09
25	5877.14	7.84693	11.8794	0.000547	0.114633	1	8.18E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-1.48E-08
25	5952.49	7.84693	11.8794	0.000547	0.114633	1	8.31E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-4.88E-08
25	6027.84	7.84693	11.8794	0.000547	0.114633	1	8.77E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-1.40E-07
25	6103.19	7.84694	11.8794	0.000547	0.114633	1	8.09E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-2.44E-07
25	6178.54	7.84696	11.8794	0.000547	0.114633	1	7.94E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-2.76E-07
25	6253.88	7.84703	11.8793	0.000547	0.114633	1	7.91E-08	5.41E-04	3.72E-02	1.36E-02	0.00E+00	0.00E+00	4.63E-04	2.87E-06	1.21E-05	1.34E-09	0.00E+00	1.00E+00	-2.11E-07

Table F-4: PHREEQC Model Scenario 2b Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

Gypsum	d_Gypsum	Barite	d_Barite	Fluorite	d_Fluorite	Rhodochrosite	d_Rhodochrosite	Fe(OH)3(a)	d_Fe(OH)3(a)	si_Calcite	si_Gypsum	si_Barite	si_Fluorite	si_Rhodochrosite	si_Fe(OH)3(a)
1.00E+00	4.90E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-999.999	-999.999	-999.999	-1.00E+03
1.00E+00	1.11E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-999.999	-999.999	-999.999	-1.00E+03
1.00E+00	2.22E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-999.999	-999.999	-999.999	-1.00E+03
1.00E+00	5.56E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-11.6882	-15.5705	-12.3994	-1.00E+03
1.00E+00	1.50E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-6.6606	-7.3542	-7.6359	-1.00E+03
1.00E+00	1.68E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-4.182	-3.7782	-5.3743	-1.00E+03
1.00E+00	2.52E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-2.668	-1.8629	-4.0477	-1.00E+03
1.01E+00	1.24E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-1.6667	-0.8009	-3.2145	-1.00E+03
1.01E+00	2.74E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.9909	-0.2644	-2.6798	-1.00E+03
1.01E+00	3.19E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.5512	-0.0527	-2.3408	-1.00E+03
1.01E+00	2.32E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.2884	0.0037	-2.1385	-1.00E+03
1.01E+00	1.29E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.1446	0.0076	-2.026	-1.00E+03
1.01E+00	6.36E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.071	0.0002	-1.9676	-1.00E+03
1.01E+00	2.89E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0353	-0.0065	-1.9398	-1.00E+03
1.01E+00	1.23E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0188	-0.0106	-1.9279	-1.00E+03
1.01E+00	5.00E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0115	-0.0127	-1.9235	-1.00E+03
1.01E+00	1.92E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0083	-0.0136	-1.9221	-1.00E+03
1.01E+00	6.97E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.007	-0.014	-1.9219	-1.00E+03
1.01E+00	2.19E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0065	-0.0142	-1.9221	-1.00E+03
1.01E+00	3.40E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0062	-0.0142	-1.9224	-1.00E+03
1.01E+00	-3.72E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0062	-0.0142	-1.9229	-1.00E+03
1.01E+00	-6.13E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9233	-1.00E+03
1.01E+00	-6.46E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9236	-1.00E+03
1.01E+00	-5.87E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9238	-1.00E+03
1.01E+00	-4.94E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.924	-1.00E+03
1.01E+00	-3.96E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9242	-1.00E+03
1.01E+00	-3.07E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9243	-1.00E+03
1.01E+00	-2.32E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9244	-1.00E+03
1.01E+00	-1.73E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9244	-1.00E+03
1.01E+00	-1.26E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9244	-1.00E+03
1.01E+00	-9.17E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-6.58E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-4.67E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-3.32E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-2.33E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-1.61E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-1.14E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-7.78E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-5.16E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-3.78E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-2.48E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-1.42E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-1.24E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-7.64E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-1.70E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-4.37E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-2.62E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	2.60E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-1.89E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	-1.64E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03
1.01E+00	4.35E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-1.00E+03

Table F-4: PHREEQC Model Scenario 2b Selected Output File
Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation
Navajo Refining Company, Artesia, New Mexico

1.01E+00	-1.09E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	-2.06E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	5.39E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	-6.92E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	-3.07E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	6.29E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	-2.83E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	-4.46E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	7.25E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	2.55E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	-6.20E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	8.34E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	1.00E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	-8.27E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	9.60E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	1.90E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	-1.07E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	1.11E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	2.86E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	-1.33E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	1.31E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	4.36E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	-1.37E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	2.39E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	3.61E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	9.28E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	4.41E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	1.48E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	4.79E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	1.38E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	2.37E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	2.62E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999
1.01E+00	1.95E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0	0	-0.0061	-0.0142	-1.9245	-999.999

Table F-4: PHREEQC Model Scenario 2b Selected Output File

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

Alk_ppm	totC_ppm	Na_ppm	Ca_ppm	Mg_ppm	K_ppm	Cl_ppm	SO4_ppm	NO3_ppm	F_ppm	Al_ppm	FeIII_ppm	As_ppm	Se_ppm	U_ppm	Zn_ppm	Mn_ppm	Cu_ppm	B_ppm	Ba_ppm
8.10E+01	1.11E+02	2.98E+02	5.96E+02	0.00E+00	0.00E+00	1.80E+02	1.73E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.38E-03	1.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
8.10E+01	1.11E+02	2.98E+02	5.96E+02	0.00E+00	0.00E+00	1.80E+02	1.73E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.38E-03	1.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
8.10E+01	1.11E+02	2.98E+02	5.96E+02	0.00E+00	0.00E+00	1.80E+02	1.73E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	4.38E-03	1.00E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
8.10E+01	1.11E+02	2.98E+02	5.96E+02	7.44E-09	6.61E-11	1.80E+02	1.73E+03	4.17E-08	2.74E-08	0.00E+00	0.00E+00	4.38E-03	1.00E-03	8.79E-12	9.57E-15	7.42E-13	0.00E+00	2.66E-09	2.21E-14
8.10E+01	1.11E+02	2.98E+02	5.96E+02	5.47E-04	5.54E-06	1.80E+02	1.73E+03	5.37E-04	3.52E-04	0.00E+00	0.00E+00	4.38E-03	1.00E-03	2.55E-07	1.42E-09	4.30E-08	0.00E+00	3.40E-05	2.36E-09
8.07E+01	1.10E+02	2.99E+02	5.97E+02	1.21E-01	1.34E-03	1.85E+02	1.73E+03	3.29E-02	2.16E-02	0.00E+00	0.00E+00	4.34E-03	1.22E-03	2.68E-05	5.35E-07	7.87E-06	0.00E+00	2.09E-03	7.11E-07
7.76E+01	1.06E+02	3.10E+02	6.04E+02	3.06E+00	3.55E-02	2.26E+02	1.73E+03	2.98E-01	1.95E-01	0.00E+00	0.00E+00	4.00E-03	3.03E-03	3.59E-04	1.99E-05	1.69E-04	0.00E+00	1.89E-02	2.34E-05
6.93E+01	9.30E+01	3.46E+02	6.17E+02	2.46E+01	2.94E-01	3.38E+02	1.77E+03	1.03E+00	6.74E-01	0.00E+00	0.00E+00	2.95E-03	8.00E-03	1.74E-03	2.13E-04	1.18E-03	3.82E-20	6.50E-02	2.38E-04
5.72E+01	7.49E+01	4.05E+02	6.19E+02	9.54E+01	1.19E+00	4.96E+02	1.97E+03	2.04E+00	1.35E+00	0.00E+00	0.00E+00	1.46E-03	1.50E-02	4.96E-03	1.05E-03	4.04E-03	2.00E-16	1.30E-01	1.13E-03
4.52E+01	5.76E+01	4.67E+02	6.00E+02	2.20E+02	2.94E+00	6.37E+02	2.37E+03	2.96E+00	1.95E+00	0.00E+00	0.00E+00	5.28E-04	2.12E-02	9.66E-03	3.01E-03	8.54E-03	7.80E-13	1.88E-01	3.05E-03
3.63E+01	4.52E+01	5.11E+02	5.77E+02	3.55E+02	5.20E+00	7.30E+02	2.82E+03	3.56E+00	2.34E+00	0.00E+00	0.00E+00	2.24E-04	2.53E-02	1.37E-02	6.21E-03	1.30E-02	6.07E-10	2.26E-01	5.43E-03
3.12E+01	3.82E+01	5.37E+02	5.61E+02	4.55E+02	7.37E+00	7.78E+02	3.17E+03	3.88E+00	2.55E+00	0.00E+00	0.00E+00	1.36E-04	2.75E-02	1.61E-02	1.10E-02	1.64E-02	7.23E-08	2.46E-01	7.42E-03
2.88E+01	3.50E+01	5.48E+02	5.52E+02	5.15E+02	9.05E+00	8.00E+02	3.38E+03	4.02E+00	2.65E+00	0.00E+00	0.00E+00	1.07E-04	2.84E-02	1.72E-02	1.78E-02	1.84E-02	2.02E-06	2.55E-01	8.70E-03
2.78E+01	3.37E+01	5.53E+02	5.48E+02	5.44E+02	1.02E+01	8.09E+02	3.49E+03	4.07E+00	2.68E+00	0.00E+00	0.00E+00	9.68E-05	2.88E-02	1.75E-02	2.54E-02	1.94E-02	2.11E-05	2.58E-01	9.39E-03
2.74E+01	3.32E+01	5.55E+02	5.46E+02	5.58E+02	1.09E+01	8.12E+02	3.54E+03	4.09E+00	2.69E+00	0.00E+00	0.00E+00	9.32E-05	2.89E-02	1.75E-02	3.21E-02	1.99E-02	1.16E-04	2.59E-01	9.73E-03
2.73E+01	3.30E+01	5.55E+02	5.45E+02	5.64E+02	1.13E+01	8.13E+02	3.56E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	9.19E-05	2.90E-02	1.74E-02	3.71E-02	2.01E-02	4.28E-04	2.60E-01	9.88E-03
2.73E+01	3.30E+01	5.55E+02	5.44E+02	5.66E+02	1.15E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	9.14E-05	2.90E-02	1.74E-02	4.03E-02	2.01E-02	1.20E-03	2.60E-01	9.95E-03
2.73E+01	3.29E+01	5.55E+02	5.44E+02	5.67E+02	1.16E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	9.11E-05	2.90E-02	1.73E-02	4.19E-02	2.01E-02	2.77E-03	2.60E-01	9.98E-03
2.73E+01	3.29E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	9.08E-05	2.90E-02	1.73E-02	4.24E-02	2.01E-02	5.51E-03	2.60E-01	9.99E-03
2.73E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	9.02E-05	2.90E-02	1.72E-02	4.22E-02	2.01E-02	9.64E-03	2.60E-01	1.00E-02
2.73E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.95E-05	2.90E-02	1.72E-02	4.16E-02	2.01E-02	1.50E-02	2.60E-01	1.00E-02
2.73E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.85E-05	2.90E-02	1.71E-02	4.08E-02	2.01E-02	2.12E-02	2.60E-01	1.00E-02
2.73E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.76E-05	2.90E-02	1.71E-02	4.01E-02	2.00E-02	2.75E-02	2.60E-01	1.00E-02
2.73E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.67E-05	2.90E-02	1.71E-02	3.95E-02	2.00E-02	3.35E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.59E-05	2.90E-02	1.70E-02	3.91E-02	2.00E-02	3.87E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.53E-05	2.90E-02	1.70E-02	3.88E-02	2.00E-02	4.30E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.48E-05	2.90E-02	1.70E-02	3.85E-02	2.00E-02	4.65E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.44E-05	2.90E-02	1.70E-02	3.84E-02	2.00E-02	4.92E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.42E-05	2.90E-02	1.70E-02	3.82E-02	2.00E-02	5.12E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.40E-05	2.90E-02	1.70E-02	3.82E-02	2.00E-02	5.28E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.38E-05	2.90E-02	1.70E-02	3.81E-02	2.00E-02	5.39E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.37E-05	2.90E-02	1.70E-02	3.81E-02	2.00E-02	5.47E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.53E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.57E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.60E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.35E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.62E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.35E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.63E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.35E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.64E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.35E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.65E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.35E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.65E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.35E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.35E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.35E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.35E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.35E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02

Table F-4: PHREEQC Model Scenario 2b Selected Output File

Reverse Osmosis Reject Fields Hydrogeologic and Water Quality Evaluation

Navajo Refining Company, Artesia, New Mexico

2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.36E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.37E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.37E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.37E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.37E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.37E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.37E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.37E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.37E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.37E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.37E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.37E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.37E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.37E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.37E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.38E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.38E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.40E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.46E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	8.70E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	9.56E-05	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	1.26E-04	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	2.40E-04	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.66E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	6.39E-04	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.67E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	1.97E-03	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.68E-02	2.60E-01	1.00E-02
2.74E+01	3.30E+01	5.55E+02	5.44E+02	5.67E+02	1.17E+01	8.13E+02	3.57E+03	4.10E+00	2.70E+00	0.00E+00	0.00E+00	6.34E-03	2.90E-02	1.70E-02	3.80E-02	2.00E-02	5.71E-02	2.60E-01	1.00E-02

APPENDIX B

Refinery Discharges

APPENDIX B.1

Refinery Discharges – Treated Wastewater to Injection Wells

2016 Treated Wastewater to Injection Wells
HollyFrontier Navajo Refining LLC, Artesia Refinery

Injection Well:	WDW-1	WDW-2	WDW-3	Total Bbls	Total Gal
1Q 2016	415,338	308,949	489,942	1,214,229	50,997,618
2Q 2016	417,759	331,533	483,519	1,232,811	51,778,062
3Q 2016	411,905	321,817	449,392	1,183,114	49,690,788
4Q 2016	314,259	292,360	393,438	1,000,057	42,002,394
			2016 Total Volume	**4,630,211**	**194,468,862**

HOLLYFRONTIER.

May 13, 2016

Mr. Carl Chavez, CHMM
NM Energy, Minerals & Natural Resources Department
Oil Conservation Division, Environmental Bureau
1220 South St. Francis Dr.
Santa Fe, NM 87505-5472

Certified Mail/Return Receipt
7015 3010 0000 3143 3326

RE: 2016 1st Quarter Injection Report for Wells WDW-1, WDW-2 and WDW-3, Navajo Refining Company, L.L.C.

Dear Mr. Chavez,

Enclosed, please find the first quarter 2016 sampling results for fluids injected into WDW-1, WDW-2 and WDW-3 and a spread sheet showing various volumes and pressures as required under Permit Condition 2.I.1, Quarterly Reports.

Over the first quarter, the average injection pressure for all three wells was 1338 psig and the average flows were 132 gpm for WDW-1, 98 gpm for WDW-2 and 155 gpm for WDW-3. There were no significant losses from the glycol expansion tanks Well Annulus Monitoring System (WAMS). The quarterly effluent analyses indicated parameters are within permit limits.

This report covers the period from January 1, 2016 to March 31, 2016. We have disposed a total of 1,214,229 barrels of fluid into the three wells during the first quarter of 2016. The volume per well is:

- 415,338 barrels into WDW-1
- 308,949 barrels into WDW-2
- 489,942 barrels into WDW-3

This report is signed and certified in accordance with WQCC section 5101.G. If there are any questions, please call me at 575-748-3311.

Respectfully,

Robert O'Brien
Vice-President & Refinery Manager
HollyFrontier Navajo Refining LLC

Enc.

Electronic cc (w/enc.): R Orosco, R Combs, S Denton
Environmental File: Injection Wells/Reports C-115 & Quarterly/2015/4th quarter/2016-02-05 4th QTR Inj. Rpt. for Wells WDW-1,2,3

Navajo Refining Company, L.L.C.

2016 FIRST QUARTER MONTHLY INJECTION PRESSURES, RATES, AND VOLUMES

	Average Pressure (psig)	Maximum Pressure (psig)	Minimum Pressure (psig)	Average Flow (gpm)	Maximum Flow (gpm)	Minimum Flow (gpm)	Average Annular Pressure Av (psig)	Maximum Annular Pressure Mx (psig)	Minimum Annular Pressure Mn (psig)	Average Volume (bpd)	Maximum Volume (bpd)	Minimum Volume (bpd)	Volume (barrels)	TOTAL CUMULATIVE Volume (barrels)
30-015-27592 WDW-1													**Previous Quarter**	37,535,146
Jan-16	1,377	1,400	1,312	135	209	120	411	577	199	4,629	7,166	4,114	143,486	37,678,632
Feb-16	1,399	1,400	1,383	131	142	128	401	637	222	4,491	4,869	4,389	134,743	37,813,375
Mar-16	1,389	1,400	1,335	129	133	119	284	417	178	4,423	4,560	4,080	137,109	37,950,483
30-015-20894 WDW-2													**Previous Quarter**	24,554,643
Jan-16	1,329	1,390	1,222	85	104	52	271	350	220	2,914	3,566	1,783	90,343	24,644,986
Feb-16	1,394	1,400	1,377	103	107	98	300	423	218	3,531	3,669	3,360	105,943	24,750,929
Mar-16	1,385	1,400	1,335	106	111	95	292	437	194	3,634	3,806	3,257	112,663	24,863,592
30-015-26575 WDW-3													**Previous Quarter**	14,769,763
Jan-16	1,377	1,390	1,338	152	158	139	849	965	683	5,211	5,417	4,766	161,554	14,931,317
Feb-16	1,387	1,390	1,335	156	159	143	699	768	621	5,349	5,451	4,903	160,457	15,091,774
Mar-16	1,384	1,400	1,335	158	162	147	675	732	584	5,417	5,554	5,040	167,931	15,259,706
													Total Injected fluids:	78,073,781

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

February 15, 2016

Micki Schultz
Navajo Refining Company
P.O. Box 159
Artesia, NM 88211-0159
TEL: (575) 746-5281
FAX

RE: Quarterly WDW-1, 2, & 3 Inj Well OrderNo.: 1601864

Dear Micki Schultz:

Hall Environmental Analysis Laboratory received 2 sample(s) on 1/22/2016 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Analytical Report
Lab Order **1601864**
Date Reported: **2/15/2016**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Navajo Refining Company
Project: Quarterly WDW-1, 2, & 3 Inj Well
Lab ID: 1601864-001 **Matrix:** AQUEOUS

Client Sample ID: WDW-1,2,&3 Effluent
Collection Date: 1/21/2016 7:35:00 AM
Received Date: 1/22/2016 9:40:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
IGNITABILITY METHOD 1010						Analyst: **SUB**	
Ignitability	>200	0		°F	1	1/29/2016	R32136
SULFIDE, REACTIVE						Analyst: **SUB**	
Reactive Sulfide	ND	1.0		mg/L	1	1/29/2016	R32136
SPECIFIC GRAVITY						Analyst: **JRR**	
Specific Gravity	1.006	0			1	1/27/2016 3:13:00 PM	R31723
EPA METHOD 300.0: ANIONS						Analyst: **LGT**	
Fluoride	20	2.0	*	mg/L	20	1/23/2016 12:57:44 AM	R31638
Chloride	570	25		mg/L	50	1/26/2016 11:44:39 PM	R31714
Nitrogen, Nitrite (As N)	ND	0.50		mg/L	5	1/23/2016 12:45:19 AM	R31638
Bromide	2.1	2.0		mg/L	20	1/23/2016 12:57:44 AM	R31638
Nitrogen, Nitrate (As N)	ND	0.50		mg/L	5	1/23/2016 12:45:19 AM	R31638
Phosphorus, Orthophosphate (As P)	ND	2.5		mg/L	5	1/23/2016 12:45:19 AM	R31638
Sulfate	2000	25		mg/L	50	1/26/2016 11:44:39 PM	R31714
SM2510B: SPECIFIC CONDUCTANCE						Analyst: **JRR**	
Conductivity	5600	0.010		µmhos/cm	1	1/25/2016 8:12:02 PM	R31664
SM2320B: ALKALINITY						Analyst: **JRR**	
Bicarbonate (As CaCO3)	220.4	20.00		mg/L CaCO3	1	1/25/2016 8:12:02 PM	R31664
Carbonate (As CaCO3)	ND	2.000		mg/L CaCO3	1	1/25/2016 8:12:02 PM	R31664
Total Alkalinity (as CaCO3)	220.4	20.00		mg/L CaCO3	1	1/25/2016 8:12:02 PM	R31664
SM2540C MOD: TOTAL DISSOLVED SOLIDS						Analyst: **KS**	
Total Dissolved Solids	3780	40.0	*D	mg/L	1	1/28/2016 6:43:00 PM	23428
CORROSIVITY						Analyst: **SUB**	
pH	7.16			pH Units	1	1/28/2016	R32136
CYANIDE, REACTIVE						Analyst: **SUB**	
Cyanide, Reactive	ND	1.00		mg/L	1	2/4/2016	R32136
EPA METHOD 7470: MERCURY						Analyst: **pmf**	
Mercury	ND	0.00020		mg/L	1	1/25/2016 4:48:50 PM	23378
MERCURY, TCLP						Analyst: **pmf**	
Mercury	ND	0.020		mg/L	1	1/28/2016 11:50:30 AM	23438
EPA METHOD 6010B: TCLP METALS						Analyst: **MED**	
Arsenic	ND	5.0		mg/L	1	1/25/2016 11:17:08 AM	23359
Barium	ND	100		mg/L	1	1/25/2016 11:17:08 AM	23359
Cadmium	ND	1.0		mg/L	1	1/25/2016 11:17:08 AM	23359
Chromium	ND	5.0		mg/L	1	1/25/2016 11:17:08 AM	23359

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D	Sample Diluted Due to Matrix	E	Value above quantitation range
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ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
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EPA METHOD 6010B: TCLP METALS						Analyst: **MED**	
Lead	ND	5.0		mg/L	1	1/25/2016 11:17:08 AM	23359
Selenium	ND	1.0		mg/L	1	1/25/2016 11:17:08 AM	23359
Silver	ND	5.0		mg/L	1	1/25/2016 11:17:08 AM	23359
EPA 6010B: TOTAL METALS						Analyst: **MED**	
Aluminum	1.0	0.020		mg/L	1	1/27/2016 10:18:42 AM	23359
Antimony	ND	0.050		mg/L	1	1/27/2016 10:18:42 AM	23359
Arsenic	ND	0.020		mg/L	1	1/27/2016 10:18:42 AM	23359
Barium	ND	0.020		mg/L	1	1/27/2016 10:18:42 AM	23359
Beryllium	ND	0.0030		mg/L	1	1/27/2016 10:18:42 AM	23359
Cadmium	ND	0.0020		mg/L	1	1/27/2016 10:18:42 AM	23359
Calcium	39	1.0		mg/L	1	1/27/2016 10:18:42 AM	23359
Chromium	ND	0.0060		mg/L	1	1/27/2016 10:18:42 AM	23359
Cobalt	ND	0.0060		mg/L	1	1/28/2016 10:29:14 AM	23359
Copper	0.012	0.0060		mg/L	1	1/27/2016 10:18:42 AM	23359
Iron	7.6	0.25		mg/L	5	1/27/2016 10:20:32 AM	23359
Lead	ND	0.0050		mg/L	1	1/27/2016 10:18:42 AM	23359
Magnesium	13	1.0		mg/L	1	1/27/2016 10:18:42 AM	23359
Manganese	0.15	0.0020		mg/L	1	1/27/2016 10:18:42 AM	23359
Nickel	0.042	0.010		mg/L	1	1/27/2016 10:18:42 AM	23359
Potassium	72	1.0		mg/L	1	1/27/2016 10:18:42 AM	23359
Selenium	0.53	0.050		mg/L	1	1/27/2016 10:18:42 AM	23359
Silver	ND	0.0050		mg/L	1	1/27/2016 10:18:42 AM	23359
Sodium	1200	50		mg/L	50	1/29/2016 11:10:54 AM	23359
Thallium	ND	0.050		mg/L	1	1/27/2016 10:18:42 AM	23359
Vanadium	ND	0.050		mg/L	1	1/27/2016 10:18:42 AM	23359
Zinc	0.035	0.020		mg/L	1	1/27/2016 10:18:42 AM	23359
EPA METHOD 8260B: VOLATILES						Analyst: **SUB**	
Acetonitrile	ND	12		µg/L	1	2/2/2016	R32136
Allyl chloride	ND	2.5		µg/L	1	2/2/2016	R32136
Chloroprene	ND	2.5		µg/L	1	2/2/2016	R32136
Cyclohexane	ND	2.5		µg/L	1	2/2/2016	R32136
Diethyl ether	ND	2.5		µg/L	1	2/2/2016	R32136
Diisopropyl ether	ND	2.5		µg/L	1	2/2/2016	R32136
Epichlorohydrin	ND	25		µg/L	1	2/2/2016	R32136
Ethyl acetate	ND	2.5		µg/L	1	2/2/2016	R32136
Ethyl methacrylate	ND	12		µg/L	1	2/2/2016	R32136
Ethyl tert-butyl ether	ND	2.5		µg/L	1	2/2/2016	R32136
Freon-113	ND	2.5		µg/L	1	2/2/2016	R32136

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EPA METHOD 8260B: VOLATILES							Analyst: **SUB**
Isobutanol	ND	25		µg/L	1	2/2/2016	R32136
Isopropyl acetate	ND	2.5		µg/L	1	2/2/2016	R32136
Methacrylonitrile	ND	12		µg/L	1	2/2/2016	R32136
Methyl acetate	ND	2.5		µg/L	1	2/2/2016	R32136
Methyl ethyl ketone	ND	12		µg/L	1	2/2/2016	R32136
Methyl isobutyl ketone	ND	12		µg/L	1	2/2/2016	R32136
Methyl methacrylate	ND	12		µg/L	1	2/2/2016	R32136
Methylcyclohexane	ND	5.0		µg/L	1	2/2/2016	R32136
n-Amyl acetate	ND	2.5		µg/L	1	2/2/2016	R32136
n-Hexane	ND	2.5		µg/L	1	2/2/2016	R32136
Nitrobenzene	ND	25		µg/L	1	2/2/2016	R32136
Pentachloroethane	ND	25		µg/L	1	2/2/2016	R32136
p-isopropyltoluene	ND	2.5		µg/L	1	2/2/2016	R32136
Propionitrile	ND	12		µg/L	1	2/2/2016	R32136
Tetrahydrofuran	ND	2.5		µg/L	1	2/2/2016	R32136
Benzene	ND	2.5		µg/L	1	2/2/2016	R32136
Toluene	ND	2.5		µg/L	1	2/2/2016	R32136
Ethylbenzene	ND	2.5		µg/L	1	2/2/2016	R32136
Methyl tert-butyl ether (MTBE)	3.2	2.5		µg/L	1	2/2/2016	R32136
1,2,4-Trimethylbenzene	ND	2.5		µg/L	1	2/2/2016	R32136
1,3,5-Trimethylbenzene	ND	2.5		µg/L	1	2/2/2016	R32136
1,2-Dichloroethane (EDC)	ND	2.5		µg/L	1	2/2/2016	R32136
1,2-Dibromoethane (EDB)	ND	2.5		µg/L	1	2/2/2016	R32136
Naphthalene	ND	2.5		µg/L	1	2/2/2016	R32136
Acetone	100	12		µg/L	1	2/2/2016	R32136
Bromobenzene	ND	2.5		µg/L	1	2/2/2016	R32136
Bromodichloromethane	ND	2.5		µg/L	1	2/2/2016	R32136
Bromoform	ND	2.5		µg/L	1	2/2/2016	R32136
Bromomethane	ND	2.5		µg/L	1	2/2/2016	R32136
Carbon disulfide	ND	2.5		µg/L	1	2/2/2016	R32136
Carbon Tetrachloride	ND	2.5		µg/L	1	2/2/2016	R32136
Chlorobenzene	ND	2.5		µg/L	1	2/2/2016	R32136
Chloroethane	ND	2.5		µg/L	1	2/2/2016	R32136
Chloroform	ND	2.5		µg/L	1	2/2/2016	R32136
Chloromethane	ND	2.5		µg/L	1	2/2/2016	R32136
2-Chlorotoluene	ND	2.5		µg/L	1	2/2/2016	R32136
4-Chlorotoluene	ND	2.5		µg/L	1	2/2/2016	R32136
cis-1,2-DCE	ND	2.5		µg/L	1	2/2/2016	R32136
cis-1,3-Dichloropropene	ND	2.5		µg/L	1	2/2/2016	R32136

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Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8260B: VOLATILES						Analyst: **SUB**	
1,2-Dibromo-3-chloropropane	ND	2.5		µg/L	1	2/2/2016	R32136
Dibromochloromethane	ND	2.5		µg/L	1	2/2/2016	R32136
Dibromomethane	ND	2.5		µg/L	1	2/2/2016	R32136
1,2-Dichlorobenzene	ND	2.5		µg/L	1	2/2/2016	R32136
1,3-Dichlorobenzene	ND	2.5		µg/L	1	2/2/2016	R32136
1,4-Dichlorobenzene	ND	2.5		µg/L	1	2/2/2016	R32136
Dichlorodifluoromethane	ND	2.5		µg/L	1	2/2/2016	R32136
1,1-Dichloroethane	ND	2.5		µg/L	1	2/2/2016	R32136
1,1-Dichloroethene	ND	2.5		µg/L	1	2/2/2016	R32136
1,2-Dichloropropane	ND	2.5		µg/L	1	2/2/2016	R32136
1,3-Dichloropropane	ND	2.5		µg/L	1	2/2/2016	R32136
2,2-Dichloropropane	ND	2.5		µg/L	1	2/2/2016	R32136
1,1-Dichloropropene	ND	2.5		µg/L	1	2/2/2016	R32136
Hexachlorobutadiene	ND	2.5		µg/L	1	2/2/2016	R32136
2-Hexanone	ND	2.5		µg/L	1	2/2/2016	R32136
Isopropylbenzene	ND	2.5		µg/L	1	2/2/2016	R32136
Methylene Chloride	ND	12		µg/L	1	2/2/2016	R32136
n-Butylbenzene	ND	2.5		µg/L	1	2/2/2016	R32136
n-Propylbenzene	ND	2.5		µg/L	1	2/2/2016	R32136
sec-Butylbenzene	ND	2.5		µg/L	1	2/2/2016	R32136
Styrene	ND	2.5		µg/L	1	2/2/2016	R32136
tert-Butylbenzene	ND	2.5		µg/L	1	2/2/2016	R32136
1,1,1,2-Tetrachloroethane	ND	2.5		µg/L	1	2/2/2016	R32136
1,1,2,2-Tetrachloroethane	ND	2.5		µg/L	1	2/2/2016	R32136
Tetrachloroethene (PCE)	ND	2.5		µg/L	1	2/2/2016	R32136
trans-1,2-DCE	ND	2.5		µg/L	1	2/2/2016	R32136
trans-1,3-Dichloropropene	ND	2.5		µg/L	1	2/2/2016	R32136
1,2,3-Trichlorobenzene	ND	2.5		µg/L	1	2/2/2016	R32136
1,2,4-Trichlorobenzene	ND	2.5		µg/L	1	2/2/2016	R32136
1,1,1-Trichloroethane	ND	2.5		µg/L	1	2/2/2016	R32136
1,1,2-Trichloroethane	ND	2.5		µg/L	1	2/2/2016	R32136
Trichloroethene (TCE)	ND	2.5		µg/L	1	2/2/2016	R32136
Trichlorofluoromethane	ND	2.5		µg/L	1	2/2/2016	R32136
1,2,3-Trichloropropane	ND	2.5		µg/L	1	2/2/2016	R32136
Vinyl chloride	ND	2.5		µg/L	1	2/2/2016	R32136
mp-Xylenes	ND	5.0		µg/L	1	2/2/2016	R32136
o-Xylene	ND	2.5		µg/L	1	2/2/2016	R32136
tert-Amyl methyl ether	ND	2.5		µg/L	1	2/2/2016	R32136
tert-Butyl alcohol	ND	25		µg/L	1	2/2/2016	R32136

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EPA METHOD 8260B: VOLATILES							Analyst: **SUB**
Acrolein	ND	12		µg/L	1	2/2/2016	R32136
Acrylonitrile	ND	2.5		µg/L	1	2/2/2016	R32136
Bromochloromethane	ND	2.5		µg/L	1	2/2/2016	R32136
2-Chloroethyl vinyl ether	ND	2.5		µg/L	1	2/2/2016	R32136
Iodomethane	ND	2.5		µg/L	1	2/2/2016	R32136
trans-1,4-Dichloro-2-butene	ND	2.5		µg/L	1	2/2/2016	R32136
Vinyl acetate	ND	2.5		µg/L	1	2/2/2016	R32136
1,4-Dioxane	ND	100		µg/L	1	2/2/2016	R32136
Surr: 1,2-Dichlorobenzene-d4	89.2	70-130		%Rec	1	2/2/2016	R32136
Surr: 4-Bromofluorobenzene	94.0	70-130		%Rec	1	2/2/2016	R32136
Surr: Toluene-d8	99.6	70-130		%Rec	1	2/2/2016	R32136
EPA 8270D: SEMIVOLATILES							Analyst: **SUB**
1,1-Biphenyl	ND	5.0		µg/L	1	2/2/2016	R32136
1,4-Dioxane	ND	5.0		µg/L	1	2/2/2016	R32136
Atrazine	ND	5.0		µg/L	1	2/2/2016	R32136
Benzaldehyde	ND	5.0		µg/L	1	2/2/2016	R32136
Caprolactam	ND	5.0		µg/L	1	2/2/2016	R32136
N-Nitroso-di-n-butylamine	ND	5.0		µg/L	1	2/2/2016	R32136
Acetophenone	ND	5.0		µg/L	1	2/2/2016	R32136
1-Methylnaphthalene	ND	5.0		µg/L	1	2/2/2016	R32136
2,3,4,6-Tetrachlorophenol	ND	5.0		µg/L	1	2/2/2016	R32136
2,4,5-Trichlorophenol	ND	5.0		µg/L	1	2/2/2016	R32136
2,4,6-Trichlorophenol	ND	5.0		µg/L	1	2/2/2016	R32136
2,4-Dichlorophenol	ND	5.0		µg/L	1	2/2/2016	R32136
2,4-Dimethylphenol	ND	5.0		µg/L	1	2/2/2016	R32136
2,4-Dinitrophenol	ND	5.0		µg/L	1	2/2/2016	R32136
2,4-Dinitrotoluene	ND	5.0		µg/L	1	2/2/2016	R32136
2,6-Dinitrotoluene	ND	5.0		µg/L	1	2/2/2016	R32136
2-Chloronaphthalene	ND	5.0		µg/L	1	2/2/2016	R32136
2-Chlorophenol	ND	5.0		µg/L	1	2/2/2016	R32136
2-Methylnaphthalene	ND	5.0		µg/L	1	2/2/2016	R32136
2-Methylphenol	ND	5.0		µg/L	1	2/2/2016	R32136
2-Nitroaniline	ND	5.0		µg/L	1	2/2/2016	R32136
2-Nitrophenol	ND	5.0		µg/L	1	2/2/2016	R32136
3,3´-Dichlorobenzidine	ND	5.0		µg/L	1	2/2/2016	R32136
3-Nitroaniline	ND	5.0		µg/L	1	2/2/2016	R32136
4,6-Dinitro-2-methylphenol	ND	5.0		µg/L	1	2/2/2016	R32136
4-Bromophenyl phenyl ether	ND	5.0		µg/L	1	2/2/2016	R32136
4-Chloro-3-methylphenol	ND	5.0		µg/L	1	2/2/2016	R32136

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EPA 8270D: SEMIVOLATILES						Analyst: **SUB**	
4-Chloroaniline	ND	5.0		µg/L	1	2/2/2016	R32136
4-Chlorophenyl phenyl ether	ND	5.0		µg/L	1	2/2/2016	R32136
4-Nitroaniline	ND	5.0		µg/L	1	2/2/2016	R32136
4-Nitrophenol	ND	5.0		µg/L	1	2/2/2016	R32136
Acenaphthene	ND	5.0		µg/L	1	2/2/2016	R32136
Acenaphthylene	ND	5.0		µg/L	1	2/2/2016	R32136
Anthracene	ND	5.0		µg/L	1	2/2/2016	R32136
Benzo(g,h,i)perylene	ND	5.0		µg/L	1	2/2/2016	R32136
Benz(a)anthracene	ND	0.50		µg/L	1	2/2/2016	R32136
Benzo(a)pyrene	ND	0.50		µg/L	1	2/2/2016	R32136
Benzo(b)fluoranthene	ND	0.50		µg/L	1	2/2/2016	R32136
Benzo(k)fluoranthene	ND	0.50		µg/L	1	2/2/2016	R32136
Bis(2-chloroethoxy)methane	ND	5.0		µg/L	1	2/2/2016	R32136
Bis(2-chloroethyl)ether	ND	5.0		µg/L	1	2/2/2016	R32136
Bis(2-chloroisopropyl)ether	ND	5.0		µg/L	1	2/2/2016	R32136
Bis(2-ethylhexyl)phthalate	ND	5.0		µg/L	1	2/2/2016	R32136
Butyl benzyl phthalate	ND	5.0		µg/L	1	2/2/2016	R32136
Carbazole	ND	5.0		µg/L	1	2/2/2016	R32136
Chrysene	ND	0.50		µg/L	1	2/2/2016	R32136
Dibenz(a,h)anthracene	ND	0.50		µg/L	1	2/2/2016	R32136
Dibenzofuran	ND	5.0		µg/L	1	2/2/2016	R32136
Diethyl phthalate	ND	5.0		µg/L	1	2/2/2016	R32136
Dimethyl phthalate	ND	5.0		µg/L	1	2/2/2016	R32136
Di-n-butyl phthalate	ND	5.0		µg/L	1	2/2/2016	R32136
Di-n-octyl phthalate	ND	5.0		µg/L	1	2/2/2016	R32136
Fluoranthene	ND	5.0		µg/L	1	2/2/2016	R32136
Fluorene	ND	5.0		µg/L	1	2/2/2016	R32136
Hexachlorobenzene	ND	5.0		µg/L	1	2/2/2016	R32136
Hexachlorobutadiene	ND	5.0		µg/L	1	2/2/2016	R32136
Hexachlorocyclopentadiene	ND	5.0		µg/L	1	2/2/2016	R32136
Hexachloroethane	ND	5.0		µg/L	1	2/2/2016	R32136
Indeno(1,2,3-cd)pyrene	ND	0.50		µg/L	1	2/2/2016	R32136
Isophorone	ND	5.0		µg/L	1	2/2/2016	R32136
Naphthalene	ND	5.0		µg/L	1	2/2/2016	R32136
Nitrobenzene	ND	5.0		µg/L	1	2/2/2016	R32136
N-Nitrosodi-n-propylamine	ND	5.0		µg/L	1	2/2/2016	R32136
N-Nitrosodiphenylamine	ND	5.0		µg/L	1	2/2/2016	R32136
Pentachlorophenol	ND	5.0		µg/L	1	2/2/2016	R32136
Phenanthrene	ND	5.0		µg/L	1	2/2/2016	R32136

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

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D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Navajo Refining Company
Project: Quarterly WDW-1, 2, & 3 Inj Well
Lab ID: 1601864-001 **Matrix:** AQUEOUS

Client Sample ID: WDW-1,2,&3 Effluent
Collection Date: 1/21/2016 7:35:00 AM
Received Date: 1/22/2016 9:40:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA 8270D: SEMIVOLATILES							Analyst: **SUB**
Phenol	ND	5.0		µg/L	1	2/2/2016	R32136
Pyrene	ND	5.0		µg/L	1	2/2/2016	R32136
o-Toluidine	ND	5.0		µg/L	1	2/2/2016	R32136
Pyridine	ND	5.0		µg/L	1	2/2/2016	R32136
1,2,4,5-Tetrachlorobenzene	ND	5.0		µg/L	1	2/2/2016	R32136
Surr: 2,4,6-Tribromophenol	94.2	10-123		%Rec	1	2/2/2016	R32136
Surr: 2-Fluorobiphenyl	80.4	19-130		%Rec	1	2/2/2016	R32136
Surr: 2-Fluorophenol	82.8	21-120		%Rec	1	2/2/2016	R32136
Surr: Nitrobenzene-d5	89.6	25-130		%Rec	1	2/2/2016	R32136
Surr: Phenol-d5	86.0	10-130		%Rec	1	2/2/2016	R32136
Surr: Terphenyl-d14	32.8	20-137		%Rec	1	2/2/2016	R32136

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.
D	Sample Diluted Due to Matrix
H	Holding times for preparation or analysis exceeded
ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits
S	% Recovery outside of range due to dilution or matrix
B	Analyte detected in the associated Method Blank
E	Value above quantitation range
J	Analyte detected below quantitation limits
P	Sample pH Not In Range
RL	Reporting Detection Limit
W	Sample container temperature is out of limit as specified

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Navajo Refining Company
Client Sample ID: TRIP BLANK
Project: Quarterly WDW-1, 2, & 3 Inj Well
Collection Date:
Lab ID: 1601864-002
Matrix: TRIP BLANK
Received Date: 1/22/2016 9:40:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8260B: VOLATILES						Analyst: **SUB**	
Acetonitrile	ND	2.5		µg/L	1	2/2/2016	R32136
Allyl chloride	ND	0.50		µg/L	1	2/2/2016	R32136
Chloroprene	ND	0.50		µg/L	1	2/2/2016	R32136
Cyclohexane	ND	0.50		µg/L	1	2/2/2016	R32136
Diethyl ether	ND	0.50		µg/L	1	2/2/2016	R32136
Diisopropyl ether	ND	0.50		µg/L	1	2/2/2016	R32136
Epichlorohydrin	ND	5.0		µg/L	1	2/2/2016	R32136
Ethyl acetate	ND	0.50		µg/L	1	2/2/2016	R32136
Ethyl methacrylate	ND	2.5		µg/L	1	2/2/2016	R32136
Ethyl tert-butyl ether	ND	0.50		µg/L	1	2/2/2016	R32136
Freon-113	ND	0.50		µg/L	1	2/2/2016	R32136
Isobutanol	ND	5.0		µg/L	1	2/2/2016	R32136
Isopropyl acetate	ND	0.50		µg/L	1	2/2/2016	R32136
Methacrylonitrile	ND	2.5		µg/L	1	2/2/2016	R32136
Methyl acetate	ND	0.50		µg/L	1	2/2/2016	R32136
Methyl ethyl ketone	ND	2.5		µg/L	1	2/2/2016	R32136
Methyl isobutyl ketone	ND	2.5		µg/L	1	2/2/2016	R32136
Methyl methacrylate	ND	2.5		µg/L	1	2/2/2016	R32136
Methylcyclohexane	ND	1.0		µg/L	1	2/2/2016	R32136
n-Amyl acetate	ND	0.50		µg/L	1	2/2/2016	R32136
n-Hexane	ND	0.50		µg/L	1	2/2/2016	R32136
Nitrobenzene	ND	5.0		µg/L	1	2/2/2016	R32136
Pentachloroethane	ND	5.0		µg/L	1	2/2/2016	R32136
p-isopropyltoluene	ND	0.50		µg/L	1	2/2/2016	R32136
Propionitrile	ND	2.5		µg/L	1	2/2/2016	R32136
Tetrahydrofuran	ND	0.50		µg/L	1	2/2/2016	R32136
Benzene	ND	0.50		µg/L	1	2/2/2016	R32136
Toluene	ND	0.50		µg/L	1	2/2/2016	R32136
Ethylbenzene	ND	0.50		µg/L	1	2/2/2016	R32136
Methyl tert-butyl ether (MTBE)	ND	10		µg/L	1	2/2/2016	R32136
1,2,4-Trimethylbenzene	ND	0.50		µg/L	1	2/2/2016	R32136
1,3,5-Trimethylbenzene	ND	0.50		µg/L	1	2/2/2016	R32136
1,2-Dichloroethane (EDC)	ND	0.50		µg/L	1	2/2/2016	R32136
1,2-Dibromoethane (EDB)	ND	0.50		µg/L	1	2/2/2016	R32136
Naphthalene	ND	0.50		µg/L	1	2/2/2016	R32136
Acetone	ND	2.5		µg/L	1	2/2/2016	R32136
Bromobenzene	ND	0.50		µg/L	1	2/2/2016	R32136
Bromodichloromethane	ND	0.50		µg/L	1	2/2/2016	R32136
Bromoform	ND	0.50		µg/L	1	2/2/2016	R32136

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

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D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Navajo Refining Company
Client Sample ID: TRIP BLANK
Project: Quarterly WDW-1, 2, & 3 Inj Well
Collection Date:
Lab ID: 1601864-002
Matrix: TRIP BLANK
Received Date: 1/22/2016 9:40:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8260B: VOLATILES							Analyst: **SUB**
Bromomethane	ND	0.50		µg/L	1	2/2/2016	R32136
Carbon disulfide	ND	0.50		µg/L	1	2/2/2016	R32136
Carbon Tetrachloride	ND	0.50		µg/L	1	2/2/2016	R32136
Chlorobenzene	ND	0.50		µg/L	1	2/2/2016	R32136
Chloroethane	ND	0.50		µg/L	1	2/2/2016	R32136
Chloroform	ND	0.50		µg/L	1	2/2/2016	R32136
Chloromethane	ND	0.50		µg/L	1	2/2/2016	R32136
2-Chlorotoluene	ND	0.50		µg/L	1	2/2/2016	R32136
4-Chlorotoluene	ND	0.50		µg/L	1	2/2/2016	R32136
cis-1,2-DCE	ND	0.50		µg/L	1	2/2/2016	R32136
cis-1,3-Dichloropropene	ND	0.50		µg/L	1	2/2/2016	R32136
1,2-Dibromo-3-chloropropane	ND	0.50		µg/L	1	2/2/2016	R32136
Dibromochloromethane	ND	0.50		µg/L	1	2/2/2016	R32136
Dibromomethane	ND	0.50		µg/L	1	2/2/2016	R32136
1,2-Dichlorobenzene	ND	0.50		µg/L	1	2/2/2016	R32136
1,3-Dichlorobenzene	ND	0.50		µg/L	1	2/2/2016	R32136
1,4-Dichlorobenzene	ND	0.50		µg/L	1	2/2/2016	R32136
Dichlorodifluoromethane	ND	0.50		µg/L	1	2/2/2016	R32136
1,1-Dichloroethane	ND	0.50		µg/L	1	2/2/2016	R32136
1,1-Dichloroethene	ND	0.50		µg/L	1	2/2/2016	R32136
1,2-Dichloropropane	ND	0.50		µg/L	1	2/2/2016	R32136
1,3-Dichloropropane	ND	0.50		µg/L	1	2/2/2016	R32136
2,2-Dichloropropane	ND	0.50		µg/L	1	2/2/2016	R32136
1,1-Dichloropropene	ND	0.50		µg/L	1	2/2/2016	R32136
Hexachlorobutadiene	ND	0.50		µg/L	1	2/2/2016	R32136
2-Hexanone	ND	0.50		µg/L	1	2/2/2016	R32136
Isopropylbenzene	ND	0.50		µg/L	1	2/2/2016	R32136
Methylene Chloride	ND	2.5		µg/L	1	2/2/2016	R32136
n-Butylbenzene	ND	0.50		µg/L	1	2/2/2016	R32136
n-Propylbenzene	ND	0.50		µg/L	1	2/2/2016	R32136
sec-Butylbenzene	ND	0.50		µg/L	1	2/2/2016	R32136
Styrene	ND	0.50		µg/L	1	2/2/2016	R32136
tert-Butylbenzene	ND	0.50		µg/L	1	2/2/2016	R32136
1,1,1,2-Tetrachloroethane	ND	0.50		µg/L	1	2/2/2016	R32136
1,1,2,2-Tetrachloroethane	ND	0.50		µg/L	1	2/2/2016	R32136
Tetrachloroethene (PCE)	ND	0.50		µg/L	1	2/2/2016	R32136
trans-1,2-DCE	ND	0.50		µg/L	1	2/2/2016	R32136
trans-1,3-Dichloropropene	ND	0.50		µg/L	1	2/2/2016	R32136
1,2,3-Trichlorobenzene	ND	0.50		µg/L	1	2/2/2016	R32136

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

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H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Navajo Refining Company
Client Sample ID: TRIP BLANK
Project: Quarterly WDW-1, 2, & 3 Inj Well
Collection Date:
Lab ID: 1601864-002
Matrix: TRIP BLANK
Received Date: 1/22/2016 9:40:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8260B: VOLATILES						Analyst: **SUB**	
1,2,4-Trichlorobenzene	ND	0.50		µg/L	1	2/2/2016	R32136
1,1,1-Trichloroethane	ND	0.50		µg/L	1	2/2/2016	R32136
1,1,2-Trichloroethane	ND	0.50		µg/L	1	2/2/2016	R32136
Trichloroethene (TCE)	ND	0.50		µg/L	1	2/2/2016	R32136
Trichlorofluoromethane	ND	0.50		µg/L	1	2/2/2016	R32136
1,2,3-Trichloropropane	ND	0.50		µg/L	1	2/2/2016	R32136
Vinyl chloride	ND	0.50		µg/L	1	2/2/2016	R32136
mp-Xylenes	ND	1.0		µg/L	1	2/2/2016	R32136
o-Xylene	ND	0.50		µg/L	1	2/2/2016	R32136
tert-Amyl methyl ether	ND	0.50		µg/L	1	2/2/2016	R32136
tert-Butyl alcohol	ND	5.0		µg/L	1	2/2/2016	R32136
Acrolein	ND	2.5		µg/L	1	2/2/2016	R32136
Acrylonitrile	ND	0.50		µg/L	1	2/2/2016	R32136
Bromochloromethane	ND	0.50		µg/L	1	2/2/2016	R32136
2-Chloroethyl vinyl ether	ND	0.50		µg/L	1	2/2/2016	R32136
Iodomethane	ND	0.50		µg/L	1	2/2/2016	R32136
trans-1,4-Dichloro-2-butene	ND	0.50		µg/L	1	2/2/2016	R32136
Vinyl acetate	ND	0.50		µg/L	1	2/2/2016	R32136
1,4-Dioxane	ND	20		µg/L	1	2/2/2016	R32136
Surr: 1,2-Dichlorobenzene-d4	89.2	70-130		%Rec	1	2/2/2016	R32136
Surr: 4-Bromofluorobenzene	93.2	70-130		%Rec	1	2/2/2016	R32136
Surr: Toluene-d8	99.6	70-130		%Rec	1	2/2/2016	R32136

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Qualifiers:

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ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company
Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID **MB**	SampType: **MBLK**	TestCode: **EPA Method 300.0: Anions**
Client ID: **PBW**	Batch ID: **R31638**	RunNo: **31638**
Prep Date:	Analysis Date: **1/22/2016**	SeqNo: **968134** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	ND	0.10								
Nitrogen, Nitrite (As N)	ND	0.10								
Bromide	ND	0.10								
Nitrogen, Nitrate (As N)	ND	0.10								
Phosphorus, Orthophosphate (As P	ND	0.50								

Sample ID **LCS**	SampType: **LCS**	TestCode: **EPA Method 300.0: Anions**
Client ID: **LCSW**	Batch ID: **R31638**	RunNo: **31638**
Prep Date:	Analysis Date: **1/22/2016**	SeqNo: **968135** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	0.49	0.10	0.5000	0	98.4	90	110			
Nitrogen, Nitrite (As N)	0.94	0.10	1.000	0	94.1	90	110			
Bromide	2.5	0.10	2.500	0	98.2	90	110			
Nitrogen, Nitrate (As N)	2.5	0.10	2.500	0	99.2	90	110			
Phosphorus, Orthophosphate (As P	4.7	0.50	5.000	0	93.3	90	110			

Sample ID **MB**	SampType: **MBLK**	TestCode: **EPA Method 300.0: Anions**
Client ID: **PBW**	Batch ID: **R31714**	RunNo: **31714**
Prep Date:	Analysis Date: **1/26/2016**	SeqNo: **970466** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	ND	0.50								
Sulfate	ND	0.50								

Sample ID **LCS**	SampType: **LCS**	TestCode: **EPA Method 300.0: Anions**
Client ID: **LCSW**	Batch ID: **R31714**	RunNo: **31714**
Prep Date:	Analysis Date: **1/26/2016**	SeqNo: **970467** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	4.8	0.50	5.000	0	96.5	90	110			
Sulfate	9.8	0.50	10.00	0	98.3	90	110			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID **MB-R32136**	SampType: **MBLK**	TestCode: **EPA Method 8260B: VOLATILES**
Client ID: **PBW**	Batch ID: **R32136**	RunNo: **32136**
Prep Date:	Analysis Date: **2/2/2016**	SeqNo: **982421** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Acetonitrile	ND	0.50								
Allyl chloride	ND	0.50								
Chloroprene	ND	0.50								
Cyclohexane	ND	0.50								
Diethyl ether	ND	0.50								
Diisopropyl ether	ND	0.50								
Epichlorohydrin	ND	0.50								
Ethyl acetate	ND	0.50								
Ethyl methacrylate	ND	2.5								
Ethyl tert-butyl ether	ND	0.50								
Freon-113	ND	0.50								
Isobutanol	ND	10								
Isopropyl acetate	ND	0.50								
Methacrylonitrile	ND	2.5								
Methyl acetate	ND	0.50								
Methyl ethyl ketone	ND	2.5								
Methyl isobutyl ketone	ND	2.5								
Methyl methacrylate	ND	2.5								
Methylcyclohexane	ND	0.50								
n-Amyl acetate	ND	0.50								
n-Hexane	ND	0.50								
Nitrobenzene	ND	0.50								
Pentachloroethane	ND	0.50								
p-isopropyltoluene	ND	0.50								
Propionitrile	ND	2.5								
Tetrahydrofuran	ND	0.50								
Benzene	ND	0.50								
Toluene	ND	0.50								
Ethylbenzene	ND	0.50								
Methyl tert-butyl ether (MTBE)	ND	0.50								
1,2,4-Trimethylbenzene	ND	0.50								
1,3,5-Trimethylbenzene	ND	0.50								
1,2-Dichloroethane (EDC)	ND	0.50								
1,2-Dibromoethane (EDB)	ND	0.50								
Naphthalene	ND	0.50								
Acetone	ND	2.5								
Bromobenzene	ND	0.50								
Bromodichloromethane	ND	0.50								
Bromoform	ND	0.50								

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
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QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID **MB-R32136**	SampType: **MBLK**	TestCode: **EPA Method 8260B: VOLATILES**
Client ID: **PBW**	Batch ID: **R32136**	RunNo: **32136**
Prep Date:	Analysis Date: **2/2/2016**	SeqNo: **982421** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Bromomethane	ND	0.50								
Carbon disulfide	ND	0.50								
Carbon Tetrachloride	ND	0.50								
Chlorobenzene	ND	0.50								
Chloroethane	ND	0.50								
Chloroform	ND	0.50								
Chloromethane	ND	0.50								
2-Chlorotoluene	ND	0.50								
4-Chlorotoluene	ND	0.50								
cis-1,2-DCE	ND	0.50								
cis-1,3-Dichloropropene	ND	0.50								
1,2-Dibromo-3-chloropropane	ND	0.50								
Dibromochloromethane	ND	0.50								
Dibromomethane	ND	0.50								
1,2-Dichlorobenzene	ND	0.50								
1,3-Dichlorobenzene	ND	0.50								
1,4-Dichlorobenzene	ND	0.50								
Dichlorodifluoromethane	ND	0.50								
1,1-Dichloroethane	ND	0.50								
1,1-Dichloroethene	ND	0.50								
1,2-Dichloropropane	ND	0.50								
1,3-Dichloropropane	ND	0.50								
2,2-Dichloropropane	ND	0.50								
1,1-Dichloropropene	ND	0.50								
Hexachlorobutadiene	ND	0.50								
2-Hexanone	ND	0.50								
Isopropylbenzene	ND	0.50								
Methylene Chloride	ND	2.5								
n-Butylbenzene	ND	0.50								
n-Propylbenzene	ND	0.50								
sec-Butylbenzene	ND	0.50								
Styrene	ND	0.50								
tert-Butylbenzene	ND	0.50								
1,1,1,2-Tetrachloroethane	ND	0.50								
1,1,2,2-Tetrachloroethane	ND	0.50								
Tetrachloroethene (PCE)	ND	0.50								
trans-1,2-DCE	ND	0.50								
trans-1,3-Dichloropropene	ND	0.50								
1,2,3-Trichlorobenzene	ND	0.50								

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID **MB-R32136**	SampType: **MBLK**	TestCode: **EPA Method 8260B: VOLATILES**
Client ID: **PBW**	Batch ID: **R32136**	RunNo: **32136**
Prep Date:	Analysis Date: **2/2/2016**	SeqNo: **982421** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
1,2,4-Trichlorobenzene	ND	0.50								
1,1,1-Trichloroethane	ND	0.50								
1,1,2-Trichloroethane	ND	0.50								
Trichloroethene (TCE)	ND	0.50								
Trichlorofluoromethane	ND	0.50								
1,2,3-Trichloropropane	ND	0.50								
Vinyl chloride	ND	0.50								
mp-Xylenes	ND	1.0								
o-Xylene	ND	0.50								
tert-Amyl methyl ether	ND	0.50								
tert-Butyl alcohol	ND	0.50								
Acrolein	ND	2.5								
Acrylonitrile	ND	2.5								
Bromochloromethane	ND	0.50								
2-Chloroethyl vinyl ether	ND	0.50								
Iodomethane	ND	0.50								
trans-1,4-Dichloro-2-butene	ND	0.50								
Vinyl acetate	ND	0.50								
1,4-Dioxane	ND	0.50								

Sample ID **LCS-R32136**	SampType: **LCS**	TestCode: **EPA Method 8260B: VOLATILES**
Client ID: **LCSW**	Batch ID: **R32136**	RunNo: **32136**
Prep Date:	Analysis Date: **2/2/2016**	SeqNo: **982422** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	9.8		10.00	0	97.7	80	120			
Toluene	9.8		10.00	0	98.4	80	120			
Ethylbenzene	10		10.00	0	102	80	120			
Chlorobenzene	9.6		10.00	0	96.0	80	120			
1,1-Dichloroethene	9.6		10.00	0	96.4	80	120			
Tetrachloroethene (PCE)	9.2		10.00	0	92.4	80	120			
Trichloroethene (TCE)	9.8		10.00	0	98.0	80	120			
o-Xylene	10		10.00	0	104	80	120			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID **MB-R32136**	SampType: **MBLK**	TestCode: **EPA 8270D: Semivolatiles**	
Client ID: **PBW**	Batch ID: **R32136**	RunNo: **32136**	
Prep Date:	Analysis Date: **2/2/2016**	SeqNo: **982533**	Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
1,1-Biphenyl	ND	5.0								
1,4-Dioxane	ND	5.0								
Atrazine	ND	5.0								
Benzaldehyde	ND	5.0								
Caprolactam	ND	5.0								
N-Nitroso-di-n-butylamine	ND	5.0								
Acetophenone	ND	5.0								
1-Methylnaphthalene	ND	5.0								
2,3,4,6-Tetrachlorophenol	ND	5.0								
2,4,5-Trichlorophenol	ND	5.0								
2,4,6-Trichlorophenol	ND	5.0								
2,4-Dichlorophenol	ND	5.0								
2,4-Dimethylphenol	ND	5.0								
2,4-Dinitrophenol	ND	5.0								
2,4-Dinitrotoluene	ND	5.0								
2,6-Dinitrotoluene	ND	5.0								
2-Chloronaphthalene	ND	5.0								
2-Chlorophenol	ND	5.0								
2-Methylnaphthalene	ND	5.0								
2-Methylphenol	ND	5.0								
2-Nitroaniline	ND	5.0								
2-Nitrophenol	ND	5.0								
3,3'-Dichlorobenzidine	ND	5.0								
3-Nitroaniline	ND	5.0								
4,6-Dinitro-2-methylphenol	ND	5.0								
4-Bromophenyl phenyl ether	ND	5.0								
4-Chloro-3-methylphenol	ND	5.0								
4-Chloroaniline	ND	5.0								
4-Chlorophenyl phenyl ether	ND	5.0								
4-Nitroaniline	ND	5.0								
4-Nitrophenol	ND	5.0								
Acenaphthene	ND	5.0								
Acenaphthylene	ND	5.0								
Anthracene	ND	5.0								
Benzo(g,h,i)perylene	ND	5.0								
Benz(a)anthracene	ND	0.10								
Benzo(a)pyrene	ND	0.10								
Benzo(b)fluoranthene	ND	0.10								
Benzo(k)fluoranthene	ND	0.10								

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID **MB-R32136**	SampType: **MBLK**	TestCode: **EPA 8270D: Semivolatiles**
Client ID: **PBW**	Batch ID: **R32136**	RunNo: **32136**
Prep Date:	Analysis Date: **2/2/2016**	SeqNo: **982533** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Bis(2-chloroethoxy)methane	ND	5.0								
Bis(2-chloroethyl)ether	ND	5.0								
Bis(2-chloroisopropyl)ether	ND	5.0								
Bis(2-ethylhexyl)phthalate	ND	5.0								
Butyl benzyl phthalate	ND	5.0								
Carbazole	ND	5.0								
Chrysene	ND	0.10								
Dibenz(a,h)anthracene	ND	0.10								
Dibenzofuran	ND	5.0								
Diethyl phthalate	ND	5.0								
Dimethyl phthalate	ND	5.0								
Di-n-butyl phthalate	ND	5.0								
Di-n-octyl phthalate	ND	5.0								
Fluoranthene	ND	5.0								
Fluorene	ND	5.0								
Hexachlorobenzene	ND	1.0								
Hexachlorobutadiene	ND	5.0								
Hexachlorocyclopentadiene	ND	5.0								
Hexachloroethane	ND	5.0								
Indeno(1,2,3-cd)pyrene	ND	0.10								
Isophorone	ND	5.0								
Naphthalene	ND	5.0								
Nitrobenzene	ND	5.0								
N-Nitrosodi-n-propylamine	ND	5.0								
N-Nitrosodiphenylamine	ND	2.0								
Pentachlorophenol	ND	5.0								
Phenanthrene	ND	1.0								
Phenol	ND	5.0								
Pyrene	ND	5.0								
o-Toluidine	ND	2.0								
Pyridine	ND	5.0								
1,2,4,5-Tetrachlorobenzene	ND	5.0								

Sample ID **LCS-R32136**	SampType: **LCS**	TestCode: **EPA 8270D: Semivolatiles**
Client ID: **LCSW**	Batch ID: **R32136**	RunNo: **32136**
Prep Date:	Analysis Date: **2/2/2016**	SeqNo: **982534** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
2,4-Dinitrotoluene	4.6		5.000	0	93.0	49	134			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID **LCS-R32136**	SampType: **LCS**	TestCode: **EPA 8270D: Semivolatiles**
Client ID: **LCSW**	Batch ID: **R32136**	RunNo: **32136**
Prep Date:	Analysis Date: **2/2/2016**	SeqNo: **982534** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
2-Chlorophenol	4.6		5.000	0	91.6	50	131			
4-Chloro-3-methylphenol	4.7		5.000	0	94.4	42	139			
4-Nitrophenol	4.5		5.000	0	90.2	19	137			
Acenaphthene	5.0		5.000	0	100	36	122			
Bis(2-ethylhexyl)phthalate	5.2		5.000	0	105	50	150			
N-Nitrosodi-n-propylamine	4.7		5.000	0	93.6	46	135			
Pentachlorophenol	3.7		5.000	0	73.2	22	138			
Phenol	5.2		5.000	0	103	45	134			
Pyrene	4.7		5.000	0	93.2	45	139			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID	**MB-23378**	SampType: **MBLK**			TestCode: **EPA Method 7470: Mercury**					
Client ID:	**PBW**	Batch ID: **23378**			RunNo: **31658**					
Prep Date:	**1/25/2016**	Analysis Date: **1/25/2016**			SeqNo: **968855**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	ND	0.00020								

Sample ID	**LCS-23378**	SampType: **LCS**			TestCode: **EPA Method 7470: Mercury**					
Client ID:	**LCSW**	Batch ID: **23378**			RunNo: **31658**					
Prep Date:	**1/25/2016**	Analysis Date: **1/25/2016**			SeqNo: **968856**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.0052	0.00020	0.005000	0	104	80	120			

Sample ID	**1601864-001BMS**	SampType: **MS**			TestCode: **EPA Method 7470: Mercury**					
Client ID:	**WDW-1,2,&3 Effluen**	Batch ID: **23378**			RunNo: **31658**					
Prep Date:	**1/25/2016**	Analysis Date: **1/25/2016**			SeqNo: **968858**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.0040	0.00020	0.005000	.00006177	79.6	75	125			

Sample ID	**1601864-001BMSD**	SampType: **MSD**			TestCode: **EPA Method 7470: Mercury**					
Client ID:	**WDW-1,2,&3 Effluen**	Batch ID: **23378**			RunNo: **31658**					
Prep Date:	**1/25/2016**	Analysis Date: **1/25/2016**			SeqNo: **968859**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	0.0041	0.00020	0.005000	.00006177	80.1	75	125	0.688	20	

Qualifiers:

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D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID	**MB-23438**	SampType: **MBLK**		TestCode: **MERCURY, TCLP**						
Client ID:	**PBW**	Batch ID: **23438**		RunNo: **31746**						
Prep Date:	**1/27/2016**	Analysis Date: **1/28/2016**		SeqNo: **971551**		Units: **mg/L**				
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	ND	0.020								

Sample ID	**LCS-23438**	SampType: **LCS**		TestCode: **MERCURY, TCLP**						
Client ID:	**LCSW**	Batch ID: **23438**		RunNo: **31746**						
Prep Date:	**1/27/2016**	Analysis Date: **1/28/2016**		SeqNo: **971552**		Units: **mg/L**				
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	ND	0.020	0.005000	0	102	80	120			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID **MB-23359**	SampType: **MBLK**	TestCode: **EPA Method 6010B: TCLP Metals**
Client ID: **PBW**	Batch ID: **23359**	RunNo: **31646**
Prep Date: **1/22/2016**	Analysis Date: **1/25/2016**	SeqNo: **968535** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	ND	5.0								
Barium	ND	100								
Cadmium	ND	1.0								
Chromium	ND	5.0								
Lead	ND	5.0								
Selenium	ND	1.0								
Silver	ND	5.0								

Sample ID **LCS-23359**	SampType: **LCS**	TestCode: **EPA Method 6010B: TCLP Metals**
Client ID: **LCSW**	Batch ID: **23359**	RunNo: **31646**
Prep Date: **1/22/2016**	Analysis Date: **1/25/2016**	SeqNo: **968536** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	ND	5.0	0.5000	0	96.1	80	120			
Barium	ND	100	0.5000	0	94.0	80	120			
Cadmium	ND	1.0	0.5000	0	92.5	80	120			
Chromium	ND	5.0	0.5000	0	93.7	80	120			
Lead	ND	5.0	0.5000	0	92.9	80	120			
Selenium	ND	1.0	0.5000	0	95.8	80	120			
Silver	ND	5.0	0.1000	0	92.0	80	120			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID **MB-23359**	SampType: **MBLK**	TestCode: **EPA 6010B: Total Metals**
Client ID: **PBW**	Batch ID: **23359**	RunNo: **31646**
Prep Date: **1/22/2016**	Analysis Date: **1/25/2016**	SeqNo: **968316** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	ND	0.020								
Antimony	ND	0.050								
Arsenic	ND	0.020								
Barium	ND	0.020								
Beryllium	ND	0.0030								
Cadmium	ND	0.0020								
Chromium	ND	0.0060								
Copper	ND	0.0060								
Iron	ND	0.050								
Lead	ND	0.0050								
Manganese	ND	0.0020								
Nickel	ND	0.010								
Potassium	ND	1.0								
Selenium	ND	0.050								
Silver	ND	0.0050								
Thallium	ND	0.050								
Vanadium	ND	0.050								
Zinc	ND	0.020								

Sample ID **LCS-23359**	SampType: **LCS**	TestCode: **EPA 6010B: Total Metals**
Client ID: **LCSW**	Batch ID: **23359**	RunNo: **31646**
Prep Date: **1/22/2016**	Analysis Date: **1/25/2016**	SeqNo: **968317** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Aluminum	0.46	0.020	0.5000	0	91.9	80	120			
Antimony	0.48	0.050	0.5000	0	95.5	80	120			
Arsenic	0.48	0.020	0.5000	0	96.1	80	120			
Barium	0.47	0.020	0.5000	0	94.0	80	120			
Beryllium	0.49	0.0030	0.5000	0	99.0	80	120			
Cadmium	0.46	0.0020	0.5000	0	92.5	80	120			
Chromium	0.47	0.0060	0.5000	0	93.7	80	120			
Copper	0.47	0.0060	0.5000	0	94.5	80	120			
Iron	0.48	0.050	0.5000	0	95.5	80	120			
Lead	0.46	0.0050	0.5000	0	92.9	80	120			
Manganese	0.47	0.0020	0.5000	0	93.5	80	120			
Nickel	0.46	0.010	0.5000	0	92.2	80	120			
Potassium	44	1.0	50.00	0	88.6	80	120			
Selenium	0.48	0.050	0.5000	0	95.8	80	120			
Silver	0.092	0.0050	0.1000	0	92.0	80	120			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID **LCS-23359**	SampType: **LCS**	TestCode: **EPA 6010B: Total Metals**
Client ID: **LCSW**	Batch ID: **23359**	RunNo: **31646**
Prep Date: **1/22/2016**	Analysis Date: **1/25/2016**	SeqNo: **968317** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Thallium	0.47	0.050	0.5000	0	93.8	80	120			
Vanadium	0.49	0.050	0.5000	0	98.1	80	120			
Zinc	0.48	0.020	0.5000	0	95.2	80	120			

Sample ID **MB-23359**	SampType: **MBLK**	TestCode: **EPA 6010B: Total Metals**
Client ID: **PBW**	Batch ID: **23359**	RunNo: **31648**
Prep Date: **1/22/2016**	Analysis Date: **1/25/2016**	SeqNo: **968397** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	ND	1.0								
Magnesium	ND	1.0								
Sodium	ND	1.0								

Sample ID **LCS-23359**	SampType: **LCS**	TestCode: **EPA 6010B: Total Metals**
Client ID: **LCSW**	Batch ID: **23359**	RunNo: **31648**
Prep Date: **1/22/2016**	Analysis Date: **1/25/2016**	SeqNo: **968398** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Calcium	50	1.0	50.00	0	99.1	80	120			
Magnesium	49	1.0	50.00	0	98.8	80	120			
Sodium	48	1.0	50.00	0	96.6	80	120			

Sample ID **MB-23359**	SampType: **MBLK**	TestCode: **EPA 6010B: Total Metals**
Client ID: **PBW**	Batch ID: **23359**	RunNo: **31737**
Prep Date: **1/22/2016**	Analysis Date: **1/28/2016**	SeqNo: **971326** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	ND	0.0060								

Sample ID **LCS-23359**	SampType: **LCS**	TestCode: **EPA 6010B: Total Metals**
Client ID: **LCSW**	Batch ID: **23359**	RunNo: **31737**
Prep Date: **1/22/2016**	Analysis Date: **1/28/2016**	SeqNo: **971327** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cobalt	0.46	0.0060	0.5000	0	91.5	80	120			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID **MB-R32136**	SampType: **MBLK**	TestCode: **CYANIDE, Reactive**							
Client ID: **PBW**	Batch ID: **R32136**	RunNo: **32136**							
Prep Date:	Analysis Date: **2/4/2016**	SeqNo: **982430**	Units: **mg/L**						
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cyanide, Reactive	ND	1.00								

Sample ID **LCS-R32136**	SampType: **LCS**	TestCode: **CYANIDE, Reactive**							
Client ID: **LCSW**	Batch ID: **R32136**	RunNo: **32136**							
Prep Date:	Analysis Date: **2/4/2016**	SeqNo: **982431**	Units: **mg/L**						
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Cyanide, Reactive	0.542		0.5000	0	108	80	120			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID **MB-R32136**	SampType: **MBLK**	TestCode: **SULFIDE, Reactive**							
Client ID: **PBW**	Batch ID: **R32136**	RunNo: **32136**							
Prep Date:	Analysis Date: **1/29/2016**	SeqNo: **982433**	Units: **mg/L**						
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Reactive Sulfide	ND	1.0								

Sample ID **LCS-R32136**	SampType: **LCS**	TestCode: **SULFIDE, Reactive**							
Client ID: **LCSW**	Batch ID: **R32136**	RunNo: **32136**							
Prep Date:	Analysis Date: **1/29/2016**	SeqNo: **982434**	Units: **mg/L**						
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Reactive Sulfide	0.18		0.2000	0	90.0	80	120			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID **mb-1**	SampType: **MBLK**			TestCode: **SM2320B: Alkalinity**					
Client ID: **PBW**	Batch ID: **R31664**			RunNo: **31664**					
Prep Date:	Analysis Date: **1/25/2016**			SeqNo: **968939**		Units: **mg/L CaCO3**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Alkalinity (as CaCO3)	ND	20.00								

Sample ID **lcs-1**	SampType: **LCS**			TestCode: **SM2320B: Alkalinity**					
Client ID: **LCSW**	Batch ID: **R31664**			RunNo: **31664**					
Prep Date:	Analysis Date: **1/25/2016**			SeqNo: **968940**		Units: **mg/L CaCO3**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Alkalinity (as CaCO3)	75.44	20.00	80.00	0	94.3	90	110			

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID **1601864-001ADUP**	SampType: **DUP**	TestCode: **Specific Gravity**							
Client ID: **WDW-1,2,&3 Effluen**	Batch ID: **R31723**	RunNo: **31723**							
Prep Date:	Analysis Date: **1/27/2016**	SeqNo: **970796**	Units:						
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Specific Gravity	1.004	0						0.179	20	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1601864**

15-Feb-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, & 3 Inj Well

Sample ID **MB-23428**	SampType: **MBLK**	TestCode: **SM2540C MOD: Total Dissolved Solids**
Client ID: **PBW**	Batch ID: **23428**	RunNo: **31755**
Prep Date: **1/27/2016**	Analysis Date: **1/28/2016**	SeqNo: **971754** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	ND	20.0								

Sample ID **LCS-23428**	SampType: **LCS**	TestCode: **SM2540C MOD: Total Dissolved Solids**
Client ID: **LCSW**	Batch ID: **23428**	RunNo: **31755**
Prep Date: **1/27/2016**	Analysis Date: **1/28/2016**	SeqNo: **971755** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	1020	20.0	1000	0	102	80	120			

Sample ID **1601864-001AMS**	SampType: **MS**	TestCode: **SM2540C MOD: Total Dissolved Solids**
Client ID: **WDW-1,2,&3 Effluen**	Batch ID: **23428**	RunNo: **31755**
Prep Date: **1/27/2016**	Analysis Date: **1/28/2016**	SeqNo: **971765** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	5800	40.0	2000	3784	101	80	120			D

Sample ID **1601864-001AMSD**	SampType: **MSD**	TestCode: **SM2540C MOD: Total Dissolved Solids**
Client ID: **WDW-1,2,&3 Effluen**	Batch ID: **23428**	RunNo: **31755**
Prep Date: **1/27/2016**	Analysis Date: **1/28/2016**	SeqNo: **971766** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Total Dissolved Solids	5820	40.0	2000	3784	102	80	120	0.379	5	D

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: NAVAJO REFINING CO Work Order Number: 1601864 RcptNo: 1

Received by/date: LM 01/22/16

Logged By: **Michelle Garcia** 1/22/2016 9:40:00 AM Michelle Garcia

Completed By: **Michelle Garcia** 1/22/2016 11:23:27 AM Michelle Garcia

Reviewed By: JO 01/27/16

Chain of Custody

1	Custody seals intact on sample bottles?	Yes ☐	No ☐	Not Present ☑
2.	Is Chain of Custody complete?	Yes ☑	No ☐	Not Present ☐
3.	How was the sample delivered?	Courier		

Log In

4.	Was an attempt made to cool the samples?	Yes ☑	No ☐	NA ☐
5.	Were all samples received at a temperature of >0° C to 6.0°C	Yes ☑	No ☐	NA ☐
6	Sample(s) in proper container(s)?	Yes ☑	No ☐	
7	Sufficient sample volume for indicated test(s)?	Yes ☑	No ☐	
8	Are samples (except VOA and ONG) properly preserved?	Yes ☑	No ☐	
9	Was preservative added to bottles?	Yes ☐	No ☑	NA ☐
10.	VOA vials have zero headspace?	Yes ☐	No ☐	No VOA Vials ☑
11.	Were any sample containers received broken?	Yes ☐	No ☑	
12.	Does paperwork match bottle labels? (Note discrepancies on chain of custody)	Yes ☑	No ☐	# of preserved bottles checked for pH: 2,2 (<2 or >12 unless noted)
13.	Are matrices correctly identified on Chain of Custody?	Yes ☑	No ☐	Adjusted? No
14.	Is it clear what analyses were requested?	Yes ☑	No ☐	
15.	Were all holding times able to be met? (If no, notify customer for authorization.)	Yes ☑	No ☐	Checked by: MG

Special Handling (if applicable)

16.	Was client notified of all discrepancies with this order?	Yes ☐	No ☐	NA ☑

Person Notified: _____ Date: _____

By Whom: _____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person

Regarding: _____

Client Instructions: _____

17. Additional remarks:

18. Cooler Information

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.2	Good	Yes			

Chain-of-Custody Record

Client: Navajo Refining Co.

Mailing Address: P.O. Box 159 Artesia,

NM 88211-0159

Phone #: 575-748-3311

email or Fax#: 575-746-5451

QA/QC Package:

☐ Standard ☐ Level 4 (Full Validation)

☐ Other

☐ EDD (Type)

Turn-Around Time:

☐ Standar ☐ **Rush**

Project Name:

Quarterly WDW-1, 2, & 3 Inj Well

Project #: P.O. # 167796

Project Manager:

Micki Schultz / Scott Denton / Mike Holder

Sampler: Elizabeth Salsberry

On Ice: ☑ Yes ☐ No

Sample Temperature: 1.2

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1601864	Specific Gravity,HCO3, CO3, Cl, SO4, TDS, pH, cond.,Fl, Cation/anion bal., Br, Fh/40	VOCs/SW-846 Method 8260C (see attached list 'VOCs')	SVOCs/SW-846 Method 8270D (see attached list 'SVOCs')	R,C,I/40 CFR part 261	Metals/SW-846 Mthd 6010, 7470 (see attached list 'Metals')	Ca, K, Mg, Na/40 CFR 136 3	TCLP Metals, only /40 CFR Part 261/ SW-845 Method 1311
1/21/16	7:35	Liquid	WDW-1, 2, & 3 Effluent	3	Neat/H2SO4	-001	X						X
1/21/16	7:35	Liquid	WDW-1, 2, & 3 Effluent	1	HNO3	-001					X	X	
1/21/16	7:35	Liquid	WDW-1, 2, & 3 Effluent	3	HCL	-001		X					
1/21/16	7:35	Liquid	WDW-1, 2, & 3 Effluent	2	Neat	-001			X				
1/21/16	7:35	Liquid	WDW-1, 2, & 3 Effluent	2	Neat	-001				X			
1/21/16	7:35	Liquid	Trip Blank	2	Neat	-002		X					
1/21/16	7:35	Liquid	Temperature Blank	1	Neat								

Date	Time	Relinquished by	Received by	Date	Time
1/21/2016	1:00	Elizabeth Salsberry			
Date	Time	Relinquished by	Received by	Date	Time
				01/22/16	0745

Remarks: Send results to Scott Denton, Mike Holder, Micki Schultz, Robert Combs and Andrew Contreras.

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Navajo Refining Company, LLC
501 E. Main
Artesia, NM 88210
(Tel) 575.748.3311
(Fax) 575.746.5451

Injection Well Quarterly Sample Details Attachment

HOLLYFRONTIER
The HollyFrontier Companies

Project Name	WDW 1,2, & 3 Qrtly Inj Well
Samplers Name	Elizabeth Salsberry
Samplers Affiliation	Navajo Refining Co. LLC
Start Date and Time	1/21/2016 @ 7:30 a.m.
End Date and Time	1/21/2016 @ 7:40 a.m.

Sample Type	
Grab	☑
Time Weighted Composite	☐
Flow Weighted Composite	☐

Parts / Sample Intervals	One

Physical Property	
Solid	☐
Liquid	☑
Sludge	☐

Type of Sampler	Directly to sample jars

Outfall / Sample Location: Waste water effluent pumps to injection wells.

☐ P-849 sample point (first from east)
☑ P-851 sample point (second from east)
☐ P-856 sample point (third from east)
☐ P-857 sample point (fourth from east)

				Preservatives							
Container	Size	Material	# of Containers	Neat (None)	HCL	HNO3	H2SO4	NaOH	Na2S2O3	NaHSO4	Other	Analysis and/or Method Requested
1			3	X			X					Specific Gravity,HCO3, CO3, Cl, SO4, TDS pH, cond., Fl, Cation/anion ba., Br, Ehl40 CFR 136.3
2			1			X						VOCs/SW-846 Method 8260C (see attached list 'VOCs')
3			3		X							SVOCs/SW-846 Method 8270D (see attached list 'SVOCs')
4			2	X								R.C.I/40 CFR part 261
5			2	X								Metals/SW-846 Mthd 6010, 7470 (see attached list 'Metals')
6			2	X								Ca, K, Mg, Na/40 CFR 136.3
7			1	X								TCLP Metals, only /40 CFR Part 261/ SW-846 Method 1311
8												
9												
10												

Field Data (Weather, Observations, Etc): 1/21/2016 Temp. 37.4 °F Humidity 70% Wind direction NW Wind Speed 11.5 mph Condition: Clear
Date and Time:

Field Temp. 40.7C Field pH 7.49

Storage Method	
Ice	☑
Refrigerated	☐
Other	☐

Shipping Media	
Ice	☑
Other	☐

HOLLYFRONTIER

July 11, 2016

Mr. Carl Chavez, CHMM
NM Energy, Minerals & Natural Resources Department
Oil Conservation Division, Environmental Bureau
1220 South St. Francis Dr.
Santa Fe, NM 87505-5472

Certified Mail/Return Receipt
7014 3490 0000 6269 5918

RE: 2016 2nd Quarter Injection Report for Wells WDW-1, WDW-2 and WDW-3, Navajo Refining Company, L.L.C.

Dear Mr. Chavez,

Enclosed, please find the second quarter 2016 sampling results for fluids injected into WDW-1, WDW-2 and WDW-3 and a spread sheet showing various volumes and pressures as required under Permit Condition 2.I.1, Quarterly Reports.

Over the second quarter, the average injection pressure for all three wells was 1355 psig and the average flows were 131 gpm for WDW-1, 104 gpm for WDW-2 and 152 gpm for WDW-3. There were no significant losses from the glycol expansion tanks Well Annulus Monitoring System (WAMS). The quarterly effluent analyses indicated parameters are within permit limits.

This report covers the period from April 1, 2016 to June 30, 2016. We have disposed a total of 1,214,229 barrels of fluid into the three wells during the second quarter of 2016. The volume per well is:

- 417,759 barrels into WDW-1
- 331,533 barrels into WDW-2
- 483,519 barrels into WDW-3

This report is signed and certified in accordance with WQCC section 5101.G. If there are any questions, please contact Scott Denton at 575-748-5487.

Respectfully,

Robert O'Brien
Vice-President & Refinery Manager
HollyFrontier Navajo Refining LLC

Enc.

Electronic cc (w/enc.): R Orosco, R Combs, S Denton
Environmental File: Injection Wells/Reports C-115 & Quarterly/2015/4th quarter/2016-02-05 4th QTR Inj. Rpt. for Wells WDW-1,2,3

2016 SECOND QUARTER MONTHLY INJECTION PRESSURES, RATES, AND VOLUMES

	Average Pressure (psig)	Maximum Pressure (psig)	Minimum Pressure (psig)	Average Flow (gpm)	Maximum Flow (gpm)	Minimum Flow (gpm)	Average Annular Pressure Av (psig)	Maximum Annular Pressure Mx (psig)	Minimum Annular Pressure Mn (psig)	Average Volume (bpd)	Maximum Volume (bpd)	Minimum Volume (bpd)	Volume (barrels)	TOTAL CUMULATIVE Volume (barrels)
30-015-27592 WDW-1													**Previous Quarter**	37,950,483
Apr-16	1,361	1,400	1,312	125	134	113	338	511	199	3,171	4,594	3,874	133,178	38,083,661
May-16	1,387	1,400	1,383	135	140	125	362	544	222	3,411	4,800	4,286	143,265	38,226,926
Jun-16	1,343	1,400	1,335	133	146	80	607	857	178	3,365	5,006	2,743	141,316	38,368,242
30-015-20894 WDW-2													**Previous Quarter**	24,863,592
Apr-16	1,360	1,400	1,222	103	113	89	312	432	220	2,598	3,874	3,051	109,111	24,972,703
May-16	1,388	1,400	1,377	112	117	105	301	391	218	2,843	4,011	3,600	119,407	25,092,110
Jun-16	1,315	1,400	1,335	97	121	80	346	455	194	2,453	4,149	2,743	103,015	25,195,125
30-015-26575 WDW-3													**Previous Quarter**	15,259,706
Apr-16	1,355	1,395	1,338	152	161	138	726	900	683	3,856	5,520	4,731	161,973	15,421,679
May-16	1,375	1,390	1,335	160	165	148	625	807	621	4,049	5,657	5,074	170,061	15,591,740
Jun-16	1,313	1,386	1,335	143	168	22	668	907	584	3,607	5,760	754	151,485	15,743,225
													Total Injected fluids:	79,306,592

	Monthly Avg.	Monthly Avg.
WDW-1	1,364	131
WDW-2	1,354	104
WDW-3	1,348	152

	Total BBLS	Beginning Volume	Ending Volume
WDW1	417,759	37,950,483	38,368,242
WDW2	331,533	24,863,592	25,195,125
WDW3	483,519	15,259,706	15,743,225
	1,232,811		79,306,592

HOLLYFRONTIER

February 20, 2017

Mr. Carl Chavez, CHMM
NM Energy, Minerals & Natural Resources Department
Oil Conservation Division, Environmental Bureau
1220 South St. Francis Dr.
Santa Fe, NM 87505-5472

Certified Mail/Return Receipt
7014 3490 0000 6269 6458

RE: 2016 4th Quarter Injection Report for Wells WDW-1, WDW-2 and WDW-3, Navajo Refining Company, L.L.C.

Dear Mr. Chavez,

Enclosed, please find the fourth quarter 2016 sampling results for fluids injected into WDW-1, WDW-2 and WDW-3 and a spread sheet showing various volumes and pressures as required under Permit Condition 2.I.1, Quarterly Reports.

Over the fourth quarter, the average injection pressure for all three wells was 1241 psig and the average flows were 117gpm for WDW-1, 94gpm for WDW-2 and 126gpm for WDW-3. There were no significant losses from the glycol expansion tanks Well Annulus Monitoring System (WAMS). The quarterly effluent analyses indicated parameters are within permit limits.

This report covers the period from October 1, 2016 to December 31, 2016. We have disposed a total of 1,050,057 barrels of fluid into the three wells during the fourth quarter of 2016. The volume per well is:

- 364,259 barrels into WDW-1
- 292,360 barrels into WDW-2
- 393,438 barrels into WDW-3

This report is signed and certified in accordance with WQCC section 5101.G. If there are any questions, please contact Scott Denton at 575-748-5487.

Respectfully,

Scott Denton
Environmental Manager
HollyFrontier Navajo Refining LLC

Enc.

Electronic cc (w/enc.): R Orosco, R Combs, S Denton, L Dade
Environmental File: Injection Wells/Reports C-115 & Quarterly/2016/4th quarter/2017-02-20 4th QTR Inj. Rpt. for Wells WDW-1,2,3

2016 FOURTH QUARTER MONTHLY INJECTION PRESSURES, RATES, AND VOLUMES

	Average Pressure (psig)	Maximum Pressure (psig)	Minimum Pressure (psig)	Average Flow (gpm)	Maximum Flow (gpm)	Minimum Flow (gpm)	Average Annular Pressure Av (psig)	Maximum Annular Pressure Mx (psig)	Minimum Annular Pressure Mn (psig)	Average Volume (bpd)	Maximum Volume (bpd)	Minimum Volume (bpd)	Volume (barrels)	TOTAL CUMULATIVE Volume (barrels)
30-015-27592 WDW-1													**Previous Quarter**	38,780,147
Oct-16	1,211	1,400	1,312	111	125	98	232	421	116	3,805	4,286	3,360	117,527	38,897,674
Nov-16	1,222	1,326	1,175	112	130	102	232	360	127	3,840	4,457	3,497	115,049	39,012,723
Dec-16	1,320	1,400	1,173	128	145	82	343	682	159	4,389	4,971	2,811	131,683	39,144,406
30-015-20894 WDW-2													**Previous Quarter**	25,516,942
Oct-16	1,209	1,400	1,132	83	94	60	290	407	217	2,846	3,223	2,057	87,824	25,604,766
Nov-16	1,201	1,325	1,122	80	107	55	327	502	211	2,743	3,669	1,886	82,295	25,687,061
Dec-16	1,308	1,400	1,182	119	330	70	322	461	146	4,080	11,314	2,400	122,241	25,809,302
30-015-26575 WDW-3													**Previous Quarter**	16,192,617
Oct-16	1,210	1,312	1,132	124	151	94	721	772	664	4,251	5,177	3,223	131,815	16,324,432
Nov-16	1,177	1,245	1,084	111	129	73	718	823	627	3,806	4,423	2,503	114,007	16,438,439
Dec-16	1,310	1,383	1,184	143	161	90	747	814	667	4,903	5,486	3,086	147,616	16,586,055
													Total Injected fluids:	81,539,763

	Monthly Avg.	Monthly Avg.
WDW-1	1,251	117
WDW-2	1,239	94
WDW-3	1,232	126
AVG.	1241	112

	Total BBLS	Beginning Volume	Ending Volume
WDW1	364,259	38,780,147	39,144,406
WDW2	292,360	25,516,942	25,809,302
WDW3	393,438	16,192,617	16,586,055
	1,050,057		81,539,763

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ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

November 16, 2016

Scott Denton
Navajo Refining Company
P.O. Box 159
Artesia, NM 88211-0159
TEL: (575) 748-3311
FAX

RE: Quarterly WDW-1, 2, &3 Inj Well OrderNo.: 1610612

Dear Scott Denton:

Hall Environmental Analysis Laboratory received 2 sample(s) on 10/13/2016 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. In order to properly interpret your results it is imperative that you review this report in its entirety. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. When necessary, data qualifers are provided on both the sample analysis report and the QC summary report, both sections should be reviewed. All samples are reported, as received, unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

ADHS Cert #AZ0682 -- NMED-DWB Cert #NM9425 -- NMED-Micro Cert #NM0190

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

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Case Narrative

WO#: **1610612**
Date: **11/16/2016**

CLIENT: Navajo Refining Company
Project: Quarterly WDW-1, 2, &3 Inj Well

Analytical Comments for WDW-1,2, & 3 Effluent:
The above referenced water sample was analyzed by EPA 8260C and the corresponding analytical report is attached in the following pages. The analyst also performed an NIST library review of the sample and the tentatively identified compounds (TIC's) are listed with estimated concentrations; 3-chloro-2-methyl-1-propene (~1 ppb), dibromofluoromethane (~9 ppb) and dimethyl disulfide (~1 ppb).
The above referenced water sample was also analyzed by EPA 8270D and the corresponding analytical report is attached in the following pages.

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Navajo Refining Company
Project: Quarterly WDW-1, 2, &3 Inj Well
Lab ID: 1610612-001 **Matrix:** AQUEOUS

Client Sample ID: WDW-1,2,&3 Effluent
Collection Date: 10/11/2016 9:00:00 AM
Received Date: 10/13/2016 8:30:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
IGNITABILITY METHOD 1010						Analyst: **SUB**	
Ignitability	>200	0		°F	1	10/18/2016	R38745
SULFIDE, REACTIVE						Analyst: **SUB**	
Reactive Sulfide	ND	0.40		mg/L	1	10/18/2016	R38745
SPECIFIC GRAVITY						Analyst: **LGT**	
Specific Gravity	0.9997	0			1	10/27/2016 10:52:00 AM	R38258
EPA METHOD 300.0: ANIONS						Analyst: **LGT**	
Fluoride	35	2.0	*	mg/L	20	10/14/2016 12:19:11 AM	R37942
Chloride	360	25		mg/L	50	10/25/2016 9:50:38 PM	R38187
Bromide	0.72	0.10		mg/L	1	10/14/2016 12:06:47 AM	R37942
Phosphorus, Orthophosphate (As P)	ND	10	H	mg/L	20	10/14/2016 12:19:11 AM	R37942
Sulfate	1500	25		mg/L	50	10/25/2016 9:50:38 PM	R38187
Nitrate+Nitrite as N	ND	1.0		mg/L	5	10/14/2016 1:21:13 AM	R37942
SM2510B: SPECIFIC CONDUCTANCE						Analyst: **JRR**	
Conductivity	4900	1.0		µmhos/cm	1	10/18/2016 4:54:00 PM	R38048
SM2320B: ALKALINITY						Analyst: **JRR**	
Bicarbonate (As CaCO3)	288.8	20.00		mg/L CaCO3	1	10/18/2016 4:54:00 PM	R38048
Carbonate (As CaCO3)	ND	2.000		mg/L CaCO3	1	10/18/2016 4:54:00 PM	R38048
Total Alkalinity (as CaCO3)	288.8	20.00		mg/L CaCO3	1	10/18/2016 4:54:00 PM	R38048
SM2540C MOD: TOTAL DISSOLVED SOLIDS						Analyst: **KS**	
Total Dissolved Solids	3210	20.0	*	mg/L	1	10/18/2016 6:58:00 PM	28098
CORROSIVITY						Analyst: **SUB**	
pH	8.23			pH Units	1	10/17/2016	R38745
CYANIDE, REACTIVE						Analyst: **SUB**	
Cyanide, Reactive	0.0250	0.0100		mg/L	1	10/25/2016	R38745
SM4500-H+B: PH						Analyst: **JRR**	
pH	8.10	1.68	H	pH units	1	10/18/2016 4:54:00 PM	R38048
EPA METHOD 7470: MERCURY						Analyst: **DBD**	
Mercury	ND	0.00020		mg/L	1	10/18/2016 5:17:17 PM	28113
MERCURY, TCLP						Analyst: **DBD**	
Mercury	ND	0.020		mg/L	1	10/19/2016 5:06:28 PM	28165
EPA METHOD 6010B: TCLP METALS						Analyst: **MED**	
Arsenic	ND	5.0		mg/L	1	10/24/2016 8:45:55 AM	28191
Barium	ND	100		mg/L	1	10/24/2016 8:45:55 AM	28191

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

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EPA METHOD 6010B: TCLP METALS						Analyst: **MED**	
Cadmium	ND	1.0		mg/L	1	10/24/2016 8:45:55 AM	28191
Chromium	ND	5.0		mg/L	1	10/24/2016 8:45:55 AM	28191
Lead	ND	5.0		mg/L	1	10/24/2016 8:45:55 AM	28191
Selenium	ND	1.0		mg/L	1	10/24/2016 8:45:55 AM	28191
Silver	ND	5.0		mg/L	1	10/24/2016 8:45:55 AM	28191
EPA 6010B: METALS						Analyst: **MED**	
Aluminum	0.31	0.020		mg/L	1	10/31/2016 10:15:38 AM	28190
Antimony	ND	0.050		mg/L	1	10/31/2016 10:15:38 AM	28190
Arsenic	0.040	0.020		mg/L	1	10/31/2016 10:15:38 AM	28190
Barium	ND	0.020		mg/L	1	10/31/2016 10:15:38 AM	28190
Beryllium	ND	0.0030		mg/L	1	10/31/2016 10:15:38 AM	28190
Cadmium	ND	0.0020		mg/L	1	10/31/2016 10:15:38 AM	28190
Calcium	96	5.0		mg/L	5	11/7/2016 12:08:14 PM	28190
Chromium	ND	0.0060		mg/L	1	10/31/2016 10:15:38 AM	28190
Cobalt	ND	0.0060		mg/L	1	10/31/2016 10:15:38 AM	28190
Copper	0.017	0.0060		mg/L	1	10/31/2016 10:15:38 AM	28190
Iron	0.14	0.050		mg/L	1	10/31/2016 10:15:38 AM	28190
Lead	ND	0.0050		mg/L	1	10/31/2016 10:15:38 AM	28190
Magnesium	36	1.0		mg/L	1	11/7/2016 12:04:39 PM	28190
Manganese	0.052	0.0020		mg/L	1	10/31/2016 10:15:38 AM	28190
Nickel	ND	0.010		mg/L	1	10/31/2016 10:15:38 AM	28190
Potassium	120	5.0		mg/L	5	10/31/2016 10:22:16 AM	28190
Selenium	ND	0.050		mg/L	1	10/31/2016 10:15:38 AM	28190
Silver	ND	0.0050		mg/L	1	10/31/2016 10:15:38 AM	28190
Sodium	800	10		mg/L	10	11/7/2016 12:15:14 PM	28190
Thallium	ND	0.050		mg/L	1	10/31/2016 10:15:38 AM	28190
Vanadium	ND	0.050		mg/L	1	10/31/2016 10:15:38 AM	28190
Zinc	0.027	0.020		mg/L	1	10/31/2016 10:15:38 AM	28190
EPA METHOD 8260B: VOLATILES						Analyst: **SUB**	
2-isopropyltoluene	ND	0.50		µg/L	1	10/20/2016	R38745
Acetonitrile	58	5.0		µg/L	1	10/20/2016	R38745
Allyl chloride	ND	0.50		µg/L	1	10/20/2016	R38745
Chloroprene	ND	0.50		µg/L	1	10/20/2016	R38745
Cyclohexane	ND	0.50		µg/L	1	10/20/2016	R38745
Diethyl ether	ND	0.50		µg/L	1	10/20/2016	R38745
Epichlorohydrin	ND	100		µg/L	1	10/20/2016	R38745
Ethyl acetate	ND	0.50		µg/L	1	10/20/2016	R38745
Ethyl methacrylate	ND	2.5		µg/L	1	10/20/2016	R38745

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EPA METHOD 8260B: VOLATILES							Analyst: **SUB**
Ethyl tert-butyl ether	ND	0.50		µg/L	1	10/20/2016	R38745
Freon-113	ND	0.50		µg/L	1	10/20/2016	R38745
Isobutanol	ND	100		µg/L	1	10/20/2016	R38745
Isopropyl acetate	ND	0.50		µg/L	1	10/20/2016	R38745
Methacrylonitrile	ND	2.5		µg/L	1	10/20/2016	R38745
Methyl acetate	ND	0.50		µg/L	1	10/20/2016	R38745
Methyl ethyl ketone	ND	2.5		µg/L	1	10/20/2016	R38745
Methyl isobutyl ketone	ND	2.5		µg/L	1	10/20/2016	R38745
Methyl methacrylate	ND	2.5		µg/L	1	10/20/2016	R38745
Methylcyclohexane	ND	1.0		µg/L	1	10/20/2016	R38745
n-Amyl acetate	ND	0.50		µg/L	1	10/20/2016	R38745
n-Hexane	ND	0.50		µg/L	1	10/20/2016	R38745
Nitrobenzene	ND	5.0		µg/L	1	10/20/2016	R38745
Pentachloroethane	ND	5.0		µg/L	1	10/20/2016	R38745
p-isopropyltoluene	ND	0.50		µg/L	1	10/20/2016	R38745
Propionitrile	ND	2.5		µg/L	1	10/20/2016	R38745
Tetrahydrofuran	ND	0.50		µg/L	1	10/20/2016	R38745
Benzene	ND	0.50		µg/L	1	10/20/2016	R38745
Toluene	ND	0.50		µg/L	1	10/20/2016	R38745
Ethylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
Methyl tert-butyl ether (MTBE)	ND	10		µg/L	1	10/20/2016	R38745
1,2,4-Trimethylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
1,3,5-Trimethylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
1,2-Dichloroethane (EDC)	ND	0.50		µg/L	1	10/20/2016	R38745
1,2-Dibromoethane (EDB)	ND	0.50		µg/L	1	10/20/2016	R38745
Naphthalene	ND	0.50		µg/L	1	10/20/2016	R38745
Acetone	4.2	2.5		µg/L	1	10/20/2016	R38745
Bromobenzene	ND	0.50		µg/L	1	10/20/2016	R38745
Bromodichloromethane	ND	0.50		µg/L	1	10/20/2016	R38745
Bromoform	ND	0.50		µg/L	1	10/20/2016	R38745
Bromomethane	ND	0.50		µg/L	1	10/20/2016	R38745
2-Butanone	ND	2.5		µg/L	1	10/20/2016	R38745
Carbon disulfide	0.96	0.50		µg/L	1	10/20/2016	R38745
Carbon Tetrachloride	ND	0.50		µg/L	1	10/20/2016	R38745
Chlorobenzene	ND	0.50		µg/L	1	10/20/2016	R38745
Chloroethane	ND	0.50		µg/L	1	10/20/2016	R38745
Chloroform	ND	0.50		µg/L	1	10/20/2016	R38745
Chloromethane	1.1	0.50		µg/L	1	10/20/2016	R38745
2-Chlorotoluene	ND	0.50		µg/L	1	10/20/2016	R38745

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Lab ID: 1610612-001 **Matrix:** AQUEOUS

Client Sample ID: WDW-1,2,&3 Effluent
Collection Date: 10/11/2016 9:00:00 AM
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Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8260B: VOLATILES							Analyst: **SUB**
4-Chlorotoluene	ND	0.50		µg/L	1	10/20/2016	R38745
cis-1,2-DCE	ND	0.50		µg/L	1	10/20/2016	R38745
cis-1,3-Dichloropropene	ND	0.50		µg/L	1	10/20/2016	R38745
1,2-Dibromo-3-chloropropane	ND	0.50		µg/L	1	10/20/2016	R38745
Dibromochloromethane	ND	0.50		µg/L	1	10/20/2016	R38745
Dibromomethane	ND	0.50		µg/L	1	10/20/2016	R38745
1,2-Dichlorobenzene	ND	0.50		µg/L	1	10/20/2016	R38745
1,3-Dichlorobenzene	ND	0.50		µg/L	1	10/20/2016	R38745
1,4-Dichlorobenzene	ND	0.50		µg/L	1	10/20/2016	R38745
Dichlorodifluoromethane	ND	0.50		µg/L	1	10/20/2016	R38745
1,1-Dichloroethane	ND	0.50		µg/L	1	10/20/2016	R38745
1,1-Dichloroethene	ND	0.50		µg/L	1	10/20/2016	R38745
1,2-Dichloropropane	ND	0.50		µg/L	1	10/20/2016	R38745
1,3-Dichloropropane	ND	0.50		µg/L	1	10/20/2016	R38745
2,2-Dichloropropane	ND	0.50		µg/L	1	10/20/2016	R38745
1,1-Dichloropropene	ND	0.50		µg/L	1	10/20/2016	R38745
Hexachlorobutadiene	ND	0.50		µg/L	1	10/20/2016	R38745
2-Hexanone	ND	0.50		µg/L	1	10/20/2016	R38745
Isopropylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
Methylene Chloride	ND	2.5		µg/L	1	10/20/2016	R38745
n-Butylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
n-Propylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
sec-Butylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
Styrene	ND	0.50		µg/L	1	10/20/2016	R38745
tert-Butylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
1,1,1,2-Tetrachloroethane	ND	0.50		µg/L	1	10/20/2016	R38745
1,1,2,2-Tetrachloroethane	ND	0.50		µg/L	1	10/20/2016	R38745
Tetrachloroethene (PCE)	ND	0.50		µg/L	1	10/20/2016	R38745
trans-1,2-DCE	ND	0.50		µg/L	1	10/20/2016	R38745
trans-1,3-Dichloropropene	ND	0.50		µg/L	1	10/20/2016	R38745
1,2,3-Trichlorobenzene	ND	0.50		µg/L	1	10/20/2016	R38745
1,2,4-Trichlorobenzene	ND	0.50		µg/L	1	10/20/2016	R38745
1,1,1-Trichloroethane	ND	0.50		µg/L	1	10/20/2016	R38745
1,1,2-Trichloroethane	ND	0.50		µg/L	1	10/20/2016	R38745
Trichloroethene (TCE)	ND	0.50		µg/L	1	10/20/2016	R38745
Trichlorofluoromethane	ND	0.50		µg/L	1	10/20/2016	R38745
1,2,3-Trichloropropane	ND	0.50		µg/L	1	10/20/2016	R38745
Vinyl chloride	ND	0.50		µg/L	1	10/20/2016	R38745
mp-Xylenes	ND	1.0		µg/L	1	10/20/2016	R38745

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EPA METHOD 8260B: VOLATILES							Analyst: **SUB**
o-Xylene	ND	0.50		µg/L	1	10/20/2016	R38745
tert-Amyl methyl ether	ND	0.50		µg/L	1	10/20/2016	R38745
tert-Butyl alcohol	ND	0.50		µg/L	1	10/20/2016	R38745
Acrolein	ND	2.5		µg/L	1	10/20/2016	R38745
Acrylonitrile	ND	2.5		µg/L	1	10/20/2016	R38745
Bromochloromethane	ND	0.50		µg/L	1	10/20/2016	R38745
2-Chloroethyl vinyl ether	ND	0.50		µg/L	1	10/20/2016	R38745
Iodomethane	ND	0.50		µg/L	1	10/20/2016	R38745
trans-1,4-Dichloro-2-butene	ND	0.50		µg/L	1	10/20/2016	R38745
Vinyl acetate	ND	0.50		µg/L	1	10/20/2016	R38745
Surr: 1,2-Dichlorobenzene-d4	105	0-0	S	%Rec	1	10/20/2016	R38745
Surr: 4-Bromofluorobenzene	96.8	70-130		%Rec	1	10/20/2016	R38745
Surr: Toluene-d8	100	70-130		%Rec	1	10/20/2016	R38745
EPA 8270C: SEMIVOLATILES/MOD							Analyst: **SUB**
1,1-Biphenyl	ND	1.0		µg/L	1	10/29/2016	R38745
Atrazine	ND	1.0		µg/L	1	10/29/2016	R38745
Benzaldehyde	2.5	1.0		µg/L	1	10/29/2016	R38745
Caprolactam	ND	1.0		µg/L	1	10/29/2016	R38745
N-Nitroso-di-n-butylamine	ND	1.0		µg/L	1	10/29/2016	R38745
Acetophenone	ND	5.0		µg/L	1	10/29/2016	R38745
1-Methylnaphthalene	ND	5.0		µg/L	1	10/29/2016	R38745
2,3,4,6-Tetrachlorophenol	ND	5.0		µg/L	1	10/29/2016	R38745
2,4,5-Trichlorophenol	ND	5.0		µg/L	1	10/29/2016	R38745
2,4,6-Trichlorophenol	ND	5.0		µg/L	1	10/29/2016	R38745
2,4-Dichlorophenol	ND	5.0		µg/L	1	10/29/2016	R38745
2,4-Dimethylphenol	ND	5.0		µg/L	1	10/29/2016	R38745
2,4-Dinitrophenol	ND	5.0		µg/L	1	10/29/2016	R38745
2,4-Dinitrotoluene	ND	5.0		µg/L	1	10/29/2016	R38745
2,6-Dinitrotoluene	ND	5.0		µg/L	1	10/29/2016	R38745
2-Chloronaphthalene	ND	5.0		µg/L	1	10/29/2016	R38745
2-Chlorophenol	ND	5.0		µg/L	1	10/29/2016	R38745
2-Methylnaphthalene	ND	5.0		µg/L	1	10/29/2016	R38745
2-Methylphenol	ND	5.0		µg/L	1	10/29/2016	R38745
2-Nitroaniline	ND	5.0		µg/L	1	10/29/2016	R38745
2-Nitrophenol	ND	5.0		µg/L	1	10/29/2016	R38745
3,3'-Dichlorobenzidine	ND	5.0		µg/L	1	10/29/2016	R38745
3-Nitroaniline	ND	5.0		µg/L	1	10/29/2016	R38745
4,6-Dinitro-2-methylphenol	ND	5.0		µg/L	1	10/29/2016	R38745
4-Bromophenyl phenyl ether	ND	5.0		µg/L	1	10/29/2016	R38745

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Collection Date: 10/11/2016 9:00:00 AM
Received Date: 10/13/2016 8:30:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA 8270C: SEMIVOLATILES/MOD							Analyst: **SUB**
4-Chloro-3-methylphenol	ND	5.0		µg/L	1	10/29/2016	R38745
4-Chloroaniline	ND	5.0		µg/L	1	10/29/2016	R38745
4-Chlorophenyl phenyl ether	ND	5.0		µg/L	1	10/29/2016	R38745
4-Nitroaniline	ND	5.0		µg/L	1	10/29/2016	R38745
4-Nitrophenol	ND	5.0		µg/L	1	10/29/2016	R38745
Acenaphthene	ND	5.0		µg/L	1	10/29/2016	R38745
Acenaphthylene	ND	5.0		µg/L	1	10/29/2016	R38745
Anthracene	ND	5.0		µg/L	1	10/29/2016	R38745
Benzo(g,h,i)perylene	ND	5.0		µg/L	1	10/29/2016	R38745
Benz(a)anthracene	ND	0.10		µg/L	1	10/29/2016	R38745
Benzo(a)pyrene	ND	0.10		µg/L	1	10/29/2016	R38745
Benzo(b)fluoranthene	ND	0.10		µg/L	1	10/29/2016	R38745
Benzo(k)fluoranthene	ND	0.10		µg/L	1	10/29/2016	R38745
Bis(2-chloroethoxy)methane	ND	5.0		µg/L	1	10/29/2016	R38745
Bis(2-chloroethyl)ether	ND	5.0		µg/L	1	10/29/2016	R38745
Bis(2-chloroisopropyl)ether	ND	5.0		µg/L	1	10/29/2016	R38745
Bis(2-ethylhexyl)phthalate	ND	5.0		µg/L	1	10/29/2016	R38745
Butyl benzyl phthalate	ND	5.0		µg/L	1	10/29/2016	R38745
Carbazole	ND	5.0		µg/L	1	10/29/2016	R38745
Chrysene	ND	0.10		µg/L	1	10/29/2016	R38745
Dibenz(a,h)anthracene	ND	0.10		µg/L	1	10/29/2016	R38745
Dibenzofuran	ND	5.0		µg/L	1	10/29/2016	R38745
Diethyl phthalate	ND	5.0		µg/L	1	10/29/2016	R38745
Dimethyl phthalate	ND	5.0		µg/L	1	10/29/2016	R38745
Di-n-butyl phthalate	ND	5.0		µg/L	1	10/29/2016	R38745
Di-n-octyl phthalate	ND	5.0		µg/L	1	10/29/2016	R38745
Fluoranthene	ND	5.0		µg/L	1	10/29/2016	R38745
Fluorene	ND	5.0		µg/L	1	10/29/2016	R38745
Hexachlorobenzene	ND	1.0		µg/L	1	10/29/2016	R38745
Hexachlorobutadiene	ND	5.0		µg/L	1	10/29/2016	R38745
Hexachlorocyclopentadiene	ND	5.0		µg/L	1	10/29/2016	R38745
Hexachloroethane	ND	5.0		µg/L	1	10/29/2016	R38745
Indeno(1,2,3-cd)pyrene	ND	0.10		µg/L	1	10/29/2016	R38745
Isophorone	ND	5.0		µg/L	1	10/29/2016	R38745
Naphthalene	ND	5.0		µg/L	1	10/29/2016	R38745
Nitrobenzene	ND	5.0		µg/L	1	10/29/2016	R38745
N-Nitrosodi-n-propylamine	ND	5.0		µg/L	1	10/29/2016	R38745
N-Nitrosodiphenylamine	ND	2.0		µg/L	1	10/29/2016	R38745
Pentachlorophenol	ND	5.0		µg/L	1	10/29/2016	R38745

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Navajo Refining Company
Project: Quarterly WDW-1, 2, &3 Inj Well
Lab ID: 1610612-001 **Matrix:** AQUEOUS

Client Sample ID: WDW-1,2,&3 Effluent
Collection Date: 10/11/2016 9:00:00 AM
Received Date: 10/13/2016 8:30:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA 8270C: SEMIVOLATILES/MOD							Analyst: **SUB**
Phenanthrene	ND	5.0		µg/L	1	10/29/2016	R38745
Phenol	ND	5.0		µg/L	1	10/29/2016	R38745
Pyrene	ND	5.0		µg/L	1	10/29/2016	R38745
o-Toluidine	ND	2.0		µg/L	1	10/29/2016	R38745
Pyridine	ND	5.0		µg/L	1	10/29/2016	R38745
1,2,4,5-Tetrachlorobenzene	ND	5.0		µg/L	1	10/29/2016	R38745
Surr: 2,4,6-Tribromophenol	103	63-110		%Rec	1	10/29/2016	R38745
Surr: 2-Fluorobiphenyl	92.4	58-112		%Rec	1	10/29/2016	R38745
Surr: 2-Fluorophenol	87.2	47-109		%Rec	1	10/29/2016	R38745
Surr: Nitrobenzene-d5	83.6	58-110		%Rec	1	10/29/2016	R38745
Surr: Phenol-d5	85.4	52-105		%Rec	1	10/29/2016	R38745
Surr: Terphenyl-d14	46.0	22-133		%Rec	1	10/29/2016	R38745

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Qualifiers:

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D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Navajo Refining Company
Client Sample ID: TRIP BLANK
Project: Quarterly WDW-1, 2, &3 Inj Well
Collection Date:
Lab ID: 1610612-002
Matrix: TRIP BLANK
Received Date: 10/13/2016 8:30:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8260B: VOLATILES							Analyst: **SUB**
Acetonitrile	ND	5.0		µg/L	1	10/20/2016	R38745
Allyl chloride	ND	0.50		µg/L	1	10/20/2016	R38745
Chloroprene	ND	0.50		µg/L	1	10/20/2016	R38745
Cyclohexane	ND	0.50		µg/L	1	10/20/2016	R38745
Diethyl ether	ND	0.50		µg/L	1	10/20/2016	R38745
Epichlorohydrin	ND	100		µg/L	1	10/20/2016	R38745
Ethyl acetate	ND	0.50		µg/L	1	10/20/2016	R38745
Ethyl methacrylate	ND	2.5		µg/L	1	10/20/2016	R38745
Ethyl tert-butyl ether	ND	0.50		µg/L	1	10/20/2016	R38745
Freon-113	ND	0.50		µg/L	1	10/20/2016	R38745
Isobutanol	ND	100		µg/L	1	10/20/2016	R38745
Isopropyl acetate	ND	0.50		µg/L	1	10/20/2016	R38745
Methacrylonitrile	ND	2.5		µg/L	1	10/20/2016	R38745
Methyl acetate	ND	0.50		µg/L	1	10/20/2016	R38745
Methyl ethyl ketone	ND	2.5		µg/L	1	10/20/2016	R38745
Methyl isobutyl ketone	ND	2.5		µg/L	1	10/20/2016	R38745
Methyl methacrylate	ND	2.5		µg/L	1	10/20/2016	R38745
Methylcyclohexane	ND	1.0		µg/L	1	10/20/2016	R38745
n-Amyl acetate	ND	0.50		µg/L	1	10/20/2016	R38745
n-Hexane	ND	0.50		µg/L	1	10/20/2016	R38745
Nitrobenzene	ND	5.0		µg/L	1	10/20/2016	R38745
Pentachloroethane	ND	5.0		µg/L	1	10/20/2016	R38745
p-isopropyltoluene	ND	0.50		µg/L	1	10/20/2016	R38745
Propionitrile	ND	2.5		µg/L	1	10/20/2016	R38745
Tetrahydrofuran	ND	0.50		µg/L	1	10/20/2016	R38745
Benzene	ND	0.50		µg/L	1	10/20/2016	R38745
Toluene	ND	0.50		µg/L	1	10/20/2016	R38745
Ethylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
Methyl tert-butyl ether (MTBE)	ND	10		µg/L	1	10/20/2016	R38745
1,2,4-Trimethylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
1,3,5-Trimethylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
1,2-Dichloroethane (EDC)	ND	0.50		µg/L	1	10/20/2016	R38745
1,2-Dibromoethane (EDB)	ND	0.50		µg/L	1	10/20/2016	R38745
Naphthalene	ND	0.50		µg/L	1	10/20/2016	R38745
Acetone	ND	2.5		µg/L	1	10/20/2016	R38745
Bromobenzene	ND	0.50		µg/L	1	10/20/2016	R38745
Bromodichloromethane	ND	0.50		µg/L	1	10/20/2016	R38745
Bromoform	ND	0.50		µg/L	1	10/20/2016	R38745
Bromomethane	ND	0.50		µg/L	1	10/20/2016	R38745

Refer to the QC Summary report and sample login checklist for flagged QC data and preservation information.

Qualifiers:

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D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Navajo Refining Company
Client Sample ID: TRIP BLANK
Project: Quarterly WDW-1, 2, &3 Inj Well
Collection Date:
Lab ID: 1610612-002
Matrix: TRIP BLANK
Received Date: 10/13/2016 8:30:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8260B: VOLATILES						Analyst: **SUB**	
2-Butanone	ND	2.5		µg/L	1	10/20/2016	R38745
Carbon disulfide	ND	0.50		µg/L	1	10/20/2016	R38745
Carbon Tetrachloride	ND	0.50		µg/L	1	10/20/2016	R38745
Chlorobenzene	ND	0.50		µg/L	1	10/20/2016	R38745
Chloroethane	ND	0.50		µg/L	1	10/20/2016	R38745
Chloroform	ND	0.50		µg/L	1	10/20/2016	R38745
Chloromethane	ND	0.50		µg/L	1	10/20/2016	R38745
2-Chlorotoluene	ND	0.50		µg/L	1	10/20/2016	R38745
4-Chlorotoluene	ND	0.50		µg/L	1	10/20/2016	R38745
cis-1,2-DCE	ND	0.50		µg/L	1	10/20/2016	R38745
cis-1,3-Dichloropropene	ND	0.50		µg/L	1	10/20/2016	R38745
1,2-Dibromo-3-chloropropane	ND	0.50		µg/L	1	10/20/2016	R38745
Dibromochloromethane	ND	0.50		µg/L	1	10/20/2016	R38745
Dibromomethane	ND	0.50		µg/L	1	10/20/2016	R38745
1,2-Dichlorobenzene	ND	0.50		µg/L	1	10/20/2016	R38745
1,3-Dichlorobenzene	ND	0.50		µg/L	1	10/20/2016	R38745
1,4-Dichlorobenzene	ND	0.50		µg/L	1	10/20/2016	R38745
Dichlorodifluoromethane	ND	0.50		µg/L	1	10/20/2016	R38745
1,1-Dichloroethane	ND	0.50		µg/L	1	10/20/2016	R38745
1,1-Dichloroethene	ND	0.50		µg/L	1	10/20/2016	R38745
1,2-Dichloropropane	ND	0.50		µg/L	1	10/20/2016	R38745
1,3-Dichloropropane	ND	0.50		µg/L	1	10/20/2016	R38745
2,2-Dichloropropane	ND	0.50		µg/L	1	10/20/2016	R38745
1,1-Dichloropropene	ND	0.50		µg/L	1	10/20/2016	R38745
Hexachlorobutadiene	ND	0.50		µg/L	1	10/20/2016	R38745
2-Hexanone	ND	0.50		µg/L	1	10/20/2016	R38745
Isopropylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
Methylene Chloride	ND	2.5		µg/L	1	10/20/2016	R38745
n-Butylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
n-Propylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
sec-Butylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
Styrene	ND	0.50		µg/L	1	10/20/2016	R38745
tert-Butylbenzene	ND	0.50		µg/L	1	10/20/2016	R38745
1,1,1,2-Tetrachloroethane	ND	0.50		µg/L	1	10/20/2016	R38745
1,1,2,2-Tetrachloroethane	ND	0.50		µg/L	1	10/20/2016	R38745
Tetrachloroethene (PCE)	ND	0.50		µg/L	1	10/20/2016	R38745
trans-1,2-DCE	ND	0.50		µg/L	1	10/20/2016	R38745
trans-1,3-Dichloropropene	ND	0.50		µg/L	1	10/20/2016	R38745
1,2,3-Trichlorobenzene	ND	0.50		µg/L	1	10/20/2016	R38745

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Qualifiers:

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ND	Not Detected at the Reporting Limit	P	Sample pH Not In Range
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Navajo Refining Company
Client Sample ID: TRIP BLANK
Project: Quarterly WDW-1, 2, &3 Inj Well
Collection Date:
Lab ID: 1610612-002
Matrix: TRIP BLANK
Received Date: 10/13/2016 8:30:00 AM

Analyses	Result	PQL	Qual	Units	DF	Date Analyzed	Batch
EPA METHOD 8260B: VOLATILES							Analyst: **SUB**
1,2,4-Trichlorobenzene	ND	0.50		µg/L	1	10/20/2016	R38745
1,1,1-Trichloroethane	ND	0.50		µg/L	1	10/20/2016	R38745
1,1,2-Trichloroethane	ND	0.50		µg/L	1	10/20/2016	R38745
Trichloroethene (TCE)	ND	0.50		µg/L	1	10/20/2016	R38745
Trichlorofluoromethane	ND	0.50		µg/L	1	10/20/2016	R38745
1,2,3-Trichloropropane	ND	0.50		µg/L	1	10/20/2016	R38745
Vinyl chloride	ND	0.50		µg/L	1	10/20/2016	R38745
mp-Xylenes	ND	1.0		µg/L	1	10/20/2016	R38745
o-Xylene	ND	0.50		µg/L	1	10/20/2016	R38745
tert-Amyl methyl ether	ND	0.50		µg/L	1	10/20/2016	R38745
tert-Butyl alcohol	ND	0.50		µg/L	1	10/20/2016	R38745
Acrolein	ND	2.5		µg/L	1	10/20/2016	R38745
Acrylonitrile	ND	2.5		µg/L	1	10/20/2016	R38745
Bromochloromethane	ND	0.50		µg/L	1	10/20/2016	R38745
2-Chloroethyl vinyl ether	ND	0.50		µg/L	1	10/20/2016	R38745
Iodomethane	ND	0.50		µg/L	1	10/20/2016	R38745
trans-1,4-Dichloro-2-butene	ND	0.50		µg/L	1	10/20/2016	R38745
Vinyl acetate	ND	0.50		µg/L	1	10/20/2016	R38745
Surr: 1,2-Dichlorobenzene-d4	102	0-0	S	%Rec	1	10/20/2016	R38745
Surr: 4-Bromofluorobenzene	96.4	70-130		%Rec	1	10/20/2016	R38745
Surr: Toluene-d8	98.0	70-130		%Rec	1	10/20/2016	R38745

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QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1610612**

16-Nov-16

Client: Navajo Refining Company

Project: Quarterly WDW-1, 2, &3 Inj Well

Sample ID **MB**	SampType: **MBLK**	TestCode: **EPA Method 300.0: Anions**
Client ID: **PBW**	Batch ID: **R37942**	RunNo: **37942**
Prep Date:	Analysis Date: **10/13/2016**	SeqNo: **1182401** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	ND	0.10								
Bromide	ND	0.10								
Phosphorus, Orthophosphate (As P	ND	0.50								
Nitrate+Nitrite as N	ND	0.20								

Sample ID **LCS**	SampType: **LCS**	TestCode: **EPA Method 300.0: Anions**
Client ID: **LCSW**	Batch ID: **R37942**	RunNo: **37942**
Prep Date:	Analysis Date: **10/13/2016**	SeqNo: **1182402** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoride	0.54	0.10	0.5000	0	107	90	110			
Bromide	2.6	0.10	2.500	0	103	90	110			
Phosphorus, Orthophosphate (As P	4.7	0.50	5.000	0	93.6	90	110			
Nitrate+Nitrite as N	3.4	0.20	3.500	0	97.3	90	110			

Sample ID **MB**	SampType: **MBLK**	TestCode: **EPA Method 300.0: Anions**
Client ID: **PBW**	Batch ID: **R38187**	RunNo: **38187**
Prep Date:	Analysis Date: **10/25/2016**	SeqNo: **1193019** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	ND	0.50								
Sulfate	ND	0.50								

Sample ID **LCS**	SampType: **LCS**	TestCode: **EPA Method 300.0: Anions**
Client ID: **LCSW**	Batch ID: **R38187**	RunNo: **38187**
Prep Date:	Analysis Date: **10/25/2016**	SeqNo: **1193020** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Chloride	4.8	0.50	5.000	0	96.7	90	110			
Sulfate	9.9	0.50	10.00	0	99.1	90	110			

Qualifiers:

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D	Sample Diluted Due to Matrix	E	Value above quantitation range
H	Holding times for preparation or analysis exceeded	J	Analyte detected below quantitation limits
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S	% Recovery outside of range due to dilution or matrix	W	Sample container temperature is out of limit as specified